Frodsham Solar

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Appendix 9-3: Hydraulic Modelling Report
Part 1 of 4

May 2025

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Frodsham Solar

Frodsham Marshes, Frodsham, Cheshire West and Chester

Hydraulic Modelling Report

May 2025

Assessment | Modelling | Design

Scheme Information	
Scheme:	Frodsham Solar
Report Title:	Hydraulic Modelling Report
Client:	Frodsham Solar Limited
Instruction:	The instruction to undertake this modelling study was received from Axis P.E.D Ltd acting on behalf of the Client
File Ref:	14740-HMR-05
Supporting Documents:	This Hydraulic Modelling Report should be read in conjunction with the associated Flood Risk Assessment (FRA) and Drainage Strategy report **ES Vol 2 Appendix 9-1: Waterco Flood Risk Assessment and Drainage Strategy [EN010153/DR/6.2]**

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Document History		
Revision	Date	Comment
1	16/09/2024	First issue
2	21/10/2024	Second issue with updated design life
3	06/02/2025	Third issue following EA request for further work.
4	07/03/2025	Fourth issue following updates to Mersey Estuary flood mapping.
5	15/05/2025	Fifth issue – Updated references to supporting documents

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Glossary and Modelling Short Codes

Table 1: Glossary of Technical Terms

Term / Acronym	Definition
1D (model)	One dimensional – A type of model typically built using watercourse cross-section survey data to represent the watercourse and adjacent floodplain
2D (model)	Two dimensional – A type of hydraulic model typically built using LiDAR and site-specific topographic data to represent the wider floodplain
1D-2D (model)	A combination of 1D and 2D modelling (i.e. typically a representation of the watercourse and floodplain respectively)
AEP	Annual Exceedance Probability – the probability that a storm event will occur in any given year
Defra	Department for Environment, Food and Rural Affairs
DfI	Department for Infrastructure – one of nine departments in Northern Ireland responsible for regional strategic planning and development policy
EA	Environment Agency – non-departmental public body responsible for the protection and enhancement of the environment in England
ESTRY	Industry standard flood modelling software (1D engine built into TUFLOW)
FCA	Flood Consequence Assessment
FRA	Flood Risk Assessment
FFL	Finished Floor Level
Flood risk	The product of the frequency or likelihood of a flood event and the consequences (such as loss, damage, harm, distress and disruption)
FMP	Flood Modeller Pro – industry standard flood modelling software
HMR	Hydraulic Modelling Report
IDB	Internal Drainage Board
LA	Local authority
LiDAR	Light Detection and Ranging (i.e. Ground elevation data)
LLFA	Lead Local Flood Authority
Main river	A watercourse on which the relevant regulatory body (e.g. EA/NRW/SEPA/DfI) has permissive powers, but not a duty, to carry out maintenance, improvement, or construction work.
MIKE (11/21/FLOOD)	Industry standard flood modelling software
NGR	National Grid Reference
NRW	Natural Resources Wales – Welsh Government sponsored body responsible for managing the environment and natural resources of Wales
Ordinary watercourse	A river, stream, ditch, cut, sluice, dyke or non-public sewer that is not a designated main river, and for which the LA has flood risk management responsibilities and powers.

Term / Acronym	Definition
SEPA	Scottish Environment Protection Agency – non-departmental public body responsible for the protection and enhancement of the environment in Scotland
TN	Technical Note
TUFLOW	Industry standard flood modelling software

Short codes are used in the naming and referencing of model files, events and scenarios to ensure a consistent, high-quality naming convention is followed and to simplify communication of model results.

Table 2: Modelling Short Codes

Model Short Code	Definition
ABC	Model identifier
BL[*x*]-[*y*]	A *y*% blockage at location *x* (e.g. BL1-67 – 67% blockage at location “1”)
BR[*x*]-[*y*]	A *y* metre wide breach scenario at location *x* (e.g. BR2-50 – 50m wide breach at location “2”)
CC	Climate change
DEV	Post-development site layout
EXG	Existing (pre-development) site layout
MIT	Flood mitigation option
NC	“Normal conditions” A model setup representative of present channel and floodplain conditions throughout the study area – no additional structure blockages, defence breaches or pump failures
OPT	Development option
Q[*x*]	1 / *x* % AEP fluvial event
R[*x*]	1 / *x* % AEP pluvial event
ST[*x*]	Sensitivity test *x* (e.g. ST1 – channel and floodplain roughness +20%)
T[*x*]	1 / *x* % AEP tidal event

Introduction

Waterco has been commissioned to undertake a hydraulic modelling study in relation to a proposed solar farm on land north of the M56, Frodsham, Cheshire, WA6 7BQ. This report has been prepared in support of a Development Consent Order (DCO) application for consent to undertake a Nationally Significant Infrastructure Project (NSIP).

The main objective of this hydraulic modelling study is to quantify existing flood risk to the study. To enable this, existing EA linked 1D/2D[1] hydraulic models have been utilised. This report summarises the hydraulic modelling works completed and should be read in conjunction with the FRA prepared by Waterco **ES Vol 2 Appendix 9-1: Waterco Flood Risk Assessment and Drainage Strategy [EN010153/DR/6.2].**

Study Area Description

An overview of the study area is detailed in Table 3. A location plan and an aerial photograph of the study area are included in Appendix A.

Table 3: Study Area Overview

Study Area Overview	
Location	The study area comprises a total of 314ha and comprises agricultural land, and fallow agricultural land, known as Frodsham Marshes, which is intersected by a series of ditches / watercourses. The site is bordered by the River Weaver and the Manchester Ship Canal to the north, the River Weaver to the east, the M56 to the south-east, and agricultural land to the south-west and west.
NGR (located at centre of study area)	350921, 378604
Watercourses	There is a network of ditches / watercourses within the study area which are part of Frodsham Marshes. The study area is bordered by the River Weaver to the north-east of the site. The River Weaver flows in a north-westerly direction past the site before meeting the Manchester Ship Canal. The Manchester Ship Canal is situated along the northern boundary of the site. The River Mersey Estuary is situated to the north of the study area, running parallel with the Manchester Ship Canal. The River Mersey flows in a westerly direction at the study area before turning north and discharging into the sea. The Mersey Estuary is tidally influenced.

[1] A 1D/2D hydrodynamic model is comprised of a 1-Dimensional (1D) river network model (based on surveyed river cross-sections) coupled with a 2-Dimensional (2D) Digital Terrain Model (DTM) of the potential floodplain (created from LiDAR).

Study Area Overview	
Topography	A topographical survey has been undertaken by PM Surveys UK Ltd in December 2022 (Appendix B). The topographical survey shows the eastern part of the site is generally low lying land and relatively flat with levels varying from 4.58 metres Above Ordnance Datum (m AOD) to 5.10m AOD. The western part of the site is shown to be between 8m AOD and 12m AOD and is therefore not shown to be at flood risk.

Proposed Development

The proposed development is for in-field solar arrays with associated access tracks, substation and battery energy storage system (BESS). The proposed development also includes the associated infrastructure for connection to the local electricity distribution network, as well as private wire electricity connections to nearby businesses that would utilise the renewable energy by the proposed development. A proposed development plan is included in Appendix C.

