Tween Bridge Solar Farm

A Nationally Significant Infrastructure Project in the Energy Sector

Preliminary Environmental Information Report

Technical Appendix 10.1 – Flood Risk Assessment

October 2023

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FLOOD RISK ASSESSMENT

Land at Tween Bridge

Thorne, Metropolitan Borough of Doncaster, South Yorkshire

On behalf of RWE Renewables UK Limited

Date: 26.09.2023 | Pegasus Ref: P21-3484 – Author: Lucy Ginn

Document Management

Version	Date	Author	Checked/ Approved by:	Reason for revision
Version 1	11.08.2023	Lucy Ginn	Luke Johnson	First Issue
Version 2	26.09.2023	Lucy Ginn	Luke Johnson	Further Sequential Test Information Added

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1. Introduction

Background

1.1. Pegasus Group has been appointed by RWE Renewables UK Limited to undertake a Flood Risk Assessment (FRA) for a proposed solar farm with battery energy storage and associated infrastructure at Land at Tween Bridge, Thorne. This FRA supports Chapter 10 (Water Resources) of the Draft Preliminary Environmental Information Report (PEIR).

1.2. This FRA reports on the baseline and Scheme design information available at the time of writing. The FRA will be updated as further assessments become available and any updates to the baseline will be reported in the next iteration of the PEIR which will be presented as part of the statutory pre-application consultation.

1.3. A proposed Drainage Strategy will also be prepared by Pegasus Group and provided as separate document to accompany the next iteration of the PEIR.

1.4. This assessment considers the risk of flooding from all sources, including tidal, fluvial, surface water, historic, groundwater, sewer and artificial sources.

National and Local Policies

1.5. The National Planning Policy Framework (NPPF) states that a site-specific Flood Risk Assessment (FRA) will be required for proposals:

a) that are greater than 1 hectare (ha) in area within Flood Zone 1;

b) that are located in Flood Zone 2 or 3 (including minor development and change of use);

c) in an area within Flood Zone 1 which has critical drainage problems;

d) in an area within Flood Zone 1 identified in a Strategic Flood Risk Assessment as being at increased flood risk in the future;

e) in an area in Flood Zone 1 that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

1.6. The site is over 1,500ha in area and located almost entirely within Flood Zone 3. A full FRA is therefore required for the proposals.

1.7. As of April 2015, the legislation for dealing with FRAs changed, with additional emphasis placed on the use of Sustainable Drainage Systems (SuDS) within drainage schemes for new developments.

1.8. In February 2016, the Environment Agency (EA) introduced new guidance relating to the climate change allowances that must be considered within an FRA. Since 2016, the allowances for sea level rise, peak river flow and peak rainfall have each been updated.

1.9. Given the above, any new planning application (including proposed DCO schemes) that requires an FRA will also require a surface water drainage strategy to be submitted. The drainage strategy must demonstrate the use of SuDS within the design and should be in line with the requirements as set out within with the relevant National Policy Statements (NPS), notably NPS EN-1, the draft NPS EN-1 and the NPS EN-3. Full details of these policies are included in Chapter 5 of the PEIR.

1.10. The draft NPS EN-1 considers the flood risk impacts associated with energy infrastructure developments, ensuring flood risk from all sources are assessed and emphasising that proposed developments located in areas of flood risk should be designed and constructed to remain operational in times of flood. The draft NPS EN-1 also provides guidance in relation to the Sequential Test and Exception Test and sets out the minimum requirements for FRAs. Some of the minimum requirements for an FRA set out in the draft NPS EN-1 will be included in the surface water drainage strategy.

1.11. In addition to the requirements as discussed above, this assessment has also reviewed the information and requirements included in the Doncaster MBC Level 1 Strategic Flood Risk Assessment (2015) (covering the western half of the site) and the North and North East Lincolnshire Strategic Flood Risk Assessment (2022) (covering the eastern half of the site).

2. Existing Site & Hydrology

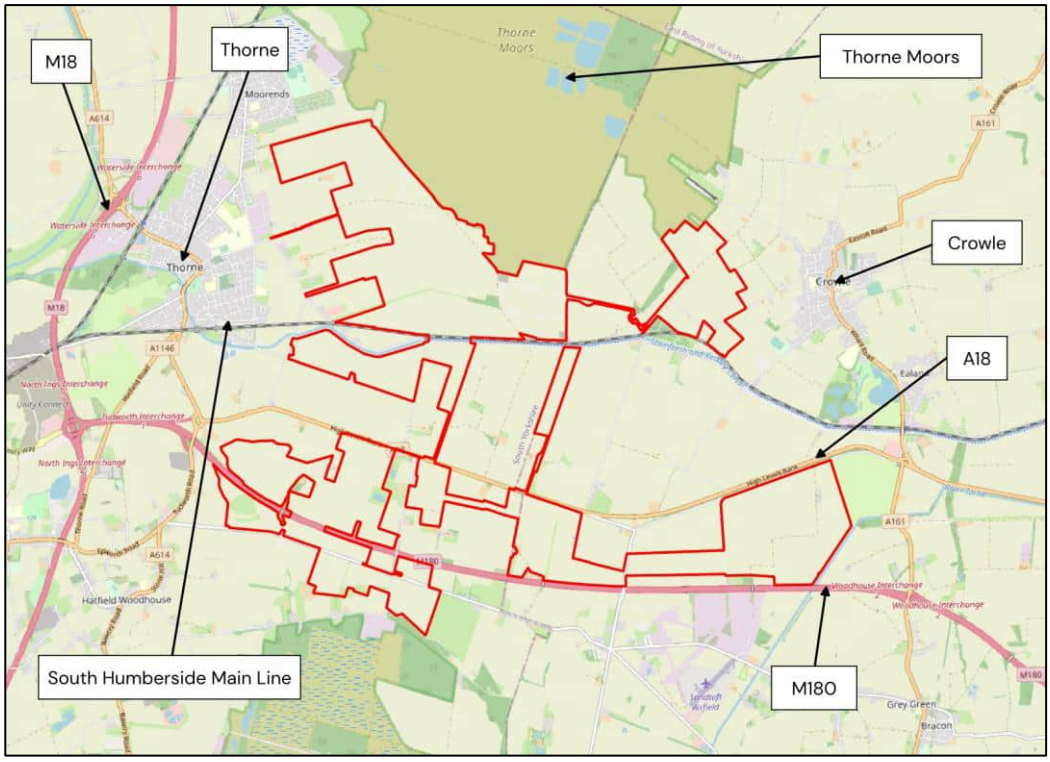
Site Location & Existing Conditions

2.1. The site is situated between Thorne to the west and Crowle to the east, in the Metropolitan Borough of Doncaster, South Yorkshire. The South Humberside Main Railway Line dissects the site. The M18 is located to the west of the site, whilst the M180 runs through the southern end of the site. The Thorne Moors are located to the north of the site. The site location is shown in Figure 2.1.

2.2. The site is over 1,500ha and is currently entirely greenfield.

2.3. A topographic survey of the site was carried out and shows that land on site is currently generally situated between 1 and 4mAOD and exhibits very low or negligible gradients.

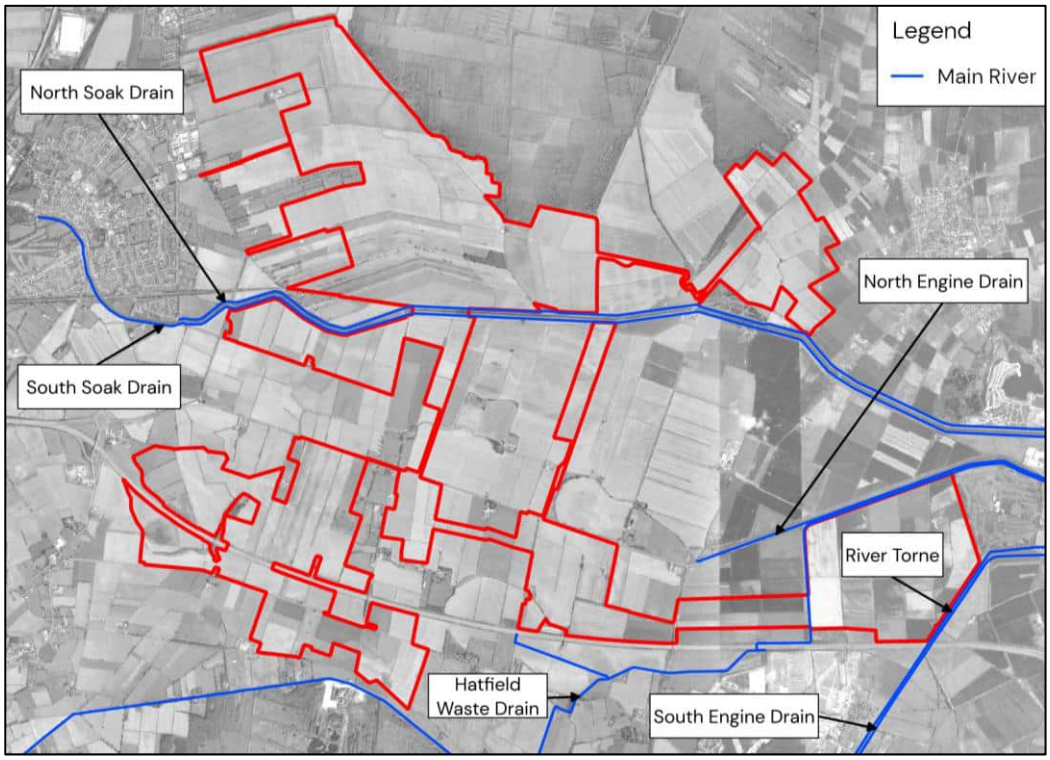
Figure 2.1 – Site Location



Existing Drainage and Hydrology

2.4. There are a large number of watercourses on site and in the immediate vicinity. These include several Main Rivers which are managed by the Environment Agency: the North Soak Drain, the South Soak Drain, the North Engine Drain, the South Engine Drain, the River Torne and the Hatfield Waste Drain. Main Rivers on site and in the immediate vicinity are shown in Figure 2.2. The River Don and River Trent (both Main Rivers) are located further west and east of the site, respectively.

Figure 2.2 – Main Rivers



2.5. In addition to the Main Rivers discussed above, there are a large number of Ordinary Watercourses running through the site. These fall under the control of two Internal Drainage Boards (IDBs): the Isle of Axholme & North Nottinghamshire Water Level Management Board and the Doncaster East Internal Drainage Board. IDB mapping showing the alignment of these watercourses is included in **Appendix A**.

2.6. IDB mapping (**Appendix A**) also shows where pumping stations are located and used to control water levels of the surrounding area. There are also several culverted pipes owned and maintained by the IDBs identified on the mapping. As the site is currently greenfield it is considered unlikely that there are any further underground drainage assets within the site boundary.

2.7. Geological data from the British Geological Survey (BGS) show that the bedrock geology at the site is split between 'Sherwood Sandstone Group – Sandstone' in the west and 'Mercia Mudstone Group – Mudstone' in the east (see Figure 2.3).

2.8. BGS also record a wide range of superficial deposits at the site. These deposits include: 'Alluvium – Clay, Silt, Sand and Gravel', 'Hemingbrough Glaciolacustrine Formation - Clay, Silty', 'Warp – Clay and Silt', 'Peat', 'Glaciofluvial Deposits, Devensian - Sand And Gravel', 'Breighton Sand Formation - Sand, Silty' and 'Sutton Sand Formation – Sand'.

2.9. The hydrogeology aquifer classification defines the western half of the site (where sandstone is generally the underlying bedrock) as a highly productive aquifer, whilst the eastern half (generally underlain by mudstone) is defined as a low productivity aquifer (see Figure 2.4).

2.10. Soilscapes data details that there are three soil types found on site: 'slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils', 'raised bog peat soils' and 'loamy and clayey soils of coastal flats with naturally high groundwater'.

Figure 2.3 – BGS Bedrock Geology

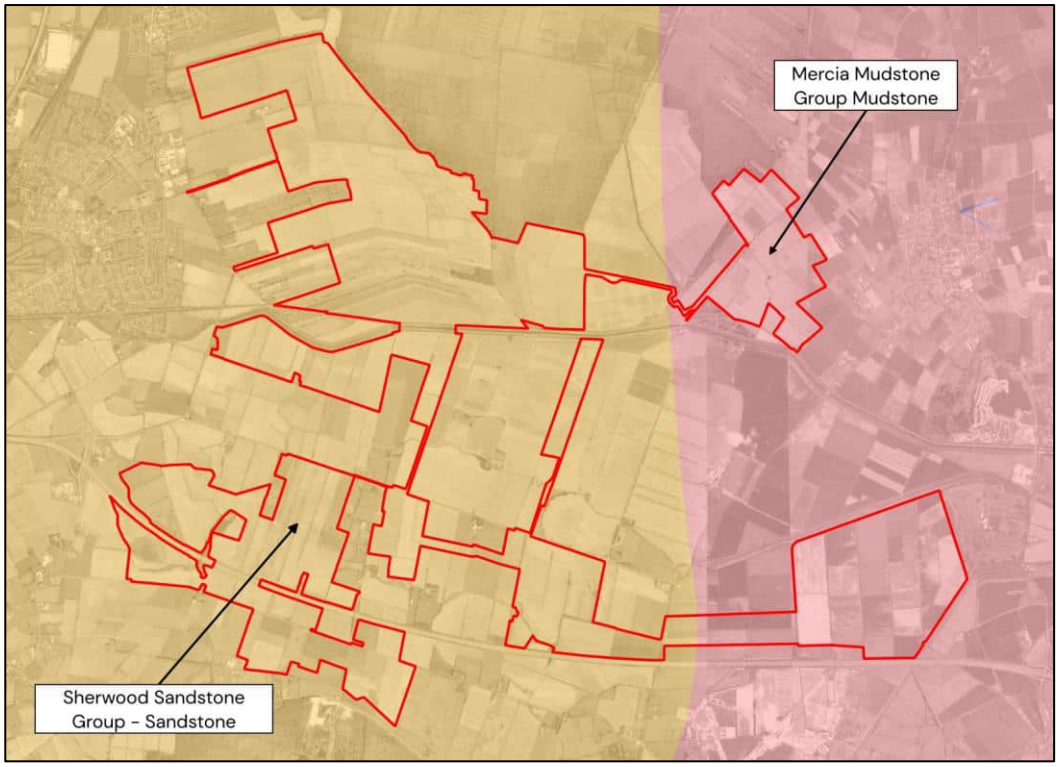
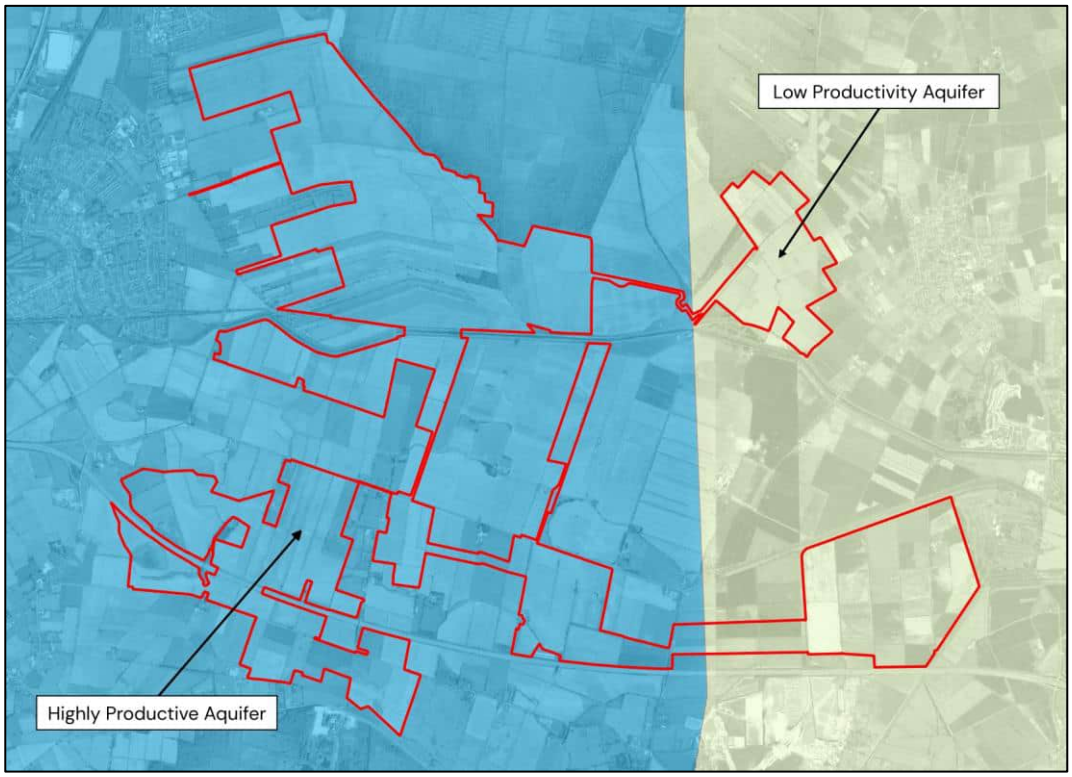


Figure 2.4 – Hydrogeology Aquifer Classification



3. Proposed Development

3.1. The main element of the proposal is the construction, operation, maintenance and decommissioning of a ground mounted solar park with an intended design capacity of over 50MWp (megawatts peak), and a battery energy storage facility with an export/import connection to the National Grid.

3.2. An operational lifespan of 45 years would be sought linked to the first export date from the Scheme. The Scheme may be carried out through a single continuous phase or in multiple phases.

3.3. The proposed site layout in included in **Appendix B.**

4. Development Vulnerability & Flood Zone Classification

National Policy Statements

4.1. NPS EN-1, draft EN-1 and draft EN-3 (described in detail in Chapter 5 of the PEIR) require the Sequential Test and Exception Test to be applied. These are discussed further below.

National Planning Policy Framework (NPPF)

4.2. Local Planning Authorities, (LPA) have a statutory obligation to consult the Environment Agency (EA) on all applications in the flood zones. The EA will consider the effects of flood risk in accordance with the NPPF.

4.3. NPPF requires that, as part of the planning process:

• A 'site specific' Flood Risk Assessment will be undertaken for any site that has a flood risk potential.

• Flood risk potential is minimised by applying a 'sequential approach' to locating 'vulnerable' land uses.

• Sustainable drainage systems are used for surface water management where practical.

• Flood risk is managed through the use of flood resilient and resistant techniques.

• Residual risk is identified and safely managed.

4.4. Table 1 of NPPF defines each flood zone based on the probability of river and sea flooding in that area, as summarised below:

• Zone 1- Low probability (< 1 in 1000 years)

• Zone 2- Medium probability (1 in 1000 - 1 in 100 years)

• Zone 3a- High probability (> 1 in 100 years)

• Zone 3b- The functional floodplain (>1 in 30 years)

4.5. The NPPF sets out a matrix indicating the types of development that are acceptable in different Flood Zones (see Table 4.1). The proposals are for a solar farm and associated battery storage and infrastructure which is classified as 'Essential Infrastructure'. The majority of the site is located in Flood Zone 3, with a very small area in Flood Zone 1. Essential Infrastructure is appropriate in all flood zones, subject to passing the Exception Test (see Table 4.1).

Table 4.1 – NPPF Guidance

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test Required	✓	✓	✓
Zone 3a	Exception Test Required	✗	Exception Test Required	Exception Test Required	✓
Zone 3b	Exception Test Required	✗	✗	✗	✓

Sequential Test

4.6. The Sequential Test is required for all developments proposed in Flood Zone 2 or 3 unless the proposals are for minor development or change of use. The Sequential Test is therefore required for the development proposals. The applicant's assessment of the Sequential Test is ongoing, and the relevant documentation will be made available of the next iteration of the PEIR.

4.7. In accordance with NPS draft EN-1, if, following application of the Sequential Test, it is not possible, (taking into account wider sustainable development objectives), for the project to be located in areas of lower flood risk the Exception Test can be applied, as required by Annex 3 of the Planning Practice Guidance. The Exception Test is discussed below.

