JBA consulting

Strategic Flood Risk Assessment - Coastal Modelling

Final

A1- C03

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Contract

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This report describes work commissioned by Wyre Council (on behalf of the Fylde Coast Authorities) by an instruction dated 27th November 2023. The Client's representative for the contract was George Briscoe of Wyre Council. Lewis Brazell, Hannah Smith, and Ian Gaskell of JBA Consulting carried out this work.

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The methodology adopted and the sources of information used by JBA in providing its services are outlined in this Report. The work described in this Report was undertaken between November 2023 and February 2024 and is based on the conditions encountered and the information available during the said period. The scope of this Report and the services are accordingly factually limited by these circumstances.

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Contents

Abbreviations

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
CFBD	Coastal Flood Boundary Dataset
DTM	Digital Terrain Model
IWL	Initial Water Level
LIDAR	Light Detection and Ranging
RCP	Representative Concentration Pathway
SFRA	Strategic Flod Risk Assessment
UKCP18	UK Climate Projections 2018

1 Introduction

This document provides a record of the methodology and decisions made to generate coastal flood map outputs to update the Strategic Flood Risk Assessment (SFRA). Coastal flood models covering Blackpool, and the Lune and Wyre Estuaries, were developed as part of the 2015 Lancashire tidal areas benefitting from defences project[1].

Since this completion of the 2015 project, new coastal datasets were released, namely the:

- 2018 Coastal Flood Boundary Dataset (CFBD) extreme sea levels; and,
- the United Kingdom Climate Projections 2018 (UKCP18) guidance.

To update the coastal mapping for use in the SFRA, new tidal water level boundaries were generated using the latest coastal datasets and following Environment Agency guidance[2]. The existing hydraulic models were updated with the new water level boundaries and simulated alongside existing wave overtopping discharges, to generate new mapping outputs.

The remainder of this technical note will cover the data used, modelling methodology and model simulations undertaken.

1 Environment Agency. 2015. Lancashire tidal areas benefitting from defences revisited. Final Model Development Report.
2 Environment Agency. 2018. Coastal flood boundary conditions for the UK: update 2018: User guide. SC060064/TR7

2 Flood inundation model boundary conditions

2.1 Background

As part of the SFRA update, three TUFLOW hydrodynamic that covered Blackpool, the Wyre Estuary and the Lune Estuary were updated with new boundary data. For reference, the original models and their development are detailed in the 2015 Lancashire tidal areas benefitting from defences Model Development Report.

The hydraulic models required two sources of coastal boundary data:

- A design tidal water level boundary; and
- Wave overtopping discharges.

As part of this SFRA update, only the design tidal water level boundaries were updated (Section 2.2) and combined with the existing wave overtopping inflows (Section 2.3).

The location of the existing model water level and wave overtopping boundaries are shown on Figure 2-1, Figure 2-2, Figure 2-3 for the Blackpool, Wyre and Lune models respectively. The overtopping discharges are injected into the model on the landward side of the coastal defences and simulated in parallel to the offshore water level boundary, peaking at the same time.

