**From:** [redacted]
**To:** SizewellC
**Subject:** Discretion to accept a submission.
**Date:** 06 November 2020 08:44:44
**Attachments:** Sizewell C – 1 DCO Response. The environment, coastal morphology and climate change-a 2020 perspective.pdf

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FAO: Ms. Wendy McKay
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National Infrastructure Planning
The Planning Inspectorate

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I respectfully ask that the Examining Authority (ExA) could exercise its discretion to accept the submission of my paper, enclosed below.

I have registered as an Interested Party but am concerned that delays may compromise the paper being fully considered.

It concerns matters of future safety of the proposed Sizewell C.

The paper is a carefully researched study and qualifies its position by reference to all the relevant BEEMS technical papers, not available in the public domain but referred to in the DCO and obtained under FOI.

I have sent the paper to the Environment Agency, [redacted] and the Office for Nuclear Regulation, [redacted]

Both would be able to comment on the paper if required. The paper has a concise Executive Summary.

I apologise for this intrusion.

Regards
Nick Scarr

# Sizewell C – Development Consent Order Response. The environment, coastal morphology and climate change - a 2020 perspective

30 October 2020 14:44

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Appendices: 'Sizewell C – DCO Response. Appendices 1-9. The environment, coastal morphology and climate change - a 2020 perspective.' Appendices Hyperlink

Spent Fuel – The nature and summarised inventory of the high burn-up Spent Fuel that will be produced by Hinkley C and Sizewell C. Spent Fuel

Author Nick Scarr[redacted]

# Executive summary

This paper is a response to EDF's Sizewell C Flood Risk Assessment (FRA) and approach to shoreline and offshore geomorphology as presented in the Development Consent Order (DCO) application. The following are my summarised conclusions and recommendations:

## 1. EDF's Flood Risk Assessment (FRA)—major aspects of EDF's FRA 'worst-case' flood modelling conclusions may not be sound.

The off-shore Sizewell-Dunwich banks have provided recent historical stability to the Sizewell coastline by creating a low energy inshore wave climate.

- This view is supported by published research and professional bodies such as the leading global coastal engineering consultancy Mott Macdonald. See sections 2 and 6.

However, there are legitimate grounds for concerns about the morphology and continued stability of the Sizewell-Dunwich banks:

- Beyond the limited area of erosion-resistant coralline crag in the Thorpeness outcrop, seabed samples indicate that the Sizewell-Dunwich banks are uncemented deposits. See section 2.
- EDF acknowledges significant recent lowering of crest height and contour changes to the northern part of the bank above 276000N—the Dunwich bank—and its continued presence cannot be assured. This will, in my view expose the Sizewell C site to a greater extent than the existing Sizewell A or B sites. See Section 2 and 6.
- EDF/Cefas states that: *"If the lowering and reduction in Dunwich Banks northern extent continued, the extent of shoreline exposed to higher wave energy from the northeast sector would be expected to expand to the south [and thereby increase the exposure of the Sizewell C foreshore] accordingly."* See Section 6.

EDF, in the DCO documents, limits discussion and appraisal of the role of the Sizewell-Dunwich banks yet retains them in their present form for Flood Risk Assessment modelling purposes in a manner that lacks transparency. Close study of the documents (including those published pre-DCO, contained within the DCO and obtained under Freedom of Information) reveals that EDF's FRA modelling is relying on a stable, unchanging offshore geomorphology and bathymetry to end of station life. This paper shows that the premise of future geomorphological stasis is both implausible and unrepresentative of a significant range of worst-case conditions. This is fully explained in section 6 and 7 and summarised as follows:

- In the DCO main Flood Risk Assessment documents, of which there appear to be 22, the Sizewell-Dunwich banks are not explicitly named. Given their overriding significance to coastal processes and their prominence in documents produced by EDF prior to the DCO, the Examiners might consider why this is so. See section 7.
- Again, given the importance of the Sizewell-Dunwich banks, I had expected EDF's DCO Flood Risk Assessment documentation to contain extensive bathymetric survey data. I could not locate these data and noted in the DCO that, according to EDF, the Sizewell-Dunwich bank is *"…not regularly surveyed…due to its large size"*. As far as I can establish the only bathymetric surveys undertaken have been partial in 2008/9 (Swathe Services) and full in

2017 (Titan/Maritime Coastguard). In my opinion, the lack of bathymetric surveys of the Sizewell-Dunwich banks represents a significant failure in EDF's geomorphological obligations and responsibility. See section 6.

- EDF states that *"reductions in Dunwich Bank are not considered to be a worst-case scenario for Sizewell C",* yet EDF fails to offer the supporting evidence of overtopping Flood Risk Assessment modelling with a lowered or missing Dunwich bank. See section 6 and 7.

- EDF's apparent lack of concern over the geomorphological impact of any disturbance to the Sizewell-Dunwich banks is exposed by Scottish Power Renewables' consideration to run its proposed windfarm cables underneath the banks in sub-sea tunnels. Scottish Power Renewables also reports that *"EDF Energy has stated it will object to any damage to the crag [The Sizewell-Dunwich banks] on a precautionary basis."* See section 6.

- EDF introduces two minor nearshore, longshore bars as important wave energy 'relief features' accompanied by extensive bathymetric analysis in the DCO—detail that, as stated, is not afforded to the Sizewell-Dunwich banks. See section 6 for a comparative map of these features.

- EDF adds the shingle beach and vegetated sand dunes as additional and significant 'positive relief features' for FRA modelling in the DCO. I draw the Examiners' attention to these 'new-to-DCO' relief features not being referred to by EDF in its January 2012 EU 'stress test' analysis for Sizewell **B,** which restricts itself to the importance of the Sizewell-Dunwich banks, nor do they appear to be mentioned as material receptors or relief features in the main Public Consultation documents until the 2019 Scoping report. See section 2,6,7.

2. Overtopping levels. EDF's 'tolerable' overtopping levels are not independently validated.

EDF's wave overtopping modelling confirms overtopping flooding of the main platform with a return period as low as 1:200. See section 4.
EDF states:

- *"During operation phase and up to end of interim spent fuel store decommissioning, the overtopping rates are below the 5 l/s/m threshold for up to 1 in 1,000-year event."*

EDF claims the 5 l/s/m threshold is a '*tolerable overtopping rate'*—a value that does not appear to have independent validation. Expert opinions affirm that ***"…overtopping rates became a danger to vehicles [and people] when the mean discharge exceeds 0.2 l/s/m."*** See section 7.1 Overtopping levels.

I have not seen a statement in the DCO documentation as to how the spent fuel, all stored onsite, could be safely managed during flooding of the operational platform nor how the reactor can be managed when flood water will preclude safe pedestrian access between buildings onsite and vehicular access from off the site. See section 7.

3. The 'Expert Geomorphological Assessment' [EGA] to establish Sizewell C's future shoreline change processes and EDF's claim that it 'future proofs' Sizewell C—a claim invalidated by its own assessors.

In EDF's 'extensive' modelling studies of the coastline in order to achieve the '*very best assessment of long-term coastal change*', EDF shows in the DCO documentation that it has critically limited the scope of the assessment when assessing Sizewell's vulnerabilities. This diverges from its stated aims to the public:

- The specified consensus of EDF's 'seven Expert Geomorphological Assessors' was a decision to adopt a future projection based on their own version of "*reasonably foreseeable*" conditions. The assessors, as in the FRA, are working on an unsupported premise when they claim that: *"The principal receptors (beach, bars, bank and crag) of the future baseline can be expected to resemble the present (i.e. no regime shift) over much or all of the station life."*

I suggest that the opportunity and capacity within which the review has taken place, combined with one of the expert geomorphological assessor's publicly stated view that forecasts cannot extend reliably beyond 10 years, compromises its value. EDF's stated commitment of 'future proofing' the plans for Sizewell C in its 'Latest News', '*Doing the Power of good to Britain'*, has not been met. See section 5.

4. Other professional bodies have concluded the Sizewell site is vulnerable:

Based on the international consensus of scientific projections found in the IPCC and UKCP18 reports, the **Institution of Mechanical Engineers (IME)**, the **global engineering consultancy Mott Macdonald**, **DEFRA** and the **Environment Agency** have reached identical conclusions about the Sizewell site, each independently stating that the coastal location is vulnerable. IME goes further: 'abandonment and relocation' of Sizewell power stations could be required **-** strong terms to come from a highly respected professional institution not noted for hyperbole. The **Nuclear Decommissioning Authority** has also raised serious environmental concerns. See Section 8.

5. The geomorphological assessment requirements of the Department of Energy and Climate Change National Policy Statement for Nuclear (EN-6) do not appear to have been met.

Government's 'National Policy Statement (NPS) for Nuclear Power Generation' (EN-6) states:

> *"1.2.2 Applicants should ensure that their applications, and any accompanying supporting documents and information, are consistent with the instructions and guidance given to applicants in this NPS…"*

The EN-6 instructions and guidance on geomorphological issues defined in its 'Appraisal of Sustainability' are as follows:

> *"3.8.3 In light of the findings of the Nuclear AoS [Appraisal of Sustainability], applicants should assess the site's geology, soils and geomorphological processes in order to understand the ongoing natural ecological, coastal and geomorphic processes. This will include identifying impacts on coastal processes, intertidal deposition and soil development processes that maintain terrestrial/coastal and/or marine habitats."*

In my opinion, EDF's compromised geomorphological shoreline change appraisal, insufficient surveys of the Sizewell-Dunwich banks and overtopping modelling methodology (untenable reliance on offshore geomorphological stasis) do not meet these requirements. See section 8.

6. The Office for Nuclear Regulation (ONR) 'Design basis flood level'—EDF's proposal does not suggest compliance.

The ONR, in public documents, states that:

> *"Defence overtopping should not occur at the Design Basis flood level" and "the thresholds set… for design basis events are 1 in 10 000 years for external hazards"***.**

EDF's overtopping modelling shows that the main platform will suffer severe flooding in a 1:10,000 event in 2090 and 2140. See sections 4, 7.1 (Overtopping levels) and 8.

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The 'Rochdale envelope' approach obliges a DCO applicant to describe 'worst-case' conditions. The worst-case, FRA overtopping modelling studies presented in the DCO and undertaken by EDF/Cefas/Haskoning, rely on an implausible 'best-case' offshore geomorphological stability, utilise variables without clear definition, refer to non-public domain documents and use opaque and ambiguous language in critical areas. There is a consequent lack of transparency to scrutiny.

I conclude that the Flood Risk Assessment does not provide reassurance. EDF's 'tolerable' wave overtopping levels far exceed national and international expert guidance and safety limits. The FRA worst-case scenarios should reasonably consider the loss or major compromise of at least the Dunwich section of the Sizewell-Dunwich banks. This loss would introduce a more vigorous inshore wave climate onto the 'new' relief features that are geomorphologically no more than constituent parts of a vulnerable coastline, a coastline that EDF itself regards as 'soft and erodible'. By ignoring this authoritative orthodoxy in the FRA flood modelling, EDF has taken an unprecedented step that does not appear to be independently validated. Major aspects of EDF's 'worst-case' FRA conclusions may not be sound. See section 6 and 7.

# Recommendations

I suggest that the following points should be actioned by the Examiners:

1. A full, independent review of the EDF/Cefas/Haskoning FRA modelling data and methodology used:

   Review how the offshore geomorphology should be addressed and considered in order to meet the 'Rochdale Envelope' requirements for worst-case flood modelling.

   The review should include an analysis of the viability and stability of the recently introduced, minor, nearshore, longshore bars.

   Independent Flood Risk Assessment wave overtopping modelling should be commissioned using the industry standard EurOtop package, and not Amazon, with at least the Dunwich bank and nearshore, longshore bars both lowered and absent.

