Dear Inspector

Goole Flood Risk

2020 Strategic Flood Risk Assessment – Level II Goole

MIQ Matter 2K – Is the L2 SFRA Robust?

The Council on 4th October 2023 have released background information regarding the modelling of the flood risk assessment. This was released under a Freedom of Information Request and is documentation not previously made available.

The Foi response and dossier are attached

This information is considered crucial to the consideration of the SFRA and its robustness. The SFRA is the basis of deleting housing allocations, future planning provisions in Goole including windfall, and hence the substitution of provision to Howden

The Council development control have refused application (23/01226) based on the SFRA and have stated that the SFRA can only be challenged in the Update proceedings; in effect asking the Inspector to verify the SFRA in approving its Goole development mapping and conclusions

It is asked that this 4/10/23 Council Foi response and the attached background dossier is included in the Hearing library. It is thought to do so will assist the hearing procedure and possibly the Update itself.

To attached this enclosure note to yourself would possibly assist the Council and other interested parties

The following comments arise solely from the Councils 4/10/23 dossier

1. The Foi question 3 asks for river levels

   The Foi reply is that SFRA modelling followed the Upper Humber Model, but updated to allow for climate change, in detail:-

   - 5.89m AOD, based year 2014 plus sea level increase of 1.109m from 2015 to 2015, for Brough
   - Concluding in a river level of **6.999m AOD**

This is the principle mistake in the L2 SFRA modelling

Breach modelling is not possible if the water level is higher than the river bank; such a modelled event would be overtopping

6.999m AOD water level which is higher than the river embankment should not have been used in a breach computer model

Goole is 25km upstream from Brough and as the Humber Strategy Study and the JBA one dimensional study produces the extreme water level at Goole which is **6.160m AOD**

2. Basic hydrology understanding of river estuaries is that the effect of the sea, e.g. tide, diminishes with the distance from the sea. The tidal dominance is replaced with non-tidal fluvial river flow. A 1m increase in sea level is reduced to 250mm, 25km upstream.
3. The L2 SFRA overtopping mapping Appendix C1 (Tidal with Climate Change) and Appendix C3 (Fluvial with Climate Change) agree with the EA Upper Humber Study assessments and are not an issue.

   They show Goole having no overtopping flooding (except around Goole-A which is overtopping from the river Aire, and Old Goole having problematic flooding (this representor agrees with the L2 SFRA regarding deleting allocations in Old Goole)

   The mapping Appendix C1 and C3 clearly confirm that the extreme water levels do not exceed 6.500m AOD, i.e. the top of the river Ouse embankment.

4. Council FOI Para 7

   For the Council to state that Aecom HOW-G looked at Howden and L2 SFRA only considered Goole is a misguided statement as the river Ouse which separates the two areas has the same water levels. The HOW-G finalised September 2022 considers more up to date data. The SFRA is not robust unless updated to reflect the HEWL and the Council assertion is contra to the current non-stationary flood risk considerations

   On 16/03/19 Andrew Pattinson EA referred to new data and asked that the SFRA should consider how any future changes could be assimilated in the SFRA (extract from Owen Robinson ERYC modelling approach) This request was not adopted, all as detailed in the Foi dossier.

   Issues

   a) Need to update and keep updating the SFRA

b) The Aecom HOW-G Para 3.33 states a breach peak water level of **6.15m AOD**. This compares closely with the EA Upper Humber breach level of 6.160m and this was the figure confirmed by Andrew Pattinson April 2023

c) The breach level currently advised for FRA's is **6.160m AOD** i.e. less than 6.500m AOD.

d) The level used in the L2 SFRA is **6.999m AOD**, all as above is impossible for a modelled breach assessment.

5. The representor has been given the breach water level of 6.999m AOD previsouly and as the RAA report this is not a feasible breach event when the river bank is lower.

   The Foi dossier page 9 of the Capita SFRA modelling approach confirms the 6.999m OAD level was used for the breach model

6. The Foi dossier, page 21 of the Capita model detailed confirmation:-

CAPITA

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Model boundary data

The Table 5-3 below provides the model boundary data, tidal levels, and climate change allowances to be applied in the models of Goole and Hedon for the SFRA Level 2.

Table 5-3 - Model boundary data for SFRA Level 2

Model boundary data for SFRA Level 2	Goole	Hedon
Closest Water Level Location	Brough	Paul
Model Node names	OUSE_-08420	Bustwick Outfall near Salt End
MHWS tide mAOD	Not known or needed for this study	4.46
tidal 1yr mAOD base date is 2014	5.15	4.56
tidal 1yr mAOD for 2019 (base year 2014 plus 0.20m)	5.35	4.76
tidal 200yr mAOD base date is 2014	5.89	5.51
tidal sea level increase from 2015 to 2115 using: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances	1.109	1.109
Tidal 200yr+Climate Change	6.999	6.619
River flow + Climate Change Higher Central % increase to 2115	30%	30%

Schedule of model runs

A schedule of model runs for the Goole and Hedon models is detailed in Table 5-4, below.

Table 5-4 - A schedule of model runs

Schedule of runs for Goole	Number of runs
Run Defended Upper Humber model with updated CC tidal boundary, no other changes will be made.	1
Use the results from the run above to provide hydrographs for separate breach models, this will include 1 on Don, and 9 others as shown on the technical approach note.	10
Schedule of runs for Hedon	
Run Defended Hedon model with updated river flow boundaries for the 0.1%, 1%, 1%+CC, and 5% AEP fluvial events coinciding with a 1 year tide level.	4
Use the results from the run above to provide hydrographs for separate fluvial breach models along the fluvial assets on Burstwick drain, as shown in the technical approach note. Breach location map copied below.	4
Run Defended Hedon model with updated river flow boundaries for the 2yr fluvial events coinciding with a 200yr+CC tide.	1
Run Defended Hedon model with a breach located at Burstwick Gates with the updated river flow boundaries for the 2yr fluvial events coinciding with a 200yr+CC tide.	1

7. The above details states *"Closest Water Level Location - Brough"*

   It was not in the Capita remit to run a Humber (at Brough) to Goole River Ouse (at Goole) a one dimensional (e.g. water retained in the river channel) or two dimensional (allowing for water storage in the active flood plain) extreme river level assessment.

   To run an extreme water level assessment from the Humber (Brough) to the Ouse at Goole is an extensive and expensive exercise.

   ** (refer to accompanying Note)

8. As a discussion, Capita were attempting to superimpose climate change assessments to upgrade the 2016 Upper Humber Study. For fluvial river levels the Capita results appear to have just used the Upper Humber assessments.

   <u>For breach modelling it appears that Capita made a simple fundamental error, and did not take into account the diminishing effect of the upstream distance from the sea.</u>

9. The Dossier shows that the breach modelling computer runs were delayed by discussion on an additional node position over and above those used on the 2011 SFRA and the Upper Humber Study. By 16/03/19 (as the Owen Robinson ERYC summary) it is clear that there was an urgency to get the modelling underway

   There is an apparent gap where neither the Council nor EA has any involvement, i.e. the running of the details Tuflow programme. As previously states by the Council this is a copyright intellectual property issue.

   Together with personal changes (Capita; Claire Gardener, Alan Worsley, John Dudley replaced but Tom Bannister)

10. The dossier reveals that Andrew Pattinson (email 27/2/19) sought an update to the water level in the estuary (Goole dock gates), and how an emerging assessment could be accommodated in the SFRA. Note this representor believes that Andrews understanding was that Capita were using the 2016 Upper Humber Study river levels; in fact for breach they were incorrectly using the impossible **6.99m AOD** river level.

11. The Foi Dossier includes Andrew Pattinson email 16/03/19, 13:18 in which the EA officer advised of the H++ scenario of a simulated 245mm tidal dominated increase. Using the Capita data highlighted in 5) above:-

    200 year tidal 5.89m

    plus H++ 0.245

    6.135m AOD

    As of 16/03/19 the EA were advising the use of 6.135m AOD with H++ allowances, since reduced to 6.016m AOD, **NOT 6.999m AOD** as used in the L2 SFRA

12. Capita Property and Infrastructure Ltd are no longer trading and apparently will not be at the Update Hearing to explain their modelling assumptions, especially the **6.999m AOD** river level

13. <u>Breach Open Period</u>

    The Foi provided the Capita L2 SFRA modelling approach February 2019 and specifically detailed on page 11.

    Breach Duration stated:-

    EA Guidance (2014) 72 hours (Anglia)

    Worth & Cox (2002) 24 hours (EA, South West)

    The L2 SFRA did not use the update 2017 EA Breach Design Guidance which states 30 hours. The L2 SFRA uses 72 hours. This makes the L2 SFRA a non-current document

    The Council Foi para 6 states that it is not necessary to update the L2 SFRA regarding the breach open period

    The duration of breach open period is a key factor in flood mapping. Use of the correct 30 hour period reduces the flood water volume by 50%

    The Foi Dossier information clearly indicates that in 2019 Capita did not use the 2017 Environment Agency published guidance on breach design.

    The Foi Dossier *"Breach duration 72 hours, following discussion at the inception meeting the response times to a breach, in the absence of any further information or confirmation of secured resources to attend any breaches, the larger of the two options (72 hours not 24) is proposed"*

This is not a robust or justification for an extended breach period which has the result of doubling the modelled flood water volume

** (Refer to accompanying Note)

14. The Council is stating in Foi para 5 states that the “SFRA is robust, without updating”. The Council para 5 misunderstands the contents of its own commissioned Aecom HOW-G High Level FRA. The HOW-G FRA shows that the HEWL ‘2121’ H++ water levels are slightly lower than the EA 2016 Upper Humber Levels, plus Climate Change and that the breach open period should be 30 (not 72 hours). It is the same river Ouse, Howden and Goole.

    In defence of EA and Council officers they did not have the benefit of the subsequent JBA assessment the HEWL, H++ when the Capita L2 SFRA was produced.

    Further the Council Executive Director Alan Menzies was advising that Capita were a company which had satisfied the Council selection process and the Capita assessment and advices should not be questioned.

15. To emphasise the current view is that for breach assessments the correct extreme water level for the river Ouse around Goole is 6.160m AOD. The use of **6.999m AOD** by consultants Capita is a gross mistake which has led to serious over stating of the Goole flood risk. The Upper Humber Study has flood depth of 0.25 - 0.5m cf Capita L2 SFRA up to 5 metres

16. <u>Breach Invert Level</u>

    The Foi question para 2 requested:-

    “Any written confirmation of discussions including the breach invert levels to be adopted”

    This request was because the 2011 SFRA used typically invert level 4.60m AOD, whereas the 2020 SFRA used typically 3.0m AOD

    This is substantially different:-

    Assuming a river level of 6.160m AOD (For comparison)

    The breach height 6.160 less 4.6m equivalent 1.56m

    6.160 less 3.0m equivalent 3.16m

    The 2020 SFRA has a breach open size 100% larger than the 2011 SFRA due to the assumed breach invert level

17. The Foi Dossier provides backup information including a Capita Technical Note (2018) based on a desktop study using LIDAR data and a 2013 Mott McDonalds topographic survey

    This Technical Note included the conclusion:-

    "*A combined structural geotechnical survey undertaken by experienced specialists is recommended in order to assess the actual conditions of the defences to identify potential issues for stability of the assets (e.g. erosion of the riverward sides, conditions of the solid structures, cracking within the earth embankment, interaction between solid- earthen adjacent defences etc)*

    To this comment the representor adds that the geotechnical survey should determine the composition (e.g. type of clay, granular) as this is required for the latest breach failure considerations. The L2 SFRA has become outdated by recent published research e.g. H.R Wallingford 2023 sponsored by DEFRA which considers breach failures.

    The 2020 L2 SFRA uses the 2011 L2 SFRA for breach node positions (plus one) but not the 2011 L2 SFRA breach invert level without robust justification for the change. This results in a 100% greater breach open size. The EA supported the use of a 4.600m AOD breach invert level, and have not instigated any embankment defence improvements; i.e. they are not concerned regarding the stability of the lower berm.

    The Capita L2 SFRA Modelling Approval included in the Dossier, dated February 2019 reveals (Page 3) that a geotechnical survey of the Goole defences was planned but had not occurred by February 2019. Instead of obtaining embankment condition details as recommended in the 2018 Technical Note, Capita used a (too low) breach invert level. No geotechnical survey is evidenced, presumably the required survey was not undertaken.

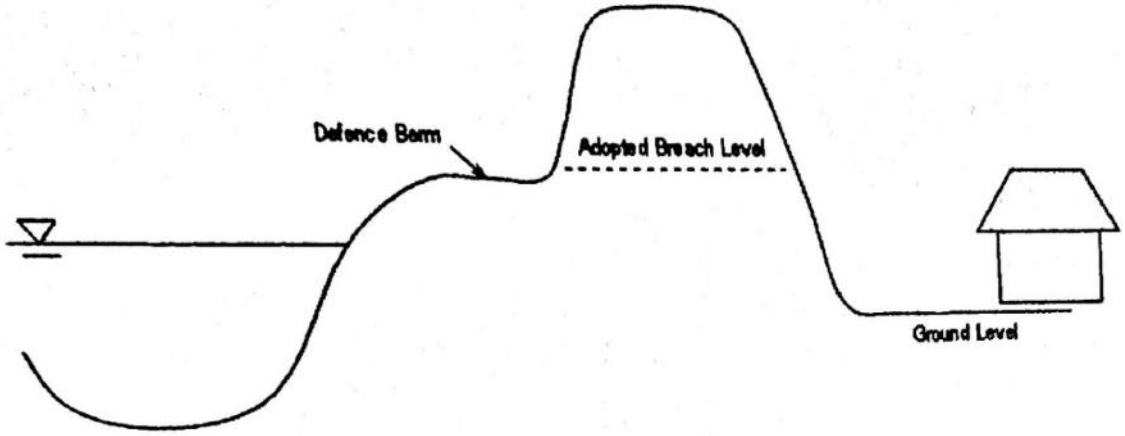
18. It is believed that a geotechnical survey plus use of the latest breach failure mechanism will confirm that the wide lower berm (up to 4.60m AOD) will be safe from instantaneous breach, and that 4.60m AOD should be the correct invert level for a residual modelled breach, not 3.0m AOD

19. The Foi Dossier included the 2011 L2 SFRA (Jacobs) a document not available via public access. This document, (which was part of the evidence base for the 2016 Local Plan) para 14-17 considers breach failure, including a cross section of the embankment highlighting the defence berm, the top of which 4.600m AOD was adopted as the breach level and quote:-

Extract from 2011 L2 SFRA

"Discussion were held with the Environment Agency to agree the most realistic failure scenario for these defences in this instance, and this is depicted in the failure below:-

14. The consequence of a breach failure of the existing flood defences has been assessed through hydraulic modelling at ten (10) agreed breach locations. The location of the breaches, the adopted configuration of the assumed breach failures, including the breach width, and the length of time assumed between failure and emergency repair of the defence are described in Appendix A. It is highlighted that a large proportion of the flood defences within the Goole area feature a large berm on the river frontage. Discussions were held with the Environment Agency to agree the most realistic failure scenario for these defences in this instance, and this is depicted in the figure below.



20. The Foi Dossier does refer to the Humber Strategy Study which details water storage in active flood plains, but the L2 SFRA appears to use a river level of 6.999m AOD for its modelled breach assessment. This is totally implausible

    Even if the correct 6.160m AOD water level was used, the extended breach open period increases the modelled flood volume by 100% and further the use of a 3.0m AOD invert level increases the flood volume by 100%

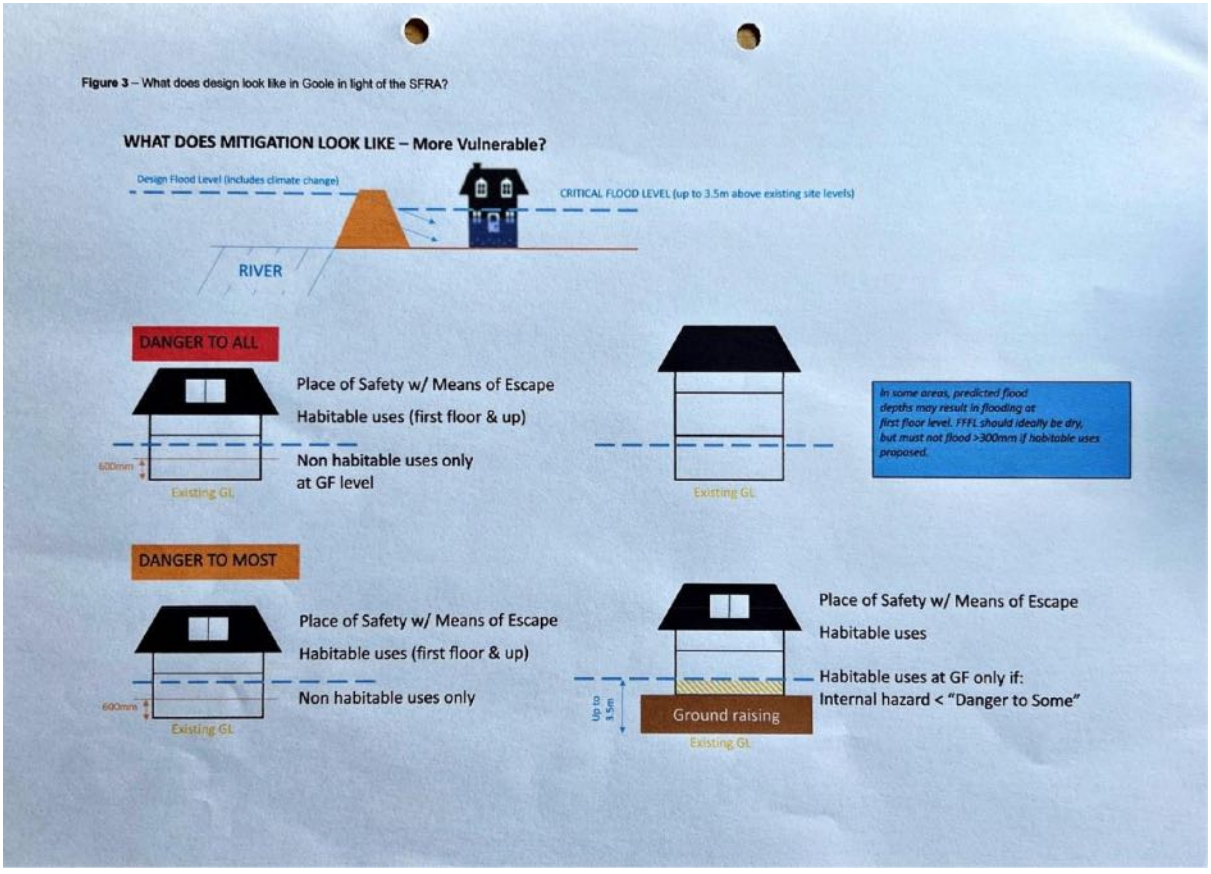
    The more realistic modelled breach flood volume should be 0.5x0.5 i.e. 25% of the L2 SFRA even if the correct extreme river level was used. The L2 SFRA compounds non-realistic modelling data

    Flood Risk modelling is now considered non-stationary and should be updated with the latest assessments, e.g. the river levels as illustrated in the Aecom HOW-G assessment. The L2 SFRA is outdated and incorrect and should not be used to prevent new build in Goole for the period up to 2039.

21. The residual flood risk mapping as the 2011 SFRA, the 2016 Upper Humber Study, the 2022/23 RAA reports do result in proposed new developments in Goole having to mitigate measures all as detailed in the PPG

The Foi Dossier includes an Environment Agency review. With a review of the L2 SFRA taking into account the above comments would produce a revised L2 SFRA with breach modelling flood mapping in line with the EA's own Upper Humber Study and indeed would be less onerous, and the 2011 SFRA mapping is not inaccurate taking into account the reduced breach open period but the increased river levels since 2011. This is as discussed in the Aecom HOW-G report; the principle of the river level and the breach open period are equally applicable for Goole and Humber.

The Environment Agency review considers Mitigation, e.g. recommendations 8.01, 9.01 – 9.03 and the Foi Dossier EA review includes an illustration of Mitigation



Goole has for the last two decades and beyond have incorporated ground and building raising (see 17/00144)

As EA review contained in the Dossier

"To successfully mitigate the potential depths shown, ground levels incorporating 'more vulnerable' or habitable uses will need to be raised high above existing ground levels. This is likely to require ground raising"

"The draft National FCRM Strategy ….. in areas of high flood risk, the strategy highlights the challenges when seeking to address those risks and the

ambition to make more climate resilient places and communities…… we would suggest that for Goole there needs to be something ambitious…… we therefore encourage the Council to think how the town of Goole can be made more resilient to the risk of flooding…..whether this is through ambitious strategic spatial planning, adaptive policies, or innovative design"

Taking such an approach now could help Goole become a landmark for flooding resilient design and adaption with the UK and create a healthy and sustainable community for the future.

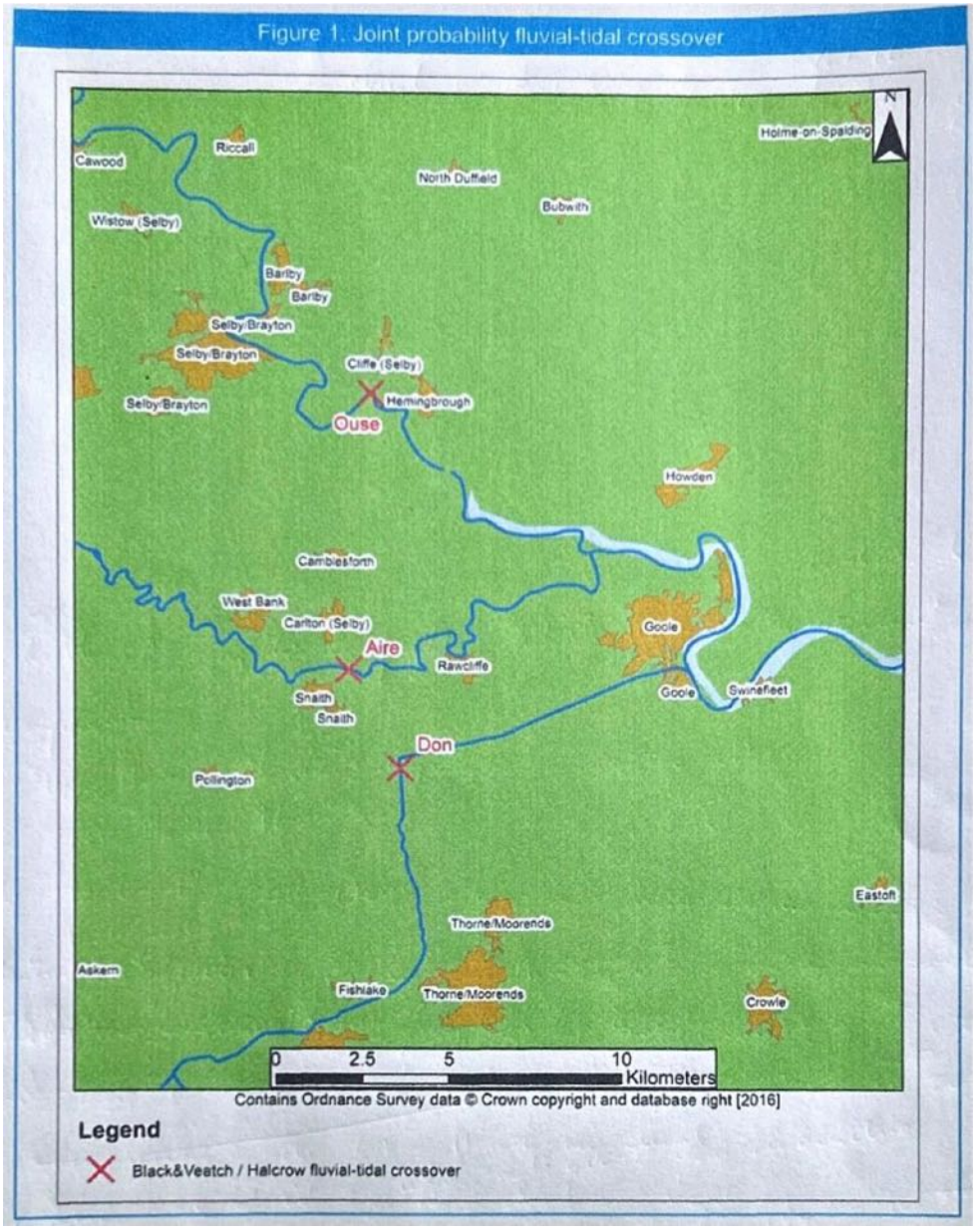
(Quote from the EA review)

Freedom of Information Request – Robustness of the L2 SFRA Goole

Council Reply 4th October

Accompanying **Notes**

1) The effect of the increase in North Sea levels with climate change diminishes with the distance upstream in the estuary/river. Spurn Point at the mouth of the Humber estuary to Goole is 90km. Goole is in a region where the controlling extreme Ouse levels change from tidal (including Old Goole) to fluvial i.e. spring tides (including the principle area of Goole)
2) The Upper Humber Study includes a map showing where the tidal diminishing is replaced with fluvial flow levels.



This illustrates that for a 1m rise in Sea Level the effect on the river level is completely lost at points upstream of Goole and pro-rata is substantially reduced at Goole.

3) The last major tidal surge was in 2013 which reached upstream as far as Old Goole (no flooding) and flooded the active flood plain at Sandtoft on the left bank opposite Goole. The data collected was used to assist in the subsequent EA one dimensional study the Humber extreme Water Level HEWL H++ prepared by JBA. This data of extreme water levels of the Ouse Goole/Howden as illustrated in the Aecom HOW-G assessment

4) The 2020 L2 SFRA modelling approach as re-confirmed in the Foi responses uses available data at Brough. Goole is 25km upstream from Brough and the L2 SFRA appears to have assessed the extreme water level by simply adding a climate change increase in sea level (1.109m) to the existing Brough extreme level. This simply is incorrect.

   An attempt at a simple explanation

5) The fluvial flow in the river channel pushes river water into in the sea, which holds back the river water and as the sea level rises the increased resistance increases the river level. At the extreme the river overflows into the active floodplains. The assessment of the water held in the floodplains is known as two dimensional. The Humber Strategy is to keep the river levels as low as possible, in order that the Trent, The Aire, The Don, The Derwent do not back-up.

6) The hydrology study to relate Brough river levels plus 1.109m sea level increase is outside the remit of the L2 SFRA. EA commissioned JBA to carry out a one dimensional study (i.e. not including the water storage in the floodplains) and the conclusion of which is that the extreme water level to be used at Goole is 6.160m AOD (confirmed by Andrew Pattinson EA April 2023). This is comparable to 6.150m AOD used in the EA 2016-28 Upper Humber Study, a two dimensional study will reduce further the extreme water level in the channels.

7) The use of **6.999m AOD** by Capita is inexcusable not only because the modelled river level cannot exceed the embankment level for a breach event, but that the consultants Capita appear to not understand the complex nature of the Humber estuary fed by the Trent, the Don (Dutch river) the Derwent, the Aire the Calder and the Ouse

8) Until the Foi replies 4/10/23 this representor considered that is was inconceivable that the L2 SFRA had used a **6.999m AOD** river level for the breach mapping and that previous similar river levels stated by the Councils forward planning officers were errors which would subsequently be explained.

9) <u>Hedon</u>

   The Council carried out two Level II SFRA - Goole and Hedon

Hedon is flood zone 3a and 3b i.e. with areas in functional flood plains and importantly is located to the east of the City of Hull, i.e. close to the month of the estuary

The data now provided refers to the river level at Paull which is close to Hedon, and hence the river levels plus climate change can be taken as accurate, cf Goole which are incorrect.

Hedon has the benefit of tidal gates and the L2 SFRA Hedon looks at the effect if the tidal defences fail.

The Hedon SFRA has accuracy cf Goole because of the proximity to the EA stated river levels at Paull

EA Water level at Paull 5.51m AOD

Increase in sea level 1.109

The representor is addressing issues with the Goole L2 SFRA but agrees with the Hedon L2 SFRA as it uses correct river level predictions

10) Breach Open Period

The Dossier *"In the absence of further information or confirmation of secured resources to attend any breaches, the larger of the two options (72 hours not 24) is proposed"*

Discussion

The embankment are Environment Agency, assets i.e. DEFRA, government owned. Any failure the cost of remedial is a direct government cost (secured resources)

Goole has a junction onto the M62 motorway, hence heavy construction plant has easy and quick access, with plant accessing along the top of the embankment to the modelled breach location. The wide lower berm (40m plus) is a ready source of cohesive material to fill the modelled breach

The FOI Dossier information does not give robust reasoning why the L2 SFRA did not adopt the 2017 EA Breach design guide of 30 hours

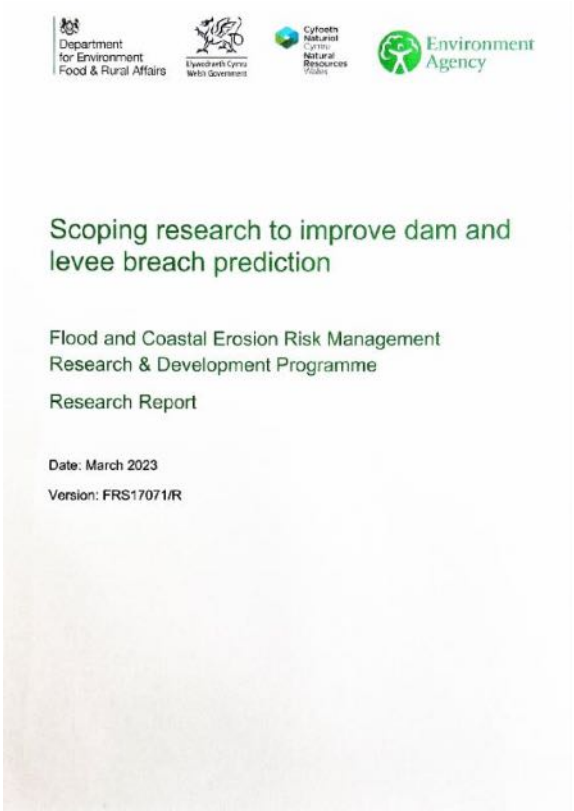
11) Breach Invert Level

The FOI Dossier reveals that a structural geotechnical survey was recommended to be undertaken, and was planned but for whatever reasons did not occur

The Dossier has not given any robust reason to change from the 2011 L2 SFRA level of 4.6m AOD, i.e. the top of the lower berm

The Dossier includes the Capita Modelling Approach including Chapter 5 Breach Scenario

The use of the ground level rather than the top of the wide lower berm relies on historic guidance rather that the latest 2023 H.R Wallingford breach prediction study


Department for Environment Food & Rural Affairs

Environment Agency

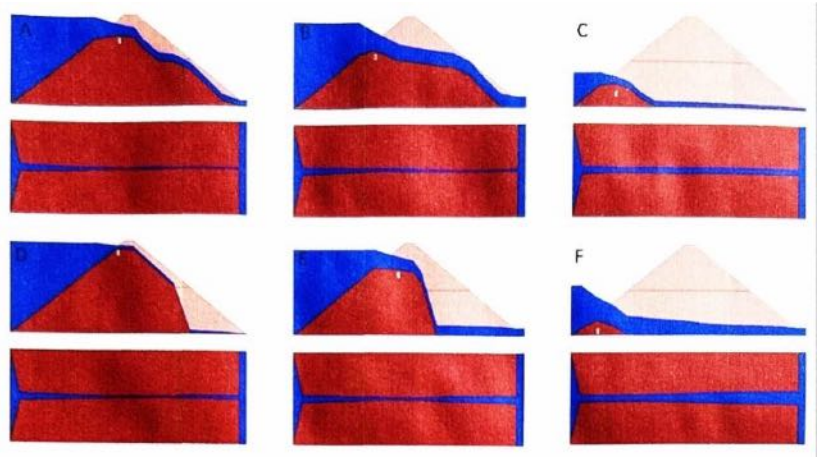
Scoping research to improve dam and levee breach prediction

Flood and Coastal Erosion Risk Management Research & Development Programme

Research Report

Date: March 2023

Version: FRS17071/R



The generalisation that breaches commonly erode to the base level of the defence does not take into account the width of the berm and an assessment of the (extended) time of the erosion to reach the base level.

