The Sizewell C Project

6.3 Ch Volume 2 Main Development Site

Chapter 22 Marine Ecology and Fisheries

Appendix 22O Eels Regulations Compliance Assessment Addendum

Revision: 1.0

Applicable Regulation: Regulation 5(2)(a)

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Planning Act 2008

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

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EXECUTIVE SUMMARY

NNB Generation Company (SZC) Limited (SZC Co.) is proposing to build and operate a new nuclear power station at Sizewell on the Suffolk Coast, north of the existing Sizewell B power station. The design of this new power station, Sizewell C, will take into account the sensitive nature of the surrounding environment, while providing enough space to build and operate the power station safely and efficiently to support approximately 7% of the UK's electricity (or approximately six million homes). However, under the Eels (England and Wales) Regulations 2009 (S.I. 2009 No. 3344) (as amended) (the 'Eels Regulations'), companies which intend to build new developments, such as Sizewell C, are required to make provision for the safe passage of European eels (*Anguilla anguilla*), an International Union for Conservation of Nature red list 'critically endangered' species.

This addendum to the **Eels Regulations Compliance Assessment** (ERCA) (**Appendix 22O** of **Volume 2**, **Chapter 22** of the **Environmental Statement** (ES) [APP-332] undertaken by SZC Co. presents additional information provided in response to the Environment Agency's Relevant Representation on the Sizewell C Development Consent Order (DCO), dated September 2020 [RR-0373] (Document reference AE/2020/125515/01). The focus areas addressed in the addendum with the respect to impacts upon European eel migration and population estimates, included limitations on glass eel surveys; efficiency of the Low-velocity Side-entry (LSVE) intake heads to reduce eel impingement; glass eel entrainment through the CWS; and potential impacts of the thermal plumes on eel migration. The potential impacts of the proposed design changes for Sizewell C,including the proposed temporary desalination plant, on eels and compliance with the Eel Regulations are also described in this addendum.

This document also examines whether the design changes that were introduced in January 2021 following engagement with the local authorities, environmental organisations, local stakeholder groups and the public and the proposed temporary desalination plant discussed with the Environment Agency in August 2021 would change the conclusions of the ERCA. No changes to the original ERCA [APP-332], which concluded that Sizewell C will not, overall, impact European eel populations and silver eel escapement have been identified.

SZC Co. now considers that all matters regarding the operation of Sizewell C and European Eel have been fully addressed.

1 INTRODUCTION

1.1 Background

1.1.1 NNB GenCo (SZC) Ltd (hereafter SZC Co) is proposing to build and operate a new nuclear power station at Sizewell on the Suffolk Coast, north of the existing Sizewell B power station. The design of the new Sizewell C (SZC) power station will take into account the sensitive nature of the surrounding environment, while providing enough space to build and operate the power station safely and efficiently to support approximately 7% of the UK's electricity (or approximately six million homes). Under the Eels (England and Wales) Regulations 2009 (S.I. 2009 No. 3344) (as amended) (the 'Eels Regulations'), no new infrastructure, including nuclear new builds, is to be constructed without provision for European eels (*Anguilla anguilla*), an IUCN red list 'critically endangered' species. Therefore, an **Eels Regulations Compliance Assessment** (ERCA) was undertaken by SZC Co to support the Development Consent Order (DCO) application to the Planning Inspectorate for Sizewell C. The ERCA is presented in **Appendix 22O** of **Volume 2**, **Chapter 22** of the **Environmental Statement** [APP-332].

1.2 Objectives

1.2.1 This document is an addendum to the original ERCA and presents additional information provided in response to the Environment Agency's Relevant Representation on Sizewell C DCO [RR-0373] (a copy is provided in Table 1:1).

1.2.2 This document also examines whether the design changes that were introduced in January 2021 following engagement with the local authorities, environmental organisations, local stakeholder groups and the public would change the conclusions of the **ERCA.**

1.2.3 This document also examines whether the proposed temporary desalination plant, submitted to the Planning Inspectorate in September 2021 would change the conclusions of the **ERCA**.

1.3 Scope to Addendum

1.3.1 The review of the Relevant Representation has identified several key focus areas associated with the ERCA for further clarification which are presented in Table 1:1. Each of these focus areas are addressed in a separate section of this addendum:

- Limitations around glass eel surveys in particular at the location of the Sizewell C intakes. Additional information is provided in **Section 2**.

- Ability of the proposed Low-velocity Side-entry (LSVE) heads of the intake tunnels to reduce the impacts of eel impingement. Additional information is provided in **Section 3**.

- Potential impacts on eel passage (all life stages) through the operational cooling water system, including the effects of hydrostatic pressure change and discharge concentrations. Additional information is provided in **Section 4**.

- Potential impacts of the thermal plumes on eel migration. Additional information is provided in **Section 5**.

- Proposed design changes, including the proposed temporary desalination plant is provided in **Section 6**.

- Proposed eel passage measures in Sizewell Drain and in the Alde-Ore river catchment is provided in **Section 7**.

Table 1:1: Relevant Representation – Sizewell C Eels Regulations Compliance Assessment

Document Title	Paragraph Number	Environment Agency Concern	Environment Agency Comment	Environment Agency Suggested Solution
SZC_Bk6_ES_V2_Ch22_Marine_Ecology Appx220_Eels_Compliance_Regulations_ Assessment	3.2.16 5.3.25 5.3.29	A review of the proposed LVSE design and its ability to reduce the number of impinged fish is currently being undertaken by the Environment Agency. We are currently not able to conclude that the impact has been reduced as described by the applicant.	We are currently reviewing BEEMS SP099 V3. The LVSE design proposed for SZC and its fish protection compliance are currently being assessed.	We are currently unable to conclude that the LVSE in take design will reduce the number of abstracted fish as described.
SZC_Bk6_ES_V2_Ch 22_Marine_Ecology_Ap px220_Eels_Compliance_Regulations_As sessment	3.3.11	It's unclear what life stages this information relates to. It should be noted that eels move between depths at a of rate of their choice which does not result in trauma. This does not mean that experiencing a change in depth and pressure in a short period of time as a result of passage through a cooing wafer loop will not result in trauma. Silver eels migrating back to the Sargasso have also experienced physiological change including changes to the swim bladder to accommodate this migration.	Eels experiencing this hydrostatic pressure change in a short period of time may result in trauma as the eel has no control over the speed of change. Yellow eels have not undergone any physiological change to their swim bladders and may also be more vulnerable to pressure change. The parasite, Auguillicoloides (Anguillicola) crassus may also alter tolerance to pressure change.	Provide details of what lifestages this assessment of potential barotrauma apples to, highlight any lifestages where impact of hydrostatic pressure are not known. Provide Barotrauma damage threshold details (log ratio pressure LRP). Compare SZC pressure change to natural movement to depth for this species for each lifestage. Provide details of any known change in pressure tolerance as a result

Document Title	Paragraph Number	Environment Agency Concern	Environment Agency Comment	Environment Agency Suggested Solution
				of infestation from Anguillicola.
SZC_Bk6_E S_V2_Ch 22_Marine_Ecology_Ap px220_Eels_Compliance_Regulations_As sessment	3.314 – 3.3.21	There are three key limitations to the surveying: 1) Monitoring at the location of the SZC intakes/outfall was limited to 8.75 hours of sampling conducted over 11 days in April and May 2015. 2) In 2015 data shows that the main glass eel run at Flatford Mill on the Stour estuary in Suffolk, took place in June with 7892 out of the 8554 glass eels recoded that year, running in that month. the next most productive month was July. This is the closest monitoring station the Environment Agency has to SZC. which is located to the south of the proposed intake location (glass eels would be expected to be observed at this location before they arrive at the SZC location).	These limitations impact the conclusions of the survey as follows: 1) This is considered too small an amount of sampling effort to concluded potential impacts from. The survey design, as well as taking place too early in the year for the location, did not include all of the variables that could influence glass eel movements at this location, such as monitoring in dark conditions (at night) and monitoring at different stages of the lunar cycle. 2) This would indicate that the monitoring that was conducted by CEFAS to assess the potential numbers of glass eel present at the location of SZC intakes took place too early in the season (April and May).	Update this section and include the limitations around the survey design and why it is not possible to draw conclusions on the potential entrainment of glass eels at the location of the SZC intakes. Amend the information to show that peak migration can take place later than suggested at this location and include details around interannual variability being an important consideration at this site. Suggest using 2015 as the reference year. Monitoring commenced on the Stour at the end of April, with the first glass eels being recorded in May (144). June recorded the highest number (7892). followed by July (345).

Document Title	Paragraph Number	Environment Agency Concern	Environment Agency Comment	Environment Agency Suggested Solution
		3) In 2014 16310 glass eels were recorded passing through the Flatford glass eel monitoring station, this is nearly double the number recorded at the same location in 2015.	3) This demonstrates interannual variation is an important consideration at this site and potential impacts cannot be concluded from a small amount of sampling conducted in a single year.	
SZC_Bk6_E S_V2_Ch22_Marine_Ecology_Appx220_ Eels_Compliancce_Regulations_Assessm ent	3.4.2	The predicted survival for glass eels has not been provided.	Cannot assess predicted survival rates for glass eels as no figure has been provided.	Provide predicted survival rate for entrained glass eel at SZC.
SZC_Bk6_E S_V2_Ch22_Marine_Ecology_App x220 _Eels_Compliance_Regulations_Assesse nt	3.4.8-3.4.9	BEE MS TR395 did not in dude pressure change or condition chemicals such as hydrazine. Temperature should represent the expected temperatures at SZC during June-July when peak migration occurs. A more precautionary assessment is required in the absence of a comprehensive experiment. Pressure change for HPC assessed in BEE MS TR273. Is the intake depth and pressure change the same at HPC and SZC? Hydrazine and other	It is not possible to conclude what effect a passage through the SZC cooling water loop will have on glass eel survival. Experiments should include replication of passage through a 3km pipe, pressure change, trauma from passage through a pump, temperature uplift, exposure to the range of chemicals to be used at SZC, second passage through a 3km pipe and second pressure change prior to discharge at the outfall. It will not be possible to	Use worst case survival predictions. Provide a clear description of the limitations of the glass eel EMU experiments and the eels surveys undertaken at Sizewell.

