Appendix D – EA Product 4 Data

Flood risk assessment data

Location of site: 624223 / 307465 (shown as easting and northing coordinates)
Document created on: 29 March 2022
This information was previously known as a product 4.
Customer reference number: Y8P2767EXHXY

Map showing the location that flood risk assessment data has been requested for.

How to use this information

You can use this information as part of a flood risk assessment for a planning application. To do this, you should include it in the appendix of your flood risk assessment.

> **We recommend that you work with a flood risk consultant to get your flood risk assessment.**

Included in this document

In this document you'll find:

- how to find information about surface water and other sources of flooding
- information on the models used
- definitions for the terminology used throughout
- flood map for planning (rivers and the sea)
- historic flooding
- modelled data
- climate change modelled data
- information about strategic flood risk assessments
- information about this data
- information about flood risk activity permits
- help and advice

Information that's unavailable

This document **does not** contain:

- flood defences and attributes

We aren't able to display flood defence locations and attributes as there are no formal flood defences in the area of interest.

Surface water and other sources of flooding

Use the long term flood risk service to find out about the risk of flooding from:

- surface water
- ordinary watercourses
- reservoirs

For information about sewer flooding, contact the relevant water company for the area.

About the models used

Model name: River Wensum, Norwich, Norfolk, 2017
Scenario(s): Defended fluvial, defences removed fluvial, defended climate change fluvial, defences removed climate change fluvial
Date: 1 August 2017

These models contain the most relevant data for your area of interest.

Terminology used

Annual exceedance probability (AEP)

This refers to the probability of a flood event occurring in any year. The probability is expressed as a percentage. For example, a large flood which is calculated to have a 1% chance of occuring in any one year, is described as 1% AEP.

Metres above ordnance datum (mAOD)

All flood levels are given in metres above ordnance datum which is defined as the mean sea level at Newlyn, Cornwall.

Flood map for planning (rivers and the sea)

Your development is in flood zone 3.

Flood zone 3 shows the area at risk of flooding for an undefended flood event with a:

- 0.5% or greater probability of occurring in any year for flooding from the sea
- 1% or greater probability of occurring in any year for fluvial (river) flooding

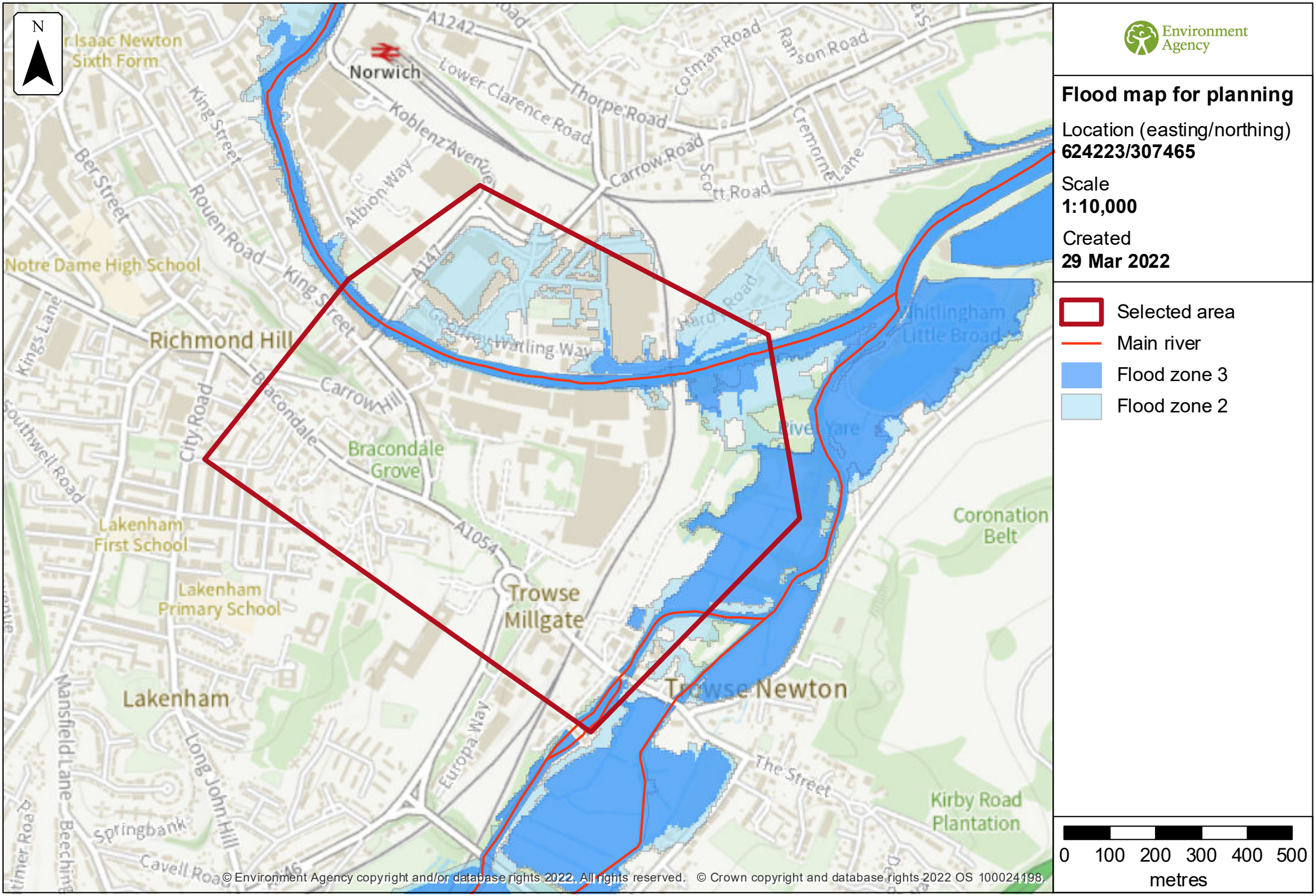
Flood zone 2 shows the area at risk of flooding for an undefended flood event with:

- between a 0.1% and 0.5% probability of occurring in any year for flooding from the sea
- between a 0.1% and 1% probability of occurring in any year for fluvial (river) flooding

It's important to remember that the flood zones on this map:

- refer to the land at risk of flooding and do not refer to individual properties
- refer to the probability of river and sea flooding, ignoring the presence of defences
- do not take into account potential impacts of climate change

This data is updated on a quarterly basis as better data becomes available.


N
Environment Agency
Flood map for planning
Location (easting/northing)
624223/307465
Scale
1:10,000
Created
29 Mar 2022
Selected area
Main river
Flood zone 3
Flood zone 2
0 100 200 300 400 500
metres
Norwich
A1242
Lower Clarence Road
Thorpe Road
Carrow Road
Koblenz Avenue
Albion Way
King Street
Ber Street
Rouen Road
Notre Dame High School
A147
Watling Way
Richmond Hill
Kings Lane
Bracondale
Carrow Hill
City Road
Southwell Road
Bracondale Grove
Lakenham First School
Lakenham Primary School
A1054
Trowse Millgate
Lakenham
Mansfield Lane
Long John Hill
Springbank
Cavell Road
Europa Way
Trowse Newton
The Street
Kirby Road Plantation
Coronation Belt
Whitlingham Little Broad
Cremorne Lane
Ranson Road
Colman Road
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Historic flooding

This map is an indicative outline of areas that have previously flooded. Remember that:

- our records are incomplete, so the information here is based on the best available data
- it is possible not all properties within this area will have flooded
- other flooding may have occurred that we do not have records for
- flooding can come from a range of different sources - we can only supply flood risk data relating to flooding from rivers or the sea

You can also contact your Lead Local Flood Authority or Internal Drainage Board to see if they have other relevant local flood information. Please note that some areas do not have an Internal Drainage Board.

Download recorded flood outlines in GIS format

Environment Agency

Historic flood map

Location (easting/northing)
624223/307465

Scale
1:10,000

Created
29 Mar 2022

Selected area

Main river

Date of flood event

September, 1912

0 100 200 300 400 500
metres

Historic flood event data

Start date	End date	Source of flood	Cause of flood	Affects location
27 September 1912	28 September 1912	main river	unknown	Yes

Modelled data

This section provides details of different scenarios we have modelled and includes the following (where available):

- outline maps showing the area at risk from flooding in different modelled scenarios
- modelled node point map(s) showing the points used to get the data to model the scenarios and table(s) providing details of the flood risk for different return periods
- map(s) showing the approximate water levels for the return period with the largest flood extent for a scenario and table(s) of sample points providing details of the flood risk for different return periods

Climate change

The climate change data included in the models may not include the latest flood risk assessment climate change allowances. Where the new allowances are not available you will need to consider this data and factor in the new allowances to demonstrate the development will be safe from flooding.

The Environment Agency will incorporate the new allowances into future modelling studies. For now, it's your responsibility to demonstrate that new developments will be safe in flood risk terms for their lifetime.

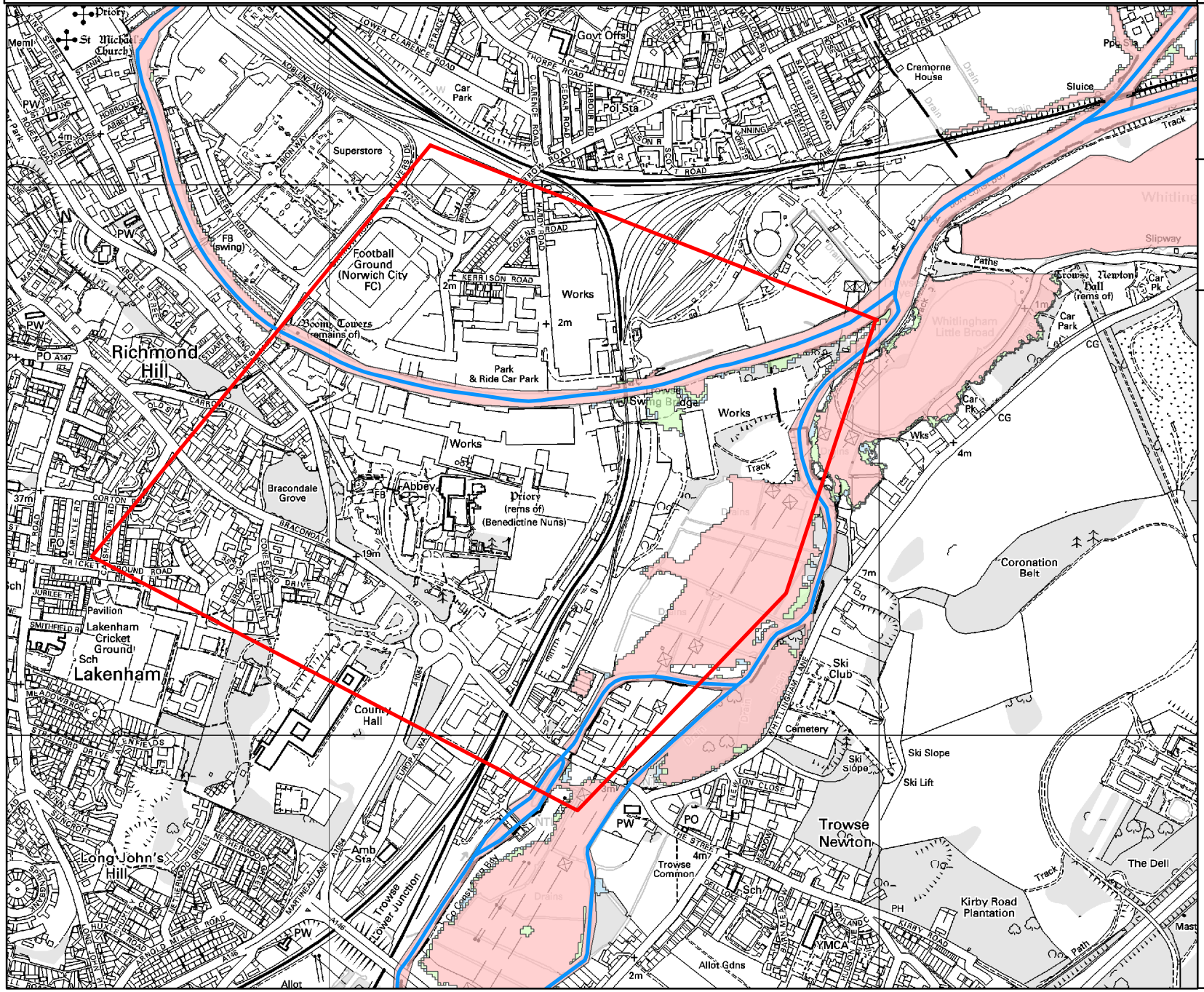
Modelled scenarios

The following scenarios are included:

- Defended modelled fluvial: risk of flooding from rivers where there are flood defences
- Defences removed modelled fluvial: risk of flooding from rivers where flood defences have been removed
- No defences exist modelled fluvial: risk of flooding from rivers where there are no flood defences
- Defended climate change modelled fluvial: risk of flooding from rivers where there are flood defences, including estimated impact of climate change
- Defences removed climate change modelled fluvial: risk of flooding from rivers where flood defences have been removed, including estimated impact of climate change

Wensum 2017 Tidal Modelled Defended Outlines

East Norwich Created: 08/04/2022 Ref: EAN/2022/256173



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 120 240 480

Metres

1:10,000

Legend

- Site Location
- Main Rivers
- 1 in 20 (5%)
- 1 in 200 (0.5%)
- 1 in 1000 (0.1%)

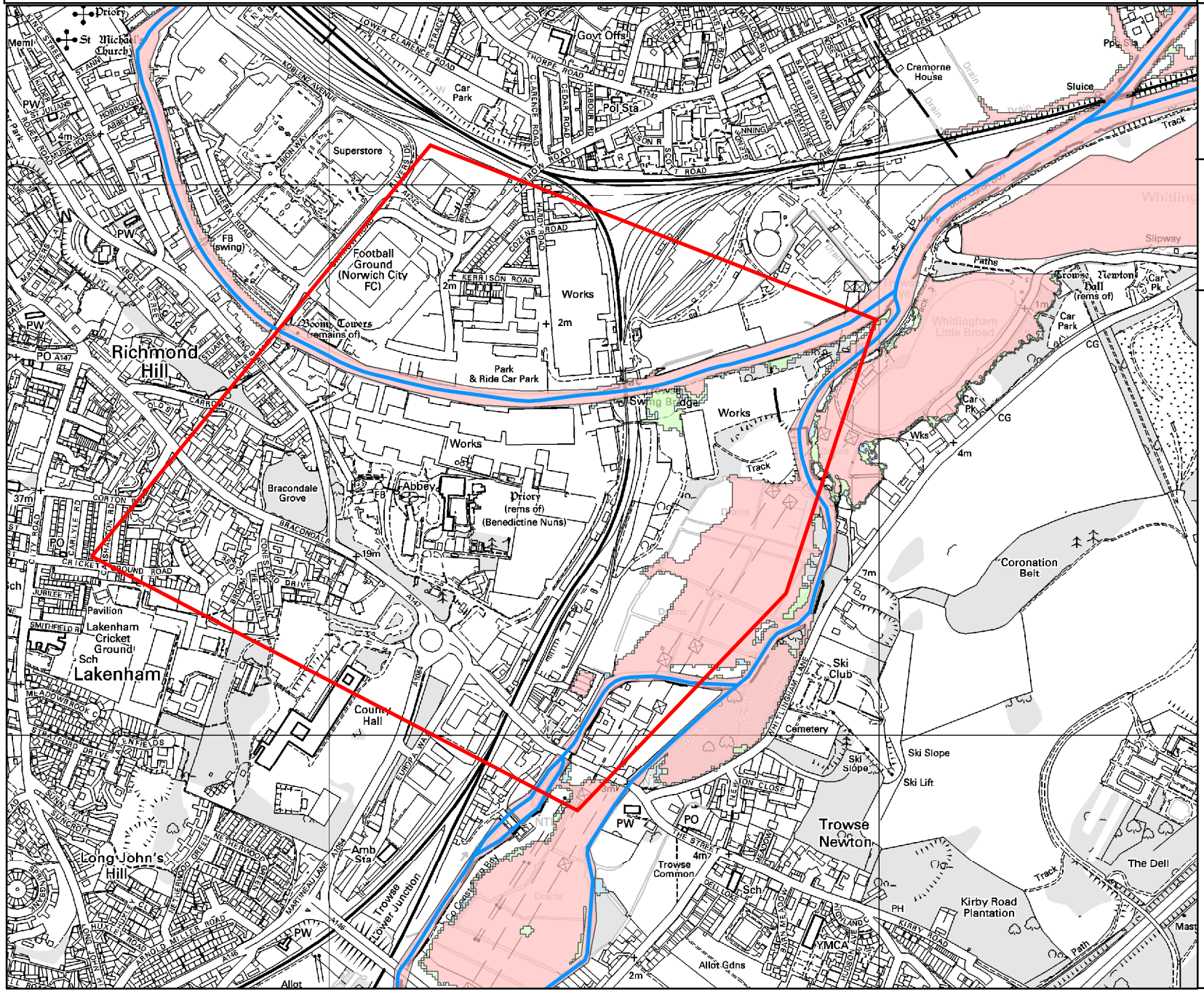
This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Produced by: Partnership & Strategic Overview East Anglia: Essex, Norfolk & Suffolk