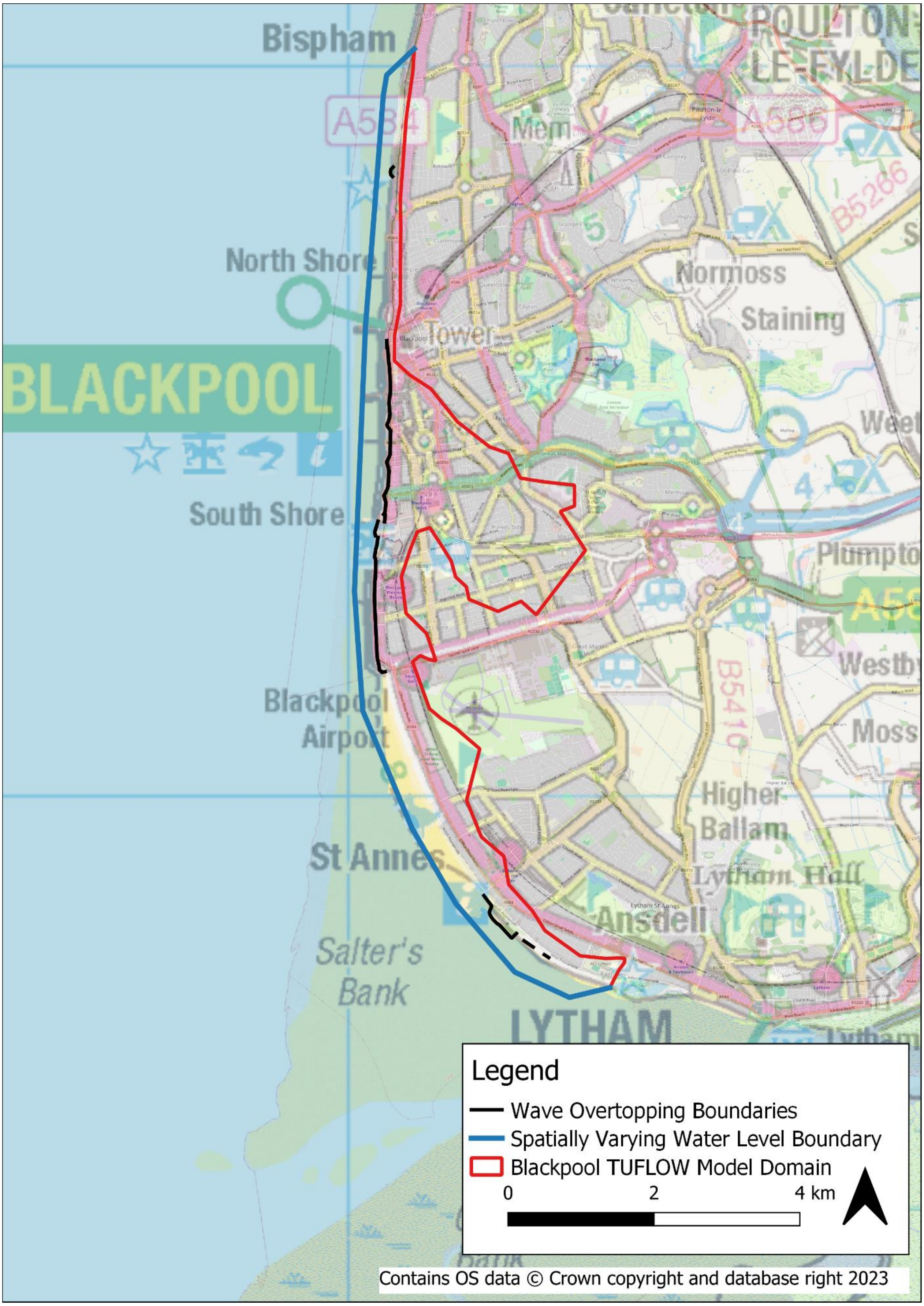

Figure 2-1 Blackpool 2015 model - tidal water level and wave overtopping boundaries