The 2020 L2 SFRA makes prominence of the Rapid Inundation Zone which assumes instantaneous breach. The modelling of an instantaneous loss of the whole lower berm material appears unfeasible, and the 2011 L2 SFRA assumption of loss of the upper embankment appears to be the correct modelling approach.

The change from the 2011 L2 SFRA modelling is not robustly justified in the background data from the 2020 L2 SFRA taking into account the more recent 2023 H.R Wallingford publication, and further the lack of any site assessment of the embankment does not give justification to a change in the breach invert level.

The wide lower berm has been in existence for centuries without known failure.

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Lisa Nicholson Interim Director of Legal and Democratic Services

Mr G Jackson
Sent by email only:-
[redacted]

Your Ref:
Our Ref: EIR0636
Enquiries to: Jo Bateson
[redacted]
Date: 4 October 2023

Dear Mr Jackson

Environmental Information Regulations - Request for Information

On 5 September 2023 East Riding of Yorkshire Council received your request for information under the Environmental Information Regulations 2004. The Council's response is set out below.

Response:

1) **The ERYC Response to Matter 2, Para K17**
"Flood risk information has been provided for omitted site GOO-28. This information was supported in support of a planning application for part of the site but was refused by the Council with an objection by the Environment Agency on the basis that the FRA had technical issues"
We request full details of the technical issues raised by the Environment Agency including any email confirmation exchanges EA-LPA

All information that the Council can provide is available on the Public Access website. If you wish to obtain further information regarding the Environment Agency's (EA's) views, please contact the Environment Agency.

2) **The Officer Report to application 22/02427 states:-**
Item 3.13 "*The submitted FRA also has technical issues leading to conclusions that contradict existing technical requirements*"
We request full details of the technical issue in the FRA as stated in the Officer Report 10/02/23 including any consultee emails
(Items 1 & 2 are related)

All correspondence with consultees is available on Public Access on the Council's website. Also see response to 1.

3) **The Strategic Flood Risk Assessment Level 2 Goole September 2020 (SFRA 2020) Page 38, Para 7.2.1**
"East Riding of Yorkshire Council hold all the evidence prepared for the SFRA"

We request copies of all the evidence held by the ERYC for preparation of the SFRA including (and not limited to)

- **Any written confirmation of input data (river levels, invert levels) provided by the ERYC or EA to Capita**
- **Any written confirmation of discussions including the breach invert levels to be adopted**
- **Copies of the individual flood mapping from each of the 12 node points around Goole. This mapping to be at 30 minutes, 30 hours and 72 hours? after breach**

(This is a repeat of any earlier (unaddressed Freedom of Information request)

To answer the first two bullet points, please find attached the:

a. The Strategic Flood Risk Assessment Level 2 - Modelling Approach 2019 (including appendices),
b. An email confirming to the EA how the Council were taking their comments on the methodology into account. (attached documents).

Please note the methodology was intended for internal purposes only. The methodology was amended after the draft L2 SFRA was published following a request from the EA to leave the dock gates open however the methodology document was not updated and the dock gates are not referred to in the 2019 methodology paper. The gates were closed in the modelling for the draft report and were open in the modelling for the final report.

In relation to the 3rd bullet point, the Council do not have individual flood maps for each breach. The RIZ contours the 12 breaches to account for the fact that the breach locations are not weak points and a breach could in theory occur at any location along the defences. Therefore, it is not possible and there is no benefit to showing the maps for each breach separately.

4) **The SFRA 2020 Para 7.2.1 states:-**
"The SFRA is a document that is intended to be periodically updated as new information and guidance becomes available. It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. The outcomes and conclusions of the SFRA may not be valid in the event of future changes of data"
We ask what if any updates have been made to the SFRA 2020 since it was made?

No, it is still a valid piece of evidence.

5) **The ERYC subsequently commissioned another relevant flood risk assessment, the Aecom HOW-G High Level flood risk assessment. Whilst this area was specific to proposed development of Howden, it involved detailed consideration of extreme river levels in the Ouse including climate change. HOW-G is north of the river, SFRA 2020 is south of the river, but both consider the same stretch of the river Ouse**

Darren Stevens
Executive Director of Corporate Resources

Has the SFRA 2020 been updated to consider and include the HOW-G extreme river levels? If not, why not?

No. The Aecom HOW-G High level Flood Risk Assessment only looked at Howden and the L2 SFRA only considered Goole. The Humber Extreme Water Levels model (HEWL) was published in 2020, after modelling for the L2 SFRA had been completed. Section 3.2.1 of the HOW-G Assessment suggests that "using the Upper Humber (2016) extents is likely provide a more conservative breach flood extent (than using the HEWL), though still suitable for strategic level allocation." The SFRA is robust, without updating it to reflect the HEWL.

6) **The SFRA 2020 states a breach open period of 72 hours which contradicts the published Environment Agency Guide to Breach Design which requires the modelled breach open period to be 30 hours. 30 hours is the initial breach plus two further high tides. 72 hours is the initial breach plus 5 further high tides. In effect the SFRA model assumes volumes of flood water 100% more than the EA Guidance**
Could the ERYC explain why the breach period used was 72 hours, and if not already done so could the ERYC confirm that it will update the SFRA to take into account the river levels (as the HOW-G report) and the time of breach open from 72 to 30 hours

The breach duration of 72 hours was used in the L2SFRA (2020). This is the same as the Upper Humber Study (2016) on which the L2 SFRA was based. It is not necessary to update the L2SFRA in response to the HOW-G Assessment or to amend the breach duration.

7) **The SFRA 2020 Appendix H maps the risk of flooding from reservoirs. The SFRA 2011 discounted as not realistic the risk of flooding of Goole from reservoirs**
Could the ERYC explain why the risk of flooding from reservoirs was re-introduced in the SFRA 2020 and further identify by way of Google mapping which are the reservoirs?

The SFRA followed national guidance on considering risk from reservoirs. It used the EA's Reservoir Flood Map.

For further information on the EA's Reservoir Flood Map contact the EA. The 2011 L2SFRA did not consider any other sources of flooding, it only considered overtopping and breach of defences.

8) **The 2020 SFRA page 12 states:-**
"Hook Drain is a major riparian watercourse serving Goole. It consists of an open channel section discharging north to Hook Clough pumping station and a culverted section along Long Lane and Thonrtree Lane which drains to the open channel via a flapped outfall. It also discharges south into the North Street trunk sewer and from there to Lock Hill pumping station"

Darren Stevens
Executive Director of Corporate Resources

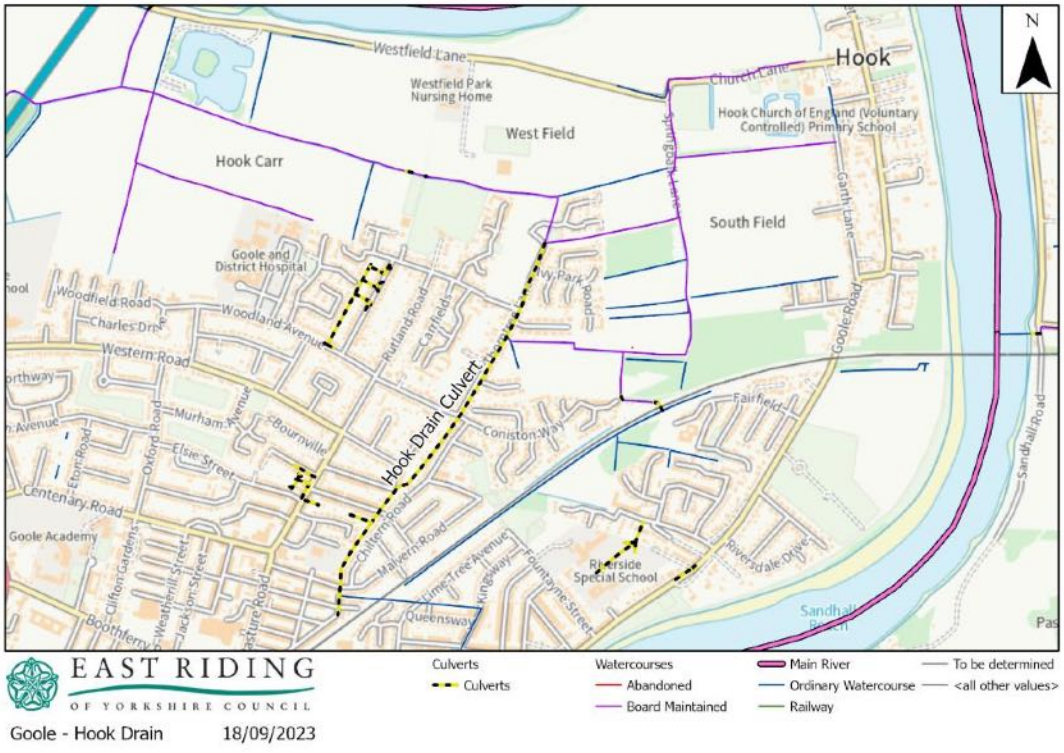
This is challenged as the culverted sections (which have been lost over the years by new residential developments) including the connection from the railway line to North Street
Could the ERYC provide mapping/survey details which support this 2020 SFRA statement?

Please see the attached map, which details our currently held records of the drainage system described in the query. Our records are based on the best available data at the time.

Our records indicate that the culverted system is still active presently and has not been removed. This is supported by Yorkshire Water's records, which also indicate that the connection across the railway line is still active, however we cannot share Yorkshire Water's records due to the limitations of our data sharing agreement. Yorkshire Water may be able to provide more details of their sewer network.

It is worth noting that currently, developers are not required to inform us with as-built drainage records, as we may only update our records following a survey or if we are presented with accurate records that supersede our own.

As this area is part of the Goole and Airmyn IDB district, they may be able to provide further details of the drainage system.



Darren Stevens
Executive Director of Corporate Resources

9) **The Capita SFRA Level 2 document has page 2 a Quality management statement dated 12th August 2020 signed by Project Officer Claire Gardner**
The LinkedIn website indicates Claire Gardner left Capita January 2020, i.e. 7 months prior
Could the ERYC advise on this apparent discrepancy?

The date on the Quality Management Page is the date that the document was completed. Claire Gardiner prepared the L2SFRA. The last date that Claire Gardner prepared/drafted the report was draft v3 in January 2020. Bryony Smith replaced Claire Gardiner on the project and checked/amended the SFRA. Bryony is listed on the Quality Management sheet as "checked by".

10) **The ERYC Response to MIQ Matter 2, Para K7**
"The main differences between the 2011 and 2020 SFRA's are the 2020 version including more up to date climate change allowances and being based on the EA's Upper Humber Model, which allowed the Assessment be based on the most up to date information available"
Could the ERYC expand on the updated information used in the 2020 version?
The 2011 SFRA is no longer available in the ERYC planning website. Could the ERYC advise how to locate this document or provide a copy direct

The Upper Humber Study is the updated information the SFRA was based on, using this was more up to date than using the model used in the 2011 SFRA. Climate change information is set out in Appendix A of the L2 SFRA. The 2011 SFRA is attached.

11) **The ERYC Response to MIQ Matter 2, Para K9 states that the 2016 Local Plan Inspector requested that 7 proposed allocations/existing commitments……were removed. This statement is not in accordance with the Inspectors Report Para 82 which is to the effect that it was the ERYC which proposed the 7 sites were removed**
We request details why the Para K9 has misquoted the 2016 Inspectors Report, and as no further information for the 2016 Local Plan is now posted on the web, could the Council please give further background information. Further K9 does not appear to be an answer to the Inspectors question Matter 2kII. Please advise

It is for the Inspector to determine the appropriateness of and question our Matters paper. This issue is being considered through the Local Plan Examination Hearings.

12) **The 2016 Local Plan settlement boundary includes area unallocated or removed during the 2015 Local Plan Review**
Could you please advise why these area which had become unallocated remained within the Goole settlement boundary

Darren Stevens
Executive Director of Corporate Resources

The land that was removed from AD1 as part of the examination had extant planning permission at the time the Local Plan (2016) was adopted. If these sites were completed, they would have become part of the built area of Goole.

13) The ERYC have evidenced Table 2 of the Statement of Common Ground (S-DC01) to support the Local Plan Update which states that the EA:-
"Reviews the draft mapping outputs and helped shape the Planning recommendations in the SFRA"
Presumably ERYC were copied to email exchanges and meetings between EA & Capita. What records do you hold?
As examples of how the EA helped shape the L2 SFRA, please find attached copies of:
c. the EA's comments on a draft document,
d. meeting minutes which the EA commented on, and
e. the final amendments to the SFRA that the EA request

The EA played a significant role in ensuring that the SFRA was appropriate for use.

If you are dissatisfied with the above response or how your request has been handled you can ask for the Council to review this by contacting the Information Governance and Feedback Team by email on [redacted] or on the above telephone number within 6 weeks of this letter.

A senior manager will carry out the review and you will receive a response within 40 working days. It will provide a fair and thorough review of the decisions taken and where necessary how your request has been handled.

If you are not content with the outcome of the review you can apply to the Information Commissioner for a decision. Generally, the Commissioner cannot make a decision unless you have exhausted the Council's review procedure. The Information Commissioner can be contacted as follows:

Online: https://ico.org.uk/make-a-complaint/
[redacted]

Yours sincerely

*
Senior Information Governance and Feedback Officer

Darren Stevens
Executive Director of Corporate Resources

{In Archive} RE: Modelling Approach SFRA Level 2 Hedon and Goole

Owen Robinson to: Pattinson, Andrew G 16/03/2019 13:18
Cc: "Lambert, Bev", "Allan, Joe", "Wiltshire, Matthew (Capita)"
Archive: This message is being viewed in an archive.

Hi Andrew

Thank you for the comments you supplied on the above. They're helpful to develop a fit for purpose study. I have had chance to discuss these with Capita and our actions/conclusions are set out below. For the most part, these are points of clarification or confirmation that we are taking a more precautionary approach. For some others, e.g. considering the use of H++ for Goole, we think that this is beyond the scope of what is necessary for a Level 2 SFRA in our circumstances. There are also instances where best practice from other parts of the country are being put forward (e.g. timing of breaches in line with EA's Anglian Region guidance).

Please could you review our response and confirm that you are satisfied with the approach adopted. I am extremely keen - as is everyone - to get the modelling underway and avoid any further delays.

Kind regards,

Owen

Andrew Pattinson's comments on Level 2 modelling approach note V2	**ERYC/Capita Discussion 11/03/19**
Goole:	
• We agree with the tidal simulations for Goole using the 2016 climate change allowances, however you should be aware that if the new water level profile indicates there could be increased sensitivity to higher water levels that you may need to consider the implications of the H++ scenarios run, in accordance with the "*Adapting to Climate Change: Advice for FCERM Authorities.* " Please see the "UH model node comparison" spreadsheet for a snapshot of the 0.5% and 0.5% +cc (+610mm) simulations which shows for Goole Docks there is a simulated 245mm increase for a tidally dominated simulation as a result of climate change; this effect reduces further upstream.	**No Action:** No additional H++ runs required, no high risk infrastructure/development pl classed as a nuclear installation or large scale energy generating infrastructure. The *"A FCERM Authorities"* referenced says: ***"Fluvial:*** *For circumstances where the consequences of rare events could be extreme and plans against the H++ scenario. Extreme consequences could include flooding of r generating infrastructure, for which the scale of the flooding impact may extend far wid flooding incident. This would help illustrate the risks such changes could present, but g Upper limit of climate projections that are considered plausible, it would not normally be designed to/ incorporate built-resilience for the H++ estimate.* ***Tidal:*** *It is envisaged that only those circumstances involving events of extremely high of rare events could be extreme would be required to consider the H++ limits within ass*
• For Goole, we would expect to see +50% river flow (rather than +30%). If this	**Action:** Capita to run +50% flows to cover the worst case scenario, which is proportion

shows that tidal peak levels and volumes are less than the tidal simulations then there would be no need to simulate a +30% as the tidal range is likely to be dominant in all cases.	The main purpose of the document is to support the council in deciding where to place FRA information. The 50% will give sufficient info for the council to determine if and wh majority of cases, there is likely to be a negligible difference between higher central an
• For Goole please confirm timing of breach in relation to the hydrograph supplied. A breach at peak level will create the greatest consequential hazard whereas a breach prior to the peak would create greatest extent.	**No Action:** Methodology is outlined in approach note (version 2) issued on 7th Februar Environment Agency's Anglian Region breach guidance which has informally been ado timings are: Fluvial - at bank full/peak level and Tidal - 1 hour before high water.
• Please confirm location of new breach location (or options being considered) on Dutch River / River Don.	**No Action:** This is clearly shown in Figure 5.1 of the verison 2 approach note.
• For Goole, the breach scenarios should be combined with the local gate failure scenarios such that the slightly higher ground near the docks is included in the overall residual risk picture. Please see screenshot in the "model boundary and setup" excel attachment (cell A26) for areas where this applies. We can supply the data if you haven't already got these. No climate change scenarios are available.	**Decision:** ERYC to decide whether they want to consider two further breaches at each the docks are shown at risk rather than out of flood risk.
Hedon:	
• For Hedon, for the downstream estuary condition, it suggests Paull Village is used rather than Saltend (Paull is 30mm higher). Is there a reason for this? It is possible this difference is insignificant. Tab added to spreadsheet with Saltend levels.	**No Action:** Paull was selected as part of Burstwick Estuary is represented in the mode Paull, we have picked the node in the middle, as alluded to by Andrew the difference is conservative number.
· For Hedon, we would expect to see +50% river flow used for the fluvial climate change simulation (rather than +30%). Ideally there should also be a +30% river flow simulation to consider other epochs and current 2016 climate change allowances which are based on flood zones and vulnerability classifications. If only +30% available, then we must highlight that subsequent allocations or site specific FRAs will need to address the limitation.	**Action:** As detailed above for Goole, Capita will take +50% flows as worst case - not n
• For Hedon, please confirm timing of breach as the hydrographs supplied suggest peak level is at 26.75hrs for fluvial locations (no.'s 2,3,4,5).	**No Action:** As detailed above for Goole, this is outlined in the approach note, the timin
• For Hedon, the fluvial breach locations (no.'s 2,3,4,5) are currently located based on the assumption that the critical flood level is 2.65mAOD. The following comments apply:	See below;
○ There appears to be a potential breach flowpath to the west of Hedon not covered by a breach location. We have suggested inclusion of a breach d/s of the A1033 which would need to simulate the interaction with land drains / culverts. This has been identified based on a desk-based study only but would be critical to western Hedon.	**Action:** Capita to include another breach to be included at this location.
○ The locations have been identified based on the critical flood level of 2.65mAOD. If the modelling suggests a different number then a review should be undertaken to confirm if any new areas could be at risk	**Action:** Capita to undertake this check after modelling.
○ We have provided a desk-based review of the proposed breach locations (see pdf	**Action:** ERYC to sense check results once modelled flood outlines are available. Grou

titled “Breachlocations-proposed-Hedon-L2SFRA”) using 2m Lidar and asset information we hold. These should be ground-truthed, particularly those where the low ground is not immediately adjacent to the watercourse / embankments to ensure the breach invert level is defined.	at this stage, the model tolerances and limitations are clearly stated and without a full t not increase confidence in the data.
• For Hedon, the tidal breach location (no.1) at Hedon New Clough. The results of that simulation should be compared to the Humber North Bank 2013 breach outputs to ensure any other relevant flowpaths from the estuary have been considered. It’s also possible that higher risk or greater flood extents are presented as a result of simulated soft embankment failures (these are generally much wider than a hard defence simulation). A copy of breach locations simulated in 2013 has been added as a tab to the excel spreadsheet, and these simulations (depth, velocity, hazard) are available for present day and 2115 simulations – if you haven’t got these already please let us know. Also worth noting that for those simulations we also hold some limited progression maps in the event speed of onset is considered relevant.	**Action:** Capita to carry out consistency check with other modelled outlines after the SF
We have also briefly discussed a possible update to the water level profile in the Humber Estuary. At this time we do not have any new data, however there is still a possibility that new information will become available during the publication of the SFRAs, and therefore we would recommend that the modelling considers how it would accommodate this if released. In any case, the best available information is always subject to change, and therefore the SFRAs should consider how any future change could be accommodated in the SFRA evidence base.	**No Action:** We cannot consider data we do not have. We have the interim Humber wa used.

Kind regards

Owen

Owen Robinsonconsider the use of H++
Principal Planning Policy Officer
Tel: [redacted]
Web: www.eastriding.gov.uk
Twitter: www.twitter.com/East_Riding
Facebook: www.facebook.com/eastridingcouncil

EAST RIDING
OF YORKSHIRE COUNCIL

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"Pattinson, Andrew G" [attachment "UH_modelnode comparison.xlsx" deleted by Owen Robinson/CPS/ERC] [atta... 27/02/2019 16:46:20

From: "Pattinson, Andrew G" <[redacted]>
To: "Wiltshire, Matthew (Capita)" <[redacted]>
Cc: "Owen Robinson" <[redacted]> "Lambert, Bev" <[redacted]>, "Allan, Joe" <[redacted]>
Date: 27/02/2019 16:46
Subject: RE: Modelling Approach SFRA Level 2 Hedon and Goole

[attachment "UH_modelnode comparison.xlsx" deleted by Owen Robinson/CPS/ERC]
[attachment "Breachlocations-proposed-Hedon-L2SFRA_v2.pdf" deleted by Owen Robinson/CPS/ERC]
[attachment "Copy of Goole and Hedon model boundary and setup - SFRA L2.xlsx" deleted by Owen Robinson/CPS/ERC]
Afternoon Matt,

Comments on the Level 2 SFRA approach for Goole and Hedon.

Goole:

- We agree with the tidal simulations for Goole using the 2016 climate change allowances, however you should be aware that if the new water level profile indicates there could be increased sensitivity to higher water levels that you may need to consider the implications of the H++ scenarios run, in accordance with the "*Adapting to Climate Change: Advice for FCERM Authorities.* " Please see the "UH modelnode comparison" spreadsheet for a snapshot of the 0.5% and 0.5% +cc (+610mm) simulations which shows for Goole Docks there is a simulated 245mm increase for a tidally dominated simulation as a result of climate change; this effect reduces further upstream.
- For Goole, we would expect to see +50% river flow (rather than +30%). If this shows that tidal peak levels and volumes are less than the tidal simulations then there would be no need to simulate a +30% as the tidal range is likely to be dominant in all cases.
- For Goole please confirm timing of breach in relation to the hydrograph supplied. A breach at peak level will create the greatest consequential hazard whereas a breach prior to the peak would create greatest extent.
- Please confirm location of new breach location (or options being considered) on Dutch River / River Don.
- For Goole, the breach scenarios should be combined with the local gate failure scenarios such that the slightly higher ground near the docks is included in the overall residual risk picture. Please see screenshot in the "model boundary and setup" excel attachment (cell A26) for areas where this applies. We can supply the data if you haven't already got these. No climate change scenarios are available.

Hedon:

- For Hedon, for the downstream estuary condition, it suggests Paull Village is used rather than Saltend (Paull is 30mm higher). Is there a reason for this? It is possible this difference is insignificant. Tab added to spreadsheet with Saltend levels.
- For Hedon, we would expect to see +50% river flow used for the fluvial climate change simulation (rather than +30%). Ideally there should also be a +30% river flow simulation to consider other epochs and current 2016 climate change allowances which are based on flood zones and vulnerability classifications. If only +30% available, then we must highlight that subsequent allocations or site specific FRAs will need to address the limitation.
- For Hedon, please confirm timing of breach as the hydrographs supplied suggest peak level is at 26.75hrs for fluvial locations (no.'s 2,3,4,5).
- For Hedon, the fluvial breach locations (no.'s 2,3,4,5) are currently located based on the assumption that the critical flood level is 2.65mAOD. The following comments apply:
    - There appears to be a potential breach flowpath to the west of Hedon not covered by a breach location. We have suggested inclusion of a breach d/s of the A1033 which would need to simulate the interaction with land drains / culverts. This has been identified based on a desk-based study only but would be critical to western Hedon.
    - The locations have been identified based on the critical flood level of 2.65mAOD. If the modelling suggests a different number then a review should be undertaken to confirm if any new areas could be at risk
    - We have provided a desk-based review of the proposed breach locations (see pdf titled "Breachlocations-proposed-Hedon-L2SFRA") using 2m Lidar and asset information we hold. These should be ground-truthed, particularly those where the low ground is not immediately adjacent to the watercourse / embankments to ensure the breach invert level is defined.
- For Hedon, the tidal breach location (no.1) at Hedon New Clough. The results of that simulation should be compared to the Humber North Bank 2013 breach outputs to ensure any other relevant flowpaths from the estuary have been considered. It's also possible that higher risk or greater flood extents are presented as a result of simulated soft embankment failures (these are generally much wider than a hard defence simulation). A copy of breach locations simulated in 2013 has been added as a tab to the excel spreadsheet, and these simulations (depth, velocity, hazard) are available for present day and 2115 simulations – if you haven't got these already please let us know. Also worth noting that for those simulations we also hold some limited progression maps in the event speed of onset is considered relevant.

We have also briefly discussed a possible update to the water level profile in the Humber Estuary. At this time we do not have any new data, however there is still a possibility that new information will become available during the publication of the SFRAs, and therefore we would recommend that the modelling considers how it would accommodate this if released. In any case, the best available information is always subject to change, and therefore the SFRAs should consider how any future change could be accommodated in the SFRA evidence base.

Let me know if you have any questions.

Andrew

From: Pattinson, Andrew G
Sent: 27 February 2019 07:18
To: Wiltshire, Matthew (Capita) <[redacted]>
Cc: Owen Robinson <[redacted]>; Lambert, Bev <[redacted]>
Subject: Re: Modelling Approach SFRA Level 2 Hedon and Goole

Morning Matt,

I'll pass on comments on the Level 2 modelling approach later today.

The Level 1 comments are being collated separately but are nearly there.

Things have been a bit busy the last couple of weeks so apologies it's taking longer than expected.

Andrew
Sent from my iPhone

On 22 Feb 2019, at 07:56, Wiltshire, Matthew (Capita) <[redacted]> wrote:

> Hi Andrew,
>
> Are you able to pass back any feedback on the modelling approach note issued a few weeks ago where we stated the assumptions for the breaches at Hedon and Goole and the climate change assumptions?
>
> Additionally, do you know when you will have had chance to review the final SFRA Level 1 document and maps?
>
> Thanks,
> Matt

Matthew Wiltshire MEng CEng MICE
Senior Engineer – Infrastructure Projects: Environment
Real Estate & Infrastructure
[redacted]
capitaproperty.co.uk
<image001.png>
Please note my working week is now Monday to Thursday inclusive.

CAPITA

EAST RIDING OF YORKSHIRE COUNCIL

East Riding of Yorkshire

Strategic Flood Risk Assessment Level 2 - Modelling Approach

CS/093155-CAP-00-XX-RP-Z-0002

February 2019

Quality Management

Job No	CS/093155		
Project	East Riding of Yorkshire SFRA		
Location	East Riding of Yorkshire		
Title	Modelling Approach for the Level 2 Strategic Flood Risk Assessment for East Riding of Yorkshire		
Document Ref		**Issue / Revision**	2
File reference	ERYC_Level2_SFRA_Methodology		
Date	23 June 2021		
Prepared by	Claire Gardner	Signature (for file)	[redacted]
Checked by	Alastair Worsley	Signature (for file)	[redacted]
Authorised by	John Dudley	Signature (for file)	[redacted]

Revision Status / History

Rev	Date	Issue / Purpose/ Comment	Prepared	Checked	Authorised
1	16/04/2018	DRAFT for comment	CG	AW	JD

1	06/02/2019	Updated approach following new information and discussions with EA and ERYC	CG, SD, JD	CG	MW

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The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by Capita has not been independently verified by Capita, unless otherwise stated in the Report.

The methodology adopted and the sources of information used by Capita in providing its services are outlined in this Report. The work described in this Report was undertaken in January 2018 and updated February 2019 is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

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Contents

Tables

Abbreviations

AIMS	Asset Information Management System
ERYC	East Riding of Yorkshire Council
FRMP	Flood Risk Management Plan
SFRA	Strategic Flood Risk Assessment

1. Introduction

Capita Real Estate & Infrastructure have been commissioned by East Riding of Yorkshire Council (ERYC) to produce new Strategic Flood Risk Assessment (SFRA) Level 2 reports for Goole and Hedon.

We understand that the Level 2 SFRAs are required to provide evidence to support the development of the Local Plan. The Level 2 SFRA for Goole is also intended to provide a more locally specific approach to modelling flood risk in Goole, addressing the limitations of the Environment Agency's more strategic level Upper Humber modelling.

This document outlines the approach to the Level 2 SFRAs for Goole and Hedon for East Riding of Yorkshire Council. We propose the SFRAs will keep a similar report format of the 2011 Goole Level 2 SFRA. Methodology

Table 2-1 outlines the methodology for the Level 2 SFRAs.

Table 2-1 outlines the methodology for the Level 2 SFRAs. Table 3-1 details the proposed structure of the Level 2 SFRAs and the information that will be included in each chapter. Section 3 outlines what maps will be produced for the Level 2 SFRAs.

2. Methodology

Table 2-1 outlines the methodology for the Level 2 SFRAs.

Table 2-1 – Methodology

Task	Approach	Notes from Inception Meeting and EA review comments
Modelling		
Assess existing defence infrastructure	Data collated for the Level 1 SFRA has been reviewed to provide a comprehensive overview of the defence infrastructure at Goole and Hedon. Additional data was requested for the Level 2 SFRA: • As-built information for the defences • Inspection/asset condition surveys that may have been undertaken • 2011 Breach analysis near Hedon This data was not provided to the project team.	Not all data will be digital for Goole but the extent of this will not be known until the data request is processed. Hedon is more likely to be digital. This survey and information has not been provided to the project team (as of Feb 2019).