Wensum 2017 Tidal Modelled Undefended Outlines

East Norwich Created: 08/04/2022 Ref: EAN/2022/256173



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 120 240 480

Metres

1:10,000

Legend

- Site Location
- Main Rivers
- 1 in 20 (5%)
- 1 in 200 (0.5%)
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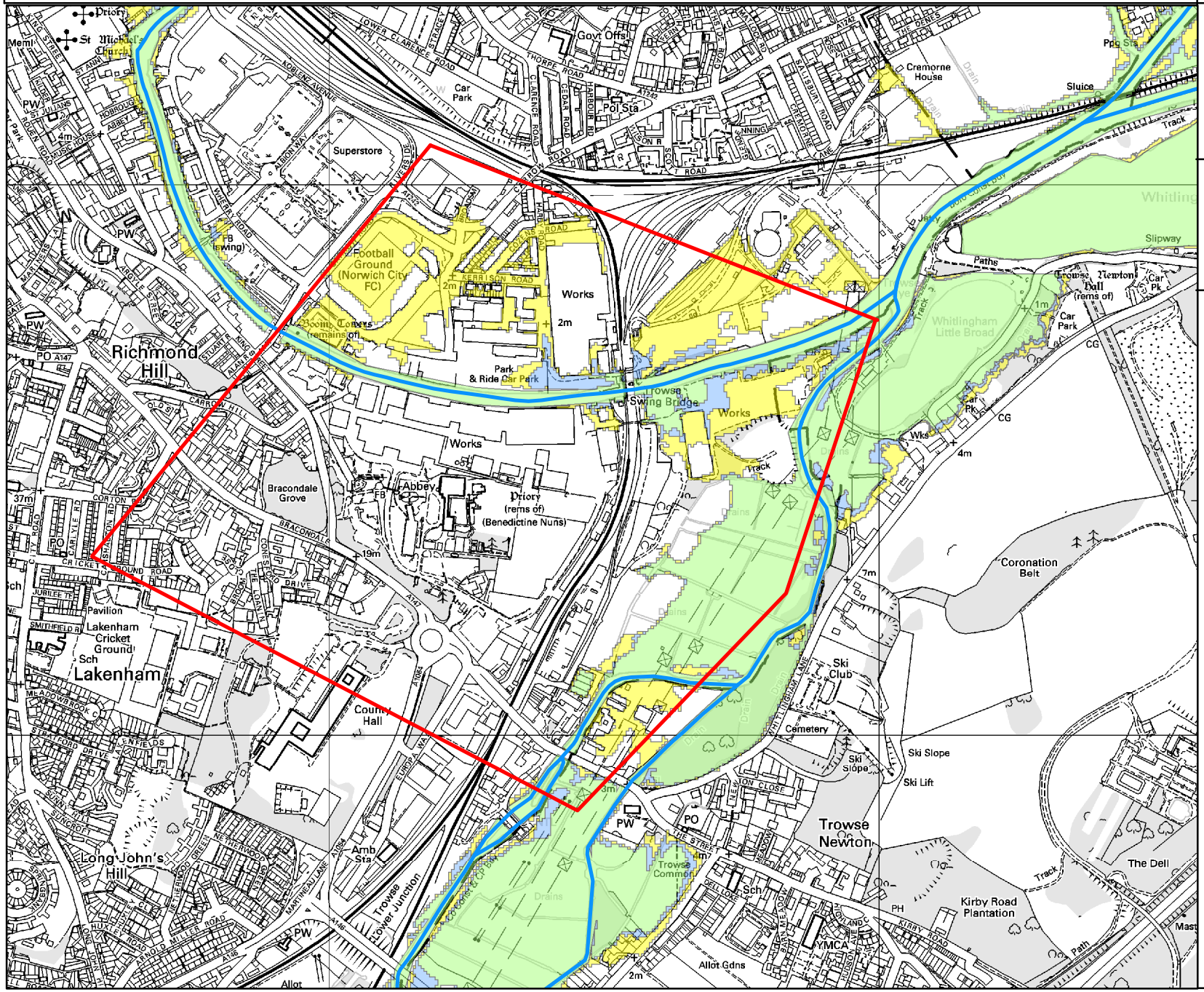
Produced by: Partnership & Strategic Overview
East Anglia: Essex, Norfolk & Suffolk

Wensum 2017 Fluvial Modelled Defended Outlines

East Norwich Created: 08/04/2022 Ref: EAN/2022/256173



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 120 240 480

Metres

1:10,000

Legend

- Site Location
- Main Rivers
- 1 in 20 (5%)
- 1 in 100 (1%)
- 1 in 1000 (0.1%)

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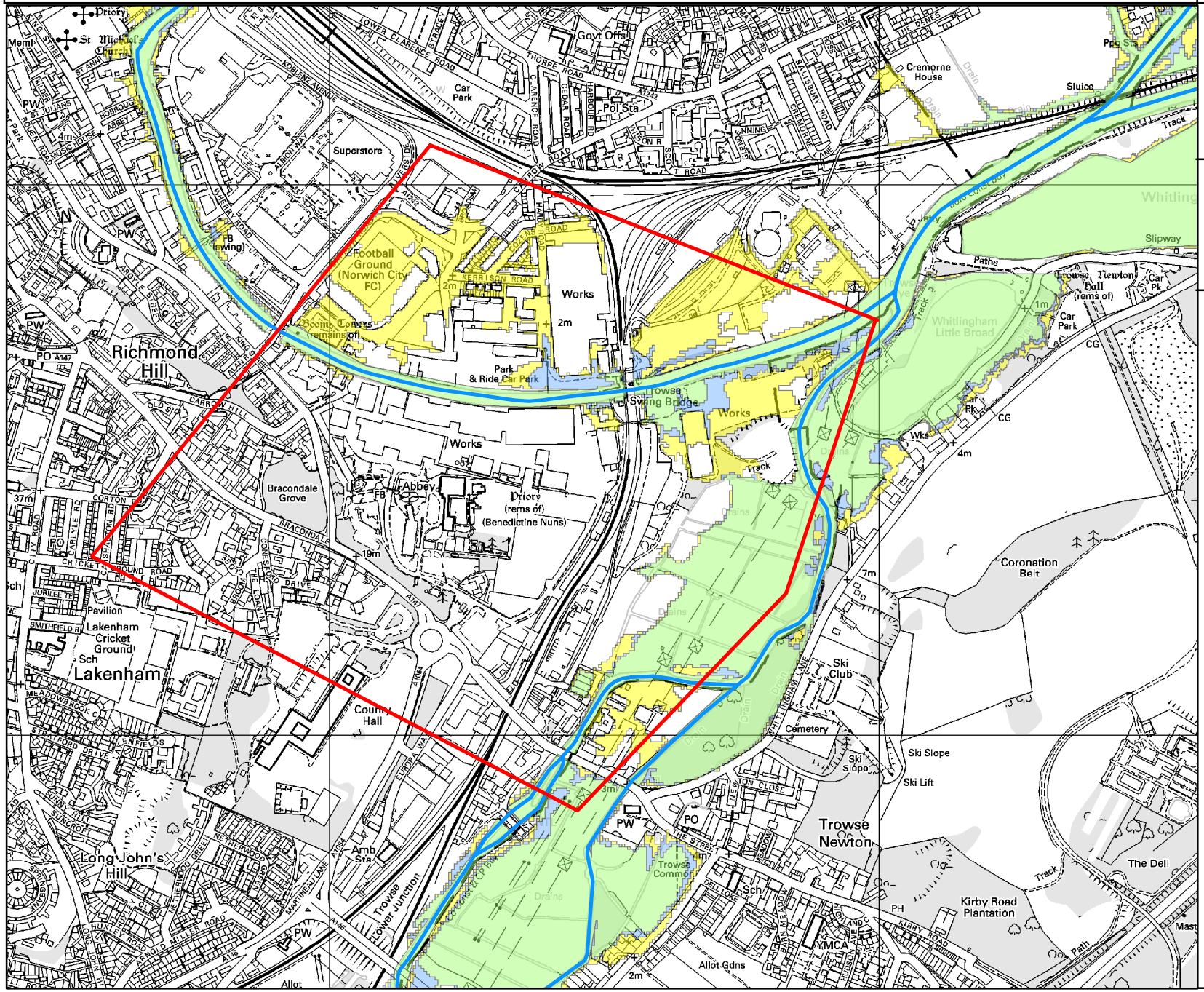
Produced by: Partnership & Strategic Overview
East Anglia: Essex, Norfolk & Suffolk

Wensum 2017 Fluvial Modelled Undefended Outlines

East Norwich Created: 08/04/2022 Ref: EAN/2022/256173



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 120 240 480

Metres

1:10,000

Legend

- Site Location
- Main Rivers
- 1 in 20 (5%)
- 1 in 100 (1%)
- 1 in 1000 (0.1%)

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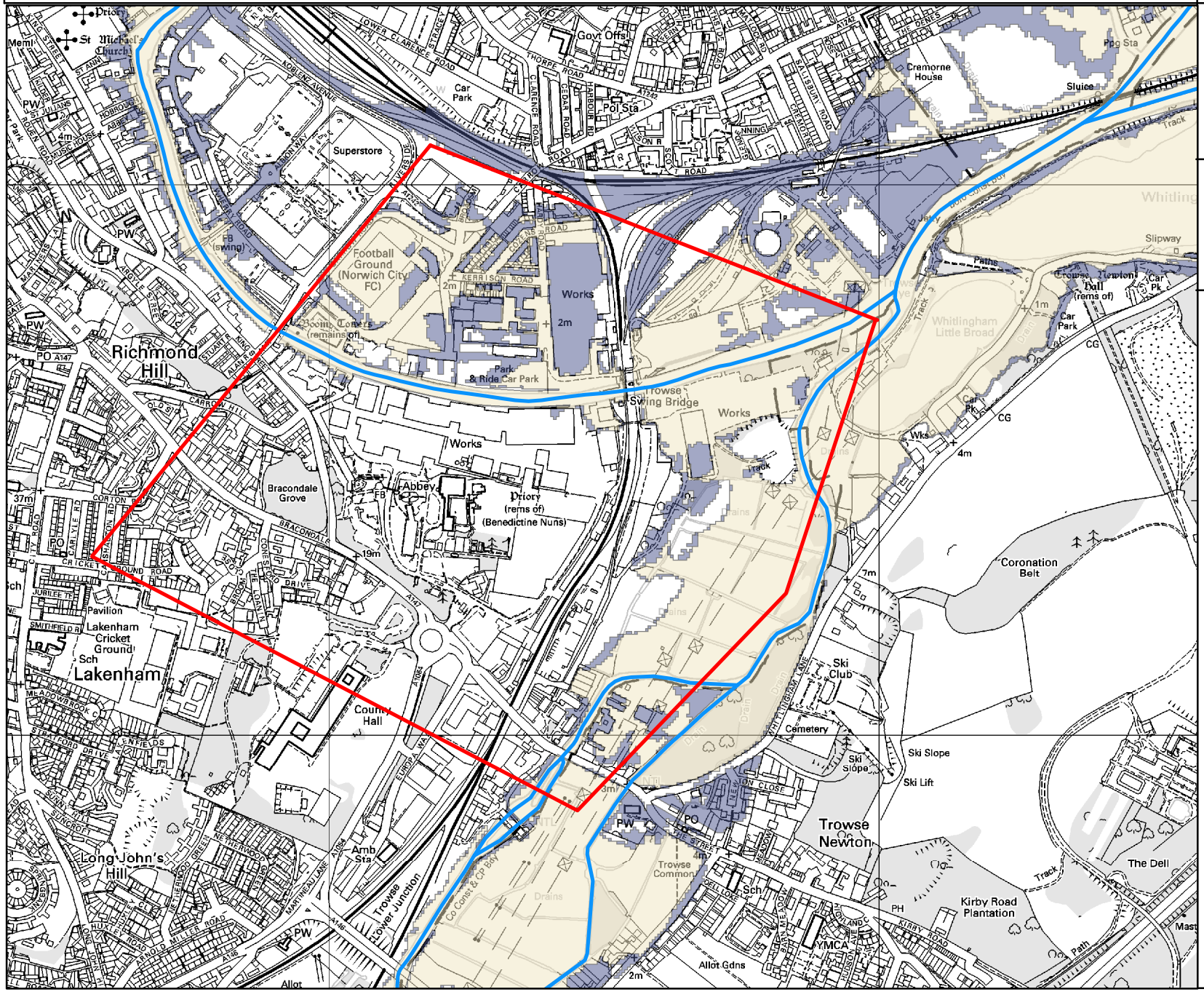
Wensum 2017 Fluvial Modelled Defended Climate Change Outlines

East Norwich Created: 08/04/2022 Ref: EAN/2022/256173



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 120 240 480

Metres

1:10,000

Legend

- Site Location
- Main Rivers
- 1 in 100 + 25% (*CC)
- 1 in 1000 + 25% (*CC)

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

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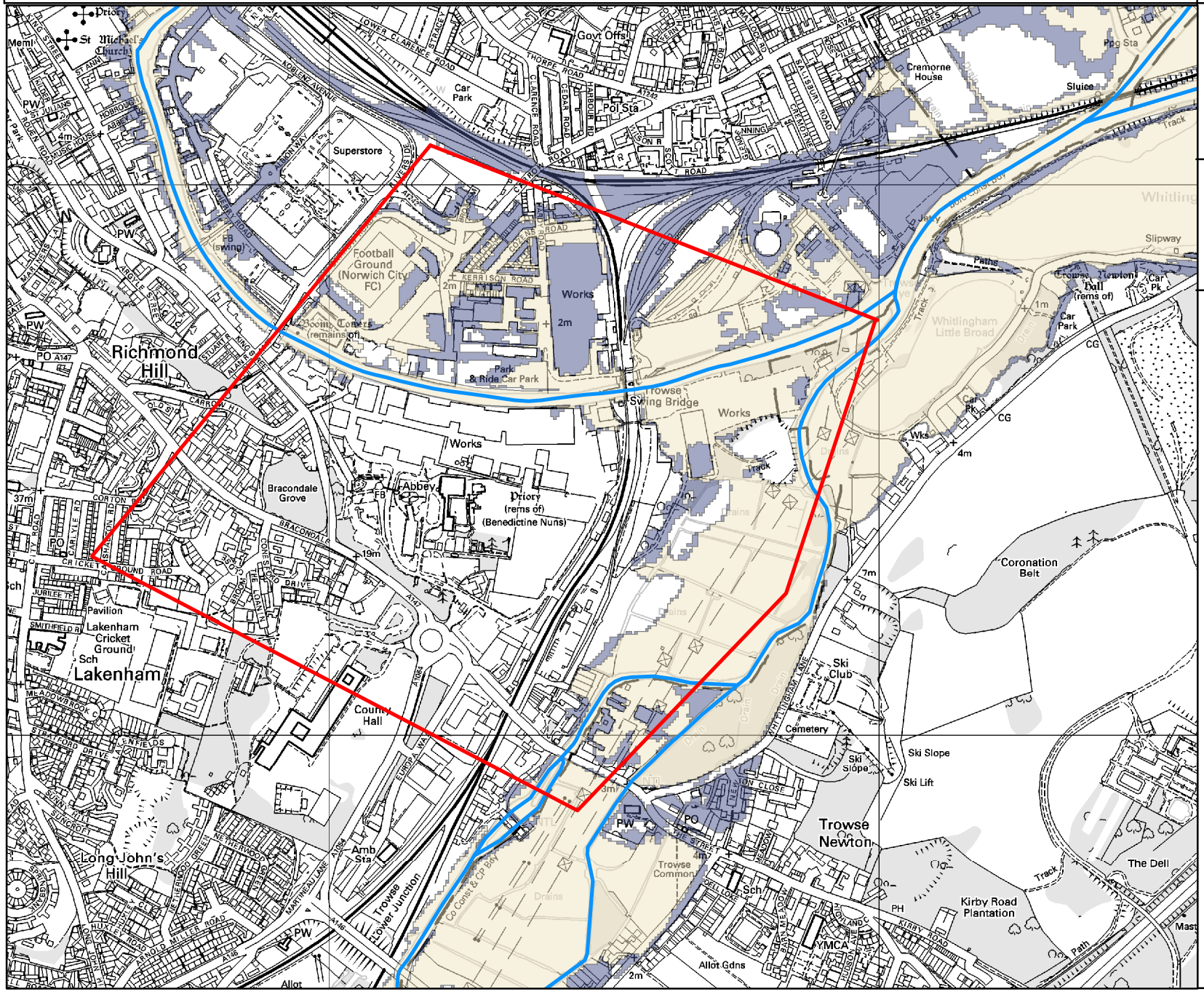
Wensum 2017 Fluvial Modelled Undefended Climate Change Outlines

