Great Yarmouth
Third River Crossing Order 202[*]

Document NCC/GY3RC/EX/077: Response to Request for Further Information (Rule 17)

Planning Act 2008

Infrastructure Planning

The Infrastructure Planning (Examination Procedure) Rules 2010

Planning Inspectorate Reference Number: TR010043

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Foreword

The Response to the Request for Further Information (Rule 17) made by the Examining Authority (ExA) on the 13th February 2020 relates to an application ('the Application') submitted by Norfolk County Council ('the Council' / 'the Applicant') to the Secretary of State for a Development Consent Order ('DCO') under the Planning Act 2008.

If made by the Secretary of State, the DCO would grant development consent for the construction, operation and maintenance of a new bascule bridge highway crossing over the River Yare in Great Yarmouth, and which is referred to in the Application as the Great Yarmouth Third River Crossing (or 'the Scheme').

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Glossary of Abbreviations and Defined Terms

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
DCO	Development Consent Order
dDCO	Draft Development Consent Order
EIA	Environmental Impact Assessment
ExA	Examining Authority
FRA	Flood Risk Assessment, Appendix 12B to the Environmental Statement (Document Reference 6.2, Planning Inspectorate Reference APP-135)
GYBC	Great Yarmouth Borough Council
IDB	Internal Drainage Board
NCC	Norfolk County Council
NN NPS	National Networks National Policy Statement
Outline CoCP	Outline Code of Construction Practice (Document Reference NCC/GY3RC/EX/073, Planning Inspectorate Reference REP6-014)
OS	Ordnance Survey
SFRA	Strategic Flood Risk Assessment
The Applicant	Norfolk County Council (in its capacity as Highway Authority and promoter of the Scheme)
UKCP09	UK Climate Projections 2009
UKCP18	UK Climate Projections 2018

1 Introduction

1.1 Purpose of this Report

1.1.1 This report, submitted for Deadline 7 of the Examination, contains the Applicant's response to the Request for Further Information (Rule 17) made by the ExA (PD-011), on 13th February 2020.

1.1.2 The report provides the Applicant's response to the issues raised by the ExA, thereby providing a reference document for all interested parties.

2 Response to the Request for Further Information (Rule 17)

2.1 Key Questions and Applicant's Response

Introduction

Tidal Residual (Breach) Risk and Emergency Preparedness

2.1.1 The Applicant's response to the points raised by the Environment Agency (EA) regarding the approach to tidal residual (breach) risk explains how the findings of the Strategic Flood Risk Assessment (SFRA) in this regard have been used as a proxy to identify the likely breach locations applicable to the Proposed Development. Furthermore, the Applicant explains that in using these locations, the effect in terms of tidal residual (breach) risk can be 'deduced' from the information relating to over-topping assessment; rather than conducting any specific modelling for the development concerned.

Applicant's Response

2.1.2 Prior to addressing the Key Questions, the Applicant has set out the differences between how tidal residual (breach) and over-topping are modelled. This further explains the Applicant's judgment not to include tidal residual (breach) analysis in the Flood Risk Assessment (FRA) (Document Reference 6.2, Planning Inspectorate Reference APP-135).

2.1.3 The Applicant notes that although tidal breaches are extremely rare, current guidance on tidal residual (breach) analysis indicates that the potential for a breach depends on defence type, location, the condition of the defence and predicted loading[1]. A tidal breach is defined as a failure / collapse of the coastal flood defences. Tidal residual (breach) analysis provides an indication of the receptors that would be at risk following a breach in the coastal flood defences. However, due to the extensive number of dependencies, tidal residual (breach) analysis has inherent limitations. Breaches tend to occur at low spots in defence levels, the interface between soft and hard defences, and close to outfall structures where storm discharge can lead to the erosion of banks. Breaches are therefore unpredictable events that lead to the sudden release of water. In the case of Great Yarmouth, the Norfolk Tactical Flood Plan (2018), produced by the Norfolk Resilience Forum Severe Weather and

[1] For example, the Natural Resources Wales 'Flood Risk Management: Modelling blockage and breach scenarios (OGN100)' published in 2015.

Flood Risk Group, in consultation with Category 1 and 2 Responders[2], and approved by Norfolk County Council, currently includes tidal breach as a trigger for issuing a Flood Warning, this is escalated to a Severe Flood Warning should it represent a risk to life.

Tidal Residual (Breach)

2.1.4 For tidal residual (breach) analysis the breach location likely to produce the maximum hazard must take into account the shortest distance from the Scheme to the coastal flood defence, or it may be some other location where the defence type, ground level, or other factor may result in a more severe breach.

2.1.5 Each tidal breach is modelled such that:

- The base of the breach is set to the typical ground level immediately adjacent to the defence;
- The breach occurs one hour before high water on the peak surge tide;
- The breach is set to be full width based on defence type.

2.1.6 The results of the tidal residual (breach) analysis are therefore dependent on the location of the breach, the specification of the coastal flood defence and the peak surge tide modelled.

