
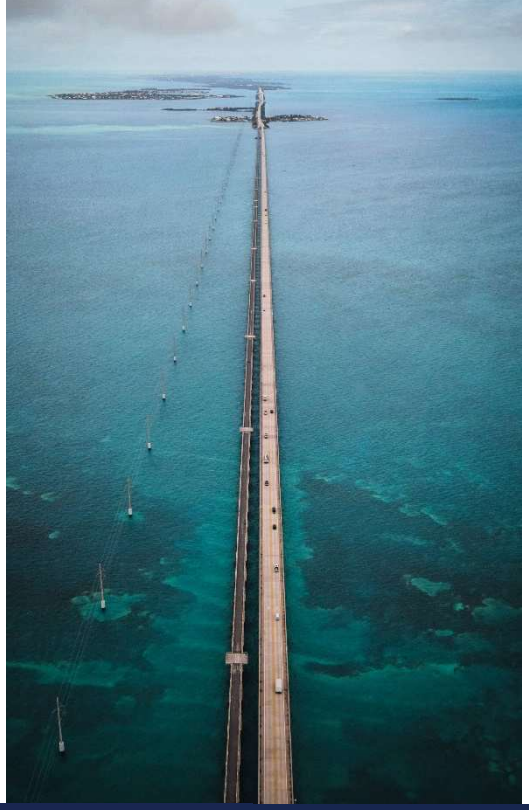


Helios Renewable Energy Project
Revised Scoping Document

Enso Energy
AEG0851_YO8_Camblesforth_03

Enso Energy
The Priory
Dursley
Gloucestershire
GL11 4HR

UK Experts in Flood Modelling, Flood Risk Assessments, and Surface Water Drainage Strategies

fra@aegaea.com

02081 641 282

www.aegaea.com

Introduction

This document comprises a brief overview of the progress on the hydraulic modelling to date and an updated proposed hydraulic modelling scope, along with associated timescales. The document has been prepared following the initial scoping and subsequent EA review that forms the basis for the strategy for the site. Aegaea proposes that this document forms the revised scope of works to be agreed by the EA.

Modelling Context

The site sits between the River Ouse and the River Aire, upstream of the Humber Estuary.

The Environment Agency provided the following hydraulic models for use in this project:

- Lower Aire model (2017)
- Lower Ouse and Wharfe Washlands model (2018)
- Upper Humber model (2016)
- 2020 Humber 2100+ Strategy Extreme Water Level model

Model Review

The following hydraulic models were reviewed internally to identify any potential risks or issues / inaccuracies which may impact the project:

- Lower Aire model (2017)
- Lower Ouse and Wharfe Washlands model (2018)
- Upper Humber model (2016)

The 2020 Humber 2100+ Strategy Extreme Water Level model was not reviewed as it is not proposed utilise any geometry associated with this hydraulic model.

Lower Aire Model Review

A summary of the Lower Aire model review is included below.

	Comment	Proposed Action
1	Model utilises out-of-date LiDAR dataset.	Update to latest LiDAR dataset.
2	Some bank markers are missing or inappropriately placed.	Review and update bank markers.
3	In-channel roughness is low in some areas of the model.	Review roughness values to ensure they are appropriate.

4	There is some glasswalling in the most extreme event (Q1000+CC).	Extend model code where necessary to remove glasswalling.
5	There is some discrepancy between the 1D and 2D channel widths.	Review channel widths and amend to ensure 1D and 2D representation matches.
6	The floodplain is disconnected from the channel in some return periods. This issue may be a result of the discrepancy between 1D and 2D channel widths.	Further review required.
7	Model is shown to be sensitive to the different parameters tested.	Review model roughness against aerial imagery and ensure it is appropriate.
8	Calibration has shown that the model does not perform as well at lower return periods (RPs).	No action proposed, as return periods of interest are larger.
9	Culverts beneath the railway to the west of the site do not appear to have been represented. This may result in flow artificially being attenuated behind the railway line.	Obtain a survey of culverts beneath the railway line for incorporation within the hydraulic model.