East Norwich Created: 08/04/2022 Ref: EAN/2022/256173



Environment Agency
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Ipswich
Suffolk
IP3 9JD

N

0 120 240 480

Metres

1:10,000

Legend

- Site Location
- Main Rivers
- 1 in 100 +25% (*CC)
- 1 in 1000 + 25% (*CC)

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

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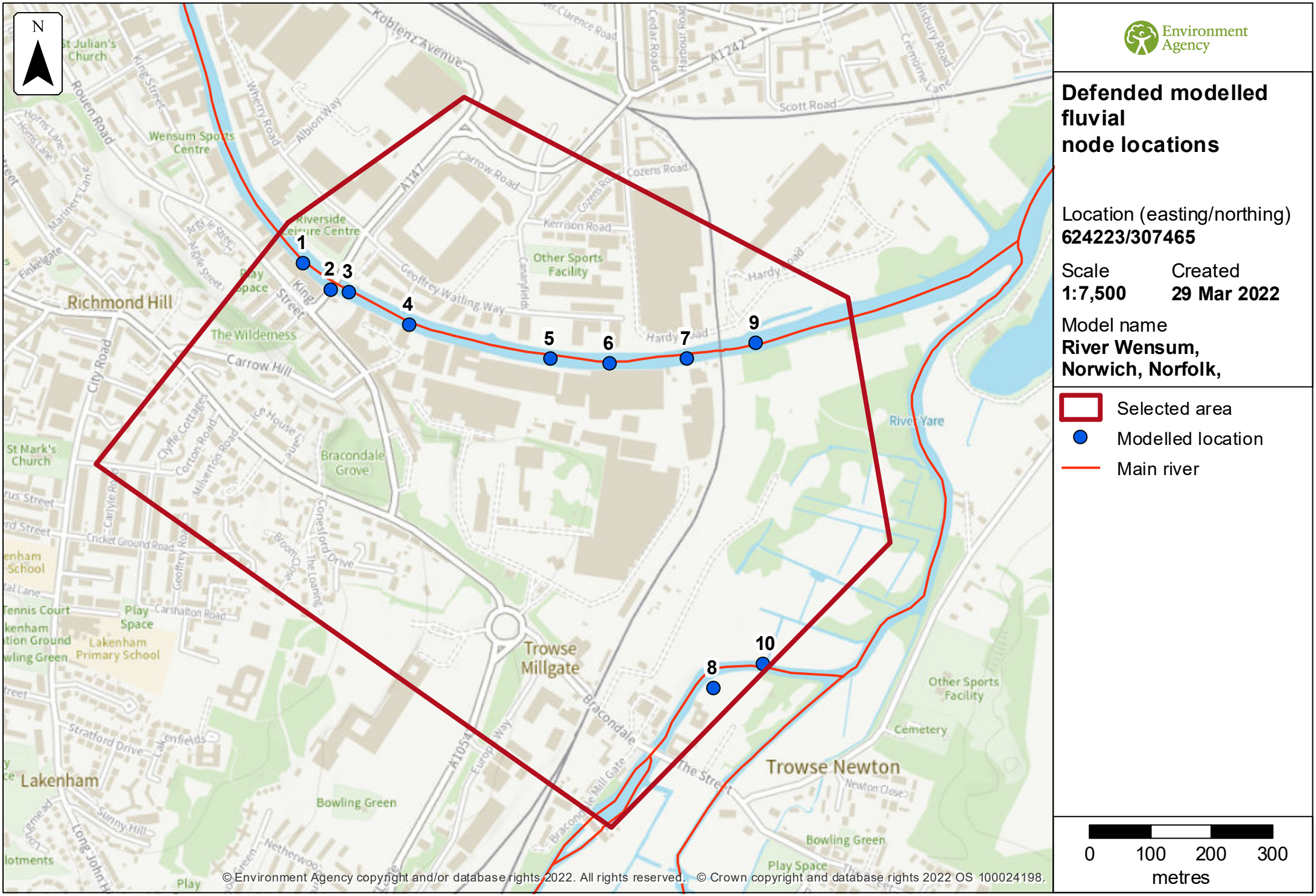
Produced by: Partnership & Strategic Overview
East Anglia: Essex, Norfolk & Suffolk


N
Environment Agency
Defended modelled fluvial node locations
Location (easting/northing)
624223/307465
Scale
1:7,500
Created
29 Mar 2022
Model name
River Wensum, Norwich, Norfolk,
Selected area
Modelled location
Main river
1
2
3
4
5
6
7
8
9
10
Richmond Hill
Trowse Millgate
Trowse Newton
Lakenham
Bracondale Grove
Other Sports Facility
Wensum Sports Centre
Riverside Leisure Centre
Lakenham Primary School
Play Space
Bowling Green
Cemetery
River Yare
0
100
200
300
metres
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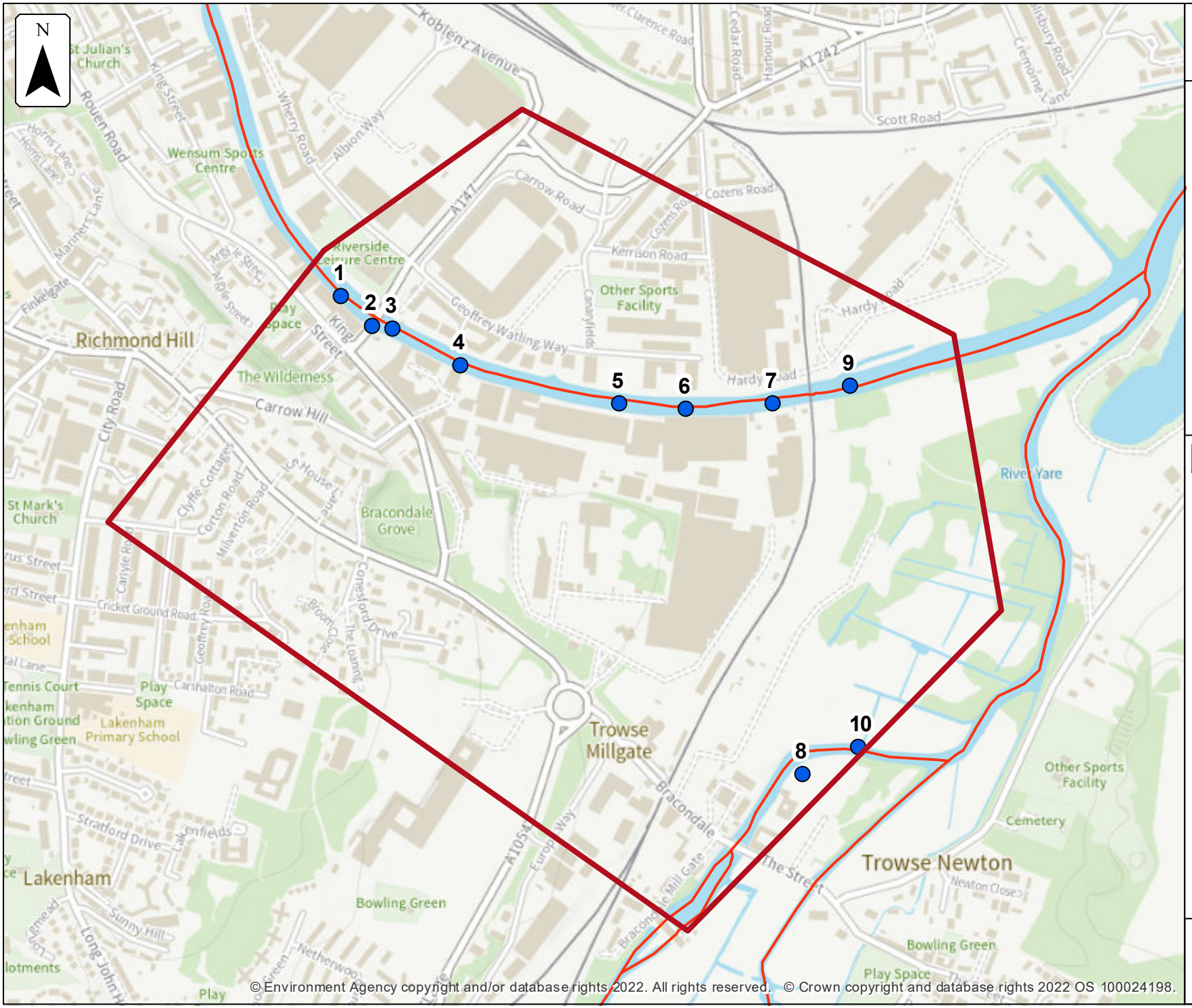
Modelled node locations data

Defended

Label	Modelled location ID	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	919059	623854	307767	1.35	17.50	1.68	59.40	1.75	64.94	1.78	66.85	1.43	17.50	2.24	113.56
2	919115	623901	307723	1.56	51.42	1.68	59.42	1.75	64.96	1.77	66.86	1.43	17.54	1.48	16.57
3	919311	623929	307720	1.34	17.59	1.66	59.44	1.72	64.97	1.74	66.87	1.92	83.68	2.18	113.58
4	919145	624030	307665	1.34	17.80	1.65	59.48	1.71	65.01	1.73	66.91	1.42	17.80	1.47	16.72
5	919091	624262	307611	1.50	51.54	1.62	59.59	1.68	65.10	1.69	66.98	1.42	18.18	2.10	113.23
6	918999	624359	307602	1.49	51.58	1.61	59.64	1.67	65.14	1.67	67.02	1.42	18.25	2.08	113.42
7	919212	624486	307610	1.34	18.66	1.59	59.70	1.65	65.18	1.65	67.06	1.42	18.66	2.05	109.16
8	919078	624530	307068	1.57	26.98	1.68	31.14	1.72	33.46	1.71	34.84	1.42	5.90	2.07	49.40
9	919213	624598	307636	1.48	51.66	1.59	59.76	1.65	65.23	1.65	67.10	1.79	82.52	1.47	18.05
10	919002	624609	307109	1.58	26.66	1.69	28.37	1.74	28.31	1.73	27.90	1.42	5.84	1.47	5.84

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.



Environment Agency

Defences removed modelled fluvial node locations

Location (easting/northing)
624223/307465

Scale
1:7,500

Created
29 Mar 2022

Model name
River Wensum, Norwich, Norfolk,

Selected area

Modelled location

Main river

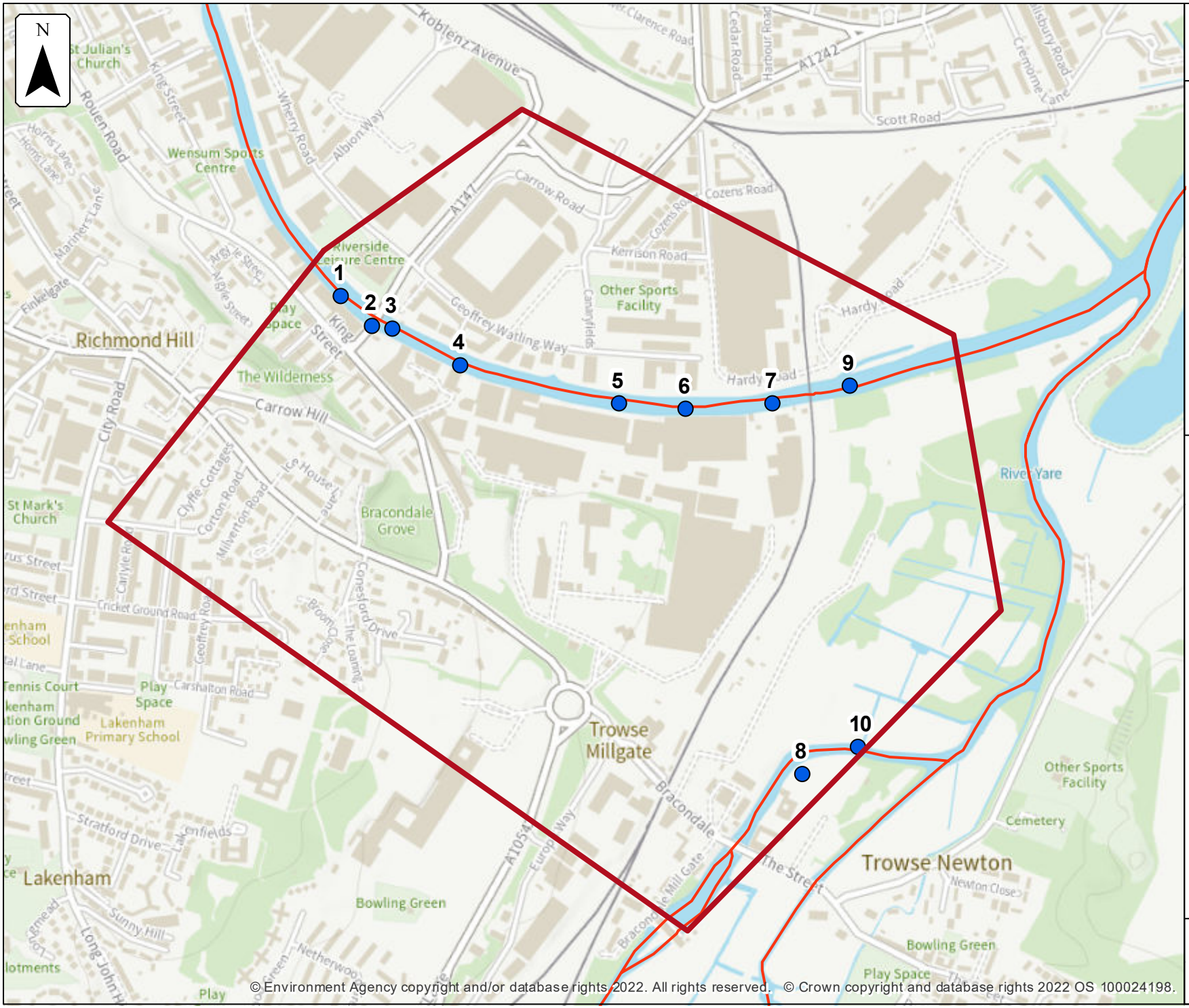
0 100 200 300
metres

Modelled node locations data

Defences removed

Label	Modelled location ID	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	919059	623854	307767	1.57	51.43	1.68	59.43	1.75	64.98	1.78	66.96	1.95	83.45	2.25	113.47
2	919115	623901	307723	1.56	51.45	1.68	59.45	1.75	65.0	1.77	66.97	1.94	83.37	1.48	16.57
3	919311	623929	307720	1.54	51.46	1.66	59.47	1.72	65.01	1.75	66.98	1.90	83.62	2.19	113.43
4	919145	624030	307665	1.53	51.49	1.65	59.52	1.71	65.05	1.73	67.02	1.42	17.80	2.17	113.26
5	919091	624262	307611	1.50	51.57	1.62	59.63	1.68	65.14	1.70	67.09	1.84	83.58	1.47	17.05
6	918999	624359	307602	1.49	51.60	1.60	59.68	1.67	65.18	1.69	67.13	1.81	83.58	2.08	113.35
7	919212	624486	307610	1.48	51.64	1.59	59.74	1.65	65.23	1.67	67.17	1.79	82.25	2.06	109.17
8	919078	624530	307068	1.57	26.98	1.68	31.14	1.72	33.46	1.74	34.83	1.84	39.67	2.07	49.40
9	919213	624598	307636	1.48	51.68	1.59	59.80	1.65	65.27	1.67	67.21	1.78	82.40	2.06	110.80
10	919002	624609	307109	1.58	26.66	1.69	28.37	1.74	28.31	1.75	27.90	1.85	28.90	2.08	39.51

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.