Document Title	Paragraph Number	Environment Agency Concern	Environment Agency Comment	Environment Agency Suggested Solution
		condition chemicals appear to have also been excluded from this experiment. DoesTR273 include the trauma associated with second pressure change and mechanical trauma from travel through the outfall pipe prior to discharge?	assess the cumulative impact of these traumas on glass if they are not all incorporated.	
SZC_Bk6_ES_V2_Ch22_Marine_Ecology_App x220_Eels_Compliance_Regulations_Assessment	5.2.49-5.2.51	What discharge concentration is being used for this assessment as both 15µgl and 30µgl concentrations have been proposed? Is this assessment for the commissioning phase or the operational phase? Bioaccumulation is described as medium by Slonim and Gisclard (1976).	Unsure of the discharge concentration being referred to in this assessment. Hydrazine impacts during either the commissioning or operational phase may not be provided. Hydrazine bio-accumulates to a higher degree than stated.	Clarify what discharge concentration this assessment refers to. Clarify if this statement applies to the commissioning or operational phase. Provide reference for the evidence of hydrazine having a low bioaccumulation potential.
SZC_Bk6_ES_V2_Ch22_Marine_Ecology_App x220_Eels_Compliance_Regulations_Assessment	5.3.27	Does this include trauma specific to the S2C location such as passage through 3km of pipe and barotrauma x2.	Potential underestimate of mortality as trauma specifically associated with the SZC cooling water loop may not be included.	Add detail of the additional trauma experienced from the SZC cooling water loop.

Document Title	Paragraph Number	Environment Agency Concern	Environment Agency Comment	Environment Agency Suggested Solution
SZC_Bk6_ES_V2_Ch22_Marine_Ecology_App x220_Eels_Compliance_Regulations_Assessment	5.3.51	Migrating eels can use chemical signals to navigate to fresh water (Cresci 2020).	Has an assessment of the chemicals in the SZC cooling water discharge been undertaken to assess if it could act as an attractant to migrating eels seeking chemical cues.	Assess whether the SZC plume will attract or disrupt migrating eels.

2 LIMITATIONS ON GLASS EEL SURVEYS

2.1 Introduction

2.1.1 This section of the addendum summarises the Relevant Representations of the Environment Agency associated with the limitations around glass eel surveys in particular at the location of the Sizewell C intakes; and provides additional information in response to this view.

2.2 Summary of Relevant Representations

2.2.1 The Environment Agency noted concern in their relevant representation (see Table 1:1) that the monitoring of glass eels at the location of the Sizewell C intakes and outfall was limited to 8.75 hours of sampling conducted over 11 days in April and May 2015 and does not fully represent the glass eel population at Sizewell C. The key reasons listed to explain their concern include the following:

- Only a small amount of sampling effort has been conducted on glass eel populations at the location of the Sizewell C intakes and outfalls to conclude potential impacts.
- The survey design, as well as taking place too early in the year for the location of Sizewell C, did not include all of the variables that could influence glass eel movements, such as monitoring in dark conditions (at night) and monitoring at different stages of the lunar cycle.
- The Environment Agency's glass eel surveys also demonstrate that interannual variation in population sizes is an important consideration at the location of Sizewell C, and potential impacts cannot be concluded from a small amount of sampling conducted in a single year.

2.2.2 The Environment Agency has thus requested the below additional evidence, which is presented in Section 2.3 along with other additional supporting information:

- Provide details on survey limitations around the Cefas survey design and why it is not possible to draw conclusions on the potential entrainment of glass eels at the location of the Sizewell C intakes.
- Provide information on peak glass eel migration periods which may take place later than that predicted by Cefas and include details

around interannual variability being an important consideration at location of Sizewell C.

2.3 Additional Information

a) European Eel Life History

2.3.1 In order to provide context on the potential limitations of the glass eel surveys undertaken by Cefas (and provide information relevant for other sections of this addendum), a summary of the life history of eels is provided.

2.3.2 The European eel has a complex life history. Leptocephalus larvae, derived from spawning in the eastern part of the Sargasso Sea, drift for as much as two or three years in the Gulf Stream and the North Atlantic Current to the continental shelf of Europe and North Africa. On reaching the continental shelf the larvae metamorphose to the unpigmented glass eel stage, settle out of the water column in estuaries in spring in the UK and metamorphose into pigmented elvers that may remain and feed in coastal marine or estuarine waters or begin active upstream migration in freshwater. There they disperse to feed and grow for up to 20 or more years as yellow eels (up to 50 years has been recorded) before maturing into the silver eel phase, at which stage they migrate back to their spawning grounds. Silver eels are believed to complete their return migration in deep water (approximately 2000 m) using Gulf Stream counter-currents that help them move in a generally westward direction. Their passage is aided by anatomical changes such as modifications to their retina, which are similar to those of abyssal fish, and changes to the wall of the swim bladder that allow the eels to swim at such depths. Age at maturity ranges from 10 to 20+ years in northern temperate waters and is earlier for males than for females (BEEMS Technical Report TR243).

2.3.3 The scientific literature suggests that glass eels generally arrive in the North Sea in January to February. However, this is dependent on met-ocean conditions over Northern Europe and the relative strength of the Gulf Stream and associated currents around the British Isles. Observations suggest that eels enter the North Sea from both the English Channel and from the north, following currents that flow around Scotland and southwards into the southern North Sea. However, it is possible to catch glass eels in the southern North Sea from January to mid-May depending on the prevailing met-ocean conditions. Environment Agency eel recruitment data from fish weirs and traps on the Rivers Stour and Blackwater indicate that glass eels migrate upstream in rivers from April through the year and can be found as late in the year as September. However, numbers recorded in these local rivers in recent years appear to be peak in May/June. Sampling for glass eels on tributaries of the River Thames is carried out annually between April and September also suggesting that glass eels would be present in the East Anglia marine environment prior to entering freshwater, in or around April and May. Targeted glass eel surveys conducted in April and May 2015 as part of the BEEMS programme (further detailed in this section) only succeeded in catching one glass eel in April on a flood tide at the location of the Sizewell C intakes (3 km offshore) from a total of 105 tows. (BEEMS Technical Report TR356).

2.3.4 When sexual maturity is reached eels leave for their return journey to the Sargasso Sea in an anatomically distinct silver eel phase. Spawning migrations occur mainly during the second half of the year. Very few specimens of nearly fully mature silver eels have been captured at Sizewell but only one mature eel in 2009 which was the first specimen in this condition observed by Pisces Conservation staff in over 30 years of impingement sampling.

2.3.5 The above survey data suggests that glass eels appear to be transit species, and as such will pass Sizewell on their passage to river estuaries; and it is reasonable to assume that adult silver eels transit past Sizewell on their return migration (or escapement) to the Sargasso Sea.

b) Existing Cefas European Eel Surveys

2.3.6 In order to fully understand the behaviour and population of European eels, in addition to the BEEMS April and May 2015 survey, Cefas have undertaken over 10 years of eel surveys and research, which have considered all eel life stages, from glass eels to silver eels, within the area of Sizewell C and Sizewell B (and overall Greater Sizewell Bay). These surveys included 24 hour sampling, which captured all phases of the tide and lunar cycle which influence eel behaviour and population counts. A summary of the key eel surveys and monitoring within the area of Sizewell C undertaken by Cefas are listed below:

- BEEMS beam and otter trawl surveys of the Greater Sizewell Bay between 2008 and 2012.
- Coastal pelagic fish survey of Greater Sizewell Bay carried out in March and June 2015. BEEMS itchyoplankton surveys of the Greater Sizewell Bay between 2008 and 2012, and 2014 and 2017.
- Cefas Comprehensive Impingement Monitoring Programmes (CIMP) 2009 - 2017 (BEEMS TR120, TR196, TR215, TR270,TR339).

- Entrainment Mimic Unit (EMU) Experimental Programme Report: European eel (Anguilla anguilla) November 2013 (BEEMS TR273).
- EMU European eel (Anguilla anguilla) - glass eel, Sizewell extended profile (BEEMS TR395). This included all stages of glass eels, including pigmented elvers.
- Sizewell glass eel surveys (BEEMS TR356).
- Predictions of entrainment by Sizewell C in relation to adjacent fish and invertebrate populations (BEEMS TR318).
- Worst case glass eel entrainment assessment for Sizewell C (BEEMS SPP104).
- Sizewell C – Impingement predictions based upon specific cooling water system design (BEEMS TR406).
- Additional information from sources such as sampling undertaken during the operation of the Sizewell A Station, characterisation studies for other marine developments in the local area, inshore fishing surveys off the Suffolk coast and international stock assessments.

c) Glass Eel Survey Limitations and Consideration of Peak Periods

2.3.7 Based on the comprehensive eel surveys and monitoring programmes undertaken by Cefas over 10 years, it is possible to draw conclusions on the potential entrainment of glass eels at the location of the proposed Sizewell C intakes. The following provides the rationale behind this statement which is also particular relevant to **Section 4**.

2.3.8 The eel surveys within the proposed location of Sizewell C, as stated above did include 24 hour sampling, which captured all phases of the tide and lunar cycle which do influence eel behaviour and population estimates. For example, the Comprehensive Impingement Monitoring Programmes (CIMP) of Sizewell B was initiated in 2009 (nearly 12 years ago) to provide information for Sizewell C. The sampling scheme consisted of sampling for six one hour samples in the daylight in addition to one 18 hour sample that was collected overnight. In each sample, the impinged material was sorted to species where possible, weighed and fish fauna, including glass eels measured. If subsampling was required, the data were raised to the individual sample first, before all seven samples (six hourly and one overnight) were summed to give an estimate of the 24 hours of sampling. A total of 128 sampling visits were completed between February 2009 and March 2013. The same sampling regime resumed in 2014 and is now ongoing; and highlights the consideration of both day and night sampling of eel populations.