Lower Ouse and Washlands Model Review

A summary of the Lower Ouse and Washlands model review is included below.

	Comment	Proposed Action
1	Model utilises out-of-date LiDAR dataset.	Update to latest LiDAR dataset.
2	Some bank markers are missing or inappropriately placed.	Review and update bank markers.
3	Model is 1D only at downstream reach.	No action required, as Upper Humber model has floodplain representation in this location.
4	Model is shown to be sensitive to the different parameters tested.	Review model roughness against aerial imagery and ensure it is appropriate.

Upper Humber Model Review

A summary of the Upper Humber review is included below.

	Comment	Proposed Action
1	Model utilises out-of-date LiDAR dataset.	Update to latest LiDAR dataset.
2	Some bank markers are missing or inappropriately placed.	Review and update bank markers.
3	There are amendments to the advanced parameters (1D and 2D) which suggest stability issues with this model.	Review stability fixes and ensure these are appropriate with no impact on results.
4	There is some discrepancy between the 1D and 2D channel widths.	Review channel widths and amend to ensure 1D and 2D representation matches.
5	The model is shown to be sensitive to roughness.	Review model roughness against aerial imagery and ensure it is appropriate.

Proposed Model Scope

Model Extent

There are three models which cover the watercourses - The Upper Humber (2016) and Lower Aire (2017). The 1D nodes and 2D model codes associated with these models are shown in Figure 1 below.