Environment Agency

Defended climate change modelled fluvial node locations

Location (easting/northing)
624223/307465

Scale
1:7,500

Created
29 Mar 2022

Model name
River Wensum, Norwich, Norfolk,

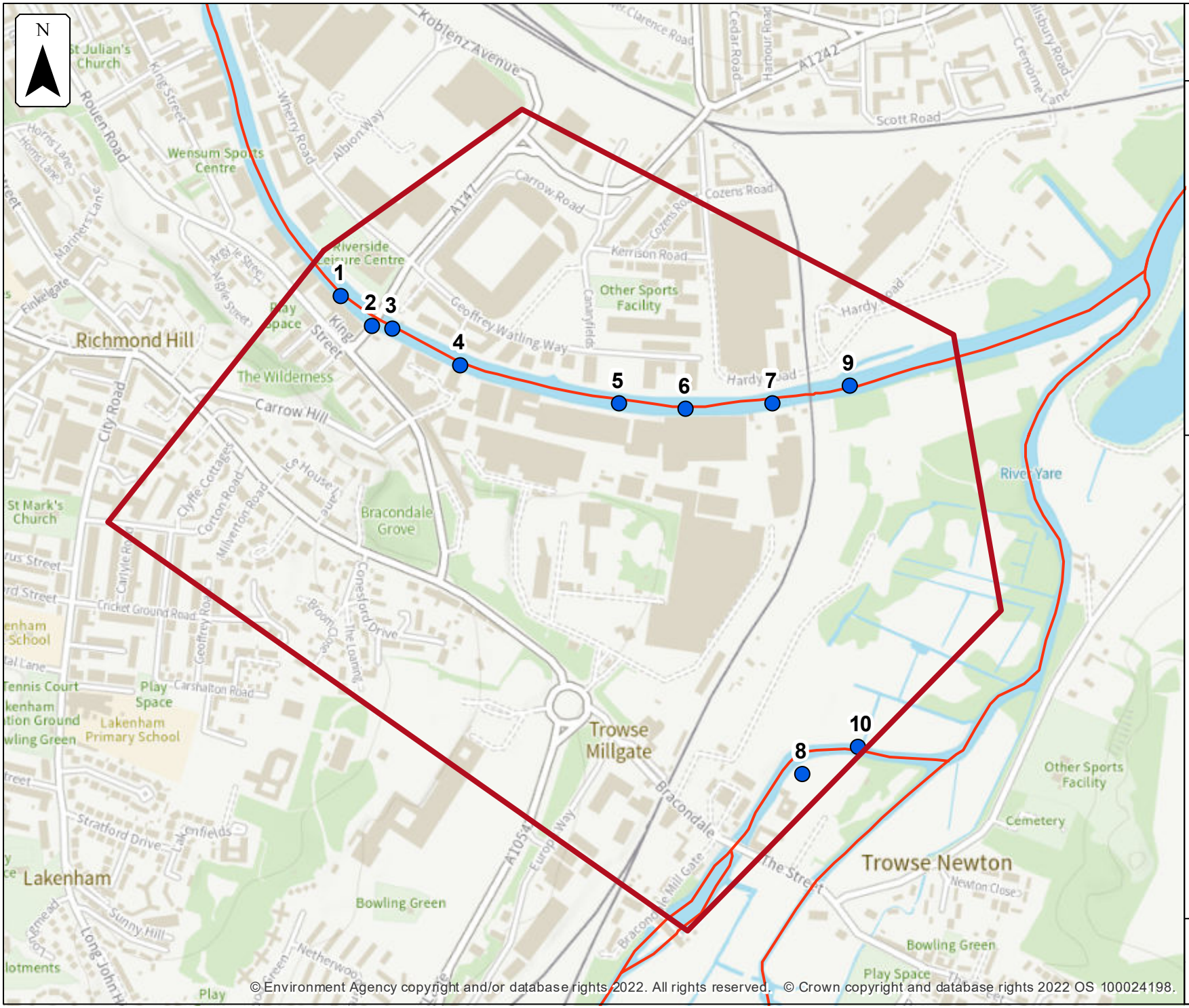
Selected area
Modelled location
Main river

Modelled node locations data

Defended climate change

Label	Modelled location ID	Easting	Northing	1.0% AEP (+20%)		1.0% AEP (+25%)		1.0% AEP (+35%)		1.0% AEP (+65%)		0.5% AEP (+20%)		0.5% AEP (+25%)		0.5% AEP (+35%)		0.5% AEP (+65%)		0.1% AEP (+20%)		0.1% AEP (+25%)	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	919059	623854	307767	2.16	85.94	2.25	92.37	2.32	96.38	2.53	124.92	2.36	104.57	2.40	108.16	2.50	122.86	2.83	156.04	2.51	138.97	2.67	143.98
2	919115	623901	307723	2.15	85.14	2.24	91.17	2.31	94.96	2.52	119.42	2.34	103.03	2.38	106.36	2.49	118.21	2.82	151.12	2.50	134.38	2.66	136.60
3	919311	623929	307720	2.12	85.86	2.19	92.18	2.26	95.98	2.45	123.86	2.30	104.21	2.33	107.58	2.43	122.01	2.74	156.79	2.42	138.21	2.58	142.37
4	919145	624030	307665	2.11	85.79	2.17	91.82	2.24	95.70	2.43	120.58	2.28	103.70	2.32	107.05	2.40	119.26	2.71	148.73	2.39	136.29	2.56	136.75
5	919091	624262	307611	2.08	85.67	2.12	91.73	2.19	95.56	2.36	120.79	2.23	103.59	2.27	107.0	2.34	119.37	2.62	149.41	2.30	136.12	2.49	136.96
6	918999	624359	307602	2.06	85.82	2.11	92.03	2.17	95.71	2.33	120.88	2.21	103.69	2.25	106.93	2.31	119.11	2.58	149.20	2.26	135.63	2.46	136.70
7	919212	624486	307610	2.05	81.91	2.10	87.23	2.15	90.76	2.30	114.48	2.19	98.11	2.23	101.22	2.29	113.12	2.54	140.63	2.22	129.61	2.44	128.91
8	919078	624530	307068	2.07	41.27	2.11	42.85	2.16	46.03	2.30	55.16	2.18	46.56	2.22	48.33	2.29	51.67	2.52	60.26	2.20	58.06	2.46	58.32
9	919213	624598	307636	2.05	83.33	2.09	88.66	2.15	92.29	2.29	115.36	2.19	99.70	2.23	103.05	2.28	114.03	2.54	143.04	2.21	131.30	2.43	130.37
10	919002	624609	307109	2.07	32.90	2.11	34.62	2.16	37.89	2.30	47.0	2.18	38.0	2.23	39.62	2.29	43.13	2.52	53.13	2.21	47.88	2.46	50.88

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.



Environment Agency

Defences removed climate change modelled fluvial node locations

Location (easting/northing)
624223/307465

Scale
1:7,500

Created
29 Mar 2022

Model name
River Wensum, Norwich, Norfolk,

- Selected area
- Modelled location
- Main river

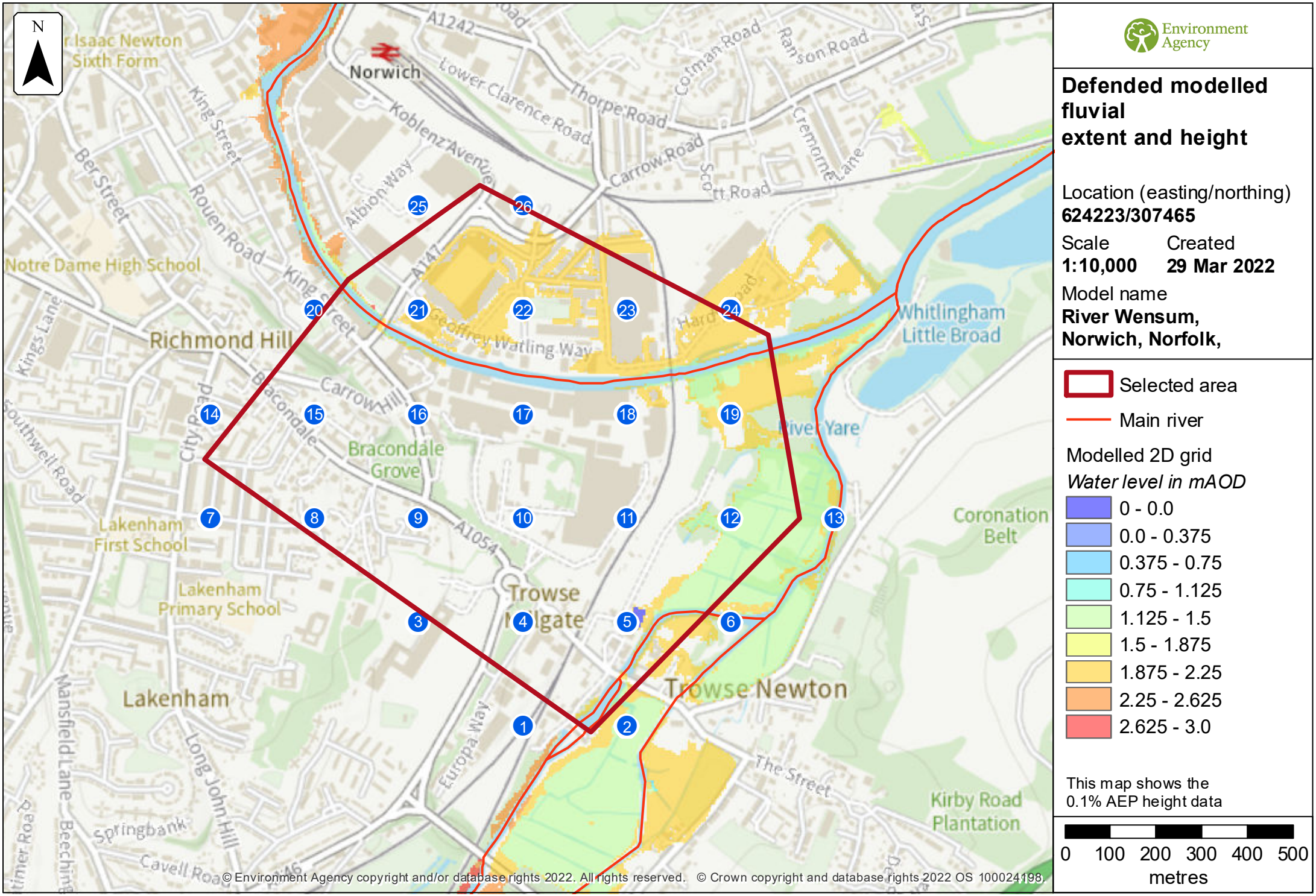
0 100 200 300
metres

Modelled node locations data

Defences removed climate change

Label	Modelled location ID	Easting	Northing	1.0% AEP (+25%)		1.0% AEP (+35%)		1.0% AEP (+65%)		0.5% AEP (+25%)		0.5% AEP (+65%)		0.1% AEP (+20%)		0.1% AEP (+25%)	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	919059	623854	307767	2.26	92.58	2.32	96.29	2.53	124.95	2.40	107.90	2.83	156.61	2.96	171.17	2.67	144.06
2	919115	623901	307723	2.24	91.31	2.31	94.98	2.52	119.39	2.38	106.19	2.82	151.15	2.94	164.65	2.66	136.99
3	919311	623929	307720	2.20	92.32	2.26	95.98	2.45	123.97	2.34	107.48	2.74	156.78	2.85	170.01	2.59	143.42
4	919145	624030	307665	2.18	92.09	2.25	95.82	2.42	120.59	2.32	107.0	2.71	148.85	2.82	160.98	2.57	137.79
5	919091	624262	307611	2.13	91.98	2.20	95.56	2.36	120.89	2.28	106.88	2.62	149.51	2.73	161.10	2.50	138.07
6	918999	624359	307602	2.11	92.30	2.18	95.82	2.32	120.58	2.25	107.12	2.58	149.39	2.68	161.23	2.47	138.04
7	919212	624486	307610	2.10	87.38	2.16	90.84	2.30	114.28	2.24	101.39	2.54	140.76	2.64	152.59	2.45	130.56
8	919078	624530	307068	2.11	42.85	2.17	46.03	2.30	55.18	2.22	48.33	2.52	60.27	2.60	56.60	2.46	58.40
9	919213	624598	307636	2.09	88.80	2.16	92.29	2.29	115.49	2.23	102.98	2.54	143.22	2.63	155.36	2.44	132.01
10	919002	624609	307109	2.11	34.59	2.17	37.87	2.30	46.98	2.23	39.62	2.52	53.11	2.61	49.0	2.46	50.94

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.



Environment Agency

Defended modelled fluvial extent and height

Location (easting/northing)
624223/307465

Scale
1:10,000

Created
29 Mar 2022

Model name
River Wensum, Norwich, Norfolk,

Selected area

Main river

Modelled 2D grid
Water level in mAOD

- 0 - 0.0
- 0.0 - 0.375
- 0.375 - 0.75
- 0.75 - 1.125
- 1.125 - 1.5
- 1.5 - 1.875
- 1.875 - 2.25
- 2.25 - 2.625
- 2.625 - 3.0

This map shows the 0.1% AEP height data

0 100 200 300 400 500
metres

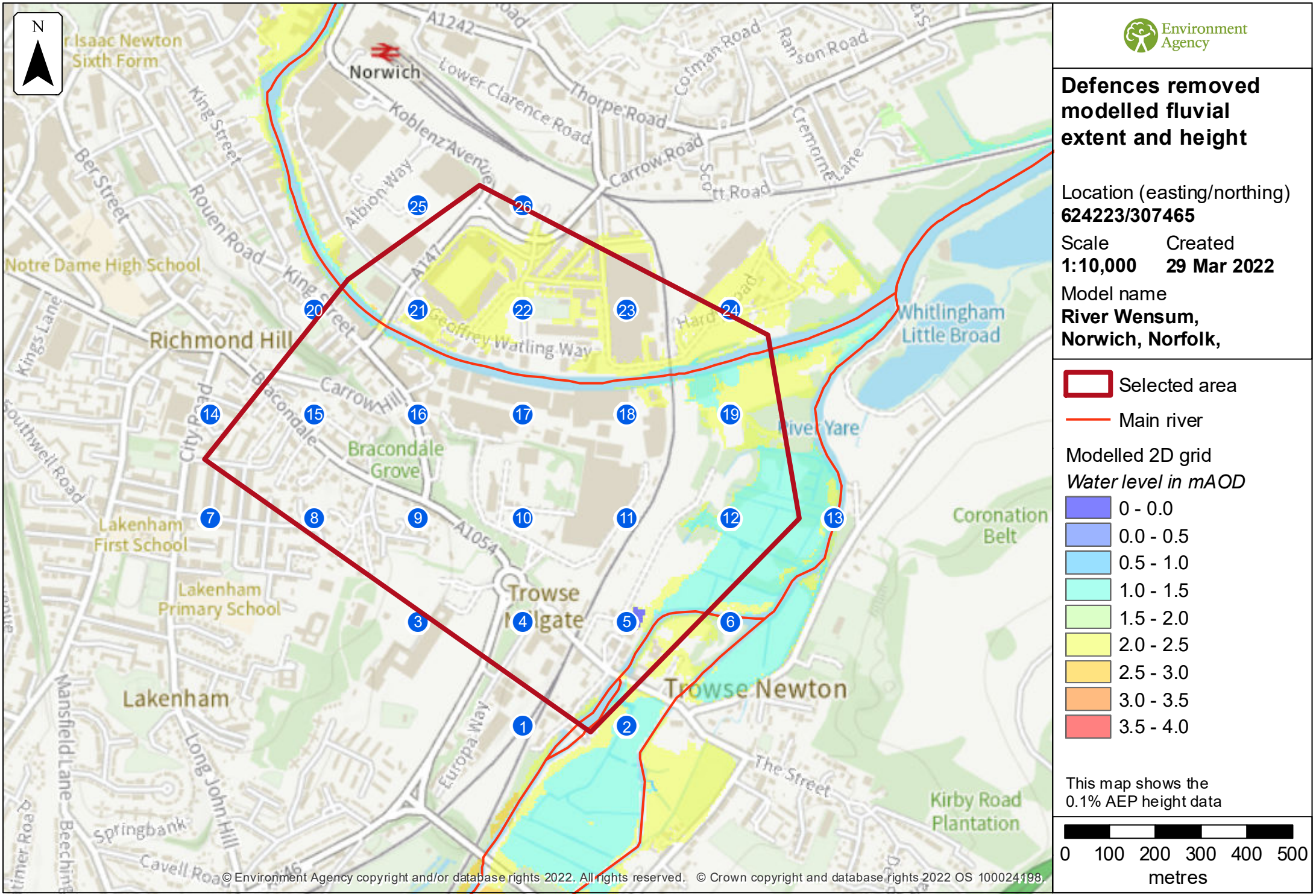
Sample point data

Defended

Label	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
1	624212	306855	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
2	624440	306855	0.73	1.64	0.86	1.77	0.91	1.82	0.94	1.85	0.52	1.43	0.56	1.47
3	623984	307083	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
4	624212	307083	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
5	624440	307083	0.09	0	0.09	0	0.09	0	0.09	0	0.09	0	0.09	0
6	624668	307083	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.40	2.08
7	623528	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
8	623756	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
9	623984	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
10	624212	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
11	624440	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
12	624668	307311	0.30	1.57	0.40	1.67	0.45	1.73	0.47	1.74	0.15	1.43	0.20	1.47
13	624896	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
14	623528	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
15	623756	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
16	623984	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData

Label	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
17	624212	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
18	624440	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
19	624668	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.24	2.03
20	623756	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
21	623984	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.57	2.02
22	624212	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.13	2.02
23	624440	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
24	624668	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.30	2.03
25	623984	307995	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
26	624212	307995	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Height values are shown in mAOD, and depth values are shown in metres.
Any blank cells show where a particular scenario has not been modelled for this location.
Cells which contain text 'NoData' for a scenario show that return period has been modelled but there is no flood risk for that return period for that location.