2.3.9 It is acknowledged that given the morphology of glass eels, which are typically 4 mm width (and up to 8 mm for 130 mm elvers), it is likely that most glass eels will pass through the 10 mm mesh on the Sizewell B and proposed Sizewell C cooling water screens and only rarely appear in impingement samples; and for the above monitoring programme only two glass eels were sampled with a length of 67.5 mm. However, no glass eels or elvers were detected in water drawn from the Sizewell B forebay during the 12 month BEEMS Comprehensive Entrainment Monitoring Programme at Sizewell in 2010/2011 (BEEMS Technical Report TR318); nor in any of the extensive multi-annual plankton surveys (620 plankton trawls 2008-2017), intensive BEEMS coastal trawl surveys or pelagic survey effort, conducted at Sizewell. Although it is recognised that the trawl survey gears do not effectively target adult eels. The CIMP programme consisted of 40, 24 hour samples taken directly from the Sizewell B forebay and represented Sizewell B abstraction at 640 m offshore. The totality of data from this extensive sampling programme led to the conclusion in BEEMS Technical Report TR318, that whilst glass eels are present in Sizewell coastal waters, that their density was very low at this location. The potential impact of glass eel entrainment in Sizewell C was therefore assessed as negligible (see **Section 4**).

2.3.10 The Environment Agency concerns regarding the influence glass eel movements, such as monitoring at night; and at different stages of the lunar cycle on population estimates, along with limitations of the BEEMS April and May 2015 glass eel surveys, are further considered below:

- There is scientific consensus that glass eels employ Selective Tidal Stream Transport (STST) up to the tidal limit in estuaries, migrating up estuary on the flood and settling on the bed during the ebb. In practice the efficiency of migration using STST (the observed migration speed divided by the flood tide current speed) has been found to be much less than 100%. Beaulaton and Castelnaud (2005) measured efficiencies of 15-19% for glass eels in the Gironde estuary, resulting in mean up estuary migration speeds of 3 to 4 km/day. Lambert et al (2007) found that 30% of glass eels migrate on the flood by day; and 70% by night in the lower section of the Gironde estuary in France.
- The BEEMS programme found no evidence of preferential migration by night in the Bristol Channel at Hinkley Point (BEEMS Technical Report TR274) where the estuary is more than 20 km wide. This

challenging 2-year monitoring programme in 2012/2013 was jointly funded by EDF Energy and the Environment Agency and consisted of 321 tows spread over 3 surveys (February/March 2012, February/March 2013 and April 2013). The surveys were conducted at 3 depths; 0 m, 4 m, and 7 m where the depth refers to the top of the 1.4 m vertical opening of the square MIK net. It was the first time such a programme has been undertaken at a wide lower estuary site in the UK. The programme found that glass eel catches were not significantly different between day and night and concluded that:

  - glass eels used the full width of the Severn Estuary to migrate upriver;
  - the greatest abundance of eels was consistently found in shallow, inshore sites on the southern and northern sides of the estuary;
  - there is evidence that eel densities are greater at the surface than at deeper depths; particularly than at depths of 7 m;
  - the density of eels at the location of the HPC intakes (3 km offshore) was less than at further inshore sites (0.5 km – 1 km offshore). Pooling the data from the three surveys, the density at the offshore HPC intakes was 59% of the density at the inshore HPB intake.

- Based on BEEMS Scientific Position Paper SPP104, it was concluded there was no evidence of diurnal variability of glass eel density in coastal waters, although there is limited evidence from estuarine locations that indicate a higher night-time density (please see BEEMS SPP104 for more details).

- Based on Environment Agency glass eel monitoring at Beeleigh weir on the River Chelmer (2010 to 2018), the peak months for the glass eel migration were April – June with peak numbers in April or May with the exception of 2016 when the peak was in June. These 3 months accounted for a mean of 83% of the migrating eels in the period 2010-2018 (2016 was excluded from this calculation due to trap damage from July – September inclusive) with a range of 62% to 95%. In 2015, the peak month was May with 88% of the migrating eels occurring in April to June.

- The Environment Agency monitoring stations at Beeleigh and Flatford, are located near the limit of saline influence and the timing of glass eel counts at these locations could be subject to delays as the eels wait for an uncertain number of weeks for appropriate environmental conditions. Under such circumstances the measured timing of peak migration will be expected to be flattened and not strongly linked to the timing of eel arrival at the estuary mouth at all. Similarly, relative timings of measured upriver migrations may reflect different arrival times at estuary mouths but also differences in environmental conditions at the Environment Agency monitoring locations.

- More recently glass eel monitoring has taken place off the Bradwell A power station in Essex near to the mouth of the Blackwater Estuary using the same fishing gear and sampling methodology as deployed for the BEEMS April and May 2015 glass eel surveys at Sizewell. Starting from February 2020, four sampling days were conducted in each month broken down into two days of daytime sampling; and two days of night sampling. The 2020 glass eel catches are shown in Table 2:1.

Table 2:1: Glass Eel Catches in the Blackwater Estuary 2020

Months in 2020	Number of glass eels captured in four fishing days/month
February	**1**
March	**9**
April	0
May	0
June	0

Source: BEEMS SPP104

d) Conclusion

2.3.11 The information provided in this section included life history and behavioural characteristics of European eel, trends in eel monitoring data and a review of the comprehensive surveys, monitoring and research undertaken by Cefas on all life stages of eels within Sizewell coastal waters. It can be concluded based on this information, which is further detailed in BEEMS Technical Report TR406 and BEEMS Scientific Position Paper SPP104, that there were no significant limitations around the eel surveys, in particular quantifying glass eel population estimates at the location of the SCZ intakes. This is clearly evident based upon the identified time lag between coastal migration glass eel peaks and the measured peaks at the tidal limit observed by Cefas, which indicated the peak migration past Sizewell could be expected in the period March to April which virtually overlaps with the BEEMS glass eel surveys in April and May 2015. Furthermore, it can be concluded that the current information on European eel obtained by Cefas has not limited the potential entrainment or impingement effects on European eel. This aspect is further detailed in **Section 4**.

3 IMPACTS OF THE COOLING WATER SYSTEM ON EEL IMPINGEMENT

3.1 Introduction

3.1.1 This section of the addendum summarises the Environment Agency's Relevant Representations with regards to the ability of the proposed Low-velocity Side-entry (LSVE) heads of the intake tunnels to reduce the impacts of eel impingement and provides additional information in response to this view.

3.2 Summary of Relevant Representations

3.2.1 The Environment Agency noted in their relevant representation (see Table 1:1) that it is not able to conclude that LSVE heads will provide any mitigation for glass eel entrapment.. BEEMS Scientific Position Paper SPP99 – Predicted impingement performance of the Sizewell C LVSE intake heads compared with the Sizewell B intakes. However, this paper is summarised and presented in **Section 3.3**, along with other supporting additional information.

3.3 Additional Information

3.3.1 The proposed Sizewell C cooling water system (CWS) intakes will be low velocity side entry (LVSE) structures. A total of four LVSE heads will be installed with two heads fitted on each of the two intake tunnels. The intake heads will be located approximately 3 km offshore, on the eastern side of the Sizewell-Dunwich Bank in approximately 15 m (ODN) depth (Figure 3-1).

3.3.2 The LVSE structures are state-of-the-art intakes which are specifically designed to reduce the cross-sectional area available to intercept any European eel being transported in the tidal flows, including all life stages. The reduction in cross-sectional area combined with their low intake velocity is predicted to substantially reduce the number of eel abstracted per cumec (cubic metre per second) of seawater compared with Sizewell B (SZB) which is fitted with two capped omnidirectional intake heads with intake velocities that exceed the ability of most eels to avoid being abstracted (see Figure 3-2 for 3D images of the HPC LSVE intakes).

Figure 3-1: Location of SZB and Proposed SZC WCS Intake and Outfall Heads

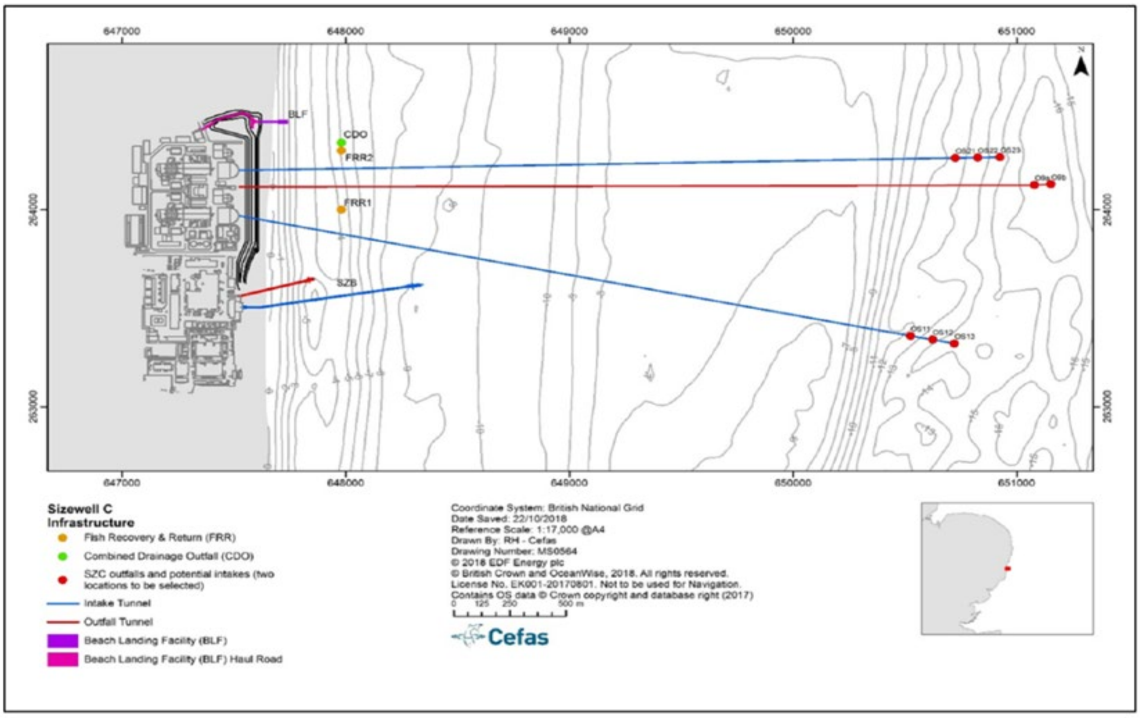
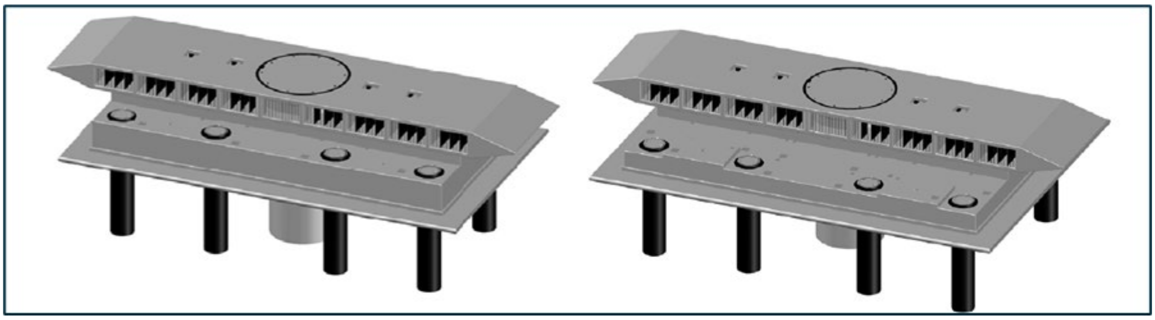


Figure 3-2: Dimensional Views of the Hinkley Point C LVSE



a) Conclusion

3.3.3 SZC Co maintains its position that the LVSE intake head <u>will </u>provide some inquantifiable mitigation of abtraction of glass eels. However, based on detailed discussion at the Hinkley Point C Water Discharge Activity Permit Appeal, SZC Co has agreed to the same concession made by HPC Co (NNB Generation Company (HPC) Ltd) that for the purposes of impact impingement assessments the LVSE intake head will provide no additional benefit over a typical 'capped' intake head.