2.1.7 Tidal residual (breach) analysis results are used to identify worst-case breach locations based on flow paths across the flood plain and the receptors that are most at risk should the flood defences fail at those locations. This information can then be used to inform emergency response plans so that, should a breach occur, measures are in place to respond.

Over-topping Modelling

2.1.8 For over-topping analysis (the assessment of flood risk caused by flood levels that exceed the height of the defences), it is assumed that the crest levels of the flood defences remain firm during the flood event. For severe flood events such as the 0.5% annual exceedance probability (AEP) water first spills over

[2] Category 1 and 2 Responders are defined by the Civil Contingencies Act 2004. Category 1 Responders are those who respond to most emergencies and are subject to civil protection duties (i.e. in the case of flood events emergency services, local authorities and the Environment Agency). Category 2 Responders are 'cooperating bodies', they are less likely to respond to emergencies unless they are reflected to a specific sector (i.e. transport, utility and drainage companies). Category 1 and 2 Responders often form resilience forums, as is the case with the Norfolk Resilience Forum.

the defences at low-points and ultimately along the whole length of the defences as waters continue to rise.

2.1.9 The primary purpose of over-topping analysis is to assess the residual risk associated with severe flood events that exceed design standards. However, the results are also used to identify the shortest distance between flood defences and groups of receptors, which can be used to make a professional judgment on the appropriate location of tidal breaches.

Applicant's Position

2.1.10 In preparing the Environmental Statement (Document Reference 6.1, Planning Inspectorate Reference APP-096), of which the FRA (Document Reference 6.2, Planning Inspectorate Reference APP-135) forms part, the Applicant has had regard to the relevant legislation, policy (national and local) and guidance. In respect of flood risk, this is reported in Appendix 12A of the Environmental Statement (Document Reference 6.2, Planning Inspectorate Reference APP-134). The FRA (Document Reference 6.2, Planning Inspectorate Reference APP-134) includes the Great Yarmouth Strategic Flood Risk Assessment (SFRA), November 2017, which included a tidal residual (breach) risk assessment for Great Yarmouth holistically.

2.1.11 Given the unpredictable nature of breach formation and the need to agree the locations in partnership with the consultees to the Emergency Preparedness and Response Plan, the Applicant considers it is more appropriate to carry out the tidal residual (breach) analysis prior to the Scheme opening for public use and prior to the preparation of the Emergency Preparedness and Response Plan, pursuant to Requirement 10 of the draft DCO (Document Reference NCC/GY3RC/EX/082). If carried out at that stage, the tidal residual (breach) analysis could be used to review and update the existing contingency actions following a breach of the baseline environment and to assist the agencies in determining trigger water levels for these actions. If carried out at that stage, the Applicant would also be able to agree breach locations with the Environment Agency.

2.1.12 However, as noted in the Applicant's Response to Written Submissions made by the Environment Agency at Deadline 5 (Document Reference NCC/GY3RC/EX/064, Planning Inspectorate Reference REP6-005) the Applicant is prepared to consider the issue further with the Environment Agency to see if a common position can be reached prior to the close of the examination. At the time of preparing this document the Applicant has further engaged with the Environment Agency and offered to undertake tidal residual (breach) analysis to respond to their queries. The scope of the tidal residual (breach) analysis was discussed with and submitted to the Environment Agency by the Applicant in writing on the 18th February 2020. The tidal residual (breach) analysis, presented within the Great Yarmouth SFRA, shows that, without the Scheme, significant areas of Great Yarmouth town are at risk

should the coastal flood defences breach. This is to be expected if the defences, designed to provide protection against flooding, fail during a flood event.

2.1.13 Tidal residual (breach) analysis has been undertaken by the Applicant for four individual breach locations based on guidance from the Environment Agency in their letter dated the 10th February 2020. Two locations are to the south and two to the north of the bascule bridge, one each in the east and west bank coastal flood defences. The Environment Agency requested the assessment to be undertaken for a tide which peaked just below the crest level of the coastal flood defences (i.e. equivalent to the design standard which is the 5% AEP event).

2.1.14 Following the commencement of the tidal (breach) analysis using the 5% AEP event, the Environment Agency advised the Applicant to carry out the analysis for the 0.5% and 0.1% AEP events with and without climate change on the 20th February 2020. Subsequently on the 27th February the Environment Agency advised the Applicant to carry out the analysis based on the maximum water levels seen during the historical tidal surge event which occurred in Great Yarmouth in 2013 (which, based on levels provided by the Environment Agency, is equivalent to an event of approximately 0.57% AEP). The Applicant is of the view that the maximum effects on the residual flood risk will be evident for the 5% AEP event as the 0.5% AEP and 0.1% AEP events over-top the flood defences and will mask the effects of a tidal breach. In addition, the main obstruction to flow escaping from a tidal breach will be the approach roads to the bascule bridge, so as the severity of the flood event (and hence flow depth) increases, the impact of these roads on the depth and extent of flooding is judged to decrease.