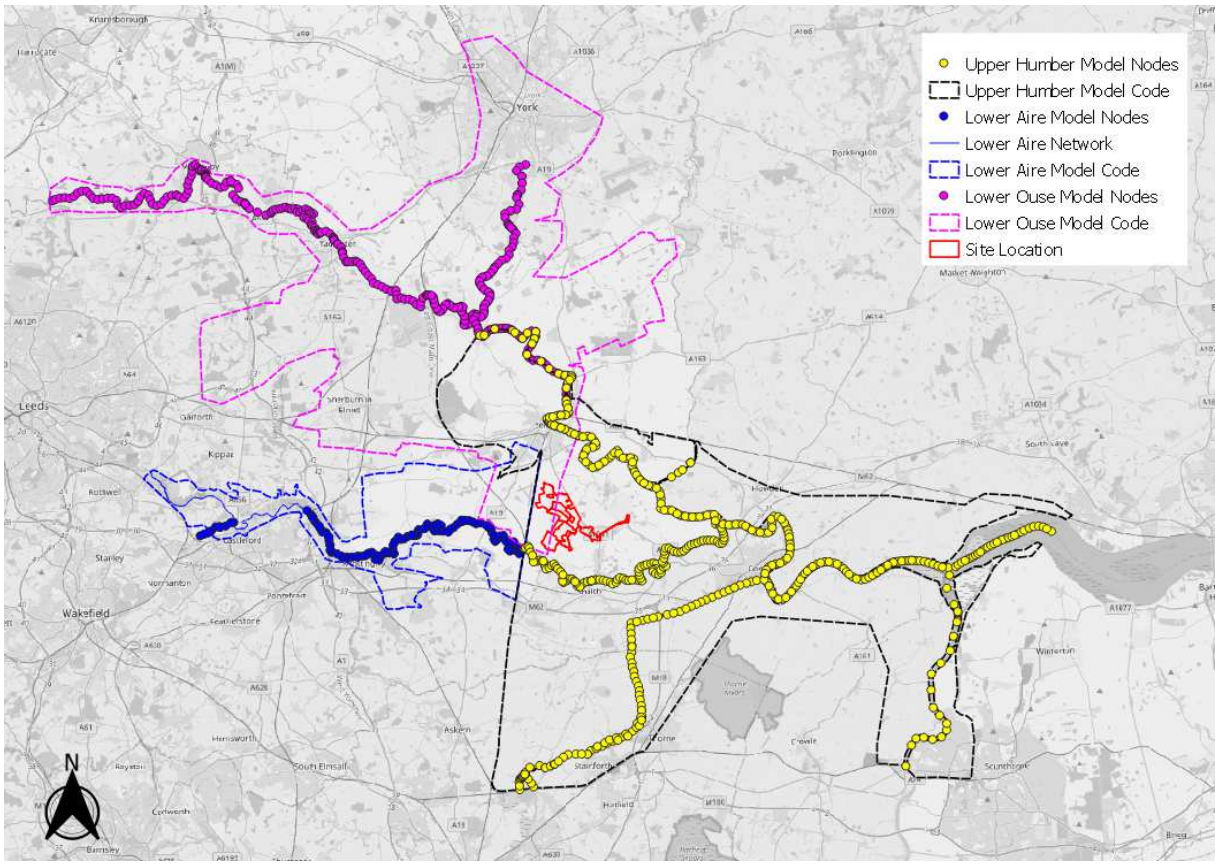

Figure 1: Existing Model Coverage

It is proposed to use the Upper Humber (2016) model as the primary model and extend the Ouse and Aire watercourses upstream as necessary using geometry from the Lower Aire and Lower Ouse models. Superfluous downstream tributaries not thought to influence flood risk at the site will be removed to reduce model simulation times.

The Humber 2100+ Extreme Water Levels model will be utilised to inform boundary conditions with the model in line with the EA suggestions.

Joint Probability and Breach

The site is outside of all modelled defended scenarios of the Upper Humber but is affected in the undefended scenarios (0.5% + CC and the 0.1%) and in the joint probability scenarios. Given the nature of the development and the relative likelihood of such scenarios during the lifetime of the development, it would not be proposed

to use undefended scenarios as part of the modelling framework. This has been confirmed as appropriate by JBA Consulting as part of their Method Statement Review (ref: 2022s0454).

The dominant source of risk is from the River Aire and the River Ouse, with the site between these two rivers. The Lower Aire modelling includes an allowance for the downstream boundary and has been extensively calibrated to previous floods. The JBA reporting concludes that:

> *"It was concluded, that, other than potentially improving the downstream boundary conditions for each event, the Lower Aire model was suitably calibrated and ready for running design flood events. The fact that the model was able to match (within tolerance) most of the recorded gauge levels across the study area during the two highest events in the recent record (estimated to have been in the order of 5% AEP and 1.3% AEP), should provide a high level of confidence in the design predictions for events within this range and the 1% AEP event."*

Given this, it is proposed to use the Upper Humber modelling with an allowance for reviewing and implementing the boundaries from the Lower Aire (owing to the issues with joint probability in the Lower Aire modelling and the seeming existence of culverts on the boundary between the two models that are not included in either).

The preliminary scoping opinion requires that the ES should "explain how the solar arrays have been designed to be resilient to flooding impacts including breach". It is also noted within the Method Statement Review (ref: 2022s0454) that "some defended or breach modelling may be required dependant on the location of ground modification and new culverts. If the area is impacted by flooding, it is expected Aegaea would undertake new model simulations and use these results to inform development plans."

In the 0.5% Joint Probability event the flood defences along the River Aire are significantly overtopped. As such the severity of a breach event on flood extents will be minimal and is scoped out of the initial appraisal.

Software and Versions

It is proposed to convert the 1D element of the hydraulic models from Flood Modeller into ESTRY (the 1D engine of TUFLOW). The advantages of this conversion are:

- EA benchmarked software
- Quick(er) run times
- Improved stability with flat water levels

It is also proposed to update the software versions for the modelling to use the latest TUFLOW versions. This is due to the fact that major releases have occurred since

2016/17 when the models were produced. The proposed software would be TUFLOW 2023-01-AB and will remain in that version for the duration of the project unless issues are identified in the codebase that will require it to be changed.