3.3.4 BEEMS Scientific Position Paper SPP116, provides sensitivity analyses assuming no benefit of the LVSE, in that impingement per cumec was assumed to be no different than the current SZB head. Therefore, impingement predictions for SZC were scaled-up from SZB at value of 1:1 for the analysis.

3.3.5 In the absence of mitigation, losses of eel due to impingement equates to 1.27% of the Anglian River District Basin (RBD) silver eel biomass. Assuming no LVSE benefit and just installation of the FRR system, this equates to 0.13% of SSB if the yellow eel Equilivant Adult Value (EAV) is applied (BEEMS Technical Report TR406).Whilst glass eels are present in the Sizewell coastal waters, their density is very low and the station presents a negligible risk to population sustainability. It is therefore concluded that impingement will not present a significant risk to the European eel stock.

4 IMPACTS OF THE COOLING WATER SYSTEM ON EEL ENTRAINMENT

4.1 Introduction

4.1.1 This section of the addendum summarises the Relevant Representations of the Environment Agency [RR-0373] associated with the potential impacts on eel passage (all life stages) through the water cooling system, including the effects of hydrostatic pressure and discharge concentrations associated with eel passage (entrainment) through the intake and outfall tunnels. This section also provides additional information in response to this view.

4.2 Summary of Relevant Representation

4.2.1 The Environment Agency noted in its relevant representation (Table 1:1) concerns in relation to the cooling water system (CWS) for Sizewell C on eel entrainment:

- Hydrostatic pressure changes associated with eel passage (entrainment) through the intake tunnels of the CWS and how this may affect the different life stages of eel.
- Level of discharge concentrations through the outfall tunnels of the CWS during the operation (and potentially commissioning) phase and implications on eel and bioaccumulation potential.

- Potential cumulative impacts of hydrostatic pressure changes on glass eels and trauma from travel through both intake and outfall tunnels, temperature uplift and exposure to chemicals associated with the cooling water loop system.

4.2.2 The Environment Agency has thus requested the below additional evidence, which is presented in **Section 4.3**, along with other additional supporting information.

- Concerning hydrostatic pressure on eels;
  - Highlight any eel life stages where impact of hydrostatic pressure are not known.
  - Provide barotrauma damage threshold details (log ratio pressure LRP).
  - Compare Sizewell C pressure change to natural movement to depth for eel life stages.
  - Provide details of any known change in pressure tolerance as a result of infestation from *Anguillicola*.
- Concerning discharge concentrations on eels:
  - Clarify discharge concentrations for the operational and decommissioning phase.
  - Provide reference for the evidence of hydrazine having a low bioaccumulation potential.
- Concerning cumulative impacts of hydrostatic pressure changes, temperature uplift and chemical exposure on glass eels:
  - Use worst case glass eel survival predictions.
  - Provide a clear description of the limitations of the glass eel EMU experiments and the eels surveys undertaken at Sizewell.

4.3 Additional Information

a) Impacts of Predicted Hydrostatic Pressure on European Eels

Background into Hydrostatic Pressure

4.3.1 Recent research makes reference to potential pressure - related effects (barotrauma) associated with fish passage through deep CWS tunnels. The basic premise is that when fish are subject to rapid depressurisation, gas-filled organs (principally the swim bladder, but also pro-optic bullae in clupeids) tend to expand according to Boyle's Law, risking rupture. Those most at risk are physoclists (e.g. sea bass), which can only adapt to prerssure change over periods of hours by vascular gas exchange, however, physostomes (e.g. European eels) can vent excess gas to the exterior and tolerate changes in hydrostatic pressure.

4.3.2 Each 10 m descent below the seabed increases the hydrostatic pressure by 1 bar, so fish drawn into the tunnel may be exposed to pressure increases of several bar, this being maintained for the duration of passage to the forebay. Approaching the forebay with its free water surface, the ascending section of the tunnel brings the pressure back towards atmospheric levels.

4.3.3 The risk of pressure-related injury to fish is most likely related to differences between the original acclimation pressure of the fish (based on the depth from which they were drawn into the intake) and atmospheric pressure as fish are lifted from the water by the fine screens. As an example, if the fish's acclimation depth was 10 m (1 bar pressure due to water + 1 bar atmospheric = 2 bar absolute), bringing the fish to atmospheric pressure (1 bar absolute) would halve the pressure and double the swim bladder gas volume, potentially rupturing the swim bladder in a physoclist.

European Eels and Hydrostatic Pressure

4.3.4 During their spawning migration, European eels perform diel vertical migrations, swimming at depths of 600–1000 m during daytime; and depths of 100–300 m at night (Wysujack et al., 2015). Accordingly, migrating eels are exposed to various hydrostatic pressures of up to 10.1 MPa (101 bar). The effects of short and long-term exposure to high hydrostatic pressure on energy metabolism, membrane properties, and muscle tissue of eels have been comprehensively analysed (Sébert et al. 1991; Scaion et al. 2008; Sébert et al., 2009b). The results have revealed that oxygen consumption decreases after long-term exposure to a pressure of 10.1 MPa; swimming efficiency appears to be improved under elevated pressure (Sébert et al., 2009a) and overall eels don't typically experience barotrauma which may impede migration.

4.3.5 The effect of elevated hydrostatic pressure on swimbladder tissue has been recently addressed, including the effects of *Anguillicola*, a nematode which can significantly impair swimbladder function of European eels. *Anguillicola* invades the swimbladder and affects its function by impairing gas deposition, feeding on swimbladder tissue, causing wall thickening, inflammation, tissue degeneration, and filling the lumen with eggs, larvae and dead nematodes. Ultimately, these effects can lead to a total loss of function (Barry et al., 2014). Comparing swimbladder tissue of uninfected yellow with uninfected silver eels, Schneebauer et al (2016) showed the concentration of antioxidants and activity of enzymes were higher after silvering, corresponding with lower levels of lipid peroxidation. Whereas in yellow eels the infection with *Anguillicola* had no effect, in silver eels the capacity to cope with oxygen free radicals was significantly impaired. In muscle tissue, silvering or the infection only affected the activity of enzymes, but in exactly the same way as in swimbladder tissue.

4.3.6 Overall, it appears that the yellow eel phase is more tolerant of Anguillicola, while the silver eel phase (silvering), may be less tolerant of altered cellular processes associated with *Anguillicola*. During silvering the oxygen free radical defence capacity of swimbladder tissue of the European eel is significantly improved in order to prepare for the high oxygen partial pressures encountered during the diurnal vertical migration during the spawning migration. However, this improvement may be diminished by the infection of the swimbladder with *Anguillicola* (Schneebauer et al., 2016). Nimeth et al (2000) showed that for glass eels, while aerobic metabolism during swimming activity is not affected by *Anguillicola*, the swimbladder tissue can show histological changes, which most likely will impair swimbladder function of glass eels, although it is unclear from current research how this may effect changes in hydrostatic pressure on the swimbladder of glass eels.

European Eels and Sizewell C CWS Hydrostatic Pressure

4.3.7 Seawater for cooling the two UK EPRTM reactor units of Sizewell C would be abstracted via a series of intake structures and tunnels. Each reactor unit would have a single dedicated 6 m internal diameter intake tunnel extending approximately 3 km out and 30 m under the seabed. The predicted maximum atmospheric pressure associated with the operation of the intake tunnels would be 4 bar (0.4 MPa). Given the diel vertical migration patterns of European eel with swimming depths up to 1000 m and hydrostatic pressure tolerances up to 101 bar, the effects of pressure changes associated with the intake tunnels of Sizewell C are not predicted to impact the energy metabolism, membrane properties, and muscle tissue of eels; and, thus cause eel mortality or injury. The same conclusion can be applied to the dedicated Fish Recovery and Return (FRR) system, which will consist of two significantly smaller outfall tunnels returning eels back into the sea. The proposed position for the FRR outfall tunnels is approximately 475 m from the forebays on the seaward flank of the outer longshore bar in water depths of 5.5-6.0 m below ODN, with an approximate atmospheric pressure of less than 1 bar.

4.3.8 It is not possible to directly measure entrainment mortality of glass eels at an operational power station. In the past experimental animals have been subject to a series of laboratory experiments that simulated individual aspects of the entrainment process e.g. temperature, pressure and chlorination. Such work has been useful but was always vulnerable to criticism that the experiments failed to capture the cumulative effects of entrainment. In order to overcome this perceived problem entrainment mimic units (EMU) have been built which more closely simulate the conditions in a power station. Cefas have built on previous EMU experiments and constructed a second-generation system which could repeatedly simulate entrainment conditions in specific power stations using user specified exposure profiles (BEEMS Technical Reports TR318, TR395). These experiments simulated the exposure of glass eels to mechanical, thermal, pressure and chemical impacts from abstraction to discharge for the same time intervals that would be experienced in a real station. The simulations included filtration through a 5 mm mesh, the complete time of exposure in the HPC cooling water system, the profile of temperature (delta T +11.6°C) and pressure (peak change 4 bar) as the eels pass through the station and also the effects of discharge concentrations (see below).