Task	Approach	Notes from Inception Meeting and EA review comments
Assess risk of defence failure	Following the assessment of the existing defence infrastructure, using current guidance, the team determined the likely failure mechanisms of the defences and the most appropriate locations of defence locations in Goole and Hedon. This included identifying the likely breach locations, depths (invert), width and duration which will define the modelling approach. Goole – the initial starting point will be the failure locations used in the 2011 Level 2 SFRA and the 2016 breach modelling undertaken by the Environment Agency. Using the information from the defence assessment, the locations were reviewed to determine if they are still appropriate (see Section 5). Hedon – the review of the defences within the catchment will be undertaken on both the fluvial watercourses through the town and the tidal defences on the Humber Estuary. A schedule of failed flood defence scenarios was produced and submitted to ERYC and the Environment Agency to accept before commencing modelling works. Geophys survey of the Goole defences is planned; the contractor is due on site in 2018. This survey and information has not been provided for this commission.	Geophys survey of the Goole defences is planned; the contractor is due on site in 2018. This survey has not been provided to the project team (as of Feb 2019). Hedon locations – breaches on Humber estuary defences and Burstwick Drain defence need to be considered. Hedon FRMP model is integrated but also has a tidal boundary so can be used for both.

Task	Approach	Notes from Inception Meeting and EA review comments
Determine consequences of failed flood defences	Once the schedule of failed flood defence scenarios have been agreed, the modelling will commence. The first step will be to create the baseline flood overtopping outputs using the existing models. The breach models will then be created by schematising each defined breach within the existing model. Each breach model will be run for one return period to allow mapping of the flood probability, extent, depth, velocity, hazard, speed of onset and duration of flood. Climate change will be assessed by using the existing climate change runs from the models to determine if there will be any resulting change to the Standard of Protection in the future as a result of climate change. Additional data requested • Humber Hull Frontages model • Sunk Island Model • Interim sensitivity and updated work carried out by the EA since the 2013 surge • Updated Upper Humber Report and any updated associated files • Any other relevant information held by the EA	Claire Brown (EA) advised that any model results will need to go to the national Modelling and Forecasting team for review. Therefore, a date for review needs to be booked in advance to allow them to set time aside and plan for the review. To facilitate the review Claire Brown was going to provide the specification that are looking at for the review. Model instabilities - in particular when trimming down Hedon model. Some allowance has been made for reasonable time to address any instabilities; however, as the contract is an NEC Option A, finite time has been included to solve these instabilities. Model results output to include Hazard.
Reporting and mapping	Once an agreed set of maps have been produced (see sections below for proposed maps), the recommendations on accepted development and the requirements to meet the Exception Test will be completed and the report produced to document the findings from the study. Note: Goole and Hedon will have their own set of maps and Level 2 report.	

3. Reporting

We propose a report structure similar to that in the 2011 Goole Level 2 SFRA. The proposed report structure is shown in Table 3-1.

Table 3-1 - Report Structure

SFRA Chapter and sub headings	Information to be covered
Introduction	Aims and objectives of the Level 2 SFRA Description of the study area Summary of past flooding Summary of flood risk management including flood defence assets, flood risk management measures and the flood warning service
Methodology	Summary of the methodology used to undertake the Level 2 analysis (a more detailed explanation of the methodology will be included in Appendix A)
Fluvial / Tidal Flood Risk	Summary of findings from the assessment of flood risk infrastructure Summary of findings from • Overtopping of existing flood defences • Effect of climate change • Breach failure The summaries will draw upon the extent, depth, velocity, speed of onset and duration of flood mapping results from the modelling undertaken.
Flood Risk from Other Sources	Summary of flood risk from other sources including • Surface water • Reservoirs • Groundwater • Canal Summaries will draw upon information collated as part of the Level 1 SFRA

SFRA Chapter and sub headings	Information to be covered
Development Management Recommendations	This section of the report will document recommendations for planners and developers, using national and local guidance and findings from the Level 2 assessment. Recommendation and information will include • Identifying the requirements for site-specific flood risk assessments in particular locations • The acceptability of flood risk in relation to emergency planning capability • Opportunities to reduce the flood risk to existing communities and developments • Information on applying the Sequential approach to development (Sequential and Exception tests) • A Decision Matrix similar to table 6.4.4 in the existing Level 1 SFRA and Goole Level 2 SFRA.
Conclusions and Recommendations	We will document conclusions and recommendations.
Appendices	Appendix A: Modelling Approach and assumptions Appendix B: Interactive map(s) of results

4. Mapping

The 2011 Level 2 SFRA for Goole contained seven maps showing extent, depth and hazard maps for the overtopping scenario as well as for all breaches combined.

We propose to produce dynamic, interactive maps which allow multiple datasets to be displayed. Datasets to be shown include:

- Extent
- Depth
- Hazard
- Velocity
- Speed of onset
- Duration

5. Breach Scenarios modelling

Representation of a breach scenario within the hydraulic models

The representation of a breach scenario within a hydraulic model requires several components to be defined. The model setup for breaches from previous studies, available guidance, and the approach to be used in this study are detailed in Table 5-1, below. Each element of the modelled breach scenario is compared and has been used to identify the approach used for this study of the Goole and Hedon areas. The modelling setup has been discussed with East Riding Yorkshire Council and Environment Agency.

Table 5-1 – Model representation of a breach scenarios from previous studies, available guidance, and the approach used for this study

Comparison Element	2011 Goole L2 SFRA	2016 Upper Humber Study	Guidance: Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping (2014)	Guidance: Worth, D & Cox,R Tidal Flood Risk Areas – Simply Credible: EA South West Region (2002)	2018 Goole L2 SFRA Approach	2018 Hedon L2 SFRA Approach
Fluvial hydrology and model setup	QMED peak inflow as constant inflows on all rivers	Fluvial breach scenarios used 1% fluvial. Tidal breach scenarios used a 0.5% AEP on Aire, and 50% AEP on Ouse, Don, Trent, EA Beck	-	4%, 1.3%, 1% 0.1% and 0.5%	Upper Humber model will only be run with the tidal level increase, as the previous Upper Humber 2016 modelling study shows a tidal breach provides a larger flood extent than fluvial breach extent. Based on this no fluvial event only modelling will be undertaken for Goole.	Fluvial 1% AEP event plus an allowance for climate change used in fluvial breach scenarios. River flows will be increased by 30% to allow for Climate Change Higher Central to 2115 following guidance: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances Climate Change allowance on flow would be run with present day tidal. For Hedon the ICM model will be changed from a direct rainfall model to a river model with fluvial inflows derived using FEH methods, and inflows added to the modelled watercourses. The fluvial breach modelling for Hedon will use a 1% AEP plus Climate Change

Comparison Element	2011 Goole L2 SFRA	2016 Upper Humber Study	Guidance: Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping (2014)	Guidance: Worth, D & Cox,R Tidal Flood Risk Areas – Simply Credible: EA South West Region (2002)	2018 Goole L2 SFRA Approach	2018 Hedon L2 SFRA Approach
						allowance as indicted above, the fluvial peak will coincide with the 1 year tide peak. 1 year tide is 4.72mOAD assumed for year 2019. In addition, defended model runs (with no breaches) will be undertaken in this updated fluvial model for the 0.1%, 1%, 1%+CC, and 5% AEP fluvial events coinciding with a 1 year tide level.
Tidal levels and model setup	0.5% AEP storm surge with a peak level of 5.76m AOD	0.5% AEP storm surge used in tidal breach scenarios with peak levels between 5.82 and 6.16mAOD at different breach locations	-	0.5% and 0.1%	A 0.5% AEP sea level plus sea level rise provides a 6.999mAOD level to be applied to the Upper Humber Model boundary at Brough. The Interim Humber water levels are 5.89mAOD for Brough and have the base year 2014.. Tidal sea level increase is 1.109m from 2015 to 2115 using: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances Model runs will be completed in the defended present day model. Upper Humber model will only be run with the tidal level increase (as the previous work shows tidal breach provides a larger flood extent than fluvial breach extent).	A 0.5% AEP sea level of 6.619mAOD will be applied to the Hedon Model boundary in Burstwick estuary. The Interim Humber water levels are 5.51mAOD for Paull and have the base year 2014. Tidal sea level increase is 1.109m from 2015 to 2115 using: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances Runs will be done in defended present day model. Climate Change allowance on tidal levels would be run with present day flow. Tidal breach modelling will use the tidal level as noted above and this coincide with a 50% AEP fluvial event.

Comparison Element	2011 Goole L2 SFRA	2016 Upper Humber Study	Guidance: Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping (2014)	Guidance: Worth, D & Cox,R Tidal Flood Risk Areas – Simply Credible: EA South West Region (2002)	2018 Goole L2 SFRA Approach	2018 Hedon L2 SFRA Approach
					Climate Change allowance on tidal levels would be run with present day flow. Upper Humber model will be updated with the tidal level as shown in the above, and will use the same fluvial inflows as per the Environment Agency 2016 model setup, no change to the fluvial inflows will be made. The 2016 study used a 0.5% AEP on Aire, and 50% AEP on Ouse, Don, Trent, EA Beck.	
Joint probability	Not undertaken	Fluvial and Tidal breach model inputs extracted from Joint Probability defended model results.	-	Recommends a JP expression, with the final tidal return period being dependent on tide and wave condition returns.	Goole breach model inputs extracted from Joint Probability defended model results.	Tide locking of the drainage network is a known issue within the Hedon area. The choice of tidal boundary used to inform the model is therefore a key factor in determining predicted flood extents for each assessed return period. A previous study[1] indicated that at Hedon there is little correlation between tidal levels and rainfall events in this catchment and it suggests that a 1-year tidal boundary is appropriate when considering pluvial/fluvial inputs. A tidal cycle with a peak level of MHWS was used in the FRMP modelling (this is slightly lower than a 1 year

[1] Hedon, Burstwick and Old Fleet Drain Hydraulic Modelling for the Hull and Holderness Flood Alleviation Study - Modelling Report, 17 July 2015, produced for East Riding of Yorkshire Council

Comparison Element	2011 Goole L2 SFRA	2016 Upper Humber Study	Guidance: Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping (2014)	Guidance: Worth, D & Cox,R Tidal Flood Risk Areas – Simply Credible: EA South West Region (2002)	2018 Goole L2 SFRA Approach	2018 Hedon L2 SFRA Approach
						return period). The modelled tidal boundary adopted in the modelling will be a present day (2019) 1 year tidal level at the model downstream boundary. The tidal peak was timed to coincide with the fluvial water level peak in the main watercourses in the model.
Breach sizes	50m wide for earth defence, 20m for hard defence in estuary	50m wide for earth defence, 20m for hard defence in estuary	50m wide for earth defence, 20m for hard defence in estuary	50m wide for earth defence, 20m for hard defence in estuary	50m wide for earth defence. 20m wide for hard defence.	
Breach timing	Two scenarios; breach at time 0, and breach coinciding with tidal peak.	For fluvial at bank full/peak level, for tidal 1 hour before high water.	For fluvial at bank full/peak level, for tidal 1 hour before high water.	Starts with peak high tide	For tidal 1 hour before high water.	For fluvial at bank full/peak level. For tidal 1 hour before high water.
Breach duration	50 hours	72 hours	72 hours	24 hours for earth, 18 hours for hard defence	72 hours. Following discussions at the inception meeting regarding the response times to a breach, in the absence of any further information, or confirmation of secured resources to attend any breaches, the larger of the two options is proposed.	
Breach Locations	10 locations	18 locations (9 around Goole area)	Chosen for maximum hazard. For tidal typically 1km spacing.	-	Goole: No evidence was found to suggest altering the 2016 study, in addition the Environment Agency requested a further breach location on the River Don.	5no. locations to be modelled as per Figure 2. 4 locations are fluvial breaches and 1 location is tidal.

Comparison Element	2011 Goole L2 SFRA	2016 Upper Humber Study	Guidance: Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping (2014)	Guidance: Worth, D & Cox,R Tidal Flood Risk Areas – Simply Credible: EA South West Region (2002)	2018 Goole L2 SFRA Approach	2018 Hedon L2 SFRA Approach
					10no. locations to be modelled as per Figure 1.	
Breach invert levels	To match river berm level	Ground level (taken from ground level entire raised bank area)	"the base of the breach shall be set to the typical ground level immediately adjacent to the defence."	"Experience shows that breaches commonly erode to the base level of the corresponding defence. The base level may be at a berm level, rather than the level of ground further inland. Specific levels would be taken from cross-sections"	Ground level to be used at all locations. See technical note in Appendix A which is in line with the HR Wallingford paper 'A guide to breach prediction' (West el al 2011).	Ground level to be used at all locations.
Climate change scenario	Over topping scenario uses 0.5% plus 1.03m tidal climate change	Fluvial 1% AEP with central estimate allowances, 0.5% Tidal with North	-	-	Current climate change guidance[2] indicates that the: - Projected sea level rise for the East of England from 1990 to 2115 to be 1.21m cumulatively. (The H++ scenario provides a significantly higher sea level rise of 2.40m. It is important note that the high++ allowances will only apply in assessments for developments that are very sensitive to flood risk and with lifetimes beyond the end of the century. For example, infrastructure projects or developments that significantly change existing settlement patterns.)	

[2] Flood risk assessments: climate change allowances Guidance. Published by the Environment Agency in 2017. Accessed March 2018. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Comparison Element	2011 Goole L2 SFRA	2016 Upper Humber Study	Guidance: Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping (2014)	Guidance: Worth, D & Cox,R Tidal Flood Risk Areas – Simply Credible: EA South West Region (2002)	2018 Goole L2 SFRA Approach	2018 Hedon L2 SFRA Approach
		East increases (0.99m cumulative from 1990-2115)			- Fluvial allowance for the Humber area for the central estimate = 20%, higher end estimate = 30%, upper end estimate 50%. - Rainfall intensity increases for the central estimate = 20%, upper end estimate = 40%. This study proposes to use: - a tidal increase of 1.21m following the upper end estimate; - river flows increased by 30% following the higher end estimate. Climate Change allowance on river flow would be run with present day tidal levels. Climate Change allowance on tidal levels would be run with present day river flow.	
Breach Model details	Tuflow model with 10m grid with Tidal/Fluvial boundaries informed by 1D model. Few details provided.	Tuflow model with 8m grid with Tidal/Fluvial boundaries informed by 1D-2D defended model results.	-	-	Model runs will be done in defended present day model. Tuflow model with 8m grid with Tidal/Fluvial boundaries informed by 1D-2D defended model results.	Model runs will be done in defended present day model. The FRMP ICM model will be changed from a direct rainfall model to a river model with fluvial inflows derived using FEH methods, and inflows added to the modelled watercourses. The FRMP model will have a fluvial and tidal boundary and would be used for both tidal and fluvial assessment.

Goole Breach locations

The modelled breach locations for Goole are shown in Figure 5-1, below.

Further information on each breach location for Goole is provided in separate Geotechnical Technical Note provided in Appendix B.

Since this technical report was produced an additional breach location was requested by the Environment Agency on the River Don to the south of Goole. The location of this new breach is shown in Figure 5-2 and Figure 5-3 below. A few points on this new location:

- The banks on the Don are very flat ranging from 5.8-6.2mAOD through the majority of survey sections.
- The selected location is ~6mAOD, close to urban areas, and does not have the main rail line, or the harbour area between it and the Goole Urban area.
- A point further downstream could be selected but this will first flood the harbour and likely yield a very similar result to the gate breach scenario.
- We propose lowering the bank to the lowest level behind the bank. In this situation the bank of the Don will be lowered, the canal behind the defence has been represented in the DTM 2D grid.

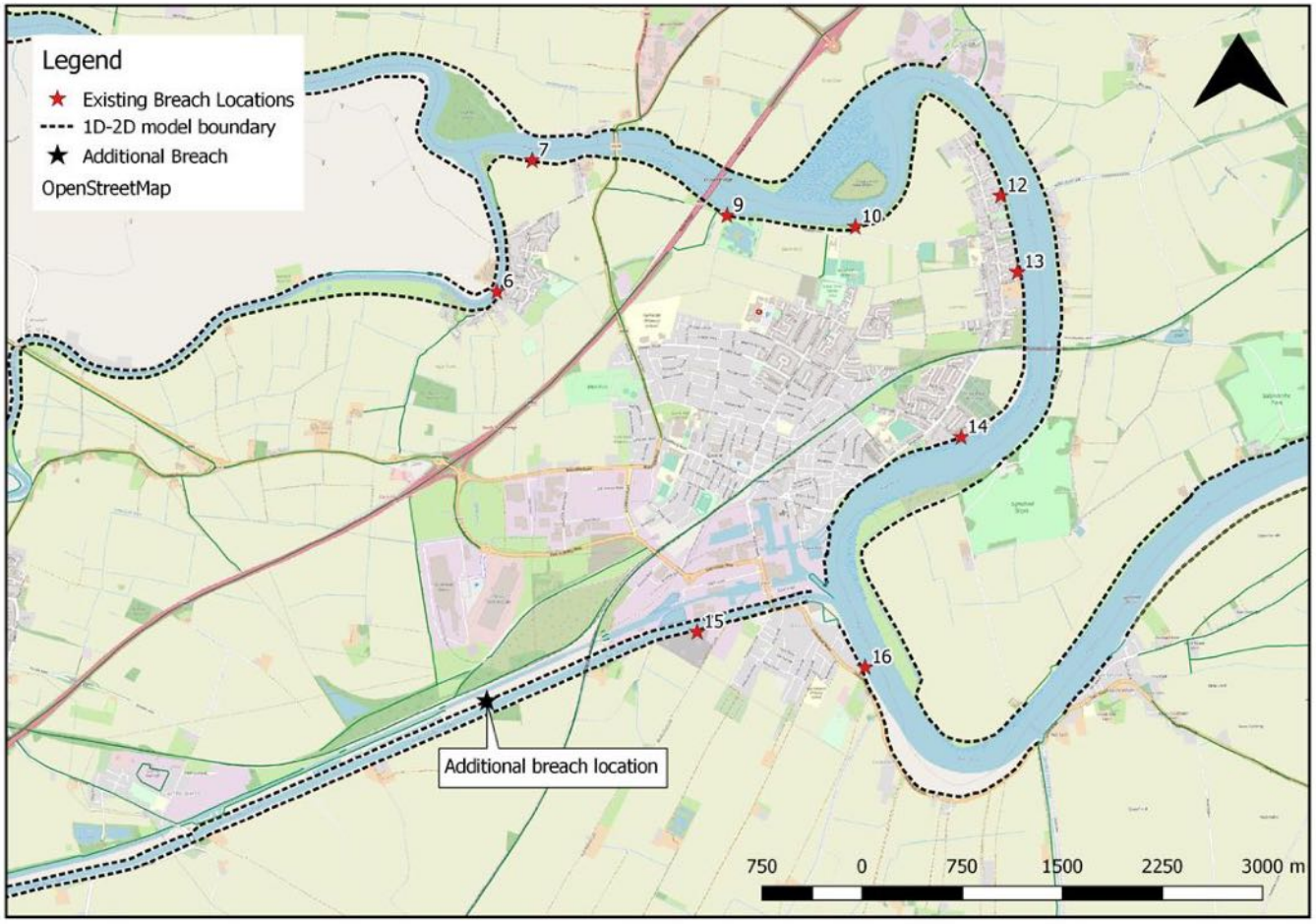


Figure 5-1 - Goole – Modelled breach locations, numbering in accordance with Upper Humber 2016 study.

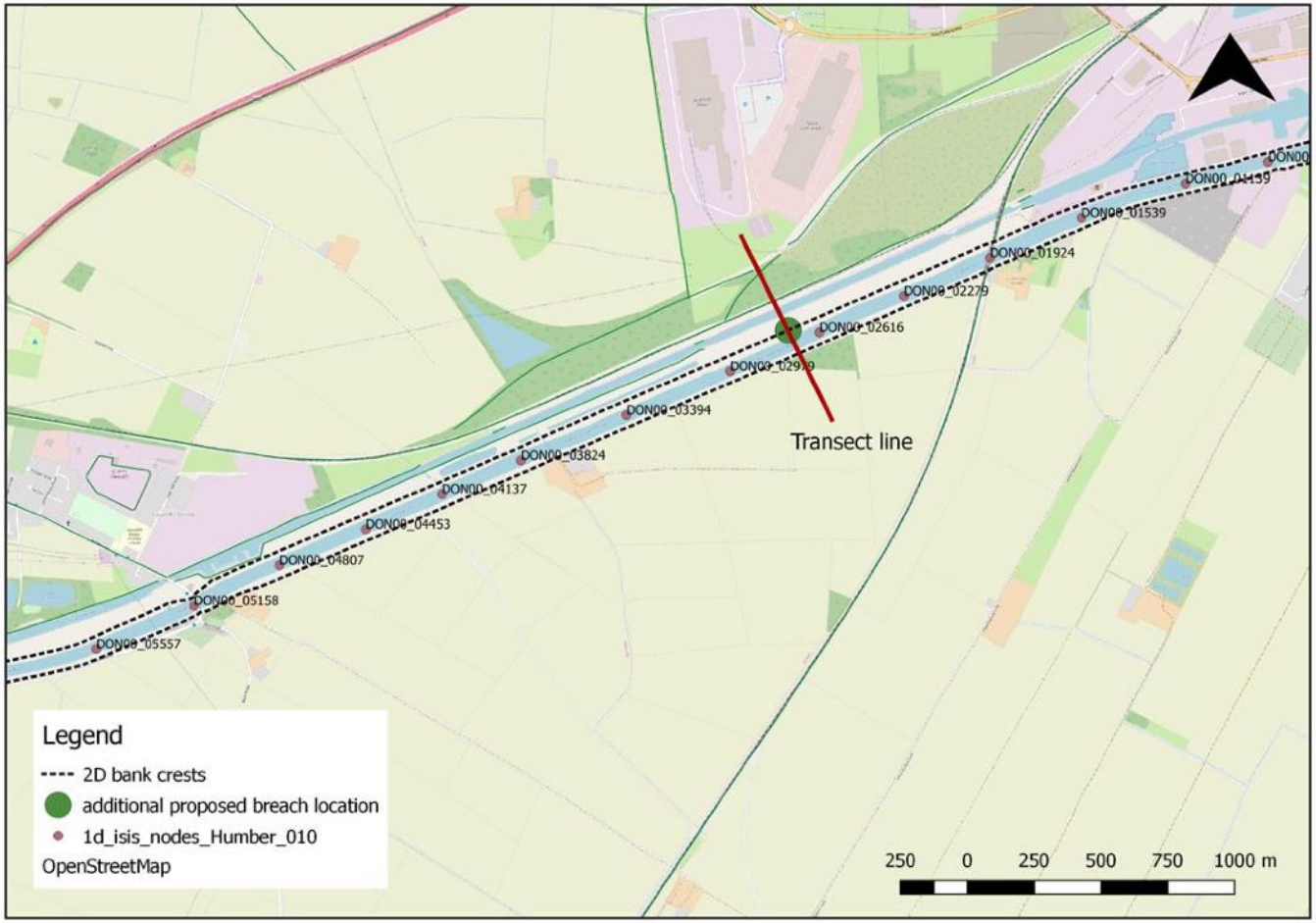


Figure 5-2 – Location of additional breach on the River Don

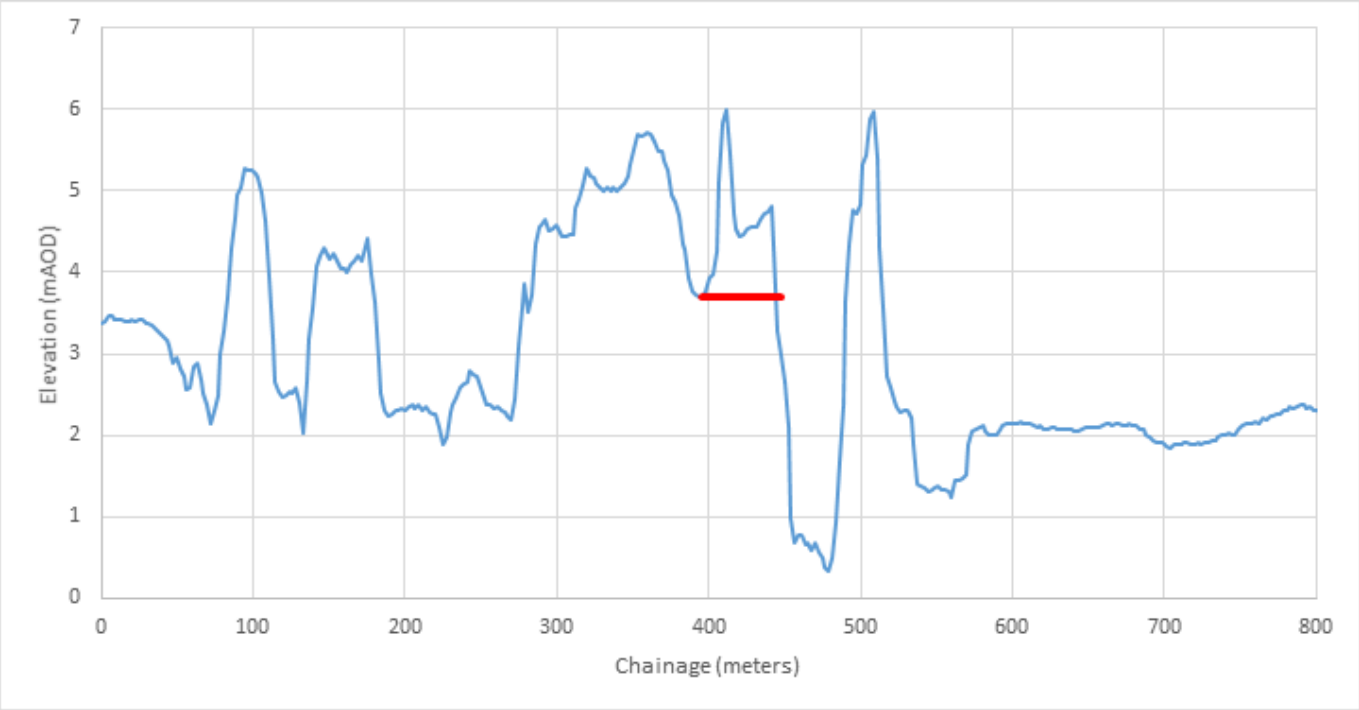


Figure 5-3 – Transect across the LIDAR DTM, the River Don is the low point between the chinagae of 400 and 500m, the red line is the proposed breach line and invert across the defeneces

Hedon breach locations

Four fluvial defence breaches and one tidal defence breach are proposed for Hedon.

The following data was available and used to support this assessment;

- Environment Agency GIS AIMS data set
- The Burstwick and Old Fleet ICM FRMP model

The following factors were considered for determining breach locations;

- Elevation of area at risk
- Elevation of defence asset
- Type of defence asset

Risk can be defined as a multiplication of probability of an incident and the severity of the incident. So both the likelihood of a breach occurring and the severity of a potential breach have been considered.

Elevation of area at risk is an important factor as a breach in a lower lying area will result in a greater area being flooded to a greater depth and as a consequence a greater number of properties affected if the area is urbanised. The breach locations selected all maximise severity of flooding impact.

Elevation of the defence asset can affect the initiation of a breach. A breach can be initiated by internal or external erosion and is heavily affected by the condition of the asset and the soil or material properties. With this data not being available the next key factor is the elevation. If the asset is over topped this can lead to erosion. Low points in linear defences were considered to be at greater risk of a breach.

Type of defence asset in particular whether an asset is a formally maintained or built asset or natural high ground is a key factor in breach probability. Natural high ground, being a naturally occurring fluvial feature was considered less likely to breach compared with an asset reliant on ongoing maintenance. As such AIMS assets classified as ‘high ground’ were not considered for breach locations. Equally embankments were considered more likely to breach than hard engineered walls. The fluvial breach locations selected were all built embankments.

The 1%AEP return 2025 model results from the Burstwick and Old Fleet indicate that peak stage on the Burstwick Drain as it passes through Hedon is 2.65m AOD. Figure 2 highlights all areas below this level in red, with a breach at an appropriate location these areas would be liable to flood. The bank lines representing the linear defences in the model have an elevation greater than 3m AOD through the majority of their length. However there are locations as low as 2.4m AOD on the north bank. Two of these have been selected as north bank breach locations. An additional location was selected on the north bank near the upstream end of the Burstwick Drain as it enters Hedon. This location had a higher bank elevation, 2.8m AOD but if breached would allow water to inundate St Micheal’s Drive and the Inmans estate. On the South Bank the low point is 2.78m AOD and this has been selected as a breach location.

The tidal gate on the Burstwick Drain was selected as the tidal breach location. This was selected over the embankments to the north and south as ingress of tidal waters up the Burstwick Drain would concentrate water levels. To the north of Burstwick Drain elevations exceed 3m AOD and to the south

there is a wide low lying rural area before ridge of land 3-4mAOD to the north and then the Burstwick Drain separating a potential breach from the urban area.

All breach locations are summarised in Table 5-2 and located in Figure 5-4.

Table 5-2 - Hedon - modelled breach locations

Breach ID no.	Asset Type	NGR X	NGR Y
1	Flood Gate	516822	427807
2	Fluvial Embankment	518638	428074
3	Fluvial Embankment	519367	428187
4	Fluvial Embankment	519129	428088
5	Fluvial Embankment	519918	428335

For the tidal breach the Burstwick Drain gates will be fully opened 1 hour before high water level. For the fluvial embankment breaches ICM's breach function will be used on the river bank lines and if necessary the mesh behind the banks will be lowered to ground level behind the embankment.

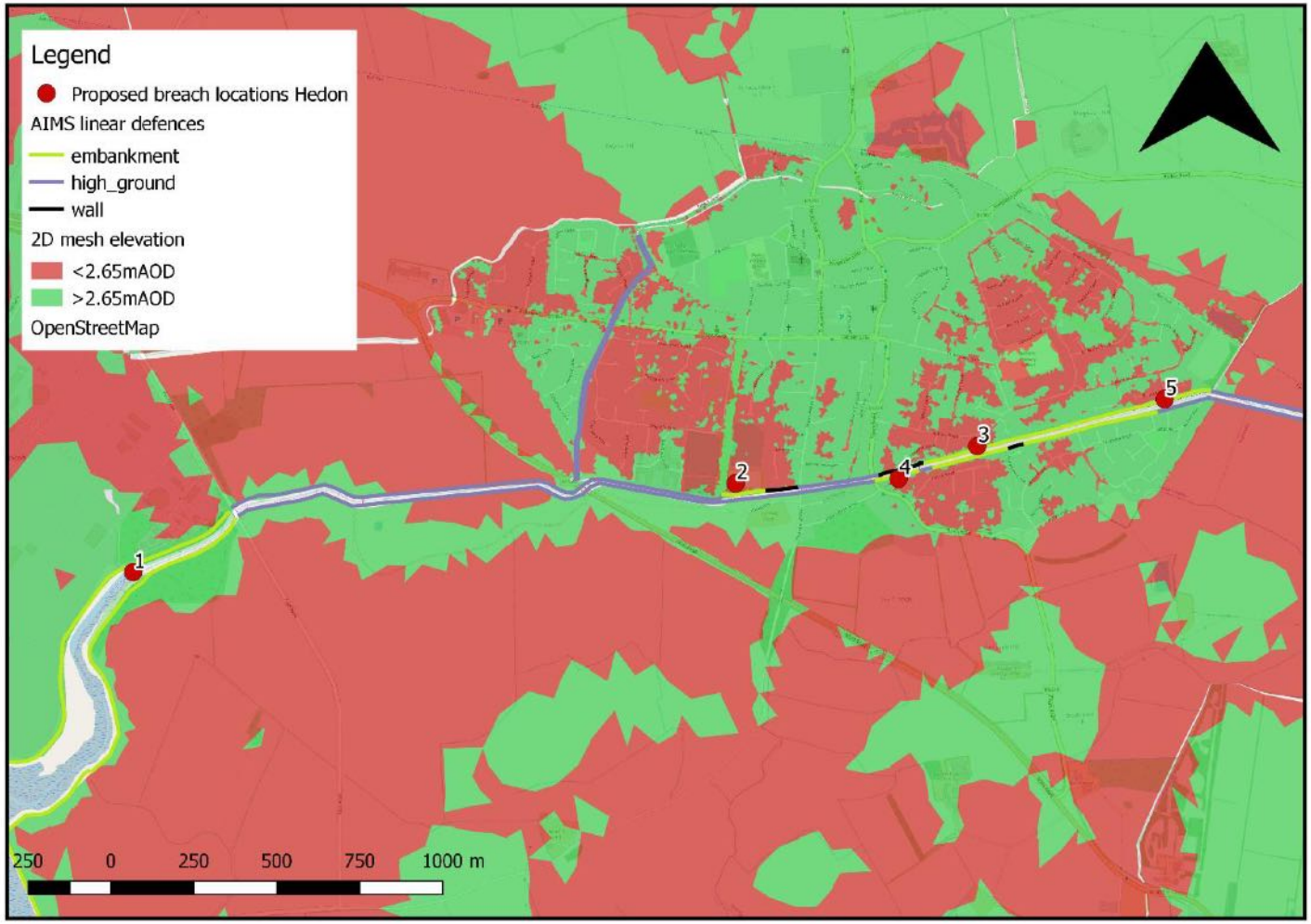


Figure 5-4 - Hedon - modelled breach locations

Model boundary data

The Table 5-3 below provides the model boundary data, tidal levels, and climate change allowances to be applied in the models of Goole and Hedon for the SFRA Level 2.