N
Environment Agency
Defences removed modelled fluvial extent and height
Location (easting/northing)
624223/307465
Scale
1:10,000
Created
29 Mar 2022
Model name
River Wensum, Norwich, Norfolk,
Selected area
Main river
Modelled 2D grid
Water level in mAOD
0 - 0.0
0.0 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
3.0 - 3.5
3.5 - 4.0
This map shows the 0.1% AEP height data
0 100 200 300 400 500
metres
Norwich
Richmond Hill
Bracondale Grove
Lakenham
Lakenham First School
Lakenham Primary School
Trowse Newton
Whitlingham Little Broad
River Yare
Coronation Belt
Kirby Road Plantation
Notre Dame High School
A1242
A1054
A147
1
2
3
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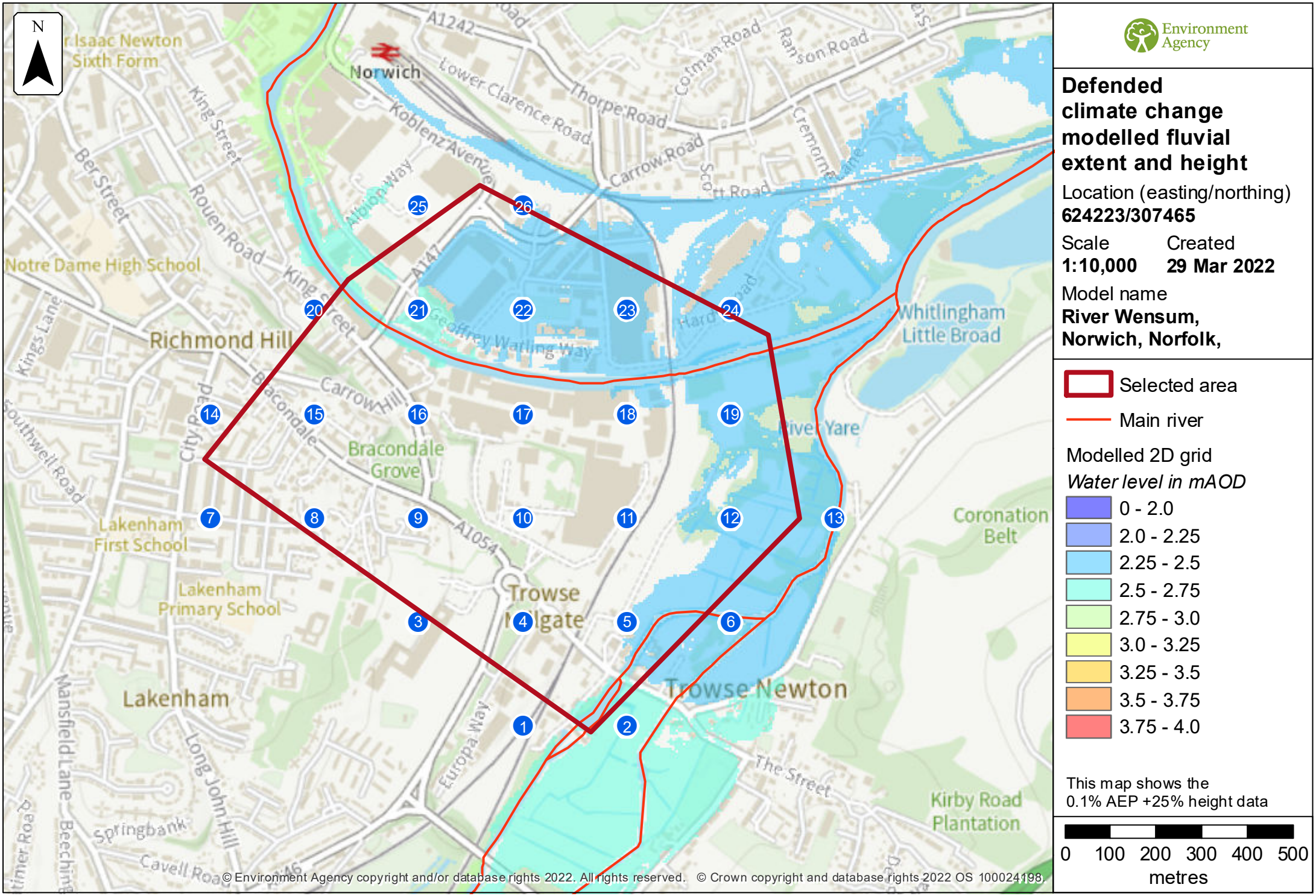
Sample point data

Defences removed

Label	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
1	624212	306855	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
2	624440	306855	0.43	1.34	0.86	1.77	0.91	1.82	0.94	1.85	1.04	1.95	0.56	1.47
3	623984	307083	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
4	624212	307083	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
5	624440	307083	0.09	0	0.09	0	0.09	0	0.09	0	0.09	0	0.09	0
6	624668	307083	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.40	2.08
7	623528	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
8	623756	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
9	623984	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
10	624212	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
11	624440	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
12	624668	307311	0.07	1.34	0.40	1.67	0.45	1.72	0.47	1.74	0.57	1.84	0.20	1.47
13	624896	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
14	623528	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
15	623756	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
16	623984	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData

Label	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
17	624212	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
18	624440	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
19	624668	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.25	2.04
20	623756	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
21	623984	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.58	2.03
22	624212	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.13	2.03
23	624440	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
24	624668	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.31	2.04
25	623984	307995	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
26	624212	307995	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Height values are shown in mAOD, and depth values are shown in metres.
Any blank cells show where a particular scenario has not been modelled for this location.
Cells which contain text 'NoData' for a scenario show that return period has been modelled but there is no flood risk for that return period for that location.



Environment Agency

Defended climate change modelled fluvial extent and height

Location (easting/northing)
624223/307465

Scale
1:10,000

Created
29 Mar 2022

Model name
River Wensum, Norwich, Norfolk,

Selected area

Main river

Modelled 2D grid

Water level in mAOD

- 0 - 2.0
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3.0
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4.0

This map shows the 0.1% AEP +25% height data

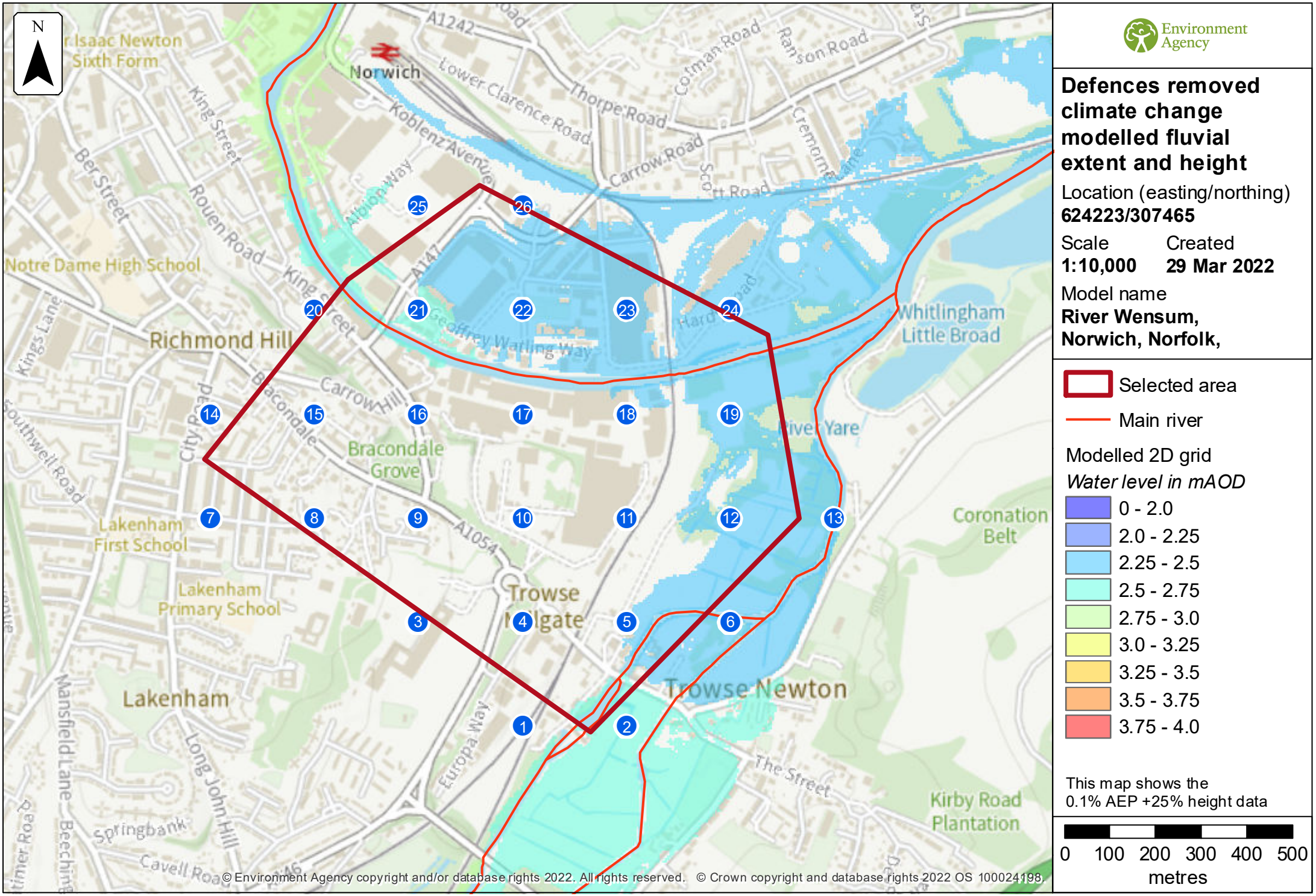
0 100 200 300 400 500
metres

Sample point data

Defended climate change

Label	Easting	Northing	1% AEP (+20%)		1% AEP (+25%)		1% AEP (+35%)		1% AEP (+65%)		0.5% AEP (+20%)		0.5% AEP (+25%)		0.5% AEP (+35%)		0.5% AEP (+65%)		0.1% AEP (+20%)		0.1% AEP (+25%)	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
1	624212	306855	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
2	624440	306855	1.26	2.17	1.30	2.21	1.36	2.27	1.53	2.44	1.38	2.29	1.42	2.33	1.50	2.41	1.74	2.65	1.64	2.55	1.70	2.61
3	623984	307083	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
4	624212	307083	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
5	624440	307083	2.02	2.07	2.06	2.11	2.11	2.16	2.25	2.30	2.13	2.18	2.17	2.22	2.23	2.29	2.47	2.52	2.35	2.41	2.41	2.46
6	624668	307083	0.39	2.07	0.43	2.11	0.48	2.16	0.62	2.29	0.50	2.18	0.54	2.22	0.61	2.28	0.84	2.52	0.72	2.40	0.78	2.46
7	623528	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
8	623756	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
9	623984	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
10	624212	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
11	624440	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
12	624668	307311	0.80	2.07	0.83	2.10	0.89	2.16	1.02	2.29	0.91	2.18	0.95	2.22	1.01	2.28	1.25	2.52	1.13	2.40	1.18	2.45
13	624896	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
14	623528	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
15	623756	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
16	623984	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
17	624212	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
18	624440	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
19	624668	307539	0.25	2.04	0.29	2.08	0.35	2.13	0.49	2.27	0.38	2.16	0.41	2.20	0.47	2.26	0.73	2.51	0.59	2.37	0.64	2.42
20	623756	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
21	623984	307767	0.56	2.01	0.62	2.07	0.71	2.16	0.94	2.40	0.76	2.20	0.80	2.26	0.92	2.37	1.24	2.68	1.02	2.47	1.09	2.54
22	624212	307767	0.11	2.01	0.17	2.07	0.25	2.15	0.45	2.35	0.29	2.19	0.34	2.23	0.43	2.33	0.71	2.61	0.52	2.42	0.59	2.49
23	624440	307767	NoData	NoData	NoData	NoData	NoData	NoData	0.01	2.31	NoData	NoData	NoData	NoData	NoData	NoData	0.27	2.56	0.09	2.38	0.16	2.45
24	624668	307767	0.31	2.04	0.35	2.08	0.40	2.13	0.54	2.27	0.43	2.16	0.47	2.20	0.53	2.26	0.78	2.51	0.64	2.37	0.69	2.42
25	623984	307995	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.11	2.74	NoData	NoData	NoData	NoData
26	624212	307995	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Height values are shown in mAOD, and depth values are shown in metres.
Any blank cells show where a particular scenario has not been modelled for this location.
Cells which contain text 'NoData' for a scenario show that return period has been modelled but there is no flood risk for that return period for that location.