2. Review and analyse the value and integrity of the Expert Geomorphological Assessment (EGA) for shoreline change processes. EDF's EGA currently limits itself to unchanging offshore geomorphology and wave climates, mid-range climate recommendations and appears invalidated by the public comments of one of its experts.

3. Establish by independent expert appraisal what constitutes 'tolerable' wave overtopping flood levels of the main platform.

4. Request full bathymetric surveys of the Dunwich bank to be undertaken now and establish a commitment from EDF for regular six-monthly surveys for the duration of station life.

5. Establish whether EDF's application meets the standards and requirements of government's 'Appraisal of Sustainability' defined by the National Policy Statement (NPS) for Nuclear Power Generation' (EN-6).

The following points also need consideration:

- EDF's commitments made in its public information DCO Newsletter, '*Doing the Power of good to Britain',* quoted in the next section have not been met. Misleading statements should be corrected. See section 5.

- The 'Main Development Site Geology and Land Quality' documents that are currently empty and marked 'confidential' should be published.

- Academic papers and variables used and referred to in EDF's DCO documents that are proprietary must be placed in the public domain—papers such as British Energy (BEEMS) Technical Reports: TR252, TR322, TR319, TR223, TR403, TR139, TR317, TR058, TR500, TR107, TR308, TR357; 'BECC Scoping Paper, *How to Define Credible Maximum Sea Level Change Scenarios for the UK Coast*. *January 2014;* Cefas TOMOWAC modelling spreadsheet *'2110_HS_WL_boundary conditions.xlsx'* which defines flood modelling variables such as 'Cefas codes', 'Combination Codes' and 'JP codes'.

  Note: I have obtained these documents under Freedom of Information (FOI). The documents have proved critical to understanding aspects of the DCO documentation considered by this paper. (See Notes).

- There is a requirement for clarification of the date spent fuel will be removed from site: The Nuclear Decommissioning Authority (NDA) states that a 140-year cooling period is required before the geological storage temperature criterion is met which could equate to a later 'interim fuel store decommissioning' date of 2230 rather than 2190 suggested by EDF.

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Notes:

1) Sizewell C timeline according to EDF from the DCO documents:

- 2022: start of construction.
- 2034: end of construction and start of operation (sometimes quoted as 2030).
- 2090: end of operation.
- 2140: interim spent fuel store decommissioned.
- 2190: theoretical maximum site lifetime.

DCO: Main Development Site Flood Risk Assessment. Op cit., section 1.2.16. Page 18.

2) BEEMS Technical Reports: 'British Energy Estuarine & Marine Studies' are technical documents produced and commissioned by the nuclear energy industry to research coastal processes. British Energy has been a wholly owned subsidiary of EDF from 2009. The reports are not intended for the public domain. These documents are used as defining references by EDF in the Sizewell C DCO and, having been obtained under FOI, are therefore extensively referred to and quoted in this paper.

3) Cefas describes itself as 'Government's marine and freshwater science experts'. Cefas, in tender documentation, states that it *'supports the construction of Sizewell C nuclear power station (SZC) by monitoring changes in the shoreline position and the geomorphology of nearshore features using a range of methods.'* Cefas has prepared, or partnered, many of the BEEMS publications and supplied much of the FRA modelling data to EDF.

4) Water levels: AOD (above ordnance datum), OD (ordnance datum) and ODN (ordnance datum at Newlyn) are to all intents and purposes the same reference level. In Britain, the datum is mean sea level (MSL) defined as the mean sea level at Newlyn Cornwall between 1915 and 1921.

5) Block quotes in the paper carry quotation marks to make clear they are direct quotations. Any bold typeface within a quotation has been added by me for emphasis.

## 1. Introduction.

This paper is an independent appraisal.

EDF pledges to *"… make sure we provide the best opportunities we can for people to engage with the application when it is submitted."* The paper engages with the Development Consent Order (DCO) application.

This paper is neither pro nor anti-nuclear as an ideological stance and does not address this idiom.

The paper concerns itself with the long-term safety of the project from flood and geomorphological processes on what is universally deemed an erodible coast. Assessments of these criteria are of particular importance to the examination of the Sizewell C DCO application as the site requires an extended period of protection to cool and store the high burn-up spent fuel created during the lifetime of the plant.

The paper studies EDF's claim of stability at the Sizewell site—a stability attributed to the protective nature of the offshore Sizewell-Dunwich banks. I consider the geomorphology and historical bathymetry of the banks, the effect of climate change and whether the banks can be relied upon to be sufficiently stable until at least 2150.

- If we allow for a 10-year overrun on EDF's stated fuel store decommissioning date of 2140 it takes us to 2150 – a date that represents, in my view, Sizewell C's minimum requirement for **unqualified** security from flood and coastal processes. This date could extend to 2230 if the spent fuel requires the full 140-year cooling period stated by the Nuclear Decommissioning Authority. EDF has not confirmed the average burn rate its fuel will be subjected to, and therefore this period cannot be accurately established.
  *For the cooling period see: NDA 'Geological Disposal Generic Design Assessment: Summary of Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR'* Jan 2014 section 6, page 6.

The paper considers EDF's references to the Sizewell-Dunwich banks in the Flood Risk Assessment (FRA) and its shift in their emphasis pre-DCO to DCO documentation by the introduction of new wave energy receptors. It also looks at the FRA modelling undertaken by EDF in the DCO and considers the overall adequacy of EDF's approach and analysis of the stress to the Sizewell foreshore and hence the risk to the Sizewell C nuclear complex in particular.

In EDF's Sizewell C 'Latest News', '*Doing the Power of good to Britain*', released after the Development Consent Order application was accepted for examination, EDF states:

> *"The plans we have developed for Sizewell C need to be 'futureproof', so we have undertaken extensive studies of the coastline. We modelled potential future scenarios along the Sizewell coast, with and without Sizewell C, to fully assess the effect of the station on coastal processes (and vice versa). We included the highest plausible, Sizewell-specific climate change predictions in the current guidance from the Met Office Hadley Centre Climate Programme, usually referred to as UKCP18. Independent experts were asked to critique the forecasts to provide the very best assessment of long-term coastal change."*

This paper examines whether EDF's DCO documentation is consistent with the stated goals.

## 2. Overview of coastal erosion, morphology and stability.

Sizewell bay, the proposed location for Sizewell C, is located between Thorpeness and Dunwich. Historical erosion on the Suffolk coast is known to be 'episodic' and particularly noticeable in Thorpeness, Dunwich, Aldeburgh, Corton, Easton Bavents and Pakefield and Felixstowe. The drivers for this erosion are forces impacting on unconsolidated geology and, according to published papers there is: "… an average recession rate of 1.49 m per year for the Minsmere and Dunwich cliffs." 'PYE, K. and BLOTT, S.J., 2006. Coastal processes and morphological change in the Dunwich-Sizewell area, Suffolk. p.468.

> Note: 'Episodic' is an observation from historical data of the coastal processes and tends to be a given for many erosion patterns. It also suggests an underlying lack of predictability as mechanisms behind the change in the cycles have not been explained. This is covered in Appendix 8. 'Thorpeness Coastal Erosion Appraisal, Final Report, December 2014', Mott Macdonald. Page 9.

One of the most significant examples of unpredictable, episodic change occurred at Sizewell itself:

> *"**The 1836 shoreline at Sizewell is the most eroded shoreline in the records assembled by Pye and Blott (2005),** being some 60 – 100 m landward of its current position and just 20 m seaward of the present location of the Sizewell B cooling-water pump house. By 1883, the shoreline had advanced by up to 130 m, presumably as a result of the increased sediment supply from the cliffs to the north."*
> BEEMS Technical Report Series 2009 no. 058, Sizewell: *Morphology of coastal sandbanks and impact to adjacent shorelines*. Page 39

EDF states that the Sizewell Bay currently benefits from a stability which has been recognised as related to the offshore Sizewell-Dunwich banks, a complex that started to grow after 1824 (BEEMS TR139 op, cit., Page 1). EDF, in its pre-DCO Scoping document, for example, states:

> *"The [Sizewell-Dunwich] bank represents a natural wave break preventing larger waves from propagating inshore and thus reducing erosion rates along this shoreline. **As a result, the Bank forms an integral component of the shore defence and provides stability for the Sizewell coastal system".*** 'Sizewell C proposed Nuclear Development, Sizewell C EIA Scoping Report, April 2014, Planning Inspectorate Ref: EN010012, Page, 150.

BEEMS TR139, obtained under FOI, confirms the reliance on the Sizewell-Dunwich banks for foreshore stability:

> *"**Although the Sizewell shoreline has been relatively stable during the past 150 years, a return to erosion could occur if there is an overall reduction in the size or crest height of the Sizewell-Dunwich Bank**, an increase in the size of the 'saddle' between the high crestal areas towards the two ends of the Bank, a significant increase in sea level (> 0.5 m), or a significant increase in the frequency, strength and duration of northerly and northeasterly winds."* TR139, Edition 2: A Consideration of "Extreme Events" at Sizewell, Suffolk, With Particular Reference to Coastal Morphological Change and Extreme Water Levels, Page 3.

I have noticed that in the DCO documents the term 'stability' of the Sizewell coastline tends to be replaced by the phrase 'present regime' which suggests EDF accepts future instability. The following quote is an example:

> *"**The present regime** is considered to be the result of a change from the energetic NE unidirectional wave climate…an overall reduction in inshore wave energy due to growth of*

*the Sizewell-Dunwich Bank (elevation, width and extent)… and the presence of headlands at natural and man-made hard points – Thorpeness' Coralline Crag, Minsmere Outfall and the Blyth river mouth jetties –* ***within an otherwise soft and erodible coast."***
DCO: Coastal Geomorphology and Hydrodynamics Appendix 20A, Page 19.

In the DCO, EDF introduces to the public domain the hypothesis of the nearshore, longshore bars and the 'shingle beach' as additional wave energy receptors providing coastline stability. This will be discussed in more detail in section 6:

*"Computer modelling of waves moving over the Sizewell–Dunwich Banks indicates that this section of shoreline is currently exposed to lower wave energy, for both primary wave directions, and consequently experiences very low net longshore sediment transport. These factors, which are influenced by the size and shape of the bank as well as the longshore bars, are considered to provide the shoreline stability observed."*
DCO: Main Development Site, Chapter 20 Coastal Geomorphology and Hydrodynamics, Appendix 20A, Coastal Geomorphology and Hydrodynamics: Synthesis for Environmental Impact Assessment. Page 40.

*"…there is a substantial shingle beach and vegetated sand dunes at all of the potential flood routes involving wave overtopping at Sizewell C…as they may have a significant impact on wave propagation".* Main DCO: Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Appendix 1 Coastal Modelling report. (Containing APPENDIX A: 'Sizewell C Flood Risk Assessment Modelling overtopping of sea defences' Technical Note Royal Haskoning DHV, February 2017) Paragraph 1.2.9.

As regards the nearshore, longshore bars, EDF notes that they cannot be regarded as having long-term stability.

*"The inner and outer longshore bars are smaller, shallower, and are consequently relatively mobile features that would change their positions relatively quickly in response to sea level rise*."
DCO: Coastal Geomorphology and Hydrodynamics Appendix 20A, op. cit., 7.2.2 Page 136.

In 2011/2012, as a result of European Council 'Stress Test' requirements for nuclear installations post-Fukushima, EDF prepared its Sizewell **B** document. Other than the Sizewell-Dunwich banks, no other receptors pertinent to shoreline stability and protection are mentioned.

*"It was noted that significant attenuation of storm surge waves occurred over the Dunwich bank."* EU Stress Test, Sizewell B. Jan 2012. Page 62. ONR: European Council "Stress Tests" for UK nuclear power plants National Final Report December 2011.