Table 5-3 - Model boundary data for SFRA Level 2

Model boundary data for SFRA Level 2	Goole	Hedon
Closest Water Level Location	Brough	Paul
Model Node names	OUSE_-08420	Bustwick Outfall near Salt End
MHWS tide mAOD	Not known or needed for this study	4.46
tidal 1yr mAOD base date is 2014	5.15	4.56
tidal 1yr mAOD for 2019 (base year 2014 plus 0.20m)	5.35	4.76
tidal 200yr mAOD base date is 2014	5.89	5.51
tidal sea level increase from 2015 to 2115 using: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances	1.109	1.109
Tidal 200yr+Climate Change	6.999	6.619
River flow + Climate Change Higher Central % increase to 2115	30%	30%

Schedule of model runs

A schedule of model runs for the Goole and Hedon models is detailed in Table 5-4, below.

Table 5-4 - A schedule of model runs

Schedule of runs for Goole	Number of runs
Run Defended Upper Humber model with updated CC tidal boundary, no other changes will be made.	1
Use the results from the run above to provide hydrographs for separate breach models, this will include 1 on Don, and 9 others as shown on the technical approach note.	10
Schedule of runs for Hedon	
Run Defended Hedon model with updated river flow boundaries for the 0.1%, 1%, 1%+CC, and 5% AEP **fluvial events coinciding with a** 1 year **tide** level**.**	4
Use the results from the run above to provide hydrographs for separate fluvial breach models along the fluvial assets on Burstwick drain, as shown in the technical approach note. Breach location map copied below.	4
Run Defended Hedon model with updated river flow boundaries for the 2yr fluvial events coinciding with a 200yr+CC tide.	1
Run Defended Hedon model with a breach located at Burstwick Gates with the updated river flow boundaries for the 2yr fluvial events coinciding with a 200yr+CC tide.	1

6. Conclusions

This document has outlined the approach to the Level 2 SFRAs for Goole and Hedon for East Riding of Yorkshire Council. It has proposed a report format and outlines the information that will be included in each chapter. The report provides the technical modelling approach for the SFRA level 2 at Goole and Hedon.

Appendix A – Geotechnical technical note

Technical Note

8 March 2018

To	Alastair Worsley
CC	John Dudley
Subject	Geotechnical Advise for Potential Breach Locations, Goole
Prepared by	Cristiano Ascolani
Reviewed by	Neil Greenwood

INTRODUCTION

Requirement

Capita are already preparing a Level 2 SFRAs for Goole and Hedon.

The EA recently consulted the council on its draft Upper Humber Modelling (UH 2016). This shows a significant change in flood risk for Goole in comparison to the previous Level 2 SFRA (SFRA L2 2011). Following the recommendations of the review, the Council would like the new Level 2 SFRA to consider a more locally specific approach to flood risk in Goole and this is to be applied to breach modelling.

This technical note is prepared for Goole, a second, follow note will be prepared for Hedon and this reflects the programme of the SFRA work.

Report Objectives

The objectives of this technical note are to assess at desk study level the configuration of the defences and immediately surrounding ground at a number of breach locations which were identified in the SFRA L2 2011 and the UH 2016 and to provide geotechnical recommendations as the likely breach invert level and other information on potential failure modes that can be ascertained purely from desk research. The review of the breach locations has been undertaken producing the following output for each location:

- Cross sections across the defences (approx. 300m landward and 100m riverward);
- Calculation of the earth embankment slopes (where it is a bund feature);
- Summary of the conditions of the affected asset as gleaned from published condition reports; and
- Estimating possible mechanism for earthwork breaching.

Sources of Information

Sources of information used during the compilation of this report include:

- Jacobs. (2011). *East Riding of Yorkshire Council, Strategic Flood Risk Assessment (SFRA), Level 2 – Goole*. Ref B1166100/TASK04/D03

- JBA Consulting. (2016). *Upper Humber Flood Risk Mapping Study*. Final Report. Ref 2013s7579 - Upper Humber Flood Mapping_v2.0.docx
- Elevation of the crest along the Humber River taken by the topographic survey carried by Mott MacDonald's in December 2013.
- EA LiDAR DTM (Digital Terrain Model), 1m resolution. Data downloaded in February 2018.
- EA spatial flood defences (including standardised attributes), available at https://data.gov.uk/dataset/spatial-flood-defences-including-standardised-attributes. Version: February 2018. This shapefile contains specific information about the outlined defences as design standard, type of asset, description and conditions (of the last EA inspection). Description of the fields at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/649593/LIT_6442.pdf (page 11)

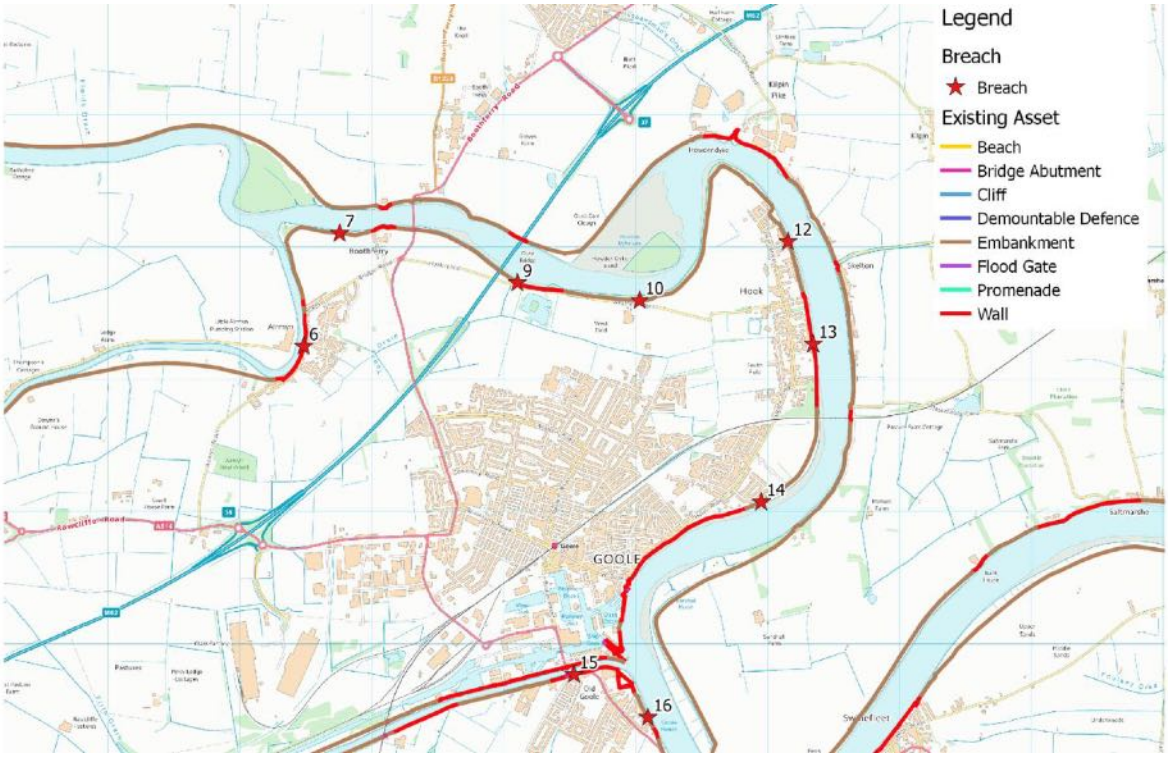


Figure 1: Breach locations, numbering in accordance with UH 2016.

DEFENCES PROFILE

Nine cross sections have been produced for each proposed breach locations in order to define the geometry of the asset and to compare the obtained profile with critical parameter used for the production of the previous breach modelling reports. Refer Figure 1 for location. Nine profiles have been produced using the Lidar data.

A summary of the asset conditions is available in Appendix A and full detailed documentation is provided in Appendix B comprising topographic profiles, location plan of the cross sections, slope calculation, crest elevation from survey, critical parameters adopted in the breach modelling of SFRA L2 2001 and UH 2016 and EA asset details.

Graphical representation of the topographic profiles presented in Appendix B includes:

- LiDAR profile;

- Slope (based on the LiDAR cross sections);
- SFRA L2 2011 breach level;
- UH 2016 breach level;
- SFRA L2 2011 peak water level;
- UH 2016 peak water level; and
- Elevation of the crest from 2013 Mott MacDonald's topographic survey.

Special attention should be given to the precision of the profile and the calculation of the side slopes. Output was obtain using a 1m-resultion LiDAR which means that abrupt steps in terrain are poorly captured. The assumption is confirmed by the profile of solid defences (e.g. flood walls), where a clear changing in elevation might be expected, however only a significant slope was recorded.

STATUS OF THE ASSET

Together with the aforementioned graphs, the EA spatial flood defence shapefile contains specific information about the outlined defences as follows:

- Downstream crest level
- Upstream crest level
- Type of flooding the asset defends against (Coastal, Fluvial, Coastal/Fluvial)
- Type of Asset (e.g. wall, embankment)
- Description of the asset (e.g. a weir description could be 'fixed concrete weir, piled/concrete wing walls, steel/concrete footbridge spanning structure)
- Design standard of defence as a return period
- Length of asset in metres
- Overall condition grade of the crest (1 to 5)
- Condition grade of asset element in worst condition at last inspection (1 to 5)

Information was not available for the assessed standard of resilience to a flood event of a particular a return period. EA asset information are summarised in Appendix A, full detailed documentation and topographic profiles are available in Appendix B.

DISCUSSION

The affected assets identified by the previous breach modelling comprises five earth embankments, two flood walls and a composite embankment (solid and earthen defences). The majority of these defences are designed for defending against tidal flooding, except for breach locations 6 and 15, which provide defence for both fluvial and tidal flooding. According to the EA asset reports, all the affected defences were constructed based on a design standard of 200-year flood event. In accordance with the Mott MacDonald's topographic survey, only location 15 has a crest lower than 6m AOD and a maximum crest of 6.656 was recorded in location 13.

Based on the 0.5% peak water level, overtopping is likely to occur in locations 15 and 16, where the crests are significantly lower than the maximum recorded levels. Overtopping can wash away the defences leading to rapid vertical degradation of the earthwork with its invert dropping until it matches the landward level of surround ground. Limited to location 15, the asset is described as a sheet pile wall placed landward and it is difficult to see how a full 60m section of pile wall could develop a breach.

For selected earthen embankments, the riverward batter slopes were recorded having a significant slope, in particular locations 7, 1 2 and 16 where these slopes are set at around 1H:1.25V (125% or approximately 50°). Significant slopes may result in a reduced slope stability during prolonged high water level or prolonged rainfall events. Assuming the embankments comprise cohesive soil, the breaching process could include an element of rotational slope failure and/or translational sliding.

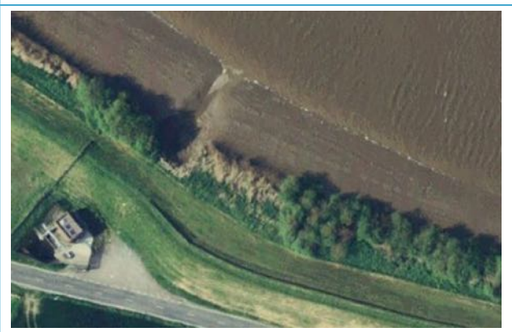
The earth embankment at location 9 is a complex structure with an outflow element and it is connected to sheet pile walls running along the crest. Erosion dictated by the flow interaction with the various components should be considered. Furthermore, sign of riverward erosion from the satellite mapping have been noticed which should be followed up with a suitable inspection regime.

CONCLUSIONS

In the SFRA L2 and HM 2016 breach modelling, two different approaches have been adopted, considering the breach invert level as the riverward berm level and the ground level respectively. The majority of the affected assets comprises earthen defences, where breaching process is mainly regulated by the washing away of the crest and erosion of the soils continues down to at least the base level of the embankment, therefore the generic ground level. In view of this, this technical note agrees with the HM 2016 in so far as it adopts a ravelling down to matching ground level approach. Only at location 15 might this approach be too cavalier as the central sheet pile wall with capping beam may well hang up the invert level above surrounding land.

A combined structural-geotechnical survey undertaken by experienced specialists is recommended in order to assess the actual conditions of the defences to identify potential issue for the stability of the assets (e.g. erosion of the riverward sides, conditions of the solid structures, cracking within the earthen embankment, interaction between solid-earthen adjacent defences, etc.)

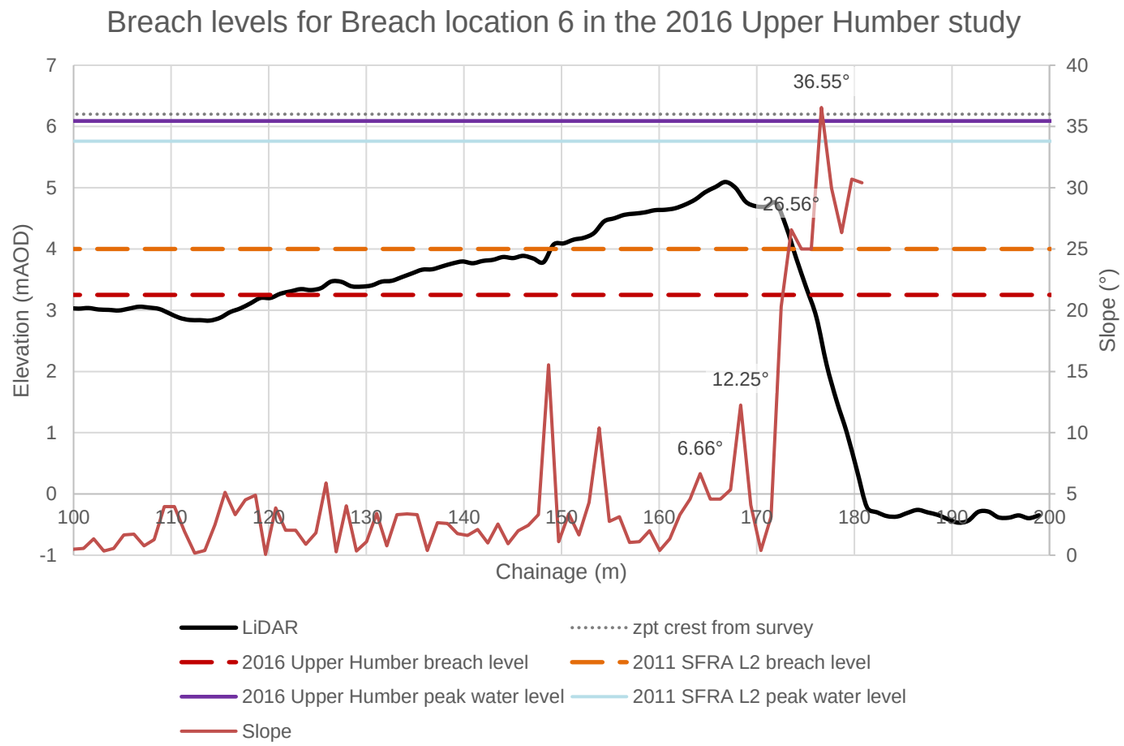
APPENDIX A – SUMMARY OF THE AFFECTED ASSET CONDITIONS

Ref		Description	Type	2016 UH peak water level (mAOD)	Elevation crest from survey (mAOD)	Side slope (H:V)	EA Condition Grade Rating (1 to 5)	Comments
6		Embankment with small brick-made retaining wall landward	Fluvial and tidal	6.09	6.201	Landward 8.5:1 Riverward 4:1 to 1.5:1	Overall: 2/5 Asset element in worst condition: 3/5	Although difference between the crest and the water peak level is very small, overtopping is unlikely to occur. Likely breach level: 3.25m AOD (landward ground level)
7		Earthen embankment	Tidal	6.15	6.617	Landward 2.8:1 Riverward 2.5:1 to 1:1.25	Overall: 3/5 Asset element in worst condition: 3/5	Overtopping does not represent an issue as the crest level is almost half meter higher than the 0.5% peak level. Consideration should be given to the riverward toe slope (between 30° and 50°), resulting in a reduced slope stability during prolonged high water level or prolonged rainfall events. Likely breach level: 4m AOD (landward ground level)
9		Composite embankment (earth embankment with outfall and adjacent sheet pile wall)	Tidal	6.16	6.462	Landward 2.4:1 Riverward 2.5:1 to 2:1	Overall: 3/5 Asset element in worst condition: 3/5	0.5% peak level is lower than crest level. The earth embankment presents in this point additional structure (an outflow) and it is connected to a sheet pile walls running along the crest. Erosion dictated by the flow interaction with the various components should be considered. Sign of riverward erosion from the satellite mapping. Likely breach level: 2.25m AOD (landward ground level)
10		Earthen embankment	Tidal	6.14	6.415	Landward: 3:1 Riverward: 3:1 to 1.5:1	Overall: 2/5 Asset element in worst condition: 3/5	Overtopping not considered a primary issue. Significant slope identified of the riverside (toe slope about 35°) Likely breach level: 3m AOD (landward ground level)

Ref		Description	Type	2016 UH peak water level (mAOD)	Elevation crest from survey (mAOD)	Side slope (H:V)	EA Condition Grade Rating (1 to 5)	Comments
12		Earth embankment	Tidal	6.14	6.592	Landward 3.5:1 Riverward 3.5:1 to 1:1.25	Overall: 2/5 Asset element in worst condition: 3/5	Overtopping is unlikely to occur as the 0.5% peak level is lower than the crest level. The toe along the riverside is particularly sloping (50°) and it could led to slope instability with prolonged high water levels or prolonged rainfall (moisture content). Likely breach invert level: 4.25m AOD (average landward ground level)
13		Earth embankment combined with riverward sheet piled wall composing the inner side of the berm.	Tidal	6.13	6.656	Landward 2.4:1 Riverward 4:1 to 1.2:1	Overall: 3/5 Asset element in worst condition: 3/5	Peak level significantly lower than crest elevation, overtopping is not considered a primary risk. The wall is located 15m far from the river (daily level), so continuous and daily corrosion and erosion of the riverbed in front of the walls is unlikely to (currently) occur. Landward embankment provides extra support to the wall from excessive hydrostatic pressure. River bank slope is significant (40°). Likely breach level: 4.25m AOD (landward ground level)
14		Earthen embankment	Tidal	6.08	6.529	Landward 2.5:1 Riverward 2.5:1 to 1.2:1	Overall: 3/5 Asset element in worst condition: 4/5	Overtopping might be excluded as the 0.5% peak level is lower that the identified crest elevation. Significant slope (up to 40°) has been noticed on the river bank. EA rated the condition grade of the asset element in worst condition as 4/5, rating for this item should be investigated. Likely breach invert level: 4.4m AOD (average landward ground level)
15		Sheet pile wall with steel capping beam protecting the adjacent road.	Fluvial and tidal	6.03	5.951	Landward: N/A (flat area) Riverward 1.35:1 to 1:1.25	Overall: 3/5 Asset element in worst condition: 3/5	Overtopping is likely to occur for 1:200 year flood events. Wall is placed landward and it could be designed to be resilient if overtopped. Washing away of the crest is not an issue for hard defences. Likely breach invert level: 5.1m AOD (landward ground level)
16		Earth embankment	Tidal	6.06	5.76	Landward 2.2:1 Riverward 2.2:1 to 1:1.1	Overall: 3/5 Asset element in worst condition: 3/5	Crest level is significantly lower than the peak for 1:200 year flood events. Overtopping could therefore occur in this location. Slope of the river bank is significant (max. 50°). Likely breach level: 4.25m AOD (landward ground level)

APPENDIX B – DETAILED INFORMATION ON ADOPTED BREACH LOCATIONS

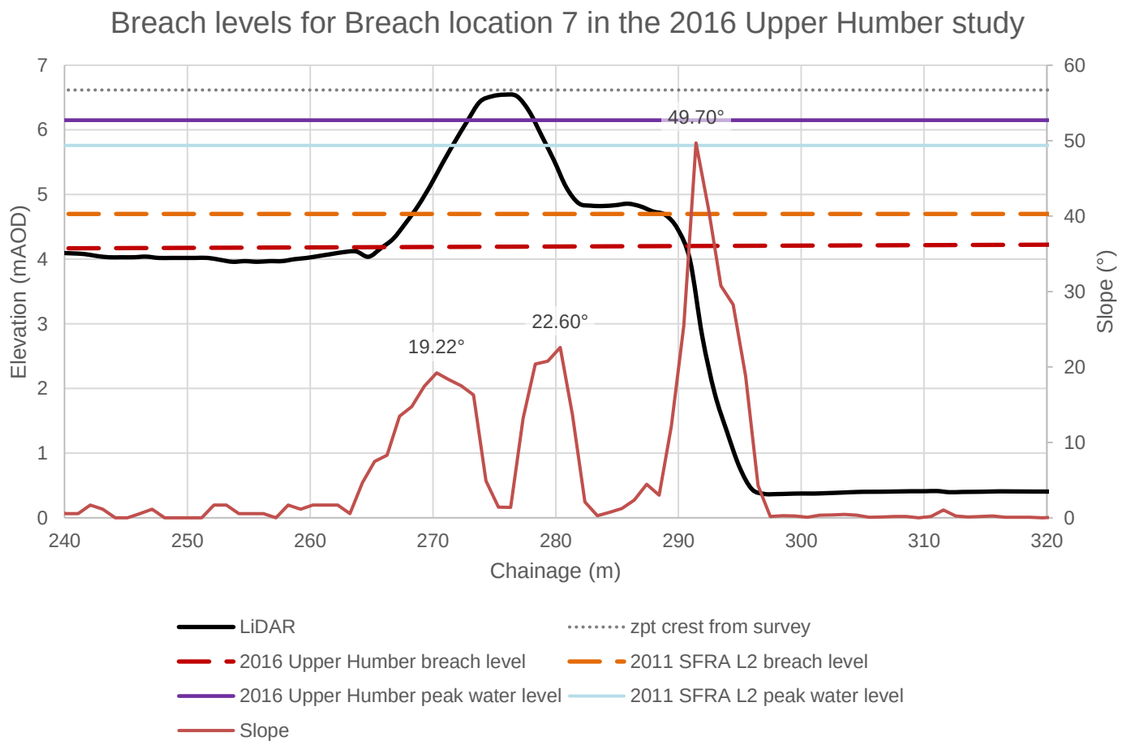
BREACH LOCATION 6



AFFECTED ASSET	
Downstream crest level (m AOD)	6.292
Upstream crest level (m AOD)	6.299
Type of flooding the asset defends against (Coastal, Fluvial, Coastal/Fluvial)	fluvial_tidal
Type of Asset (one of 17 asset types)	wall
Description of the asset	EMBANKMENT+WALL
Design standard of defence as a return period (years)	200
Length of asset (m)	625.29
Overall condition grade of the crest (1 to 5)	2
Condition grade of asset element in worst condition at last inspection (1 to 5)	3

Item	Elevation (m AOD)
zpt crest from survey	6.201
2016 Upper Humber breach level	3.25
2011 SFRA L2 breach level	4
2016 Upper Humber peak water level	6.09
2011 SFRA L2 peak water level	5.76

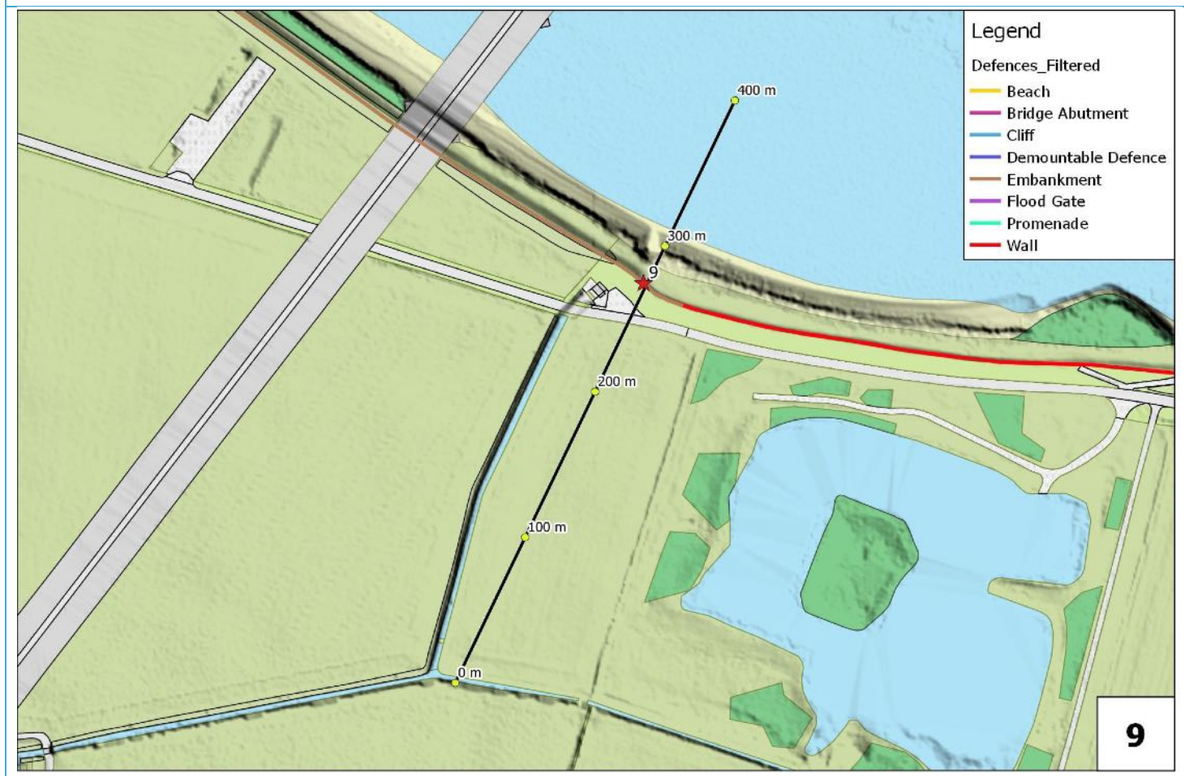
BREACH LOCATION 7

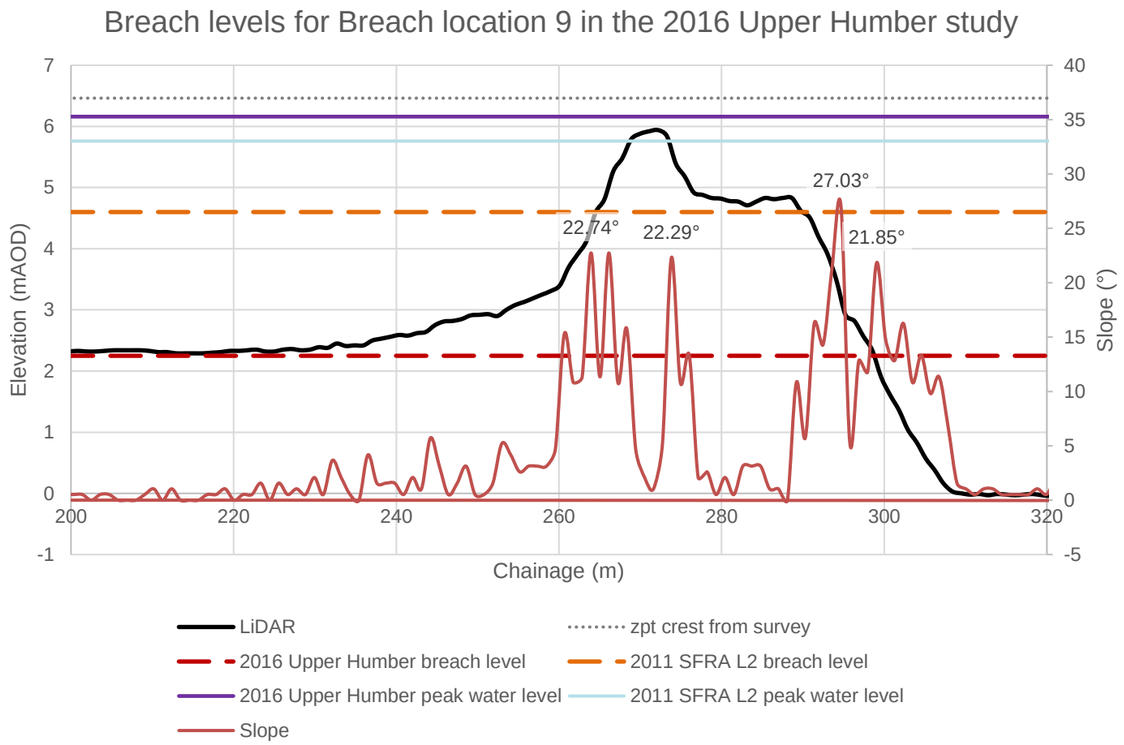


AFFECTED ASSET	
Downstream crest level (m AOD)	6.616
Upstream crest level (m AOD)	6.57
Type of flooding the asset defends against (Coastal, Fluvial, Coastal/Fluvial)	tidal
Type of Asset (one of 17 asset types)	embankment
Description of the asset	EMBANKMENT
Design standard of defence as a return period (years)	200
Length of asset (m)	689.14
Overall condition grade of the crest (1 to 5)	3
Condition grade of asset element in worst condition at last inspection (1 to 5)	3

Item	Elevation (m AOD)
zpt crest from survey	6.617
2016 Upper Humber breach level	4
2011 SFRA L2 breach level	4.7
2016 Upper Humber peak water level	6.15
2011 SFRA L2 peak water level	5.76