N
Environment Agency
Defences removed climate change modelled fluvial extent and height
Location (easting/northing)
624223/307465
Scale
1:10,000
Created
29 Mar 2022
Model name
River Wensum, Norwich, Norfolk,
Selected area
Main river
Modelled 2D grid
Water level in mAOD
0 - 2.0
2.0 - 2.25
2.25 - 2.5
2.5 - 2.75
2.75 - 3.0
3.0 - 3.25
3.25 - 3.5
3.5 - 3.75
3.75 - 4.0
This map shows the 0.1% AEP +25% height data
0 100 200 300 400 500
metres
Norwich
Richmond Hill
Lakenham
Trowse Newton
Whitlingham Little Broad
River Yare
Coronation Belt
Kirby Road Plantation
Bracondale Grove
Lakenham First School
Lakenham Primary School
Notre Dame High School
Trowse Millgate
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Sample point data

Defences removed climate change

Label	Easting	Northing	1% AEP (+25%)		1% AEP (+35%)		1% AEP (+65%)		0.5% AEP (+25%)		0.5% AEP (+65%)		0.1% AEP (+20%)		0.1% AEP (+25%)	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
1	624212	306855	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
2	624440	306855	1.30	2.21	1.37	2.28	1.54	2.45	1.43	2.34	1.74	2.65	1.64	2.55	1.70	2.61
3	623984	307083	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
4	624212	307083	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
5	624440	307083	2.06	2.11	2.12	2.17	2.25	2.30	2.17	2.22	2.47	2.52	2.35	2.41	2.41	2.46
6	624668	307083	0.43	2.11	0.49	2.17	0.62	2.29	0.54	2.22	0.84	2.52	0.72	2.40	0.78	2.46
7	623528	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
8	623756	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
9	623984	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
10	624212	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
11	624440	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
12	624668	307311	0.83	2.11	0.89	2.16	1.02	2.29	0.95	2.22	1.25	2.52	1.13	2.40	1.19	2.46
13	624896	307311	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
14	623528	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
15	623756	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
16	623984	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
17	624212	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
18	624440	307539	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData

Label	Easting	Northing	1% AEP (+25%)		1% AEP (+35%)		1% AEP (+65%)		0.5% AEP (+25%)		0.5% AEP (+65%)		0.1% AEP (+20%)		0.1% AEP (+25%)	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
19	624668	307539	0.29	2.08	0.36	2.14	0.49	2.27	0.42	2.20	0.73	2.51	0.59	2.37	0.64	2.43
20	623756	307767	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
21	623984	307767	0.63	2.08	0.72	2.17	0.94	2.39	0.81	2.26	1.23	2.68	1.02	2.47	1.09	2.55
22	624212	307767	0.18	2.08	0.26	2.16	0.45	2.35	0.34	2.24	0.71	2.61	0.52	2.42	0.59	2.49
23	624440	307767	NoData	NoData	NoData	NoData	0.01	2.30	NoData	NoData	0.27	2.56	0.09	2.38	0.16	2.45
24	624668	307767	0.35	2.08	0.41	2.14	0.54	2.27	0.47	2.20	0.78	2.51	0.64	2.37	0.69	2.42
25	623984	307995	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.11	2.74	NoData	NoData	NoData	NoData
26	624212	307995	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Height values are shown in mAOD, and depth values are shown in metres.
Any blank cells show where a particular scenario has not been modelled for this location.
Cells which contain text 'NoData' for a scenario show that return period has been modelled but there is no flood risk for that return period for that location.

Strategic flood risk assessments

We recommend that you check the relevant local authority's strategic flood risk assessment (SFRA) as part of your work to prepare a site specific flood risk assessment.

This should give you information about:

- the potential impacts of climate change in this catchment
- areas defined as functional floodplain
- flooding from other sources, such as surface water, ground water and reservoirs

About this data

This data has been generated by strategic scale flood models and is not intended for use at the individual property scale. If you're intending to use this data as part of a flood risk assessment, please include an appropriate modelling tolerance as part of your assessment. The Environment Agency regularly updates its modelling. We recommend that you check the data provided is the most recent, before submitting your flood risk assessment.

Flood risk activity permits

Under the Environmental Permitting (England and Wales) Regulations 2016 some developments may require an environmental permit for flood risk activities from the Environment Agency. This includes any permanent or temporary works that are in, over, under, or nearby a designated main river or flood defence structure.

Find out more about flood risk activity permits

Help and advice

Contact the East Anglia Environment Agency team at enquiries_eastanglia@environment-agency.gov.uk for:

- more information about getting a product 5, 6, 7 or 8
- general help and advice about the site you're requesting data for

Appendix E – Flood Risk Mitigation Technical Design Note

TECHNICAL DESIGN NOTE

Hydrock

Project name	East Norwich		
Design note title	Flood Risk - Mitigation Options		
Document reference	16650-HYD-XX-XX-TN-FR-0000 P02		
Author	Simon Mirams		
Revision	P02		
Date	15 March 2022	Approved	✓

1. INTRODUCTION

The East Norwich Masterplan is being developed to support the Site Allocation for up to 4,000 homes and 6,000 jobs within the Greater Norwich Local Plan. The Masterplan area is comprised of four parcels of land, they are as below and as shown on Figure 1.

- The Carrow Works site;
- The Deal Ground;
- May Gurney, and
- The Utilities Site.

This technical note details works undertaken by Hydrock to both quantify the existing level of risk to the site from fluvial and tidal sources but also to determine what level of mitigation is required to ensure the development can meet the requirements of National Planning Policy Framework (NPPF) and the Environment Agency (EA) whilst still providing the required housing numbers. In order to meet these requirements this note explains mitigation measures that have been modelled to ensure that the development proposals are 'safe' whilst resulting in no increase in flood risk to third party land.

The post development scenarios investigated has used the emerging masterplan drawing (Ref 20118_AAM_SK_027) that has been prepared and issued by Allies and Morrison. This document has been prepared through detailed discussions and has incorporated all of the recommendations as detailed within previous Hydrock reports (ref - 16650-HYD-XX-XX-RP-FR-0001-P01 and 16650-HYD-XX-XX-RP-FR-0003-P01). In addition, the principles discussed in the Hydrock report have been discussed with the EA and Norwich City Council to determine acceptability. Following the meeting the scope of post development scenario modelling was verbally agreed along with some additional EA/NCC requirements and these, where possible, have been addressed/included within this note.

All measures being proposed are for measures to be provided within the site boundary to suitably manage/redistribute flows such that all development is safe and in line with National Guidance but also ensure no detrimental impact on flood risk elsewhere and, where possible, provide a betterment.

2. BASELINE MODEL AND UPDATES

2.1 Introduction

A request for product 6 and 7 data was made to the EA in December 2021 for the River Wensum Catchment Model Review and Update study which was published in May 2017. Through discussions the EA have confirmed that the modelling study is fit for purpose with the only updates/alterations needed being to reflect the latest climate change allowances. The latest updates were made in August 2021 and as such the model does not include for these. These values were discussed and agreed with the EA at a meeting in December 2021 and it is these that have been used within the modelling.

A review of the existing model has confirmed that the River Wensum is tidally influenced up to New Mills in Norwich (622616, 309026) and Trowse Mill on the River Yare which is upstream of the site. As such the model includes both fluvial and tidal inflows to ensure the interaction is suitably represented. A schematic of the tidal limit of the Wensum and provided model is shown in figure 1 and 2 below.

Whilst the site is within an area that is tidally influenced it has been confirmed with the EA that any post development scenario focus on ensuring the fluvial events are suitably managed/compensated within the site boundary. This is not to say the risks from tidal sources are to be ignored but just that compensation storage etc is not required and the impact of fluvially dominant flood events is considered worse in this area. As such the design event for the purposes of this note is the 1 in 100 year plus climate change fluvial event. This was agreed with the EA at a December 2021 meeting and confirmed via email in February 2022.

Figure 1: Site location and extent of tidal influence

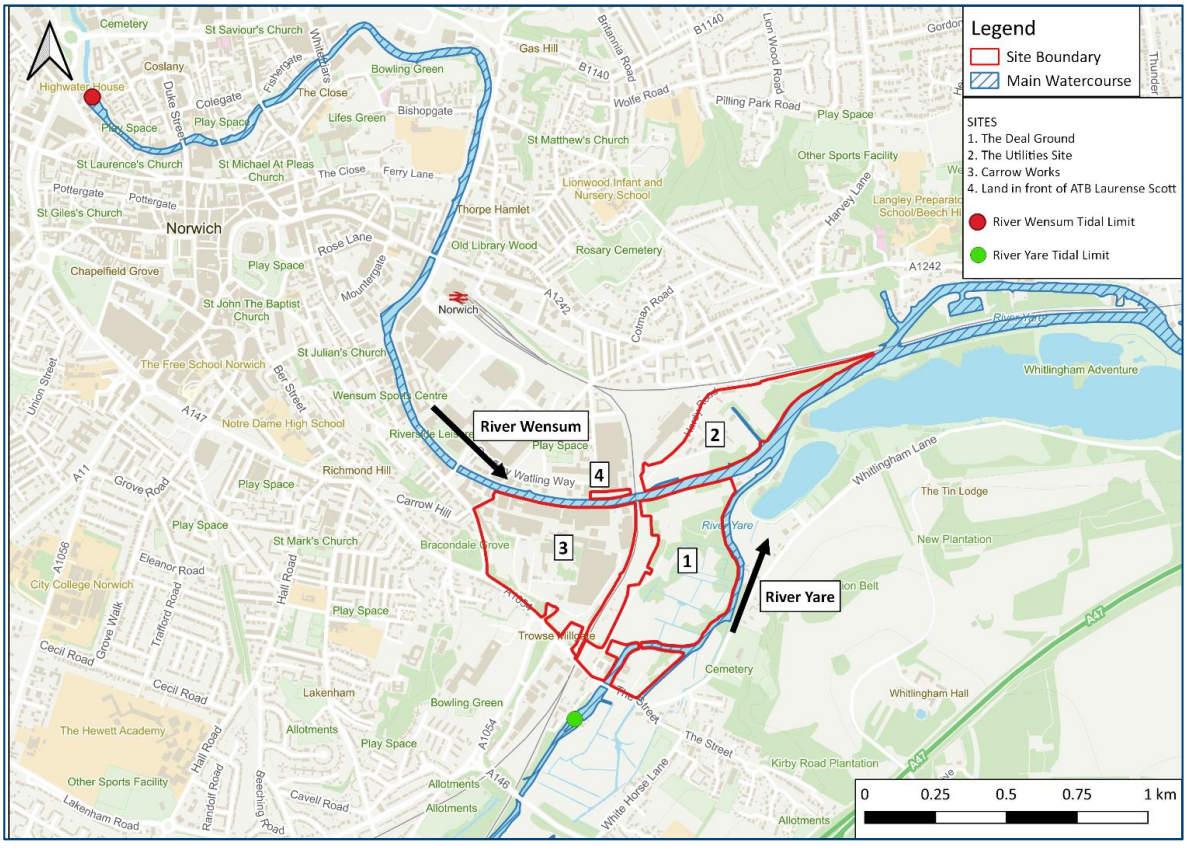
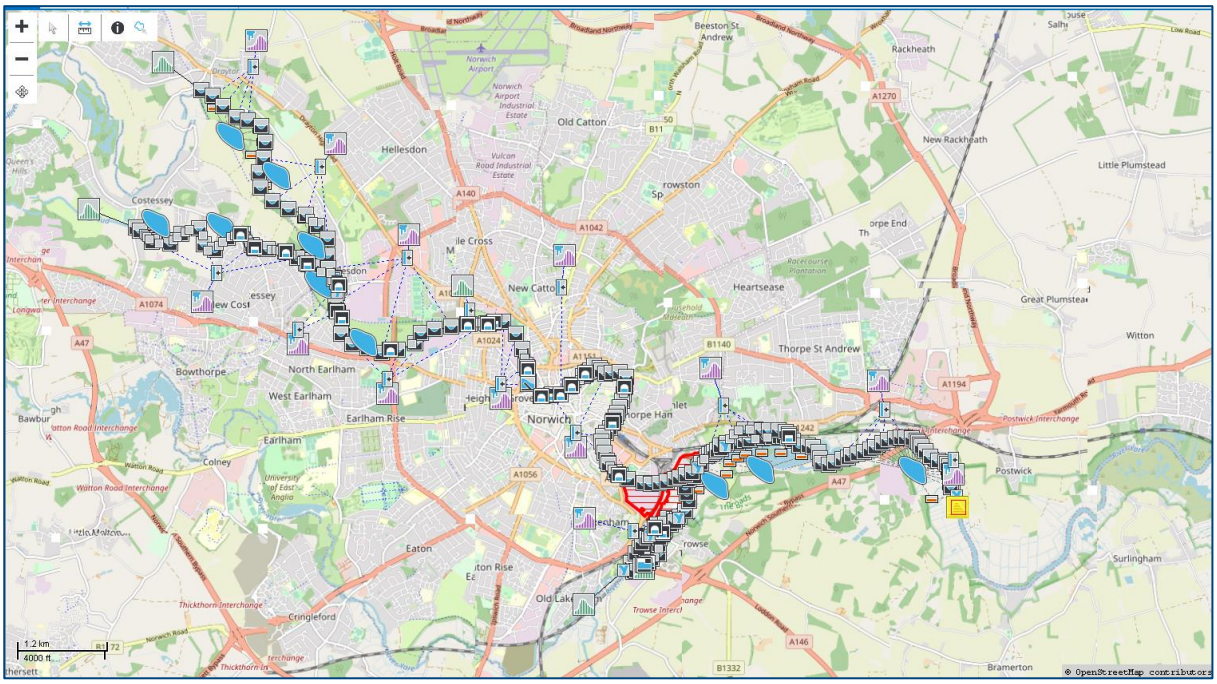


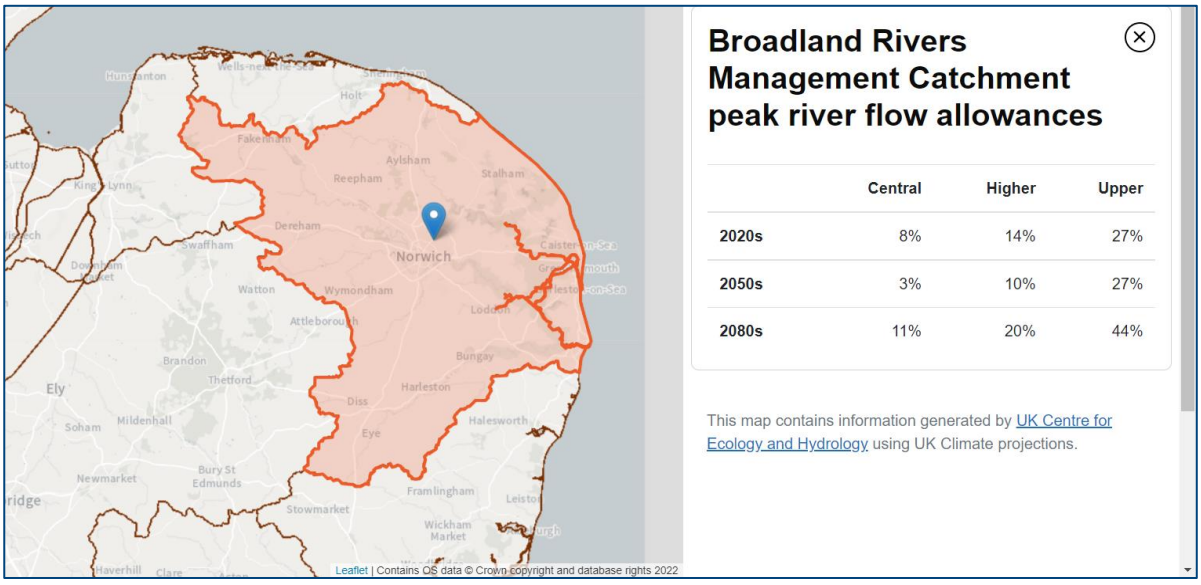
Figure 2: EA 2017 Wensum Model Schematic (Masterplan area shown in hashed red)



2.2 Climate Change Allowances - Fluvial

As discussed, the provided modelling was undertaken in 2017 and does not make reference to the latest climate change allowances and, as such, these require updating. Current DEFRA Climate change guidance provides uplifts to peak river flows based on the wider river management catchment that the watercourse is located within. Norwich and the surrounding area are located within the Broadland Rivers Management Catchment area. Figure 3 below is an extract from the DEFRA website and displays the peak river flow uplifts to be applied for this catchment.

Figure 3 Climate Change Uplifts for Broadlands Management Catchment



Current guidance indicates that the uplift allowance to be used, should be based on the flood risk vulnerability classification of the development as per Annex 3 of the National Planning Policy Framework (NPPF) and what flood zone the development is located within when referring to the

existing flood mapping. The proposed masterplan is comprised of mixed development uses, including residential and commercial which are classed as "More Vulnerable" and "Less Vulnerable" respectively within Annex 3. For both these classifications it is appropriate to use the central allowance.

It also states that for strategic flood risk assessments, both the central and higher central allowances should be assessed. Therefore, for assessing the baseline flood risk scenario, two climate change uplift simulations have been assessed with both 11% and 20% uplifts to the previously modelling 100yr fluvial flows having been applied. Given this, and in order to adopt a conservatory approach where possible the design event for assessing mitigation measures is the 1 in 100year plus 20% climate change event with existing tidal levels. This has been agreed with the EA and no further changes have been made to the hydrology within the provided modelling.

2.3 Climate Change Allowances - Tidal

As stated previously, the River Wensum and River Yare are tidally influenced. Therefore, any allowances for climate change should also take into account any changes to sea levels that are predicted to occur. Current guidance provides annual uplift rates to existing sea levels based on the river basin district that the proposed development is located within. Norwich is located within the Anglian district.