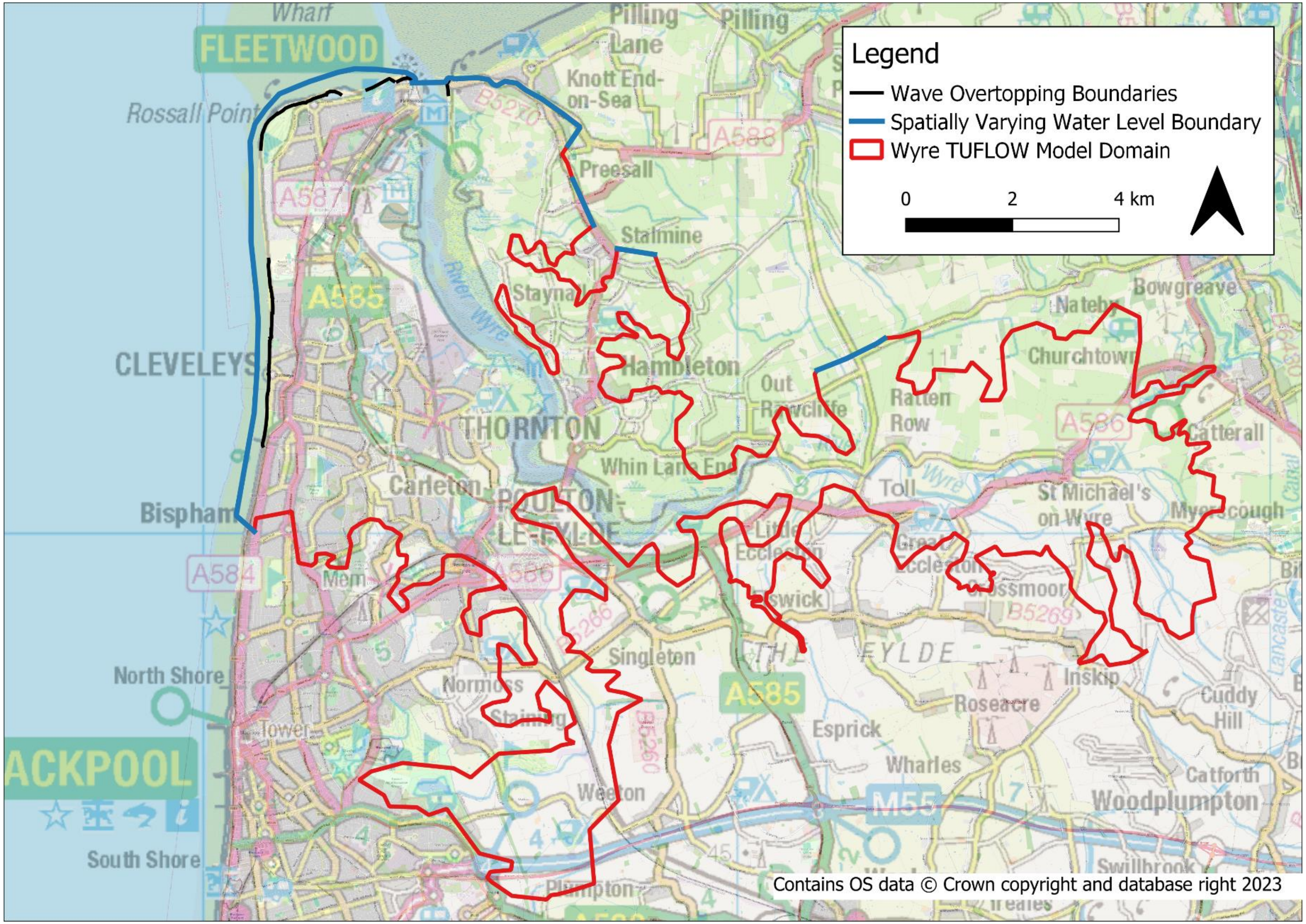

Figure 2-2 Wyre 2015 model - tidal water level and wave overtopping boundaries

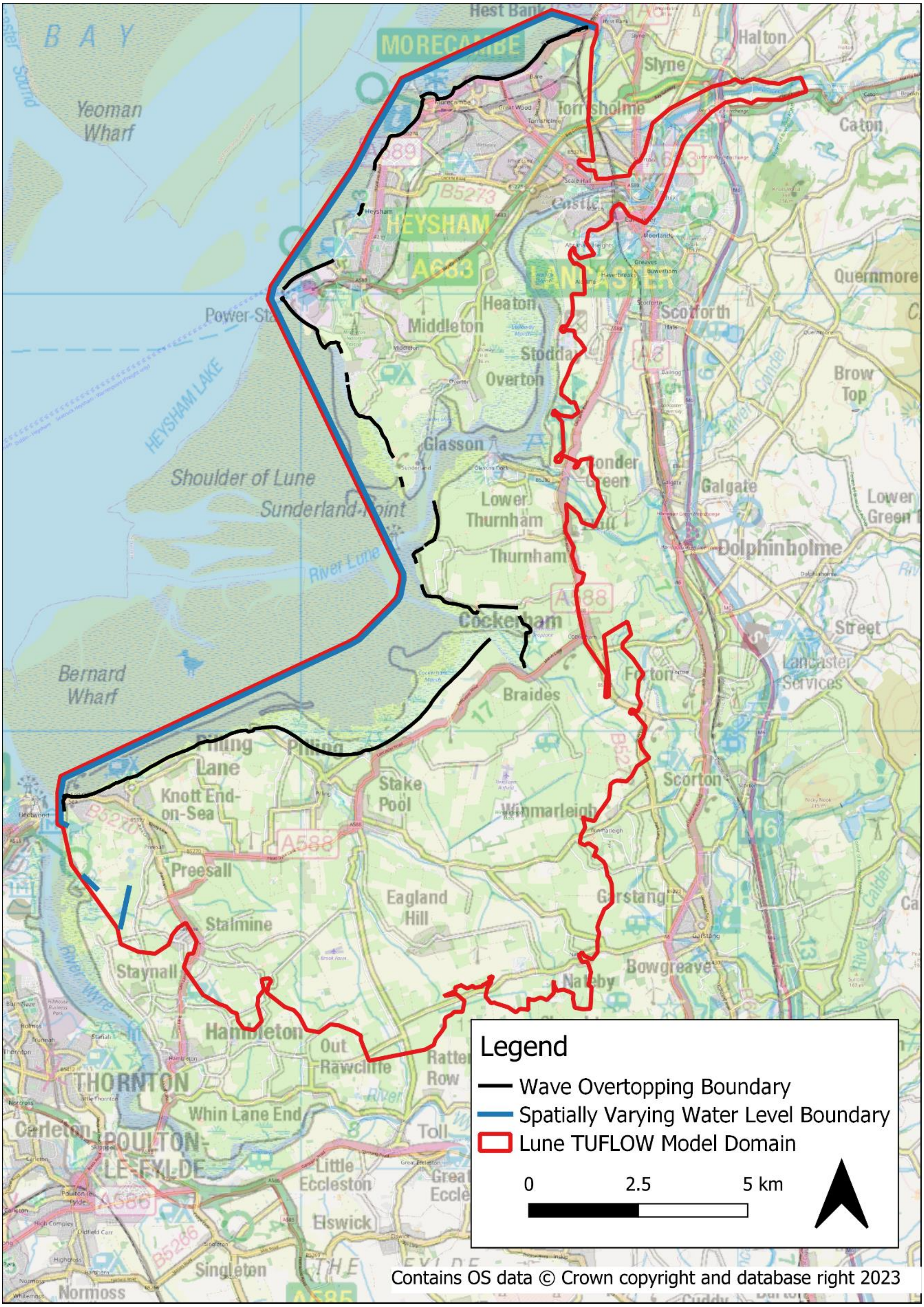

Figure 2-3 Lune 2015 model - tidal water level and wave overtopping boundaries

2.2 Tidal water level curve update

Design tidal water level curves were generated for three Annual Exceedance Probability (AEP) events, namely the 3.3%, 0.5% and 0.1% events. These three AEPs were produced for present day (2024 epoch) and climate change (2124 epoch).