Exception Test

4.8. As the vast majority of the site is located within Flood Zone 3, it will be necessary to pass the Exception Test.

4.9. There are two parts to the Exception test that the proposals must demonstrate:

1. That development that has to be in a flood risk area will provide wider sustainability benefits to the community that outweigh flood risk; and

2. That the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

4.10. The sustainability benefits of the proposals are hopefully self-evident. They include:

- A reduction in carbon emissions and greenhouse gas emissions
- A reduced dependency on the National Grid
- Reduced strain on finite resources like coal, oil, and natural gas which are contributing to global warming

4.11. A complete analysis of the sustainability benefits of the proposed development will be available in the next iteration of the PEIR.

4.12. Part 2 of the Exception Test will be addressed, in part, throughout this report which provides evidence to show that the proposed development will be safe from flooding over its lifetime (see Section 5). Evidence to show that the proposed development will not increase flood risk elsewhere will be provided by proposed drainage strategy.

4.13. In accordance with NPS draft EN-1, the Exception Test is only appropriate for use where the Sequential Test alone cannot deliver an acceptable site. Both elements of the Exception Test will have to be satisfied for development to be consented.

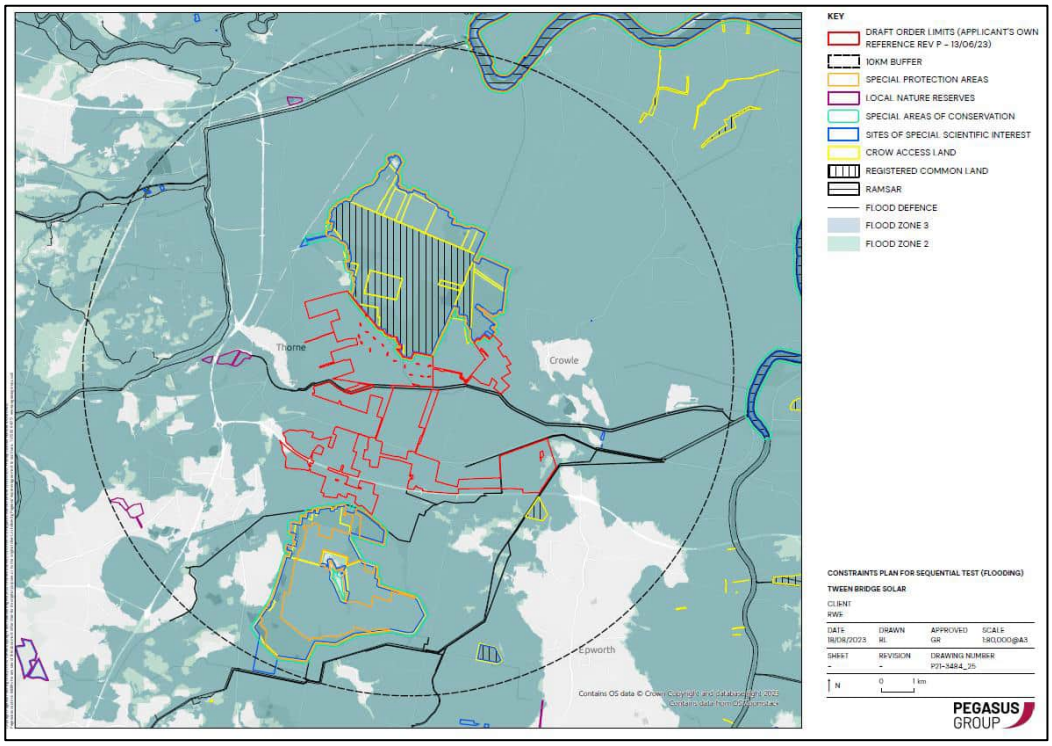
Application of the Sequential Test

4.14. One of the biggest constraints which must be considered when developing a renewable led energy scheme is securing a viable point of connection to the electricity network. Securing a grid connection is very difficult and problematic for energy proposals and this is consistently identified by stakeholders as a major barrier to achieving renewable energy targets. The availability of grid capacity and the ability to connect at a reasonable cost is therefore a material consideration in the site selection process. In the market-led system, the Applicant must ensure that there will be the necessary infrastructure and capacity within the electricity network to accommodate the power generated from an energy project. The availability of feasible grid connections allows projects to come forward meaning the location of the grid connection must be a material consideration in the site selection process.

4.15. RWE have accepted a grid offer from National Grid. The grid connection offer secured for the Scheme is independent of any other grid connection offer relating to other potential energy projects in the same region. The grid connection agreement with National Grid is to connect the Scheme to the existing 400KV Drax to Keady overhead line via the construction of a new 400KV substation. The connection date to the new substation is currently scheduled to be in 2029. This is subject to construction of new substation and completion of the necessary grid reinforcement works by National Grid. A 400Kv underground cable will be used to connect the Scheme to the new National Grid substation.

4.16. The authorised transmission export capacity will be 400MW with a further 200MW available in 2032, giving a total export capacity of 600MW. The site selection was guided by the initial 400MW export capacity. Following the initial identification of the site, the development area was subsequently extended to accommodate the additional 200MW. For the original 400MW export capacity, it was understood that the preferred location of the National Grid substation was within the site demise, and this is detailed within the Applicant's Screening Report. No national or local guidance is available which provides clarification regarding the extent of the area in which sequentially alternative sites should be assessed. Professional judgement has therefore been used to determine a suitable area in which this study should focus. Within the proximity of the order limits, there are no comparable land areas adjoining the site which provide a reasonable alternative site appropriate for the development. This is illustrated below in Figure 4.1.

Figure 4.1 – Constraints Plan for Sequential Test (Flooding)



4.17. It is also noted that the sequential approach has also been applied to the layout and design of the scheme, with more vulnerable uses located on parts of the site at lower probability and residual risk of flooding. The design iteration includes the repositioning of the battery energy storage system and substations.

5. Site Specific Flooding Issues and Existing Flood Records

5.1. Local Planning Authorities, (LPA) have a statutory obligation to consult the Environment Agency (EA) on all applications in the flood zones. The EA will consider the effects of flood risk in accordance with the NPPF.

National Planning Policy Framework (NPPF)

5.2. In accordance with the National Planning Policy Framework, this Flood Risk Assessment considers all sources of flooding including:

a) Tidal Flooding – from the sea;

b) Fluvial Flooding – from rivers and streams;

c) Surface Water Flooding – from overland surface water flow and exceedance;

d) Historic Flooding – known historic flooding issues;

e) Groundwater Flooding – from elevated groundwater levels or springs;

f) Flooding from Sewers – exceedance flows from existing sewer systems; and

g) Artificial Sources – reservoirs, canals etc.

Tidal Flooding

5.3. The Flood Map for Planning generally defines the entire site as Flood Zone 3, at High risk of flooding, impacted by a 1 in 200 year tidal flood event. Tidal flood risk at the site is associated with the tidally influenced River Trent (there are also fluvial sources of flooding to consider – see Fluvial Flooding section below).

5.4. There is a small area (approximately 4ha of the over 1,500ha site) at the far western end of the site that is defined as Flood Zone 1, at Low risk of flooding.

5.5. The Flood Map for Planning also highlights flood defences at the site and defines the site as an area that benefits from a 'reduction in risk of flooding from rivers and sea due to defences'.

5.6. The Flood Map for Planning is shown in Figure 5.1 and included as a larger, A3 drawing in **Appendix C.**

5.7. In addition to the Flood Map for Planning, the EA have provided detailed hydraulic model data for the Tidal Trent. Information provided by the EA is included in **Appendix D.**

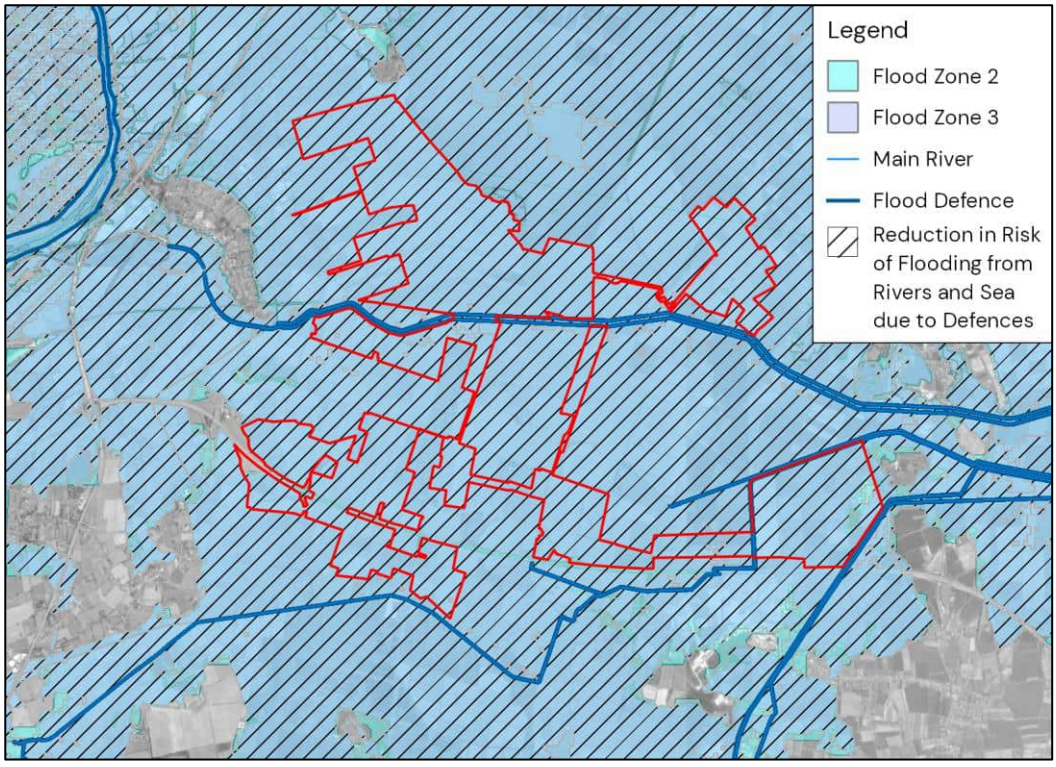
5.8. During a worst-case 1 in 1000 year flood event, the Tidal Trent model predicts flood levels on site to range from approximately -1mAOD to 2.2mAOD. Ground levels on site as defined by the topographic survey are generally in the approximate range of -0.2mAOD and 2.6mAOD.

5.9. Mitigation measures on site are proposed to include raising the lowest edge of all solar panels and infrastructure at least 1m above the ground. A defensive bund is also proposed to be sited around the vulnerable infrastructure on site. Mitigation measures will be discussed in further detail in the proposed surface water drainage strategy.

5.10. It should be noted that the EA have advised (in June 2023) that the Tidal Trent modelling has recently been updated. The required raising of panels and infrastructure will therefore be updated following receipt of this updated data.

5.11. With the proposed mitigation measures in place, the proposed development will be designed to remain safe and operational during a 1 in 1000 year tidal flood event, as informed by detailed hydraulic data from the EA. The tidal flood risk to the proposed development is therefore considered to be **Low**.

Figure 5.1 – Flood Map for Planning



Fluvial Flooding

5.12. The Flood Map for Planning generally defines the entire site as Flood Zone 3, at High risk of flooding, impacted by a 1 in 100 year fluvial flood event. There is a small area (approximately 4ha of the over 1,500ha site) at the far western end of the site that is defined as Flood Zone 1, at Low risk of fluvial flooding. The Flood Map for Planning is shown in Figure 5.1 and included as a larger, A3 drawing in **Appendix C.**

5.13. As detailed in the EA correspondence included in **Appendix D**, parts of the site are also defined as Flood Zone 3b, the functional floodplain predicted to be impacted by a 1 in 30 year fluvial flood event. Where development is proposed here, level-for-level floodplain compensation will be required.

5.14. There are a large number of watercourses on site and in the surrounding area, many of which are managed by the IDB. IDB mapping is included in **Appendix A**. All IDB watercourses will have a 9m easement which is left clear of all development. Main Rivers are also expected to have a 9m easement, to be confirmed following consultation with the EA.

5.15. Correspondence with the EA (included in **Appendix D**) highlights that the site is at risk of flooding from the River Trent, River Torne and associated Drains. The EA also highlight that land drainage represents the dominant flood risk at the site and that the site is located in the Isle of Axholme Critical Drainage Area which has a reported critical flood level of 4.1mAOD. The area is under the management of Doncaster East Internal Drainage Board (IDB).

5.16. As discussed above, mitigation measures on site are proposed to include raising the lowest edge of all solar panels and infrastructure at least 1m above the ground. A defensive bund is also proposed to be sited around the vulnerable infrastructure on site.

5.17. Although advised by the EA that the site has a critical flood level of 4.1mAOD, given the ground levels on site generally vary between approximately -0.2mAOD and 2.6mAOD, it is not feasible to raise infrastructure above this critical flood level. Mitigation measures will be discussed in further detail in the proposed surface water drainage strategy to be prepared by Pegasus as a separate document.

5.18. In addition, although no formal information has been provided as to how the critical flood level has been derived, it is understood that this level accounts for an absolute worst-case scenario where no defences are acting to protect the site. This includes failure of a range of IDB and EA controlled pumping stations which control water levels at the site and a large surrounding area. Given the design life of that development of approximately 45 years, this event and the critical flood level of 4.1mAOD is considered a highly unrealistic scenario.

5.19. In addition to providing details of the critical flood level at the site, the EA also provided detailed hydraulic model data for the River Torne (see **Appendix D**). The outputs of the River Torne model predict significantly reduced flood risk at the site compared to the Tidal Trent model discussed above and as such, proposed mitigation measures designed against the tidal output will suitably protect the development from the fluvial flood risk associated with the River Torne.

5.20. Overall, the fluvial flood risk to the site is considered to be **Low to Medium**.

Surface Water Flooding

5.21. The Risk of Flooding from Surface Water (RoFSW) dataset shows that the majority of the site is not predicted to be impacted by a 1 in 1000 year rainfall event and is a Very

Low Risk of surface water flooding (see Figure 5.2 and **Appendix C**). The dataset also highlights areas of High to Low risk, impacted by a 1 in 30 and 1 in 1000 year rainfall event, respectively, spread across the site. These at-risk areas are generally isolated and associated with surface water arising within the site boundary itself.

5.22. During a 1 in 1000 year rainfall event, surface water flood depths on site are generally not predicted to exceed 600 to 900mm (see Figure 5.2 and **Appendix C**). The lowest edge of proposed solar panels and infrastructure in areas at risk of surface water flooding will be raised above the predicted 1 in 1,000 year flood depths. This will ensure that the proposed panels will be safe over their lifetime and that surface water flow patterns on site will not be impacted.

5.23. In addition to the above mitigation measures, surface water arising within the site boundary itself with be managed with the proposed surface water drainage strategy for the development.

5.24. Overall, with the necessary mitigation measures and drainage strategy in place, it is considered that the site is at **Low** risk of flooding from surface water.

Figure 5.2 – RoFSW Extents

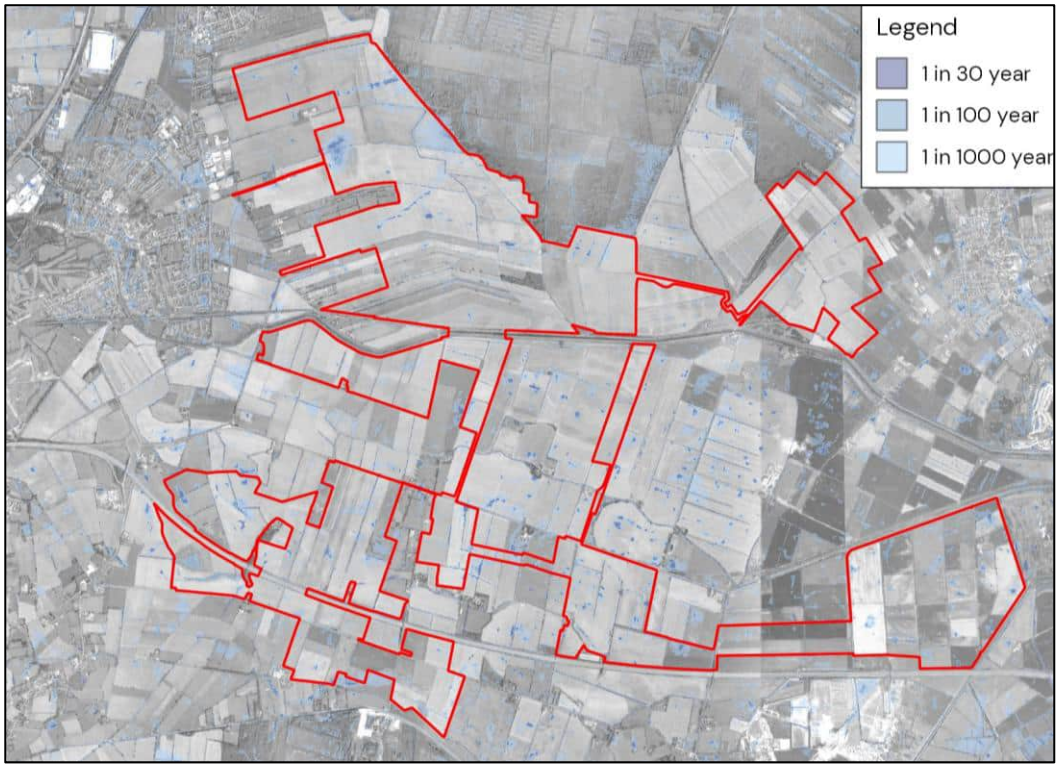
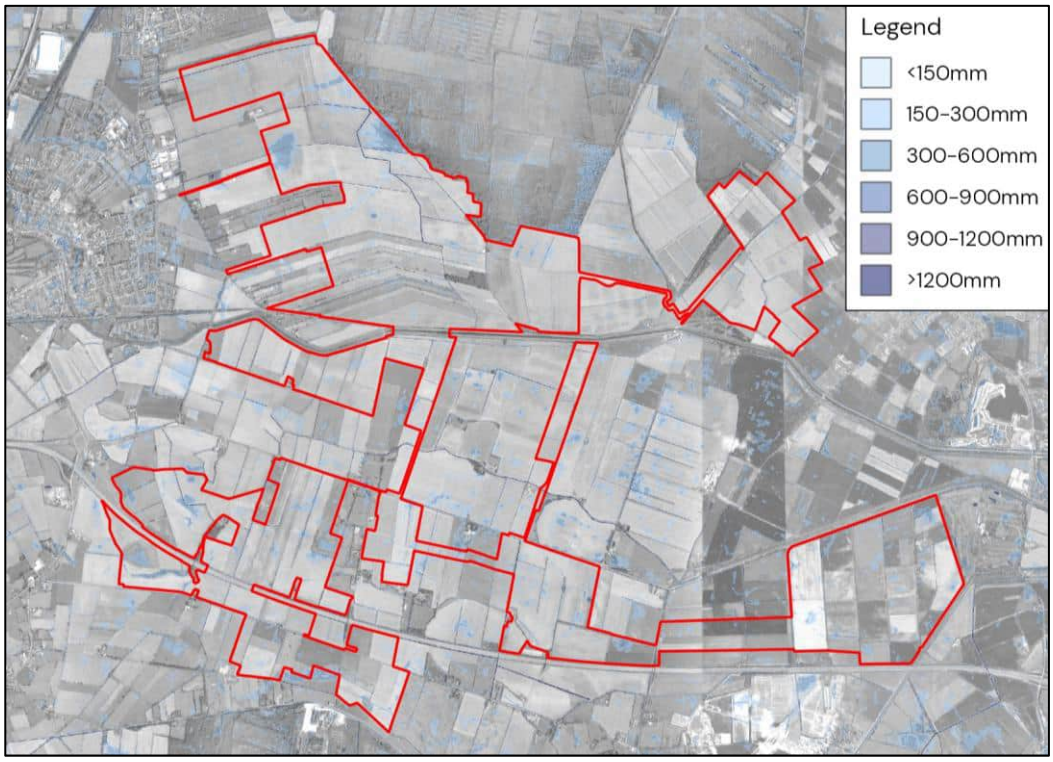


Figure 5.3 – RoFSW 1 in 1000 year Depths



Historic Flooding

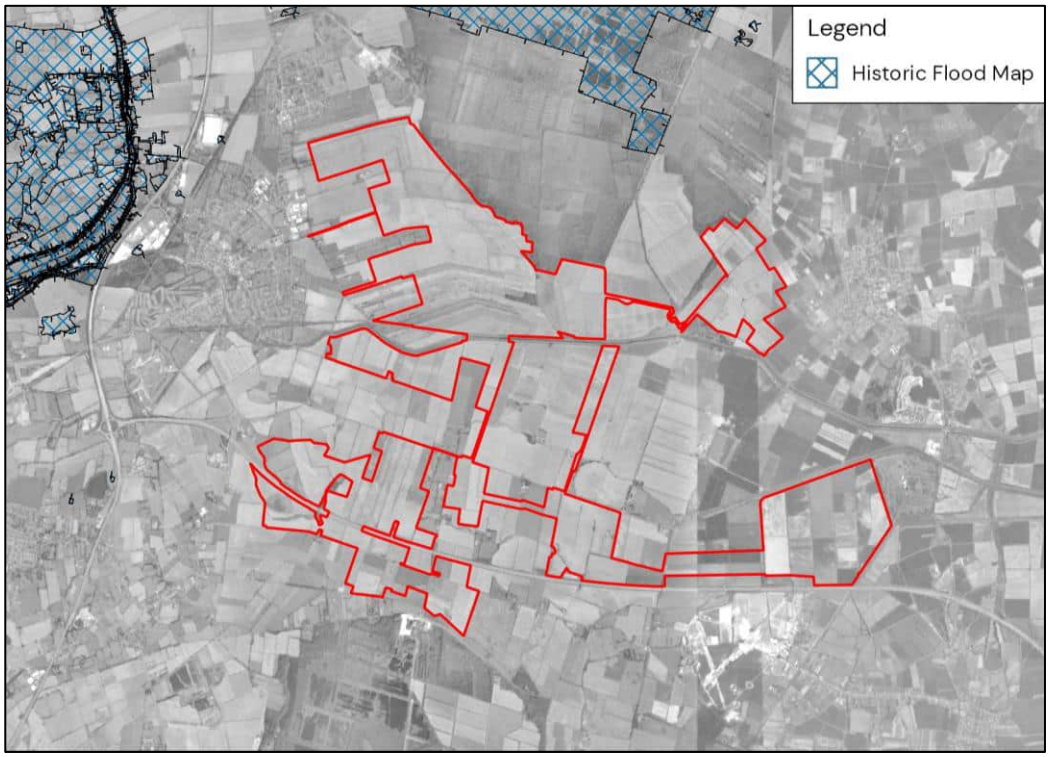
5.25. The EA's Recorded Flood Outlines dataset does not record any historic flood events impacting the site. The nearest recorded historical events are located approximately 1.5km north of the northern end of the site and 2.3km west of the site (see Figure 5.4 and **Appendix C**).