I consider it is important for Examiners to understand the offshore morphology:

*"The Sizewell–Dunwich Bank is a single sedimentary feature, 8 km in length and with a landward flank located 1.2 – 1.7 km from shore. Its higher north and south ends, often referred to as Dunwich Bank (-4 to -5 m elevation) and Sizewell Bank (-3 to -5 m elevation) respectively, are joined by a lower elevation saddle (-7 m elevation). The Sizewell-Dunwich bank must not be confused with the inner and outer longshore bars: "…the inner longshore bar is 50 – 150 m from shore of -1.0 to -3.0 m (ODN) elevation, as well as a larger outer bar 150 – 400 m from shore of -2.5 to -4.5 m (ODN) elevation".* DCO, Appendix 20A, op.cit., Page 21.
<u>Section 6 has a chart of these features</u>.

The current limit to the protection of the Sizewell-Dunwich banks northward of the Sizewell A and B stations is noted below. Sizewell C, as well as being built further seaward, will be facing this northerly low-lying flood land (Sizewell A and B being slightly better protected):

> *"…the area north of Sizewell Power Station is still experiencing periodic storm erosion. This may be related to changes in the nearshore and offshore morphology, including the development of a gap between the crests of the Sizewell and Dunwich Banks through which waves are able to penetrate".* Op cit., PYE, K. and BLOTT, page 464.

Historical hydrographical surveys (see Appendix 1 for hydrographic charts between 1868 and 1992) show that the offshore Sizewell-Dunwich bank complex has been dynamic and capable of notable structural change. This is consistent with seabed analysis undertaken by the Institute of Oceanographic Sciences. Their survey shows that offshore and northwards of the proposed location of Sizewell C seabed samples show unconsolidated gravel, sands, intercalated sands and clay—with no erosion-resistant coralline crag in evidence. For full information see: Lees,B J, Sizewell-Dunwich Banks field study Topic Report 88, Institute Oceanographic sciences, 1980. Important aspects of this report are included in Appendix 2.

The work of Lees is fully accepted by EDF:

> *"4.6.6 The majority of the seafloor within the study area is characterised by fine sands, with muddy sediments in areas of deeper water. Analysis of …. new and existent grab sample data (e.g.Lees 1980), has provided a detailed picture of the seabed surface sediments. Most of the survey area is characterised by sands at the seabed surface, in accord with the findings of other researchers (Lees, 1980; 1983)."*
> DCO: Chapter 23 Marine Historic Environment, Appendices 23A - 23C.

The DCO documents covering the land geology that will underpin and surround the Sizewell C are empty and marked 'Confidential', however available information indicates that the northern part of the main development site and coastal defence is also underlain by non-erosion-resistant soft alluvium and peat deposits. See Appendix 2.

In recent years it has been realised that the northern part of the Sizewell-Dunwich bank—specifically, the Dunwich section north of 267000N—has shown rapid loss of crest height and seaward contour change. In my view, the significance of this cannot be ignored. This is discussed further in Section 6 including a chart.

## 3. Historical Flooding

Sizewell C is surrounded by the low-lying land of the Sizewell and Minsmere levels. Much of the land across Minsmere Level and Leiston Marsh (extending up to 3 km inland) lies between 0.6 and 0.7 m OD (OD = Ordnance Datum). Areas to the north of the Minsmere Old River and Coney Hill are slightly higher, at ca. 1.5 m OD.
Pye and Blott, op.cit., Page 469.

Beems TR139 explains that even moderate storms will produce significant erosion and flooding of the low-lying areas faced by the proposed location for Sizewell C:

> *"Very extreme tide plus surge conditions, or tide plus surge plus waves, are not necessary to cause significant erosion and flooding of low-lying areas. **Studies to the north and south of Sizewell have shown that even moderate storms, with estimated return***

***periods of 1 in 5 to 1 in 10 years, have caused significant flooding*** *as a result of breaching of shingle ridges, narrow dunes and earth embankments (e.g. Pye & Blott, 2006, 2009). The outer defence at the northern end of the Minsmere frontage was breached, and the inner defence partially overtopped, during moderate storms in 2006 and 2007.* ***These events also caused significant dune erosion between Sizewell B and Minsmere Sluice but*** *had relatively little effect on the beach and dunes in front of the 'A' and 'B' power stations.* ***The main reason for this long-shore variation in storm susceptibility appears to be the morphology of the Sizewell-Dunwich Bank.*** *Waves from the NNE are refracted across the northern end of Dunwich Bank and focused towards the shore at the northern end of the Minsmere frontage. Refracted north-easterly waves also pass through the saddle between Dunwich Bank and Sizewell Bank. The size, depth and position of this 'saddle' is therefore of critical importance with regard to the risk of erosion and flooding between the proposed Sizewell 'C' site and Minsmere Sluice."*

TR139, Edition 2: A Consideration of "Extreme Events" at Sizewell, Suffolk, With Particular Reference to Coastal Morphological Change and Extreme Water Levels, Page 5

The floods of 1953 that submerged large areas of this part of Suffolk were caused by a significant storm surge associated with a high astronomical tide. The resulting water levels will be more frequently attained in the future due to predicted higher median baselines sea levels. It is the case that Sizewell A (built in the 1960s) and B (finished in 1995) have been subjected to, and survived tidal surges but these have not been on the scale of the 1953 surge at 3.5m OD.

EDF, in the Main Development Site Flood Risk Assessment Document reports four main storm surges:

*"• 1927 with tide level of 3.10m AOD;*
*• 1938 with tide level of 3.25m AOD;*
*• 1949 with tide level of 3.00m AOD; and*
*• 1953 with tide level of 3.44m AOD."*

DCO: Main Development Site FRA, op cit., Page 65, Paragraph 5.14. AOD = Above Ordnance Datum

The more recent major storms raised water levels as follows:

- 3 January 1976 2.5m OD
- 11 January 1978 2.5m OD
- 5-6 December 2013 2.75m OD

Water levels OD Southwold. OD = Ordnance Datum (equivalent to AOD).
For water levels before 2006 see: Pye and Blott 2006, op.cit., Page 457. For 2013 see: 'A comparison of the 31 January–1 February 1953 and 5–6 December 2013 coastal flood events around the UK' Matthew P. Wadey. Et al. 'Frontiers in Marine Science', 6th Nov 2015.

Technical note 1: Wave heights.
The largest waves recorded by a Waverider buoy deployed offshore from the Sizewell-Dunwich Bank complex (SDBC) in 18m of water from 11 February 2008 to 24 February 2011 had a significant wave height of 4.71m (15.45 ft). The highest waves are predicted to approach the coast from the north and northeast. According to Mott MacDonald "the Halcrow (2001a) wave hindcast study estimated a maximum 1 in 100-year offshore Hm0 (significant wave height) value of 7.8m for waves from the N –NNE sector". According to Pye

and Blott the 1:100 would be 7.3- 7.8m. These predictions predate IPCC climate change scenarios. (It is important to note that wave height is the difference between the crest and the trough, however this is complicated by the wave being a transient phenomenon. Flood risk assessments are likely to have a still water level to which overtopping volumes due to the waves are added. The calculation of this overtopping volume will include wave setup and wave runup.) Initial section from: 'Thorpeness Coastal Erosion Appraisal Final Report December 2014', Mott Macdonald, Page 15.

## 4. Sea level changes, storm surges and flooding: expert opinion

The UK Government has two main accepted reference documents for sea level change, UKCP 18 (UK Climate Predictions UKCP18) and the 2019 IPCC (Intergovernmental Panel on Climate Change) report. EDF also commissioned—and in the DCO documentation prioritises the use of—a 'British Energy Climate Change (BECC) working group' report for their climate change and flood modelling in the 2100s. The '*BECC Scoping Paper: How to Define Credible Maximum Sea Level Change Scenarios for the UK Coast*. *January 2014*' is not in the public domain.

UKCP18, the Met Office document for climate projection, confirms the accepted science of significant median sea level rises into the next century linked to different emission scenarios. The IPCC (Intergovernmental Panel on Climate Change) report of 24 September 2019 stated that extreme sea level events that are rare (once per century) are projected to occur much more frequently by 2050 in many places.
See Appendix 4.

Technical Note 2: From 'IPCC The Ocean and Cryosphere in a changing climate 24 September 2019, page spm-22' *"Sea level continues to rise at an increasing rate. Extreme sea level events that are historically rare (once per century in the recent past) are projected to occur frequently (at least once per year) at many locations by 2050 in all RCP (Representative Concentration Pathway) scenarios, especially in tropical regions (high confidence). The increasing frequency of high-water levels can have severe impacts in many locations depending on exposure (high confidence). Sea level rise is projected to continue beyond 2100 in all RCP scenarios."*
The IPCC report continues: *"Under the same assumptions, annual coastal flood damages are projected to increase by 2–3 orders of magnitude by 2100 compared to today (high confidence)".* 'IPCC The Ocean and Cryosphere', ibid. Page spm-32.

UKCP18 continues ***"We cannot rule out substantial additional sea level rise associated primarily with dynamic ice discharge from the West Antarctic Ice Sheet. We recommend that decision makers make use of multiple strands of evidence, including H++ [high-end climate change scenarios incorporating ice-melt and projected for 2100] when assessing vulnerabilities to future extreme water levels."***
UKCP18, op cit., Page 5. "High-plus-plus or 'H++' scenarios are designed to explore the high-end plausible future sea level rise and complement the process-based sea-level projections presented in IPCC assessments." UKCP18, op cit., Page 3.

EDF states that, *"When built, the permanent sea defences would protect the power station from a 1:10,000-year storm event, including climate change and sea level rise."* The flood map below, in Figure 1, projects this 1:10,000 year flood event with the recommended H++ sea level rise of 1.9m. (EDF says that the 1:10,000 case is a matter for 'nuclear safety case' and not for DCO consideration.)
DCO: Main Development Site Flood Risk Assessment Appendices 1-7 Part 6 of 14 page 62).

Figure 1 on the following page represents these conditions:

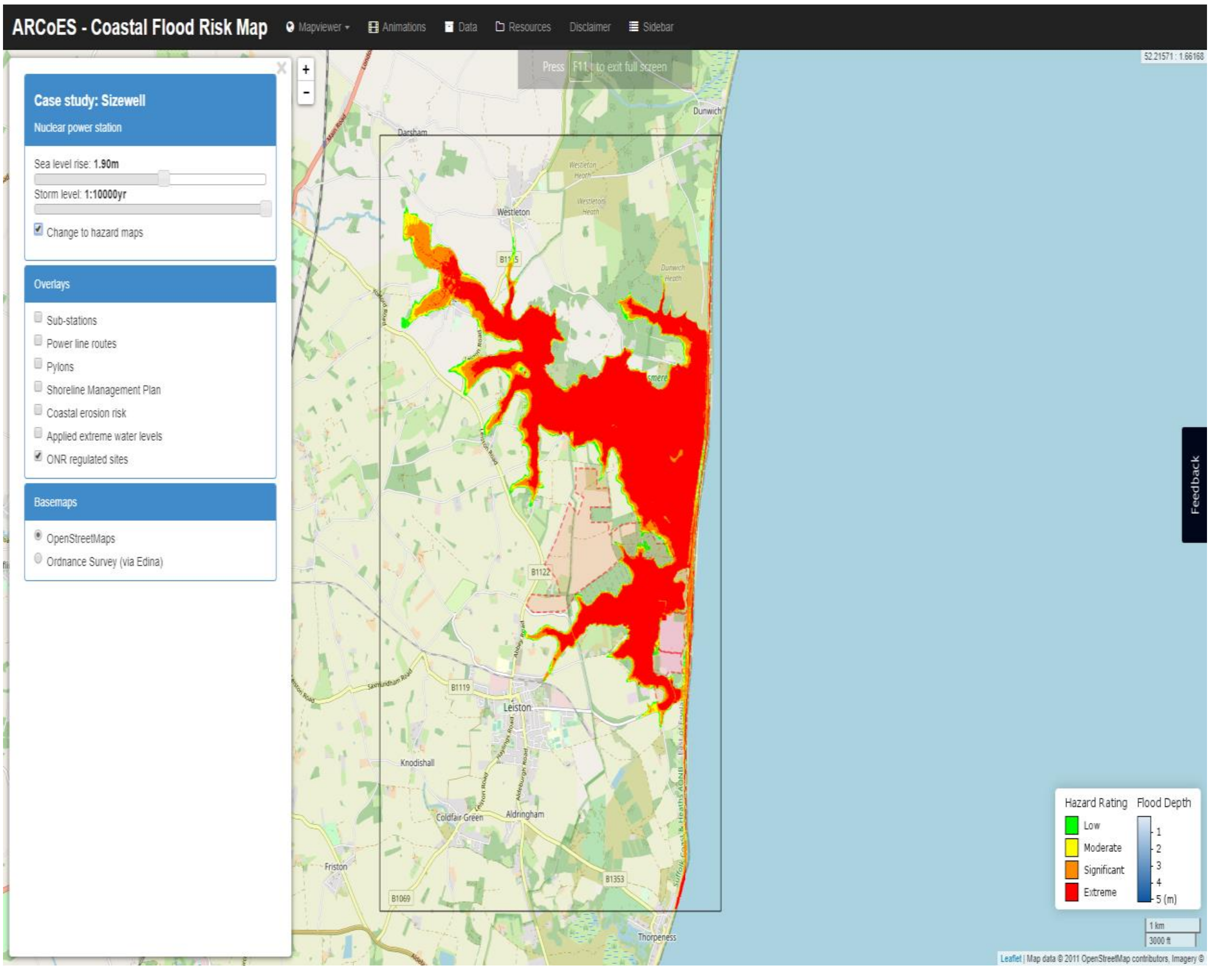

Figure 1: Projection for 1:10,000 year flood event (still water) with the H++ sea level rise of 1.9m showing hazard rating. Red is extreme hazard.

Technical note 3: Explanation and data used.
Source: ARCoES, https://arcoes-dst.liverpool.ac.uk/. Select 'Map Viewer', 'Sizewell'.
The nearest Environment Agency chainage point at Sizewell is 4192.
(Newlyn is chainage point zero).
The applied extreme water level data at 4192, which do not incorporate any sea-level rise, are:

| | |
|---|---|
| 1:200 | 3.13m |
| 1:500 | 3.36m |
| 1:1,000 | 3.55m |
| 1:10,000 | 4.21m |

Note: *"Statistical estimates of the 1 in 10,000 year high water level for present conditions range from 3.61 m OD (Joint Probabilities Method) to 5.05 m OD (Generalised Pareto Distribution Method). A 1 in 10,000 year value of 4.26 m OD was obtained using the method of Dixon & Tawn (1997) and a 1 in 1 year level for Sizewell of 2.21 m OD"*
BEEMS TR139 Op cit., Page 3

The ARCoES chart in Figure 1 above represents an H++ scenario of the 'extreme' water level of 4.21m plus the forecast sea-level rise by 2100 of 1.9m which I understand to be the level that EDF must design to meet 'the Nuclear Safety Case'. The chart, as stated, does not consider any wave action, which would be additional.

DEFRA's floods and coastal erosion team, as part of a major investigation of the effects of climate change, produced an unpublished government analysis (now partly obtained under FOI) which shows that Sizewell is considered a high flood risk up to and including 2080 which is far as the report goes. See Appendix 9.

EDF's claim that the site is protected from a 1:10,000-year event must be considered alongside its admission that the platform will be flooded by a 1:200-year event if the defence is breached, a scenario that must be considered for all events:

> *"7.1.6. For the scenario with breach of the main sea defence (HCDF), the main platform would get flooded to a depth of approximately 0.2-0.4m (for the 1 in 200-year event) and 0.3-0.7m (for the 1 in 1,000-year event). This breach scenario was assessed for the credible maximum climate change (very conservative but plausible) scenario."*
> Main Development Site FRA Appendix 1-7, Part 7 of 14, op.cit., Page 91. Epoch not stated—see 5.4.13 below which states 2030.

This is confirmed in the main FRA document for the end of the *construction and start of operation* period:

> *"5.4.12 The most significant area of risk in both events is to the north-west of the existing Sizewell Drain in the area of the main platform which is at 'danger for most' in the 1 in 200-year event and rises to 'danger to all' for the 1 in 1,000-year event. However, for the platform area to the south-east of the Sizewell Drain, the hazard rating is 'low hazard' in the 1 in 200-year event and rises to 'danger for most' for the 1 in 1,000-year event."*
>
> *"5.4.13 The analysis for the Sizewell C Project shows the main platform area is at risk of flooding due to breach of coastal defences at both 1 in 200-year and 1 in 1,000-year events* ***in 2030*** *(Figure 25 and Figure 26) with water levels at 1.83m AOD and 2.05m AOD respectively."* Figure 25 and 26 are shown in the Appendix 3 'Flood Map Projections'.
>
> DCO: Main Development Site Flood Risk Assessment, op cit., Page 77 (See Appendix 3 for a copy of Figure 25 and 26)
> For Figure 25 and 26 see: DCO: Development Site Flood Risk Assessment Figures 21- 30.

EDF's overtopping flood modelling, which is covered in more detail in section 7, shows overtopping of the main sea defences, without breach:

> Modelled flood overtopping levels for a 10.2m defence crest at 2090/2140 for various return periods are:

| | | |
|---|---|---|
| 1:200 (RCP 8.5) | in 2140 is 0.3 l/s/m | (litres per second per metre) |
| 1:1000 (RCP 8.5) | in 2140 is 3.79 l/s/m | |
| 1:10,000 (RCP8.5) | in 2090 is 5.8 l/s/m | |
| 1:10,000 (RCP8.5) | in 2140 is 36.42 l/s/m. | |

> Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Op. cit., Table 5.6. Page 35.
>
> Technical note 4: A 1:200 return period means that there is a 57.3% probability of the event occurring between now and 2190, and a 15.6% probability of a 1:1000 event.
> See https://www.weather.gov/epz/wxcalc_floodperiod

There does not appear to be a statement in the DCO documentation as to how the spent fuel, all stored onsite, is to be safely managed during such an event or how the reactor can be managed

when flood water will, in my view, preclude safe pedestrian or vehicular access to buildings from off the site.
There is a requirement for a greater level of substantive assurance than that offered by an EDF spokesman: *"Sizewell C will safely manage the spent fuel from the station on the site for its lifetime, or until a deep geological repository becomes available."*
EDF, as quoted to Paul Brown 'Sea level rise threatens UK nuclear reactor plans' April 28th, 2020. Climate News Network.

Appendix 3 contains flood map projections from EDF and the Environment Agency taken from the DCO flood risk assessment papers.

## 5. Coastal geomorphology and shoreline change processes - a response to DCO studies.

EDF informs us in the documentation, that it commissioned seven expert geomorphologists to examine the shoreline change processes associated with Sizewell C:

> *"Seven Expert Geomorphologists, internal and external to Cefas, were convened to assess the physical and scientific evidence for shoreline change processes and to derive a plausible future shoreline baseline using the EGA [Expert Geomorphological Assessment] approach. "*
>
> DCO: 6.3 Revision: 1.0 Applicable Regulation: Regulation 5(2)(a) PINS Reference Number: EN010012 Volume 2 Main Development Site Chapter 20 Coastal Geomorphology and Hydrodynamics Appendix 20A Coastal Geomorphology and Hydrodynamics: Synthesis for Environmental Impact Assessment TR311 Sizewell MSR1 (Ed 4) Paragraph 7.2.1.

The study, however, was characterised by several assumptions and limitations, important ones listed as follows:

1. To adopt a future projection based on "reasonably foreseeable" conditions.
2. Sea level rise in the year 2070 would be 0.52 m relative to 1990 levels
3. The offshore wave climate remains unchanged
4. The inshore wave climate remains unchanged
   Coastal Geomorphology and hydrodynamics, Appendix 20A, op.cit., Page 134

These assumptions and limitations are each discussed below:

1) The Expert Geomorphological Assessment limited their study to 'reasonably foreseeable conditions' a phrase that does not occur in the UKCP18 Marine report and is not externally defined. EDF claims that, 'no assessment can be made of extreme events', and the drivers of change are 'moderate' events only:

> *"A projection based on the 'reasonably foreseeable' conditions was considered the most appropriate method of reaching consensus as 'extreme events' that could occur have a low (or poorly-determined) chance of occurrence and geomorphic systems tend to be shaped by more frequent moderate events (Wolman and Miller, 1960), with the exception of cataclysmic change"*
> Coastal Geomorphology and hydrodynamics, Appendix 20A, op.cit., Page 134

2) The 'panel of seven' stipulated a limited 0.52m sea-level rise at 2070 – a mid-category Representative Concentration Pathway (RCP 4.5).

> *"…future shoreline change affecting the Sizewell C development was assessed based on SLR in 2070 of 0.54m (the 95th percentile under the UKCP18 mid-range scenario)."*
> DCO: Coastal Geomorphology and hydrodynamics, Appendix 20A, op.cit., *Paragraph 2.4.1 Page 48*

EDF continues:

> *"The 50-year (2070) timeframe represents a plausible timeframe sufficient to expose the HCDF* [Hard Coastal Defence Feature], *based on the shoreline trends.".*
> DCO: Coastal Geomorphology and hydrodynamics, Appendix 20A, op.cit., *Paragraph 7.2.1 Page 133/4*

This statement above has considerations for the FRA modelling which will be discussed later in section 7.

3) The panel limited the offshore wave climate to 'unchanged'. This is despite EDF noting in the Main Development Site Flood Risk Assessment:

> *"4.2.16 The Environment Agency guidance (Ref 1.7) suggests assuming a precautionary increase in wave height of 5% up to 2055 and then 10% from 2055 to 2115."*
> DCO: Main Development Site Flood Risk Assessment, op.cit., Page 54.

Also, UKCP18 suggests 'inherent uncertainty' as regards 'Significant Wave Height' predictions as they represent an area of low predictive accuracy:

> *"Given the inherent uncertainty in projections of storm track changes and the limited sample size available, the wave projections presented here should be viewed as indicative of the potential changes with **low confidence**."* UKCP18, Ibid., Page 28.

It continues that wave patterns are defined by local activity, which, for Sizewell C will be from a North/North/East fetch across the large expanse of the North Sea. The 1:100 return period (an 81.9% chance of occurring between now and 2190) wave height being 7.3m-7.8m.

4) For the 'inshore wave climate to remain unchanged' is in my view to explicitly state that the panel's review of Sizewell C placed full reliance and dependency on the Sizewell-Dunwich offshore bank feature remaining in its current form. This bank network, as previously stated, attenuates and dissipates offshore waves reducing and controlling the inshore wave climate.
(Tucker, Carr et al.) (BEEMS TR311).

In my opinion, and that of leading authorities such as Mott Macdonald, the respected global engineering consultancy which undertook an extensive study of the area in 2014 considers that:

> ***"…at a local scale the SDBC [Sizewell-Dunwich Bank Complex] has the potential to change over time-scales shorter than a few decades."*** Mott Mac., op. cit., page 57.

Cefas also acknowledges uncertainty:

> ***"…our understanding of bank dynamics is poor"***
> BEEMS Technical Report Series 2009 no. 058, Sizewell: Morphology of coastal sandbanks and impact to adjacent shorelines. Page 47.

However, despite these considerations, EDF's Expert Geomorphological Assessment tells us in the DCO:

> *"The principal receptors (beach, bars, bank and crag) of the future baseline can be expected to resemble the present (i.e. no regime shift) over much or all of the station life."* Chapter 20 DCO: Coastal Geomorphology and Hydrodynamics. Paragraph 20.4.78.