The tide curve generation process used information from three principal sources of data:

- Extreme still water sea level estimates using the 2018 release of the CFBD.
- A design astronomical Mean High-Water Springs tide taken from Blackpool, Fleetwood, Heysham and Morecambe based on its proximity to the model boundary.
- A design surge shape taken from Liverpool and Heysham based on its proximity to the model boundary.

A summary of the data used in the boundary generation for each model is detailed in Table 2-1. Extreme still water sea level estimates were obtained from the 2018 release of the CFB dataset using the same chainage points as per the existing modelling. Each CFB chainage point used in the modelling is located in orange on Figure 2-4, Figure 2-5, and Figure 2-6 for the Blackpool, Wyre and Lune models respectively.

The CFBD estimates are provided for a baseline year of 2017 and were uplifted to account for climate change allowances using UKCP18 Representative Concentration Pathway (RCP) 8.5 70th percentile (Higher Central). The sea level rise uplifts applied in the modelling are detailed in Section 3.

The astronomical tide data was extracted from the Admiralty TotalTide software at Fleetwood, Blackpool (Approaches), and Heysham dependant on proximity to the CFBD data being used in the modelling.

Environment Agency guidance[3] was followed to develop design tidal curves for each model, combing the three sources of data. The peak of the design surge profile was aligned to coincide with the low tide occurring prior to the maximum peak of the MHWS to generate the tidal profile; this provided a more conservative estimate of overall flood volume than when aligning the peak of the surge with the peak of the astronomical tide. The design surge profile was standardised to a value of 1 and scaled by a growth factor, such that when added to the astronomical tide, it achieved the desired extreme sea levels.

The 0.5% AEP present day design tidal curve at Blackpool is shown on Figure 2-7.

[3] Environment Agency. 2018. Coastal flood boundary conditions for the UK: update 2018: User guide. SC060064/TR7.