5.26. The Doncaster MBC Level 1 Strategic Flood Risk Assessment (2015) (covering the western half of the site) states that "DMBC have limited records regarding any flood incidents related to fluvial or tidal flooding" and do not record any historic flood events impacting the site.

5.27. The North and North East Lincolnshire Strategic Flood Risk Assessment (2022) (covering the eastern part of the site) refers to the EA's mapping discussed above when discussing historical flooding in the region and as such, does not highlight any site specific historic flood events.

5.28. Overall, the historic flood risk to the site is considered to be **Low**.

Figure 5.4 – Recorded Flood Outlines



Groundwater Flooding

5.29. As discussed above in Section 2, bedrock geology at the site is split between sandstone in the west and mudstone in the east. It is considered likely that the sandstone in the west will be permeable, whilst the mudstone in the east is expected to be impermeable. There is potential for groundwater emergence where these two bedrocks meet.

5.30. The hydrogeology aquifer classification defines the western half of the site (where sandstone is generally the underlying bedrock) as a highly productive aquifer, whilst the eastern half (generally underlain by mudstone) is defined as a low productivity aquifer. As with having two difference bedrocks, there is potential for groundwater emergence where these to aquifer types meet.

5.31. A wide range of superficial deposits are also recorded at the site (see Section 2). Any clay superficial deposits across the site are expected to restrict groundwater emergence. Soilscapes data also details the presence of clayey soils across parts of the site, which will also act to reduce the risk of groundwater emergence.

5.32. Given the significant number of watercourses on site and in the surrounding area, it is considered unlikely that groundwater would rise above the fluvial/tidally influenced flood levels on site.

5.33. Site topography is also not considered conducive to groundwater flooding – any ground water to emerge is generally expected to follow site topography and fall towards the watercourses on site without accumulating to significant depths.

5.34. Overall, given the above, although there is potential for groundwater emergence on site, the risk is considered to be **Low**.

Flooding from Sewers

5.35. The Doncaster MBC Level 1 Strategic Flood Risk Assessment (2015) interactive mapping does not show any recorded flood events from the Severn Trent Water Floods Register that impact the site.

5.36. The North and North East Lincolnshire Strategic Flood Risk Assessment (2022) states that 'sewerage drainage problems' have been mapped on their 'interactive maps'. These interactive maps have not been made available at the time of writing this report and as such, no records of sewer flooding at the site have been found.

5.37. As the site is entirely greenfield, it is unlikely that there is an existing underground drainage network located within the site boundary. Additionally, any flood water from sewers in the close vicinity of the site would follow local topography and would not be expected to accumulate within the site boundary.

5.38. The risk of flooding from sewers to the site is therefore considered to be **Low.**

Flooding from Artificial Sources

5.39. The EA's Reservoir Flood Extents shows the extent of flooding should a catastrophic breach occur during a 'wet day' when local rivers had already overflowed their banks and highlights parts of the site to be at risk during a 'wet day' (see Figure 5.5). The site is not shown to be at risk during a 'dry day' when local rivers are not overflowing their banks.

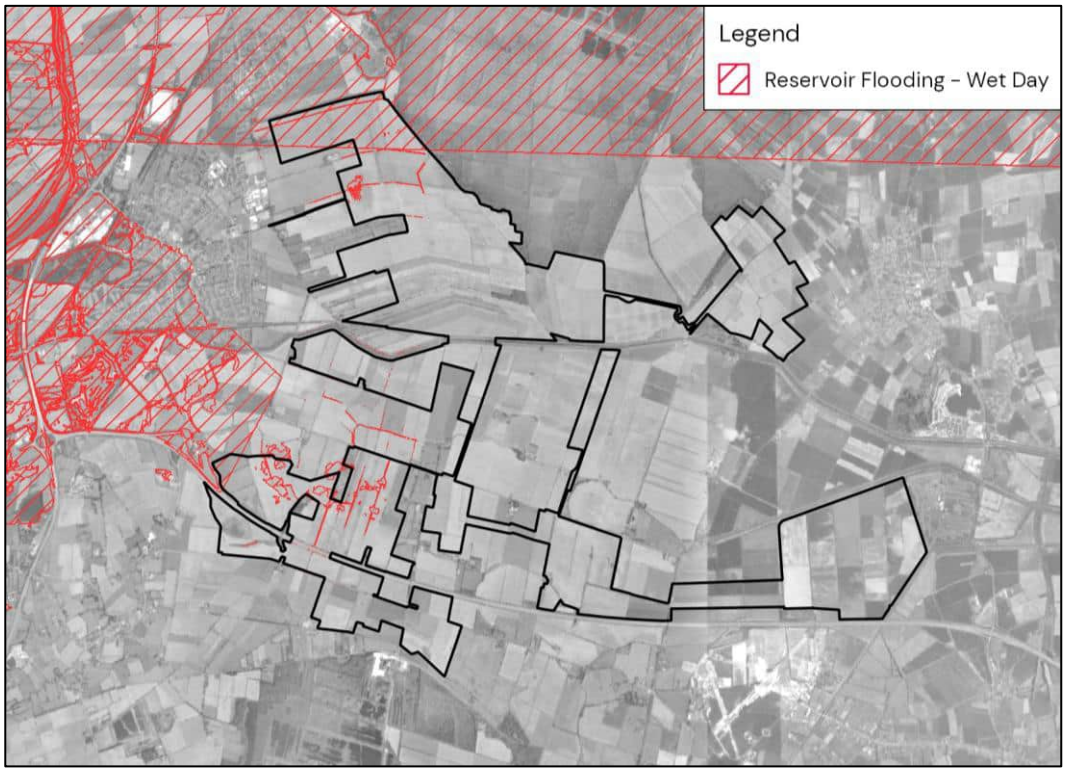
5.40. The North and North East Lincolnshire Strategic Flood Risk Assessment (2022) states that "reservoir flooding is extremely rare in the UK due to very strict regulations and mandatory assessments". As such, the likelihood and risk of a catastrophic reservoir breach occurring at the site is considered to be Very Low.

5.41. The Stainforth and Keadby Canal runs through the centre of the site, roughly in line with the South Humberside Main Railway Line. The North and North East Lincolnshire Strategic Flood Risk Assessment (2022) advises that this canal is manages by British Waterways and only highlights flood risk associated with the canal where it is influenced by the River Ouse and River Don, which are both located a notable distance from the site.

5.42. There are no other artificial sources of flooding or canals located in the vicinity of the site that would present a flood risk.

5.43. The site is therefore considered to be at **Low** risk of flooding from artificial sources.

Figure 5.5 – Reservoir Flooding – Wet Day



Post Development Flood Risk Summary

5.44. The risk of flooding to the site from all sources has been assessed above, with the conclusions summarised in Table 5.1:

Table 5.1 – Flood Risk Summary

Flood Source	Flood Risk	Mitigation/Comments
Tidal	Very Low	• The site is generally located in Flood Zone 3. • Solar panels and proposed infrastructure will be raised at least 1m above the ground. Protective bunds will also be proposed around the vulnerable infrastructure. •The site benefits from a 'reduction in risk of flooding from rivers and sea due to defences'.
Fluvial	Low	• Solar panels and proposed infrastructure will be raised at least 1m above the ground. Protective

		bunds will also be proposed around the vulnerable infrastructure. •All IDB watercourses will have a 9m easement which is left clear of all development. It is expected that Main Rivers will also include this 9m buffer (to be confirmed with the EA).
Surface Water	Low	• Large areas of the site are at Very Low risk, not predicted to be impacted by 1 in 1000 year rainfall event. • Proposed solar panels and infrastructure will be raised at least 1m above the ground. •The proposed surface water drainage strategy (to be prepared by Pegasus as a separate document) will manage surface water arising on site.
Historic	Low	• The SFRA and EA data do not include records of any historic flood events impacting the site.
Groundwater	Low	• Given the close proximity to watercourses, groundwater levels are not expected to rise above fluvial flood levels on site. • Clayey soils and superficial deposits recorded on site are expected to restrict groundwater emergence on site. • Site topography is not considered conducive to groundwater flooding.
Sewers	Low	• There are no records of sewer flooding occurring at site. • Site topography is not considered conducive to sewer flooding. • As the site is entirely greenfield, it is unlikely that there is an existing underground drainage network located within the site boundary.
Artificial	Very Low	• There are no recorded flood events of the Stainforth and Keadby Canal running through the site.

		• The site is not shown to be at risk of reservoir flooding during a 'dry day' when local rivers are not overflowing their banks. • The likelihood and risk of a catastrophic reservoir breach occurring at the site is considered to be Very Low

Access & Egress

5.45. The site will be managed remotely and only visited occasionally for maintenance. Site access and egress should therefore not be needed during an extreme flood event.

5.46. Access roads that cross any watercourses on site will be designed to be clear-span to ensure existing flows are not impacted.

Existing Essential Infrastructure On site

5.47. It is also worth noting that there is already some existing Essential Infrastructure (wind turbines and a substation) located on site which have been functioning unimpeded by flooding since construction.

6. Summary

6.1. The site area is over 1,500ha in area and is entirely greenfield. The site is proposed for a solar farm development with battery energy storage and associated infrastructure.

6.2. The site is generally located entirely in Flood Zone 3. Mitigation measures are proposed to ensure the development will remain safe and operational during an extreme tidal or fluvial flood event. Mitigation measures have been designed against 1 in 1000 year tidal flood levels provided by the Environment Agency. The proposed mitigation measures include raising solar panels and infrastructure at least 1m above the ground and providing a protective bund around vulnerable infrastructure.

6.3. A critical flood level of 4.1mAOD has been provided by the Environment Agency but it is not considered feasible to design mitigation measures against this extreme flood level. In addition, no detailed model data has been provided to back up this level. Following this, it is proposed to raise proposed solar panels and vulnerable infrastructure at least 1m above the ground. This is considered to be the greatest level of feasible raising across the site. Protective bunds will also be proposed around the vulnerable infrastructure on site.

6.4. The site is not considered to be at significant risk of flooding from any other source.

6.5. The Sequential Test will be required for the proposals. Assessment of this is ongoing by the applicant and will be available in the next iteration of the PEIR. In accordance with NPS draft EN-1, if, following application of the Sequential Test, it is not possible, for the project to be located in areas of lower flood risk the Exception Test can be applied, as required by Annex 3 of the Planning Practice Guidance.

6.6. It is proposed to manage surface water runoff from the proposed development with a surface water drainage strategy. The surface water drainage strategy will be prepared by Pegasus as a separate document.

6.7. With the proposed mitigation measures and drainage strategy in place, the proposed development is not considered to be at significant risk of flooding and will not increase the risk of flooding elsewhere.

6.8. The proposal is considered to accord with the requirements of the National Planning Policy Framework (NPPF) with residual risk to the site fully mitigated, and as such considered low risk.

Appendix A – IDB Watercourse Mapping

Key

- IOANN Pumping Station
- IOANN Piped Length
- IOANN Watercourse
- IOANN Board Area
- EA Main River

EASTOFT CP

CROWLE AND EALAND CP

Isle of Axholme

Isle of Axholme & North Nottinghamshire Water Level Management Board

Water Management Consortium

Senior Engineer - Mr R. Brown, BEng (Hons), GMICE

N

Tween Bridge Solar Farm IOANN Area

Drawing No:	Overview		
Drawn By:	D Cowling	Checked:	R Brown
Date:	07/02/2023	Scale:	1:25,000
Dept:	Engineering		

Wellington House
Manby Park
Manby
Louth
Lincolnshire
LN11 8UU
01507 328095
engineers@lmdb.co.uk
www.wmc-idbs.org.uk

Key

- DEIDB Pumping Station
- DEIDB Piped Length
- DEIDB Maintained Watercourse
- DEIDB Board Area
- EA Main River

Doncaster East Internal Drainage Board

Water Management Consortium

Senior Engineer - Mr R. Brown, BEng (Hons), GMICE

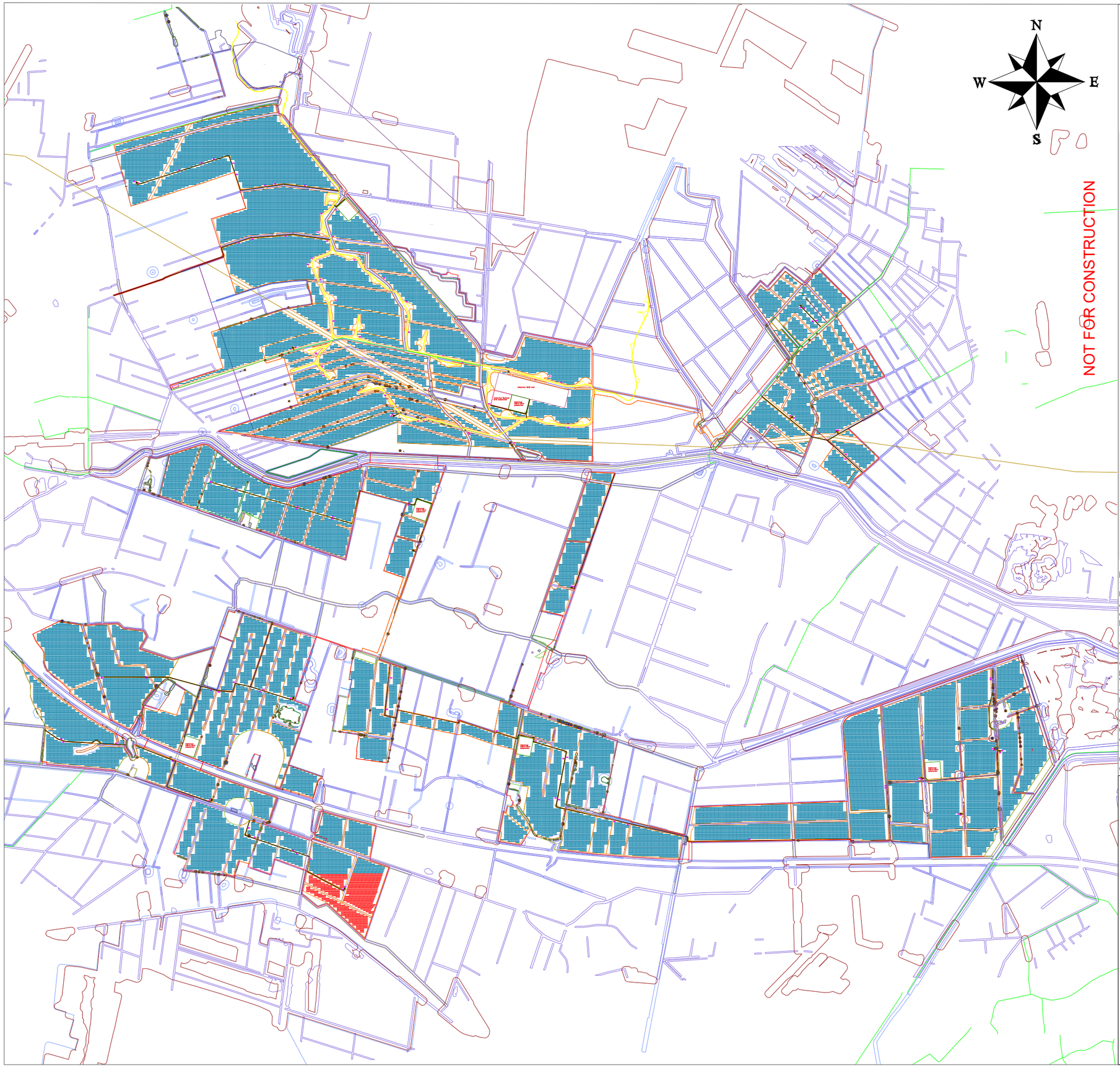
N

Tween Bridge Solar Farm DEIDB Area

Drawing No:	Overview		
Drawn By:	D Cowling	Checked:	R Brown
Date:	07/02/2023	Scale:	1:20,000
Dept:	Engineering		

Wellington House
Manby Park
Manby
Louth
Lincolnshire
LN11 8UU
01507 328095
engineers@lmdb.co.uk
www.wmc-idbs.org.uk

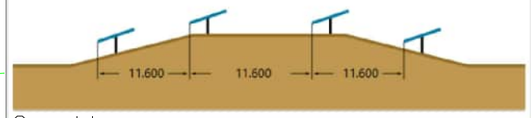
Appendix B – Proposed Site Layout



NOT FOR CONSTRUCTION

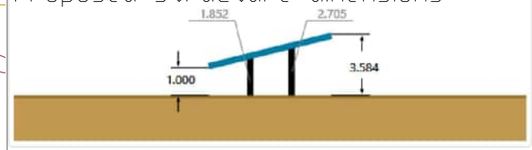
PV TWEEN BRIDGE	
MAIN EQUIPMENT	
PV Module type	N-type Half-cut Bifacial, 570 Wp
Substructure type	Fle Tilt, South 54º tilt
Inverter type	Central, 4200 kVA
OVERVIEW	
Nº PV Modules per String	27
Azimuth (º)	0 (S)
Pitch (m)	11.60
Total Nº Strings	53,210
Total Nº PV Modules	1,436,662
Total Installed DC Capacity (MWp)	818.90

Inter-row separation



Corridors

Proposed structure dimensions



NOTES:
1. A slope limit of 8.5º (15%) is considered along the structure length, using the topographic data provided.
2. All constraints (e.g. avian ecology, drains, water-courses, ditches, hedgerows, ponds, ecology, wind turbine generator buffers) have been considered in design.
3. Structures marked in red indicate no topographic data available.
4. Fence is assumed to be installed along the site boundary. Also, 3m is offset from the site boundary to allow for perimeter circulation during operational phase.
5. Existing roads are yet to be determined whether they will fall inside or outside the fence. Irrespective of its location, these roads will be used for circulation of different parts of the PV site, with the corresponding gates required at each fence-road boundary.
6. Proposed internal roads have been added to facilitate access to the inverter stations.
7. Existing 7kV lines have been assumed that they will be moved or placed underground in order to install more DC capacity.