I have already established in this paper that this scenario of future offshore geomorphology 'resembling the present' would be an unsupported and unsupportable premise. This is, in fact, agreed by EDF and discussed further in the following section 6.

In a recent 'East Anglian Daily Times' article*,* Tony Dolphin, senior coastal scientist at Cefas, and one of the seven expert geomorphologists responsible for the study is reported as saying:

> *"… that while Cefas does look far ahead into the future, it is generally only possible to predict detailed changes to the coastline over the next 10 years."* He continues, *" We can try and predict as much as we like, but almost every prediction in the very long-term has no certainty around it."* *'Flooding and 'extreme' storms won't put Sizewell C in danger, experts say'* by Andrew Papworth, East Anglian Daily Times, 06 August 2020',

This is a different perspective to that of EDF which suggests in its public information newsletter, '*Doing the power of good to Britain'*, and quoted in the introduction, that the Expert Geomorphological Assessment forecasts the 'very best' of long-term coastal change and therefore shows Sizewell C to be 'future-proofed'.

In my view the opportunity and capacity within which the review has taken place, combined with one of the geomorphologist's view that forecasts cannot extend reliably beyond 10 years, compromises its value. The approach also does not appear consistent with DCO 'Rochdale Envelope' requirements. An independent review is required so that the limits of the Expert Geomorphological Assessment's merits may be fully understood.

## 6. The Sizewell-Dunwich banks

The offshore Sizewell-Dunwich complex—referred to in previous sections and in its current form—mitigates the effects of storm surges onto the Sizewell foreshore by wave refraction and attenuation. The work of Tucker and Carr using Waverider buoys installed in the 1970s (and later work by BEEMS, and EDF, including modelling) shows that any incident wave approaching the Sizewell-Dunwich banks from offshore, if higher than a critical value, is forced to break on the offshore banks thereby reducing its height to that value before it hits the Sizewell coastline. This critical value of wave height is 2.52m to 2.12m depending on tidal depth. This feature of the Sizewell-Dunwich bank complex is of primary importance to the inshore wave climate and protection of the Sizewell foreshore. This is detailed in Appendix 6 and referred to in the DCO: Coastal Geomorphology and Hydrodynamics. 20.4.19.

Cefas's BEEMS technical report TR500 states that, should Dunwich bank remain the same, then it:

> *"…would therefore be expected to continue to provide protection from high-energy storm waves across the majority of the GSB." [GSB = Greater Sizewell Bay]*
> BEEMS Technical Report TR500 Sizewell-Dunwich Bank Morphology and Variability, Page 11

Therefore it must be accepted that if the Sizewell-Dunwich banks are compromised by the formation of a significant gap, loss of height or change of orientation then incident waves—such as one of 4.71m N/NNE as recorded off the banks by Waverider buoys in 2008-2011, or the forecast 1:100 N/NNE wave height of 7.3-7.8m, as examples—could have direct access to the Sizewell foreshore. (see Technical note 1, Section 3). Mott Macdonald confirms that:

"*.. a reduction in the size of this feature…[would reduce its effect in attenuating waves thereby increasing] the magnitude of extreme events on the shoreline and increase the risk of erosion".* Mott Mac., op. cit., page 57.

The converse is of course possible in that the banks could build-up or remain the same, but Sizewell C needs **unqualified** site security until at least 2150, a timeframe that I believe will cover many 'episodic' changes, some of which could be a serious threat to the Sizewell-Dunwich banks and hence the stability and protection of the Sizewell foreshore.

An independent, 2020 perspective concerning the importance and fragility of the Sizewell-Dunwich banks can be established from Scottish Power Renewables' research and reports. Scottish Power Renewables is intending to land offshore windfarm cables in the Sizewell area and therefore has a requirement to cross the Sizewell-Dunwich banks. Scottish Power's independent studies are consistent with those of this paper and reveal that any 'disturbance' of the Sizewell-Dunwich banks could have significant geomorphological implications to the banks themselves and the stability of the Sizewell shoreline. Scottish Power also notes:

*"EDF Energy has stated it will object to any damage to the crag [The Sizewell-Dunwich bank] on a precautionary basis."* This is explained fully in the document below.

East Anglia 2 Offshore Windfarm Appendix 4.6, Coastal Processes Applicant: East Anglia TWO Limited, Document Reference: 6.3.4.6, SPR Reference: EA2-DWF-ENV-REP-IBR-000896_006 Rev 01 Pursuant to APFP Regulation: 5(2)(a). The Sizewell-Dunwich banks are analysed at length in the paper, see page 54 for the quotation used.

As stated in Section 2, evidence from core samples and seabed grab samples do not suggest the existence of erosion-resistant Coralline Crag in the Sizewell-Dunwich banks offshore and northwards of the proposed location for Sizewell C. (Seabed analysis and core samples are detailed in Appendix 2 and discussed further in this section) The loss or part-loss of the Sizewell-Dunwich banks would be highly significant to the foreshore. It is also the case that as mean sea-levels rise, water over the banks will be deeper which will reduce the attenuating effect of the banks on larger waves.

BEEMS report TR058, confirms that sea level rise will compromises the banks' protective qualities:

*"In a scenario of rising sea level combined with a reducing volume and/or sediment supply at the bank, the resultant increase in water depth over the bank crest (i.e., sea level rising and/or bank elevation lowering) will have a more significant effect on inshore wave climate and shoreline response."*
BEEMS Technical Report Series 2009 no. 058, Sizewell: *Morphology of coastal sandbanks and impact to adjacent shorelines*. Page 46.

EDF itself is fully aware of the importance of the Sizewell-Dunwich Bank complex as can be confirmed from its pre-DCO Scoping document:

*"7.13.7 Approximately 1.5km offshore from the coast is the Sizewell-Dunwich Bank. The bank represents a natural wave break preventing larger waves from propagating inshore and thus, reducing erosion rates along this shoreline.* ***As a result, the Bank forms an integral component of the shore defence and provides stability for the Sizewell coastal system.****"*
Sizewell C EIA Scoping Report, April 2014, Planning Inspectorate Ref: EN010012

In EDF's Newsletter for the public, *SIZEWELL C LATEST NEWS, Doing the power of good for Britain*, released after the DCO was accepted, informs us that:

*"Sizewell is located within a stable part of the Suffolk coastline, between two hard points and the offshore bank of sediment known as the 'Dunwich-Sizewell Bank'."* Page 13

However, in the DCO there is a significant modification:

*"The waves acting on the shingle beach face and, during elevated water levels on its landward barrier, are substantially lowered before arriving at the shore due to dissipation across the GSB's [Greater Sizewell Bay's]* ***three positive relief features****; the Sizewell – Dunwich Bank and the two longshore bars. Coastal sandbanks and longshore bars dissipate wave energy through bottom friction in shallow water (e.g., over the 1-km-wide [Sizewell-Dunwich] sand bank) and wave breaking, when the water depth is less than about 1.3 times the wave height (i.e., waves larger than about 3-4 m approaching the Greater Sizewell Bay). As waves shoal across these morphologies, they are also refracted toward a more shore-normal direction of travel, which reduce longshore transport potential."*
DCO: Coastal Geomorphology and Hydrodynamics Appendix 20A: 2.3.2.2.3.

EDF has added two additional 'positive relief features': the two nearshore, longshore bars.
This idea is found in the BEEMS Technical Report TR 058:

*"The Sizewell bars and bank can be considered as a three tiered system of coastal defence, where the inner bar, outer bar and bank dissipate respectively dissipate energy associated with small, moderate and large storm waves."*
TR 058 British Energy Estuarine & Marine Studies Technical Report Sizewell: Morphology of coastal sandbanks and impact to adjacent shorelines. Page 49.

The paragraph is stating that two nearshore, longshore bars dissipate small and moderate waves whereas the 'bank'—a reference to the Sizewell-Dunwich bank—reduces large storm waves to moderate inshore waves.

I consider the nearshore longshore bars to be geomorphologically insignificant minor shoreline features that lack the qualities for serious consideration as receptors providing long term stability and wave attenuation to the Sizewell coastline. I am supported in this by the following statement from EDF itself, as stated earlier: *"The inner and outer longshore bars are smaller and shallower and are consequently relatively mobile features that would change their positions relatively quickly…"*
DCO: Coastal Geomorphology and Hydrodynamics Appendix 20A. op. cit., P.135

It is also my view that it would not be plausible to consider the loss of the Dunwich bank as compatible with the retention of the nearshore, longshore bars. See Figure 2 in this section.

EDF also introduces 'the shingle beach' in the DCO and suggests it to be a critical and significant wave receptor and 'relief feature' in its flood risk modelling assessment; this will be discussed in section 7. The use of the 'shingle beach' appears to be first mentioned in the 2019 Scoping report:

*"The potential receptors have been adjusted compared to those described [previously, and are now] the:*
*- shingle beach and its shoreline position;*
*- two sandy, shore-parallel longshore bars;*
*- Sizewell–Dunwich Bank; and*
*- erosion-resistant Coralline Crag ridges that extends to the north-east from Thorpeness."*
EDF 2019 Scoping Report op.cit., Paragraph 6.14.25.

This is extended in the DCO to become:

> *"…there is a substantial shingle beach and vegetated sand dunes at all of the potential flood routes involving wave overtopping at Sizewell C. It is important that those features are considered in the wave overtopping analysis as they may have a significant impact on wave propagation and run-up before waves reach the formal new engineered sea defences".* Main DCO: Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Appendix 1 Coastal Modelling report. (Containing APPENDIX A: 'Sizewell C Flood Risk Assessment Modelling overtopping of sea defences' Technical Note Royal Haskoning DHV, February 2017) Paragraph 1.2.9.

EDF has stated however, that by 2070 the Hard-Coastal Defence feature could be exposed and therefore voided of its vegetated shingle. (See section 5). Sizewell C will also be built much further to seaward than Sizewell A and B:

> *"The Sizewell C platform is estimated to extend ~40m tbc further seaward than the `building line' established by Sizewell A and continued by Sizewell B."*
> East Suffolk Council, Extraordinary Meeting of the Full Council, to be held on Thursday 3 September 2020 at 6.30pm. Page 68.

EDF then dismisses the importance of the Dunwich bank as critical to coastal processes at the Sizewell C foreshore:

> ***"Reductions in Dunwich Bank are not considered to be a worst-case scenario for Sizewell C as they would eventually lead to cliff erosion and increased sediment supply, minimising the chance or degree of exposure of the HCDF (or the amount of mitigation required to prevent this)."***
> DCO: Geomorphology Appendix 20A, op cit., Page 135 of 167.

This statement is contrary to geomorphic principles and academic and empirical studies (Carr/Tucker et al., Mott Macdonald and BEEMS). EDF's claim is notably not supported by its Flood Risk Assessment modelling where reduced or absent Dunwich bank scenarios are not considered. This is discussed in Section 7. Also EDF's comments on the HCDF contradicts its own Expert Geomorphological Assessment that, as mentioned earlier, states the "*..50-year (2070) timeframe represents a plausible timeframe sufficient to expose the HCDF* [Hard Coastal Defence Feature], *based on the shoreline trends."* (See section 5). More importantly, it also makes gross assumptions as to what the impact of the loss of the Dunwich section of the bank would be, **assumptions that are counter to BEEMS report TR058**, obtained under FOI, for example, which states:

> *"**Rapid changes in bank form are thought to be linked to downstream bank-to-bank interactions in a sand bank complex** (Dolphin et al., 2007 and Thurston et al., 2009). **This model may have application at Sizewell-Dunwich [bank] as it is feasible that changes at Dunwich bank could have knock-on effects at Sizewell.** In addition, the narrowing of the tidal channel with shoreward advance of the inner flank will alter the local tidal flows and may lead to relatively rapid system adjustment. **There will be a tipping point beyond which further shoreward migration will significantly alter bank hydrodynamics and could result in large scale reconfiguration of the bank** (assuming the bank is not underpinned by coralline crag)."*
> BEEMS Technical Report Series 2009 no. 058, Sizewell: *Morphology of coastal sandbanks and impact to adjacent shorelines*. Page 45-6. The report is authored by University of East Anglia and Cefas.