BREACH LOCATION 9

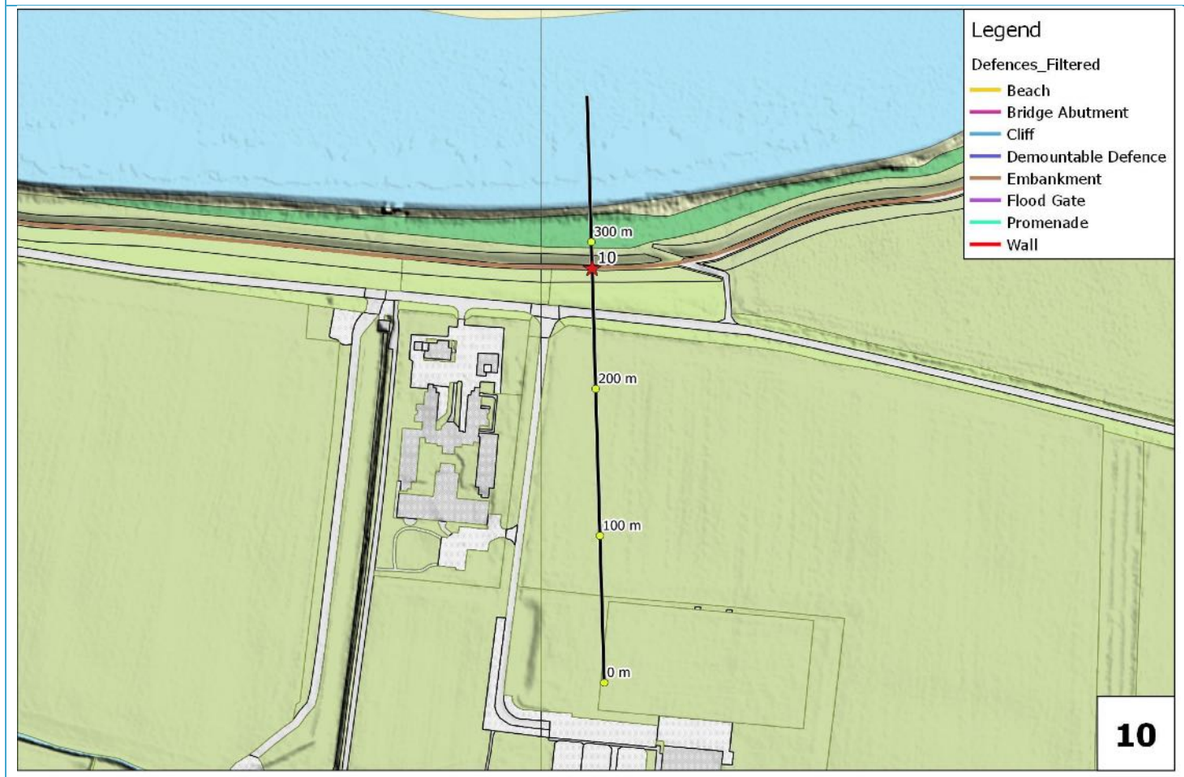


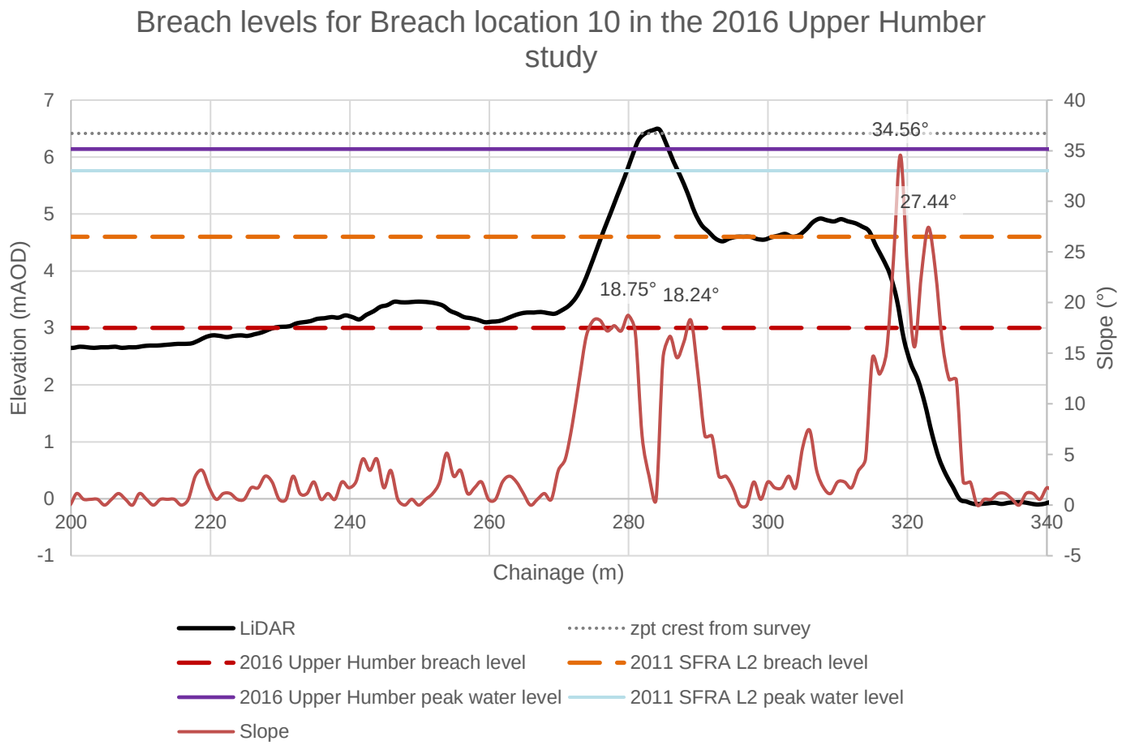


AFFECTED ASSET	
Downstream crest level (m AOD)	6.471
Upstream crest level (m AOD)	6.593
Type of flooding the asset defends against (Coastal, Fluvial, Coastal/Fluvial)	tidal
Type of Asset (one of 17 asset types)	embankment
Description of the asset	EMBANKMENT
Design standard of defence as a return period (years)	200
Length of asset (m)	898.3
Overall condition grade of the crest (1 to 5)	3
Condition grade of asset element in worst condition at last inspection (1 to 5)	3

Item	Elevation (m AOD)
zpt crest from survey	6.462
2016 Upper Humber breach level	2.25
2011 SFRA L2 breach level	4.6
2016 Upper Humber peak water level	6.16
2011 SFRA L2 peak water level	5.76

BREACH LOCATION 10

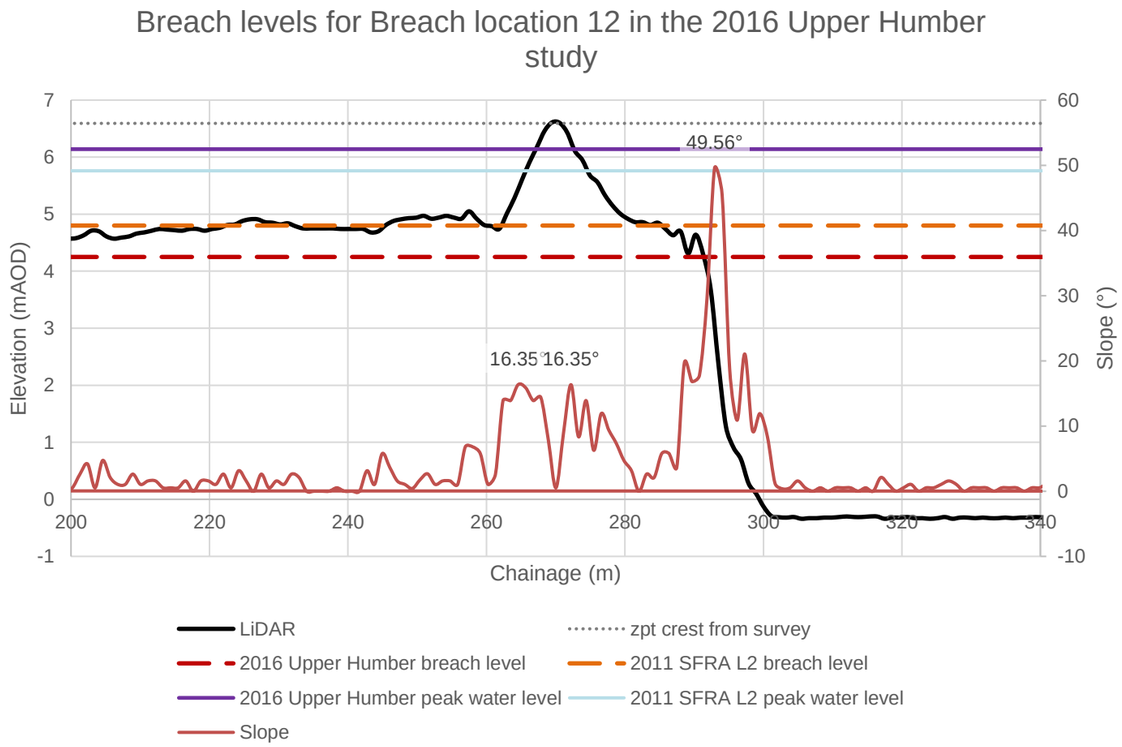




AFFECTED ASSET	
Downstream crest level (m AOD)	6.621
Upstream crest level (m AOD)	6.44
Type of flooding the asset defends against (Coastal, Fluvial, Coastal/Fluvial)	tidal
Type of Asset (one of 17 asset types)	embankment
Description of the asset	EMBANKMENT
Design standard of defence as a return period (years)	200
Length of asset (m)	1748.69
Overall condition grade of the crest (1 to 5)	2
Condition grade of asset element in worst condition at last inspection (1 to 5)	3

Item	Elevation (m AOD)
zpt crest from survey	6.415
2016 Upper Humber breach level	3
2011 SFRA L2 breach level	4.6
2016 Upper Humber peak water level	6.14
2011 SFRA L2 peak water level	5.76

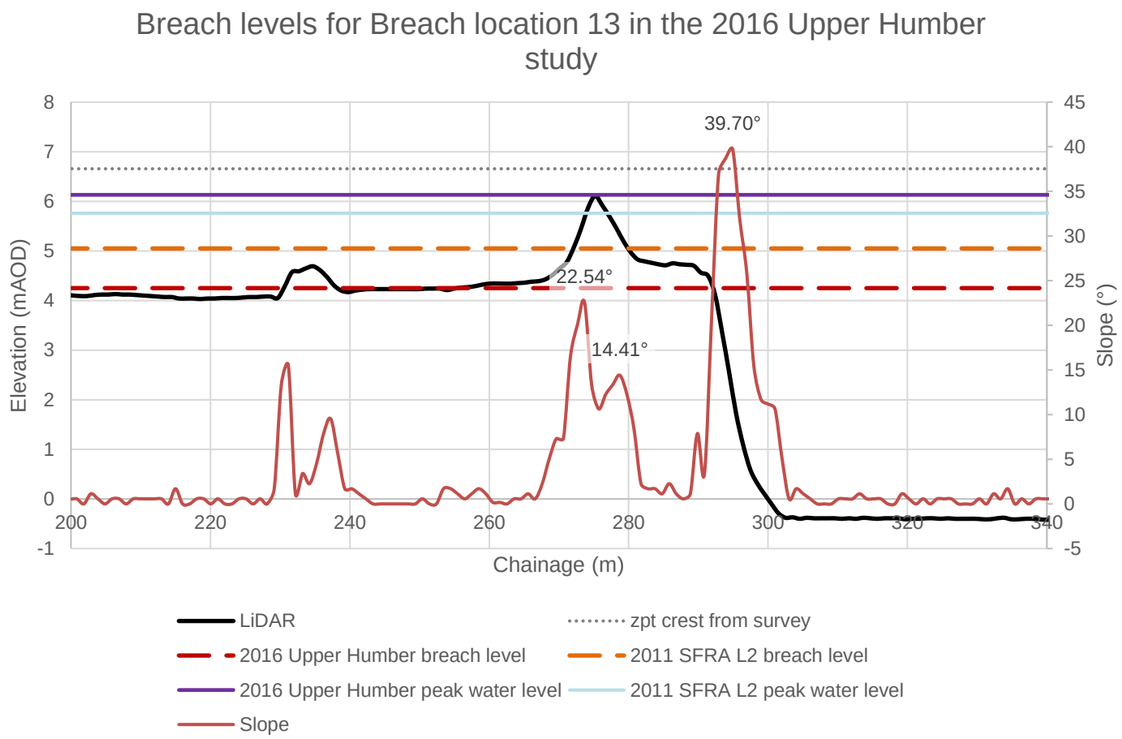
BREACH LOCATION 12



AFFECTED ASSET	
Downstream crest level (m AOD)	6.545
Upstream crest level (m AOD)	6.621
Type of flooding the asset defends against (Coastal, Fluvial, Coastal/Fluvial)	tidal
Type of Asset (one of 17 asset types)	embankment
Description of the asset	EMBANKMENT
Design standard of defence as a return period (years)	200
Length of asset (m)	1380.73
Overall condition grade of the crest (1 to 5)	2
Condition grade of asset element in worst condition at last inspection (1 to 5)	3

Item	Elevation (m AOD)
zpt crest from survey	6.592
2016 Upper Humber breach level	4.25
2011 SFRA L2 breach level	4.8
2016 Upper Humber peak water level	6.14
2011 SFRA L2 peak water level	5.76

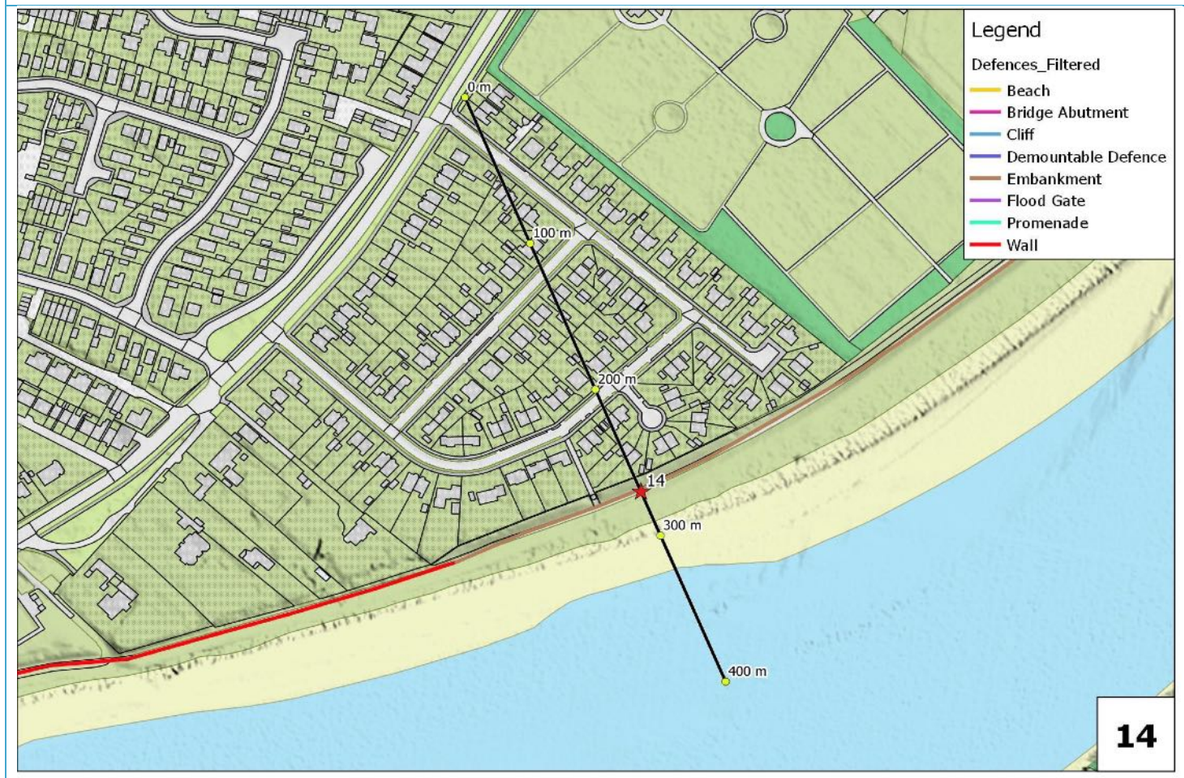
BREACH LOCATION 13

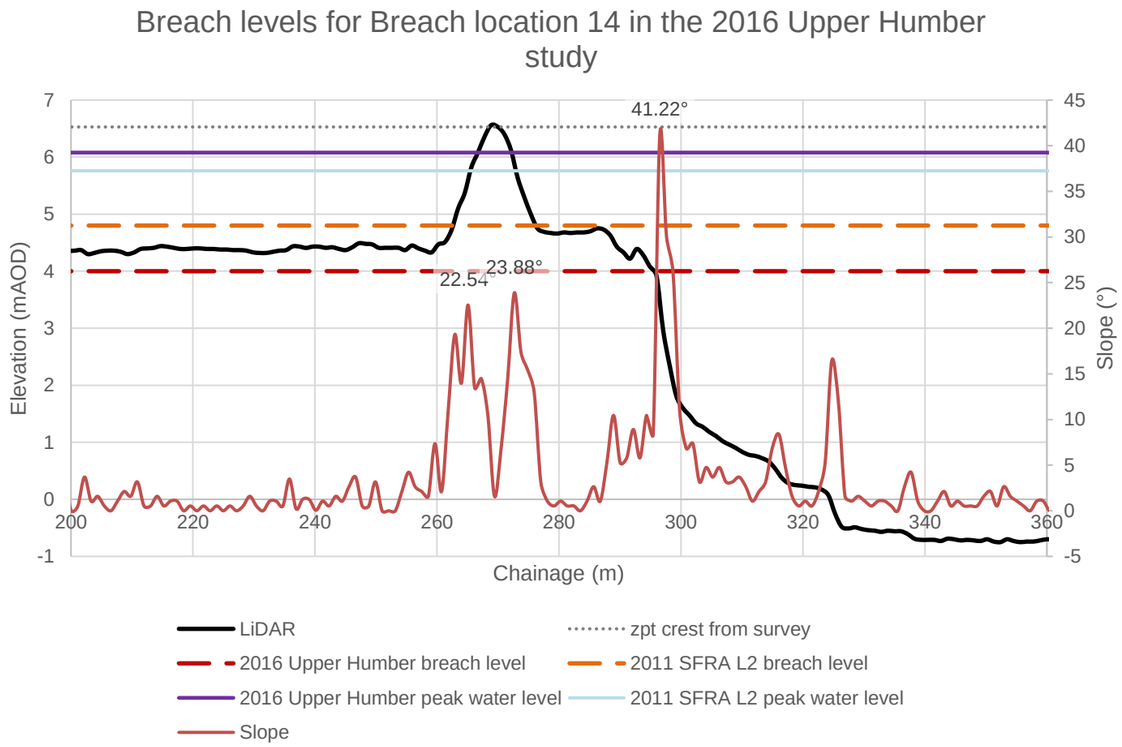


AFFECTED ASSET	
Downstream crest level (m AOD)	6.54
Upstream crest level (m AOD)	6.545
Type of flooding the asset defends against (Coastal, Fluvial, Coastal/Fluvial)	tidal
Type of Asset (one of 17 asset types)	wall
Description of the asset	EMBANKMENT WITH SHEET PILED WALL
Design standard of defence as a return period (years)	200
Length of asset (m)	847.82
Overall condition grade of the crest (1 to 5)	3
Condition grade of asset element in worst condition at last inspection (1 to 5)	3

Item	Elevation (m AOD)
zpt crest from survey	6.656
2016 Upper Humber breach level	4.25
2011 SFRA L2 breach level	5.05
2016 Upper Humber peak water level	6.13
2011 SFRA L2 peak water level	5.76

BREACH LOCATION 14

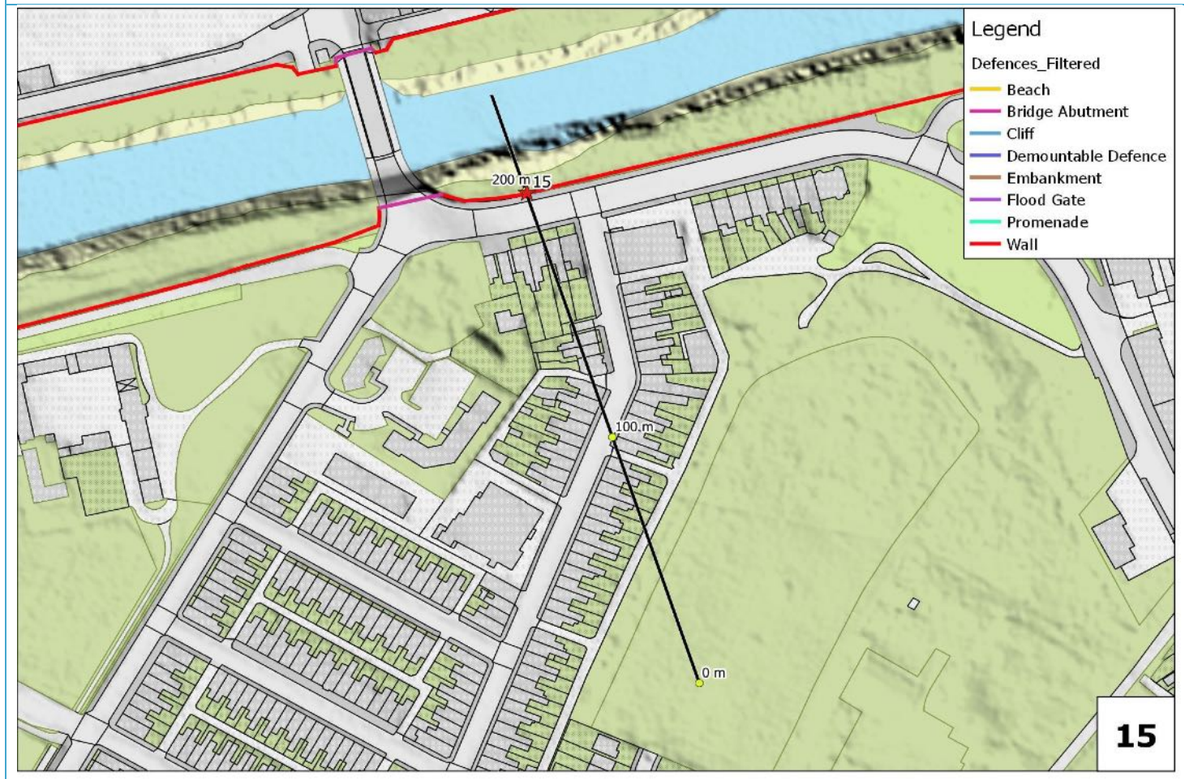


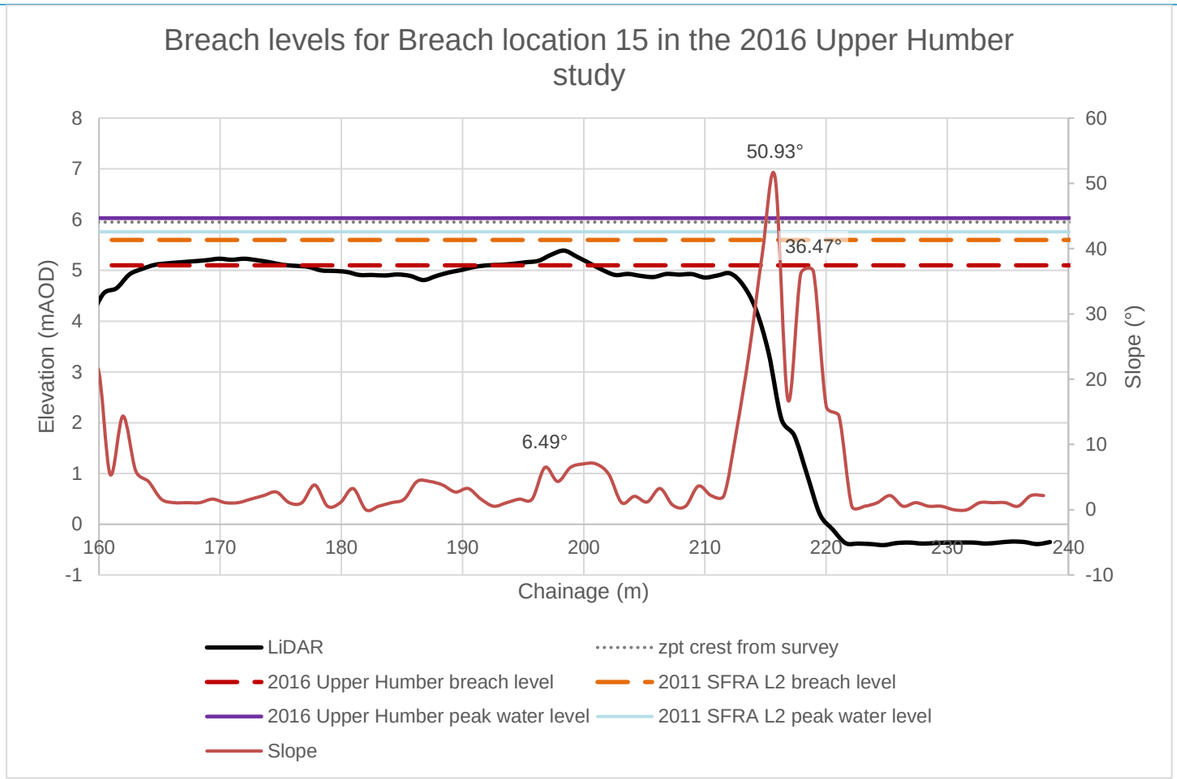


AFFECTED ASSET	
Downstream crest level (m AOD)	6.689
Upstream crest level (m AOD)	6.54
Type of flooding the asset defends against (Coastal, Fluvial, Coastal/Fluvial)	tidal
Type of Asset (one of 17 asset types)	embankment
Description of the asset	EMBANKMENT
Design standard of defence as a return period (years)	200
Length of asset (m)	1032.09
Overall condition grade of the crest (1 to 5)	3
Condition grade of asset element in worst condition at last inspection (1 to 5)	4

Item	Elevation (m AOD)
zpt crest from survey	6.529
2016 Upper Humber breach level	4
2011 SFRA L2 breach level	4.8
2016 Upper Humber peak water level	6.08
2011 SFRA L2 peak water level	5.76

BREACH LOCATION 15

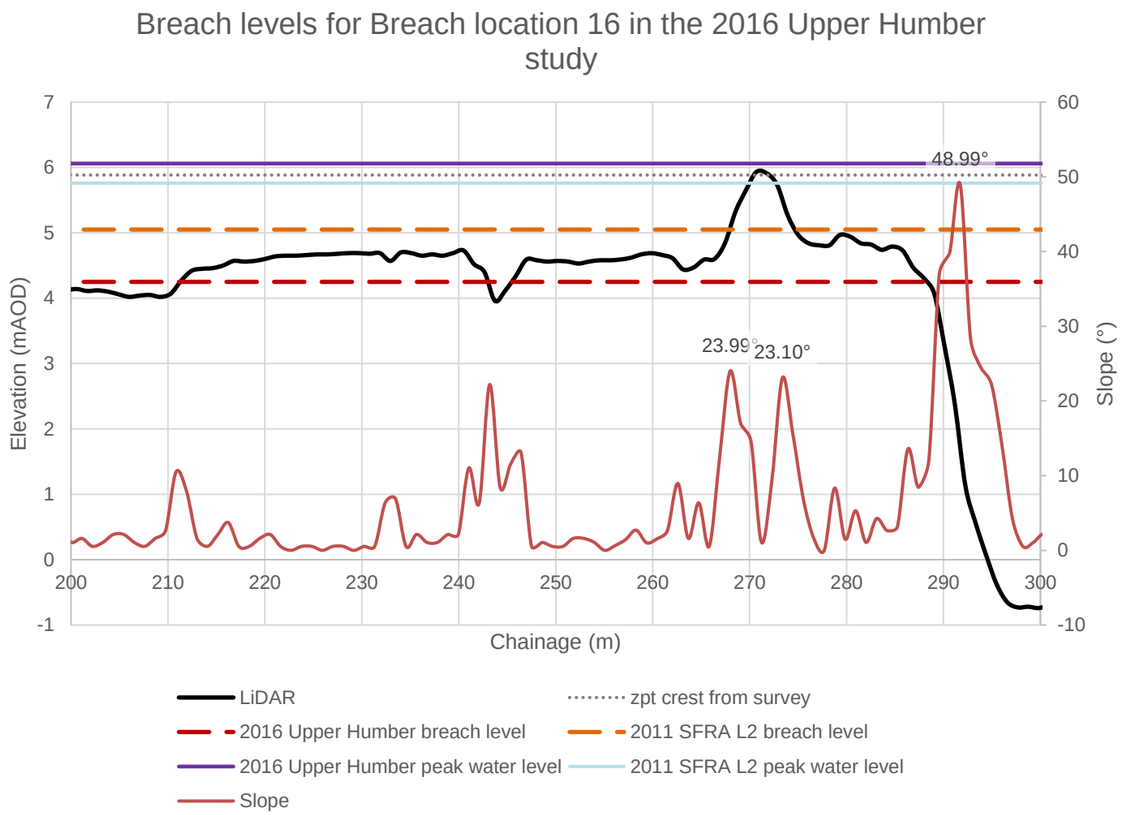




AFFECTED ASSET	
Downstream crest level (m AOD)	5.857
Upstream crest level (m AOD)	5.278
Type of flooding the asset defends against (Coastal, Fluvial, Coastal/Fluvial)	fluvial_tidal
Type of Asset (one of 17 asset types)	wall
Description of the asset	Sheet Pile Wall with steel capping beam.
Design standard of defence as a return period (years)	200
Length of asset (m)	385.07
Overall condition grade of the crest (1 to 5)	3
Condition grade of asset element in worst condition at last inspection (1 to 5)	3

Item	Elevation (m AOD)
zpt crest from survey	5.951
2016 Upper Humber breach level	5.1
2011 SFRA L2 breach level	5.6
2016 Upper Humber peak water level	6.03
2011 SFRA L2 peak water level	5.76

BREACH LOCATION 16



AFFECTED ASSET	
Downstream crest level (m AOD)	6.51
Upstream crest level (m AOD)	6.295
Type of flooding the asset defends against (Coastal, Fluvial, Coastal/Fluvial)	tidal
Type of Asset (one of 17 asset types)	embankment
Description of the asset	EMBANKMENT
Design standard of defence as a return period (years)	200
Length of asset (m)	309.36
Overall condition grade of the crest (1 to 5)	3
Condition grade of asset element in worst condition at last inspection (1 to 5)	3

Item	Elevation (m AOD)
zpt crest from survey	5.884
2016 Upper Humber breach level	4.25
2011 SFRA L2 breach level	5.05
2016 Upper Humber peak water level	6.06
2011 SFRA L2 peak water level	5.76

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EAST RIDING OF YORKSHIRE COUNCIL

East Riding of Yorkshire Council Strategic Flood Risk Assessment (SFRA) Level 2 – Goole

July 2011

Document Reference: B1166100/TASK04/D03

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Introduction

1. This Level 2 Strategic Flood Risk Assessment (SFRA) considers the town of Goole, a key focus for development and regeneration within the East Riding that is nestled between the River Ouse, the River Aire and Dutch River and falls almost entirely within Flood Zone 3 High Probability[1]. It builds upon the findings of the Level 1 SFRA (published in January 2010) and the Environment Agency's National Flood Map (reviewed quarterly), and forms an important part of the evidence base for the East Riding of Yorkshire Local Development Framework.