2.1.15 The results of the tidal (breach) analysis for the 5% AEP event, presented in the Applicant's Response to Written Representations submitted by the Environment Agency at Deadline 6 (Document Reference NCC/GY3RC/EX/078), confirm the judgements made in preparing the FRA (Document Reference 6.2, Planning Inspectorate Reference APP-135). To summarise, breach events, with the Scheme in place, lead to very localised flood risk effects (extent, depth, velocity and hazard) and do not lead to greater numbers of receptors being at risk of flooding when compared to over-topping events. Such risks will be mitigated through the Emergency Preparedness and Response Plan, pursuant to Requirement 10 of the draft DCO (Document Reference NCC/GY3RC/EX/082).

Key Question (Question 1)

Tidal Residual (Breach) Risk and Emergency Preparedness

2.1.16 Can the Applicant explain the apparent reluctance/inability to provide the assessment requested by the EA, noting that tidal breach is an important issue for the Proposed Development?

Applicant's Response

2.1.17 The Applicant has previously engaged with the Environment Agency and has indicated to it that the Applicant is willing to carry out tidal residual (breach) analysis prior to the Scheme opening as the Applicant acknowledges that this would helpfully inform the Emergency Preparedness and Response Plan. However, it is the Applicant's competent expert's professional judgment that the modelling carried out for the FRA (Document Reference 6.2, Planning Inspectorate Reference APP-135) together with the results presented in the Great Yarmouth SFRA are sufficient to assess that the number of people living or working in areas of residual flood risk (sensitive receptors) and the scale of any evacuation required will not increase as a result of the Scheme. This position is explained in Paragraphs 2.1.10 to 2.1.15 above.

2.1.18 The FRA (Document Reference 6.2, Planning Inspectorate Reference APP-135) proposes that no part of the Scheme is to be opened to the public until an Emergency Preparedness and Response Plan has been developed in consultation with Great Yarmouth Borough Council (GYBC), Norfolk County Council (NCC) (as county planning authority), the Environment Agency (and other organisations with emergency response functions) and that the Emergency Preparedness and Response Plan must be approved in writing by the county planning authority.

2.1.19 Notwithstanding the Applicant's position, the Applicant has undertaken tidal residual (breach) analysis to respond to the Environment Agency's queries (as described in Paragraphs 2.1.10 to 2.1.15 above). Details of the methodology and the results of the tidal residual (breach) analysis undertaken by the Applicant are provided in the Applicant's Response to Written Representations submitted by the Environment Agency at Deadline 6 (Document Reference NCC/GY3RC/EX/078).

Key Question (Question 2)

Tidal Residual (Breach) Risk and Emergency Preparedness

2.1.20 Can the Applicant explain why it considers the SFRA is an appropriate information source for formulating the approach to tidal residual (breach) risk having regards to the fact that the SFRA does not include the Proposed Development within its modelled scenarios?

Applicant's Response

2.1.21 The Great Yarmouth SFRA is referred to in so far as it indicates the type and condition of existing coastal flood defences and gives the appropriate locations for breaches, based on likely failure points and the proximity to groups of receptors.

2.1.22 It is acknowledged that the Great Yarmouth SFRA did not include the Scheme and hence indicates the existing tidal residual (breach) flood risk. It is the opinion of the Applicant's competent expert that this information, together with the results of the over-topping modelling, which includes the Scheme, and is presented in the FRA (Document Reference 6.2, Planning Inspectorate Reference APP-135) is sufficient to assess the effects of the Scheme on tidal residual (breach) flood risk (as justified further in Paragraphs 2.1.24 to 2.1.27 below and which is borne out by the results of the tidal residual (breach) analysis undertaken by the Applicant and submitted for Deadline 7 (Document Reference NCC/GY3RC/EX/078)).

Key Question (Question 3)

Tidal Residual (Breach) Risk and Emergency Preparedness

2.1.23 Can the Applicant explain the extent to which the 'deduction' used to inform the assessment of tidal residual (breach) risk is appropriate and representative having regard to the likely different flood characteristics when compared with an over topping assessment?

Applicant's Response

2.1.24 The 'deduction' is based on the professional judgment of the Applicant's competent expert for flood risk who has considered the following factors:

- The water level in the River Yare just prior to the breach occurring; and
- The potential impact of the Scheme on flow routes once flood water has left the main channel and flows across the floodplain.

2.1.25 With respect to the water level in the River Yare, the model results presented in Tables 6.9 and 6.11 of the FRA (Document Reference 6.2, Planning Inspectorate Reference APP-135) show that the maximum increase in peak water level is 0.02m for the 0.5% AEP event increasing to 0.10m when climate change is included. These increases are minor when compared to the depths of water in the channel of 2.59 m Above Ordnance Datum (AOD) and 3.96 m AOD respectively at the time of breach. It is therefore considered that the effects of the Scheme on the water level at the time of a breach do not have the potential to be significant.

2.1.26 The results of the over-topping modelling presented in Figures 12.6 and 12.7 of the FRA (Document Reference 6.3, Planning Inspectorate Reference APP-169) show that there are relatively small changes in the flood hazard on the floodplain within which the Scheme is located and that the breach location likely to show the greatest potential effects of the Scheme is located immediately south of the Scheme on the east bank of the River Yare.