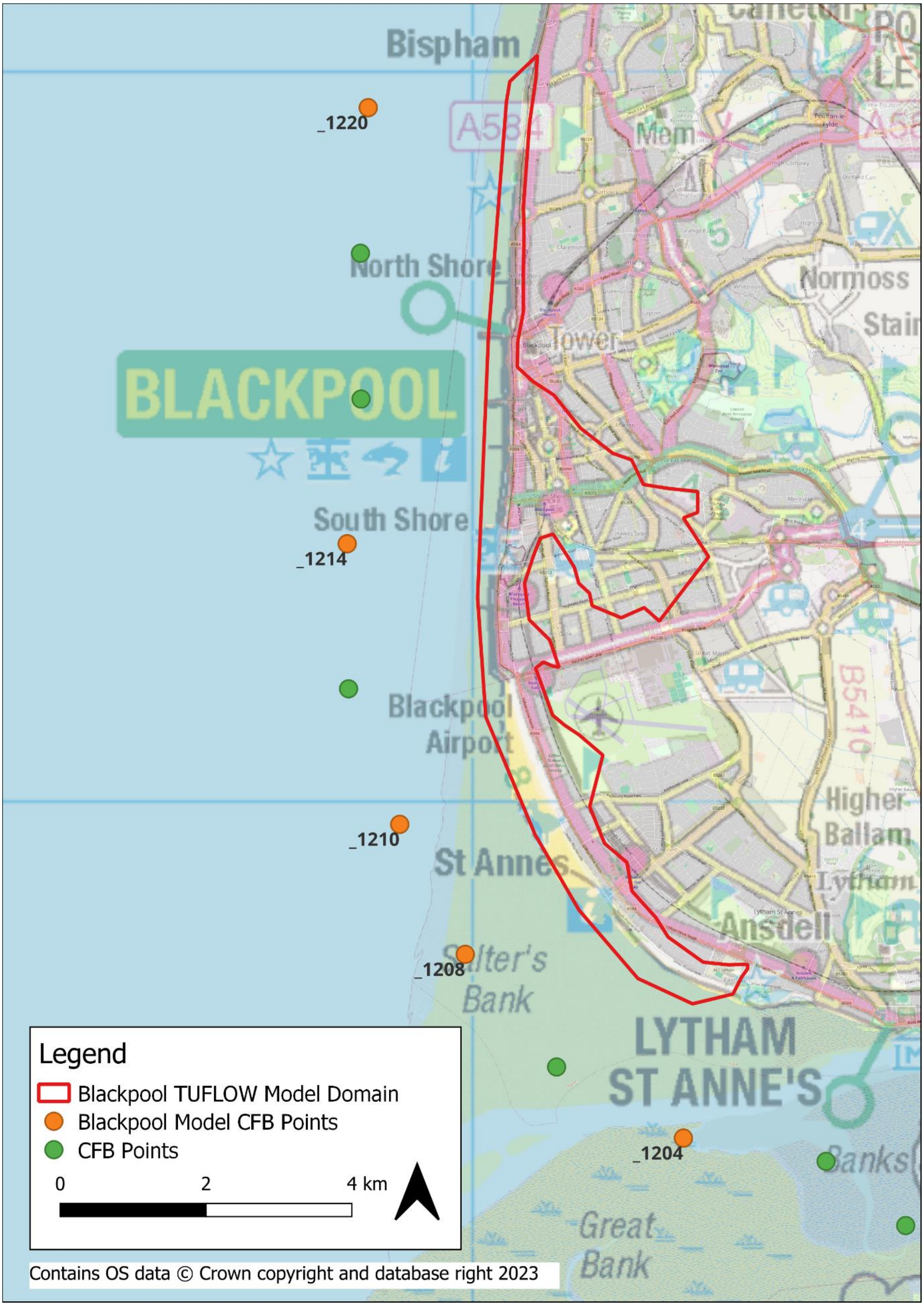

Figure 2-4 Blackpool model - CFB point used for tidal boundary

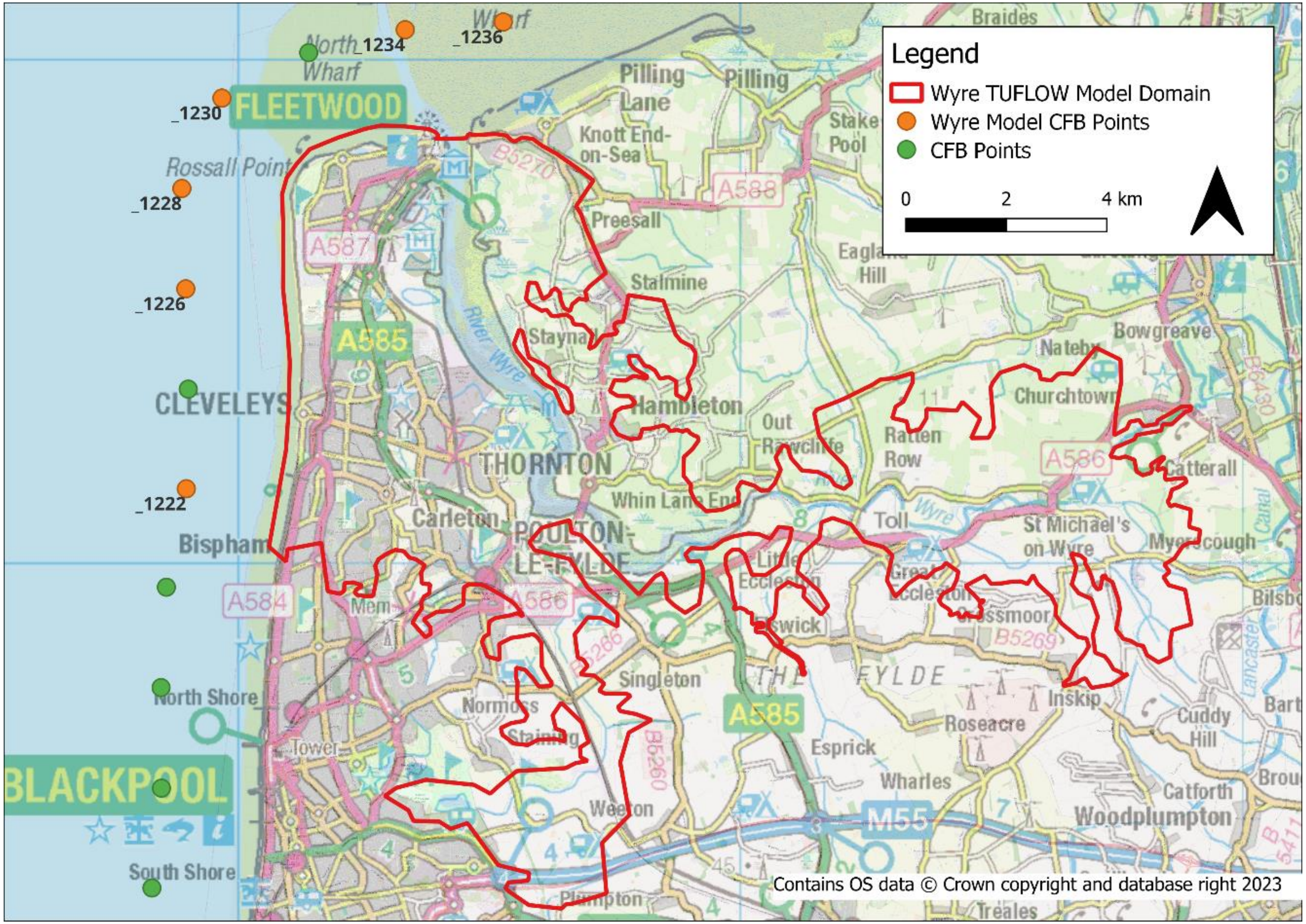

Figure 2-5 Wyre model - CFB point used for tidal boundary

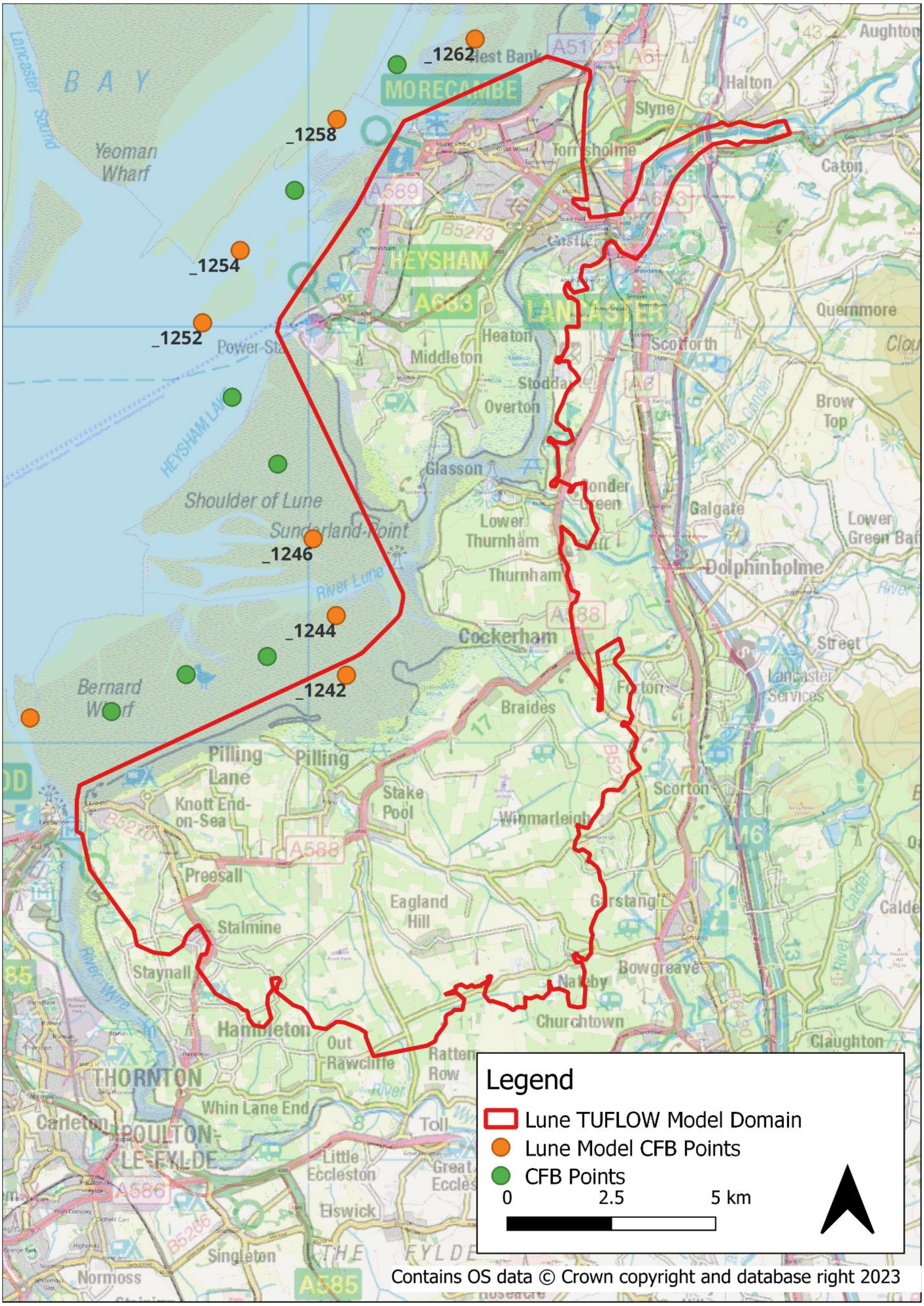

Figure 2-6 Lune model - CFB point used for tidal boundary

Table 2-1 Boundary data for Blackpool, Wyre and Lune models

Model	Extreme Sea Level	Astronomical Tide - Admiralty TotalTide software	Surge Shape Location
Blackpool	CFBD Chainage Points (1204, 1208, 1210, 1214, 1220)	Blackpool from Admiralty TotalTide software (MHWS 4.00mAODN)	Liverpool CFBD design surge shape
Wyre	CFBD Chainage Points (1222, 1226, 1228, 1230, 1234, 1236)	Chainage points 1226, 1228, 1230, 1234, 1236 used Fleetwood (MHWS 4.50mAODN) Chainage point 1222 used Blackpool (MHWS 4.00mAODN)	Liverpool CFBD design surge shape
Lune	CFBD Chainage Points (1234, 1238, 1242, 1244, 1246, 1252, 1254, 1258, 1262, 1264)	Chainage points 1234, 1238, 1242, 1244, 1246 used Fleetwood (MHWS 4.50mAODN) Chainage point 1252 used Morecambe (MHWS 4.60mAODN) Chainage points 1254, 1258, 1262, 1264 used Heysham (MHWS 4.70mAODN)	Heysham CFBD design surge shape

Table 2-2 Blackpool model - Extreme still water levels used in the modelling update

CFB chainage point	Extreme still water levels per AEP (mAOD)					
	3.3%		0.5%		0.1%	
	2024	2124	2024	2124	2024	2124
1204	5.93	6.86	6.23	7.16	6.50	7.43
1208	5.94	6.87	6.25	7.18	6.52	7.45
1210	5.88	6.82	6.19	7.12	6.44	7.37
1214	5.90	6.82	6.23	7.16	6.49	7.42
1220	5.95	6.88	6.29	7.22	6.58	7.51