The proposed development would have the capacity to generate approximately 130 megawatts (MW) of electricity, as well as store up to 100 MW of electricity in a BESS.

The majority of the site will remain permeable, with land beneath the solar panels retained as grassland. Access tracks will be formed from permeable surfacing, with the existing access tracks in the western extent of the site (serving the wind turbines) retained. The proposed substation and BESS compound will cover an area of approximately 2.5ha. Measurements are taken from the 'Landscape Masterplan DRAFT' (reference: 3272-01-SK005) and are approximate only. The Proposed Development comprises a temporary development with an operational lifespan of up to 40 years, following this period the above ground development would be removed from site and the land returned to its current condition.

Full details of the Proposed Development are described in Chapter 2.0 of the Preliminary Environmental Information Report (PEIR).

As agreed with the EA during a meeting on 08/11/2024, the proposed development will be modelled using high roughness and a flow constriction approach. Further details regarding model setup are discussed in the Proposed Development Model Updates section.

Flood Risk & History

Table 4 provides a brief overview of the flood risk pertaining to the site.

Table 4: Site Flood Risk

Site Flood Risk	
Type of Flood Risk	Fluvial and Tidal
Primary Source of Flood Risk	The primary sources of flooding to the site are from the River Mersey Estuary and the River Weaver.
EA Flood Map for Planning (September 2024)	Flood Zone 1 – an area considered to be at low risk of fluvial flooding with an annual probability of the flooding lower than 0.1%. Flood Zone 2 - an area considered to be at moderate risk of fluvial and/or tidal flooding with an annual probability of flooding from rivers of between 1% and 0.1% and from the sea of between 0.5% and 0.1%. Flood Zone 3 - an area considered to be at high risk of fluvial flooding with an annual probability of the flooding greater than 1%. The flood map is included in Appendix D.
Available Model Data	The EA currently hold four detailed hydraulic models of the area including the River Mersey Estuary, the River Weaver, the Manchester Ship Canal and the Ince and Frodsham models. The River Mersey Estuary model was built by JBA Consulting in December 2018. The 1D/2D FMP/TUFLOW model extends from the Irish Sea up to the town of Warrington. The River Mersey Estuary has been utilised to assess tidal flood risk for this study. The River Weaver model was built by JBA Consulting in September 2020. The 1D/2D FMP/TUFLOW model extends from the Mersey Estuary up to the town of Northwich. The River Weaver model has been utilised to assess fluvial flood risk for this study. The Ince and Frodsham model was built by Halcrow Group Limited in June 2011. The 1D/2D FMP/TUFLOW model contains the network of ditches within and to the southwest of the study area. Minor flooding is shown from the ditches and watercourses onsite from the available model data. However, the water levels associated with these ditches are significantly lower than those associated with the River Weaver and River Mersey Estuary and therefore has not been considered for this assessment (this is described further in the Hydraulic Modelling section). The Manchester Ship Canal model was built by CH2M in 2018. The 1D/2D FMP/TUFLOW model contains the network of the Manchester Ship Canal from Salford Quays to its connection with the River Mersey. The study area is not at risk of flooding from the Manchester Ship Canal and therefore has not been considered for this assessment.

The EA 'Historic Flood Risk' map (Appendix D) indicates that there are no records of fluvial or tidal flooding at or near to the site. A review of publicly available information online revealed no evidence of historical flooding at or near to the site.

Hydraulic Modelling

The information provided in this section details the modelling works carried out as part of this scheme. The current EA Mersey Estuary and EA River Weaver FMP/TUFLOW hydraulic models have been used as a base for this scheme.

The latest versions of the software available at the start of the project have been utilised (FMP version 7.2 and TUFLOW version 2023-03-AF).

The model logs[2] provided with the FMP/TUFLOW model files (Model Reference: 14740-30533-020 Mersey Estuary Model and 14740-30533-052 River Weaver Model) should be consulted if further details are required. An explanation of the file, event and scenario naming convention used is provided in the model log.

EA Correspondence

A response from the EA, dated 01/07/24 (included in Appendix E), with regards to a previous Waterco FRA written in May 2024, requested hydraulic modelling works to adequately consider flood risk throughout the lifetime of the development. The EA requested that modelling works should consider alternative climate change allowances, breach scenarios and the interaction between the tidal and fluvial flood risks. This section summarises the recent EA correspondence.

The EA response stated that the EA's River Weaver model has recently been reviewed by the EA and is suitable to be used for this assessment.

The EA response stated that the EA's Mersey Estuary model requires the tidal boundary condition to be updated in line with the latest Coastal Flood Boundary data (CFB, 2018) before it can be used to assess flood risk at the site.

Waterco issued a letter to the EA (reference 14740-EA FRA Letter, dated 15/07/24) detailing the proposed modelling methodology that would be adopted for the assessment. The letter is included in Appendix E. Whilst the methodology considered a design life up to 2100, a design life up to the year 2075 has been applied. The development design life is 40 years and a design life of up to 2075 allows for flexibility in the time taken to construct the scheme.

In response to the letter (dated 01/08/24, included in Appendix E), the EA confirmed that the proposed events and proposed breach locations were acceptable for the Mersey Estuary and River Weaver models.

The EA response agreed that the water levels are significantly lower from the Ince and Frodsham model when compared with the River Weaver and Mersey Estuary flood levels. As such, the Ince and Frodsham flood event will not inform the design levels of infrastructure on site.

The EA response stated that there is significant freeboard available within the Manchester Ship Canal and therefore agreed with the summary within the FRA that risk from flooding from the Manchester Ship Canal is very low. Therefore, no further works have been undertaken on the Manchester Ship Canal.

During a meeting with the EA on 08/11/2024, the EA requested modelling to assess the off-site impact of the proposed development on flood risk. The EA were in acceptance of the methodology proposed to model the

[2] Doc ref: 14740-30533-Mersey_Estuary_Model_Log.xlsx and 14740-30533-River_Weaver_Model_Log.xlsx

development which included a flow constriction approach, blocking out a percentage of cells based on the displacement, and increasing roughness at the location of the solar panels.

Baseline Model Updates

To complete the required hydraulic modelling works both the EA's Mersey Estuary and River Weaver models have been updated. This section of the report describes the updates required in each of the models.

Mersey Estuary Model Updates

The EA's Mersey Estuary model has been updated to quantify the existing flood risk in the study area. A plan of the 1D/2D model extent is included in Appendix F.

The downstream boundary of the Mersey Estuary model has been updated to take into consideration the latest CFB data. The closest Extreme Sea Level chainage to the location where the Mersey Estuary meets the Irish Sea is _1168. Therefore, chainage _1168 has been utilised for the extreme sea level data. The tide curves input into the model were derived using the latest UKCP18 guidance but it should be noted that the Extreme Sea Level dataset is dated from 2017.