4.3.9 Based upon the EMU experiments, the predicted entrainment mortality for glass eels in Sizewell C was found to be approximately 20% (i.e. 80% survival rate). Glass eels were found to be relatively insensitive to everything, including hydrostatic pressure, except mechanical damage passing through the system, particularly the 5 mm filter. The only issue that was missing from the EMU simulations was estimated losses in the cooling water pumps. These pumps are very large and estimates prepared for the HPC DCO were of losses between 1.6% to 1.8% based upon modelling using the STRIKER programme that has been widely applied to other pump mortality calculations (the Sizewell C pumps would be the same or similar to those planned for HPC). However, the EMU system was not specifically designed for glass eel experiments, in particular, the radius of bends in the EMU pipework were too small for glass eel experiments and subjected the experimental animals to far more mechanical stress than would be expected in Sizewell C. This additional mechanical stress is considered to be greater than the predicted losses from the cooling water pumps and therefore the EMU derived entrainment mortality of 20% is considered to be appropriate.

Impacts of Discharge Concentrations on Glass Eels

4.3.10 As stated above, it is not possible to directly measure entrainment mortality of glass eels at an operational power station, including the effects discharge concentrations, although the EMU experiments included the effects of chlorination at a TRO level of 0.2mg/l from the precise time that it would be applied in Sizewell C to glass eel discharge in the power station outfalls. In addition to chlorination, small quantities of process waste hydrazine would be discharged into the cooling water flow at the seal pit in a single daily pulse of 2.32 hours per day resulting in an initial hydrazine concentration of 69 ng l-1 in the cooling water flow. This discharge scenario is the worst case as far as entrainment risk is concerned and alternative daily discharge scenario has been modelled by Cefas of 4.6h of 34 ng l-1 (BEEMS Technical Report TR193).

4.3.11 However, when hydrazine is added to chlorinated seawater, it is oxidized to non-toxic nitrogen, sodium chloride and water and the hydrazine concentration immediately decreases by approximately 90%. For example, in experiments described in BEEMS Technical Report TR363, an initial hydrazine concentration of 69 l-1 fell to 8.4 ng l-1 in the presence of chlorinated seawater at the planned TRO concentrations for Sizewell C. To put these concentrations into an environmental risk context, the Canadian Federal Water Quality Guidelines for hydrazine indicate that concentrations below 200 ng l-1 have a low likelihood for adverse effects for marine life (Environment Canada 2013). Even at the planned Sizewell C initial concentration of 69 ng l-1 for the operational the concentration of hydrazine for only 2.3 h per day would be considered to present a very low risk for entrained glass eels; at 8 ng l-1 the additional risk is considered negligible and has not been necessary to simulate in the EMU system by Cefas.

4.3.12 In addition, given the low concentrations of hydrazine and short half-life of this chemical, the risk of potential bioaccumulation within the CWS of Sizewell C is considered extremely low.

Impacts of the Sizewell C CWS on Glass Eel Entrainment

4.3.13 Cefas has undertaken a worst case glass eel entrainment assessment for Sizewell C which is covered in BEEMS Scientific Position Paper SPP104.

The following provides a summary of the key points raised in this paper in relation to survival predictions of glass eels:

- As previously stated, the second generation EMU system simulated entrainment conditions in specific power stations using user specified exposure profiles, which included various controlled temperature, pressure and chemical conditions. These were simultaneously modelled in order to take into consideration the cumulative effectives of such controls on the morality of glass eels through the whole CWS (BEEMS Technical Reports TR318, TR395). For the Sizewell C profile, the EMU experiments predicted entrainment mortality for glass eels once through the whole CWS of Sizewell C to be approximately 20%. The key limitation of EMU experiments have been described above.

- Based on BEEMS April and May 2015 glass eel surveys (the limitations of which have been detailed in Section 2), the calculated glass eel entrainment loss at Sizewell C would be 0.0089% of the Anglian River Basin District (RBD) Spawning Stock Biomass (SSB).

- Considering the cumulative effect of the sensitivity analyses described in BEEMS Scientific Position Paper SPP104, estimates for glass eel revised entrainment losses range between 0.0071% and 0.024% Anglia RBD SSB. The glass eel entrainment losses calculated on the basis of the 2015 surveys could therefore have been underestimated by a factor of 2.67 or overestimated by a factor of 0.25.

Impacts of the Sizewell C CWS on Glass Eel Entrainment

4.3.14 To put the Sizewell C entrapment estimate into context, the estimated Sizewell C mean eel impingement loss is 0.045% of the Anglian RBD SSB i.e. the predicted Sizewell C entrapment loss is in the range 0.052% to 0.069% Anglian RBD (BEEMS Scientific Position Paper SPP104). One percent of the Anglian RBD SSB is equivalent to an estimated 0.005% of the European eel stock. Predicted entrapment losses at Sizewell C therefore represent considerably less than 0.005% of the total European eelstock.

4.3.15 Furthermore, BEEMS Scientific Position Paper SPP116 "*Quantifying Uncertainty in Entrapment Predictions for Sizewell C*" [REP6-028], concludes the range in FRR mortality proposed by the Environment Agency in Technical Brief: TB008 ("*Fish Recovery and Return System Mortality Rates*") indicates that the FRR may be more effective than assumed in the DCO Environmental Statement. Consequently, for European eel estimates of annual entrapment losses in BEEMS Scientific Position Paper SPP116 [REP6-028], were even lower.

Summary and Conclusions

4.3.16 Entrainment mimic unit (EMU) studies have demonstrated high survival rates (80%) of glass eel during entrainment passage (BEEMS Technical Report TR318). Glass eel entrainment loss at SZC would be <0.01% of the Anglian RBD Spawning Stock Biomass (SSB) based upon 2015 survey data (BEEMS Scientific Position Paper SPP 104). Whilst glass eels are present in the Sizewell coastal waters, their density is very low and the station presents a negligible risk to population sustainability. It is therefore concluded that entrainment will not present a significant risk to the European eel stock.

4.3.17 Based on the above it can be concluded that the potential impacts on eel entrainment and impingement associated with the CWS of Sizewell C, will not significantly impact the Anglian RDB SSB.

5 IMPACTS OF CHEMICAL PLUMES ON EEL MIGRATION

5.1 Introduction

5.1.1 This section of the addendum summarises the Relevant Representations of the Environment Agency regarding the potential impacts of the thermal plumes on eel migration and provides additional information in response to this view.

5.2 Summary of Relevant Representations

5.2.1 Based on Table 1:1, the Environment Agency has concerns on the potential impacts of thermal plumes associated with the cooling water discharge of Sizewell C on eels, in particular if the chemicals of the discharge could act as an attractant to migrating eels seeking chemical cures. The Environment Agency have thus requested additional evidence to determine if the Sizewell C thermal plume could attract or disrupt migrating eels and this is presented in Section5.3.

5.3 Additional Information

a) Impacts of SZC Thermal Plumes on European Eel Passage and Populations

5.3.1 The cooling water discharge from Sizewell C (outfall tunnels) would be returned back to in the Greater Sizewell Bay via the outfall tunnel and outfalls some 3km offshore. Returned abstracted water would be the main waste stream from Sizewell C and would represent approximately 99.9% by volume of the total overall daily discharge of non-radioactive effluent. The thermal uplift in the discharged cooling water is assumed to be 11.6°C (and 23.2°C for the maintenance scenario).

5.3.2 The behaviour of the Sizewell C thermal plume at the point of discharge can be characterised in three zones:

- Near-field: Occurs at the point of discharge where the plume has restricted horizontal movement and mixes in a vertical profile.
- Mid-field: Vertical momentum decreases, and the plume begins to travel slowly with the ambient tidal flow. Shear with the seabed causes the ambient flow to be more turbulent and interact with the edge of the thermal plume causing heat losses.
- Far-field: The plume is integrated in the tidal flow and mixing is subject to differences in density gradients, wave energy and bathymetry, which can cause the plume to decrease in thickness and break into filaments and eddies.

5.3.3 As stated in the original ERCA [APP-332] (Section 5.3.48 onwards), the operation of the cooling water discharge for Sizewell C and behaviour of the thermal plume, will not cause long-term impacts upon eel passage, in particular the successful escapement of silver eels or migration of glass eels and elvers. This is further detailed below based upon BEEMS Technical Reports TR302, TR306, TR480; and **Volume 2**, **Chapter 21** of the **ES**.

b) Potential thermal barriers to European Eel migration in transitional waters

5.3.4 Existing thermal standards for transitional waters specify that an estuary's cross section should not have an area larger than 25% with a temperature uplift above 2°C, for more than 5% of the time (Wither et al., 2012). There are no such standards for coastal waters, however an assessment still needs to be made on whether a coastal plume could act as barrier to migration for those species that migrate between coastal and transitional waters, such as European eel. At Sizewell the only transitional water bodies that could be affected by the thermal plume are the Blyth and the Alde-Ore estuaries. Figure 5-1 shows the Sizewell B and Sizewell C thermal plume at both estuaries as a 98th percentile at the surface.

5.3.5 As can be seen from Figure 5-1, the thermal plume only intersects the mouth of the Alde-Ore Estuary at excess temperatures in the 0□C to 1□C range as 98th percentiles. At these temperatures the standard for thermal barriers in estuarine waters cannot be exceeded.

5.3.6 The Sizewell B and Sizewell C thermal plume intersects the Blyth Estuary at temperatures in the 2°C to 3°C range as 98th percentiles (Figure 5-1) and there is, therefore, a potential to exceed the estuarine thermal standard and to create an impact on the movement of European eel. The temperatures in the cross section across the estuary mouth were extracted from the GETM Sizewell B and Sizewell C model outputs and the time series of exceedance of the thermal standard is shown in Figure 5-2. Over the annual cycle the condition was exceeded in 307 hourly episodes or 3.50% of the time. This is below the 5% threshold in the standard and therefore no barriers to eel migration in the estuary are expected, in particular the upstream migration of glass eels and elvers; and escapement of silver eels.