2. Planning Policy Statement (PPS) 25: *Development and Flood Risk* encourages Local Planning Authorities to apply a Sequential Test when preparing their LDFs (informed by a Level 1 SFRA) to ensure that development is steered to areas of lowest flood risk, as far as possible. In places such as Goole however, where this is not possible (due to there being little land available outside Flood Zones 2 and 3), PPS25 recommends that a more detailed study should be undertaken - a 'Level 2' SFRA. A Level 2 SFRA provides a better understanding of flood risk, for instance, taking into account the benefits offered by any existing flood defences and assessing what the likely flood hazard would be to people and property if, in a 'worst case scenario', such defences were to fail. In particular, a Level 2 SFRA helps to assess whether it will be possible for developments to meet part 'c' of the PPS25 Exception Test (required for some types of development in Flood Zones 2 and 3).

> **The PPS25 Exception Test**
>
> To pass the Exception Test, the following criteria must be satisfied:
>
> a. *It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk;*
>
> b. *the development should be on developable, previously developed land or if it is not on previously developed land, that there are no reasonable alternative sites on previously developed land; and*
>
> c. *a Flood Risk Assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall."*

3. **The primary objective of this Level 2 SFRA, therefore, is to ensure that the risk of flooding in Goole can be realistically mitigated through the design process**.

[1] See the Environment Agency's National Flood Map at: http://www.environment-agency.gov.uk/homeandleisure/37837.aspx

Adopted Methodology

4. As outlined in Section 5.2 of the Level 1 SFRA, the speed and depth with which floodwaters affect developed areas of the Authority area is an important consideration. Deep, fast flowing water may potentially pose risk to life. This must be considered when planning future development. The town of Goole (and surrounding villages) is situated at the confluence of the River Ouse, the River Aire and the Dutch River. The town is protected against flooding by a series of raised flood defences. If these flood defences were to fail, areas immediately behind the defences and low lying areas within the town would be at risk of flooding. The potential impact that rising sea levels will have upon the standard of protection currently provided by the flood defences has also been considered as part of this investigation.
5. A two dimensional TuFLOW model has been prepared to assess the extent, depth and speed of floodwaters as a result of the overtopping and/or breach of the River Ouse, River Aire and Dutch River defences. In accordance with PPS25, all analyses have been carried out assuming a 0.5% Annual Exceedance Probability (AEP) (1 in 200) design tidal event, representing the worst combination of possible tidal and/or fluvial scenarios for the three river systems, appropriate for the consideration of development proposals. The design flow regime, and the hydraulic characteristics of the main river channel, were adopted from existing Environment Agency ISIS models of the river systems. The development of the adopted TuFLOW model is set out in Appendix A.
6. To assess the risk that the floodwaters pose to life, an assessment of flood hazard has been carried out using the adopted 2D model. The 'hazard' posed by flooding is determined as a product of the depth and the speed of the flow[2], and assessed in accordance with Defra guidance 'Flood Risk to People (FD2320). The hazard categories adopted for SFRA purposes are outlined below:

Flood Hazard Rating	Flood Hazard	Description
<0.75	Low	**Caution:** *Flood zone with shallow flowing water or deep standing water*
0.75 – 1.25	Moderate	**Dangerous for Some (e.g. children, the elderly and infirm):** *Danger: Flood zone with deep or fast flowing water*
1.25 – 2.0	Significant	**Dangerous for Most (e.g. the general public):** *Danger: flood zone with deep fast flowing water*
>2.0	Extreme	**Danger to All (includes emergency services):** *Extreme Danger: flood zone with deep fast flowing water*

7. A total of ten breach locations have been modelled as set out in Appendix A. The risk of flooding due to overtopping in the 0.5% (1 in 200) and 0.5% plus climate change (in 100 years) design events, has also been considered.
8. The hydraulic modelling outputs for the hazard zones were 'contoured' to remove the gaps between the modelled breach locations. The findings of the detailed Level 2 assessment are summarised below.

[2] Hazard = (Depth(m) x (Velocity(m/sec)+0.5)) + DF)

Level 2 SFRA Findings

Overtopping of the Existing Flood Defences (2008)
Refer Figures A.1 (Flood Depth) & A.2 (Flood Hazard) in Appendix B

9. The existing flood defences do not overtop in the 0.5% (1 in 200) design event within Goole itself. This confirms that the defences currently provide at least a 0.5% (1 in 200) standard of protection to Goole.

10. Areas to the west of Goole and to the east of the town (on the River Ouse) do experience some flooding in the 0.5% (1 in 200) design event. Whilst these areas are not an intended focus for the current investigation, these findings should be used to inform any potential future planning decisions within the East Riding.

Overtopping of the Existing Flood Defences (Climate Change, 2108)
Refer Figures B.1 (Flood Depth) & B.2 (Flood Hazard) in Appendix B

11. An increase of 1.03m over the current 0.5% (1 in 200) sea level is predicted as a result of climate change[3] over the next 100 years. The overtopping of the existing flood defences in this event has been assessed. It is clear that a relatively large proportion of the existing flood defences will need to be raised if the 0.5% (1 in 200) standard of protection is to be maintained through to 2108.

12. A comprehensive review of flood risk management related policies from relevant strategy documents published by the Environment Agency, including The Humber Flood Risk Management Strategy (March 2008) and the draft River Ouse Catchment Flood Management Plan (CFMP) (July 2010), has found that there are long term intentions to continue to provide protection to the current annual exceedance probability (AEP), and keep pace with climate change. This demonstrates a commitment to adapt/improve defences to ensure the same standard of protection is sustained into the future. However, regardless of the continuing protection provided by the defences, the majority of Goole remains classified as Flood Zone 3[4].

13. The Humber Strategy highlights that improving the defences will be expensive and that contributions will be sought to supplement public funds "from major beneficiaries and from developers, who will be expected to pay the full cost of any new works needed to protect their development". The Council's approach to developer contributions is to be established through the Local Development Framework (Core Strategy), informed by an Infrastructure Study and financial viability assessment. The Infrastructure Study (currently in preparation) focuses on a range of infrastructure (including flood risk management infrastructure) that may be needed to support the level of development proposed in the East Riding to 2026.

Breach Failure of the Existing Flood Defences
Refer Figures C.1 to L.1 (Flood Depth) & C.2 to L.2 (Flood Hazard) in Appendix B

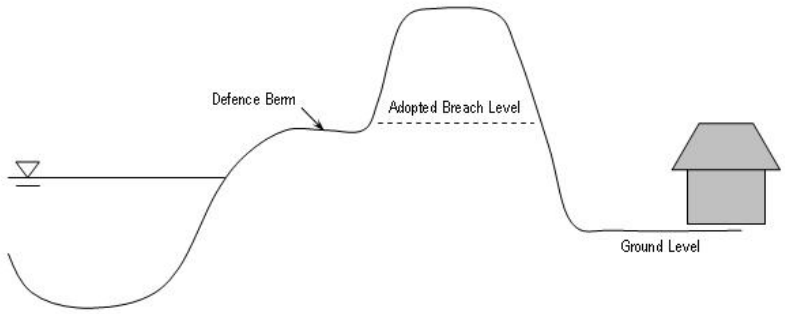
14. The consequence of a breach failure of the existing flood defences has been assessed through hydraulic modelling at ten (10) agreed breach locations. The location of the breaches, the adopted configuration of the assumed breach failures, including the breach width, and the length of time assumed between failure and emergency repair of the defence are described in Appendix A. It is highlighted that a large proportion of the flood defences within the Goole area feature a large berm on the river frontage. Discussions were held with the Environment Agency to agree the most realistic failure scenario for these defences in this instance, and this is depicted in the figure below.

[3] PPS25 Appendix B

[4] The PPS25 Flood Zones ignore the presence of flood defences

15. The time during the flood event at which the breach occurred in the modelling was chosen such that it would create the worst case scenario. However, the time that generates the worst case in terms of depth of flooding is different to the time which creates the worst case in terms of velocity.

16. For flood depth and extent, it was assumed that the breach has already occurred prior to the high tide, as this would allow more water through the breach and create the largest extent. For the hazard maps it was assumed that the breach occurred at the peak of the tide. The sudden failure of the defences at the high tide would create the maximum velocities, but not necessarily the largest extent. The results for the two separate model scenarios were created and the outputs combined to create the worst case hazard map. The approach is described further in Appendix A.



17. The consequence of failure of the existing flood defences, at the ten locations identified in Appendix A, is presented in the figures in Appendix B. The depth of flooding within Goole is represented in Figures C.1 to L.1, and the flood hazard (calculated in accordance with FD2320, as set out in Appendix A) is represented in Figures C.2 to L.2. Figure N shows the combined flood hazard of all the ten breach locations.

18. As expected, it is clear that a relatively large proportion of Goole, and the surrounding area, is potentially at risk of flooding if the raised defences were ever to fail. The assessment of flood hazard confirms that, if a breach were to occur, the depth and velocity of the flow within these areas may pose a potential risk to property and life. The Environment Agency would be responsible for managing the repair operation in such a situation. The response time would be dependant on a number of factors including: ease of access, availability of suitable materials and available staff and plant resources. Other factors that might impede the rate of repair could be: extreme weather, number of breaches and type of breach.

19. Also, there is no natural means for water to flow back into the river, therefore the area would be inundated for an extended period, and would require artificial pumping to drain the area. All areas that are potentially at risk of flooding following a breach failure would be inundated within a 6 hour period (see Figure M), and therefore the available warning time for residents is limited.

20. In light of these findings it is emphasised that the flood defences around Goole are, according to The Humber Flood Risk Management Strategy (March 2008) “generally in good condition and provide a good standard of protection”, and, as mentioned above, there is a commitment to continue to maintain the defences to a good standard into the future. It is therefore not considered likely that such a breach event would ever occur, but these findings are useful in enabling the Council and other relevant organisations to plan for the ‘worst case scenario’. Specific recommendations for managing flood risk through the development planning process in Goole are provided in the next section.

Recommended Planning Response

21. It has been highlighted that Goole's formal defences offer a 0.5% AEP (1 in 200 year) standard of protection and that they would be overtopped in a 0.1% AEP (1 in 1000 year) event. The EA are committed to maintaining the current standard of protection of the town and to modify defences to keep up with climate change predictions. However, as the benefits from defences are not considered in the Flood Zone classifications, Goole remains classified as Flood Zone 3 High Probability. It has also been highlighted that a substantial part of the town would be subject to flooding in the event of any breach(es) of the town's defences.

22. It is therefore essential that future development within Goole considers the potential hazard (denoted as Danger to All, Danger to Most and Danger to Some on the maps at Appendix B) as a result of flooding. Developments should be considered on a site-specific basis in respect to appropriate land uses to prevent vulnerable developments being located within potentially hazardous areas. Also, it will be necessary to mitigate a site's flood hazard through the design of new developments.

23. The following sections contain more information on the appropriate planning response with consideration of the results obtained from the hydraulic modelling undertaken as part of this Level 2 SFRA.

Development in Rapid Inundation Zones

24. It is recommended that no development is allowed in the Rapid Inundation Zone. This area will experience the worst potential depths, velocities and debris, which may pose a risk even to water-compatible developments. Instead of developing this area it could be more suitable for open spaces and landscaped gardens. This would reduce the risk to people and, reduce the risk for others if the land use was vegetated, by further slowing the velocity of the water moving into other areas. Note that for Goole, a notional 20m has been assumed as the Rapid Inundation Zone, as no further guidance can be found to define the extent.

Development in 'Danger to All ', 'Danger to Most' and 'Danger to Some' Areas

25 Figure N (- Combined flood hazard for defence breaches) should be used as the principal map for identifying whether a site is situated in one of these flood hazard classifications, as this map depicts the 'worst case scenario' for Goole.

26. In areas where the level of flood hazard has been classified as 'danger to all', it is recommended that the council should adopt a policy to strongly resist development. In a minority of cases (i.e. in exceptional circumstances), development *may* be appropriate (assuming the Sequential Test and Exception Test have both been passed). However, 'more vulnerable' land uses (refer to annex D of PPS25) should not be located at ground floor level.

27. In areas that have been classified as 'danger to most', 'more vulnerable' development (e.g. residential) should avoid habitable uses at ground floor level. The Building Regulations (part 'M') define habitable uses as rooms used for dwelling purposes, including bedrooms and kitchens but not bathrooms or utility rooms. The Environment Agency generally adopts this definition. A planning condition would need to be applied to prohibit habitable accommodation at ground floor.

28. In the 'danger to some' areas, 'more vulnerable' development can be considered without ground floor restrictions, but only if the buildings have more than one storey so that there is available access to a floor above the predicted flood level.

29. In all instances the Council should not consider any planning application in the 'danger to all', 'danger to most', and 'danger to some' areas without an accompanying FRA which

clearly acknowledges the level of residual risk (flood hazard) and includes appropriate mitigation measures. Appropriate mitigation measures could include:

- Electrical circuits lowered from the ceiling, raised sockets
- Reinforced structural elements of building to withstand loading during a flood event
- Flood gates to doors
- Air brick covers
- Horizontal plaster boards
- Damp proof membranes.

30. The effectiveness of the mitigation measures should be backed up with evidence included in the FRA, such as engineering reports (if necessary), that the proposed measures are appropriate and can withstand the expected depth and velocity should there be a breach of the defences around Goole. Consideration should also be made for evacuation routes out of a site that has applied mitigation measures.

31. Developers and planners seeking advice on appropriate mitigation measures should be guided to the following document in the first instance:

    'Improving the Flood Performance of New Buildings', Flood Resilient Construction (May 2007).

Development Across Multiple Hazard Zones

32. Development proposals and FRAs should have regard to how flood hazard varies within a site. Where part of a development encroaches on areas classified as 'danger to all' the Council should ensure the following:

    - Any development classified as 'more vulnerable' is resisted (in the Danger to All part)
    - A sequential approach is applied at the site level. i.e. the more vulnerable types of land use are located in the areas of lowest flood hazard
    - Changes to flood hazard as a result of the development are clearly identified both within the proposed site itself and areas outside of the development.

Additional Considerations

33. Consideration should also be given to resilience to all sources of flooding, for example surface water and groundwater, as well as fluvial and tidal flooding. The Level 1 SFRA contains information on potential and historic flooding from other sources.

34. Consideration should also be given to emergency planning arrangements, as the construction of "more vulnerable developments" in areas of residual flood risk may have implications for the existing Emergency Plans. A review of the Emergency Planning in place for the East Riding is available in the SFRA Level 1 (Section 6.8), which outlines the responsibilities of different government bodies.

35. Any policy or guidance developed by East Riding of Yorkshire Council should be subject to continual review and updating to ensure it reflects the latest guidance.

Decision Matrix

36. The Level 2 SFRA's planning recommendations are summarised in the matrix provided below. This largely mirrors the matrix at Section 6.4.4 of the Level 1 SFRA (January 2010). If the proposal is on a site that falls outside the Level 2 SFRA's flood hazard classifications (i.e. not shown as a colour on any of the maps), the Environment Agency's Flood Map should be accessed to identify which Flood Zone applies to the site. In the majority of cases, this will be Flood Zone 3a, as only a very small proportion of Goole is classified as Flood Zone 1 or 2.

<table>
<tr><td rowspan="4">PPS25 Requirement</td><td colspan="7">PPS25 Flood Zone</td></tr>
<tr><td colspan="6">TIDALLY DOMINATED FLOOD RISK (Flood Zone 3a)</td><td rowspan="3">Flood Zone 2 (See EA Flood Map)</td><td rowspan="3">Flood Zone 1 (See EA Flood Map)</td></tr>
<tr><td colspan="5">Areas in Close Proximity to Defences</td><td rowspan="2">Remaining Flood Zone 3a (See EA Flood Map)</td></tr>
<tr><td>Rapid Inundation Zone</td><td>Danger to All</td><td>Danger to Most</td><td>Danger to Some</td><td>Caution</td></tr>
<tr><td colspan="8">SPATIAL PLANNING RECOMMENDATIONS</td></tr>
<tr><td>Important Considerations</td><td rowspan="3">No development - reserved for open space / landscaping</td><td colspan="5">Future development within areas at risk of tidal flooding can only be considered following application of the Sequential Test</td><td>Future development within Zone 2 Medium Probability can only be considered following application of the Sequential Test</td><td>It is important to recognise that sites within Zone 1 may be susceptible to flooding from other sources. Development may contribute to an increase in flood risk elsewhere if not carefully mitigated</td></tr>
<tr><td rowspan="2">Land Use (refer Table D2 of PPS25)</td><td colspan="5">Land use should be restricted to Water Compatible, Essential Infrastructure or Less Vulnerable development. More Vulnerable development may only be considered if Exception Test can be passed</td><td rowspan="2">Land use should be restricted to Water Compatible, Less Vulnerable, Essential Infrastructure or More Vulnerable development. Highly Vulnerable development may only be considered if Exception Test can be passed</td><td rowspan="2">No restrictions</td></tr>
<tr><td>Development will only be permitted in this zone in exceptional circumstances

Habitable development should not be permitted at ground level</td><td>More vulnerable development should not be permitted in single storey buildings; habitable uses should not be permitted at ground level in multi-storey buildings</td><td>More vulnerable development should not be permitted in single storey buildings</td><td>~</td><td>~</td></tr>
</table>

DEVELOPMENT CONTROL RECOMMENDATIONS					
Detailed Flood Risk Assessment (FRA)	N/a	Required			Required for all sites greater than 1ha in area, and/or situated within the Groundwater Emergence Zone, and/or a Surface Water Hazard Zone.
Floor Level and flood proofing	N/a	To be agreed on a site by site basis and to be informed by Figures N & O		Finished floor levels to be set at 300mm above average site level or adjacent road frontage level, whichever is higher. (Road frontage level defined as the average between the gutter and the crown of the road).	No minimum level stipulated by PPS25
Site Access & Egress	N/a	A safe refuge should be available on an upper floor, providing an immediate route of escape should a breach failure occur	To ensure the safety of residents and employees during a flood, access and egress routes must be designed to meet Environment Agency defined criteria, as set out in Appendix E. It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.		No minimum level stipulated by PPS25
Basements	N/a	Basements are subject to rapid inundation without warning within this zone, and should not be permitted	Separate dwellings should not be permitted at basement level. All basements must have an access point that is above the 1 in 100 year fluvial, or 1 in 200 year tidal (whichever is greater) flood level, including climate change	No restrictions	No restrictions
Site Runoff	N/a	Implement SuDS on all sites unless it can be demonstrated that they are not practicable or that they will present an unacceptable pollution risk to controlled waters. Development on greenfield sites will be expected to restrict runoff to the greenfield runoff rate. Developments on brownfield sites will be expected to reduce existing runoff rates by a minimum of 30% in order to tackle the predicted impacts of climate change. Any SuDS design must take due account of groundwater and geological conditions (refer Section 6.6.3). It should be ensured that all developments adequately mitigate for the additional volume of surface water generated, not just the rate at which it runs off, to ensure that existing receiving waters are not over burdened.			
Buffer Zone	N/a	A minimum 8m buffer zone from the bank top of a main river or landward toe of a flood defence should be provided within sites immediately adjoining a river corridor. This relates to both open waterways and culverted waterway corridors. Reference should be made to the Environment Agency's "Living on the Edge" guide (www.environment-agency.gov.uk) that discusses any development situated in, over, under or adjacent to rivers and/or streams. This requirement may be negotiated with the EA in heavily constrained locations.			
Other	N/a	Ensure that the proposed development does not result in an increase in maximum flood levels within adjoining properties. This may be achieved by ensuring (for example) that the existing building footprint is not increased, that overland flow routes are not truncated by buildings and/or infrastructure, or hydraulically linked compensatory flood storage is provided within the site (or upstream)			
	N/a	As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the renaturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be promoted			

APPENDIX A
Modelling Approach & Assumptions

1. Summary of modelling approach

A hydraulic model was constructed to establish the residual flood risk from breaches and overtopping. A one dimensional (1D) hydraulic model of the Lower Ouse River channel and two of its tributaries the River Dutch and River Aire was dynamically linked to a two dimensional (2D) model of the floodplain within the Goole area using Tuflow 2D modelling software. At ten specific locations, a breach in the flood defence line protecting Goole was artificially created assuming failure at river berm level. For each breach location, flooding across the floodplain was then simulated with the hydraulic model, assuming 0.5% annual probability (200 -1 annual chance) tidal surge conditions in the river system.

2. Overview of the 1D model

The 1D model of the River Ouse and its two tributaries extend from Asselby Island on the River Ouse, Airmyn Butt on the River Aire and Decoy Farm on the Dutch River to Swinefleet on the River Ouse towards the Humber estuary. For each modelled reach, a constant inflow corresponding to the 50% annual probability (QMED) peak flow (estimated using FEH methods) was set at the upstream boundaries.

As the river system is tidally dominated within the study area, the downstream boundary was informed with a water level time series representing spring tide conditions plus a storm surge component associated with a 0.5% annual probability (200-1 annual chance) at Goole. As shown on Figure 1, under such conditions, the water level peaks at 5.76m AOD. The tidal information was provided by ABPmer Ltd.

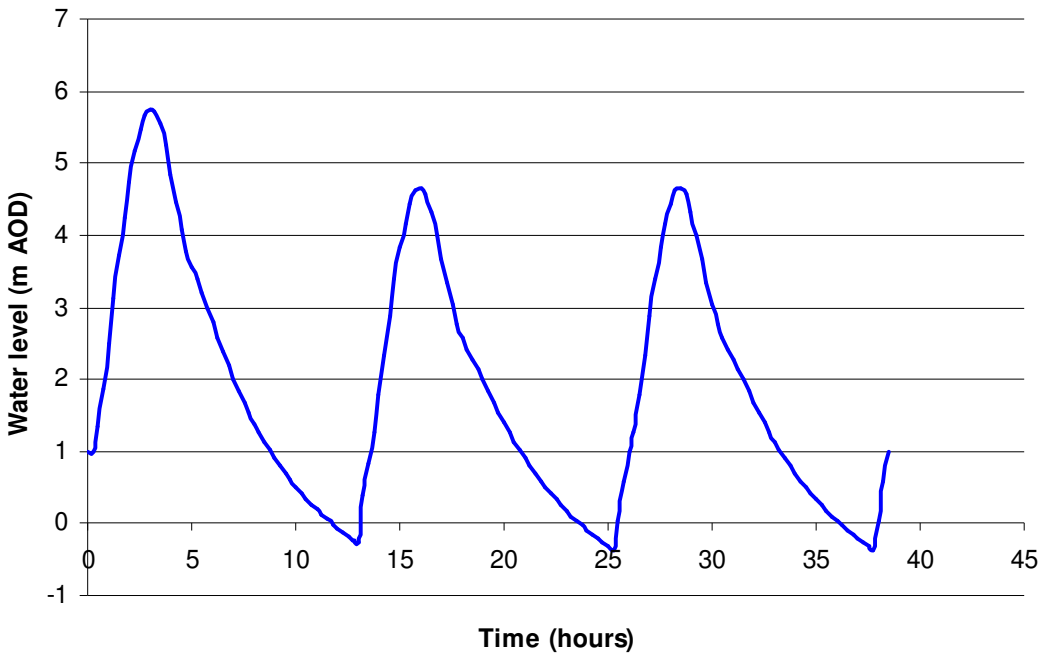


Figure 1: Tidally influenced downstream boundary conditions in the hydraulic model

3. Overview of the 2D model

The boundary extent of the 2D model representing the floodplain was centred on the Goole area. The 2D domain was based on a regular grid comprising individual square cells of a 10m side, as it was considered that this would provide adequate representation of the floodplain features – at least two to three grid cells across the major flow paths – whilst not becoming computationally cumbersome.

Each cell was given characteristics relating to the topography such as ground elevation, hydraulic resistance value and initial water level. Ground elevation information was extracted from low level filtered LiDAR data collected from the Environment Agency.

On either side of the modelled river reach, boundary lines were digitised along the raised defence crest lines to select 2D open flow boundary cells representing the dynamic links between the river system (1D domain) and the 2D domain. These allow flood water to spill to and from the 2D domain when the computed water level exceeds the bank crest elevation.

The 2D domain also includes a range of different hydraulic friction zones which alter the velocity and flow path depending on the land use (e.g.: buildings, roads, pasture).

Wherever appropriate the model grid was manipulated to ensure the accuracy the overland flow paths across the floodplain, in particular allowing flow under road bridges, through existing culverts within embankment.

4. Location & Configuration of Breaches

Ten specific breach locations in the flood defence line protecting Goole (right bank of the Ouse) were selected, which can be seen in Figure 2. Two methodologies were applied to generate the worse case scenario for extent and hazard. The first was to assume the breach occurred at t = 0, and was already in place before the flood event occurred, which meant a greater volume of water would pass through the breach and inundate the town. The second method assumed the breach would occur 3 hours into the simulation to coincide with the peak tidal level. This method would create the largest velocities due to the large difference between the maximum tidal level and ground level. The breach in this case was assumed to occur over 6 minutes.

In both methods, the width of the breach depended on the nature of the flood defence, which was set to 20m or 50m width for a hard and earth defence respectively. The bottom of the breach was assumed to be at the river berm level. The time it took for the breach to occur differed between the two methods. Table 1 details the width and breach level assumed for each breach.

Table 1: Breach details

Breach	Nature	Breach Width (m)	Breach Level (m AOD)
1	Earth defence	50	5.05
2	Hard defence	20	5.10
3	Hard defence	20	4.50
4	Earth defence	50	4.80
5	Hard defence	20	5.05
6	Earth defence	50	4.80
7	Earth defence	50	4.60
8	Earth defence	50	4.60
9	Earth defence	50	4.70
10	Hard defence	20	4.70

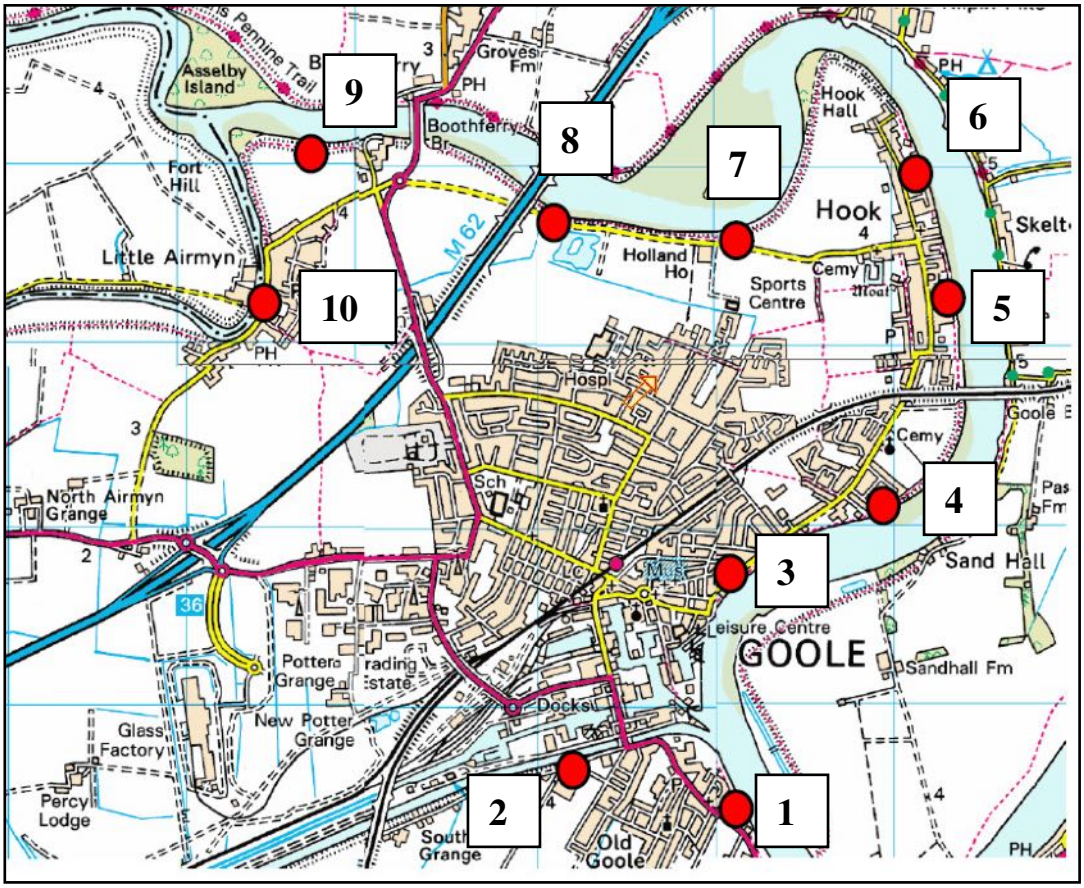


Figure 2: Breach locations

5. Model Runs

- *Defence Overtopping Runs*

To simulate overtopping of the defences from the river, the hydraulic model was run with all defences in place (existing situation) assuming 0.5% annual probability (200 -1 annual chance) tidal surge conditions in the river system.

An additional run was also considered to assess the effect of climate change (over a period of 100 years) on the above event. Considering the river regime is tidally dominated, a net water level rise of 1.03m (calculated following Defra guidance) was applied to the tidal cycle set at the downstream boundary of the 1D model.

- *Breach Modelling Runs*

The breach scenarios were run using the same 2D domain as the overtopping runs. Each of the 10 breach scenarios was run individually assuming 0.5% annual probability (200 -1 annual chance) tidal surge conditions in the river system. Although the duration of the flow across the breach would be limited to a couple of hours (as the tide rises and falls), the simulations were run for 50 hours to record the maximum extent of flooding across the very flat floodplain.

6. Flood Risk Mapping

For each scenario simulated, flood depth outputs were processed and converted into flood maps showing the maximum extent of flooding and the distribution across the modelled domain of the maximum flood depths recorded during each simulation.

Flood hazard was also computed by the hydraulic model and hazard zones were subsequently mapped according to Table 2 and Table 3 below.

Flood hazard was calculated as follows:

$$FH = D\ (V + 0.5) + DF$$

where, FH = flood hazard, D = flood depth, V = velocity, DF = debris factor

Table 2: Hazard to People as a Function of Velocity and Depth (Source: FD2320)

Flood Hazard	Degree of Flood Hazard	Description
< 0.75	Low	Caution
0.75 – 1.25	Moderate	Dangerous for some (children)
1.25 – 2.0	Significant	Dangerous for most people
> 2.0	Extreme	Dangerous for all

Table 3: Debris factors for different flood depths, velocities and dominant land uses (Source: FD2320)

Depths (m)	Conservative
0 to 0.25	0.5
0.25 to 0.75	1
d>0.75 and / or v>2	1

The debris factor has been calculated as a function of the flood depth within an urban environment, as set out in Table 3.

Combining the breach scenarios, a final map (Figure M) was also produced indicating the rate of ingress of the flood waters across the floodplain distributed by zones <6 hours, 6 to 12 hours, and >12 hours.

The final hazard maps were contoured so as to generate a complete hazard map for the entire Goole area. The methodology relies on the areas between the modelled breach locations being 'filled in' by using the modelled extents to interpolate the degree of hazard, influenced by interpreting the local topography. Land use was also taken into account in the assessment; for example, roads and watercourses tend to convey flood flows more efficiently than dense built up areas therefore high hazard was extended along major roads running away from the defences.