Seabed samples do not show evidence that the Dunwich bank is underpinned by coralline crag (see section 2 and appendix 2). This is also confirmed in the DCO:

> ***"…the Dunwich Bank has no inherited stabilising hard geology (i.e., no headland or underpinning crag).*** DCO: Geomorphology Appendix 20A, op cit., Page 135 of 167

EDF's view that reductions in the Dunwich bank would not be regarded as worst-case for Sizewell C could be related to its awareness of significant instability of the northern part of the Sizewell-Dunwich bank, confirmed by the following:

> *"Bathymetric surveys undertaken between 2007 and 2017 showed that Sizewell Bank has remained in a relatively stable position…* ***In comparison, the Dunwich Bank has … showed greater variability over the same period [a decade]:*** *migration landward of the landward flank of the bank by 50 m and by 200 – 400 m on the seaward flank, whilst substantial lowering (1-2 m) occurred across approximately 10% of its area*. "
> DCO: Geomorphology Appendix 20A, op cit., Page 135 of 167

EDF continues:

> ***"Records over the last decade show…Dunwich Bank exhibited greater variability in both its morphology and position with:***
> - ***erosion north of 267000N, resulting in bank lowering of -0.5 – -1.5 m,***
> - ***a decrease in its northern extent of approximately 250 m,***
> - ***landward movement (200 – 475 m) of the northernmost 2.75 km of its seaward flank,***
> - *accretion/migration on its landward flank adjacent to its peak and most landward position (between approximately 267000N – 267600N), and*
> - *ongoing migration of the landward flank for the -6 to -10 m (ODN) contours*
>
> *(approximately -6 m/yr)"* DCO: Geomorphology Appendix 20A, op cit., Page 21. (BEEMS Technical Report TR500).

This erosion of the Dunwich bank is confirmed by Cefas in BEEMS TR500:

> *"In contrast to Sizewell Bank,* ***Dunwich Bank exhibited large-scale erosion*** *across its northern third."* BEEMS Cefas Technical Report TR500, ibid., Page 32.

As stated earlier there has been a paucity of bathymetric surveys of the Dunwich bank which compromises detailed analysis, however:

Cefas's BEEMS technical report TR500, obtained under FOI, tells us that:

> ***"If the lowering and reduction in Dunwich Banks northern extent continued, the extent of shoreline exposed to higher wave energy from the northeast sector would be expected to expand to the south accordingly." [and hence threaten Sizewell C].*** BEEMS, Cefas Technical Report TR500 Sizewell-Dunwich Bank Morphology and Variability, Page 59.

As noted by Cefas, the predominant driver of significant wave heights is from the North to North East—a direction which will expose both the erodible shoreline of Sizewell C, if the Dunwich bank were lost, as well as the northern parts of the Sizewell bank. EDF effectively acknowledges this driver in the following statement:

> *"The largest fetch is towards the north (up to 3,000 km) and correspondingly* ***the largest and longest waves arrive from the N-NE sector. [1:100 wave heights 7.3m-7.8m]****. Waves with periods greater than 8 seconds approach exclusively from the NE – ENE sector."* DCO: Geomorphology Appendix 20A. op.cit., Paragraph 2.3.2.2.2

I conclude that it is an obvious requirement for the three DCO Geomorphological Assessment papers and/or the twenty-two FRA (Flood Risk Assessment) papers to show detailed bathymetry of the Sizewell-Dunwich banks, yet I have been unable to find these detailed survey data.

A seeming disparity exists between pre-DCO statements and the DCO regarding the frequency of bathymetric survey of the Sizewell-Dunwich banks. The pre-DCO Scoping Report states that EDF has undertaken:

> ***"…high resolution bathymetric surveys of Sizewell-Dunwich Bank (2008/9) with further surveys in 2010, 2011 and 2012 to provide additional coverage, particularly in the nearshore zone…and a full survey of Sizewell-Dunwich Bank in 2017".***
> Sizewell C EIA Scoping Report May 2019 Ref: EN010012. Paragraph 7.13.2, page 149 and Paragraph 6.14.5, page 174.

However, the DCO states that: ***"due to its large size…the bank is not regularly surveyed.***"
DCO: Geomorphology, Appendix 20A, op.cit., Page 21

The DCO statement appears to be more accurate: In 2008/9 Swathe Services made a partial survey of the Sizewell-Dunwich banks and in 2017 Titan Services and the Maritime and Coastguard Agency made a full survey. Radar transects were taken with 1km spacing in 2014-16 which provide peripheral detail but the surveys of 2010, 2011 and 2012 do relate to the Sizewell-Dunwich banks.

There is however extensive recent, but not historic, detailed bathymetry of the geomorphologically insignificant nearshore, longshore bars which, as noted earlier, now seem to be regarded as primary relief features. (Extensive nearshore/longshore bar bathymetry and analysis is in Coastal Geomorphology and hydrodynamics, Appendix 20A, op.cit., Paragraph 7.2.1 Page 45/46)

It appears to be the case that the Sizewell-Dunwich banks have not been extensively surveyed by EDF which, in my opinion, represents a significant failure in EDF's geomorphological obligations and responsibility.

Figure 2 below illustrates the Sizewell Dunwich banks and references the points made in the above discussion.
Map from BEEMS Technical Report TR500 'Sizewell-Dunwich Bank Morphology and Variability'. Page 14.

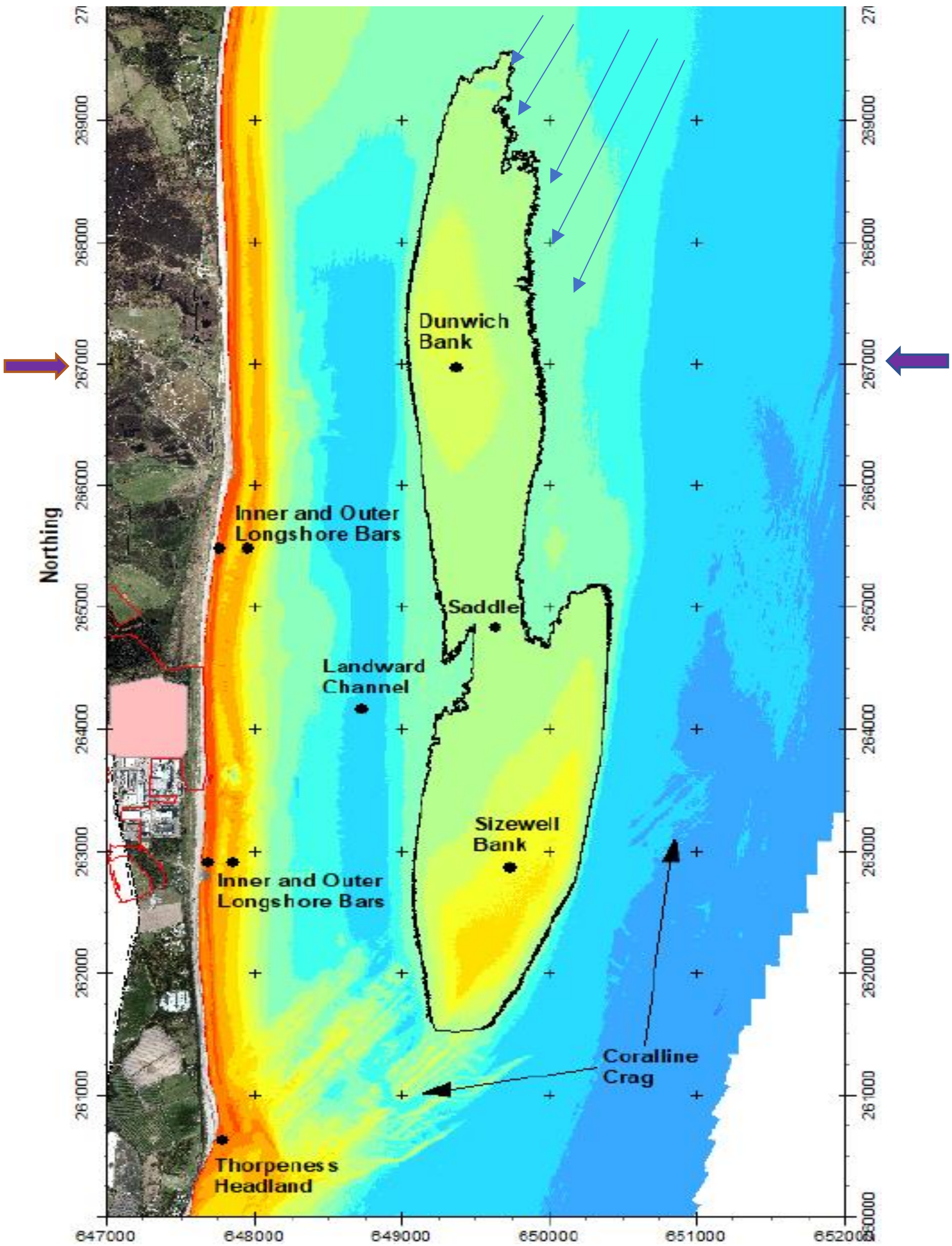


Figure 2. The Sizewell-Dunwich Banks. The purple arrows mark 26700N— to the north of which the crest height of Dunwich bank is lowering.

- The 'three positive relief features' as suggested by EDF in the DCO. The orange and red lines show the 'inner and outer' nearshore, longshore bars, now regarded in the DCO as significant relief features. The DCO provided detailed bathymetry of the inner and outer Longshore bars and not the Sizewell-Dunwich banks.

- The pink square shows the proposed location of Sizewell C.

- ***"Records over the last decade show…Dunwich Bank exhibited greater variability in both its morphology and position with erosion north of 267000N,*** [shown by the purple arrows] ***resulting in bank lowering of -0.5 to -1.5 m"*** DCO: Geomorphology Appendix 20A, op cit., Page 21. BEEMS Technical Report TR500).

- The five blue, fine arrows show the direction of the most significant storm waves from the North/North East— ***the largest and longest waves arrive from the N-NE sector. [1:100 wave heights 7.3m-7.8m].*** DCO: Geomorphology Appendix 20A. op.cit., Paragraph 2.3.2.2.2

## 7. EDF's datasets for the overtopping wave modelling in the DCO documentation.

I understand the Planning Inspectorate requires DCO applicants to consider the 'Rochdale Envelope Approach' in their applications, which obliges them to describe 'cautious, worst case conditions:

> *"It is important that these [descriptions] should be adequate to deal with the worst case, in order to optimise the effects of the development on the environment"*. The Planning Inspectorate, *Using the Rochdale Envelope*. July 2018

In view of this, EDF's modelling study is required to consider and publish worst-case conditions in its Flood Risk Assessment.

Considering EDF's previously held importance of the Sizewell-Dunwich banks for both Sizewell B and C, I had expected that they would merit much mention and discussion in the main DCO Flood Risk Assessment (FRA) document.

However, the main FRA document: '5.2 Revision: 1.0 Applicable Regulation: Regulation 5(2)(e) PINS Reference Number: EN010012 Main Development Site Flood Risk Assessment', *does not mention the Sizewell-Dunwich banks by name* and gives greater attention to the nearshore, longshore bars and not the Sizewell-Dunwich banks:

> *"5.3.5 The sub-tidal part of the beach along the existing power station complex frontage is sand-dominated with inner and outer longshore bars that run parallel to the shore. The longshore bars are a conduit for longshore sand transport and act to dissipate some wave energy by causing waves to break which reduces the remaining wave energy at the shoreline."*

EDF in 5.3.5 above is clearly referring to the nearshore, longshore bars, not the Sizewell-Dunwich banks.