To generate a tide curve, the closest gauge for the assessment is Liverpool – Gladstone Dock. The POLTIPS software was utilised to extract tide data for the current year (2024) at 15-minute intervals. As per the EA guidance, a base tide curve was selected based on a peak level (4.93m AOD) between the High Astronomical Tide (HAT, 5.44m AOD) and the Mean High Water Spring (MHWS, 4.40m AOD) tide. The base tide curve contains 96 hours of data, comprising 48hrs before the selected peak of 4.93m AOD and 48hrs after.

To apply the storm surge to the curve the closest surge donor profile of number 29 at Liverpool was selected. The surge profile is utilised to scale the base tide curve to the extreme sea levels. The donor peak surge height was shifted to match the time of the peak tide level.

Sea level rise has then been applied to the entire tide curve to consider both present day (2024) sea levels and sea levels when considering climate change up to 2075. For climate change the High Central (HC), Upper End (UE) and H++ sea level rise allowances have been considered.

Table 5 gives the predicted extreme sea levels for each simulated return period. The base tide curve, surge shape and 0.5% AEP tide events are shown in Figure 1.

Table 5: Peak sea levels calculated for selected return periods

	Epoch	T2	T200	T1000
Base Year	2017	5.57	6.43	6.74
Present Day 2024	2024	5. 60	6.46	6.77
Climate Change 2075 - Higher Central	2075	5.97	6.83	7.14
Climate Change 2075 - Upper End	2075	6.12	6.98	7.29
Climate Change 2075 - H++	2075	7.47	8.33	8.64

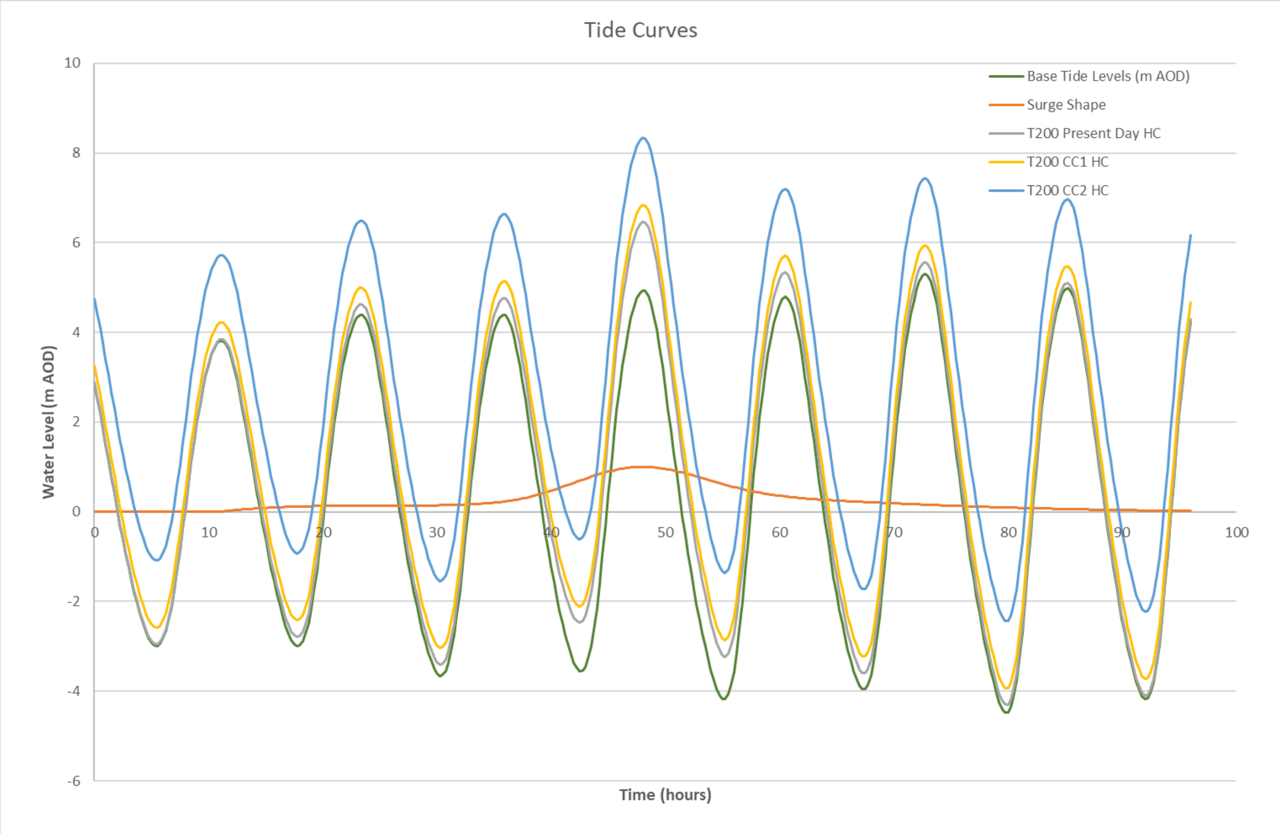


Figure 1: Base tide curve, surge shape and 0.5% AEP tide event curves

The updates which have been made to the Mersey Estuary model and are detailed below:

- The site falls with Domain 2 of the multi-domain Mersey Estuary model. The extent of Domain 2 has been increased to prevent glasswalling.
- A specific H++ 1D network file has been created which removes the siphon named WOOLSsyph (NGR 365214, 388666). As the software does not allow siphons to have reverse flow, and the extremely high water levels, associated with H++ scenario, were causing backflow through the siphon, the structure has been removed. The removal of the siphon is unlikely to have a significant effect on flood risk at the site give its location ~26km along the channel, upstream of the site.
- Aerial photography indicates the presence of hedgerows and wooded areas on-site which have are not included in existing materials layer defining roughness values based on land use types. Roughness values across the site have been updated in the locations of the hedgerows and wooded areas by applying a Manning's n coefficient of 0.07.

River Weaver Model Updates

The EA's River Weaver model has been updated to quantify the existing flood risk in the study area. A plan of the 1D/2D model extent is included in Appendix F.

The updates which have been made to the River Weaver model and are detailed below:

- Event files have been created to consider the 1% AEP +67%CC event and the 1% AEP +106%CC event.

- The downstream boundary of the River Weaver model uses the MHWS tide curves from the Mersey Estuary model for both the present day and climate change simulations. The MHWS events were updated and re-run through the Mersey Estuary model in line with latest UKCP18 data. The models showed similar results, with the current EA MHWS results being higher (~200mm). Therefore, no change has been made from the previous EA model for the MHWS boundaries as this is slightly conservative for the subject site.
- The results of the Mersey Estuary model have been extracted from the model node MEST_26000 for the 0.5% AEP +CC HC tide event and input as the downstream boundary for the River Weaver model for the joint probability assessment.
- The model extent has been increased to the south-west of the site as the model results were shown to glasswall.
- During initial simulations, the higher climate change simulations was shown to crash when water levels reached the soffit of a bridge at near Saltersford Locks (model node: WEAF_0616bu, NGR 362690, 375140). The option to model the surcharge bridge as orifice flow was switched on, with a transition distance of 0.15m. The bridge is located 14km upstream of the site and therefore the impact of the bridge is thought to be negligible on the assessment of flood risk.
- The model was shown to take over 30 hours to complete per simulation. Therefore, the model has been simulated using TUFLOWs HPC engine to reduce model run times.
- Aerial photography indicates the presence of hedgerows and wooded areas on-site which have are not included in existing materials layer defining roughness values based on land use types. Roughness values across the site have been updated in the locations of the hedgerows and wood areas by applying a Manning's n coefficient of 0.07.