2.1.27 Analysis of the over-topping modelling results has established that for severe events flood water overtops both the east and west banks of the flood defences in the vicinity of the Great Yarmouth SFRA breach locations 2 and 3 (see Figure 7-5 of the SFRA). Figure 12.3 of the FRA (Document Reference 6.3, Planning Inspectorate Reference APP-169) therefore gives a reasonable indication of the receptors that would be at risk following a breach in the defences at these locations with the Scheme in place.

Key Question (Question 4)

Tidal Residual (Breach) Risk and Emergency Preparedness

2.1.28 Taking into account the apparent uncertainty associated with the approach to tidal residual (breach) risk can the Applicant explain the extent to which this should affect confidence in the likely efficacy of Emergency Preparedness and Response Plan and what if any additional measures should/could be proposed?

Applicant's Response

2.1.29 The Applicant does not consider there to be a significant degree of uncertainty with respect to tidal residual (breach) risk that would affect the efficacy of the Emergency Preparedness and Response Plan.

2.1.30 The Applicant has indicated that a tidal residual (breach) analysis will be required to prepare the Emergency Preparedness and Response Plan, pursuant to Requirement 10 of the draft DCO (Document Reference NCC/GY3RC/EX/082). The analysis will be used to review and update the existing contingency actions following a breach and to assist the agencies in determining trigger water levels for these actions. For example, contingency actions could include: procedures used for alerting those at risk; actions taken by the emergency services and co-ordination during an incident; the identification of safe evacuation routes; and the measures taken to repair a breach. If tidal residual (breach) analysis is carried out in due course, to inform the preparation of the Emergency Preparedness and Response Plan, prior to the opening of the Scheme for public use, it must be approved by the county planning authority (following consultation with relevant bodies including the Environment Agency). Such tidal residual (breach) analysis would reflect the Environment Agency's working knowledge of the state of the existing flood defences (i.e. any defence improvements since the hydraulic modelling undertaken to inform the FRA (Document Reference 6.2, Planning

Inspectorate Reference APP-135)) and would also take account of the detailed design of the Scheme, and, on that basis, the analysis results will facilitate a review of the procedures in existing emergency plans for managing tidal residual (breach) flood risk.

2.1.31 The scope of the tidal residual (breach) analysis would be confirmed with the Environment Agency. The Applicant would expect the assessment to adopt guidance set out in Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping (Version 8, January 2014) and for a 5% AEP event to be included in the assessment. The 5% AEP should be included to allow for the event whereby the maximum tidal level peaks below the crest of the coastal flood defences. The Applicant has amended Requirement 10 in revision 5 of the draft DCO (Document Reference NCC/GY3RC/EX/082) to secure the commitment to carry out this further tidal residual (breach) analysis.

2.1.32 The Applicant does not propose any specific measures at this time beyond agreeing with the Environment Agency and other parties the parameters of the tidal residual (breach) analysis. Once the results have been issued the Applicant would develop and propose a review of the Emergency Preparedness and Response Plan, pursuant to Requirement 10 of the draft DCO (Document Reference NCC/GY3RC/EX/082), with a focus on the receptors at risk, time of arrival of a flood and flood hazard.

Key Question (Question 5)

Tidal Residual (Breach) Risk and Emergency Preparedness

2.1.33 Can the Applicant explain why it considers the Proposed Development should be defined as ‘safety critical’, taking into account the need to remain open in an emergency event and the acceptance that certain access points to the bridge would be rendered inoperable during the 0.1% AEP climate change flood event?

Applicant’s Response

2.1.34 The bascule bridge will be designed to have a lifespan of at least 120 years, in accordance with the requirements of BS EN 1990:2002 Eurocode – Basis of Structural Design (Document Reference 6.1, Planning Inspectorate Reference APP-096).

2.1.35 Safety-critical is a term commonly used to refer to infrastructure which, if compromised, poses a risk to the health, safety and security of individuals within a given area (e.g. residents etc.).

2.1.36 The Applicant considers the bascule bridge component of the Scheme to be safety-critical, such that it should be able to be raised and lowered in the event of an emergency to enable vessel movement. In accordance with

Requirement 10 of Draft DCO (Document Reference NCC/GY3RC/EX/082) emergency events include:

- A flood event;
- A fire event; and
- An incident involving terrorism / substantial threat to security.

2.1.37 The Applicant does not consider any other components of the Scheme to be safety-critical. In accordance with the Applicant's Response to Relevant Representations (Document Reference NCC/GY3RC/EX008, Planning Inspectorate Reference REP1-002) and Written Representations (Document Reference NCC/GY3RC/EX/016, Planning Inspectorate Reference REP3-006), in order to ensure safety-critical operation, the bascule bridge design is to include an emergency operation mode. This mode will be applied when the operator considers an emergency has arisen under the Standard Operating Procedures.

2.1.38 When this emergency operation mode is activated, the bridge and its mechanisms will stop in a controlled manner under the actions of the hydraulic system. Manual emergency operation will be subsequently allowed to return the bridge to the lowered position. Once lowered, 'back-up systems', as described in the Applicant's Response to Written Representations (Document Reference NCC/GY3RC/EX/016, Planning Inspectorate Reference REP3-006), will allow the bascule bridge to raise to allow safe vessel passage in emergency events.