APPENDIX B
Figures

Re: FW: FW: Hedon SFRA Final Report Comments

Stephanie Robson to: Wiltshire, Matthew (Capita) 20/07/2020 09:30

Hi Matt

I support the extra sentence in the more vulnerable uses row. It incorporates the extra text from the row that has been deleted.

In terms of access, egress and place of safety, can I please clarify that both overtopping and breach are meant to have separate columns but the same text? If the text is supposed to be the same it would be best to just have one column.

Other than that I'm happy finalise the Goole report.

Kind regards

Steph

Stephanie Robson MRTPI
Senior Planning Policy Officer
[PLEASE NOTE: I am currently working from home and do not have access to my phone, please use email to contact me]
Web: www.eastriding.gov.uk
Twitter: www.twitter.com/East_Riding
Facebook: www.facebook.com/eastridingcouncil

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"Wiltshire, Matthew (Capita)" Hi Steph, Please see the table below,... 13/07/2020 10:59:47

From: "Wiltshire, Matthew (Capita)" [redacted]
To: "Stephanie.Robson@eastriding.gov.uk" [redacted]
Cc: "Smith, Bryony (Capita)" [redacted]
Date: 13/07/2020 10:59
Subject: FW: FW: Hedon SFRA Final Report Comments

Hi Steph,

Please see the table below, with the additional sentence Bryony included highlighted in yellow.

No need for an update call today, still looking into getting the model files across to you, I will chase our IT this morning but I think it is going to have to be via a hard-drive in the post, but there are difficulties at the moment in even doing that. I will try and get an answer this week.

Thanks,
Matt

Table 6- 2: Spatial Planning and Development Management Minimum Requirements

Recommendation *(applies to all development types unless stated otherwise)*		This table should be used in It should be noted that development in this area is likely to present significa equipped emergency services. The recommendations		
		Defence Buffer Region	**Rapid Inundation Zone$_1$**	**Overto**
Sequential Test		No development is permitted in this region.	Sequential Test must be applied (unless the site falls under o • Minor developments[3] (as https://www.gov.uk/guidance/flood-risk-and-coastal- • Changes of use, except for a change of use to a car • Replacement dwellings with no increase in the numb	
Exception Test			Must be passed for More Vulnerable development and Essen	
Land Use	**All vulnerabilities**		Caravans, mobile homes and park homes are not permitted.	
	Water Compatible Development		Water compatible development is acceptable. Where ancilla	
	Essential Infrastructure		In Flood Zone 3a essential infrastructure should be designed Where ancillary sleeping or residential uses are required, the greatest flood depths in Appendix B, C, D.	
	Highly Vulnerable		Development not permitted in Flood Zone 3, in line with Table considered in Goole, the proposal should be discussed early be supported by a site-specific Flood Risk Assessment with f	
	More Vulnerable		Development not permitted, except minor development[3]. Change of use is considered in a separate row.	**Sleeping uses:** Sleeping areas **Habitable spaces:** Finished floor levels to be set nc passive flood resistance measur **Non-habitable spaces:** Should be designed to be dry ab (whichever is highest). Spaces **Single storey buildings and gr** More vulnerable development sh Where flood resilience is incorpo B, C, D; where a minimum of 30
	Less Vulnerable		Development not permitted, minor development[3]. Change of use is considered in a separate row.	Finished floor levels to be set nc passive flood resistance measur Where other forms of flood proo the greatest flood depths in App Where there is an operational ne Examples may include loading b maximised to reduce the likeliho
	Change of use with increase in vulnerability and / or additional residential units proposed		Development not permitted in Rapid Inundation Zone.	**Sleeping uses:** Sleeping areas should be set ab **Habitable spaces:** Finished floor levels should be s 300mm flood resilience measure **Non-habitable spaces:** Should be designed to be dry ab (whichever is highest). **Single storey buildings and gr** More vulnerable development sh
	Changes of Use with no increase in vulnerability		Environment Agency National Flood Risk Standing Advice sh structural stability information will be included.	
Important Considerations			Where developments contain different elements of vulnerabili the development is considered in its component parts	
Detailed FRA			Required – including for minor development and change of us An assessment of the design and residual risks of flooding wi provide maps of design and residual risks. Additional modelli The FRA should specify whether the site is in an area of surfa	

Raising of Ground Levels	Raising of ground levels is not permitted in these regions.	If modifying ground levels to red care must be taken to ensure th specific flood risk assessment. surface water on third party land The raising of ground levels may demonstrate that residual flood
Flood Resistance	No development is permitted in this region.	Additional flood mitigation measures (e.g. in addition to floor practical, a combination of flood resistance and resilient cons should not be used instead of passive resistance measures d should only be proposed after careful consideration of how qu In cases where flood risk remains to a development additiona appropriate mitigation measure and their effectiveness is ofte
Flood Resilience		Flood resilience involves measures designed to reduce the im enter the building itself, by aiming to reduce the impact of wat This allows faster re-occupancy of the building after the flood • Use of water-resistant materials • Installation of electrical circuitry at higher levels • Use of non-return valves to prevent waste water pushing Further information can be found in the publication Improving
Access, Egress and Place of Safety		Offsite evacuation in a flood is unlikely to be possible due to t not divert occupants to 'dry islands' and should not require cr A Place of Safety at or above 7m AOD must be provided. / A Place of Safety should be pro above the greatest flood depths Given the high risk and speed o within each building. Where there is a reliance on an additional flood mitigation, Flood shown to have reasonable prote
Surface Water and Site Drainage		Surface water drainage assessments need to report into how the development will have on surface water flood risk and out Greenfield developments, the peak runoff rate to any highway never exceed the peak greenfield runoff rate for the same dev be required along with sufficient proof that flood risk will not b the calculated brownfield runoff rate then a reduced discharge Detailed Standing Advice on surface water drainage is availal Water Drainage Requirements For New Development: Comb SuDS should be implemented on all sites unless it is demons Any SuDS design should take due account of groundwater ar
Watercourse Buffer Zone		Development free buffer zones around watercourses should b buildings and structures, trees, shrubs, willow or similar grow • IDBs: with the exception of Thorntree IDB, IDBs in East • Thorntree IDB requires a 6 metre wide buffer zone arou Where existing development comes forward, opportunities sh situation.
Structural Stability		Differential water levels (internal vs external) of >600mm may the measures would remain effective in a flood event.

Notes on Table 6-2

1. Development within the Rapid Inundation Zone shown in Appendix E may be at risk from overtopping and a breach of the flood defences. Where development is permitted in this zone, a site-specific Flood Risk Assessment should take account of the flood risk shown in Appendix B and C for overtopping, and Appendix D for breach risks.

2. Development within the overtopping region shown in Appendix E will also be at risk of a breach of the flood defences. Developments should take account of the minimum requirements for the overtopping and breach columns.

3. In this instance, minor development is classified as:
   - minor non-residential extensions: industrial/commercial/leisure etc extensions with a footprint less than 250 square metres.
   - alterations: development that does not increase the size of buildings eg alterations to external appearance.
   - householder development: For example; sheds, garages, games rooms etc within the curtilage

of the existing dwelling, in addition to physical extensions to the existing dwelling itself . This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling eg subdivision of houses into flats .

(source https://www.gov.uk/guidance/flood-risk-and-coastal-change#minor-development-to-flood-risk)

4. Habitable uses are defined within the SFRA main report as: "As defined in Part M of the Building Regulations - A room used, or intended to be used, for dwelling purposes, including a kitchen but not a bathroom or utility room."

Matthew Wiltshire MEng CEng MICE
Principal Flood Risk Engineer – Infrastructure Projects: Environment
Real Estate & Infrastructure
([redacted])
capitaproperty.co.uk

European Union
European Regional Development Fund

Please note I will be on leave on the afternoons of 9th and 10th July.

Commercial in confidence

From: Stephanie Robson [redacted]
Sent: 13 July 2020 10:18
To: Wiltshire, Matthew (Capita) [redacted]
Subject: Re: FW: Hedon SFRA Final Report Comments

****EXTERNAL****

Hi Matt

Are you able to attach the table with the text in blue highlighted please. Just so I can visualise it.

Do we need to meet today? There's nothing I need to discuss unless you want to discuss something?

Kind regards

Steph

Stephanie Robson MRTPI
Senior Planning Policy Officer
[redacted]**I am currently working from home and do not have access to my phone, please use email to contact me]**
Web: www.eastriding.gov.uk
Twitter: www.twitter.com/East_Riding
Facebook: www.facebook.com/eastridingcouncil

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From: "Wiltshire, Matthew (Capita)" [redacted]
To: [redacted]

Date: 08/07/2020 20:57
Subject: FW: Hedon SFRA Final Report Comments

Hi Steph,

Bryony has been through all of this and just had one comment in light blue about non-habitable spaces. Is this ok? If so I should be able to reissue the docs straightaway. Other than that Bryony has incorporated everything else and into the document and doesn't think there is anything else remaining.

Thanks,
Matt

From: Stephanie Robson <[redacted]>
Sent: 06 July 2020 15:47
To: Smith, Bryony (Capita) <[redacted]>; Pattinson, Andrew G <[redacted]>
Cc: Wiltshire, Matthew (Capita) <[redacted]>; Tom Bannister <[redacted]>; Griffiths, Lizzie <[redacted]>
Subject: RE: Hedon SFRA Final Report Comments

****EXTERNAL****

Andrew

Thank you for your comments, highlighting the change that needs to be made in Goole and clarifying the reasons that the approaches can or shouldn't be the same in the 2 towns. I've just made a note (in red) of my understanding against each of your comments and replied to each of your comments on the clean version.

Bryony

Can you please make the changes Andrew has suggested to the Goole table. I also noticed that in the more vulnerable section there are 3 statements on non-habitable places that repeat each other. Can you please ensure that the repetition is removed.

In terms of Hedon can you please make changes too. I've amended Andrew's clean version in track changes to answer the queries he had and commented below on his email. I think this should cover all the remaining changes and all of Andrew's comments. Can you please accept the changes, if you support them, and incorporate the recommendations into the final document.

I've attached the track changes/comments on Andrew's clean Hedon table and on Andrew's Goole table.

Kind regards

Steph

Stephanie Robson MRTPI
Senior Planning Policy Officer
[redacted]: I am currently working from home and do not have access to my phone, please use email to contact me]
Web: www.eastriding.gov.uk
Twitter: www.twitter.com/East_Riding
Facebook: www.facebook.com/eastridingcouncil
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From: "Pattinson, Andrew" <[redacted]>
To: "Stephanie Robson" <[redacted]> "Smith, Bryony (Capita)" <[redacted]>
Cc: "Matthew [redacted] "Tom Bannister" <[redacted], "Griffiths, Lizzie" <[redacted]>
Date: 03/07/2020 13:28
Subject: RE: Hedon SFRA Final Report Comments

Steph,

GOOLE
There is some text that has been retained which should have been deleted to allow the approach to work at ground floor level on More Vulnerable development. You need to delete the highlighted text below as previously agreed.

More Vulnerable - **Habitable spaces:**
No habitable uses[4] at ground floor level. Finished floor levels to be set no lower than 600mm below the greatest flood depths in Appendix B, C, D; where a minimum of 600mm passive flood resistance measures are incorporated above finished floor levels

We also suggested removing the first sentence in the following text about sleeping uses at GF level. This text should be the same in the More Vulnerable and CoU (with increase) rows:
~~No sleeping areas at ground floor level or within single storey buildings.~~ Sleeping areas should be set above the greatest flood depths in Appendix B, C, D, plus an additional 300mm freeboard.

Goole presents significant challenges, and clearly a special case to apply flood risk standards to. The SFRA that you've produced is extremely good – very ambitious, but also pragmatic.

Version attached with those changes (that we previously agreed) highlighted. As per previous conversation, where these changes were incorporated, we consider the Goole SFRA complete.
- SR understanding - Need to remove references to Habitable spaces at ground level. Not noted by AP but there is repetition of non-habitable spaces guidance in more vulnerable developments. Need to remove repetition. Extra lines removed. Following text added to the Non-habitable spaces line to cover what was in the repeated lines: "Spaces should also incorporate 600mm of passive flood resistance measures above that highest level."

HEDON
Your first question is whether there should be a different standard between Goole and Hedon. I appreciate that consistency is important, but as we've previously discussed (and Bryony described

below), the flood risk context is quite different between Goole and Hedon. There are therefore some things that can be consistently applied, and others less so. The starting point should be to seek exclusion of flood water (generally by raising floor level). Only if this is not possible should alternatives be explored. If you applied the same rationale to the mitigation in Hedon, you could in theory see floor levels below existing ground levels, where there is a reliance on resistance or resilience measures to exclude water from habitable spaces. Given flood depths in Hedon (whether from OT or Breach) are generally less than 1m (and often <500mm), traditional forms of passive resistance / resilience measures seem realistically achievable. Where flood depths exceed 1m, where traditional approaches may be more difficult to achieve, alternatives could be explored and justified on a site-specific basis. - SR understanding - We should ensure floor level is raised rather that giving the option of resilience. Giving the option could mean the floor level doesn't need to be raised at all. Excluding water by raising the floor level is the safest option and should therefore be the priority. In Goole we give the option because it's unrealistic to raise floor levels to the potential depth of the water. In Hedon there may be some occasions where the floor level can't be raised high enough but these will be very few and can be considered on a case by case basis. When looking at the suggested text for developments where it is not possible to set floor levels above the gtreatest flood depth I'm not sure how this would work. Much of Hedon has a hazard of caution or danger to some, so does that mean that in those locations they wouldn't need to do anything? also, it seems that it would be more straight forward for an applicant or planning officer to understand and act on floor levels and resilience measures than complicated calculations about internal hazard. Therefore I'm suggesting use of the wording in AP's comments rather than track changes.

Your second question about why the standards are different between new and CoU rows. Again, the approach in Goole was specific to its flood context (extreme depths), but also its development pressures. Where flood depths are 3-4m in Goole, you are not going to be able to include resistance measures to exclude floodwaters. The CoU text in Goole was different to the new development because it removed the reference to using resistance measures; but the standard was the same if using resilience measures. The starting point for CoU should be to achieve the same standards as new development, unless this would clearly not be achievable. Given flood depths in Hedon are generally <1m (and often <500mm), this seems realistic. Another way to look at this is there is a hierarchy for flood risk mitigation. Adopting a lower standard introduces further risk and complexity – so in general you should avoid this for overall effectiveness and simplicity. There are also different bottom lines to how far down the hierarchy you can go – the key example is that where there is a design risk (shown by the Overtopping column and maps), these places should always be dry. Where risk is residual (shown by the Breach column and maps), water may be allowed to enter these areas so long as internal hazards can be restricted (e.g. to enable access/egress). - SR understanding - should be using the same standard for CoU and new development, if possible. This should be possible in Hedon. It wont always be possible in Goole so a different approach is warranted. In Hedon water should be excluded from CoU. The approach to CoU should be the same as new build development in Hedon.

Your third question about the RIZ / FZ3b comparisons. Bryony has explained these, they are not easily comparable.

- FZ3b is specifically set out in NPPG and refers to frequency of flooding. In Goole there is very limited FZ3b owing to the large flood defences around the town, but in Hedon there is some on the boundary of the existing town.
- The RIZ is not set out in NPPG, but is employed in places around the country to apply an additional screening criteria generally on consequence. It is often used, as in the case of Goole, to establish areas that might be particularly susceptible to extremely hazardous forms of flood risk. That hazard may be extreme depths, hazards, velocities, speed of onset or duration; or where flood risk is particularly difficult to predict / forewarn. In Goole, there is a very large RIZ (defined locally for Goole as depths exceeding 900mm within 30mins), very limited areas when applied in Hedon. Where future development sites undertake additional modelling, particularly those close to the estuary where there are large raised defences, it is possible that FRAs will need to screen those results against the RIZ definition in Hedon. - SR understanding - no changes required to Goole table / RIZ.

In terms of the additional changes that have been made to the table, there are some cells that we must flag as being incompatible with policy / advice.

1. Under “All Vulnerabilities” you have retained the text that “caravans, mobile homes and park homes not permitted” from the Goole tables. NPPG excludes these uses in FZ3b. In FZ3a they may be acceptable subject to a Flood Warning and Evacuation Plan. In Goole, we discussed these

particularly uses and agreed that because of the local flood risk context, it was not appropriate to allow these developments. In Hedon, where flood depths are significantly lower, it may be possible to employ mitigation and/or an effective FWEP in response to the flood risk context. - we'll go with option B and stay in line with NPPG. However, PPG distinguishes between residential and short lettings. I have clarified this in the track changes.

a. Can you confirm if this approach in Hedon is a LPA decision? We could support this, understanding that the remaining FZ3/2 areas are dealt with by the Level 1 – and therefore caravans (or similar) would still potentially be considered in some parts of Hedon.

b. If this is not a LPA decision, then "Caravans, mobile homes and park homes" are not permitted in FZ3b only (as per NPPG). In the overtopping, breach and remaining FZ3/2 areas they could potentially still be considered.

2. Under "Highly Vulnerable" you have copied text from Goole referencing "exceptional circumstances." This followed a discussion between ERYC/EA earlier this year for Goole. We must make it clear that our default position will be to object in principle to such development coming forward (in line with NPPF/NPPG). However, like Goole, where such uses are required to be located in Hedon – it may be possible to agree to this type of development after conversations between ERYC/EA. For example, it may be possible to raise ground levels (lifting site out of FZ3), or applying a vertical sequential approach within a development. No change required, but we must make our position clear. SR understanding - noted. The default is that highly vulnerable uses should not be permitted in FZ3. If there are exceptional circumstances they will need to be justified. Most of the Town is in FZ3 so if a highly vulnerable use is be necessary there may be exceptional reasons why oot is required in FZ3. We could add further detail on this when we update our flood risk guidance note.

3. Under CoU – no increase in vulnerability, the text has changed from the version we previously reviewed. FRSA cannot be applied in FZ3b (consistent with the Level 1 Table 8-3). The previous text was fine for the FZ3b columns – "Developers and planners should seek to relocate development from these Zones, where possible." The FRSA can be retained for the Overtopping and Breach columns. SR understanding - need to add a column so that standing advice is not considered in FZ3b. Reinsert text to relocate existing development where possible.

4. The table heading says "this table should be used in combination with the map provided in **Appendix E**." The draft report previously sent to us had Appendix B (Flood Zones map). SR understanding - Appendix E is the development management map., It sets out the breach and overtopping zones. Appendix B does not include this sub delineation. The table should be read in combination with appendix E

5. There is reference in the watercourse buffer zone row to the Thorntree IDB – our information shows this is not relevant to Hedon? - SR understanding. Agree South Holderness IDB covers this area, therefore Thornetree IBD reference is not needed.

6. We support the inclusion of the text about ongoing development of the flood alleviation scheme and integrated flooding data. - Noted

7. Less vulnerable - Insert AP's suggested text on less vulnerable uses and operational need, to make consistent with Goole approach.

I've marked up these changes / questions on the version attached (also included a clean version). The presumption is that, for Hedon, floor levels should generally be set above predicted flood depths (or 600mm above average ground levels / adjacent road frontage so as to match the Level 1 minimum standards in all FZ3). This makes for a far simpler approach in Hedon, making it consistent with the traditional approach to mitigating risks. Where it is less consistent with Goole, I believe those reasons are explained.

It feels like we need an agreed way forward for Hedon. I am available for the remainder of today, Monday and Wednesday mornings next week. Can you please keep Lizzie copied in, as I'm on flood incident standby until next Wednesday.

My current contact details via phone are [redacted] I'm working Mon-Fridays, but on reduced hours due to childcare.

Andrew

From: Stephanie Robson [redacted]

Sent: 17 June 2020 13:11
To: Smith, Bryony (Capita) [redacted]
Cc: [redacted] Pattinson, Andrew < [redacted], Tom Bannister < [redacted]
Subject: Fw: Hedon SFRA Final Report Comments

Hi Bryony

Thanks for reorganising the Hedon recommendations table to make it clearer and following your suggestion to make it more like the Goole recommendations table.

Now that it looks more like the Goole table I think it has become more apparent that the approach we're taking to mitigating the risk is different in Hedon and Goole. Unless there is a clear reason to take a different approach in each town, e.g. because of the nature of the risk or speed of onset, we should be taking the same approach and have the same recommendations (though based on the relevant depths). I don't know of anything that suggests we should take a different approach. Therefore, I've amended the Hedon table in track changes to reflect the Goole table. I need you to confirm, based on your expert opinion, is this the correct approach. In particular I have specific queries on the following:

Finished finished Floor Levels

In Goole finished floor levels were incorporated into the rows for each vulnerability classification. I think this worked well and should continue. Otherwise we are requesting floor level increases that my be unobtainable to COU with no increase in vulnerability. Finished floor levels in Goole varied depending on the vulnerability of development and flood resistance measures that are taken, where as in Hedon finished floor levels are set the same for all vulnerabilities irrespective of other measures taken. If the same approach be taken in both locations. If not, why?

More vulnerable uses

The same should be approach be taken in Goole and Hedon. If not, why? Specifically, these points need to be clarified:

- The Hedon report makes reference to restricting internal hazard to danger to some or less, whilst in Goole there is no reference to internal hazard.
- With regard to acceptable uses on the ground/1st floor we didn't refer to these in Goole. We only referred to mitigation based on the depth of potential flooding. This was because it allowed the developer to come up with a design solution to make a proposal safe.
- For clarity, if this is still relevant after making other changes, when you say 1st floor do you mean the ground floor or the level above ground floor? This needs to be made clear.

Less vulnerable uses

Max depth at Hedon Haven is 1-2m. At Goole depth is more like 3-4m. In Goole less vulnerable development can have floor levels below the greatest depth as long as passive flood resistance or resilience measures are in place, or there is an operational need. In Hedon the approach is that finished floor levels should be set on the greatest depths and an additional 300mm flood proofing should also be required. Hedon seems more stringent. In Hedon, flood proofing is required above the greatest depth and there are no options or exceptions for functional need, where as in Goole flood proofing/resilience is only required up to the greatest depth and there is a caveat for operational need. We may end up accepting development in Goole, where the risk is greater, that is not acceptable in Hedon. Why are these approaches different?

Change of use with increased vulnerability

In the Goole table change of use had the same requirements as a new development. This ensures that COU would be safe. This is not the case in Hedon. Is there a justification for a different approach in Hedon?

Additional Changes

I've also made some less significant changes to bring the Hedon approach in line with Goole. I've made these in the track changes and comments boxes. If you disagree, please explain why.

I've made these suggestions because we need to be consistent across the East Riding. If there is a different approach in Hedon to Goole, you will need to justify this in the studies.

Also in relation to Goole - When comparing with Hedon I've noticed that we've said change of use to more vulnerable uses is acceptable in the RIZ. Given that RIZ is greater risk that FZ3b. I don not believe this in line with PPG table 3 that says more vulnerable uses should not be accepted in FZ3b. Do you agree with my interpretation of PPG? If you agree, please update the Goole table to reflect the changes I have made to the Hedon table.

To support understanding of the discussion in this email I've attached the track changes Hedon recommendations and the agreed Goole recommendations.

Bryony and Andrew, can you please confirm that you support the revised table and respond to my queries as soon as possible. We need to finalise the SFRA in the next few weeks in order for the Local Plan consultation to go ahead as planned,

Kind regards

Steph

Stephanie Robson MRTPI
Senior Planning Policy Officer
[redacted] **I am currently working from home and do not have access to my phone, please use email to contact me]**
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(Working days - Monday, Tuesday and Wednesday)

From: "Smith, Bryony (Capita)" [redacted]
To: "Wiltshire, Matthew (Capita)" [redacted] "Stephanie Robson" <[redacted]>
Date: 11/06/2020 14:01
Subject: RE: Hedon SFRA Final Report Comments

HI Steph,

Following our discussion earlier, please find an updated version of Table 6.2 from the Hedon L2 SFRA where I have listed out the Land Use categories similar to the Goole table. Please could you review and let me know if you agree with the way I have set it out I have taken some statements from Goole and commented where I have done this. I have shifted some of the text around. We didn't explicitly discuss Less Vulnerable class in the previous table, so I have included some text for that.

Happy to have a quick discussion on Monday if you would like to talk through anything.

Thanks

Bryony

-----Original Appointment-----
From: Wiltshire, Matthew (Capita) <[redacted]>
Sent: 11 June 2020 05:23
To: Wiltshire, Matthew (Capita); Smith, Bryony (Capita); Stephanie Robson
Subject: Hedon SFRA Final Report Comments
When: 11 June 2020 10:00-11:00 (UTC+00:00) Dublin, Edinburgh, Lisbon, London.
Where: Microsoft Teams Meeting

Exchange Server re-created a meeting that was missing from your calendar.

Sent by Microsoft Exchange Server

sender immediately, delete it and do not copy it to anyone else. We have checked this email and its attachments for viruses. But you should still check any attachment before opening it. We may have to make this message and any reply to it public if asked to under the Freedom of Information Act, Data Protection Act or for litigation. Email messages and attachments sent to or from any Environment Agency address may also be accessed by someone other than the sender or recipient, for business purposes. [attachment "Goole_Table_6_2_20200624 (005)_EA.docx" deleted by Stephanie Robson/CPS/ERC] [attachment "Hedon_Table_6_2_20200624 (005)_EA_v2.docx" deleted by Stephanie Robson/CPS/ERC] [attachment "Hedon_Table_6_2_20200624 (005)_EA_v2_clean.docx" deleted by Stephanie Robson/CPS/ERC]

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[1] Environment Agency and Department for Communities and Local Government, May 2007. Improving the flood performance of new buildings: flood resilient construction

Thank you for submitting the draft Level 2 Strategic Flood Risk Assessment (SFRA) for Goole. This presents a substantial revision to the understanding of flood risk in the town, which clearly presents significant challenges in terms of appropriate development now and into the future. The comments and recommendations below refer to the original draft evidence package and draft Level 2 SFRA for Goole.

Evidence Base

1. The **Rapid Inundation Zone (RIZ)** is shown in Appendix E, on the Development Management Map, and has been defined based on any areas that would be expected to flood within 0.5hrs. We foresee this causing some issues, particularly when used alongside the development control policies in the main report. For example, most development coming forward in this area would result in an objection on policy grounds from the Environment Agency.

RECOMMENDATION 1.01 – consider revising the Rapid Inundation Zone. This should reflect an area that would be subject to "extremely hazardous flooding where there may be little or no warning prior to onset of flooding." Whilst the onset of flooding is a critical factor in this, you could combine it with a depth or hazard. For example, "areas that flood within 0.5hrs of a breach and are subject to depths exceeding 300mm by that time".

RECOMMENDATION 1.02 – You should consult relevant departments within the council on the implications of such a position on development. Aside from obvious issues relating to restrictions on development, we foresee such a position having political and social consequences.

RECOMMENDATION 1.03 – Areas that lie between individual breaches appear to be at lower flood risk than those immediately behind other parts of the defence. In reality, a breach could occur anywhere. We would recommend a "contouring" of the hazard zones near the flood defences, similar to what was done with the previous 2012 Level 2 SFRA (see Figure 1). The contouring exercise would also help to remove anomalous areas, for example, those behind defences, which appear in lower hazard categories than might be expected. Alternatively, you could re-introduce a notional distance for the RIZ, as per the previous L2 SFRA.

2. The majority of the town now lies either within the **RIZ** or **"Danger to All."** Consequently, the hazard to occupants is extremely high, should those defences ever fail. This is a significant change to the previous Level 2 SFRA, but matches the evidence resented in the Upper Humber 2016 EA modelling.

In light of this significant change, we would recommend a review of the corresponding development control recommendations, and apply a local approach that is sustainable and pragmatic.

RECOMMENDATION 2.01 – Consider making more significant changes to the development control tables and the spatial design recommendations (which we take to represent minimum mitigation standards). See recommendations 6.01 – 6.06.

3. We are unable to see evidence that the Goole Docks have been considered as a failure mechanism. This would show increased risk to some areas that might otherwise seem preferential within Appendix E and/or combined breach maps.

RECOMMENDATION 3.01 – Use the Environment Agency modelled failure of dock infrastructure at Victoria and Ocean Docks. In the event the gates fail, a large part of the town would flood, including areas that, on the basis of Appendix E, would currently appear to be at lower flood risk. The simulations modelled by the Environment Agency follow the parameters used for breaching. The results show increased risk to parts of the town around the docks, and may influence the location, scale and design of developments coming forward in those areas (see Figure 2).

SFRA Main Report

Our main focus is on the development control tables (6.1 & 6.2) of the SFRA.

4. **Application of the Sequential Test –** it is unclear from the table how the SFRA would help with the application of the Sequential Test for the upcoming Local Plan site allocations; or future windfall applications. The application of the Sequential Test is a matter for the Local Planning Authority, but in the absence of any direction within the SFRA, the revised SAM (Site Assessment Methodology) attached to the Local Plan makes it clear that development will be steered to areas of lowest flood risk, based on the Flood Zones (i.e. 3b,3a,2,1). Given the majority of Goole lies within FZ3a, it is difficult to see how this could be applied in a meaningful way. We have previously made comments on the Local Plan Review - Options Document Section 3.22 – 3.29 in this respect.

RECOMMENDATION 4.01 – The draft Level 2 SFRA should be discussed with relevant departments within the council involved in Forward Planning, Strategic development and day to day planning work.

RECOMMENDATION 4.02 – A clear steer on the application of the Sequential Test within the Local Plan should be provided, in light of the revised L2 SFRA. For Goole, we are aware of the intention to apply the Sequential Test on a sub-regional scale, which would includes the town of Goole and the immediate surroundings. Note that this includes the town of Goole in addition to those areas outside, as per the Local Plan ‘Options Document Section 3.22 – 3.29’. However, the SFRA evidence base only covers the town of Goole, and therefore not the full subarea to apply the Sequential Test.

5. **Table 6.1** – Using Appendix E, the majority of the town would fall within Rapid Inundation Zone or "Danger to All." With this in mind, we would have expected to see a change in the local development control policies with respect to appropriate ground floor uses. Whilst we support exclusion of "more vulnerable" at ground floor level in 'Danger to All' areas and no habitable uses in 'Danger to Most' areas, this is likely to require a change in design of dwellings in the town.

RECOMMENDATION 5.01 – We recommend that you consult with emergency planners and also the Local Resilience Forum. They may wish to make recommendations within the SFRA in terms of location, scale and quantum of development, or make comment on the emergency planning provisions at strategic or site scale unique to Goole's setting and context. We believe it is vitally important to have their views represented, particularly as there appears to be a reliance on them should a flood occur. It is also an opportunity to clarify standards relating to access/egress arrangements either offsite or within individual developments (i.e. vertical evacuation).

6. **We would have expected to see the evidence base used more in the setting of mitigation standards**. For example, Appendix C1 shows design overtopping risks for some parts of the town. In addition to onsite mitigation, development in these areas will need to consider additional mitigation to acknowledge that those risks are "design" and not "residual."

RECOMMENDATION 6.01 – Distinguish between "design flood risks" (e.g. those shown in Appendix C1) and "residual flood risks" (i.e. those shown in Appendix D1), ensuring that development control requirements reflect the likelihood and consequence of each.