Figure 4: Extract of Guidance on Sea level uplift allowances

Table 2: sea level allowances by river basin district for each epoch in mm for each year (based on a 1981 to 2000 baseline) – the total sea level rise for each epoch is in brackets

Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
Anglian	Higher central	5.8 (203)	8.7 (261)	11.6 (348)	13 (390)	1.20
Anglian	Upper end	7 (245)	11.3 (339)	15.8 (474)	18.1 (543)	1.60
South east	Higher central	5.7 (200)	8.7 (261)	11.6 (348)	13.1 (393)	1.20
South east	Upper end	6.9 (242)	11.3 (339)	15.8 (474)	18.2 (546)	1.60

This guidance states that for flood risk assessments and strategic flood risk assessments, both the higher central and upper end allowances should normally be assessed. Based on the assumption of a construction start date of 2025 and that the design life of the Masterplan area would be 100 years, this would equate to an uplift to the existing peak tide levels of 1.10m and 1.41m for the higher central and upper end allowances respectively. Whilst model runs for these events have been undertaken these are not being used as a design event, with this being the fluvial events as detailed in Section 2.3. Whilst this is the case, the modelled flood depths will be used in informing on site mitigation measures given the potential risks from this source.

2.4 Climate Change Uplifts Conclusion

It was agreed in February 2022 at a meeting with the EA (and confirmed by email), that flood depths predicted during a modelled scenario where both the river inflows and tide levels were updated for

climate change would not be required as this would, if anything, be an overestimation of flood levels at the site. Results generated from the 2017 study indicate that the modelled peak tidal flood levels are lower than the equivalent fluvial flood levels for all return periods. For this reason, the climate change scenario used for assessing the baseline predevelopment flood risk, is the 1% AEP + 20% climate change uplift fluvial event, combined with the present day tidal event.

3. CONFIRMATION OF THE EXISTING SITUATION

To assess the existing level of flood risk the following event simulations have been completed:

- 1 in 20yr, 5% AEP (Flood Zone 3b)
- 1 in 100yr, 1 % AEP (Flood Zone 3a)
- 1 in 100yr + 20% climate change uplift
- 1 in 1000yr, 0.1% AEP (Flood Zone 2)

The baseline model generated outlines that match those currently shown on the Flood Map for Planning for both the 1 in 100 year (Flood Zone 3) and 1 in 1,000 year (Flood Zone 2) events as shown in Figure 5 below. This confirms that the model is in working order and the existing flood zones are repeatable. Given the approved nature of the EA's model this gives confidence in the generated outputs for both the 1 in 20 year and 1 in 100 year plus 20% events. The 1 in 20 year and 1 in 100 year plus 20% outlines are shown in Figure 6 and 7 below and shows the predicted extents at the site for each event.

Figure 5: Flood Map for Planning

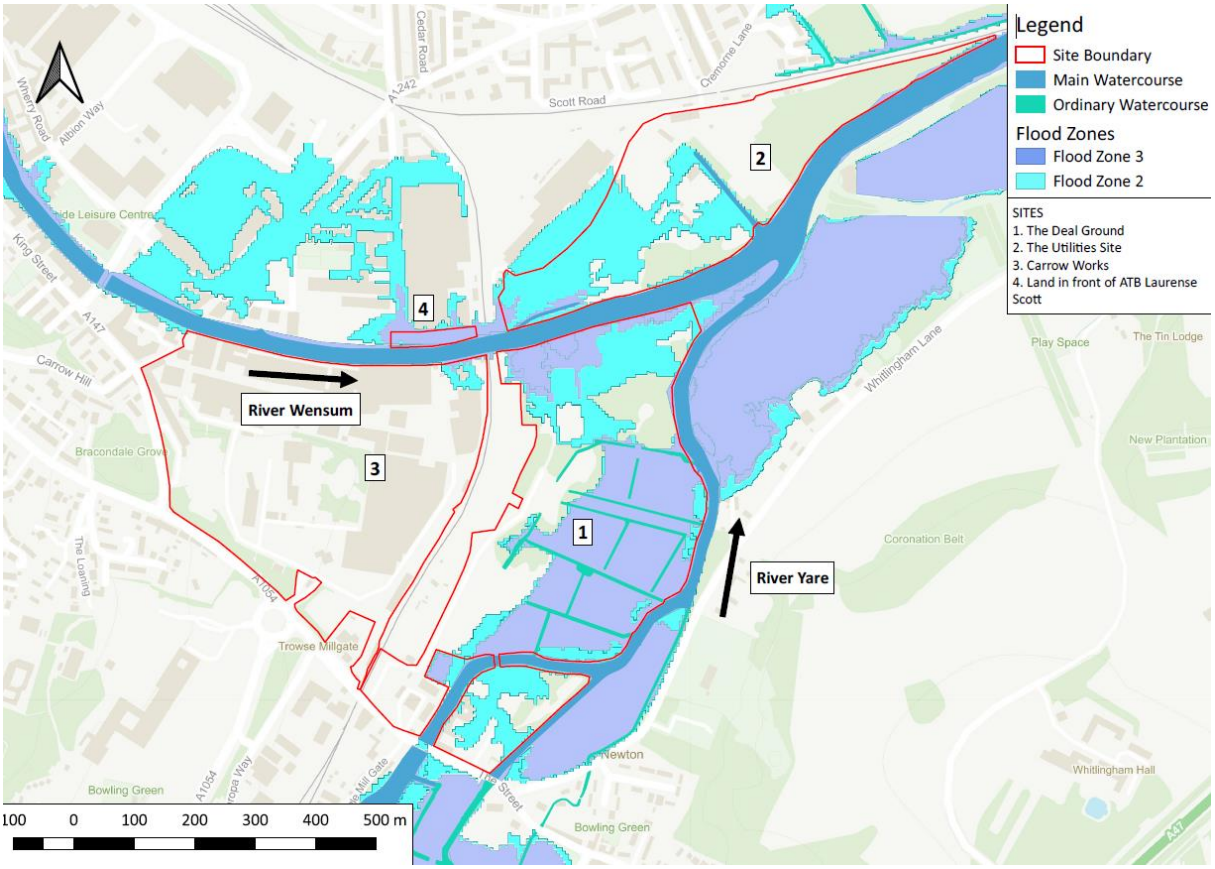


Figure 6: 1 in 100yr plus 20% fluvial flood extents.

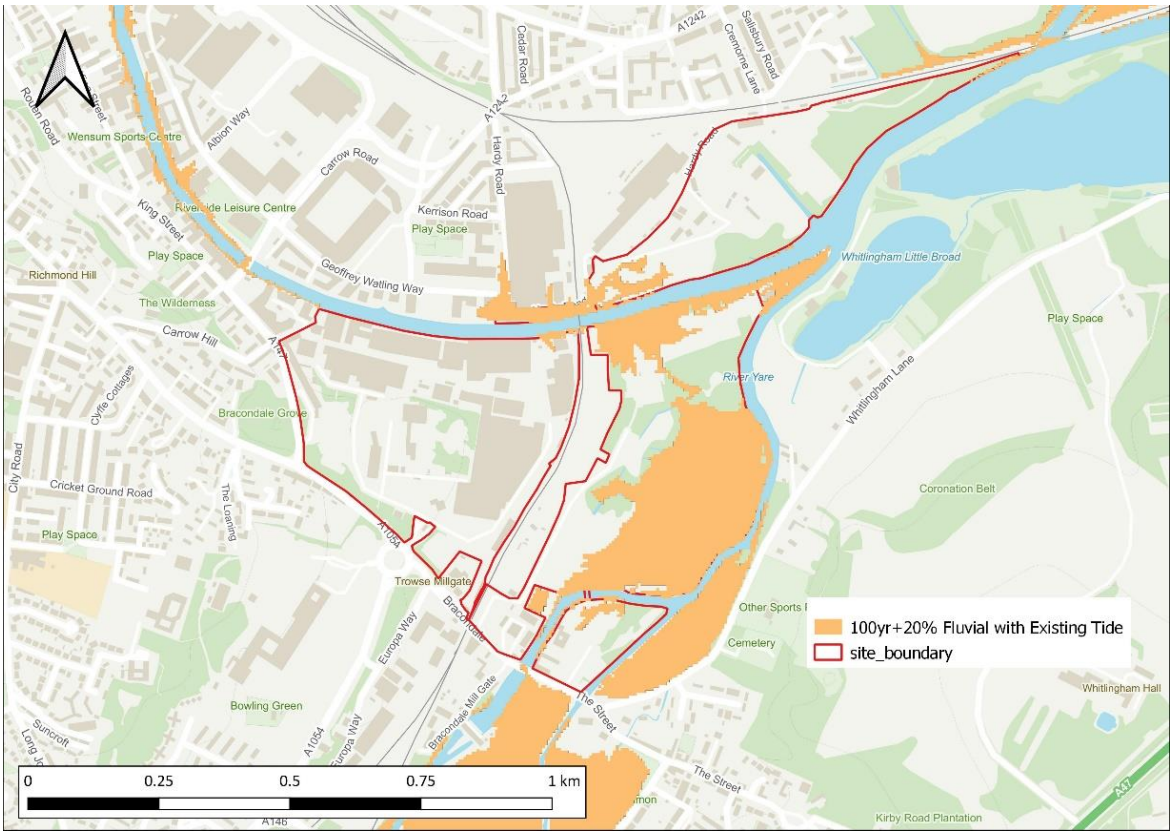
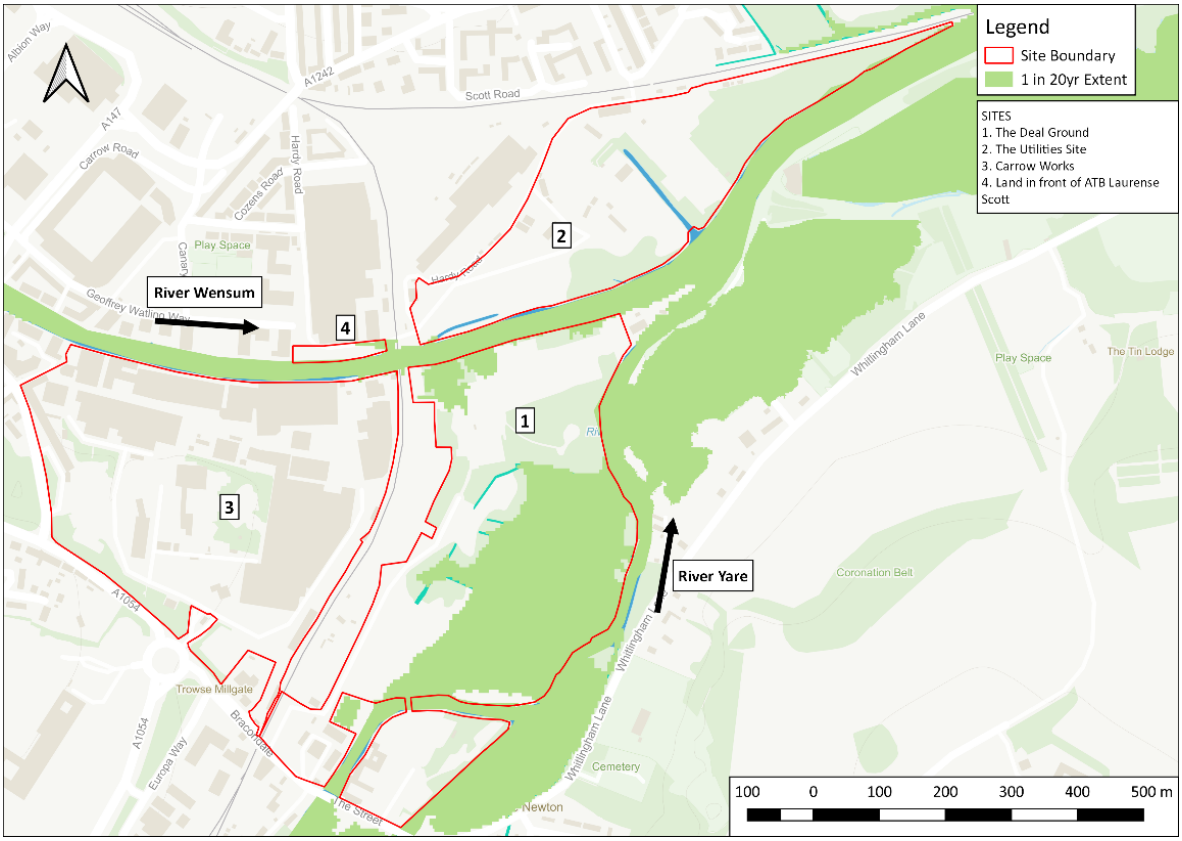


Figure 7: 1 in 20 year flood extent (approx. red line plan shown)



These outputs have shown the following:

a. The Deal Ground - the northern and eastern sections of this parcel are shown as being at high and medium risk (Flood Zones 3 and 2 respectively). Much of the areas of Flood Zone 3 are shown to be around the (expected) lower lying areas to the east that are crossed by a series of land drainage ditches. Another smaller area of Flood Zone 2 is shown to affect a line along the northern boundary of this parcel. The area at medium risk is predominantly along the northern site boundary but this extends to provide connectivity into the lower lying eastern section of the site. As shown in Figure 7, the eastern and northern limit as shown as being inundated during the 1 in 20 year event and therefore within Flood Zone 3b: Functional Floodplain. The updated modelling shows that whilst climate change allowances have increased the extent of flooding these are not significant with the majority of flooding being limited to the existing pattern with floodplains for both watercourses being kept separate with flooding from the River Yare being contained within the lower lying areas to the south east and the flooding associated with the River Wensum being restricted to the northern boundaries of the site. That said the inclusion of climate change values has shown a small area of flooding that connects the two floodplains. This flows from the River Wensum in a southerly direction before draining into the lower lying area of land adjacent to the River Yare.
b. Utilities Sites - The western sections of this site are shown as being almost entirely at medium risk and within Flood Zone 2. Small areas of Flood Zone 3 (High Risk) are identified at the south western boundary and immediately adjacent to the River Wensum. The impacts of climate change have resulted in an increase in flood extents within the site but these are contained within the south western limit of the site.
c. Carrow Works & Carrow House - This parcel is shown as being entirely within Flood Zone 1 and at 'low' risk from fluvial and tidal flooding. In being classified as this Flood Zone it is considered that site levels are suitably raised above the extreme fluvial and tidal flood events.
d. ATB Laurence Scott Land - This parcel is shown as being entirely withing Flood Zone 3 and at high risk from fluvial/tidal flooding. This is the same when climate change allowances are included, this site is entirely within this flood extent.

The provided mapping has included the 1 in 100 year plus climate change event as these are not shown on the EA's Flood Map for Planning but Figure 6 confirms that during such an event large portions of the site are shown to be affected. A summary of the flood levels is shown in Table 1 below.

Table 1: Flood Levels - taken from onsite. NOTE - flood levels are consistent across the site due to flat topography.

Event	River Wensum Flood Level (m AOD)	River Yare Flood Level (m AOD)
1 in 100 year	1.66	1.74
1 in 100year plus 20% CC	1.78	1.83
1 in 1000 year	2.02	2.07

The review of the baseline model, and inclusion of the latest climate change allowances has confirmed that the above summary of fluvial flood risk is an accurate representation of flood risk to the site. This also confirms that the existing flood extents shown on the Flood Map for Planning are correct and confirms where mitigation measures are required - i.e., mostly within the Deal Ground.

4. PROPOSED MITIGATION

Given the confirmation that section of the Deal Ground is at high risk of fluvial flooding (all modelled events) mitigation measures are required in order to ensure the proposed development could be achieved safely whilst resulting in no detrimental impact to third party land - i.e., be policy compliant.

Previous reports prepared by Hydrock (ref 16650-HYD-XX-XX-RP-FR-0001-P01) have outlined principles of mitigation. These include the lowering of river frontage areas and use of proposed marinas in order to provide 'blue corridors' through the proposed development and ensure any flooding maintains connectivity with the existing watercourses. In addition, some localised areas are likely to need to be lowered in order to provide required compensation storage.

The above approach was discussed with the EA and Norwich City Council and it was agreed that all measures outlined were sound and a reasonable approach. However, the main comment from the EA was in relation to development being proposed within the Functional Floodplain. The EA's position was that whilst ground raising in these areas of risk are not necessarily in line with NPPF the EA stated that if areas of Flood Zone 3b could be managed by ground lowering only, then they would be happy to consider the proposals.