2.1.39 In accordance with Paragraphs 4.41 and 4.43 of the National Policy Statement for National Networks (NN NPS), the Applicant has used both the UK Climate Projections 2009 (UKCP09) and the updated UK Climate Projections 2018 (UKCP18) to inform:

- The FRA (Document Reference 6.2, Planning Inspectorate Reference APP-135); and
- Chapters 11 (Road Drainage and the Water Environment), 12 (Flood Risk) and 13 (Climate Change) of the Environmental Statement (Document Reference 6.1, Planning Inspectorate Reference APP-096).

2.1.40 It should be acknowledged that UKCP09 has not been wholly superseded by UKCP18 yet and parts of UKCP09 remain valid, hence the use of both UKCP09 and UKCP18 in the assessments undertaken. Notably, UKCP18 does not include updated H++ estimates, therefore the H++ estimates from UKCP09 were used in the assessments undertaken.

2.1.41 As stated in paragraph 7.2.5 of the FRA (Document Reference 6.2, Planning Inspectorate Reference APP-135), the 'safety critical' bascule bridge itself remains operational and safe during the 0.1% and 0.5% (high risk, low

probability) AEP events modelled. It is therefore flood resilient in these scenarios. With regards to the extreme 0.1% and 0.5% AEP H++ events, which include the climate change allowances recommended in Paragraph 4.43 of NN NPS, to mitigate the residual flood risk, the bascule bridge would be raised (in accordance with the procedure explained in paragraph 2.1.37 and 2.1.38 above, to enable vessel movement) in advance of the 0.1% AEP event levels being exceeded.

2.1.42 However, the approach roads, sloping from the bascule bridge to the existing ground level on either side of the River Yare, the wider connected road network, and much of Great Yarmouth town are expected to be affected by flooding where the levels start to approach the 0.5% AEP H++ event. As a low-lying area Norfolk, and Great Yarmouth in particular, is inherently susceptible to the effects of climate change due to the low-lying topography. This is shown on Figure 12.8 (Document Reference 6.3, Planning Inspectorate Reference APP-169) which shows the modelled extents for the baseline climate change events (5%, 0.5% and 0.1% AEP events) without the Scheme in place. There is actually a slight reduction in approach road flood depths predicted with the Scheme, compared to the baseline, in the 0.5% AEP H++ climate change event (see Figure 12.13 (Document Reference 6.3, Planning Inspectorate Reference APP-169)).The Applicant considers it to be impractical to raise the connecting approach roads above the flood levels associated with the 0.1% and 0.5% AEP H++ events in this area, given the existing vulnerability of Great Yarmouth to flooding in the existing and future baseline scenarios and given that the residual flood risk in these climate change events is capable of being managed (as described above, in paragraphs 2.1.37 and 2.1.38).

Key Question (Question 6)

Flood Management

2.1.43 The Applicant explains that as part of its flood management plan for the operational development, Requirement 11 in the draft Development Consent Order requires a surface water drainage system to be prepared 'in general accordance with the drainage strategy' and with approval of relevant bodies.

2.1.44 Can the Applicant explain why the EA is not also a body to be consulted in relation to discharging this Requirement?

Applicant's Response

2.1.45 The Environment Agency has not requested to be consulted on this requirement, but the Applicant does not object to the inclusion of the Environment Agency as a body to be consulted under Requirement 11. The Applicant has amended Requirement 11 of the draft DCO (Document Reference NCC/GY3RC/EX/082) to reflect this.

Key Question (Question 7)

FRA Information and Status

2.1.46 The ExA notes that as a consequence of discussions, clarification and further analysis there is now a body of evidence which corrects, clarifies, supports and substantiates findings in the Applicant's FRA. The ExA is also aware that in response to the questions raised above there may well be additional information submitted in this regard.

2.1.47 The ExA is concerned that the iteration of information relevant to the assessment is now so spread amongst examination documents as to render it less accessible for those seeking a definitive view of accounts. This may be of particular relevance with regard to any subsequent certification or discharging activities.

2.1.48 Therefore, in response to the questions raised above and to address the issues outstanding can the Applicant please provide a definitive list of information which pertains to and is necessary for understanding the proposed developments impacts to flood risk?

2.1.49 In addition, in responding to the questions raised above, the Applicant should seek the views of the EA in effort to agree the approach to these outstanding issues.

Applicant's Response

2.1.50 The Applicant acknowledges the concern underlying the question and it is a matter that is frequently raised during the examination of applications under the Planning Act 2008 where corrections, clarifications and supporting information is produced in response to questions and submissions made by stakeholders during the course of the examination.

2.1.51 The issue is addressed through Article 64 and Schedule 15 to the draft DCO (Document Reference NCC/GY3RC/EX/082). Article 64 requires the Applicant, as soon as practicable after the making of the Order, to submit copies of the plans and documents listed in Schedule 15 to the Secretary of State for certification as true copies of the plans and documents referred to in the DCO.