Proposed Development Model Updates

The hydraulic models for both the River Weaver and Mersey Estuary have been setup to consider the proposed development scenario. This section of the report details the modifications undertaken.

The proposed development scenario has been considered by removing a proportion of the site from the floodplain to represent the volume of floodplain lost by the solar panel brackets and by increasing roughness across the site to represent the presence of the brackets slowing the flow of water across the floodplain. The methodology for each model is discussed below.

Mersey Estuary Proposed Development Scenario

The proposed development updates for the Mersey Estuary model include:

- The roughness of the floodplain at the location of the solar panels and perimeter fencing has been represented by a Manning's n coefficient of 0.075.
- 1,400m^2 of the site floodplain will be displaced by the proposed structures (the area calculated considers the dimensions of each individual proposed structure, such as fence posts and Module piles, and has been rounded up for a precautionary approach). The loss of floodplain has been accounted for by removing the equivalent area from the modelled floodplain. Based on the 10m grid size utilised in the Mersey Estuary model, 14 modelled cells have been removed from the floodplain

(14 cells x 10m^2 grid = 1400m^2).

A plan of the proposed 1D/2D model extent is included in Appendix F.

River Weaver Proposed Development Scenario

The proposed development updates for the River Weaver model include:

- The roughness of the floodplain at the location of the solar panels and perimeter fencing has been represented by a Manning's n coefficient of 0.075.
- 1,400m^2 of the site floodplain will be displaced by the proposed structures (the area calculated considers the dimensions of each individual proposed structure, such as fence posts and Module piles, and has been rounded up for a precautionary approach). The loss of floodplain has been accounted for by removing the equivalent area from the modelled floodplain. Based on the 6m grid utilised in the Mersey Estuary model, 40 modelled cells have been removed from the floodplain (40 cells x 6m^2 grid = 1400m^2 which is conservative).

A plan of the proposed 1D/2D model extent is included in Appendix F.

Hydraulic Model Simulation Setup

The list of primary and breach simulations for both models for this study are detailed in this section.

Mersey Estuary Model

Simulations have been modelled for a range of tidal design events for the existing site and proposed development scenarios in the Mersey Estuary model.

Table 6: Mersey Estuary Model Simulations

Watercourse / Source	Scenario	Event (% AEP)
Mersey Estuary	Defended	0.5% AEP (year 2024)
		0.1% AEP (year 2024)
		0.5% AEP Higher Central CC to the year 2075
		0.5% AEP Upper End CC to the year 2075
		0.5% AEP H++ Scenario (+1.9m of sea level rise)
	Breach (of the Mersey defences only, discussed below)	0.5% AEP (year 2024)
		0.1% AEP (year 2024)
		0.5% AEP Higher Central CC to the year 2075
		0.5% AEP Upper End CC to the year 2075
		0.5% AEP H++ Scenario (+1.9m of sea level rise)

A breach (M-BR1) has been set up by lowering a 50m section of flood defence along the Mersey Estuary (associated with the 1D spill node MEST_26250sp) adjacent to the Manchester Ship Canal, in close proximity to the site. The breached flood defence levels have been set to 5m AOD based on LiDAR levels adjacent to the breach in the Manchester Ship Canal. The location of the breach is shown on the model extent plan.

River Weaver Model

Simulations have been modelled for a range of fluvial design events for the existing site and proposed development scenarios in the River Weaver model.

Table 7: River Weaver Model Simulations

Watercourse / Source	Scenario	Event (% AEP)
Lower Weaver Fluvial	Defended	1% AEP present day
		0.1% AEP present day
		1% AEP plus 67% CC event
		1% AEP plus 106% CC event
		Joint probability 1% AEP plus 67% CC fluvial event with 0.5% AEP Upper End CC (year 2075) tidal event.
	Breach (2no. breach scenarios on the River Weaver defences, discussed below)	1% AEP plus 67% CC event
		1% AEP plus 106% CC event
		Joint probability 1% AEP plus 67% CC fluvial event with 0.5% AEP Upper End CC (year 2075) tidal event.

A breach (W-BR1) has been set up by lowering a 50m section of flood defence along the River Weaver flood defences along the northern boundary of the site. The breached flood defence levels have been set to between 5.28m AOD and 5m AOD based on LiDAR levels adjacent to the breach location. The location of the breach is shown on the model extent plan.

A second breach (W-BR2) has been set up by lowering a 50m section of flood defence along the River Weaver flood defences along the eastern boundary of the site. The breached flood defence levels have been set to between 4.9m AOD and 5m AOD based on LiDAR levels adjacent to the breach location. The location of the breach is shown on the model extent plan.

Joint Probability Analysis

During the EA meeting in November 2024, the EA requested a joint probability analysis which assesses whether the flows associated with a 1% AEP plus CC fluvial event would occur at the same time as the peak tide level associated with the 0.5% AEP plus CC tidal event. The joint probability analysis has been undertaken utilising the software tool developed as part of the EA's 'Joint Probability: Dependence Mapping and Best Practice' study (reference: FD2308/TR1 and FD2308/TR2).

Sea levels have been input into the software from the tidal calculations undertaken at the mouth of the River Mersey Estuary (utilising the UKCP18 dataset). Sea level rise have been applied based on projections given in the EA's CC guidance. Fluvial inflows have been extracted from the EA's River Weaver model used as part of this assessment. Climate change has been applied to each return period by increasing flows by 67% based on the EA's CC guidance.

A dependence variable of 0.1 has been selected based on the dependence measure between daily mean flow (flow station 69007 on the River Mersey) and daily maximum surge occurring at high tide (Liverpool Gladstone Docks tide station) in Table 4.8 of the report FD2308/TR1. As an allowance for climate change the dependence variable has been doubled to 0.2, as recommended.

Based on the output from the software, the River Weaver's 1% AEP plus 67%CC peak flow of 389.11m^3/s correlates with a tide level of 6.16m AOD on the 1% AEP joint exceedance curve. The model simulation considered the River Weaver's 1% AEP plus CC (389.11m^3/s) with a 0.5% AEP plus CC tidal event (7.44m AOD). On the joint probability curves a River Weaver flow of 389.11 m^3/s and a tidal level of 7.44m AOD correspond to a joint exceedance of well below 0.1%. Therefore, the flood risk at site is low from the combined probability of the modelled simulation.