Figure 5-1: SZB and SZC Thermal Plumes at Blyth and Alde-Ore Estuaries

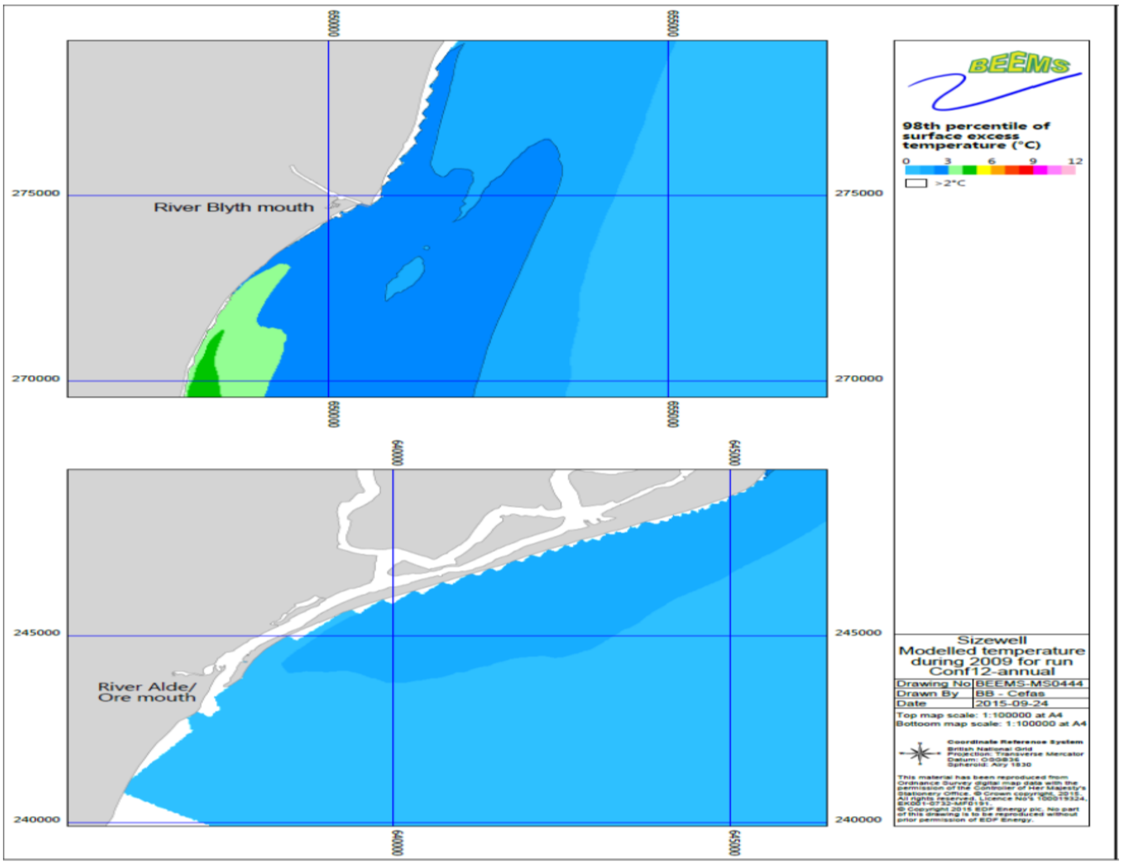
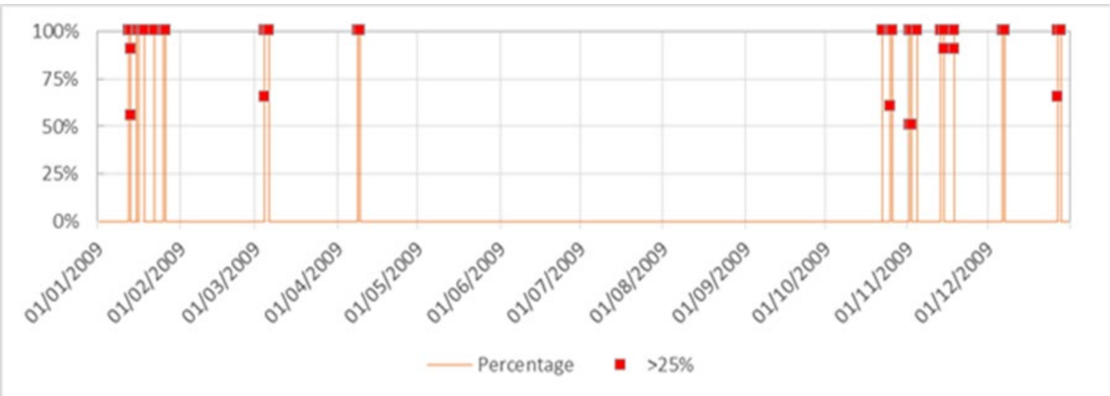


Figure 5-2: River Blyth Mouth Cross Section Area 2°C Exceedance Thermal Uplift Threshold for SZB and SZC Scenario (Hourly Data)



5.3.7 Table 5:1 presents thermal the barrier prediction for River Blyth with Sizewell C and Sizewell B in operation and the number of hours that the estuary’s cross section is predicted to have an area larger than 25%, with a temperature uplift above 2°C, for more than 5% of the time.

5.3.8 The analysis shows that a potential thermal barrier was predicted to exist for a total of 124 hours in the period 1st August 2009 to 31st December 2009 i.e. 3.4% of the total period. There was no period when a potential barrier lasted for more than 1 day. Under such circumstances the analysis further demonstrates that there would be no barrier to European eels, in particular silver eels on their return migration to the Sargasso Sea

Table 5:1: Thermal Barrier Prediction - River Blyth with SZC and SZB Operational

Month	Total hours in with a potential thermal barrier in the period 1/9/09 to 31/12/15	Number of separate days subject to a potential barrier
August	0	0
September	0	0
October	26	3
November	58	4
December	40	4
Total	**124**	**11**

Source: BEEMS TR302

5.3.9 It should be noted regarding the potential impacts of the thermal plumes associated with operation of cooling water outfall and Minsmere Sluice, as stated in the ERCA (NNB GenCo, 2020), eel passage will not be impacted upon by a potential chemical barrier caused by the plume based on laboratory thermal preference experiments undertake by Cefas (BEEMS TR302). These showed that glass eel and silver eel, with avoidance thresholds of ≥3°C (see Table 5:2), would not experience a barrier to migration in a transect from the coast to the Sizewell C outfalls and, thus, eel migration routes from sea to freshwater (and vice versa) would not be impacted by the operation of both of the Minsmere Sluice.

5.3.10 Further details on potential thermal barriers to eel migration in transitional waters can be found in BEEMS Technical Report TR302.

c) Possibility of a thermal barrier to European Eel migration off Sizewell

5.3.11 There are no thermal standards to assess potential migration barriers for eels in coastal waters. However, if eels have to pass through a coastal plume on their migration route to or from an estuary, there is a possibility of the plume acting as a barrier to migration. If an attempt is made to apply the estuarine standard (see paragraph 5.3.4) to a coastal location such as Sizewell, there is an issue of selecting the width of a transit corridor which brackets a reasonable estimate of how far offshore the eels would normally travel or could travel without experiencing loss of fitness.

5.3.12 In common with most thermal standards, the estuarine barrier to migration threshold has been set to act as an indicative trigger; its roots stem from older regulatory thresholds set to protect salmonids in rivers and estuaries. Wither et al. (2012) presents a summary of data from laboratory thermal preference experiments that show the avoidance thresholds for various species including European eel.

Table 5:2: Published Thermal Avoidance Thresholds for European Eel

Species	Avoidacne threshold	Notes
Eels: Adult silver eels	**+3°C**	
Eels: Young elvers	**>+12°C**	No upper threshold found in experiments

Source: Wither et al (2012)

5.3.13 Based on detail modelling of temperature and thermal uplift created by the cooling water discharge undertaken by Cefas, the Sizewell C thermal plumes are not predicted to present a barrier to the migration of eels off Sizewell based on eel avoidance thresholds presented in Table 5:2. This is further detailed below:

- Thermal standards for transitional waters specify that an estuary's cross section should not have an area larger than 25% with a temperature uplift above 2°C, for more than 5% of the time to avoid potential barriers to migratory fish.
- The percentage of the coastal transect predicted to experience the >2°C and >3°C uplift is shown in Figure 5-5, with migration periods of glass and silver eel indicated. Also see Table 5:3.
- Based on the available evidence for thermal avoidance of migratory species off Sizewell a precautionary 3°C thresholds may be applied for glass eel and silver eel. For these species, modelling results show that potential avoidance thresholds would occur over 25% of the coastal corridor for less than 5% of the time during their migration periods. Therefore, no occlusion effects are predicted.
- The sensitivity of migratory fish to thermal occlusion from the operational thermal discharge of both Sizewell B and Sizewell C in-combination, is assessed as not sensitive, with only minor behavioural changes predicted.