2.1.52 Schedule 15 lists all of the plans and documents that are referred to in the draft DCO (Document Reference NCC/GY3RC/EX/082). The Applicant amended Schedule 15 at Deadline 6 (Document Reference NCC/GY3RC/EX/068, Planning Inspectorate Reference REP6-009) to reflect the relevant versions of the plans and documents, taking into account corrections and clarifications made during the course of the examination. This includes the substitution of the corrected version of Figure 12B.1 which was included in Appendix B to the Applicant's Response to Written Submissions

made by the Environment Agency at Deadline 5 (Document Reference NCC/GY3RC/EX/064, Planning Inspectorate Reference REP6-005).

2.1.53 The updates to Schedule 15 of the draft DCO which were made at Deadline 6 have been carried forward into the further updated version of Schedule 15 which is included in the version of the draft DCO submitted at Deadline 7 (Document Reference NCC/GY3RC/EX/082).

2.1.54 In relation to information supplied to the Environment Agency during the Examination, the Applicant has undertaken two stages of further sensitivity testing relating to flood risk to address technical queries raised by the Environment Agency in relation to the Applicant's FRA (Document Reference 6.2, Planning Inspectorate Reference APP-135) and Chapter 12 of the Environmental Statement (Document Reference 6.1, Planning Inspectorate Reference APP-096).

2.1.55 The first stage of further sensitivity testing and a supporting memorandum were submitted to the Environment Agency for review on 21st and 22nd October 2019. The first supporting memorandum is included in Appendix A. Following the Environment Agency's initial review of the first stage of the further sensitivity testing and the supporting memorandum, two additional technical queries raised by the Environment Agency were received by the Applicant on 13th November 2019. The Applicant responded to these two queries on 28th and 29th November 2019 through the provision of a second stage of further sensitivity testing and a supporting memorandum. The second supporting memorandum was presented as Appendix A to the Applicant's Response to Written Submissions made by the Environment Agency at Deadline 5 (Document Reference NCC/GY3RC/EX/064, Planning Inspectorate Reference REP6-005). The memoranda do not comprise part of the FRA (Document Reference 6.2, Planning Inspectorate Reference APP-135) or the ES (Document Reference 6.1, Planning Inspectorate Reference APP-096), nor do they alter the conclusions of the assessments presented in those documents. As such the Applicant does not consider it to be appropriate or necessary for these memoranda to be identified in Schedule 15 to, or certified under Article 64 of, the draft DCO (Document Reference NCC/GY3RC/EX/082).

2.1.56 With regard to outstanding issues relating to tidal residual (breach) analysis, raised as part of the examination process in the Environment Agency's Response to the Examining Authority's Second Written Questions (REP5-011) at Deadline 6, the Applicant has continued to engage further with the Environment Agency to reach a common position.

2.1.57 To summarise, it is agreed that the Applicant will undertake further tidal residual (breach) analysis prior to the Scheme opening for public use. The analysis will be used to inform the preparation of the Emergency

Preparedness and Response Plan, pursuant to Requirement 10 of the draft DCO (Document Reference NCC/GY3RC/EX/082).

2.1.58 A record of the continued engagement undertaken with the Environment Agency is provided in Table 2.1 of the Statement of Common Ground with the Environment Agency submitted at Deadline 7 of the Examination (Document Reference NCC/GY3RC/EX/085).

Appendix A

MEMO

TO	Environment Agency	**FROM**	GYTRC Project Team
DATE	21 October 2019	**CONFIDENTIALITY**	Confidential
SUBJECT	GYTRC – Environment Agency – Further Sensitivity Flood Modelling		

Further to the ongoing discussions on the Flood Risk Assessment, Environmental Statement - Appendix 12B (Document Reference 6.2, PINS Reference APP-135) and the associated modelling with the Environment Agency, Norfolk County Council has undertaken further sensitivity modelling to address the concerns raised by the Environment Agency for each of the following scenarios:

Present Day:

- 1 in 20 Year
- 1 in 200 Year
- 1 in 1000 Year

Climate Change:

- 1 in 20 Year (plus climate change)
- 1 in 200 Year (plus climate change)
- 1 in 1000 Year (plus climate change)

H++ (High Impact, Low Probability):

- 1 in 20 Year (plus H++)
- 1 in 200 Year (plus H++)
- 1 in 1000 Year (plus H++)

The further sensitivity modelling accompanies this memorandum. The further sensitivity modelling is supplementary to that presented in the Flood Risk Assessment, Environmental Statement - Appendix 12B (Document Reference 6.2, PINS Reference APP-135). The conclusions of the Flood Risk Assessment remain as presented in the application documents.

Table 1 provides a summary of how Norfolk County Council has addressed each of the Environment Agency's concerns (as per the Environment Agency's letter dated the 31st July 2019).