RECOMMENDATION 6.02 – Consider delineating "residual flood risks" into those that may be policy-dependent. This may provide a distinction between those residual risks that will always be present (e.g. breach), and those that may be dependent on a policy or physical intervention. Applied in Goole, this could for example be based on the Catchment Flood Management Plan (CFMP), similar to that used in the previous L2 SFRA. Providing this distinction may provide an extra layer to inform a sequential approach within the subarea or town (e.g. between Goole and Old Goole). This could also draw on the current 2008 Humber Strategy.

RECOMMENDATION 6.03 – Consider including additional local land base definitions and development control policies / requirements. The following land uses are not specifically referred to in Table 6.1, but are likely to be of use to practitioners of this document relevant to the local setting:

a. Changes of Use (*either within the same vulnerability class, or those that increase vulnerability such as Less Vulnerable to More Vulnerable*)
b. Caravans

RECOMMENDATION 6.04 – Set clear expectations for 'change of use' applications, where these result in a change in vulnerability class (as defined in Table 2 of the PPG to NPPF). Given that these are likely to have certain limitations imposed from

the current use (e.g. building structure and fabric), it would be useful to create a pragmatic compromise. Whilst we will recommend the mitigation is initially assessed against what would be required for new development, we believe the compromise is to seek betterment where possible. However, we expect to see that some form of mitigation is provided to demonstrate that future occupants will be able to access a place of safety.

RECOMMENDATION 6.05 – Set clear expectations for 'change of use' applications within the same vulnerability class. Frequently, we are consulted on changes within the same vulnerability categories, such as pubs to dwellings. These pose particular challenges and the SFRA is an ideal opportunity to clarify expectations for these developments. We expect to see that some form of mitigation is provided to demonstrate that future occupants will be able to access a place of safety.

RECOMMENDATION 6.06 – In light of the significant flood depths and hazards, it may be appropriate to set a clear expectation that the mitigation package offered by new developments should seek to exclude floodwater from internal habitable spaces. Where this is not possible, the aim should be to ensure internal flood hazards are no higher than 'Danger to Some'. This could be achieved through a comprehensive mitigation package, which is likely to involve ground raising. Where internal hazard is greater than 'Danger to Some', certain habitable uses should be excluded or removed to an upper floor. The current table does not appear to push for additional mitigation to the critical flood depths shown in Appendix D.1 and could be interpreted to mean that the minimum finished floor levels given might be considered acceptable. Figure 3 shows a possible issue relating to the mitigation package required to address the risks presented.

RECOMMENDATION 6.07 – the consequences of deep, hazardous and fast flowing water will have implications for structural integrity. It would be useful for the SFRA to provide a position on this and to make appropriate recommendations; otherwise this may be required on individual sites.

7. **Table 6.2** – the table is referenced with a note that it is a copy of that used in the Level 1 SFRA. This adds little value to the overall development control in Goole given there appears to be no FZ3b, and very little FZ2 or FZ1. It's therefore unclear what the application is for this table. If there are situations where this table would be used, then we suggest that the Level 2 report refers the user to the relevant table in the Level 1 report to reduce bulk of the report.

RECOMMENDATION 7.01 – remove Table 6.2. Any relevant information should be transferred to Table 6.1, and a reference inserted to the effect of 'refer to the table in the Level 1 SFRA if development is proposed outside of the residual breach zones…and follow any recommendations within Table 8.4 of the Level 1 SFRA'

8. We have made a number of further comments throughout the report, which would benefit from further revisions to clarify their interpretation (for the avoidance of any doubt), or to make them more specific to the local context they are being applied to.

RECOMMENDATION 8.01 – review other minor comments made on the report itself and consider amending text as appropriate.

We strongly recommend that the council considers the implications and future application of this SFRA on both the Local Plan and subsequent windfall or infill applications. It is clear that this evidence will present substantial challenges to the scale and design of new development coming forward within the geographical area covered by the SFRA. We have included below some of the most likely implications of how development may be expected to mitigate the risks shown:

- To successfully mitigate the potential depths shown, ground floor levels incorporating 'more vulnerable' or habitable uses will need to be raised high above existing ground levels. This is likely to require ground raising.
- Developments that are unable to achieve acceptable ground floor levels will need to consider removing certain ground floor uses, making three storey development more likely.
- There is a clear reliance on Flood Warning and Emergency Planning given the potential depths, hazards, and rate of onset of flooding. Given the infrastructure limitations of the town, vertical evacuation is likely to be relied on. This will affect both design of new developments and emergency planning requirements.
- The town of Old Goole does not appear to be able to support any development of any kind as it is located entirely within the Rapid Inundation Zone. You may wish to consider the implications for this on sustainability and the potential of making any development or regeneration of the area unfeasible.
- The main town of Goole appears to have a strong preference towards the west of the town, into the existing and emerging commercial and industrial areas. Whilst a certain degree of development may be possible in these areas, it is clear that very significant residual risks will be a challenge to manage in a meaningful way.

The draft National FCRM Strategy (England), which has recently been out for consultation, highlights the importance of spatial planning and place making through sustainable design. In areas of high flood risk, the strategy highlights the challenges when seeking to address those risks and the ambition to make more climate resilient places and communities. The SFRA will be used for strategic and local spatial planning, but we would suggest that for Goole there needs to be something ambitious. Whilst there will clearly be a certain degree of reliance on maintenance and/or investment in the flood risk infrastructure, the draft FCRM Strategy makes it clear that this cannot and should not be seen as the answer. We therefore encourage the council to think about how the town of Goole can be made more resilient to the risks of flooding now and in the future – whether this is through ambitious strategic spatial planning, adaptive policies, or innovative design.

Taking such an approach now could help Goole become a landmark for flood resilient design and adaptation within the UK and create a healthy and sustainable community for the future. This could be achieved, for example through:

- Innovative and coordinated building design at a strategic scale, perhaps through Neighbourhood Planning rather than site scale.
- Creating more flood resilient places and unlocking development areas through appropriate flood projects – which could unlock regeneration possibilities.

RECOMMENDATION 9.01 – Consider a place making exercise with stakeholders and potential developers to look at what flood resilient design might look like in Goole in the future, inviting innovative design proposals.

RECOMMENDATION 9.02 – Consider the long term aspirations and future of the town. The exploratory time-mean sea level projections from UKCP18 suggest that UK sea levels will continue to rise beyond 2100, as illustrated by the 2300 projections. It will take time to plan and adapt to those changes, but the council should be thinking about how the town will look in the longer term future, and to start planning for that now.

RECOMMENDATION 9.03 – consider the role of other strategic aspirations and directions and how that could provide security or betterment to long term flood risk to the town of Goole. This may necessitate the formation of plans to consider financial contributions to flood risk infrastructure. Consideration should also be given to non-financial objectives to manage flood risk in the town, for example, through safeguarding of land – acknowledging that this information may not be available now, but may become accessible over the lifetime of the document.

The table below discusses the benefits that the above recommendations will bring, over and above that provided by the existing Level 2 SFRA:

Recommendation	What this would achieve over current draft L2 SFRA
1.01 (RIZ definition)	Apply local context, showing areas that are completely unsuitable for development and those where it may be acceptable to consider development (subject to agreing mitigation package). The current RIZ and associated DC recommendations in Table 6.1 would prevent development across large areas of Goole. In considering the local definition of RIZ, it should be used to identify areas where development may be unsustainable now, and in the long term. This may include areas subject to frequent or extremely hazardous areas, with limited options for adequate mitigation. This could also consider areas where new or improved flood risk infrastructure is unlikely, and therefore making these areas more susceptible to the effects of flooding in the future.
1.02 (Council position)	In light of the risk of development stagnation, we recommend that the wider council interests are considered before publishing the new SFRA. This will avoid or reduce the risk of causing concern and questions if published without that review, some of which will undoubtedly be directed towards the council and the Environment Agency, relating to how we intend to manage the risks presented in the SFRA. This may be particularly sensitive after recent flood incidents in places like Wainfleet (Lincolnshire), Swaledale (North Yorkshire) and Whaley Bridge (Derbyshire). Whilst none of these incidents are identical to the risks presented to Goole, similarities may be drawn to certain factors.
1.03 (Contouring)	This would improve robustness in areas not covered by specific breaches and help to remove any anomalies in the evidence package. It would be similar to that undertaken for the previous Level 2 SFRA. The approach could also be used for the Rapid Inundation Zone.
2.01 (Implications of mapping on DC table application)	The mapping largely places the town within either the Rapid Inundation Zone, or areas of ‘Danger to All’. The corresponding policies in the development control tables make development difficult to bring forward – either “in principle” or “technically”. Adding further local context to the table would improve its usability and application.
3.01 (Dock Failures)	As per previous discussions, we would expect to see the inclusion of the dock failure simulations within the evidence package. This would ensure that areas which may be seen as being at lower flood risk must still consider the residual risks associated with a failure of those dock assets.
4.01 (Implications of ST for Local Plan)	It would be useful to understand how the council foresees the L2 SFRA in completing the Local Plan aspect – the subarea in the Local Plan extends beyond the town of Goole, whilst the SFRA does not. This is likely to push allocations for the Local Plan outside the town to areas demeed to be at lower flood risk – this may be true, but care should be taken as some of the alternatives are not covered by the same robust evidence package.
4.02 (Application of ST using L2 SFRA)	It would also be useful to understand how the council foresee applying the Sequential Test within the subarea on windfall sites, noting the comments in 4.01. The Rapid Inundation Zone (Appendix E) does not appear in the hierarchy in Figure 6-1. The majority of the town lies in either the Rapid Inundation Zone or ‘Danger to All’ area. It would be useful to apply further delineation, such that the Sequential Test can be applied more meaningfully within the town and Sequential Test sub-area.
5.01 (Emergency Planning & LRF engagement)	Strengthening the understanding and standards expected relating to strategic or development specific emergency planning. This particularly important given the current reliance on these services for existing development. This engagement may also help understand if there are any limitations on layout, scale or quantum of future development relating to pressures that may be expected on these services.
6.01 (Mitigation of risks)	Design and residual risks may allow mitigation to be provided for in different ways. This may be particularly relevant given the potential depths shown in the Appendix maps. Whilst we will always seek for exclusion or passive resistance from all sources of risk, the way residual risk is mitigated may consider pragmatic compromise. Areas with “design risk” (Appendix C.1) will require compensation. Areas with “residual risk” (Appendix D.1) require consideration of impact on others. This is required to ensure compliance with the NPPF and associated PPG. The way this is delivered in Goole needs consideration, given that compensatory storage would require areas of Flood Zone 1 to be available.
6.02 (Policy-dependent flood risk)	The SFRA would acknowledge the intended direction of travel for flood risk interventions. Whilst it is unclear what those physical interventions are, it may still help with the application of the Sequential Test and setting of mitigation standards.
6.03 (Local land-use context)	This would help add local definitions and avoid interpretation questions. Such clarity would improve understanding of intention by various practitioners and also ease conflicting views. This would therefore reduce potential objections and reduce time/cost implications.
6.04 (Change of Use expectations – increased vulnerability)	This type of development is relatively common in Goole. Nither the previous L2 SFRA or the current draft L2 SFRA provides any significant guidance for these applications. These types of developments pose particular challenges with respect flood risk, and the SFRA would be a useful place to set expectations.
6.05 (Change of Use expectations – same vulnerability)	This type of development is relatively common in Goole, and again may pose particular challenges with respect to flood risk.
6.06 (Mitigation package)	This would set clear expectations for developers. The current recommendations need to take account of all sources of risk (design and residual). The current minimum standards in the development control tables may be interpreted as being a bottom line and in those cases it is likely that hazardous internally flooding would still occur.

	A strengthening of the DC table would be to consider the internal depths / hazards after mitigation taken into account.
6.07 (Structural integrity issues)	Deep and fast flowing water poses structural issues to development in the floodplain. To ensure that new development is appropriately resilient, consideration will need to be given to the ability of structures to withstand potential depths and velocities, including impact of debris. Provision of guidelines within the SFRA, taking advice from suitable expert(s) would provide clarity for developers.
7.01 (Table 6.2)	Table 6.2 appears to have limited application in Goole given it refers to areas outside of those affected by breach. Removing it, and perhaps replacing with a link to the Level 1 SFRA would reduce bulk and also potential misapplication. Some elements in Table 6.2 may be useful bringing into Table 6.1 where they would add explicit value, or require different mitigation (e.g. basements, multiple sources of flooding).
8.01 (Other comments throughout report)	Comments relating to consistency, interpretation or intent. These aimed to improve the functionality of the report.
9.01 (Placemaking exercise)	The new SFRA suggests a change to design of new development in the town, which is likely to have implications in layout and design both horizontally and vertically. Opportunities should also be explored for placemaking at a strategic scale, or over longer durations – providing solutions to identified areas of flood risk. This could, for example, include strategic ground raising across a number of sites to reduce overland flood risk, or consideration of flood resilient communities over larger sites. Undertaking such an exercise would follow some of the intent within the Environment Agency's draft National Flood and Coastal Erosion Risk Management Strategy for England to make more climate resilient places, and to help places plan and adapt to flooding.
9.02 (Future ambition and anticipation)	The predicted effects of climate change will increase the risk of flooding to the town – both in terms of likelihood and consequence. The Council should consider their expectations of Goole in the future, and consider how the next phase of development of Goole can contribute to improving the resilience of the town. This could consider the implications of the climate change projections from UKCP18 (released November 2018) using the 2300 projections. In considering the implications for increased flood risk in the future, it will require time to plan and adapt. The SFRA could consider how this next phase of planning for the town could help or contribute to managing or reducing overall flood risk into the future. This may indicate the need for financial or non-financial (e.g. safeguarding) provisions.
9.03 (Interaction with emerging strategies that may influence design and future flood risk)	The SFRA could consider the role of emerging strategic ambition from elsewhere, and explore opportunities to interact with these to contribute to managing or reducing overall flood risk. This may indicate the need for financial or non-financial (e.g. safeguarding) provisions.

Figure 1 – “contouring” to interpolate hazard between breach locations – taken from previous L2 SFRA.

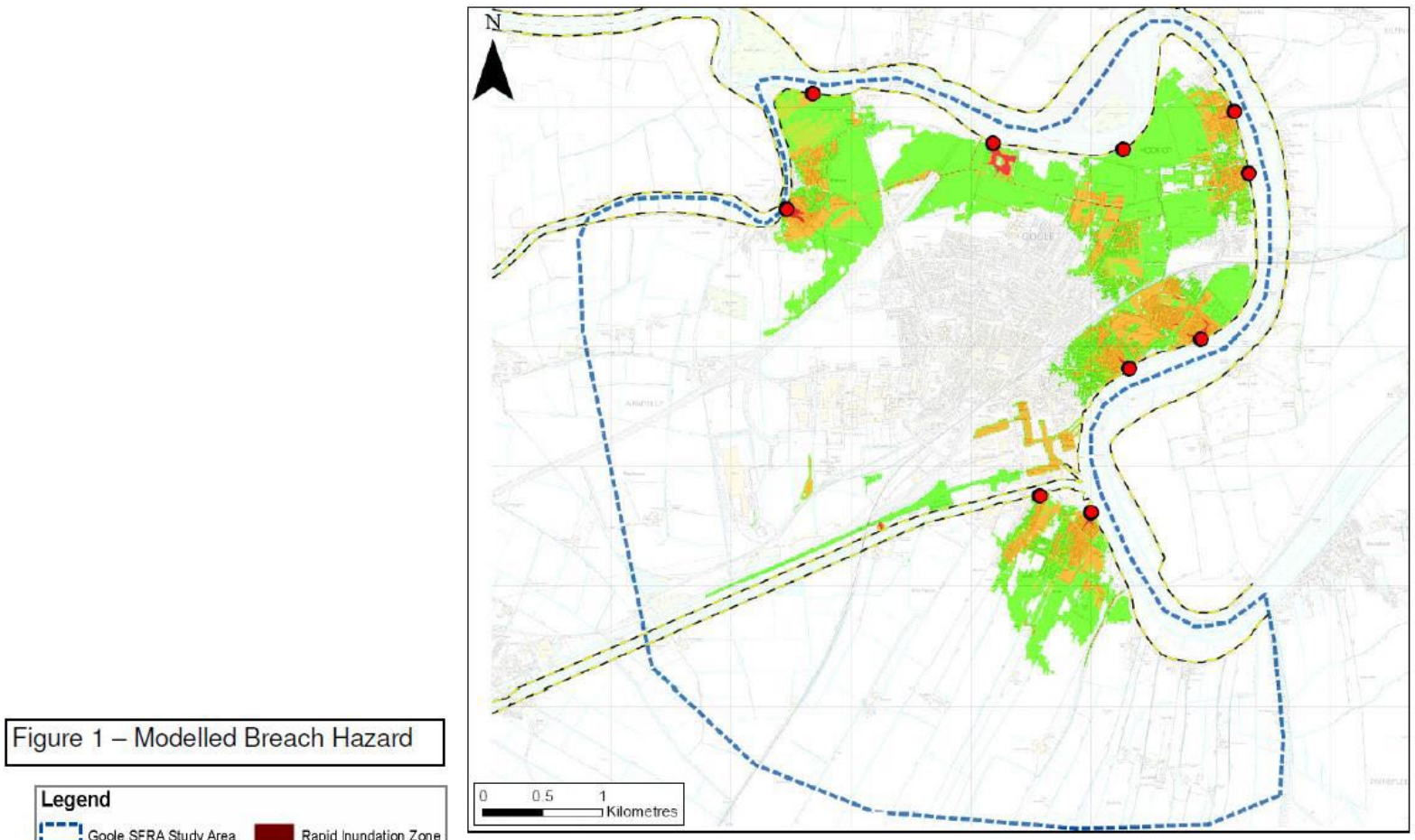


Figure 1 – Modelled Breach Hazard

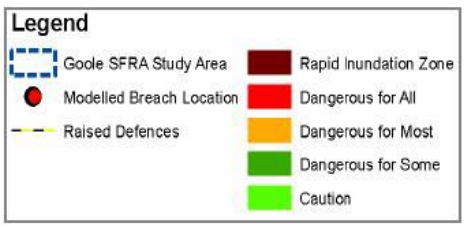


Figure 2 – Contoured Breach Hazard

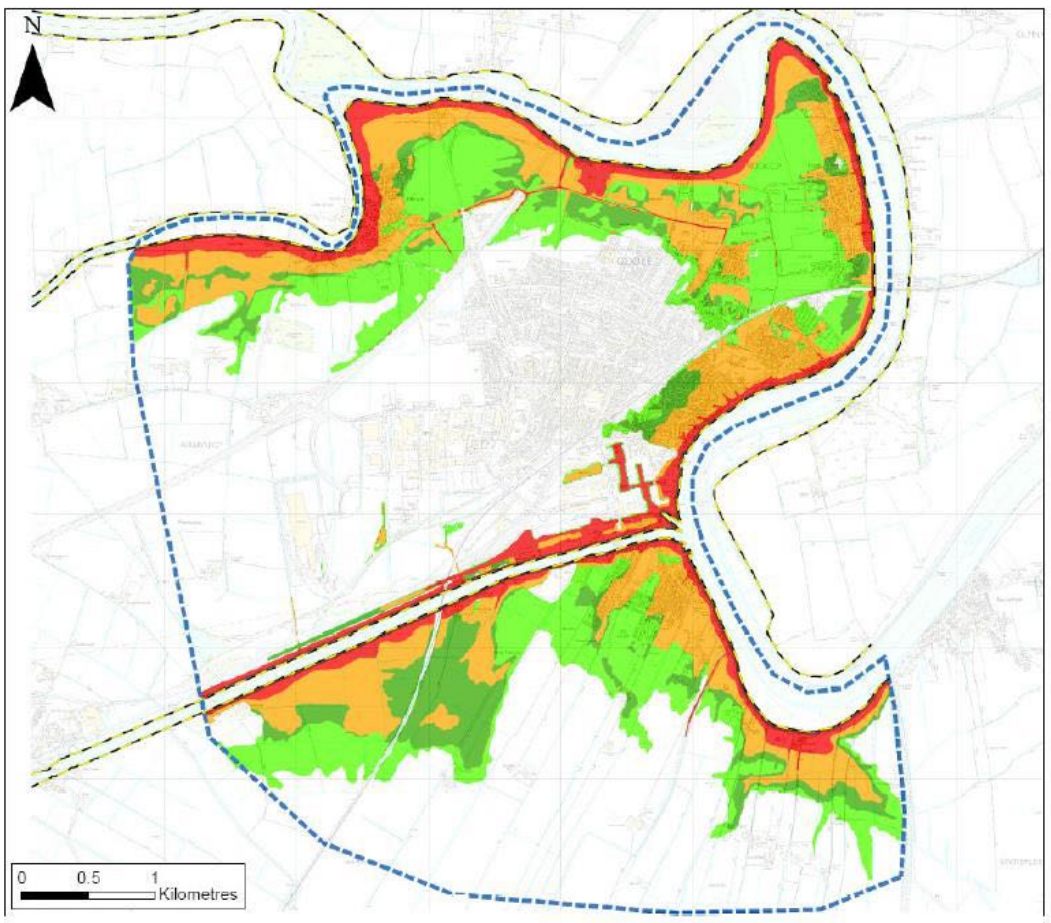
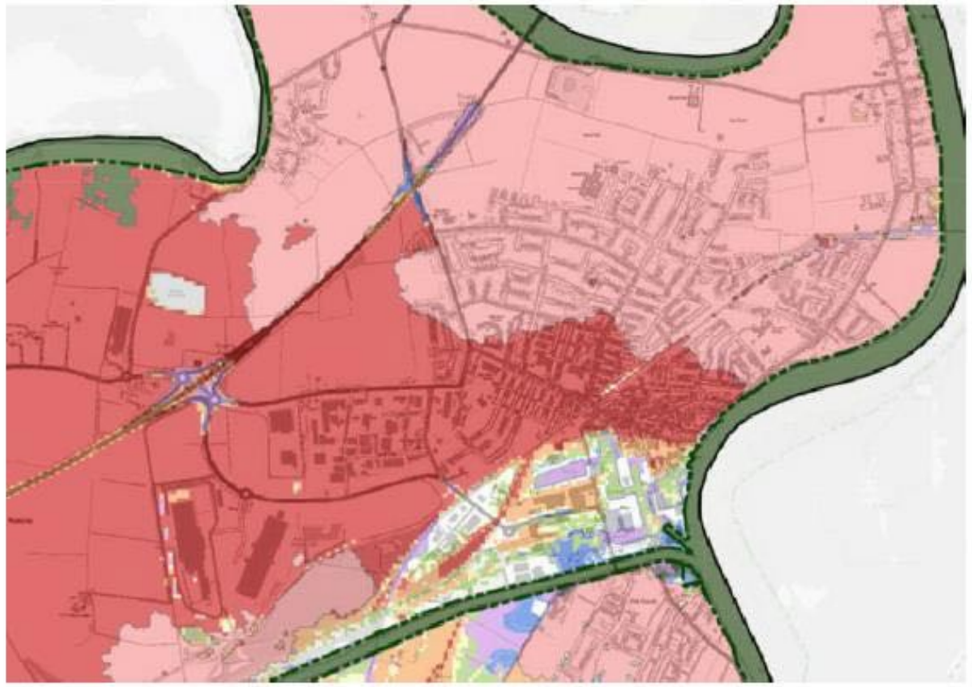


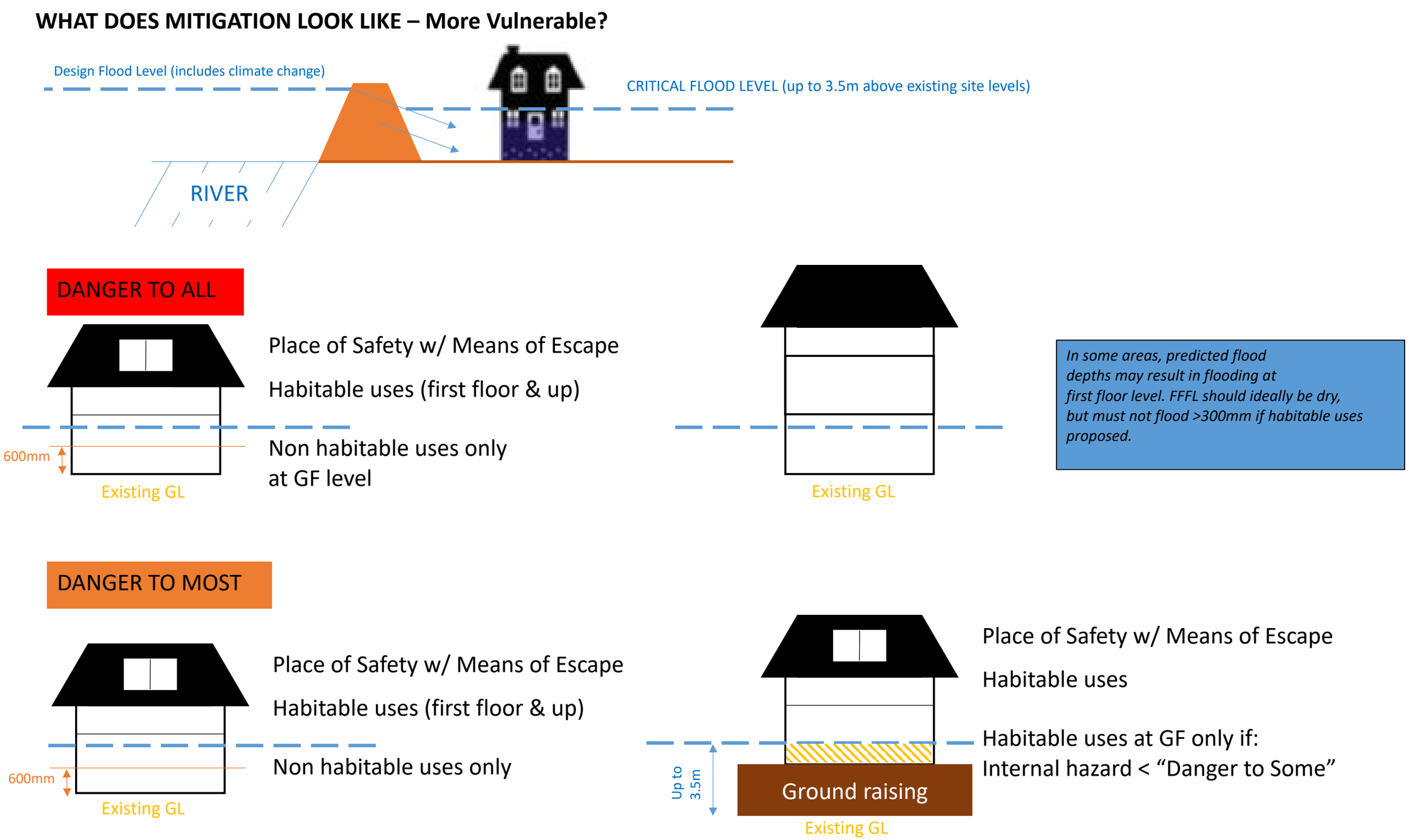
Figure 2 – Goole dock failure extents

Appendix E – Draft (v1)



Dock failure flood extents- 2016 Upper Humber

Figure 3 – What does design look like in Goole in light of the SFRA?



Proposed Approach to Addressing Key Review Comments on the Draft L2 SFRA for Goole

Development Management Map, including RIZ

Proposed/Agreed Approach	Comments Addressed

The development management map will be revised with the following
• 20m Defence Buffer Zone
• RIZ – based on those areas that flood to depths up to 900mm within 0.5 hours. To be contoured between breach locations to account for the fact that a breach can occur anywhere
• Danger to All – two categories to be displayed for this. Overtopping and No Overtopping.
  ○ Overtopping will use the modelled extent for the Overtopping Climate Change scenario (Note: this will use the full modelled extent of the Overtopping Climate Change Scenario, 0.5%AEP+cc)
  ○ No Overtopping will use those areas of the combined breach classified as Danger to All (0.5%AEP+cc).
• All other layers to remain the same.
	EA recommendations 1.01, 1.03 (RIZ) and 4 (Application of Sequential Test), 6.01 and 6.02 (evidence base)
	
	Combined ERYC Comments on Draft L2 SFRA

The report will be updated to provide an explanation of how the layers have been defined and the justification behind them (brief summary below)

- 20m defence buffer zone – Required for access e.g. maintenance and/or future flood risk management options
- RIZ – a threshold of 900mm used because standard mitigation would not exceed 900mm
- Danger to All – Uses a policy-dependent approach where the overtopping provides the 'design flood risk' scenario whilst the non-overtopping provides the residual risk scenario. This will be linked to the CFMP policies and 2008 Humber Strategy.

Development Management Table

Proposed/Agreed Approach	Comments Addressed

An additional column is to be added to the development management table and Danger for All is to be split into 2 – Overtopping and No-Overtopping
The following has been proposed
• 20m Defence Buffer
  ○ no development allowed
• RIZ
  ○ no new development allowed
  ○ new extensions will be permitted
  ○ Change of Use in RIZ – Change of Use within same category – use Standing Advice, with an expectation the development should be made safer for future users e.g. provision of a place of safety.
  ○ Change of Use to different category – must demonstrate structural stability and include a place of safety on 1st floor.
• Development management table to be reviewed to make sure restrictions are logically and feasible
• Additional map to be included for elevation requirement for the Place of Safety. Two zones – RIZ and Danger for All. To be
	EA Recommendations 2, 6.03, 6.04, 6.05, 6.06, 6.07
	
	ERYC comments on Table 6.1
	
	EA Comments in Main Report

Proposed/Agreed Approach	Comments Addressed
based on modelled level (including climate change) plus a freeboard allowance of 300mm • Separate section for Access and Egress, including Place of Safety to be provided in the report due to the importance of this consideration in light of the level of flood risk. • Wording to be altered from recommendations to minimum standards to avoid any confusion and inference that a lower level of mitigation would be allowed	

Sequential Test

Proposed/Agreed Approach	Comments Addressed
The subdivision of Danger to All into the Overtopping and No Overtopping scenarios allows for better application of the Sequential Test. It was agreed that • Areas shown as No Overtopping are sequentially preferential to areas shown as Overtopping. This is because of the difference in level of risk (i.e. the No Overtopping is a residual risk) and also the catchment policies for these areas i.e. the CFMP policies.	EA Recommendation 4 EA Comments in Main Report

Failure of Dock Infrastructure

Proposed/Agreed Approach	Comments Addressed
Capita have modelled the dock gate failure but EA did not see the updated maps. EA reviewed the maps in the meeting and confirmed the dock gate scenario was showing what they expected.	EA Recommendation 3 EA Comments in Report
Report was written before dock gate scenarios were run. It will be updated to reflect the dock gate scenario results	EA and ERYC comments in report

EA Recommendation 7 – Table 6.2

Table 6.2 to be removed and ~~and~~ relevant information transferred to Table 6.1. A reference will be included, as recommended, to the Level 1 SFRA.

EA Recommendation 5.1 – Emergency Planners

Were ERYC's Emergency Planners / Local Resilience forum consulted on the draft report?

I would highly recommend any consultation with the emergency planners/LRF is also with ERYC development control/planning officers as there will need to be an agreement between all parties on the approach and any recommendations included in the SFRA.

General EA and ERYC comments on the Main Report text

All other comments on the main report text will be addressed, where required. (ERYC comments and EA Comment 8.01)

EA Recommendations 9.01 – 9.03

These are recommendations for ERYC to consider going forward rather than to be addressed as part of the SFRA.