Figure 5-3: Percentage of Sizewell C Transect with >2°C and >3°C Uplift

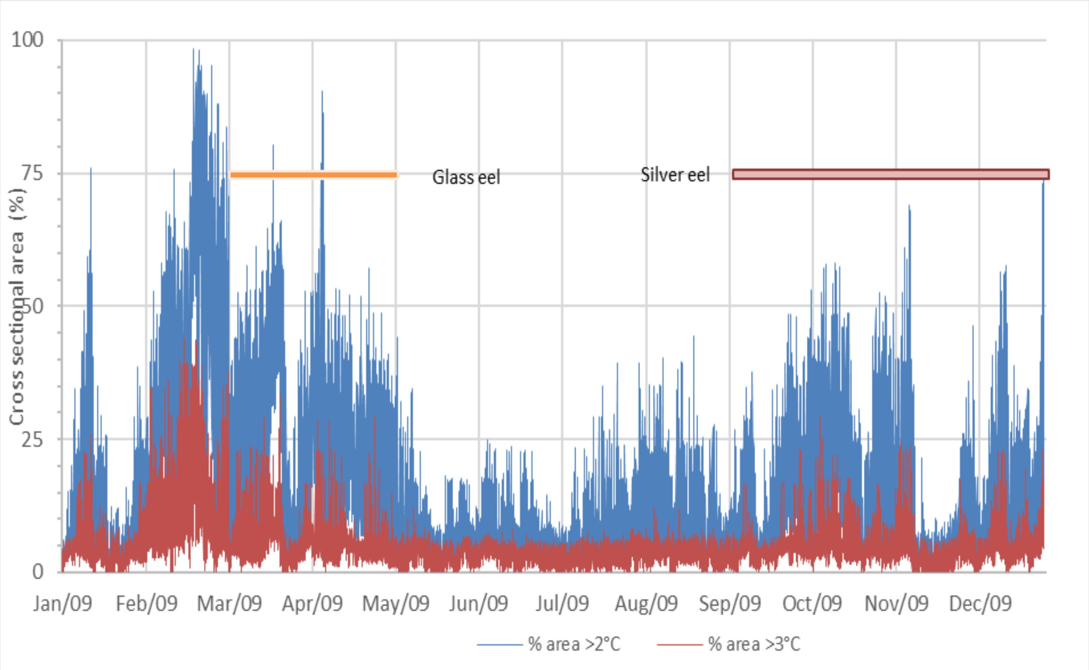


Table 5:3: Potential Thermal Occlusion During Migration Periods

Species	Assumed thermal threshold for this analysis	Percentage of migration period that the 25% occlusion threshold is exceeded	Migration period	Conclusion
Eels: Adult silver eels	>+12°C	**0%**	March - April	Would not experience a barrier to migration in a transect from the coast to the SZC outfalls
Eels: Young elvers	3°C	**0.07%**	September - December	

Source: BEEMS TR302

5.3.14 Further details on potential thermal barriers to eel migration in coastal waters can be found in BEEMS Technical Report TR302.

d) Conclusion

5.3.15 It can be concluded based on information summarised in this section (and discussed in detail in BEEMS Technical Report TR302) that no thermal barriers to European eel migration are predicted at Alde-Ore or Blyth estuaries. Furthermore, no thermal barriers are predicted for eels migrating to or from these water bodies via a route off the Sizewell coast.

6 IMPACTS OF PROPOSED DESIGN CHANGES ON EELS REGULATIONS

6.1 Introduction

6.1.1 Following submission of the DCO application, SZC Co has continued to engage with the local authorities, environmental organisations, local stakeholder groups and the public to gather their responses to the Application. They have also been working with their contractors to develop our proposals to the next level of detail in preparation for implementation, in the event that DCO consent is granted. This section of the addendum summaries the proposed changes relevant to the Eels Regulations and provides an assessment of these changes against compliance with the Regulations.

6.2 Proposed Design Changes

6.2.1 The proposed design changes relevant to the Eels Regulations include the following:

- Enhanced permanent beach landing facility (BLF) and options for a new, temporary facility to import material by sea;
- Change to the Site of Special Scientific Interest (SSSI) crossing design to a single span bridge with embankments;
- Surface water removed early in the construction process to be discharged to the foreshore via a temporary outfall;
- Extension of the Order Limits to provide for additional fen meadow habitat at Pakenham as mitigation for fen meadow loss;
- Extension and reduction of the Order Limits for works on the main development site and related sites (fen meadow mitigation and marsh harrier improvement sites);

- Extension of the Order Limits for works on the two village bypass, change to the public rights of way around Walk Barn Farm and additional habitat mitigation proposals; and

- Provision of a temporary desalination plant to provide a temporary supplementary source of potable water during the construction phase.

6.2.2 The changes to the BLF, SSSI crossing, construction-stage outfall and changes to the Order Limits are described in more detail in the January 2021 DCO Change submission [AS-181, AS-182, AS-183, AS-184, AS-185, AS-186, AS-187 and AS-188]. Further information regarding the temporary construction-phase desalination plant is provided in The Sizewell C Project Consultation Document: Consultation on Temporary Desalination Plant (EDF Energy, 2021), the **Environmental Statement Addendum 4** (Doc Ref 6.18 and the updated **Construction Method Statement** (Doc Ref. 6.3 (3A-3D(B) Ch))

6.3 Additional Information

6.3.1 Table 6:1 presents the potential implications of the proposed design changes on the conclusions of the ERCA [APP-332] and determines whether there is any potential for non-compliance with the requirements of the Eels Regulations.

Table 6:1: Assessment of Eel Regulations implications of proposed design changes

Design change	Outline description	Eel Regulations implications
Enhanced permanent beach landing facility and options for a new, temporary facility to import material by sea	Changes to the seabed in front of the proposed permanent BLF so that it is better able to receive regular deliveries by barge without requiring additional maintenance. Construction and operation of a new temporary BLF to facilitate the delivery of bulk materials.	Whilst there may be increased piling and dredging requirements which could give rise to increased sediment concentrations over and above those outlined in the ERCA [APP-332], the plume would be transitory, short term in nature and likely to remain within the levels of natural variation experienced in the coastal waters of Sizewell. In addition, it has been shown that turbidity increases in water bodies, although affecting some fish species to complete their migration routes do not impact European eel (Vohs et al 1993; De Casamajor et al. 1999). The vertical location of glass eels is also related mainly to turbidity (and phases of lunar cycle), with migrating individuals in turbid waters found through the entire water column, while in clear water they move close to the bottom of the river or seabed (De Casamajor et al. 1999). The works directly associated with the beach landing facility will not impact European eel migration and/or population status, once the suite of control measures embedded in the Code of Construction Practice (CoCP) are in place (secured pursuant to Requirement 2 of the DCO). As such, there is no change from the conclusions stated in the ERCA [APP-332].
Change to the Site of Special Scientific Interest (SSSI) crossing design to a single span bridge with embankments	The revised crossing will comprise separate embankments at either side of Leiston Beck with a 30 m long single-span bridge connecting them, to provide additional flood relief and ecological connectivity. This will also result in less SSSI land-take. There is also potential to change the gradient of the embankments to allow taller and more	The revised crossing of Leiston Beck would consist of a bridge that does not directly interact with the natural bed and banks of the watercourse (compared with the previously proposed causeway) or associated in-channel and riparian habitats. Furthermore, there would be considerable space for natural channel adjustments to occur in the future. The lack of obstruction of the watercourse will allow continued passage for fish species, including European eel (*Angulia anguila*) which has been recorded in Sizewell Marshes SSSI. Overall, for the works directly

	substantial trees to establish on the seaward side.	associated with the revised crossing of Leiston Beck , will not impact European eel migration and/or population status, once the suite of control measures embedded in the Code of Construction Practice (CoCP) are in place (secured pursuant to Requirement 2 of the DCO). As such, there is no change from the conclusions stated in the ERCA [APP-332].
Surface water removed early in the construction process to be discharged to the foreshore via a temporary outfall	A Combined Drainage Outfall (CDO) will be built early in the construction phase to discharge treated surface water run-off from the site to the sea in compliance with an environmental permit. A temporary outfall pipe would be required to discharge surface water in periods of extreme storm events prior to completion of the CDO. The outfall would not be used under normal conditions because surface water would be collected in balancing ponds, treated via water treatment systems and then either infiltrated to ground or discharged to the surrounding watercourses at greenfield rates. The temporary outfall pipe would be laid below ground as it crosses the Suffolk Coastal Path and would terminate landward of the mean high spring water tide level. Once the CDO is constructed the outfall would be removed.	This new activity was not directly assessed in the ERCA [APP-332]. Any discharges to the Suffolk coastal water body would consist of clean surface run-off that has been treated in the construction site drainage system, would only occur for a limited period during storm events, and would consist of a small volume of water relative to the volume of the receiving coastal water body. These temporary discharges are not therefore expected to impact upon European eel migration and/or population status.
Extension of the Order Limits to provide for additional fen meadow habitat at Pakenham as mitigation for fen meadow loss	The Application identifies two sites for fen meadow mitigation habitat at Benhall and Halesworth. Further advice from Natural England	There is potential for long-term impacts on the conveyance of flows through the existing surface drainage network within the floodplain following completion of the fen meadow and the installation of new control structures, with eel passage

	recommends that a larger extent of land is required in order to ensure sufficient mitigation habitat. A third site at Pakenham as therefore been identified to further increase the probability of creating sufficient fen meadow habitat to mitigate for the loss of fen meadow from the Sizewell Marshes SSSI.	facilities, in the floodplain drainage network. The local effect would be to reduce the overall effectiveness of drainage within the site, thereby retaining more water within floodplain wetland habitats. However, it is anticipated that the design will complement the existing floodplain and river channel habitats. Any changes are unlikely to result in significant changes to the hydrological regime and are therefore considered to be beneficial, locally contributing to improved floodplain connectivity and eel habitat. Thus, no impact on European eel migration and/or population status is predicted. As such, there is no change from the conclusions stated in the ERCA [APP-332].
Extension and reduction of the Order Limits for works on the main development site and related sites (fen meadow mitigation and marsh harrier improvement sites)	There are a number of minor reductions and additions proposed to the Order Limits for the main development site to account for mapping or boundary discrepancies, to facilitate access to surrounding sites or to optimise highway usage.	The proposed changes to the Order Limits would not change the way in which the proposals would interact with surface waters associated with proposed fen meadow compensation areas. Thus, no impact on European eel migration and/or population status is predicted, with the compensation habitat benefiting potential eel recruitment. As such, there is no change from the conclusions stated in the ERCA [APP-332].
Extension of the Order Limits for works on the two village bypass, change to the public rights of way around Walk Barn Farm and additional habitat mitigation proposals	A minor change to the Order Limits is proposed to maximise visibility of the existing access road which will join the two village bypass at the north-west staggered junction, east of the River Alde bridge crossing. The route used by the public would also be formalised as a public right of way route at Walk Barn Farm. There are two options for the route in this location, and potential for the right of way to be upgraded to a bridleway. There is also an opportunity to use land	The proposed changes to maximise the visibility of the existing access road and formalise the public right of way would not alter the way in which the proposals would interact with freshwater habitats. The changes associated with the improvement of floodplain grazing marsh will provide a linkage between the River Alde and its floodplain and overall increase the complexity of the surface drainage network; and contribute towards an improvement in eel habitat. Thus, no impact on European eel migration and/or population status is predicted. As such, there is no change from the conclusions stated in the ERCA [APP-332].