Table 1 – Environment Agency Concerns and Norfolk County Council's Response

Environment Agency (EA)			Norfolk County Council
Item Checked	**EA Comments**	**Action Suggested by EA**	**WSP Response**
Are out of bank flows represented in 1d? If so, how has it been done and is it appropriate? *Extended channel sections, storage areas; or secondary channel sections.*	*FRA created a reservoir storage area in the urban area to the north of the 2D domain. A polygon shape or outline image should be included in the report as a reference somewhere, to clarify how the reservoir volumes were created.*	*It is likely that this area will need to be replaced as a 2D domain (see below comments). If it is to remain as 1D domain, then give appropriate polygon/ image.*	Actioned. Within the further sensitivity modelling the 2D domain of the model has been extended, the 1D channel which represents the River Bure has been removed and the 1D boundary to the north of Great Yarmouth has been removed as this is now represented in the 2D domain.

Environment Agency (EA)			Norfolk County Council
Item Checked	**EA Comments**	**Action Suggested by EA**	**WSP Response**
How have the boundaries been applied? *Flow time boundary, FEH units etc.*	*River flow triangular hydrograph with 5 cumecs Tp = 1 hour both for west and north river boundaries, Unclear how these values are derived.*	*Derive appropriate FEH hydrology (hydrograph) for the two rivers.*	Explanation. The River Yare is tidally dominated and the main risk of flooding to Great Yarmouth is tidal. The Broadlands river network is also tidally dominated, therefore the same approach as used for the 2011 Halcrow model[1] has been used where nominal fluvial inflows have been applied in the flood modelling. The 2011 flood modelling used catchment descriptors to produce a hydrograph for the fluvial inflows but then scaled them by 0.001 to input as nominal flows. The 2011 Halcrow Report that accompanies the model[2] recognises that "The Yare and Bure rivers are tidally dominated, and fluvial flows have very little effect on the water levels". Due to the study area and Scheme area being tidally dominant, the tidal inflow boundary is presented in the Flood Risk Assessment submitted as part of the application documents to represent present tidal levels and the climate change allowances.
Have any of the parameters and advanced parameters been changed from the default. If so, has it been justified?		*Justification needs to be given.*	Justification. The value of dflood was increased from 3 (the value used in the Halcrow 2011 model) to 10 in the first submission of the model prior to the submission of the application. The dflood[3] value was increased to stabilise the model, particularly during the early part of the larger model runs where there is a large exchange of water between the 1D and 2D domains. This increase has been shown not impact on the model results. Therefore, the value of dflood has not been subsequently changed.

[1] *Halcrow developed a 1D-2D ISIS TUFLOW model in 2011 on behalf of the EA as part of the Great Yarmouth Flood Defences Framework for Action (GYFDFFA) Project.*

[2] *The report was produced as a part of the GYFDFFA Project in 2011.*

[3] *Dflood is the height (m) of vertical walls that the Flood Modellers adds to the highest point on each river cross section. The default value is 3 m.*

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Has the DTM been rotated to optimise flow route representation? *Check Loc file or TCF.*	*Grid orientation angle. X axis set at 0 degrees with respect to East. Should be rotated to 90 degrees angle, to be similar to JBA 2018's 2d_loc file and would be better suited for tidal inundation.*	*Rotate 2D grid.*	Explanation. Same orientation used as in 2011 Halcrow model[4] (2011 2d_loc file is 0 degrees with respect to east). The River Yare is orientated north south so this is appropriate. The grid would be the same if a 90-degree orientation was used and the tidal inflows would still be in the same location.
Obstructions to flow (or not an obstruction to flow)?	*The 'existing bridge' modelled in 2D doesn't appear to be surveyed (and is not in the Halcrow 2011 model).*	*Provide survey for bridge.*	Actioned. Norfolk County Council provided a Bridge Inspection Report[5] that gave bridge dimensions to the Environment Agency. Levels are not quoted on the drawings, but they are to scale so the deck level of the double-leaf bascule bridge was measured from the scale drawing and also checked against lidar data of the adjoining road.
	The subways under Gapton Hall Road are not modelled, which are included in Halcrow 2011 & JBA 2018 models.	*Include subways & culverts in model. Also apply local adjustment to new LIDAR files to allow access passage to these structures, consistent with Halcrow 2011.*	Actioned. Within the further sensitivity modelling the subways and culverts have been included.

[4] *Halcrow developed a 1D-2D ISIS TUFLOW model in 2011 on behalf of the EA as part of the Great Yarmouth Flood Defences Framework for Action (GYFDFFA) Project.*

[5] *Principal Inspection Report, Haven Bridge, Great Yarmouth Port Authority, September 2006.*

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	JBA 2018 have included culvert data that should also be in the model. This data appears to be located in the .ecf files of the appropriate models.	*Include subways & culverts in model. Also apply local adjustment to new LIDAR files to allow access passage to these structures, consistent with Halcrow 2011.*	Actioned. Within the further sensitivity modelling the subways and culverts have been included.
Are defences/ embankments/ bank crests accurately represented?	*The crest levels (i.e. 3m) of JBA 2018 file 2d_zln_Great_Yarmouth_defences_Breydon_ Water doesn't seem to be incorporated into the relevant 1D cross sections.*	*Correct and include in future model work.*	Actioned. Within the further sensitivity modelling the Breydon Water has been included in the 2D domain. The crest levels (2d_zln_Great_Yarmouth_Breydon_Water) has been included as a zline with constant value of 3m AOD.
	JBA's 2d_zsh_flow_path_GYMR_20100827_GM01 should be included or alternatively local LIDAR edit (Halcrow 2011 approach) to allow access to subways under road.	*Correct and include in future model work.*	Actioned. Within the further sensitivity modelling JBA's (2d_zsh_flow_path_GYMR_20100827_GM01) has been included.