> *"5.3.16 As discussed in section 5.3.5 of this report, the presence of the sub-tidal longshore sand bars may contribute to dissipation of some of the wave energy nearshore. There is concern that the sand bars might erode in the future. That would most likely represent greater flood risk as it would result in the greater wave energy nearshore."*

Again, EDF in 5.3.16 is referring to the nearshore, longshore bars, not the Sizewell-Dunwich banks.

> *"5.3.17 An additional series of lowered sand bar scenarios were analysed in the wave transformation model by the lowering of the sand bank by 5m with assumption the sediment is lost from the system entirely. This was to test the effect of the sand bank on nearshore wave conditions. The derived nearshore wave conditions for the baseline (with sand bar) and lowered sand bar scenarios were compared showing that the baseline scenario predicted higher nearshore waves than the lowered bar scenario. Therefore, the baseline scenario was*

*taken forward for wave overtopping assessment for the Sizewell C FRA, as it is more conservative."*

From a cross-reference with BEEMS TR319 we know that EDF, in 5.3.17 (despite its use of opaque language) must now be referring to the Sizewell-Dunwich banks - variously called 'sand bank' and 'sand bar' in the first sentence. *EDF is stating that the derived nearshore wave conditions are not increased by the loss of the Sizewell-Dunwich banks.* As a generalised statement this is counter to geomorphic principle and established orthodoxy as discussed in section 6.

In further examining the modelling I expected the industry standard overtopping modelling package EurOtop to have been used. EDF decided not to use this package for the following stated reason:

*"1.2.7. EurOtop methods are regarded as the UK industry standard for predicting wave overtopping, particularly for 'standard' defence profiles, which have been well tested and are incorporated into the EurOtop database. The primary issue with using EurOtop at Sizewell C is that the defence profiles at SIZEWELL C are not 'standard', as they comprise of shingle beach and vegetated sand dunes."*
DCO: 5.2 Revision: 1.0 Applicable Regulation: Regulation 5(2)(e) PINS Reference Number: EN010012 Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14

EDF then continues with details of the package it did use:

*"1.2.9. Plate 1.2 to Plate 1.4 [pictures of shingle and sand dunes shown in Appendix 7] demonstrate that there is a substantial shingle beach and vegetated sand dunes at all of the potential flood routes involving wave overtopping at Sizewell C. It is important that those features are considered in the wave overtopping analysis as they may have a significant impact on wave propagation and run-up before waves reach the formal new engineered sea defences, referred to as 'Hard Coastal Defence Feature (HCDF). These defence shapes cannot be properly represented by the EurOtop methods, and therefore AMAZON software was recommended and used for predicting wave overtopping for the Sizewell C coastal flood risk assessment."*
DCO: Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14, op cit.

Input wave data to the Amazon modelling was provided by Cefas:

*"1.2.11. The TOMOWAC wave model has been developed by Cefas for investigating wave propagation from offshore to nearshore areas. To derive inputs to the wave transformation model, a comprehensive joint"*
DCO: Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Op cit.

*"1.3.11 To determine whether the disappearance of the offshore sand banks could have a significant impact on wave overtopping, the TOMOWAC wave transformation model was tested for three scenarios. These are the baseline [as the banks are now], 'Low 5' with the offshore sand banks lowered by 5m and 'ST1' with a shallow south trough."*
DCO: Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Op cit.

The use of opaque language is again found in an associated document so it is difficult to regard its use as a mistake – the 'sand banks', being offshore and capable of a 5m reduction refers to the Sizewell-Dunwich banks:

*"Overall, the 'baseline' scenario predicted slightly higher nearshore waves*

> *than the other scenarios and was therefore taken forward for assessment for the FRA overtopping model runs."*
> DCO: Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Op cit. Section 1.3.13.

EDF in this statement (and the paragraph 5.3.17 in the FRA quoted earlier) is seemingly explaining that the output data from the TOMOWAC modelling provided by Cefas (which feeds the AMAZON modelling) claims that the Sizewell-Dunwich offshore banks produce little effect on the inshore wave climate, and were therefore 'taken forward' (and retained in their present form) for all the FRA modelling runs.

I recommend that the Examiners consider how EDF justifies its claim that the Sizewell-Dunwich banks do not reduce the inshore wave climate and yet should be carried forward as a fixture in the FRA modelling.

Close analysis of documents reveals as follows: If we consider BEEMS TR319, obtained under FOI, we find the origin for the claim:

> *"However, for extreme waves (1:1000 return period), when sea levels are also raised [i.e. late epoch] there is little difference in the near shore [wave climate] between the geoscenarios and present bathymetry…whereas the present bathymetry has been accurately surveyed. It would, therefore seem logical* ***to focus wave run up calculations on the present bathymetry cases."***
> Cefas BEEMS TR319 ed. 2. 'Sizewell – Derivation of extreme wave and surge events at Sizewell with results of the coastal wave modelling, climate change and geomorphic scenario runs.' Page 11

Extrapolating from the paragraph above, EDF/Cefas/Haskoning appear to have taken a scientifically non-compliant approach, explained below:

Cefas notes that the Sizewell-Dunwich banks will have little effect on inshore wave climate in late epoch, extreme raised water level scenarios due to the depth of water over the banks.

EDF/Cefas/Haskoning have seemingly accepted this particular case and suggested it is applicable to all scenarios and all epochs and therefore the Sizewell-Dunwich banks can be considered as a permanent, unchanging geomorphic fixture—to end of Sizewell C life— for the purposes of all wave overtopping modelling studies. This would not be a valid, generalised premise.

This is compounded by EDF/Cefas and Haskoning measuring—or rather, sampling Tomowac output with embedded bathymetry of the Sizewell-Dunwich banks—the inshore wave heights 'one wavelength from the shore' and therefore inshore of the longshore bars:

> ***"The wave height at a distance of one wave length from the waters' edge is used as the input condition for the AMAZON modelling, and this is therefore the location where wave height sensitivity to offshore sand bank depletion was measured."***
> DCO: Main development Site Appendices 1-7 Part 1 of 14. Op. cit., Page 23.

Measuring inshore wave heights 'one wavelength' from the shore is inconsistent with Carr Tucker et al., Mott Macdonald and BEEMS studies that measure inshore wave heights **one kilometre** from the foreshore or in the lee of the Sizewell-Dunwich bank.

EDF/Cefas/Haskoning have, *"…therefore recommended that the 'baseline' scenario is taken forward for assessment in the FRA model runs."* 'Page 29 of the Haskoning section of Main Development Site Flood Risk, Assessment Appendices 1-7 Part 1 of 14'

The 'Baseline' scenario appears to represent more than the permanence of the Sizewell-Dunwich banks but suggests an overall 'present bathymetry' of all claimed 'receptors to wave energy'—the Sizewell-Dunwich banks, the longshore bars and the vegetated shingle—and therefore conforms to the same, unsupportable, premise as the 'Expert Geomorphological Assessment':

> *"The principal receptors (beach, bars, bank and crag) of the future baseline can be expected to resemble the present (i.e. no regime shift) over much or all of the station life."* Chapter 20 DCO: Coastal Geomorphology and Hydrodynamics. Paragraph 20.4.78.

I consider that this means the FRA 'worst-case' flood overtopping modelling **is relying and dependent upon a 'best-case', no regime shift, geomorphological scenario—a scenario adoption that could understate overtopping modelling results in early to mid-epoch, high wave breach modelling for instance.**

That this approach is non-compliant for worst-case modelling (which must reasonably acknowledge offshore and nearshore geomorphological change), seems to be confirmed by Cefas itself in its BEEMS TR319 report, which, as stated, is not in the public domain but underpins the modelling exercise (See DCO: Appendix 1-7, Part 1 of 14, Haskoning Page 25 of 57). TR319 admits that the modelling *does in fact show* that if the Sizewell-Dunwich bank is lowered the modelled data show increased inshore wave size and energy, a statement in full conformity to orthodox geomorphological principles:

> *"The simulations of the geomorphic scenarios show that…the lowered bank scenario…results in near shore wave increases in the vicinity of the SZC proposed site.* ***Simulations run at low return periods (2 to 100 years) do show near shore (1000m) increase in wave energy in the lowered bank simulations and by inference the importance of the present [Sizewell-Dunwich] bank."***
> Cefas TR319 ed. 2. 'Sizewell – Derivation of extreme wave and surge events at Sizewell with results of the coastal wave modelling, climate change and geomorphic scenario runs.' Page 11.

Cefas, again in BEEMS TR319:

> *"The lowered bank by 5m (which includes removal of sediment) shows the greatest difference from baseline for conditions A, E and B, with higher wave heights inshore.* ***The lowered bank simulation is therefore worthy of further consideration****."* Cefas BEEMS TR319 ed. 2. 'Sizewell – Derivation of extreme wave and surge events at Sizewell with results of the coastal wave modelling, climate change and geomorphic scenario runs.' Page 49.

In my view the Flood Risk Assessment does not provide reassurance that adequate, reliable and appropriate modelling has been undertaken. I consider it unreasonable that worst-case flood modelling scenarios rely on an implausible best-case geomorphological stability which includes acceptance and reliance on present offshore morphology and bathymetry to end of station life.

I also consider that the FRA cannot be regarded as in full accordance with the Rochdale envelope required by the Planning Inspectorate.

Given the unconventional approach and results, the EDF/Cefas/Haskoning FRA modelling needs to be subjected to independent review.

## 7.1 Overtopping levels.

Notwithstanding the considerable reservations I have on the modelling approach, the results show dangerous overtopping if UKCP18 recommendations are fully considered.

> *"5.4.7. For the end of theoretical maximum site lifetime at 2190, the results suggest that with the design defence crest at 10.2m AOD the overtopping rates might be dangerous to people and vehicles for the in 1 in 1,000 and 1in 10,000-year events,* [Note that the 1:10,000 event is only 0.71m above the 1953 historical flood level] *however with adaptive defence* [i.e. rebuilding the defence crest from 10.2m to 14.2m] *the risk would be mitigated to **a tolerable overtopping rate of 5 l/s/m**."*
>
> Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Op. cit., Page 36.

EDF's modelled overtopping levels for a 10.2m defence crest before 2190 can also be dangerous:

> Modelled flood overtopping levels for a 10.2m defence crest at 2090/2140 for various return periods are:
>
> | | | |
> |---|---|---|
> | 1:200 (RCP 8.5) | in 2140 is 0.3 l/s/m | (litres per second per metre) |
> | 1:1000 (RCP 8.5) | in 2140 is 3.79 l/s/m | |
> | 1:10,000 (RCP8.5) | in 2090 is 5.8 l/s/m | |
> | 1:10,000 (RCP8.5) | in 2140 is 36.42 l/s/m. | |
>
> Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Op. cit., Table 5.6. Page 35.

EDF, quoting the 1:1000 result from the above, states:

> *"5.4.5. Once the proposed interim sea defence is constructed, there is no predicted overtopping for the 1 in 1,000-year return period event and therefore the construction site would not be at risk. During operation phase and up to end of interim spent fuel store decommissioning, the overtopping rates are below the 5l/s/m threshold for up to 1 in 1,000-year event."*
>
> DCO: Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Op. cit., Table 5.6. Page 36.