LAYOUT LEGEND

- Boundary line (Fence)
- Public Right of Way
- Existing Road for Wind farm
- New Road
- Indicative BESS site
- Fixed Tilt Structure - 2Px27
- Trees/vegetation
- Ecological constraints
- Individual plots
- Indicative 132/33kV substation
- Central Inverter + MV Power Station

A SITE PLAN
Scale: 1:800

RWE

RWE RENEWABLES EUROPE

LOCATION: THORNE, ENGLAND
LATITUDE: 53.606894º
LONGITUDE: -0.899778º
ELEVATION: 2.0 m.a.s.l

TWEENBRIDGE 818.9 MWp PV PLANT LAYOUT

REV	DATE	DRAWN	REVISION
1	19-05-23	KDR	PRELIMINARY LAYOUT
2	27-06-23	KDR	Addition, modification and removal of plots. Updated constraints plan.

E01

Appendix C – A3 Flood Risk Drawings

Legend

- <150mm
- 150-300mm
- 300-600mm
- 600-900mm
- 900-1200mm
- >1200mm

Pegasus REF No: P21-3484 Tween Bridge Solar

A3 Drawing Name: Risk fo Flooding from Surface Water - 1 in 1,000 year Depths

Pegasus REF No: P21-3484 Tween Bridge Solar
A3 Drawing Name: Risk fo Flooding from Surface Water - Extents

Legend

Recorded Flood Outline

Pegasus REF No: P21-3484
Tween Bridge Solar
A3 Drawing Name: Recorded Flood Outlines

Legend

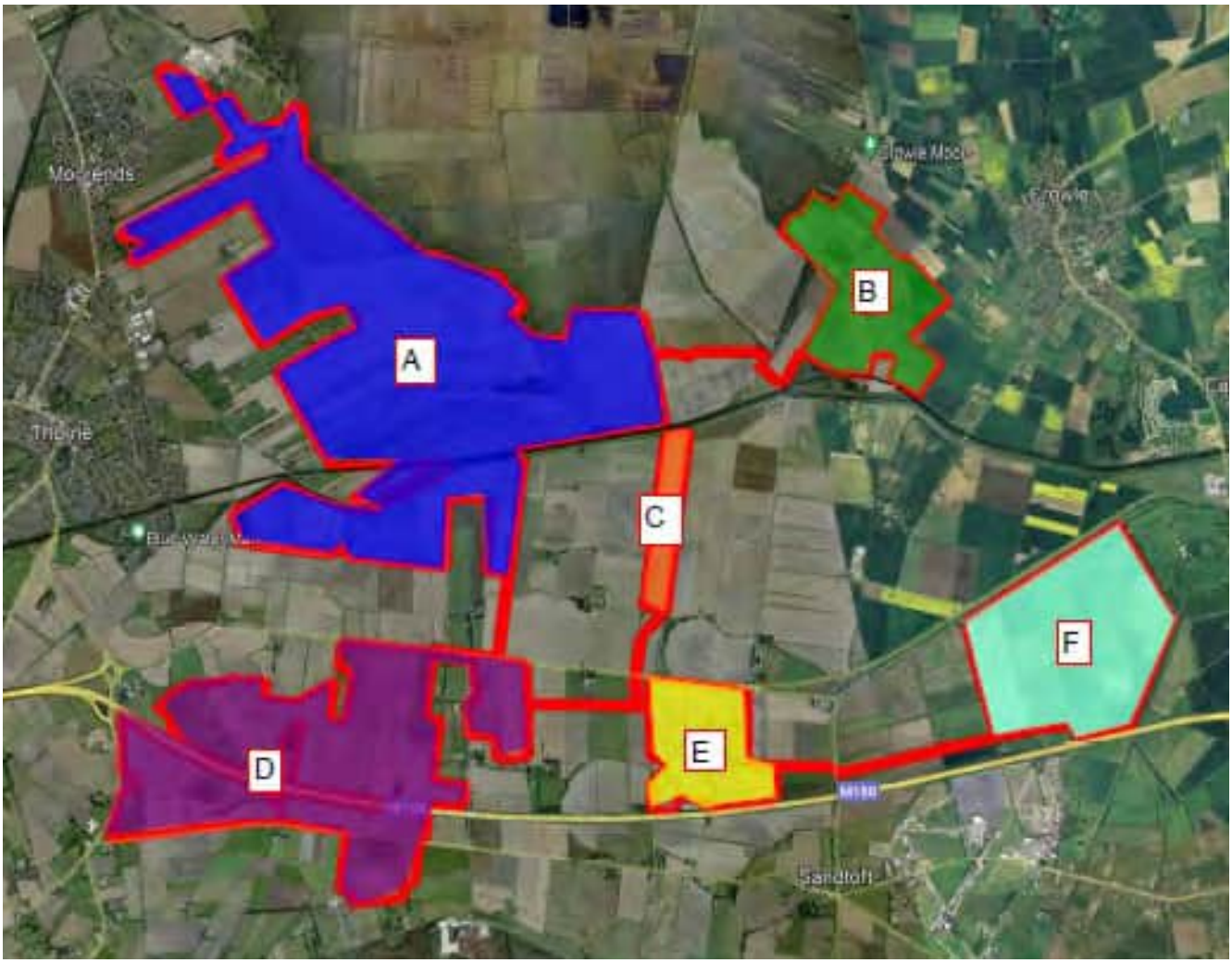
- Flood Zone 2
- Flood Zone 3
- Main River
- Flood Defence
- Reduction in Risk of Flooding from Rivers and Sea due to Defences

Pegasus REF No: P21-3484
Tween Bridge Solar
A3 Drawing Name: Flood Map for Planning

Appendix D – Environment Agency Data

Product 4 : Flood Risk Data Package for
Multiple Sites Around Thorne - SE 73321 12882

EMD 301466 **Date: 14/03/2023**



Flood Map for Planning:
The Flood Map for Planning is now classed as Open Data. As such it can be downloaded free of charge under an open data licence from the following addresses:

- https://data.gov.uk/publisher/environment-agency
- https://flood-map-for-planning.service.gov.uk/

Your development is in **flood zone 3**

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.
- ignore 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.

Zone 1: Low Probability	Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b)
Zone2: Medium Probability	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a: High Probability	Land having a 1% (1 in 100) or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. (Land shown in dark blue on the Flood Map)
Zone 3b: Functional Floodplain	• land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or • land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding). • Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. • (Not separately distinguished from Zone 3a on the Flood Map)

Probability	Percentage chance of flooding each year
1 in 2 year	50%
1 in 5 year	20%
1 in 20 year	5%
1 in 50 year	2%
1 in 100 year	1%
1 in 1000 year	0.1%

Modelled Information
The modelled flood extents and floodplain heights for the River Trent, River Torne and associated Drains have been provided. The dominant flood risk here however is from the land drainage. It is a critical drainage area with a critical flood level of **4.1m AOD.** Please see the section on this below, along with links to futher information.

Updated Climate Change Guidance: On 19th February 2016, the Flood risk assessments: climate change allowances' was published on www.gov.uk website. It has replaced previous guidance Climate Change Allowances for Planners. The climate change guidance can be found at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

The climate change allowances provided with this RFI are a 20%, 30% and 50% increase in the peak river flow for the 1% Annual Exceedance Probability (1 in 100 year) scenario. Please see the suggested allowance for your location and development in the links above. It is likely appropriate flood and climate resilience measures will need to be included.

Breach Information: It is recommended that a site specific breach analysis is carried out for the site using the joint DEFRA/Environment Agency document Flood Risk Assessment Guidance for New Development (FD2320). This document can be downloaded directly using the following link (FD2320.pdf).

Defence Information Flood defence data in routinely updated and freely available at: AIMS Spatial Flood Defences (inc. standardised attributes) - data.gov.uk and AIMS Asset Bundle - data.gov.uk. The flood defences offer a 1 in 100 year (1% chance of occurring in any given year) standard of protection in this area.

Historic Information We have records of historic fluvial flooding at this location in **2007**. Please note that we may or may not hold the original records in question. We do not make any claim as to the reliability of recorded flood extents or that all flood events in the area have been recorded. Please also be aware that flood defences may have been built subsequent to these historic flood events. Note - This information relates to the area the above named property is in, and is not specific to the property itself - it ***does not*** provide an indicator of flood risk ***at individual property level***.

Surface Water & Drainage: The Environment Agency (empowered under the Water Resources Act 1991) concentrates on the major elements of the drainage system, managing flood risk arising from designated "main rivers" and the sea. The Flood & Water Management Act (2010) has given Lead Local Flood Authorities (LLFAs) responsibility for the management of local flood risk, which includes surface runoff, groundwater and flooding from ordinary watercourses (smaller rivers and streams). The LLFA for this area is **Doncaster District Council/ North Lincolnshire County Council,** and we recommend that you contact them with concerns about any flooding issues for this area. Further information and maps for surface water, ordinary watercourses, and reservoir flooding can be found here:
https://www.gov.uk/check-long-term-flood-risk ; Reservoir flood maps: when and how to use them - GOV.UK (www.gov.uk)

Critical Drainage Area: This area is also under the management of **Doncaster East Internal Drainage Board.** This is due to the complex drainage system. There is a critical flood level of **4.1m AOD** applied. Here are asome useful links: IOAANN - Homepage; NELincs SFRA 2022; Keadby.

Open Data Information: Many datasets are now classed as Open Data and as such can be downloaded free of charge under an open data licence from the following address: https://data.gov.uk/publisher/environment-agency

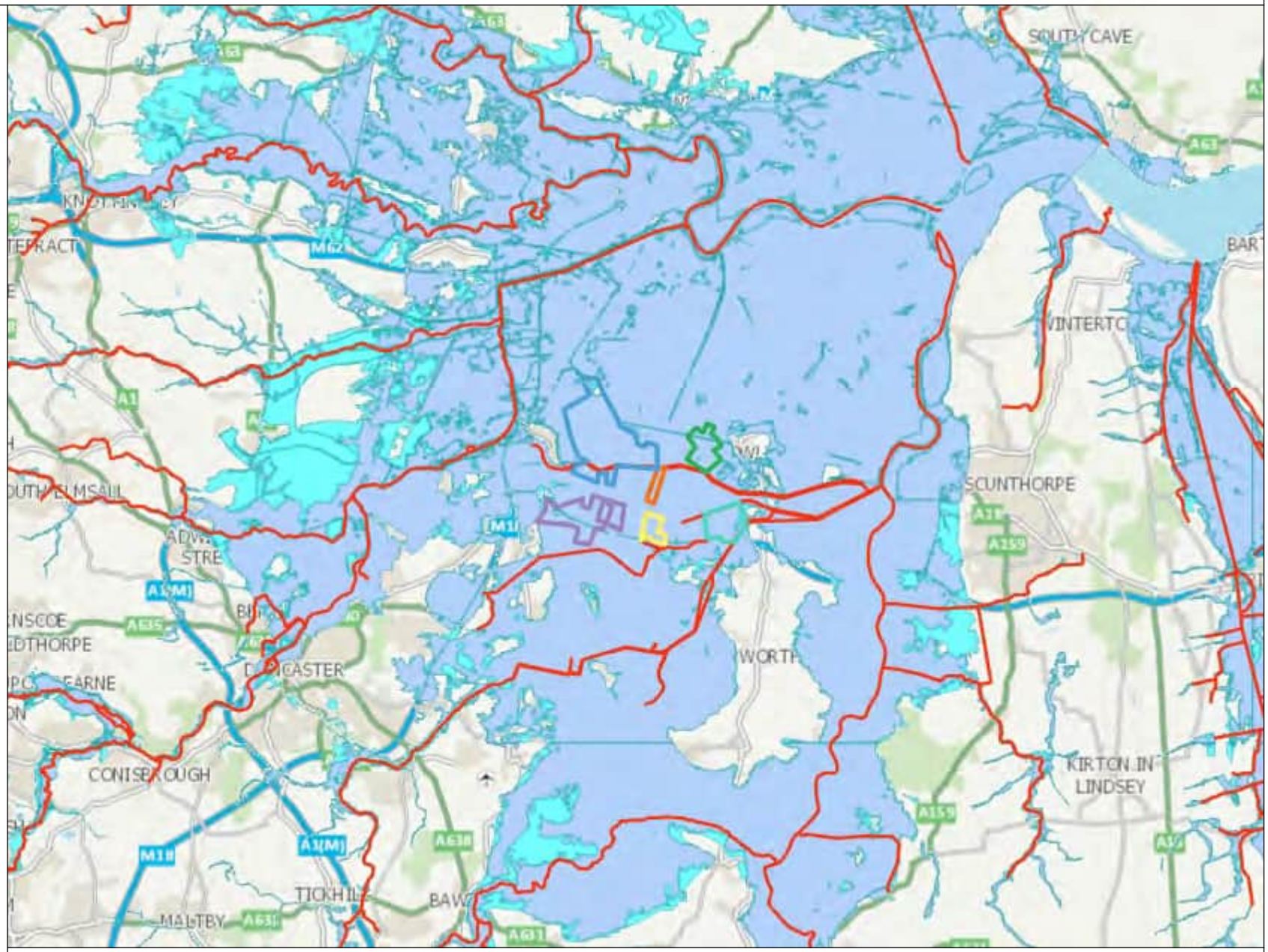
Permitting Information: Under the Environmental Permitting (England and Wales) Regulations 2016, any permanent or temporary works in, over or under a designated main river will require an Environmental Permit for Flood Risk Activities from the Environment Agency. Any permanent or temporary works within 8 metres of the top of bank of a designated main river, or landward toe of a flood defence may require an Environmental Permit for Flood Risk Activities from the Environment Agency. In addition, any permanent or temporary works within the floodplain of a designated main river may also require an Environmental Permit for Flood Risk Activities. To find out whether your activity requires a permit or falls under a relevant exclusion, exemption or standard rule please follow this link: https://www.gov.uk/guidance/flood-risk-activities-environmental-permits. The Environment Agency require access to the watercourse and free movement up to 8m from the river bank/ defence for maintenance purposes.

Please note that a permit is separate to and in addition to any planning permission granted.

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. 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.

Extended Flood Map, centred on Land Near Thorne [EMD301466]

Environment Agency

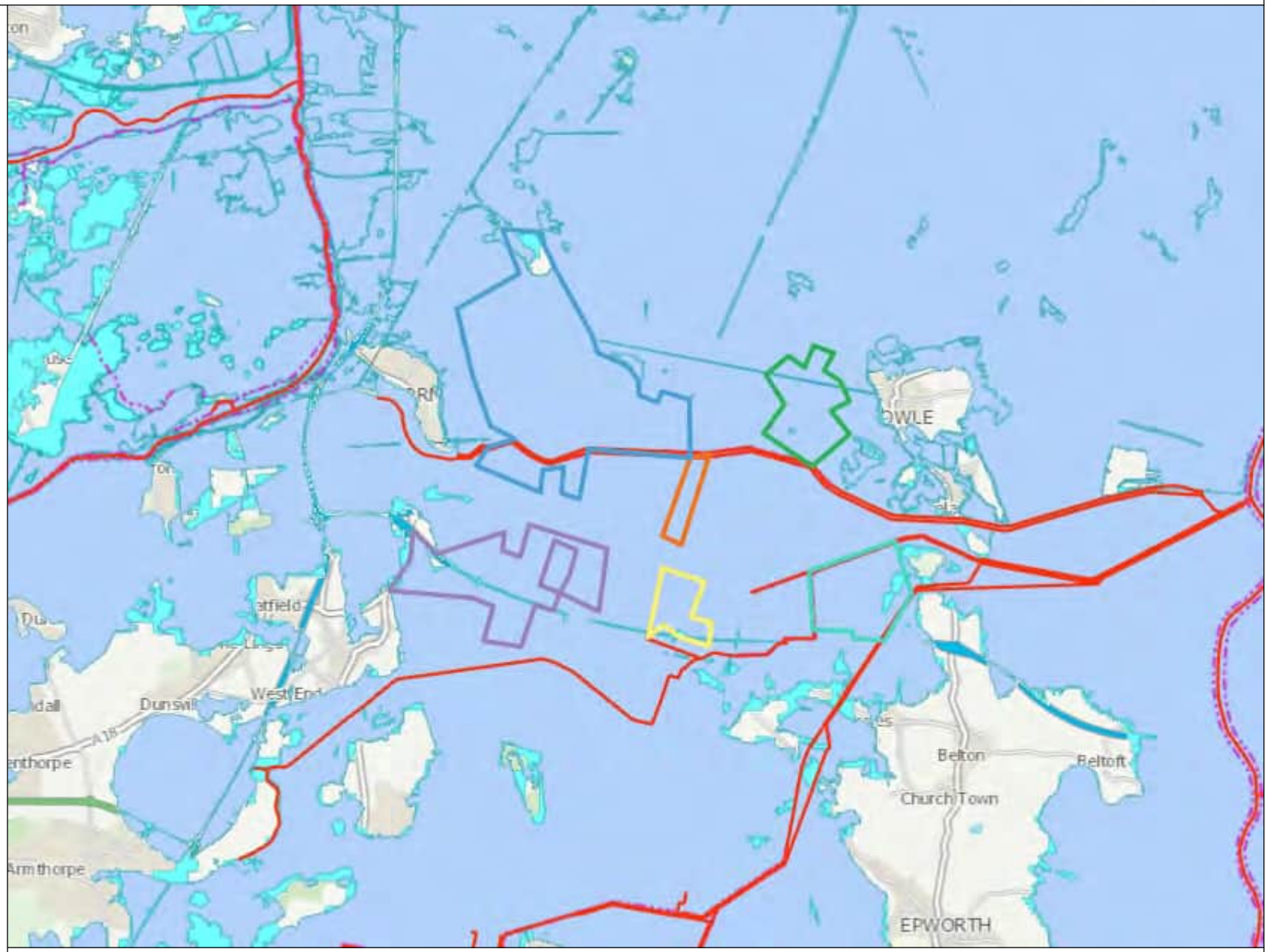


Detailed Flood Map, centred on Land Near Thorne [EMD301466]

Environment Agency

Legend

- Statutory Main Rivers
- Defences
- Flood Storage Areas
- Flood Zone 3
- Flood Zone 2



1: 100,000

0 2,500

Metres

N
W E
S

Detailed River Network Map, centred on Land Near Thorne [EMD301466]