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	JBA's 2d_zlg_Great_Yarmouth_001 should be included to allow water passage under road.	*Correct and include in future model work.*	Actioned. The flow path at this location was represented in the model DEM for sensitivity analysis as shown by the 20CC results at that location (Scheme 20CC results shown in figure below). 

	Below (to side) is the FRA's Tidal HT boundary (dark green dotted line). 2D model domain boundary (red dotted line) and sea defences (yellow triangles). The 2D and HT boundary should be further out to east behind defences.	*Correct and include in future model work.* *When correcting the HT boundary, it is advisable to set this line 1 or 2 grid cells behind defence lines so the overtopping mechanism occurs slightly behind defence rather start right on top of defence line.*	Explanation. The defence layer along the east coast is taken from LiDAR data, therefore the levels applied along the HT (Head -Time) line in the model are similar to the levels in the defence layer. However, there may be some locations where the HT layer selects cells at a lower level than the defence level. A sensitivity test has been carried out by shifting the HT boundary by more than 2 cells east of the coastal defence. This sensitivity test has been undertaken with the baseline 200CC event. The results of the sensitivity test show that the in-channel water levels along the River Yare increase by approx. 20 mm when the tidal boundary is moved east from the coastal defence. At the location of the Scheme, there is a decrease in modelled water level of approximately 15 mm. The 200CC baseline modelled water level at the Scheme is 4.058 m AoD and the water level from the sensitivity model results is 4.046 m AoD. The decrease in water depth due to the shift of the boundary is only 0.3% of the baseline maximum water depth in the location of the proposed scheme. Furthermore, the shifting of the HT boundary has no impact on the outcome of the Magnitude of impact and hence the Significance of a change in flood risk. Therefore, it was not deemed necessary to re-run all the baseline models with this updated boundary'.

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			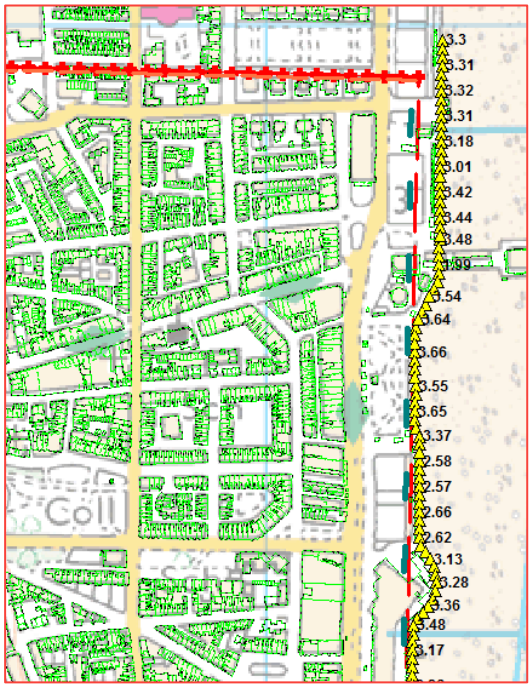

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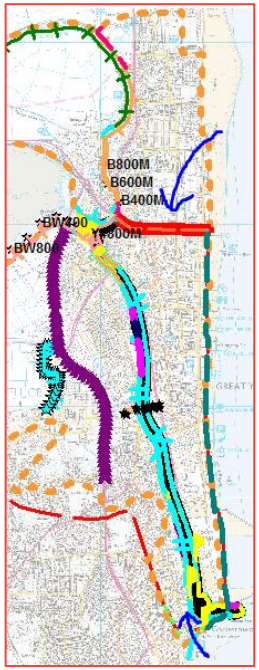
Is the model boundary suitably large? i.e. the flood extent should not reach the boundary. *Check that the largest modelled flood extent does not intercept model extent i.e. glasswall. Can check with the code layer.*	*No, 2D domain is too small as it impacts tidal inundation from the north and the south (i.e. blue arrows in below image), especially at higher tidal events. The FRA tidal boundary is the dark green dotted line. Halcrow 2011 larger 2D model boundary is the orange dotted line.* 	*Make the 2D domain larger. As a guide, the smallest 2D domain should be roughly the same size as Halcrow 2011, particularly on the sea facing side. If expanding the model domain, make sure any additional structures (e.g. bridges, culverts, subways etc) are included in new domain.*	Actioned. Within the further sensitivity modelling the 2D domain has been extended to cover the area similar to 2011 Halcrow model[6] and culverts and sub-ways have been included. All other relevant layers were adjusted accordingly.

[6] *Halcrow developed a 1D-2D ISIS TUFLOW model in 2011 on behalf of the EA as part of the GYFDFFA Project.*