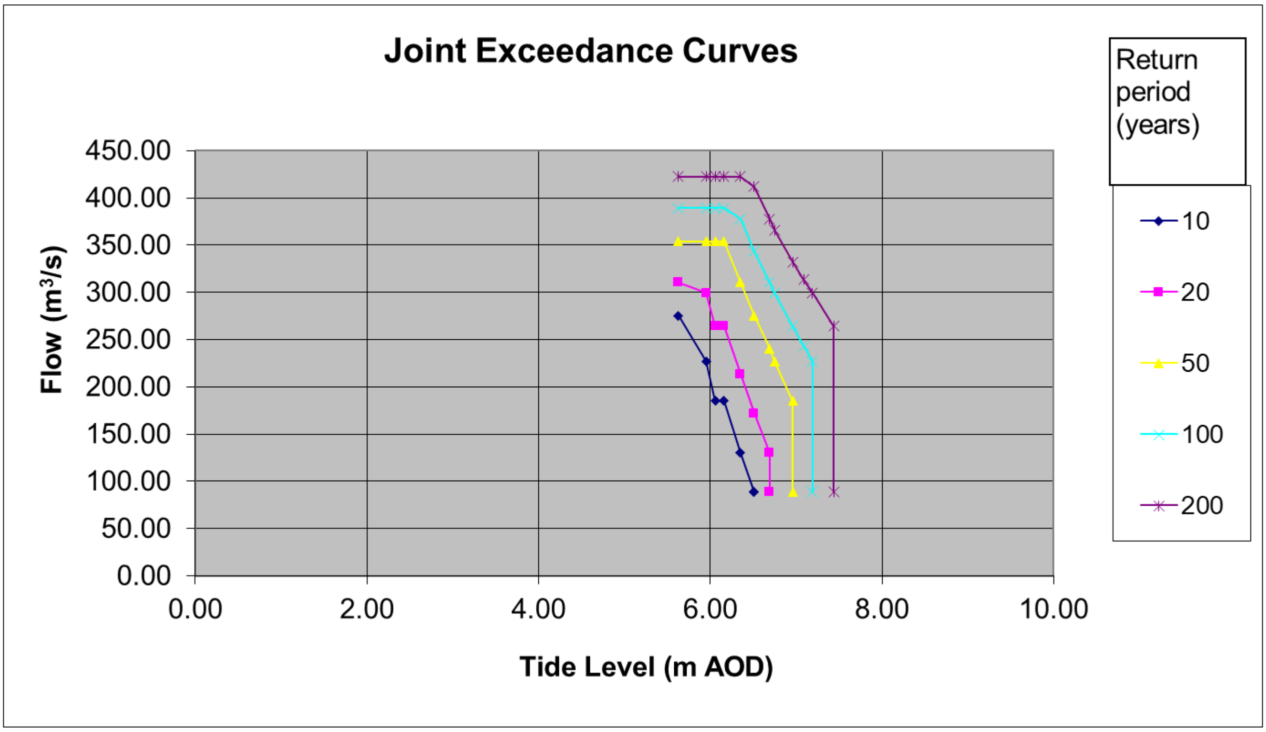


Figure 2 Joint Exceedance Curves

Model Performance and Stability

Model run performance of the Mersey Estuary and River Weaver models have been reviewed during each simulation carried out to ensure a suitable model convergence was achieved.

Mersey Estuary Model

Model run performance for the Mersey Estuary model is considered to be reasonable and appropriate for the scale and nature of the scheme.

The 1D element of the Mersey Estuary model is showing between 5 and 28 unconverged timesteps, which equate to 0.00% and 0.02% proportion of the simulations unconverged, respectively. Therefore, the unconverged timesteps have a negligible effect on the assessment of flood risk at the site.

Peak mass error is shown to be within tolerable limits (+/-1%) throughout the majority of the simulation, including peak water level at the site. The 2D output shows that mass error is up to 24% at 0hrs in the simulation but then immediately drops to a tolerable value. This is likely due to initial conditions in the original model and deemed appropriate for this study.

The majority of the simulations contain 2D negative depths (with a maximum of 92 negative depths recorded). The majority of negative depths all occur in Domains 1 and 3, away from the site which is situated in Domain 2. There are recorded negative depths in Domain 2, however these are associated with a watercourse modelled in 2D, in the western domain of Domain 2, away from the site. The negative depths will have negligible impact on the assessment of flood risk at the site.

A review of the log files shows that there are no comments, warnings or errors warranting attention.

River Weaver Model

Model run performance for the Mersey Estuary model is considered to be reasonable and appropriate for the scale and nature of the scheme.

The majority of the River Weaver simulations have no 1D unconverged timesteps. The 1% and 0.1% Defended events have 1 unconverged timestep which occurs at 0hrs in the simulations. 1D stability is considered suitable for the assessment.

Given the 2D element of the model is simulated using TUFLOWS HPC engine, mass error is 0%. The HPC efficiency rating is 98.2% or higher in each simulation and therefore the 2D stability is considered suitable for the assessment.

A review of the log files shows that there are no comments, warnings or errors warranting attention.

Model Results

This section of the report discusses the results obtained from the hydraulic model simulations for the existing site scenario, for both the defended and breach events.

Maximum flood depth, velocity and hazard mapping has been provided for each primary simulation in Appendix G. Flood hazard ratings have been calculated in accordance with DEFRA document 'FD2320: Flood Risks to People' and EA guidance document 'Supplementary Note on Flood Hazard Ratings and Thresholds'.

Maximum water level mapping for selected return periods is provided in Appendix H.

Mersey Estuary Model

Existing Scenario Results

Defended

During the existing scenario, the site is shown to flood during each simulated tidal flood event when the defended scenario is considered.

During the 0.5% AEP 2024 tidal event and above, floodwaters are shown to overtop the flood defences of the River Weaver, situated along the northern boundary of the site. Floodwaters then flow in a southern direction through the eastern portion of the site. During the climate change simulations, floodwaters are shown to flow through the eastern portion of the site, exiting through the southern boundary and travelling in a south westerly direction along low-lying ground levels.

During the 0.1% AEP 2024 tidal event and the 0.5% AEP plus climate change events, floodwaters are shown to overtop the River Weaver flood defences along the eastern boundary of the site and flow in a south westerly direction through the eastern portion of the site.

Mersey Breach (M-BR1)

During the existing scenario, the site is shown to flood during each simulated flood event when a breach of the defences along the River Mersey is considered.

The flood mechanism for the site is the same as the defended scenario, where the River Weaver flood defences are overtopped. However, the maximum flood depths are shown to be generally 100mm higher onsite during the breach scenario.

Proposed Development results

Defended

During the proposed development scenario, the site is shown to flood during each simulated tidal flood event when the defended scenario is considered.

The flood mechanisms during the proposed development scenario are the same as those described for the existing scenario.

As shown in Appendix H, water levels are shown to increase onsite adjacent to the flood defences along the River Weaver during the proposed development scenario as the higher roughness associated with the solar panels decreases flood velocity, raising water levels.

There is predominantly negligible change in flood risk offsite when the proposed development scenario is compared with the existing scenario.

Mersey Breach (M-BR1)

During the proposed development scenario, the site is shown to flood during each simulated flood event when a breach of the defences along the River Mersey is considered.

The flood mechanisms during the proposed development scenario are the same as those described for the existing scenario.

As shown in Appendix H, water levels are shown to increase onsite adjacent to the flood defences along the River Weaver during the proposed development scenario as the higher roughness associated with the solar panels decreases flood velocity, raising water levels.