It is proposed that, given runtime considerations and a scale of development, that the HPC (Heavily Parallelised Computing) version of the TUFLOW software is used. This has been extensively benchmarked for use in studies and produces equivalent accuracy results to the classic solver. While there can be some differences between the two solvers, the benefits of the transition will outweigh these concerns. It is proposed to create a revised baseline for assessment (see "Scenarios, Base Simulations").

Where possible, it is also suggested that the modelling utilises the "quadtree" solver of TUFLOW. Also, heavily benchmarked, this would allow the modelling to take advantage of decreased runtimes, higher resolution in the area of interest and lower resolution away from the site.

LiDAR

It is proposed to update the model LiDAR to the most recent LiDAR. A review of the DEFRA LiDAR portal suggests that the latest terrain data would be a 1m resolution data set, flown in 2020, potentially supplemented by 2m data also flown in 2020.

The update of the LiDAR will ensure that latest accurate data is used in the study.

Mitigation Requirements

It is proposed that the impact of the renewable energy solar arrays will be modelled with two mitigations requirements.

1. The impact of the piles and panel uplifts
2. The impact of any land raising or ground level changes associated with the infrastructure of the renewable energy project i.e. bunding, access, or flood defences required for electrical infrastructure.

It is proposed for the impact of the solar array pillars that this is undertaken through an area and volume method. This will look at the number of pillars and their area, combined with the flood depth across the site to produce a volumetric displacement of water in each scenario. While there are methods for modelling this impact explicitly, they are not suitable for models with such a grid size (and the grid size is likely to need to be fixed because of the impact on run times). Furthermore, these methods do not adequately reflect the sub grid scale processes that are required for accurate reflection of the distribution of impacts.

The impact of any land raising or infrastructure other than the pillars will be modelled explicitly through standard modelling techniques of terrain adjustment within the 1d or 2d domains as appropriate.

Scenarios

Baseline Simulations

The incoming models will be updated to use the latest versions of software discussed previously. As part of this work, models will need to be combined to adequately represent the risk to the site, but no technical challenges to the underlying models will be undertaken, except with LiDAR updates and recent software updates. The outcome of this stage is to create a new baseline situation from which impact of the proposed development can be measures.

The baseline modelling will be shared with the Environment Agency for review and sign off prior to any post development work being undertaken. It is critical that this updated baseline model is approved for use prior to updates and development planning. The baseline model will be rerun for the following return periods:

- 50% AEP
- 5% AEP
- 1% AEP+ climate change
- 0.5% AEP
- 0.1% AEP
- Joint probability simulations as required following discussions.

It is requested that the both the 50% AEP and either the 1% AEP or 0.5% AEP simulations are reviewed by the EA to give confidence that both the low flow and high flow modelling is fit for purpose.

Development Simulations

The proposed development modelling will cover a range of return periods between 50% AEP and the 0.1% AEP. The exact distribution of these runs will be decided through consultation with the EA, but is expected to cover (at minimum):

- 50% AEP
- 5% AEP
- 3.33% AEP
- 2% AEP
- 1% AEP
- 1% AEP plus climate change allowances
- 0.5% tidal influence (plus cc as appropriate)
- 0.1% AEP

It is acknowledged that a range of breach and tidal increments and joint probability will be required however, given the issue with the defences on the Lower Aire and the potential variation between models, it is anticipated that the exact simulations will be decided through consultation.

Climate Change

A set of precautionary project timescales have been established by the project team as follows:

- Decision - 2025
- Procurement/construction - 2028
- Operation (40 years) – 2068
- Decommissioning – 2069/70 (depending on conditions attached for decommissioning works)

The 2050s epoch used to assess the peak river flow allowances covers the period 2040-2069. It is proposed the 'Design Flood' would be the 'Higher Central' allowance for the 2050s epoch.