Table 2-2 Wyre model - Extreme still water levels used in the modelling update

CFB chainage point	Extreme still water levels per AEP (mAOD)					
	3.3%		0.5%		0.1%	
	2024	2124	2024	2124	2024	2124
1222	5.96	6.89	6.29	7.22	6.58	7.51
1226	5.99	6.91	6.34	7.26	6.65	7.57
1228	6.01	6.92	6.36	7.28	6.66	7.58
1230	6.10	7.02	6.46	7.38	6.77	7.69
1234	6.29	7.21	6.66	7.58	6.99	7.91
1236	6.34	7.26	6.70	7.62	7.01	7.93

Table 2-3 Lune model - Extreme still water levels used in the modelling update

CFB chainage point	Extreme still water levels per AEP (mAOD)					
	3.3%		0.5%		0.1%	
	2024	2124	2024	2124	2024	2124
1234	6.29	7.21	6.66	7.58	6.99	7.91
1238	6.38	7.30	6.73	7.65	7.04	7.96
1242	6.46	7.38	6.81	7.73	7.10	8.02
1244	6.50	7.42	6.85	7.77	7.13	8.05
1246	6.49	7.41	6.84	7.76	7.14	8.06
1252	6.47	7.38	6.84	7.76	7.16	8.08
1254	6.52	7.43	6.89	7.81	7.20	8.12
1258	6.73	7.64	7.12	8.04	7.45	8.37
1262	6.93	7.85	7.34	8.26	7.69	8.61
1264	7.01	7.38	7.38	8.30	7.69	8.61

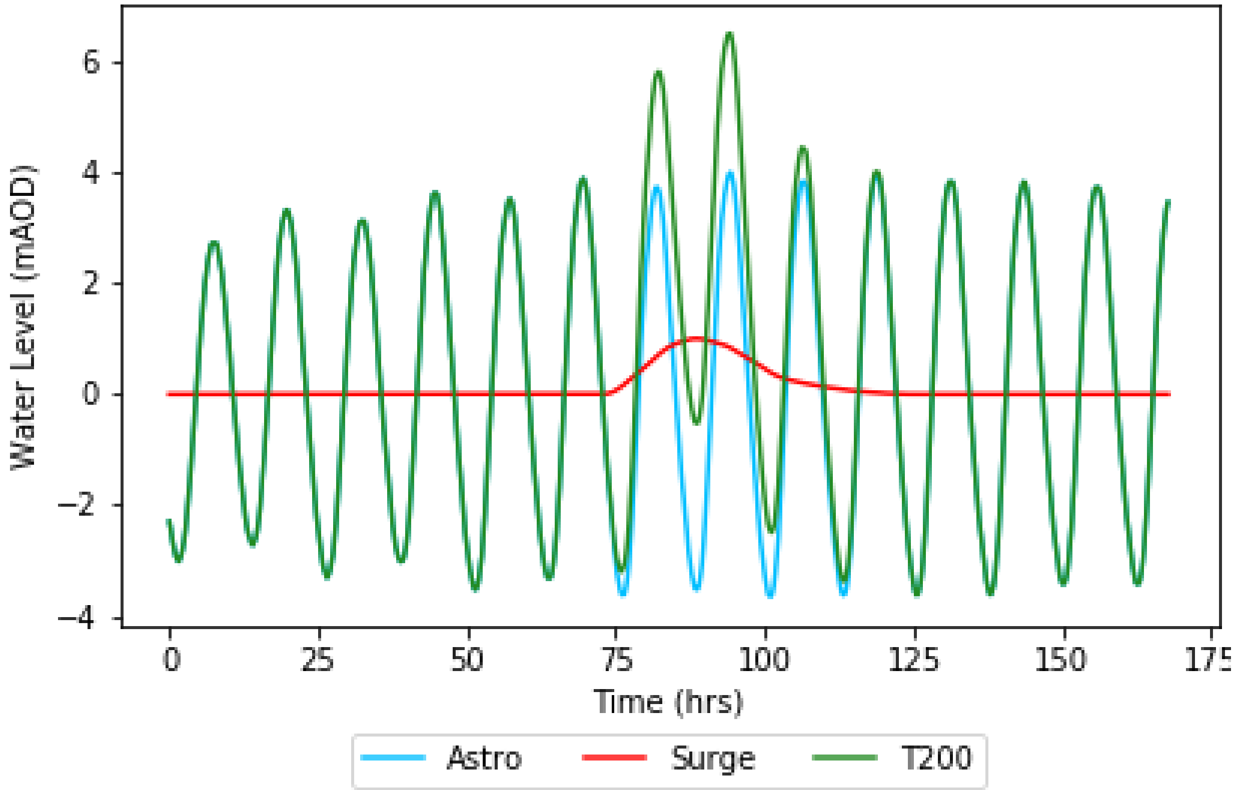

Figure 2-7 Tide curve example at Blackpool - Chainage 1204 0.5% AEP (present day)

2.3 Topographic model updates

As a consequence of updating the model boundary conditions, the existing model domains were assessed to make sure they extend inland further than any potential flooding, to avoid 'glass walling' of flood flows within the model. For each of the models, the domain was extended in some areas to account for increased sea levels and the model topography in these areas was assigned values using the 1m horizontal resolution 2022 Light Detection and Ranging (LIDAR) Composite Digital Terrain Model (DTM) Open-Source data.