There is predominantly negligible change in flood risk offsite when the proposed development scenario is compared with the existing scenario.

River Weaver Model

Existing Scenario

Defended

During the existing scenario, the site is shown to flood during each simulated fluvial flood event when the defended scenario is considered.

During the 1% AEP fluvial event and above, floodwater is shown to flow through a low spot in the flood defences along the eastern boundary of the site. The low spot is associated with the confluence of a tributary onsite. Floodwater spills and flows in a south westerly direction across the eastern portion of the site.

During the 1% AEP plus climate change and the 0.1% AEP events, floodwaters are shown to overtop the flood defences along the eastern boundary of the site. Floodwaters flow through the eastern portion of the site in a south-westerly direction and exit the site at the southern extent.

Weaver Breach 1 (W-BR1)

During the existing scenario, the eastern portion of the site is shown to flood during each simulated flood event when a breach of the flood defence along the northern boundary of the site is considered.

During the 1% AEP plus 67% climate change event coupled with the MHWS downstream boundary, the maximum flood depths onsite are shown to be higher, by up to 50mm, during the breach of the flood defence along the northern boundary in comparison to the defended scenario. However, the flood extents to the southwest of the site are shown to be slightly wider in the defended event. This is due to the flood mechanism onsite. Peak water level is shown to occur earlier in the simulation when the breach is considered as more water enters the site through the breach to the north, whilst the defences are overtopped to the east. However, as the flood recedes, floodwater is allowed to leave the site at a faster rate, through the breach. Whereas in the defended scenario, there is no breach for the flood to return to the channel and therefore continues to spread further south, with peak water level to the southwest of the site during the defended scenario occurring approximately seven hours after the peak of the breach scenario.

During the 1% AEP plus 106% climate change event coupled with the MHWS downstream boundary, the maximum flood depths are predominantly higher, by up to 10mm, during the defended scenario then they are when the breach of the northern defence is considered. This is because the predominant flow route onto the site is from the overtopping of the eastern defence. During the breach scenario, the flow routes are shown to pass through the northeastern portion of the site from east to west and back through the breach location. During the defended scenario, the absence of the breach retains more water onsite, increasing flood depths and extents.

During the 1% AEP plus 67% climate change event coupled with the 0.5% AEP plus climate change downstream boundary, the maximum flood depths are shown to be generally 200mm higher during the breach scenario when compared with the defended scenario. This is because the primary cause of flood risk to the site comes from the tidally influenced downstream boundary.

Weaver Breach 2 (W-BR2)

During the existing scenario, the eastern portion of the site is shown to flood during each simulated flood event when a breach of the flood defence along the eastern boundary of the site is considered.

During each simulated event, floodwater is shown to enter the site through the breach and over the top of the flood defences along the eastern boundary of the site.

Maximum flood depths are shown to be up to approximately 300mm higher onsite during the breach of the eastern flood defences in comparison to the defended scenario.

Proposed Development Scenario

Defended

During the proposed development scenario, the site is shown to flood during each simulated fluvial flood event when the defended scenario is considered.

The flood mechanisms during the proposed development scenario are the same as those described for the existing scenario results.

There is no increase in flood risk elsewhere as a result of the proposed development scenario.

Weaver Breach 1 (W-BR1)

During the proposed development scenario, the eastern portion of the site is shown to flood during each simulated flood event when a breach of the flood defence along the northern boundary of the site is considered.

The flood mechanisms during the proposed development scenario are the same as those described for the existing scenario results.

There is no increase in flood risk elsewhere as a result of the proposed development scenario.

Weaver Breach 2 (W-BR2)

During the proposed development scenario, the eastern portion of the site is shown to flood during each simulated flood event when a breach of the flood defence along the eastern boundary of the site is considered.

The flood mechanisms during the proposed development scenario are the same as those described for the existing scenario results.

There is no increase in flood risk elsewhere as a result of the proposed development scenario.

Conclusions

Waterco have been instructed to undertake a hydraulic modelling study for a proposed solar farm at land north of the M56, Frodsham. The EA requested that hydraulic modelling works inform the Flood Risk Assessment being produced for the site by Waterco (**ES Vol 2 Appendix 9-1: Waterco Flood Risk Assessment and Drainage Strategy [EN010153/DR/6.2])**.

To satisfy EA comments with regards to flood risk at the site, the current EA Mersey Estuary and River Weaver models have been obtained and updated to quantify existing flood risk at the site.

Following a meeting with the EA in November 2024, the proposed development scenario has been modelled by increasing roughness across site in the location of the solar panels and security fences and removing a percentage of modelled cells out of the floodplain to represent the proposed flood volume displacement.

The Mersey Estuary model has been utilised to assess tidal flood risk and the River Weaver has been utilised to assess fluvial flood risk. Both models have been set up to consider the defended scenario and breach scenarios.

The models were set up to consider updated climate change allowances and take into account the latest CFB data.

The results of the Mersey Estuary model show that the eastern portion of the site is shown to flood during each simulation.

The results of the breach of flood defences along the Mersey River show maximum flood depths are generally 100mm higher onsite in comparison to the defended scenario.

The results of the River Weaver model show that the eastern portion of the site is shown to flood during each simulation.

The results of the breach of the flood defences along the northern boundary vary between return periods given the changing flood mechanisms on site per simulation. The 1% AEP plus 67%CC event coupled with the MHWS tide event shows maximum flood depths to increase by up to 50mm onsite when the northern breach is compared to the defended event. The 1% AEP plus 106%CC event coupled with the MHWS tide event shows flood depths generally decrease by 10mm when the northern breach is compared with the defended scenario. The 1% AEP plus 67%CC event coupled with the 0.5% AEP plus CC tide event shows flood depths to increase by generally 200mm when the northern breach is compared to the defended scenario.

The results of the breach of the flood defences along the eastern boundary of the site show that maximum flood depths are up to approximately 300mm higher than the defended scenario.