Environment Agency

Legend

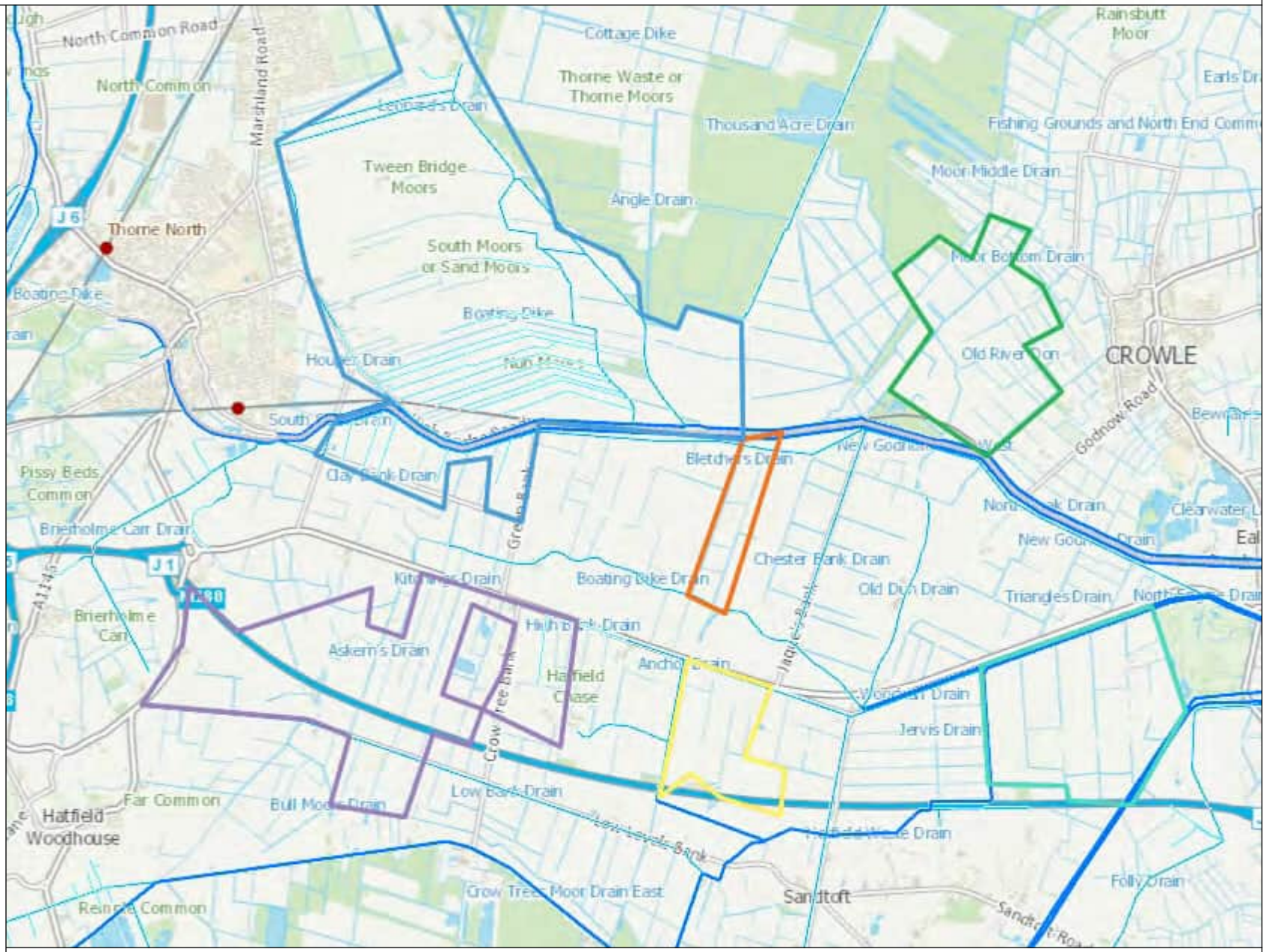
Detailed River Network

- Primary River
- Secondary River
- Tertiary River
- Lake / Reservoir
- Canal
- Canal Tunnel
- Extended Culvert
- Multiple Channel Culvert
- Underground River (potential sewer)
- Underground River (inferred)
- Underground River (local knowledge)
- Undefined

Offline Drainage features

Detailed River Network

- Primary River
- Secondary River
- Tertiary River
- Lake / Reservoir
- Canal
- Canal Tunnel
- Extended Culvert
- Multiple Channel Culvert
- Underground River (potential sewer)
- Underground River (inferred)
- Underground River (local knowledge)
- Undefined



1: 50,000

0 1,250

Metres

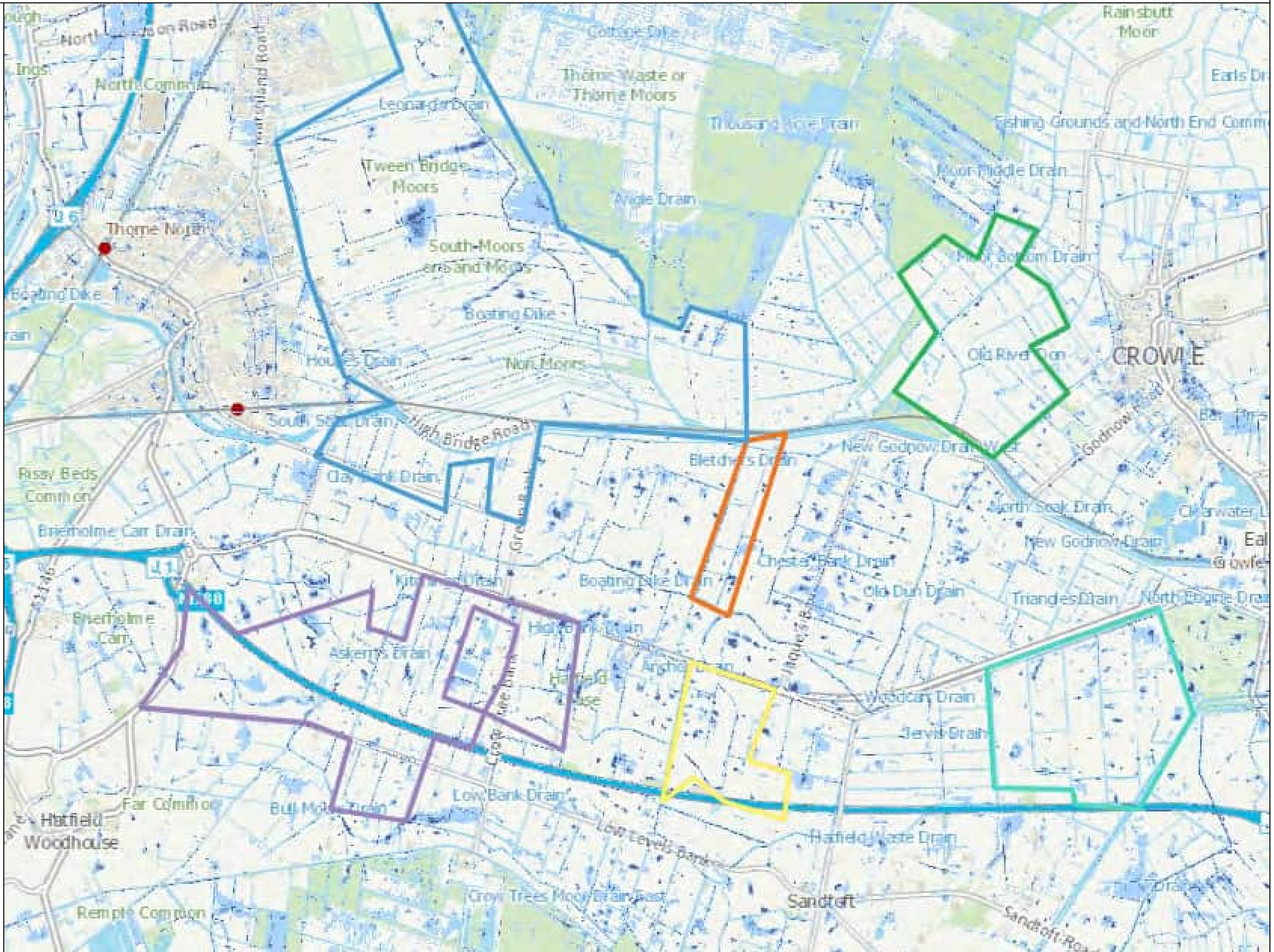
N W E S

Surface Water Flood Map, centred on Land Near Thorne [EMD301466]