In the Wyre model, the Initial Water Levels (IWL) for all boundary points were updated, rather than using a single model IWL across the model domain. This reduced initial "Negative Depth" messages on model start-up. A stability patch was used to increase the Manning's n topographic roughness coefficient within the model to slow water at an area near Wyre dock and improve the model stability.

3 Climate change guidance and uplift summary

Sea level rise estimates were based on the UKCP18 projection pathway guidance using the RCP 8.5 emissions scenario for the 70th percentile Higher Central allowances.

UKCP18 data is published by the Met Office giving an assessment of how the climate of the UK may change over the 21st century. Data on sea level rise is split into a grid that covers the whole UK coastline with each grid cell detailing site-specific sea-level rise for each year through to 2100. These uplifts were extrapolated to the year 2124 for the largest climate change epoch in this study. The UKCP18 grid squares used in this project are at the following locations No. 444 (53.94°, -2.92°), No. 450 (53.94°, -3.08°), No. 451 (53.94°, -2.92°), No. 457 (53.83°, -3.08°), No. 463 (53.72°, -3.08°).

The sea level rise estimates used to uplift the flood inundation model tide curves are detailed in Table 3-1 through Table 3-3.

Table 3-1 Blackpool inundation model - UKCP18 sea level rise uplifts from 2017 base year

Guidance	UKCP18 Grid Square and Location	Epoch	Estimated sea level rise (m) from 2017 base year	Estimated increase in wind speed and wave height (%)
UKCP18	463 (53.72°, -3.08°)	2024	0.032	N/A
UKCP18	463 (53.72°, -3.08°)	2124	0.963	N/A
UKCP18	457 (53.83°, -3.08°)	2024	0.032	N/A
UKCP18	457 (53.83°, -3.08°)	2124	0.957	N/A

Table 3-2 Wyre inundation model - UKCP18 sea level rise uplifts from 2017 base year

Guidance	UKCP18 Grid Square and Location	Epoch	Estimated sea level rise (m) from 2017 base year	Estimated increase in wind speed and wave height (%)
UKCP18	450 (53.94°, -3.08°)	2024	0.032	N/A
UKCP18	450 (53.94°, -3.08°)	2124	0.950	N/A
UKCP18	451 (53.94°, -2.92°)	2024	0.032	N/A
UKCP18	451 (53.94°, -2.92°)	2124	0.955	N/A
UKCP18	457 (53.83°, -3.08°)	2024	0.032	N/A
UKCP18	457 (53.83°, -3.08°)	2124	0.957	N/A

Table 3-3 Lune inundation model - UKCP18 sea level rise uplifts from 2017 base year

Guidance	UKCP18 Grid Square and Location	Epoch	Estimated sea level rise (m) from 2017 base year	Estimated increase in wind speed and wave height (%)
UKCP18	444 (53.94°, -2.92°)	2024	0.032	N/A
UKCP18	444 (53.94°, -2.92°)	2124	0.947	N/A
UKCP18	450 (53.94°, -3.08°)	2024	0.032	N/A
UKCP18	450 (53.94°, -3.08°)	2124	0.950	N/A
UKCP18	451 (53.94°, -2.92°)	2024	0.032	N/A
UKCP18	451 (53.94°, -2.92°)	2124	0.955	N/A

4 Model simulations and outputs

The three hydraulic models covering Blackpool and the Lune and Wyre Estuaries, were simulated for the 3.3%, 0.5% and 0.1% AEP events under the defended scenario 2024 and 2124 epochs.

Wave overtopping modelling was not undertaken as part of this SFRA modelling update. The existing wave overtopping discharges from the 2015 project were available for the 3.3%, 0.5% and 0.1% 2013 epoch, and the 0.5% 2115 climate change epoch.

The water level and existing overtopping event data used in each model simulation are detailed in Table 4-1.

Table 4-1: Modelled event boundary data

Model event and epoch	Water level used - new	Overtopping discharge used - existing
3.3% 2024	3.3% 2024	3.3% 2013
3.3% 2124	3.3% 2124	3.3% 2013
0.5% 2024	0.5% 2024	0.5% 2013
0.5% 2124	0.5% 2124	0.5% 2115
0.1% 2024	0.1% 2024	0.1% 2013
0.1% 2124	0.1% 2124	0.5% 2115

Model outputs for each model simulation include the following:

- Maximum flood depth grid,
- Maximum flood Level grid,
- Maximum velocity grid,
- Hazard rating grid
- Flood outlines*.

**Flood outlines were generated using the maximum flood depth grid model output. The outlines were amended to fill isolated areas <=200m2 and to fill gaps left by wave overtopping as a consequence of inflow being injected on the landward side of the coastal defenses.*

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