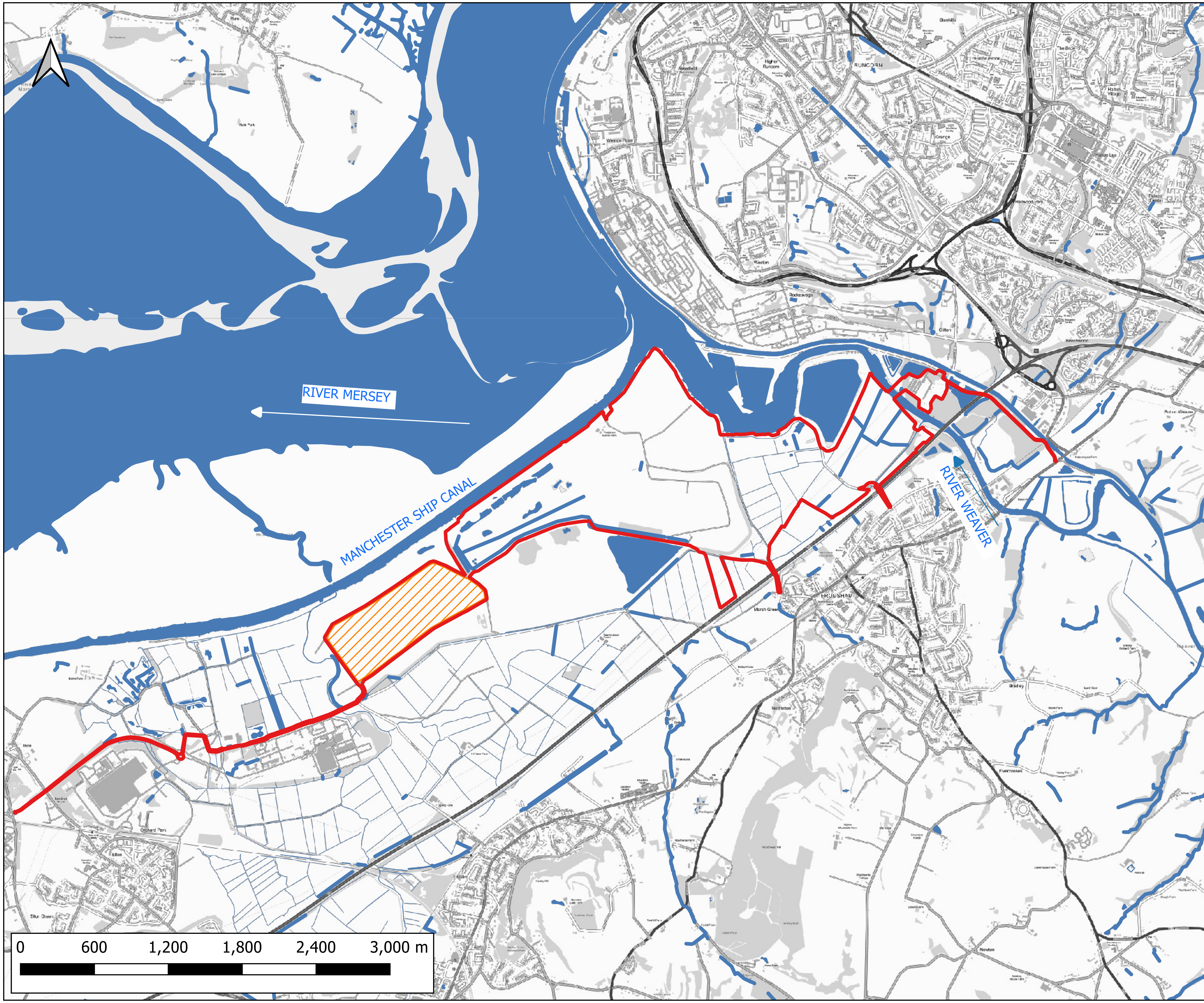
The results of both models show that generally there is negligible change in flood risk elsewhere as a result of the proposed development scenario.

Recommendations

This hydraulic model is considered suitable to support the FRA (**ES Vol 2 Appendix 9-1: Waterco Flood Risk Assessment and Drainage Strategy [EN010153/DR/6.2])** being prepared by Waterco for the proposed solar farm at land north of the M56, Frodsham.

Hydraulic model and supporting report should be issued to the EA for review.

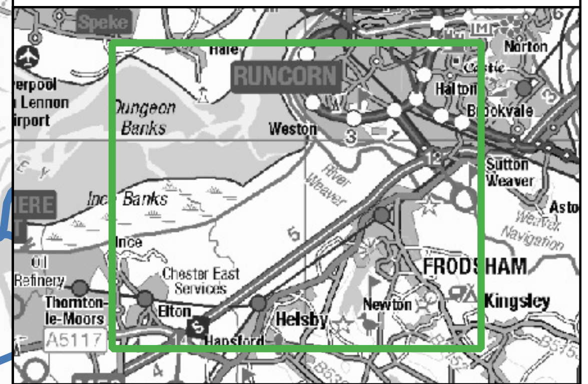
Appendix A Location Plan and Aerial Image



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Land Not Within Site Boundary
- Watercourses
- Waterbodies



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SCHEME:

Frodsham Solar

PLOT TITLE:

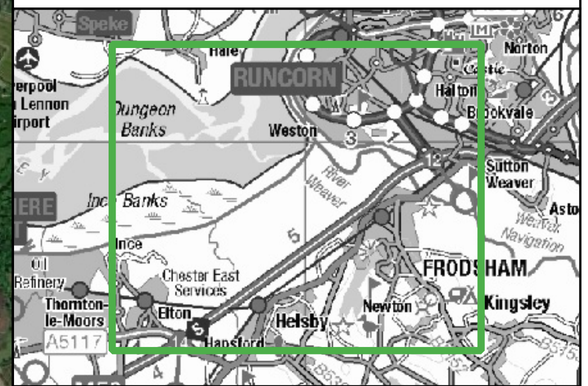
Location Plan

PLOT STATUS:			DATE:
FINAL			30-04-2025
DRAWN: JP	CHECKED: AW	APPROVED: NJ	PLOT SCALE AT A3: 1:30000
PLOT NAME: 14740_Location_Plan			REVISION: -

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Land Not Within Site Boundary



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PLOT TITLE:

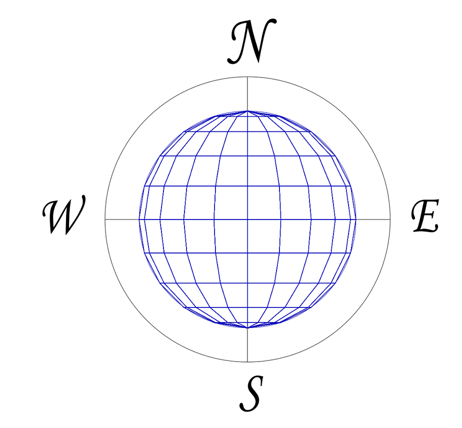
Aerial Plan

PLOT STATUS:	DATE:
FINAL	30-04-2025

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
JP	AW	NJ	1:30000

PLOT NAME:	REVISION:
14740_Aerial_Plan	-

Appendix B Topographic Survey



Symbols/Abbreviations (Where Applicable):