Environment Agency

Legend

- Flood Extent 1 in 30
- Flood Extent 1 in 100
- Flood Extent 1 in 1000



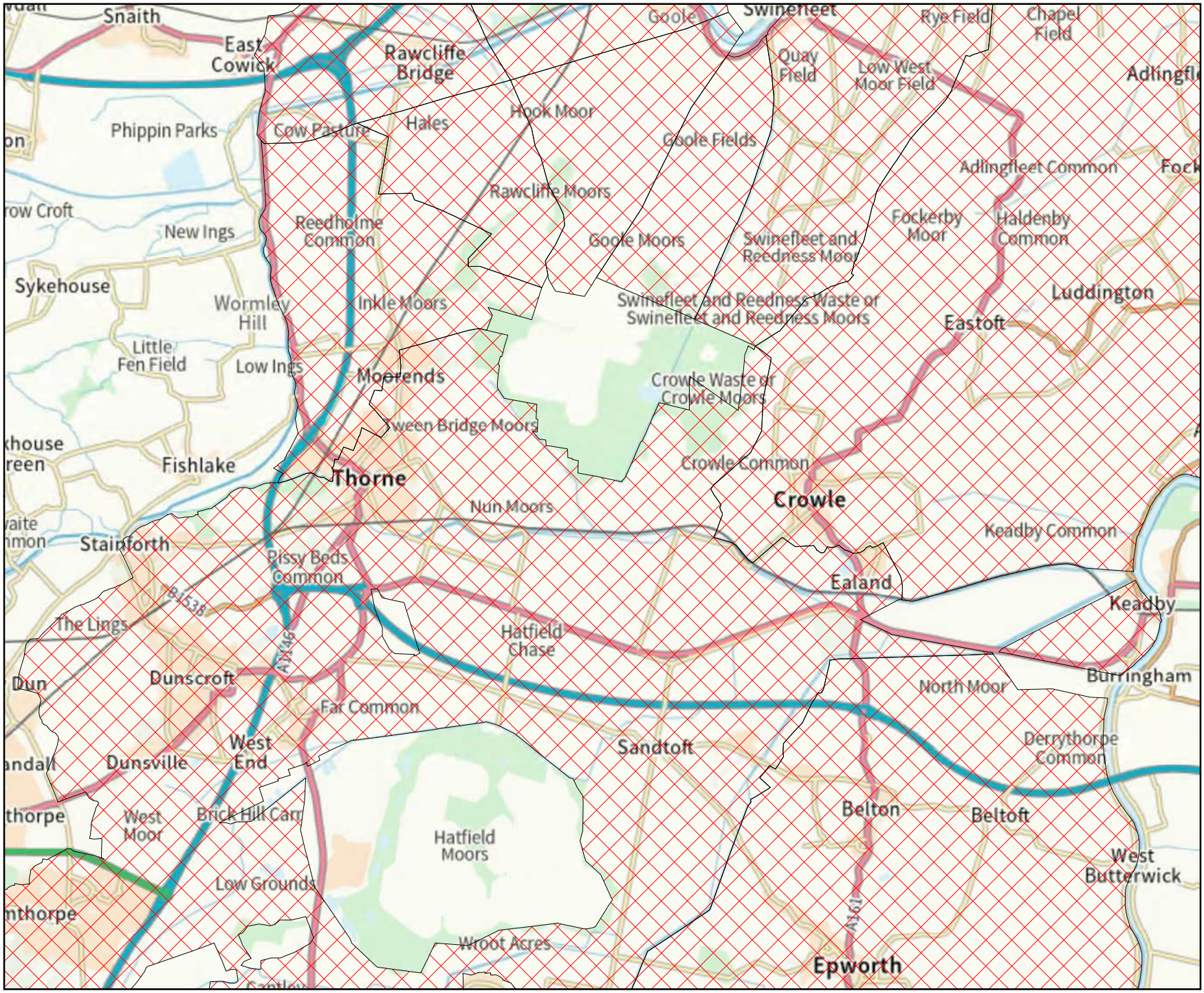
1: 50,000

0 — 1,250

Metres

N, E, S, W

Isle of Axholme Area Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

N
W E
S

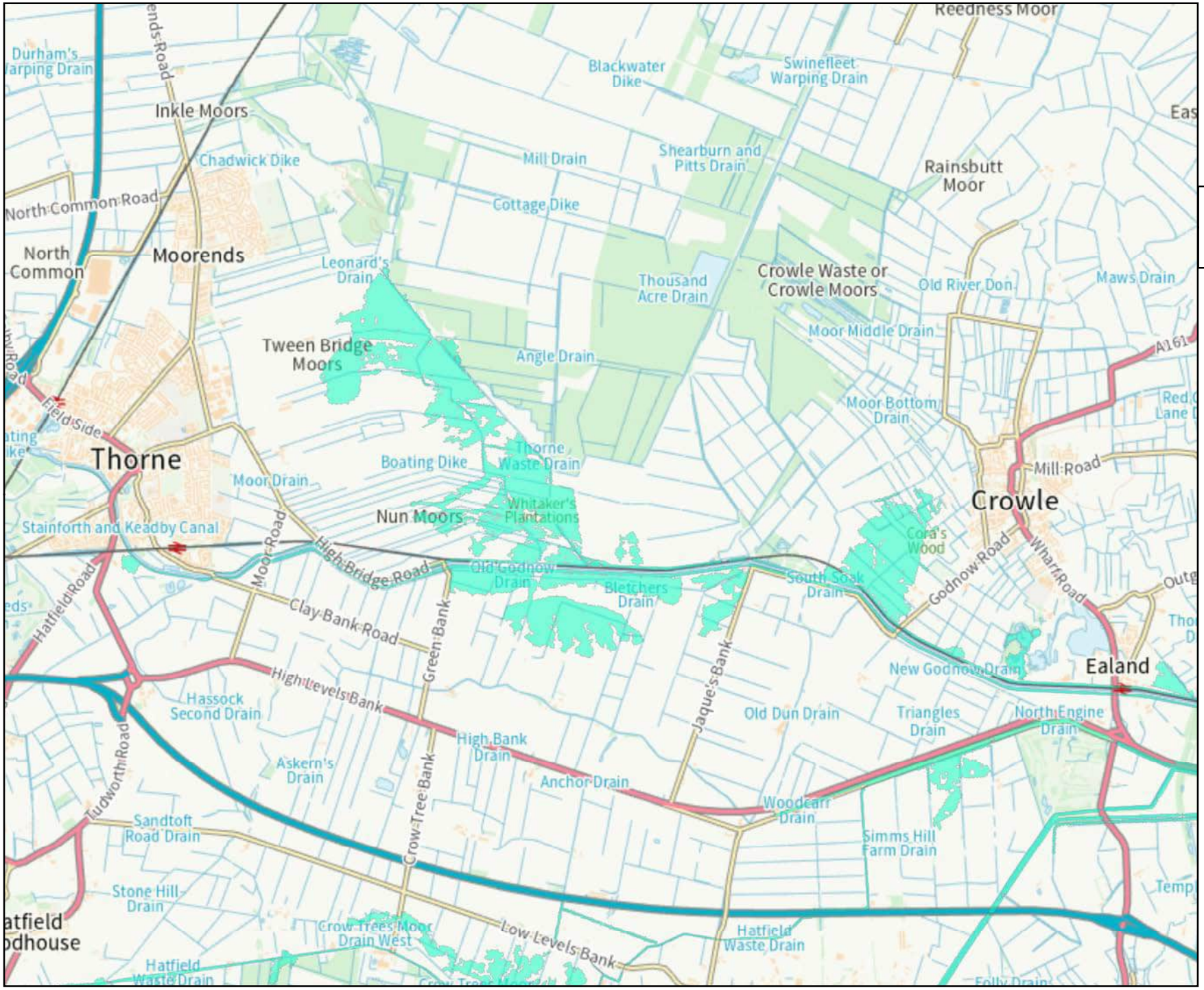
Scale 1:100,000

Date created: 14 March 2023

Legend

Isle_Axholme_IDB_Full Area

Modelled Flood Extents Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

N
W E
S

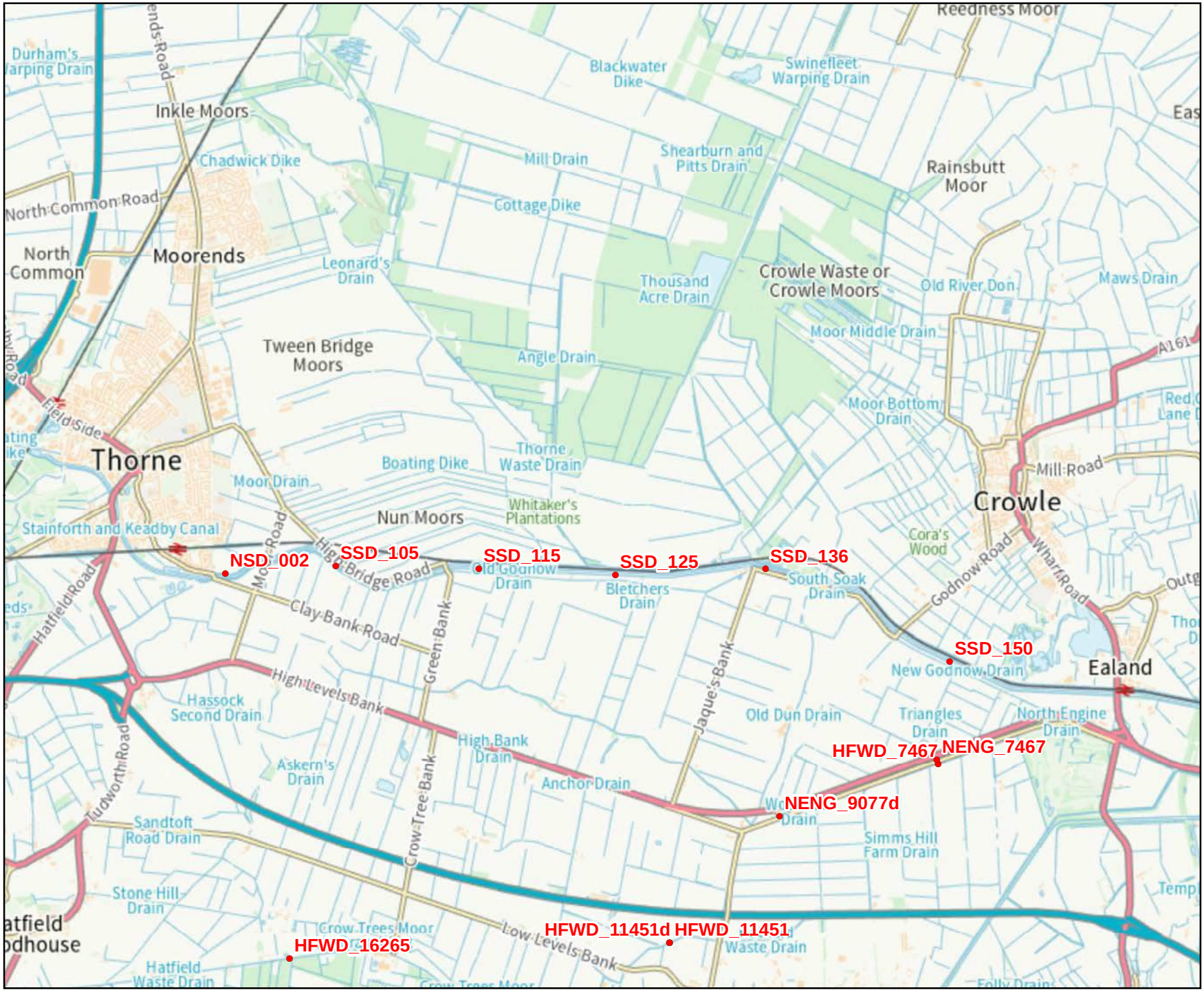
Scale 1:50,000

Date created: 14 March 2023

Legend

30 Year [Functional Floodplain Sept22]

Modelled Nodes Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

N
W E
S

Scale 1:50,000

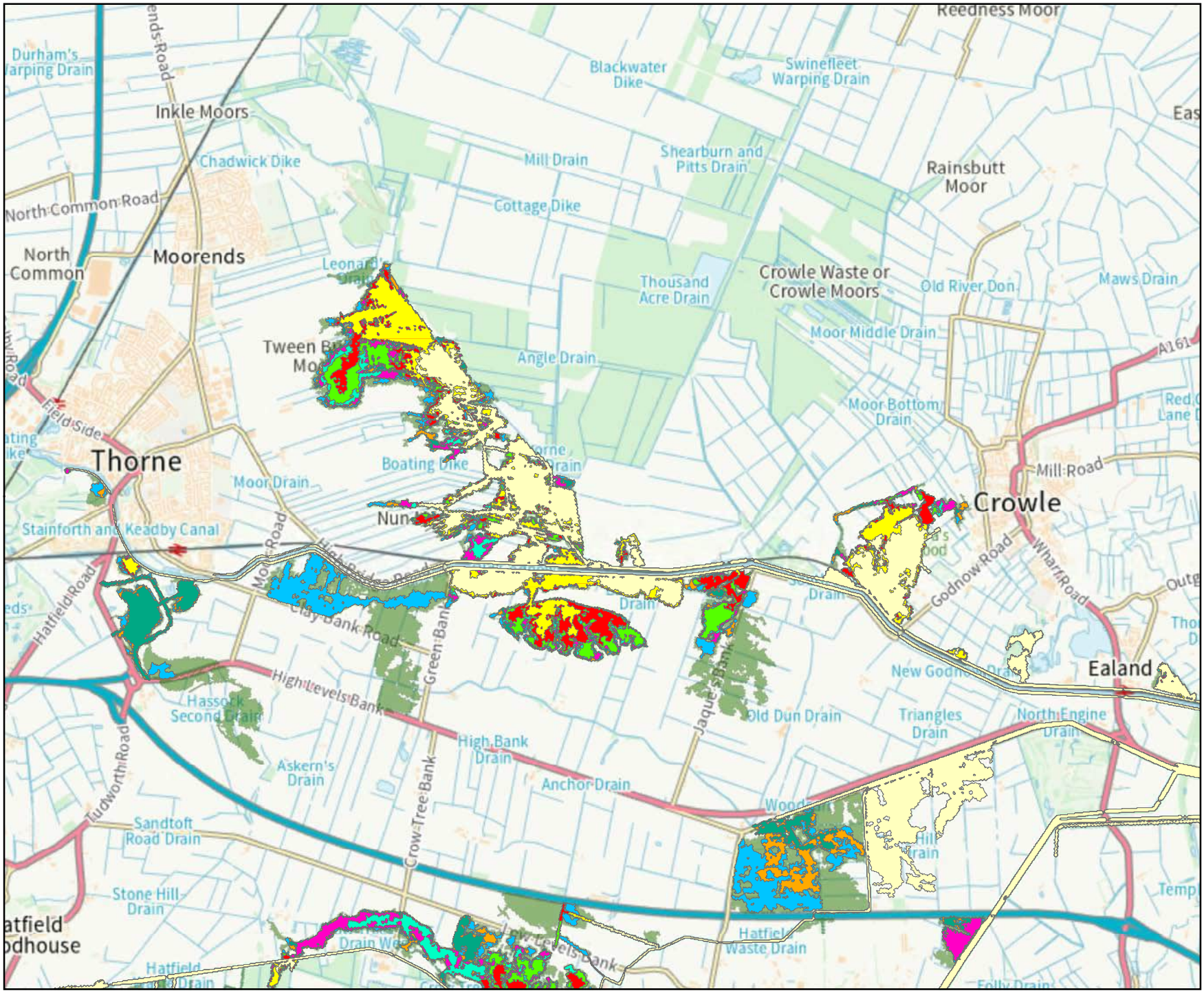
Date created: 14 March 2023

Legend

- River Torne & Drains Nodes

SOURCE
River Torne
Hazard Mapping Study,
Capita AECOM, 2018

Modelled Flood Extents Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

N
W E
S

Scale 1:50,000

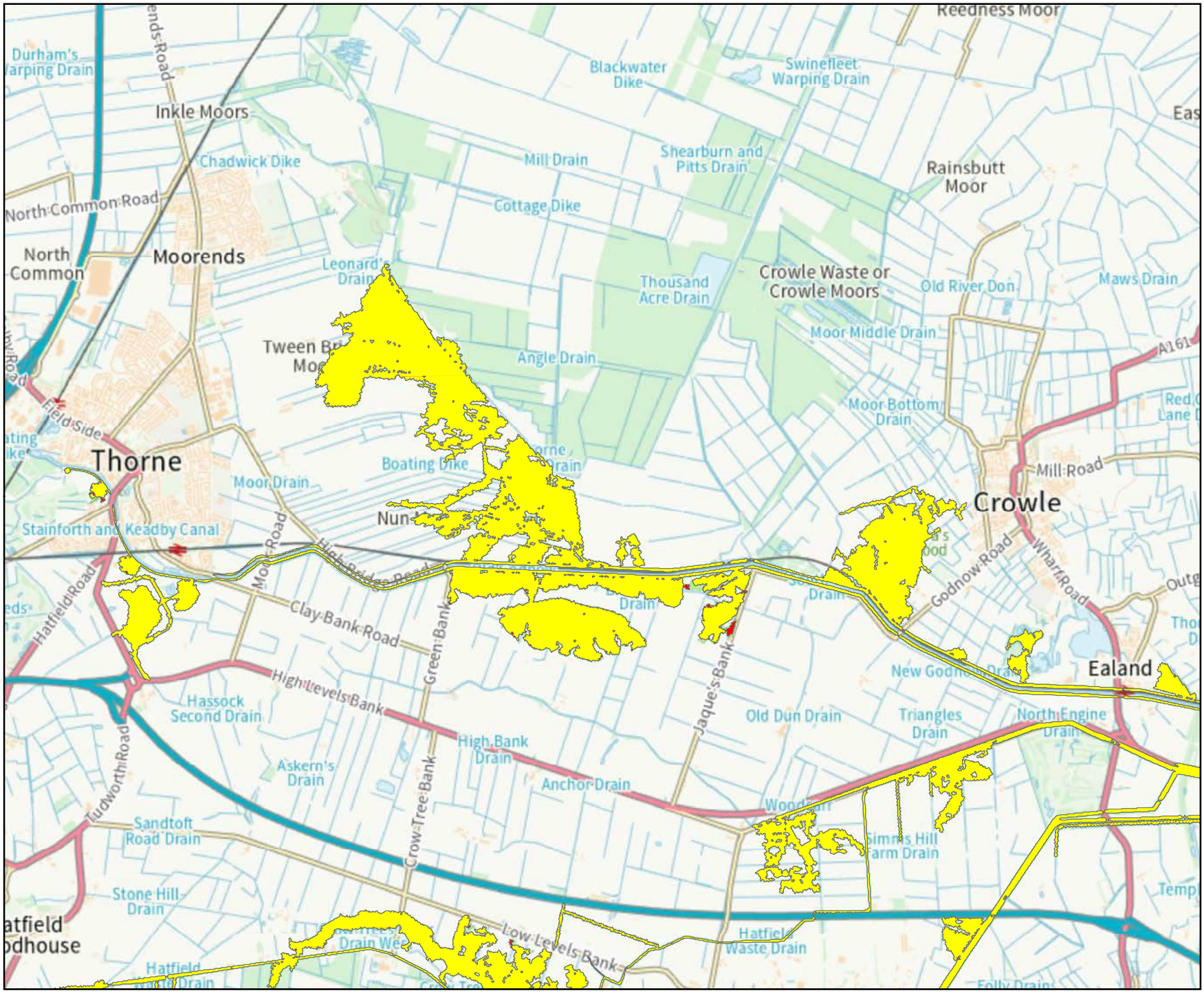
Date created: 14 March 2023

Modelled Flood Extents

- 1 in 2 year extent
- 1 in 5 year extent
- 1 in 10 year extent
- 1 in 20 year extent
- 1 in 30 year extent
- 1 in 50 year extent
- 1 in 75 year extent
- 1 in 100 year extent
- 1 in 200 year extent
- 1 in 1000 year extent

SOURCE
River Torne
Hazard Mapping Study,
Capita AECOM, 2018

Modelled Flood Extents Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

N
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S

Scale 1:50,000

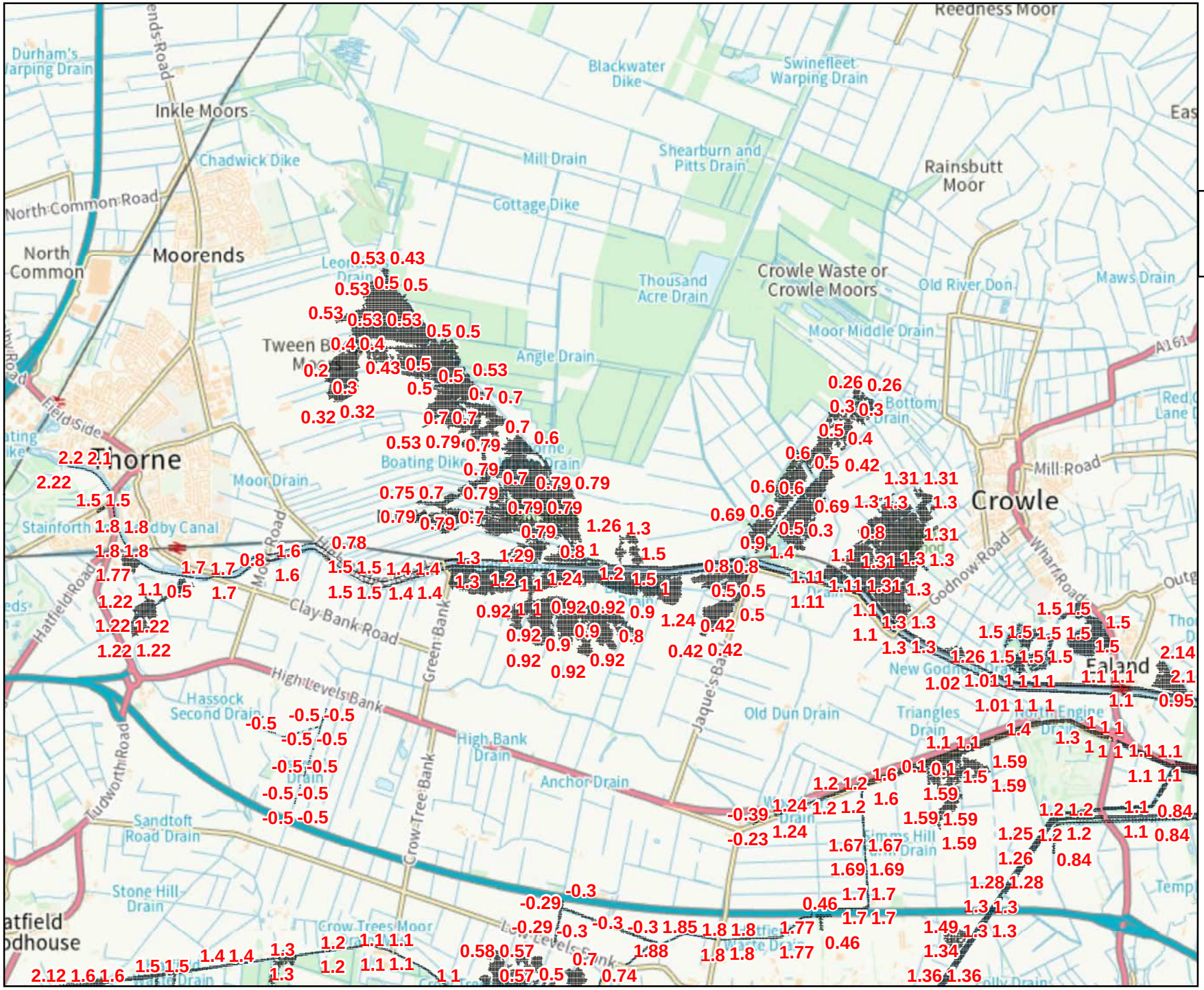
Date created: 14 March 2023

Modelled Flood Extents Climate Change Legend

- 1 in 100 year +20%CC extent
- 1 in 100 year +30%CC extent
- 1 in 100 year +50%CC extent

SOURCE
River Torne
Hazard Mapping Study,
Capita AECOM, 2018

Floodplain Heights Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

Scale 1:50,000

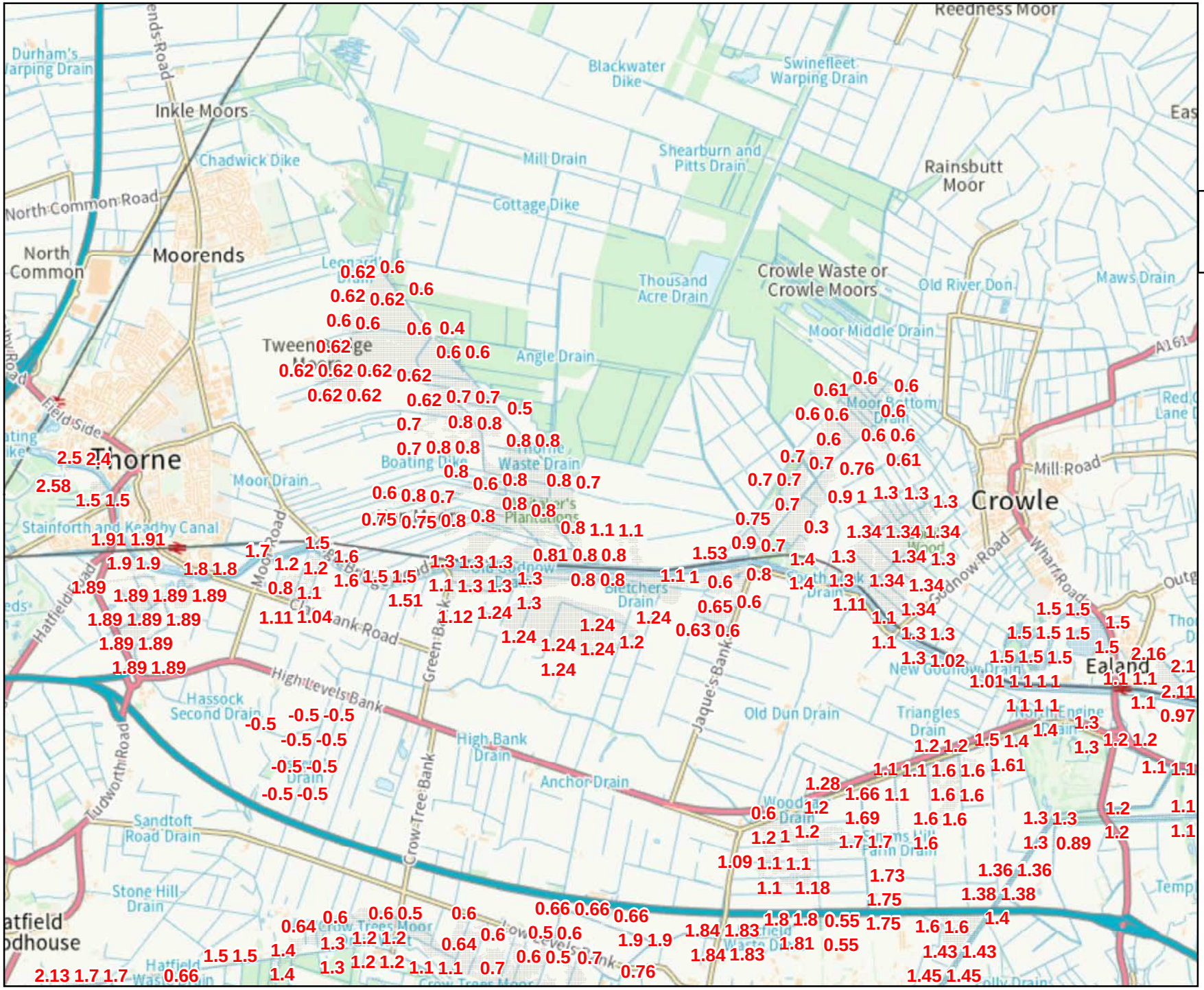
Date created: 14 March 2023

Legend

Thorne 1 in 20 year height (mAOD)

SOURCE
River Torne
Hazard Mapping Study,
Capita AECOM, 2018

Floodplain Heights Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

N
W E
S

Scale 1:50,000

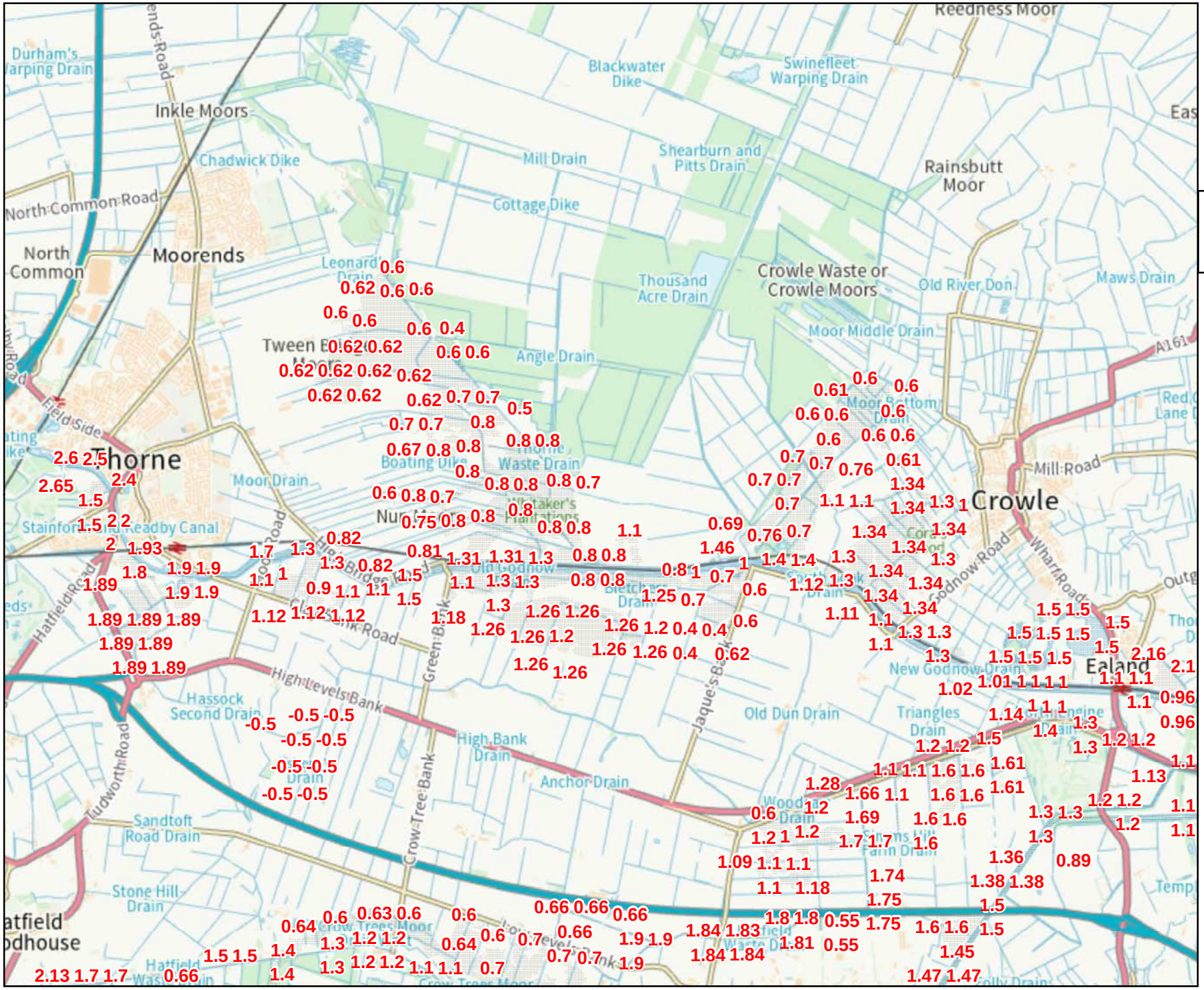
Date created: 14 March 2023

Legend

Torne 100yr+30%CC height (mAOD)