	within the Order Limits to provide additional habitat to mitigate for the loss of the floodplain grazing marsh habitat.	
Provision of a temporary construction-phase desalination plant	The desalination plant will create potable water using a Sea Water Reverse Osmosis (SWRO) system. The plant is required to produce potable water for the construction period. It is anticipated that the desalination plant will be used to provide a maximum potable water demand of approximately 2,600 m^3/d in Phase 1 and 4,000m^3/d in Phase 2 (see construction section for explanation of phases). A desalination plant typically converts 40% of the seawater it abstracts into fresh water. Therefore, the seawater intake pipe will be sized to abstract up to 10,000m^3/day of water. This requires a small-bore pipeline (approximately 35cm diameter). The pipe would extend up to approximately 490m seaward from the temporary Hard Coastal Defence Feature (HCDF) in a minimum 5m depth of water at lowest astronomical tide (LAT) conditions. As part of the desalination process, there will be a need to discharge reject effluent; this will primarily comprise seawater of a high salinity or 'brine'. Brine will be stored on site with sufficient storage	The Eels Regulations require provision for the safe passage of European eels to be incorporated for any abstraction of greater than 20m^3 per day, including measures for eel screens. The design and orientation of the desalination intake heads is based on established best practice guidance (Environment Agency, 2014b) and incorporates screening measures to protect eels in order to comply with the Eels Regulations. Specifically, the seawater intake would consist of a Passive Wedge-Wire Cylinder (PWWC) screen with a mesh size of approximately 2mm to minimise the potential for eel entrainment (including glass eels). The screen would be approximately 60cm in diameter and the headworks would be approximately 1.6m in length. The headworks would be positioned to reduce the tidal forcing against the screens and minimise approach velocities where possible, thereby minimising eel impingement. In addition, given the desalination plant will be decomissionsed beofe the start of operation of SZC, no incombibation effects with the FRR are predicted. ith respect to salinity, changes in excess of 1psu would be restricted to within 10m of the discharge point. Whilst there is a small increase in salinity predicted over baseline, the magnitude and spatial extent of change is very small. However, unlike exclusively marine or fresh water fish, migratory fish such as European eel are likely to be tolerant of salinity fluctuations (cf. Bhat et al. 2012). Furthermore, exposure to salinity changes is likely to be further diluted during high tide and/or during flood events which would predominately coincide with the upstream and downstream migration of European eel (migratory fish typically migrate through

	capacity to allow discharge over a 24-hour period. The brine will be discharged through a pumping station to the outfall (490m seaward from the HCDF in a minimum of 4.5m of water at LAT) where it will disperse in the water column.	estuaries triggered by flood events and at night time (Milner et al. 2012; Moore et al.1995)). Exposure to salinity changes would therefore be extremely small for all eel populations and not considered sufficient to create a barrier to their movement or migration. The temporary construction-phase desalination plant is therefore considered to be compliant with the requirements of the Eels Regulations and not change the overall conclusions of the ERCA [APP-332].

6.3.2 Table 6:1 demonstrates that the proposed changes to the BLF, SSSI crossing or construction-stage outfall would not result in any adverse impacts on eels. Furthermore, the proposed changes to the Order Limits to accommodate additional fen meadow habitat at Pakenham, fen meadow mitigation and marsh harrier impromeent sites at the MDS, and public rights of way and habitat creation at the two village bypass would not affect eel populations.

6.3.3 In addition, Table 6:1 also demonstrates that the proposed provision of a temporary construction-stage desalination plant would not not result in any adverse impacts on eels.

6.3.4 The proposed changes are therefore all considered to be compliant with the requirements of the Eels Regulations, and would not therefore change the conclusions of the original ERCA [APP-332].

7 EEL PASSAGE MEASURES

7.1 Introduction

7.1.1 This section presents an update on proposals for the inclusion of eel passage measures in Sizewell Drain and in the Alde-Ore river catchment.

7.2 Eel passes on Sizewell Drain

7.2.1 The proposed water control features in the realigned Sizewell Drain could potentially present a barrier to the free movement of eels within the drainage network in the Sizewell Marshes SSSI. In order to mitigate this impact and ensure that eel and elver passage can be maintained, suitable eel passage measures will be incorporated into the design of the water control features during the post-DCO detailed design process (secured through the **Construction Method Statement** (Doc Ref. 6.3 (3A-3D(B)

Ch)), pursuant to Requirement 8 of the DCO). Further details are provided in Appendix C Sizewell Drain Water Management Control Structure (DCO Task D5) of NNB Generation Company (SZC) Limited Deadline 5 Submission - 9.54 SZC Co. Comments on Submissions from Earlier Deadlines (Deadlines 2-4) [REP5-120].

7.2.2 As set out in the **ERCA (Appendix 22O** of **Volume 2**, **Chapter 22** of the **Environmental Statement**) [APP-332], these measures will be designed in accordance with the Environment Agency's 2011 guidance on eel passage (Environment Agency, 2011) and presented to the Environment Agency for approval prior to construction as part of the environmental permitting process.

7.3 Eel passage measures in the Alde-Ore catchment

7.3.1 The Environment Agency has concerns over the certainty of the assessment of eels, both in relation to eel numbers entrained at SZB and the number of eels that constitutes the baseline population (with which potential impacts are compared). The Environment Agency has requested additional monitoring of eels at SZB and the coastal waters offshore.

7.3.2 However, the resources required for an extended survey at sea for glass eels are disproportionately high compared with the benefit it would provide to the assessment. SZC Co does not consider this additional monitoring is required considering the conclusions in the assessment. However, to further reduce any residual significant effects, SZC Co has agreed that it will contribute financially to two identified Environment Agency schemes, one at Snape Maltings (River Alde) and another at Blythford Bridge (River Blyth). This commitment is secured within the Deed of Obligation.

8 SUMMARY

8.1.1 SZC Co is proposing to build and operate a new nuclear power station at Sizewell on the Suffolk Coast, north of the existing Sizewell B power station. The design of this new power station, Sizewell C, will take into account the sensitive nature of the surrounding environment, while providing enough space to build and operate the power station safely and efficiently to support approximately 7% of the UK's electricity (or approximately six million homes). However, under the Eels (England and Wales) Regulations 2009 (S.I. 2009 No. 3344) (as amended) (the 'Eels Regulations'), companies which intend to build new developments, such as Sizewell C, are required to make provision for the safe passage of European eels (Anguilla anguilla), an IUCN red list 'critically endangered' species.

8.1.2 This addendum to the Eels Regulations Compliance Assessment (ERCA) [APP-332] undertaken by SZC Co to support the Development Consent Order (DCO) application for Sizewell C presents additional information provided in response to the Environment Agency's Relevant Representation on the Sizewell C DCO, dated September 2020 [RR-0373]. The focus areas addressed in the addendum with the respect to potential impacts upon European eel migration and population estimates, included:

- limitations on glass eel surveys;
- efficiency of the Low-velocity Side-entry (LSVE) intake heads to reduce eel impingement;
- glass eel entrainment through the cooling water system;
- potential impacts of the thermal plumes on eel migration;
- potential impacts from a temporary desalination plant on the Eel Regulations.

8.1.3 No changes to the original ERCA [APP-332], which concluded that Sizewell C will not, overall, impact European eel populations and silver eel escapement have been identified.

8.1.4 SZC Co. considers that all matters regarding potential impacts from the construction and operation of the Sizewell C Project and European Eel have been fully addressed.

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APPENDIX A: ACRONYMS

Acronym	Acronym description
ATP	Adenosine Triphosphate
AIL	Abnormal Indivisible Load
ADCP	Acoustic Doppler Current Profiler
AD	Associated Development
BLF	Beach Landing Facility
DCO	Development Consent Order
Defra	Department of Environment, Food and Rural Affairs
EC	European Commission
EA	Environment Agency
ES	Environmental Statement
ERCA	Eels Regulations Compliance Assessment
EMU	Entrainment Mimic Unit
EMP	Eel Management Plan
hCDF	Hard Coastal Defence
HGV	Heavy Goods Vehicle
LEMP	Landscape Environmental Management Plan
LVSE	Low-velocity Side-entry
MDS	Main Development Site
MOLF	Marine offloading Facility
NNB	Nuclear New Build
PAH	Polycyclic Aromatic Hydrocarbons
TBM	Tunnel Boring Machine
TSHD	Trailing Suction Hooper Dredging
RBD	River Basin District
SSB	Spawning Stock Biomass
SLR	Sizewell Link Road
sCDF	Soft Coastal Defence Feature
STST	Selective Tidal Stream Transport

Acronym	Acronym description
SSSI	Sites of Special Scientific Interest
TVB	Two Village Bypass
WDA	Water Discharge Activity
WFD	Water Framework Directive

APPENDIX B: GLOSSARY

Glossary Term	Glossary Text
B_0 (biomass)	Spawner escapement biomass in absence of any anthropogenic impacts.
Entrainment	Entrainment mainly affects aquatic species small enough to pass through the intake screen mesh and, as a result, travel through the entire cooling water system.
Entrapment	This is the term used to describe th combined impacts of entrainment and impingement and reflects all organism abstracted in the cooling water flow. It may also be used to describe that abstraction at the intake head.
Eel Escapement	The amount of silver eel that leaves (escapes) a waterbody, after taking account of all natural and anthropogenic losses.
Elver	Young eel, in its first year following recruitment from the ocean. The elver stage is sometimes considered to exclude the glass eel stage. To avoid confusion, pigmented 0+ cohort age eel is included in the glass eel term (below).
Glass eel	Young, unpigmented eel, recruiting from the sea into continental waters. Generally, all recruits of the 0+ cohort age. In some cases, however, also includes the early pigmented stages.
Impingement	Impingement typically involves adult aquatic organisms (fish, crabs, etc.) that are large enough to be retained by intake screens,

Glossary Term	Glossary Text
River Basin District	The area of land and sea, made up of one or more neighbouring river basins together with their associated surface and groundwaters, transitional and coastal waters, which is identified under Article 3(1) of the Water Framework Directive as the main unit for management of river basins. The term is used in relation to the EU Water Framework Directive.
Silver eel	Migratory phase following the yellow eel phase. Eel in this phase are characterized by darkened back, silvery belly with a clearly contrasting black lateral line, enlarged eyes. Silver eel under-take downstream migration (escapement) towards the sea. This phase mainly occurs in the second half of calendar years, although some are observed throughout winter and following spring.