As part of the NSIP process, the applicant must agree the scope of the climate change allowances for the credible maximum scenario. Given that this application is for a solar array with a defined termination date, it would not be appropriate to use the H++ allowances for sea level rise, nor a climate change percentage beyond the 2080s horizon. It is therefore suggested the Upper End Climate Change for the 2050s is a viable credible maximum which should be treated as a sensitivity test.

The modelling for both studies used peak flow allowances from the 2016 NPPF guidance. This will need to be updated to account for the revisions in the NPPF from July 2021. The percentage allowances will be taken from the Wharfe and Lower Ouse, or Aire and Calder (in brackets) and applied to the relevant watercourses:

Table 1 - Climate Change Percentage Allowances

Epoch	Central	Higher	Upper
2020s	11 (11)	14 (15)	22 (24)
2050s	13 (13)	18 (18)	29(31)
2080s	23(23)	31 (31)	48 (51)

Sea level rise will be added to the model based on the NPPF uplift table 1 up to the 2068 design year.

Model Sensitivity

A range of sensitivity tests are proposed as part of the model development. All sensitivity tests will be undertaken on the 1% AEP event or the 0.5% AEP as appropriate.

- Flow – reduction in flow of 20%. No increase in flow as sensitivity required as it is covered by the climate change testing.
- Hydraulic Roughness – a 1d change of plus and minus 20%. A 2d change of plus and minus 20% (with no change in the 1d component).
- Downstream Boundary – an update to the downstream boundary of both plus and minus 20%, OR a change in the downstream boundary level of 250mm plus and minus, depending on the schematic arrangements and discussions with the EA.

At this point it is assumed that the joint probability discussions will also include a discussion of peak river flow timing with peak tide and the appropriateness of sensitivity checks based on the coincidence of these peaks.

Hydrology

Significant updates to the model hydrology of both the Humber and River Aire were undertaken as part of the incoming modelling. Although it would perhaps be standard practice to update the hydrology given the age of the modelling (5 years old), it is suggested that given the nature of the model and calibration that this is not going to be necessary. At most, it is suggested that the same methodology as previous studies is utilised, but incorporating the intervening flood years to establish if there is a variation in peak water levels. If there is, the additional flood years will be incorporated, but the shape of the hydrograph will remain the same, given the calibration and verification already undertaken.

Reporting Proposed

The modelling should be undertaken in line with this document provided the EA are in agreement. All models will be accompanied by:

- A model log detailing file versions and changes.
- A model report discussing the changes and impacts of the modelling, incorporation of revisions and the impacts on the study site. The model report will include information about the amendments to the model and any updates that have been undertaken. It will not cover previous models and their creation but will reference (to the section) where the information can be found in previous reports as long as that information is available.
- A discussion on the modelling, and the limitations of its use (both in this study and for wider use by the EA).

Review Requirements

Models submitted to the EA are expected to be reviewed in line with EA best practice, including the review of the application of changes to the model. Given the large nature of the models and the fact that they have been extensively calibrated and approved for use, it is suggested that the scope of the review should be limited to updates and amendments made as part of this study only.

Agreements Sought

Type	Item	Approved?
Hydrology	Update to include additional flood years only	
Breach	Breach is not required given the minimal impact on the 0.5% AEP events. However, if breach is required, 3 locations of breach will be tested under the design floods only.	
Modelling	Estry conversion is appropriate and will not constitute a 'new model' as long as extents and results are similar	
Modelling	HPC and quadtree is agreed as appropriate for use	
Modelling	HEWL downstream boundary is the most appropriate	
Design	The design Event will be the 100cc18 including a MHWS CC event on the tidal boundary. The exceedance (credible maximum) event will be the 100cc31 with MHWS	

	CC event. Tidal boundaries will have design life years incorporated to decommissioning (2070).	
Review	Scope of the review to be limited to model and hydrological updates undertaken as part of this work only.	