SOURCE
River Torne
Hazard Mapping Study,
Capita AECOM, 2018

Floodplain Heights Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

Scale 1:50,000

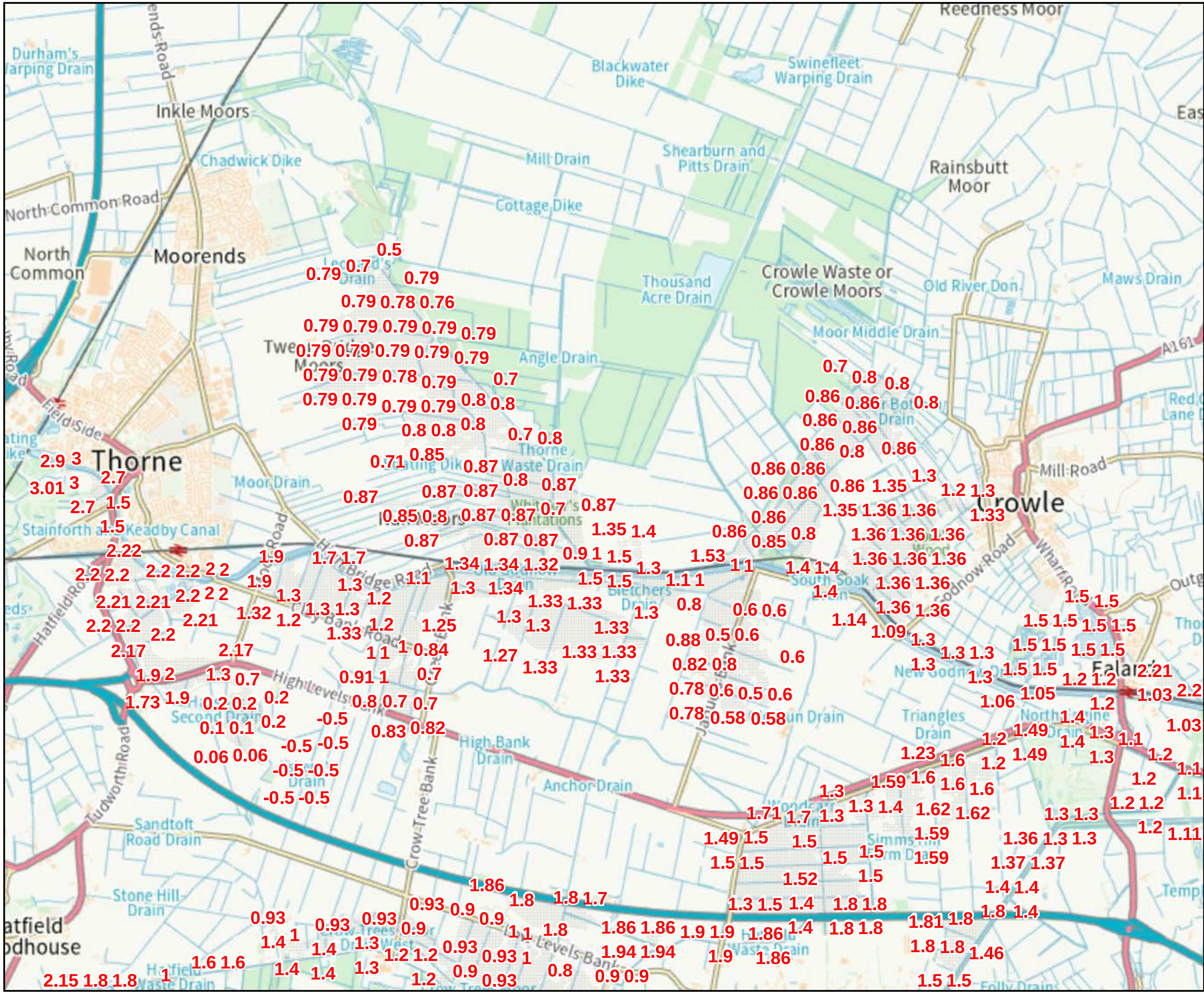
Date created: 14 March 2023

Legend

Torne 100yr+50%CC height (mAOD)

SOURCE
River Torne
Hazard Mapping Study,
Capita AECOM, 2018

Floodplain Heights Map centred on the Land near Thorne
Ref: [EMD301466]



Scale 1:50,000

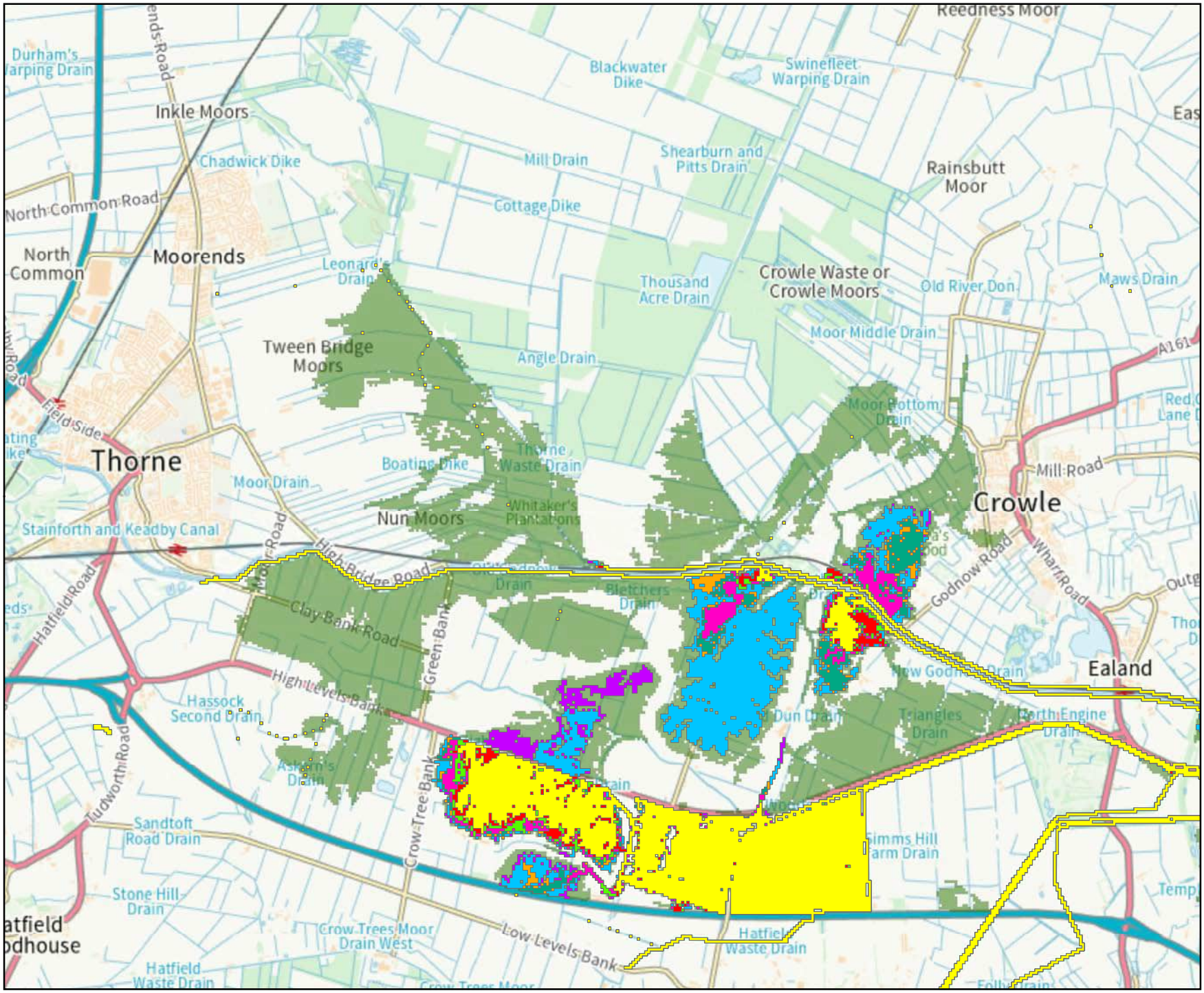
Date created: 14 March 2023

Legend

Torne 1 in 1000 year height (mAOD)

SOURCE
River Torne
Hazard Mapping Study,
Capita AECOM, 2018

Modelled Flood Extents Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

N
W E
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Scale 1:50,000

Date created: 14 March 2023

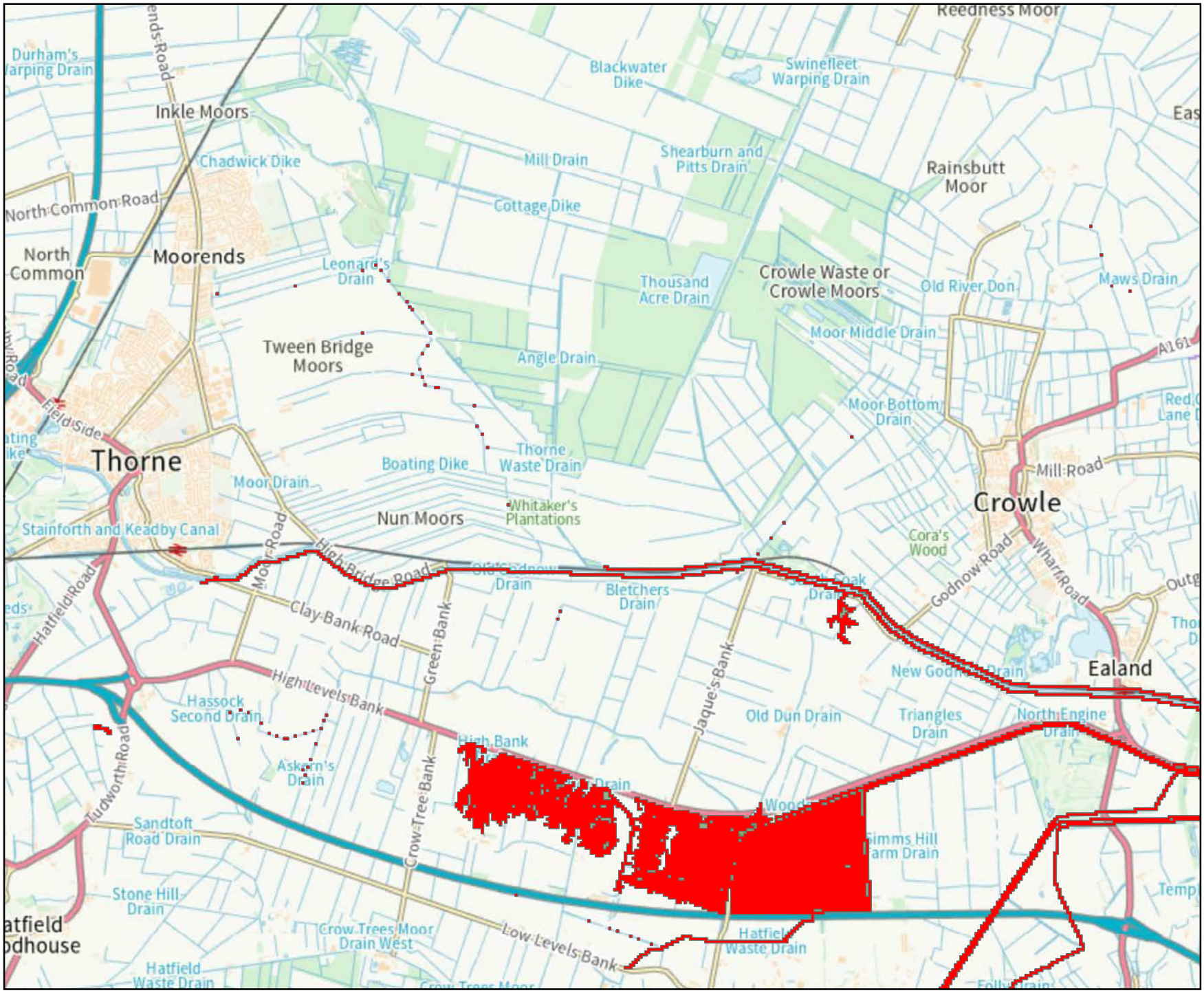
Tidal Trent MFO Map Legend (FLUVIAL)

- 1 in 5 year Modelled Extent (with 5 year Tidal flow)
- 1 in 10 year Modelled Extent (with 5 year Tidal flow)
- 1 in 20 year Modelled Extent (with 5 year Tidal flow)
- 1 in 50 year Modelled Extent (with 5 year Tidal flow)
- 1 in 75 year Modelled Extent (with 5 year Tidal flow)
- 1 in 100 year Modelled Extent (with 5 year Tidal flow)
- 1 in 100 year Modelled Extent including climate change forecast (with 5 year Tidal flow)
- 1 in 200 year Modelled Extent (with 5 year Tidal flow)
- 1 in 1000 year Modelled Extent (with 5 year Tidal flow)
- Modelled Node Location and Reference

SOURCE
Tidal Trent
SFRM Update,
Mott MacDonald 2014

Climate Change Update
Environment Agency, 2021

Modelled Flood Extents Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

N
W E
S

Scale 1:50,000

Date created: 14 March 2023

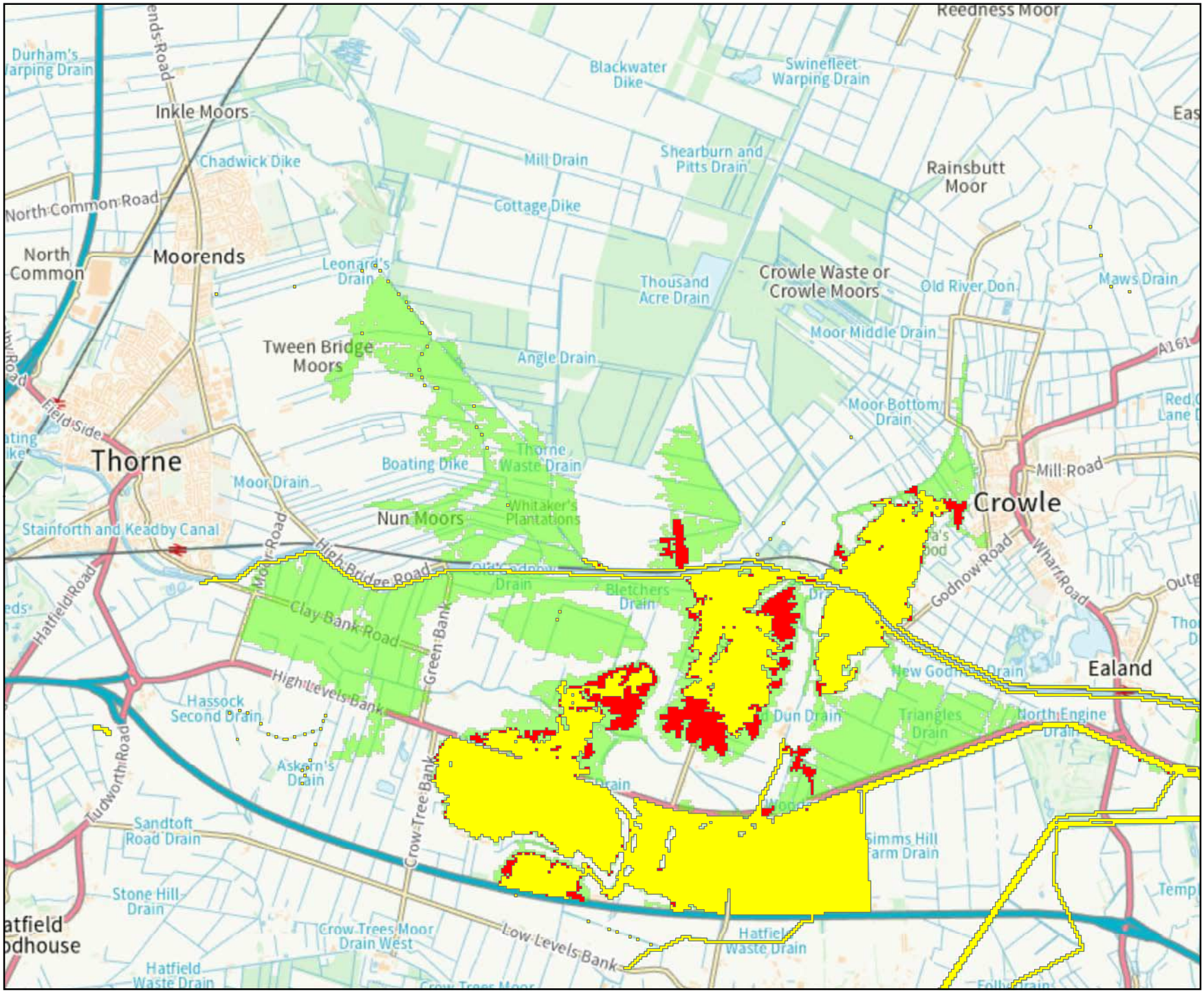
Tidal Trent MFO Map Legend (TIDAL)

- 1 in 10 year Modelled Extent (with 2 year Fluvial flow)
- 1 in 20 year Modelled Extent (with 2 year Fluvial flow)
- 1 in 50 year Modelled Extent (with 2 year Fluvial flow)
- 1 in 100 year Modelled Extent (with 2 year Fluvial flow)
- 1 in 200 year Modelled Extent including climate change forecast (with 2 year Fluvial flow)
- 1 in 200 year Modelled Extent (with 2 year Fluvial flow)
- 1 in 1000 year Modelled Extent (with 2 year Fluvial flow)
- Modelled Node Location and Reference

SOURCE
Tidal Trent
SFRM Update,
Mott MacDonald 2014

Climate Change Update
Environment Agency, 2021

Modelled Flood Extents Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

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S

Scale 1:50,000

Date created: 14 March 2023

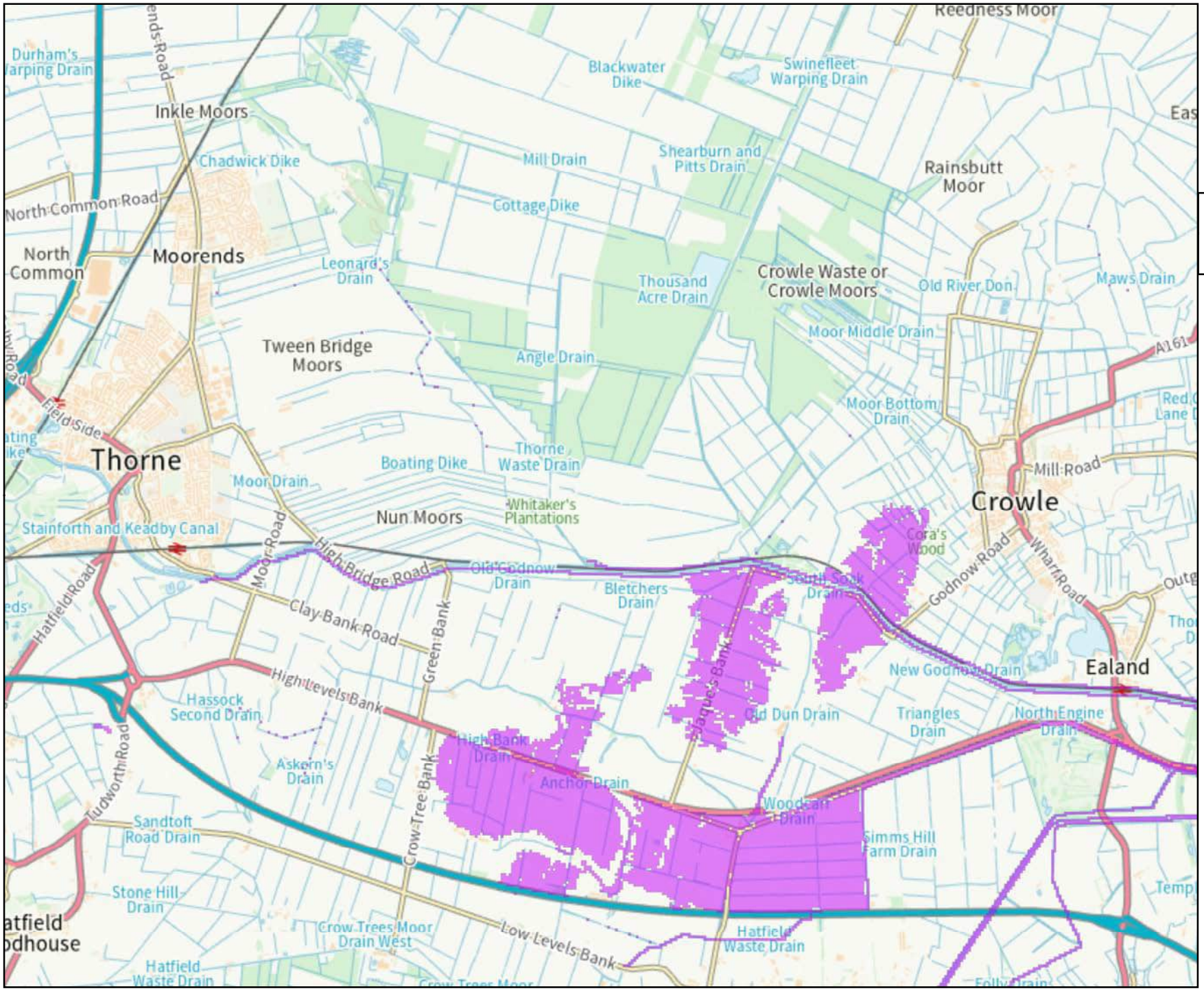
Modelled Flood Extents Climate Change Legend

- 1 in 100 year +20%CC extent
- 1 in 100 year +30%CC extent
- 1 in 100 year +50%CC extent