The overtopping rates are below the 5 l/s/m threshold at 3.79 l/s/m but **EDF's 'tolerable overtopping level' of 5 l/s/m is not justified by any guidance that I am aware** of and is inconsistent with the advice from world-leading coastal consultant, HR Wallingford:

> *"…overtopping rates became a danger to vehicles when the mean discharge exceeded 0.2 l/s/m."*
>
> Wave Overtopping of Seawalls Design and Assessment Manual HR Wallingford Ltd February 1999 R&D Technical Report W178

The following paragraphs are EDF's justification that 5 l/s/m is a 'tolerable level':

> *"5.3.4. The EurOtop Manual does not provide clear guidance on tolerable overtopping thresholds for people behind coastal defences. Since the main Sizewell C platform would be set back from the coastal defence, the overtopping threshold for people at seawall crest of 0.3 l/s/m would be considered too conservative. Therefore, the same tolerable overtopping threshold as for the SSSI crossing of 5 l/s/m was adopted."*
>
> DCO: Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Appendix 1 Coastal Modelling report. Page 34.

EDF Continues:

*"7.1.34 …Available guidance on tolerable overtopping rates does not provide specific thresholds for people behind the defences, especially considering that the main platform would be set back from the new hard coastal defence. Therefore, the referenced threshold of 5 l/s/m should be considered very conservative [i.e. very safe] as it does not account for energy dissipation between overtopping of the defence and water reaching the main platform area."*
DCO: Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Op. cit., Page 107

Other professional bodies 'do provide specific thresholds' and concur with HR Wallingford, **not EDF:**

The *Institute for Water Education, Unesco-IHE EurOtop* document for example:

*"…aware pedestrian, clear view of the sea, not easily upset or frightened, able to tolerate getting wet, wider walkway would represent 0.1 l/s/m" and "damage to equipment set back 5-10m would occur at 0.4 l/s/m."*
*Admissible overtopping Linked movies on overtopping behaviour, Unesco-IHE, Chapter 3 in EurOtop. Wave Overtopping of Seawalls Design and Assessment Manual.*

Allsop et al. in '*Direct Hazards from Wave overtopping*':

*"A precautionary limit of q = 0.03 l/s/m might apply for conditions where pedestrians have no clear view of incoming waves; may be easily upset or frightened; are not dressed to get wet; may be on a narrow walkway; or are in close proximity to a trip or fall hazard. Research studies have however shown that this limit is only applicable for the conditions identified and should NOT be used as the general limit for which q [mean overtopping discharge] = 0.1 l/s/m in Table 1 is appropriate."*
DIRECT HAZARDS FROM WAVE OVERTOPPING – THE FORGOTTEN ASPECT OF COASTAL FLOOD RISK ASSESSMENT? WILLIAM ALLSOP et al. Page 7

EDF itself appears to acknowledge that overtopping levels should be 'equal to or less than' 1 l/s/m:

*"Building structure elements; Hm0 (significant wave height) = 1-3m =< 1 l/s/m*
*Damage to equipment set back 5-10m =< 1 l/s/m"*
DCO: Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Op. cit., Tables 5.4 and 5.5, Page 33.

Nevertheless, EDF accepts 5 l/s/m as a safe, tolerable overtopping level for the main platform. This is a level of overtopping that would introduce 240,000 litres of water onto the main platform **in one minute** of continued flow over an 800-metre seaward, seawall stretch.

Technical note 5:
If the main platform receiving the overtopping floodwater is 800m x 400m (for example) this would represent 0.23 metres flood depth over an hour period *if the floodwater were evenly and uniformly spread over the entire platform area*. (240,000 litres or 240 m3 divided over 0.2 x320,000 m2, assuming 80% of the site contains buildings) However, flow is most likely to be significantly deeper and rapidly varied over a short distance from the point of overtopping, then gradually varied for the rest of the floodplain.

I maintain that EDF is 'accepting as tolerable' overtopping rates that are significantly greater than national and international guidance. EDF has not, in my opinion, deferred to accepted, external and recognised sources as shown by EDF's statements in their main FRA document paragraphs 5.3.4 and 7.1.34 quoted above.

In conclusion I find the modelling to be inadequately justified, the methodology and approach inconsistent with conventional and accepted tenets which, nevertheless, produces results as presented indicating overtopping conditions that far exceed national and international safety limits.

## 8. Sizewell as a potentially suitable site – Nuclear Energy policy statement EN-6 and 'Mitigative measures'.

The Department of Energy and Climate Change in its 'National Policy Statement for Nuclear Power Generation (EN-6) July 2011', considered Sizewell to be a '*potentially* suitable site'. This judgment is derived from the following guidelines: "Nuclear power stations need access to cooling water…therefore…nuclear power stations in the UK are most likely to be developed on coastal or estuarine sites… at greater risk of flooding." However, the document continues:

> ***"In light of the findings of the Nuclear AoS, (Appraisal of Sustainability) applicants should assess the site's geology [and] geomorphological processes in order to understand the ongoing…coastal and geomorphic processes. This will include identifying impacts on coastal processes."*** The National Policy Statement for Nuclear Power Generation (EN-6) Vol 1 of 11. July 2011: Paras. 2.10.2, 3.6.6, 3.8.3

EDF's infrequent surveys of the Sizewell-Dunwich banks combined with their retention in unchanging form in its FRA modelling appears to be in direct contradiction to the requirements of the AoS.

The EN-6 National Policy Statement quoted (under review and paused by government) pre-dates fresh evidence on coastal stability presented in the two authoritative reports discussed earlier – the 2019 IPCC report (IPCC The Ocean and Cryosphere in a changing climate 24 September 2019) and UKCP18, published in November 2018. I would suggest that although EN-6 is the current national policy the impact of the above reports on the application should also be considered by the Examiners.

The Office for Nuclear Regulation's (ONR) 'Nuclear Safety Case', which is not fully public, is aimed at enforcing a 1:10,000 flood event risk as a basis for design which would, I believe, have to be considered alongside high-end climate change scenarios:

> *"The FRA assesses the risk from all sources of flooding up to the 1 in 1,000-year return period event. More extreme events, such as the 1 in 10,000-year and 1 in 100,000-year events are considered in the safety case assessment as set out by the Office for Nuclear Regulation (ONR) and are not considered in detail in this FRA."*
> DCO: Main Development Site Flood Risk Assessment, op cit., Executive Summary

**The ONR states the following view on overtopping:**

> ***"Defence overtopping should not occur at the Design Basis flood level and there should be some margin available above this to cover the possibility of Beyond Design Basis cliff edge effects."***
> Principles for Flood and Coastal Erosion Risk Management Office for Nuclear Regulation and Environment Agency Joint Advice Note July 2017 – Version 1. Page 20.

This advice note is taken from ONR's Safety Assessment Principles as follows:

> *"261. Facilities should be protected against a design basis flood by adopting a layout based on maintaining the 'dry site concept'. In the dry site concept, all vulnerable structures, systems and components should be located above the level of the design basis flood"*

The ONR continues:

> *"239. For external hazards, the design basis event should be derived conservatively to take account of data and model uncertainties. The thresholds set in FA.5 for design basis events are 1 in 10 000 years for external hazards and 1 in 100 000 years for internal hazards".*
>
> SAFETY ASSESSMENT PRINCIPLES FOR NUCLEAR FACILITIES 2014 EDITION, REVISION 1 (JANUARY 2020) Paragraphs 261 and 239.

However, for a 1:10,000 event, as discussed in the previous section, EDF would rely on its 'adaptive defence' to reduce the flood level to its 'tolerable overtopping level ' of 5 l/s/m – this means building the sea defence crest up from 10.2m to 14.2m.

Without the 'adaptive defence' the overtopping is severe:

> "*7.1.32 The modelled results at the new Hard Coastal Defence Feature for the 1 in 10,000-year event predicted higher mean overtopping rates in 2140 of 36.42 l/s/m*."
> (This event is modelled with a defence crest height of 10.2m / 2140 year / 6.75m water level and 4.42m wave height.)
> DCO: Main Development Site Flood Risk Assessment Appendices 1-7 Part 1 of 14. Op. cit., Page 106-8.

In the executive summary of the *Main Site Flood Risk Assessment DCO document*, EDF states:

> *"The sea defence crest level would initially be constructed to a level of 10.2m AOD with adaptive design to potentially raise the defence in the future up to 14.2m AOD, if sea level changes require."*

**The works necessary to raise the sea defence crest level would be extensive, expensive and involve additional rock armour and significant earthworks. This cannot be regarded as responsive to sudden flood risk.**

An adaptive approach is also not capable of restructuring the development of a breach in the offshore bank complex any more than it can modify sea level rise over the banks. It means that post-breach the site's safety is compromised until a new defence is constructed. I do not understand how an 'adaptive approach' could be adequate to deal with sudden flood risk or surge, unknown rates of change to the Sizewell foreshore in event of compromise to the Sizewell-Dunwich banks or a breach of the proposed defences.

The Environment Agency states:

> ***"Much of the Sizewell C Main Development Site and associated development sites are in Flood Zone 3—a high probability of flooding".***
> Environment Agency Relevant Representation on Sizewell C DCO Sept 2020. Page 6.

The Environment Agency goes on to say that it is therefore essential that the DCO is supported by an adequate Flood Risk Assessment. Sizewell C needs unqualified protection from flooding of the main platform to at least 2150. It is not at all clear how EDF's FRA can be seen to illustrate this standard.

The Institution of Mechanical Engineers, referring specifically to Sizewell B, state:

> ***"…in the UK, nuclear sites such as Sizewell, which is based on the coastline, may need considerable investment to protect it against rising sea levels, or even abandonment/relocation".*** It is not clear how EDF's design for Sizewell C would satisfy the criteria of the IME." IME (Institution of Mechanical Engineers) (2009): Climate Change: Adapting to the inevitable, Institution of Mechanical Engineers, Westminster, London.

DEFRA produced an unpublished government analysis (now partly obtained under FOI) in 2011 which shows that Sizewell is considered a high flood risk up to and including 2080 which is far as the report goes:

> ***"Experts suggested that the main worry was that inundation would cause nuclear waste to leak. 'Sea level rise, especially in the south east of England, will mean that some of these sites will be under water within 100 years,' said David Crichton, a flood specialist and an honorary professor at the Hazard Research Centre in University College London."***
>
> ***"This will make decommissioning expensive and difficult, not to mention the recovery and movement of nuclear waste to higher ground."***
> Guardian, 8 March 2012, Rob Edwards, *'Most nuclear sites at risk of flooding and coastal erosion, says government study.' https://www.robedwards.com/2012/03/most-nuclear-sites-at-risk-of-flooding-and-coastal-erosion-says-government-study.html*

It is also necessary to consider the complications arising from building Sizewell C and maintain the safe operation of Sizewell B and the continued decommissioning of Sizewell A. Sizewell A is controlled by Magnox under the auspices of the Nuclear Decommissioning Authority. Their solicitors have offered the following Representation:

> ***4.4 At this stage, and on the basis of the Applicant's current [DCO] proposals, the NDA and Magnox are not yet satisfied that the Sizewell C Nuclear Generating Station can be constructed and operated in accordance with the Applicant's application proposals in a manner which adequately ensures the safe, secure and environmentally sound decommissioning of the Sizewell A Nuclear Site.***
> JOINT RELEVANT REPRESENTATION OF THE NUCLEAR DECOMMISSIONING AUTHORITY AND MAGNOX LIMITED submitted to the Planning Inspectorate 30 September 2020 From Pinsent Masons LLP.

In my opinion, the National Policy Statement (NPS) that declared Sizewell to be a 'potentially suitable site' for newbuild reactors eleven years ago is adversely impacted by UKCP18 and IPCC reports that it was unable to consider. I consider the claim to current stability of this coast is weak and has a dependency on the offshore Sizewell-Dunwich banks for the security of the Sizewell foreshore. EDF has admitted the potentially insecurity of the offshore morphology; nevertheless, EDF's FRA 'worst-case' flood overtopping modelling appears to be relying and dependent upon a best-case, no regime shift, geomorphological scenario—rather than considering variance in offshore geomorphology—which suggests it fails to meet the current requirements of EN-6's Appraisal of Sustainability as defined in this section.