As part of previous discussions reservations were made by Norwich City Council as to the efficiency of the marinas in providing compensation storage. Their concerns related to how the additional storage from the marinas would be quantified owing to other issues (ground water, existing river levels etc). As such, and for the purposes of this assessment the marinas have been included but with a 'water level'. In the absence of the provided modelling including a 1 in 2-year levels this was assumed as being 100mm below the modelled 1 in 20-year level in order to, where possible, adopt a conservative approach and ensure no overestimation of available storage is made.

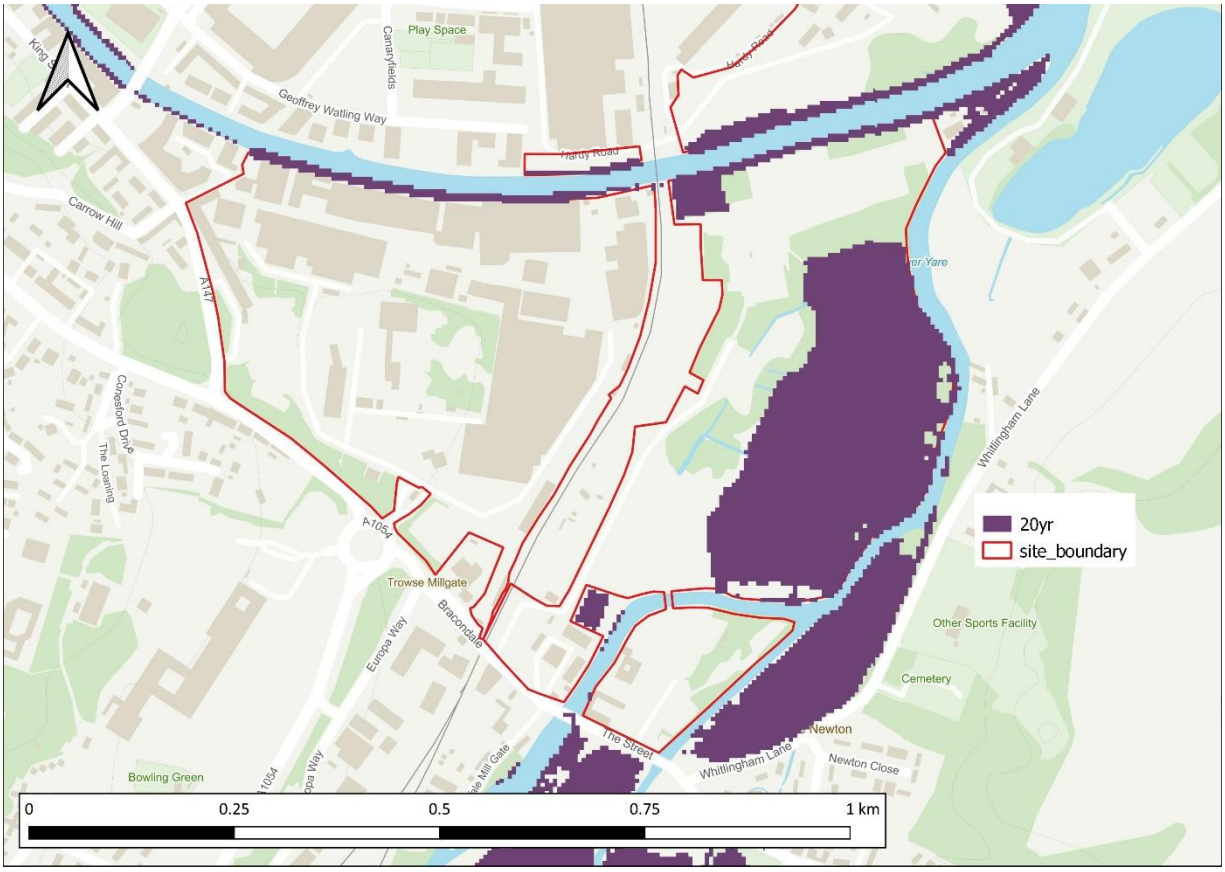
4.1 Ground lowering

In line with EA requirements ground lowering only was investigated to redistribute the 1 in 20-year flood extent away from areas earmarked for development. In order to achieve this the river frontage through all parcels was lowered. This was lowered to a level of 1.4m AOD through the wider site area and extended 10m through the development site on both sides of the River Wensum. The 10m wide corridor was considered consistent with the typical easement requirement and through the lowering of this it maintained an access route for management and maintenance whilst also provide a pedestrian link to the watercourse (i.e., provide a wider use for flood compensation areas). It should be noted that the model resolution is at 5m and as such, modelling at 8m width would have effectively resulted in a 10m wide corridor due to modelling constraints and this is why a 10m width was used.

The river corridor areas have been lowered to an elevation of 1.4m AOD with the marinas, as stated, being a maximum of 100mm below these levels and at a level of 1.3m AOD. In setting ground levels to this level, it ensured storage would be mobilised during the 1 in 20-year event but not at events smaller than this so as to ensure the amenity use of the area remains.

On review of the model outputs, it was evident that whilst lowering of the river frontages and inclusion of marinas provided a significant amount of flood storage and redistributed the majority of the Functional Floodplain, there were some localised areas within the Deal Ground parcel that are currently at a level lower than the modelled 1 in 20-year flood level (and lower than 1.3m AOD). These areas are adjacent to the proposed marina at the north western limit of the site and adjacent to the water meadows to the west. As such, and given further lowering of the river frontages was not possible (for operational reasons - i.e., it would be in flood too frequently) localised areas of raising were required to prevent 1 in 20-year flood outlines extending into the site. However, in order to meeting EA requirements these were kept to an absolute minimum. Figure 8 shows the 1 in 20-year output for both the lowering of the river frontages and localised raising.

Figure 8: 1 in 20-year flood extent with post development mitigation in place (approx. red line plan shown)



4.2 Ground raising

In line with general approach the EA have agreed that it would be acceptable to raise areas within the 1 in 100-year and 1 in 100-year plus climate change event provided suitable compensation storage was provided within the site boundary. As such, it was proposed for development parcels to be raised so as to ensure all development is set above and outside these events.

Through modelling of the proposed raising, an area of high ground to the northern area of the water meadow within the Deal Ground site has been identified as being outside any proposed development, proposed for public open space and outside the flood extents. As such, and in order to compensate for lost storage as a result of the proposed ground raising, this area was lowered to a level of 1.1m AOD to provide connectivity to the water meadow but also provide compensation floodplain storage. In setting the land lowering this has been aimed at limiting the ground raising required. However there has been a

need to raise proposed development parcels to a level of 2m AOD based on the current modelling (which equates to a maximum raise of circa 400mm - subject to confirmation of site levels). In setting development at this level it ensures all finished floor levels are raised a minimum of 300mm above the 100-year plus climate change flood level of 1.65m AOD and therefore in line with typical requirements with all development being considered to be 'safe'. This approach has also been applied to the areas of the Utilities Land that were shown as being within the 100-year plus climate change extents.

The proposed lowering of this area and raising of proposed development parcels has been modelled in detail. This modelling included the proposed lowering with sloping sides and a gradient falling towards the River Yare to ensure it is 'free draining'. The outputs for this scenario are shown in Figure 9 below but confirms suitable compensation storage is available through the lowering of the area of public space and that the raising of ground results in no detrimental impact on flood risk elsewhere, as shown in Figure 10 below.

Figure 9: Ground raising compensatory storage areas.

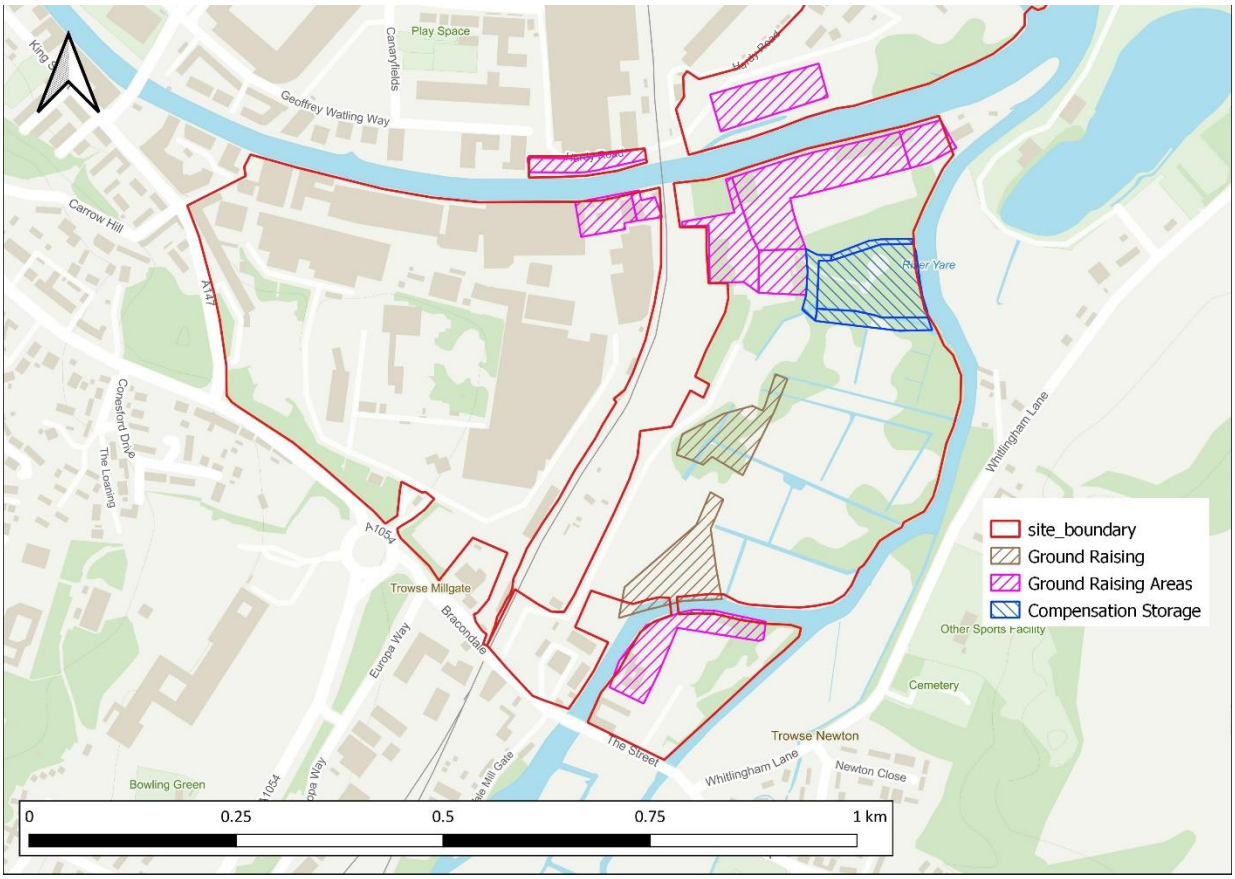
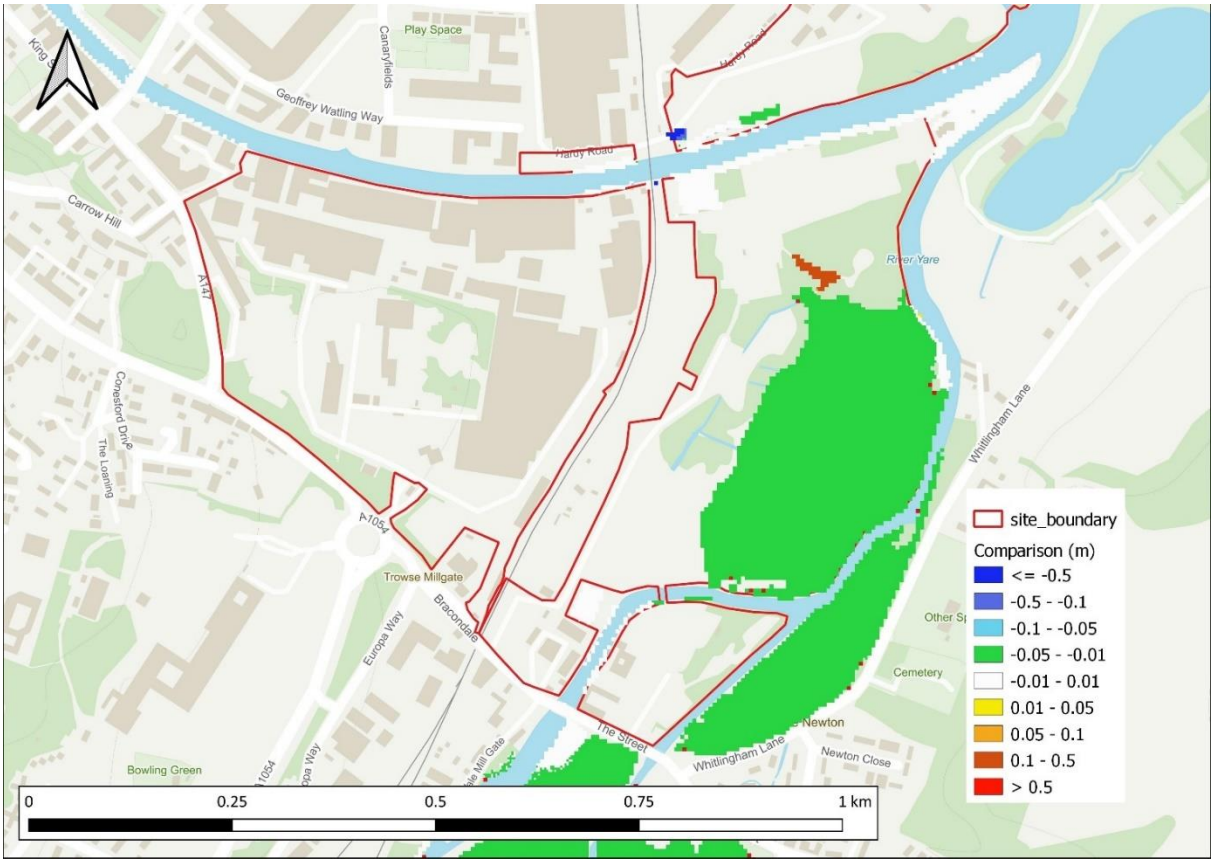


Figure 10: Comparison of Flood Depths.



5. CONCLUSION

As has been detailed within this note, the proposed development site is currently shown to be at an increased risk of fluvial and tidal flooding with the Deal Ground parcel being particularly susceptible. As such, and as discussed with the EA and NCC, mitigation measures are required in order to ensure the development is safe for its design life but also resulting in no increase in flood risk elsewhere.

As such a number of measures have been investigated across a number of events. These are summarised below:

- Lowering of River Frontage - 10m wide corridor to be lowered to provide a 'blue corridor' whilst also providing amenity space.
- Installation of Marinas - These are to be areas of new marinas achieved through ground lowering. These areas have been set to provide a conservatively low volume of storage to address concerns raised by NCC but also to make an allowance for existing constraints- groundwater levels etc.
- Raising of Development Parcels (for 100yr+CC events only) - It is proposed for development parcels to be raised to a level of 2m AOD. This sets the development at a level of 300mm above the predicted flood level and in line with typical EA guidance.
- Compensation Storage provided through lowering of areas to the north of Water Meadow area - This area has been modelled to be at a level of 1.1m AOD to ensure it freely drains back to the River Yare.

All of the above have been modelled in detail and the outputs have demonstrated that such measures have managed the flood risk through the site such that the proposals can come forward in line with policy with respect to fluvial flooding but, and critically, resulting in no increase in flood risk to third party land. As such, and whilst some very minor land raising is needed for localised low areas the proposals also address this in line with discussions/requirements made to date by the EA and NCC. It should be noted that this remains subject to confirmation through detailed review of the modelling but, on the assumption, this is given, the development is considered to suitably address fluvial flood risk.

Whilst fluvial risks are managed through the measures detailed above it should be noted that through inclusion of climate change allowances areas of the Deal Ground would remain as being at risk from tidal flooding. As such, additional measures would be needed. This is considered as being less onerous and achievable through design - such as duplex units on ground floor (i.e. no sleeping accommodation), a flood resilient/resistant construction for ground floors (i.e. water entry strategy), and preparation of a detail and robust Flood Evacuation Management Plan to deal with any potential issues related to access and egress.

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