SOURCE
Tidal Trent
SFRM Update,
Mott MacDonald 2014

Climate Change Update
Environment Agency, 2021

Modelled Flood Extents Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

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Scale 1:50,000

Date created: 14 March 2023

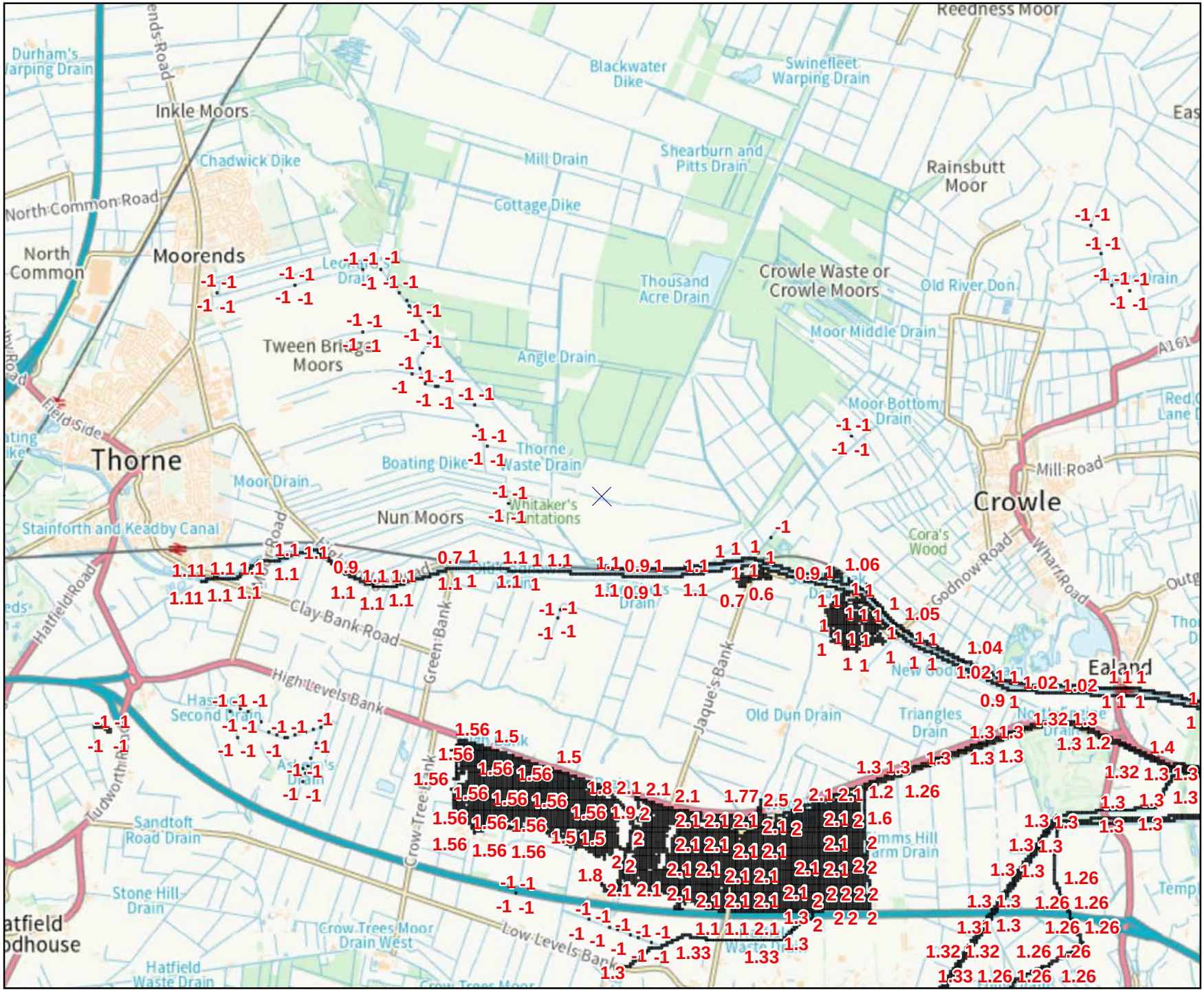
Legend

f100cc_t05_combined_breach_extent

SOURCE
Tidal Trent
SFRM Update,
Mott MacDonald 2014

Climate Change Update
Environment Agency, 2021

Floodplain Heights Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

Scale 1:50,000

Date created: 14 March 2023

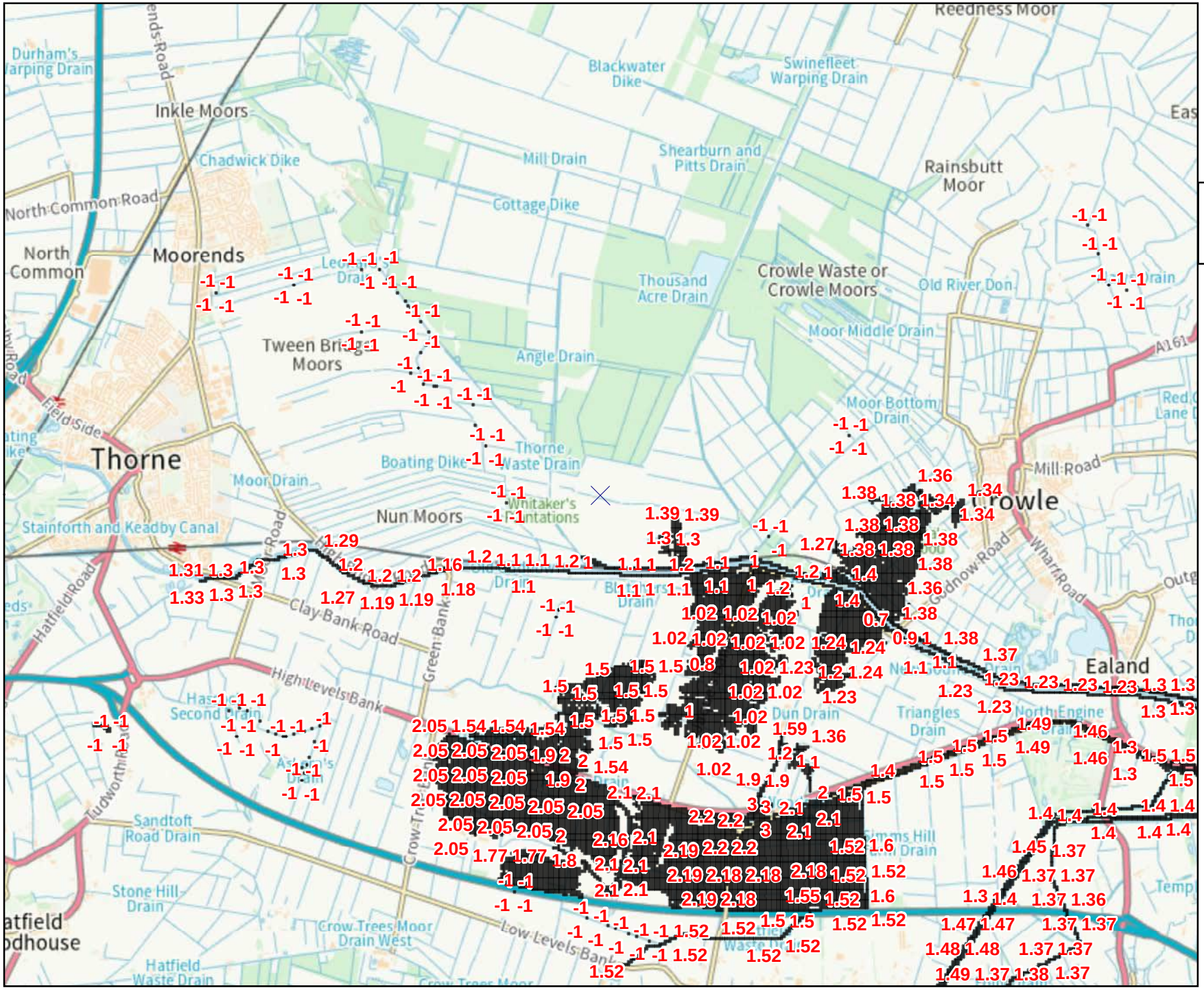
Legend

- Trent 1 in 20 year height

SOURCE
Tidal Trent
SFRM Update,
Mott MacDonald 2014

Climate Change Update
Environment Agency, 2021

Floodplain Heights Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

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Scale 1:50,000

Date created: 14 March 2023

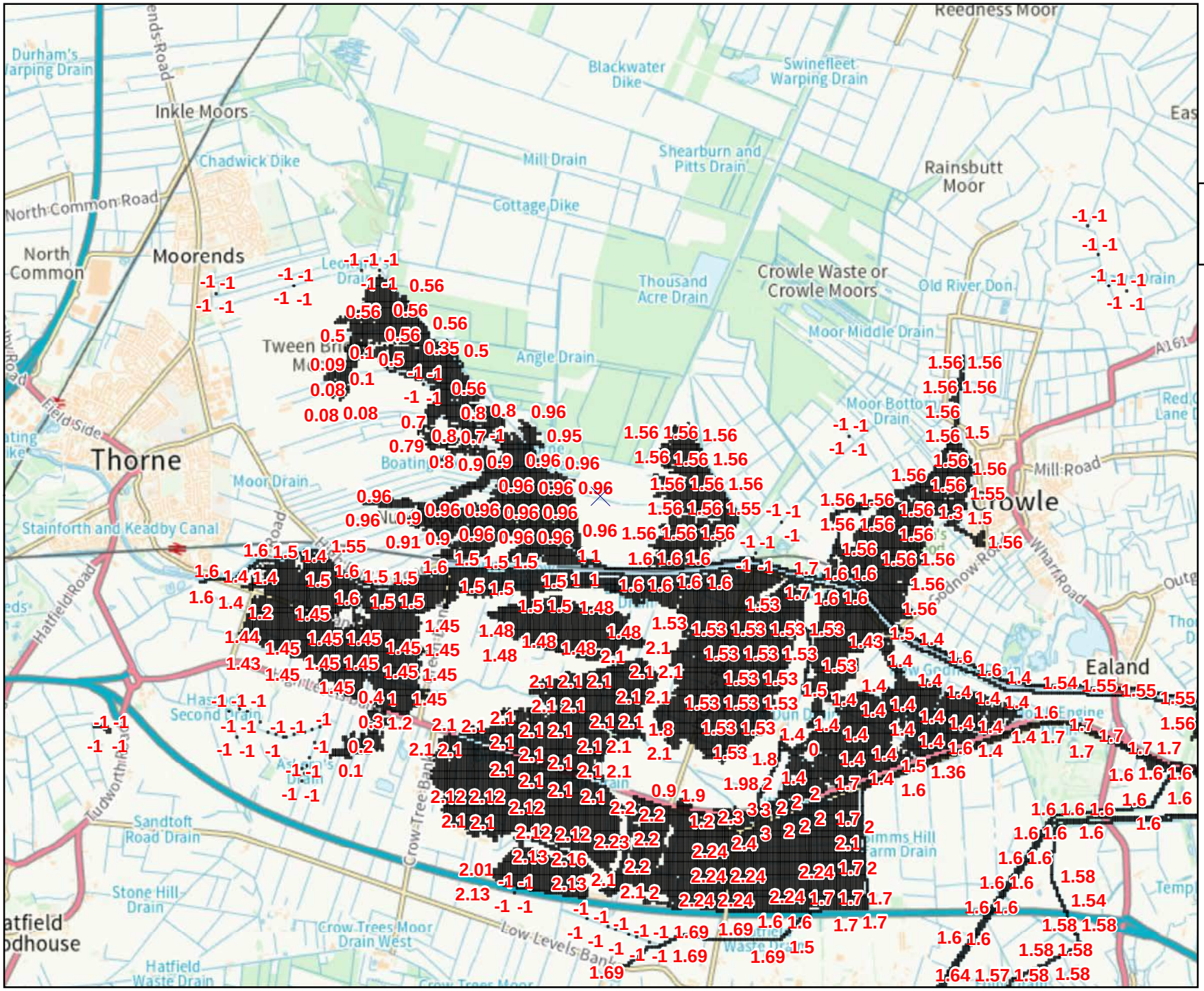
Legend

· 1 in 100 year +30%CC height (mAOD)

SOURCE
Tidal Trent
SFRM Update,
Mott MacDonald 2014

Climate Change Update
Environment Agency, 2021

Floodplain Heights Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

Scale 1:50,000

Date created: 14 March 2023

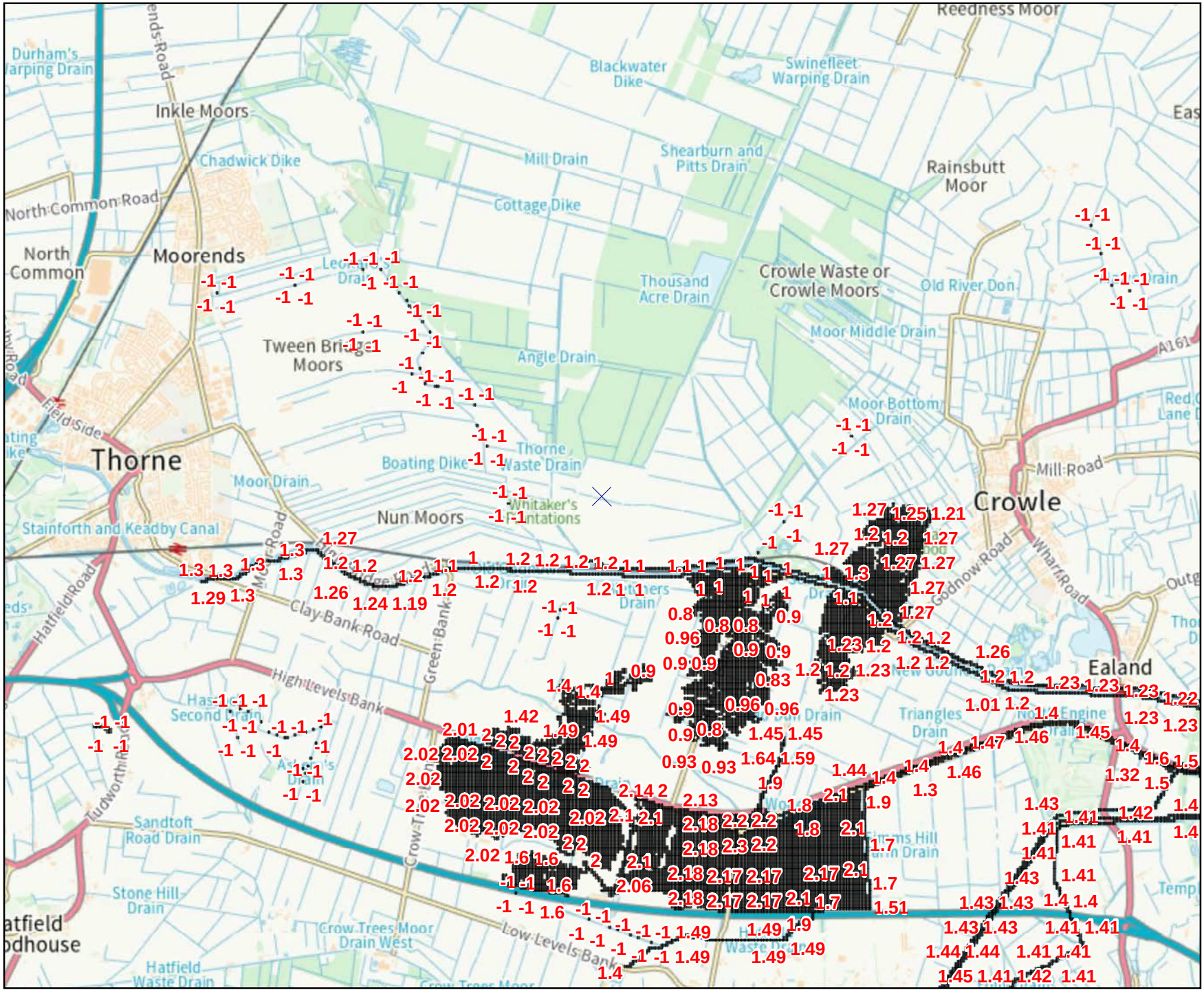
Legend

· 1 in 100 year +50%CC height (mAOD)

SOURCE
Tidal Trent
SFRM Update,
Mott MacDonald 2014

Climate Change Update
Environment Agency, 2021

Floodplain Heights Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

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Scale 1:50,000

Date created: 14 March 2023

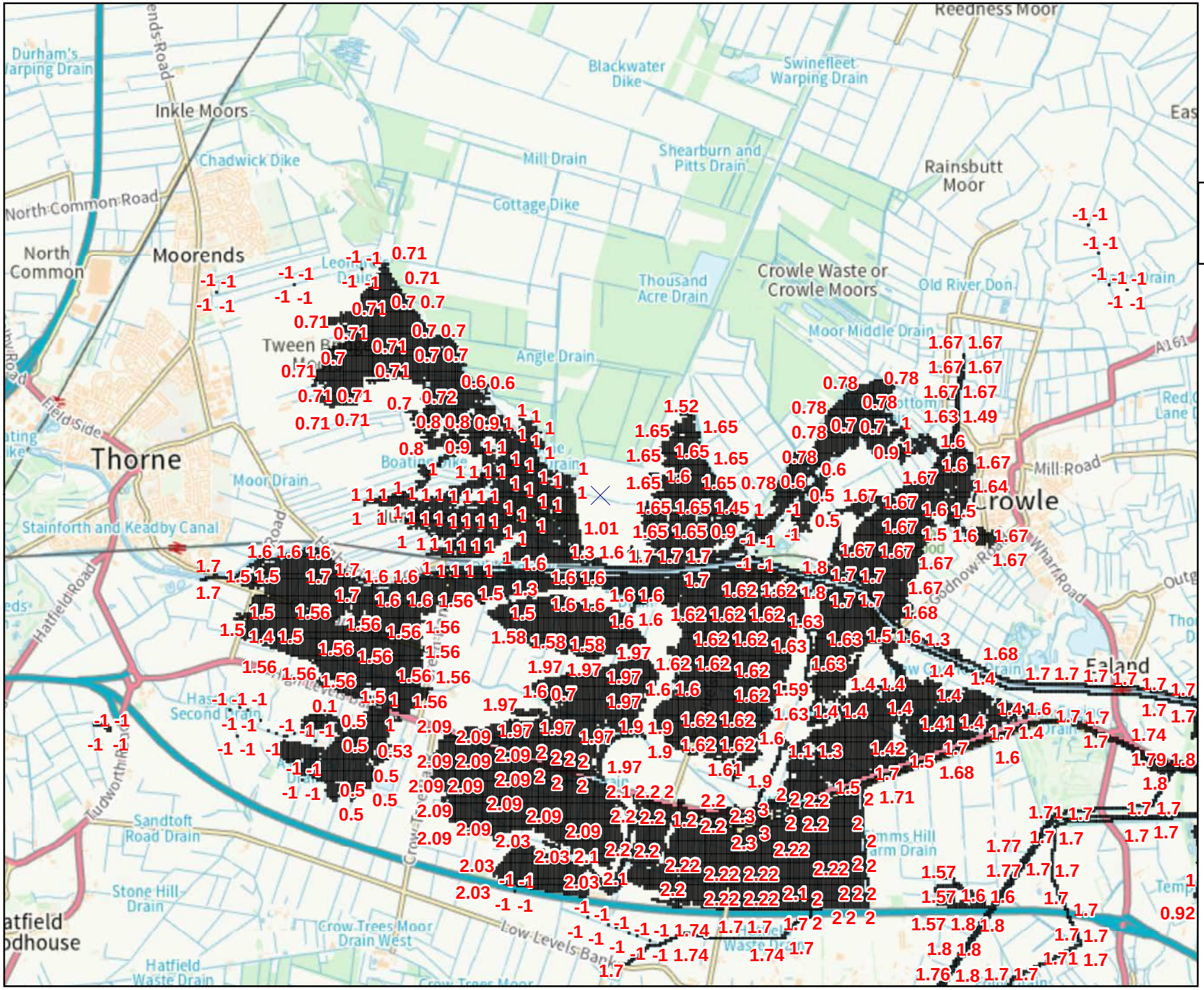
Legend

- 100yrCC Breach Height (mAOD)

SOURCE
Tidal Trent
SFRM Update,
Mott MacDonald 2014

Climate Change Update
Environment Agency, 2021

Floodplain Heights Map centred on the Land near Thorne
Ref: [EMD301466]



Environment Agency

N
W E
S

Scale 1:50,000

Date created: 14 March 2023

Legend

· 1 in 1000 year height (mAOD)

SOURCE
Tidal Trent
SFRM Update,
Mott MacDonald 2014

Climate Change Update
Environment Agency, 2021

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