AV:	AIR VALVE
BB:	BELISHA BEACON
BH:	BOREHOLE
BM:	BENCHMARK
BOL:	BOLLARD
B/S:	BUS STOP
CAM:	CAMERA
CS:	CABLE STAY
CATV:	C.A.T.V INSPECTION CHAMBER
CBOX:	ELECTRICITY BOX, CABLE BOX, ETC.
CCTV:	C.C.T.V CAMERA
C.PIT:	CATCH PIT
EC:	ELECTRICITY COVER
EP:	ELECTRICITY POLE
ER:	EARTH ROD
FH:	FIRE HYDRANT
FP:	FLAG POLE
G:	GULLY
G:	GULLY (ROUND)
GV:	GAS VALVE
IC:	INSPECTION COVER (SQUARE)
IC:	INSPECTION COVER (ROUND)
IL:	INVERT LEVEL
KO:	KERB OUTLET
LB:	LETTER BOX
LC:	LIGHTING COLUMN
LP:	LAMP POST
LP/BS:	LAMP POST/BUS STOP
MH:	MANHOLE (SQUARE)
MH:	MANHOLE (ROUND)
MKR:	MARKER
P:	POST
RE:	RODDING EYE
R/S:	ROAD SIGN
S/P:	SIGN POST
SNP:	STREET NAME PLATE
ST:	STOP TAP
SV:	STOP VALVE
TCB:	TELEPHONE CALL BOX
TL:	TRAFFIC LIGHT
TP:	TELEGRAPH POLE
TP/EP:	TELEGRAPH POLE/ELECTRIC POLE
T/IC:	TELECOM INSPECTION COVER
WO:	WATER OUTLET
WM:	WATER METER
	GATE
	DEFINED POINT
	CONTROL POINT
	TREE (CONIFEROUS)
	TREE (DECIDUOUS)
	FOLIAGE
	HEDGE
DPC 99.99m	DAMP PROOF COURSE LEVEL
EL 99.99m	EAVES LEVEL
FL 99.99m	FLOOR LEVEL
RL 99.99m	RIDGE LEVEL
SL 99.99m	SOFFIT LEVEL
TL 99.99m	THRESHOLD LEVEL

FENCE DESCRIPTIONS:

B/W:	BARBED WIRE FENCE
C/B:	CLOSE BOARDED FENCE
C/L:	CHAIN LINK FENCE
C/P:	CHESTNUT PALING FENCE
CONC/P:	CONCRETE PANEL FENCE
I/R:	IRON RAILING FENCE
P/R:	POST AND RAIL FENCE
P/W:	POST AND WIRE FENCE
P/C:	POST AND CHAIN FENCE
S/PAL:	STEEL PALISADE FENCE
S/B:	SAFETY BARRIER
T/PAL:	TIMBER PALISADE FENCE

SITE LAYOUT:

Revision Information

Rev	Date	Description
A	9/12/22	Levels in fields added (taken from drone & GPS)

INFORMATION

1) Ordnance Survey co-ordinates and level are derived from OSTN15 and OSGM15, transformed from WGS84.

2) Only services located during the site survey are shown on this plan. Further investigation may be required to ascertain the full extent of the site services.

3) Copyright of this drawing remains the property of PM Surveys UK Ltd. Do not scale from this drawing. In the event of any discrepancy, refer query to PM Surveys UK Ltd.

NOTES

PM SURVEYS UK

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Client Info

Peel L&P Group Management Ltd

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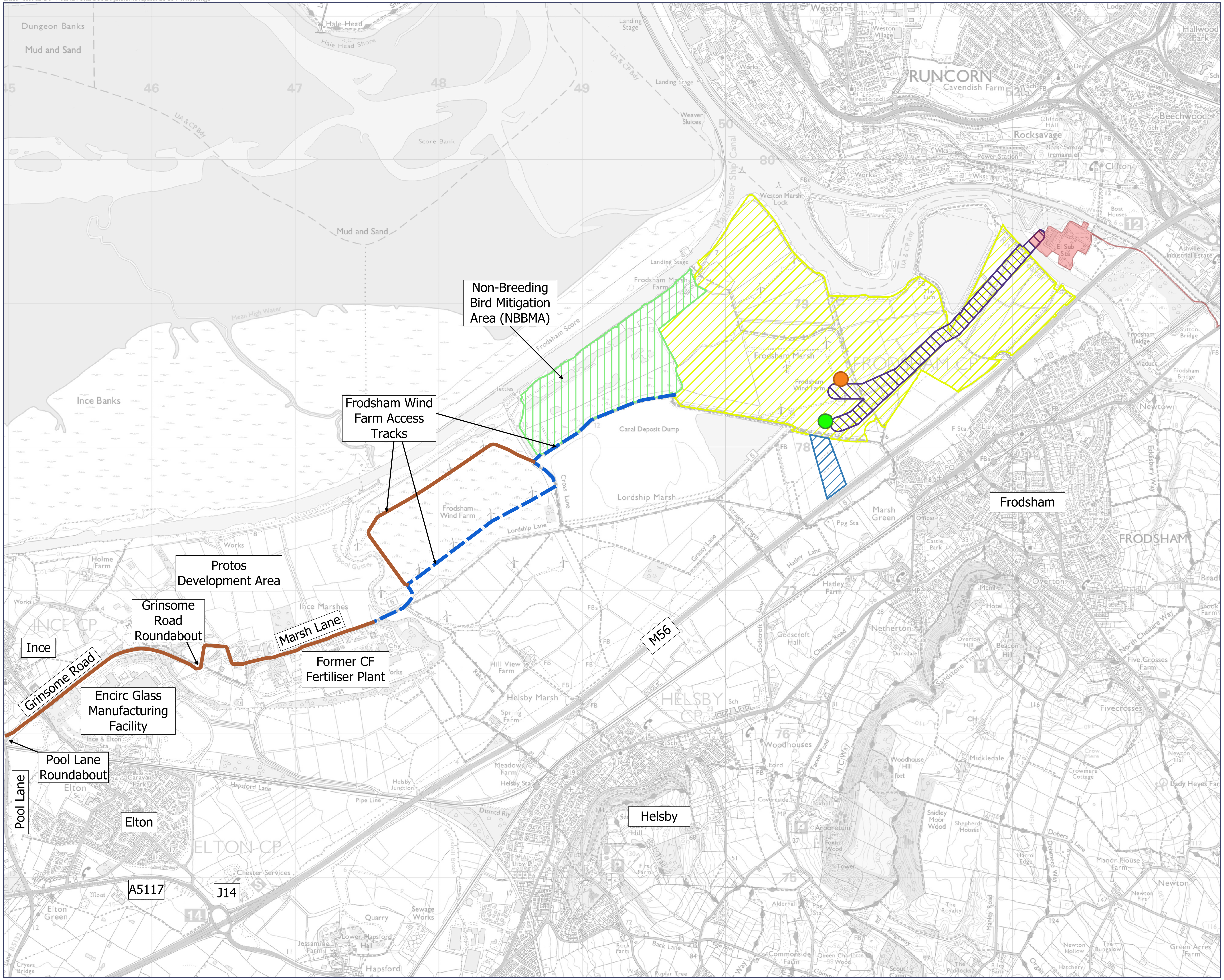
Email: alardeur@peellandp.co.uk

Project

Land East of Frodsham Windfarm

Project No PMS22250	Sheet: A0 Scale: 1:500	Surveyed By: PD HBB TW Drawn By: JW Approved By: PM
Dwg PMS22250-01A		Issued: 05/12/22

Appendix C Proposed Development Plan



N

0 500 1,000 1,500 2,000 2,500 m

- Solar Array Development Area
- SPEN / National Grid Substation and Access to the Substation Compound
- SPEN Grid Connection
- Skylark Mitigation Area
- Main Site Access with Private Wire Connection
- Main Site Access without Private Wire Connection
- BESS and Substation Compound (Option 1)
- BESS and Substation Compound (Option 2)

Case Reference: EN010153
Document Reference: EN010153/DR/6.3
Regulation 5(2)(a) Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Environmental Statement: Volume 3

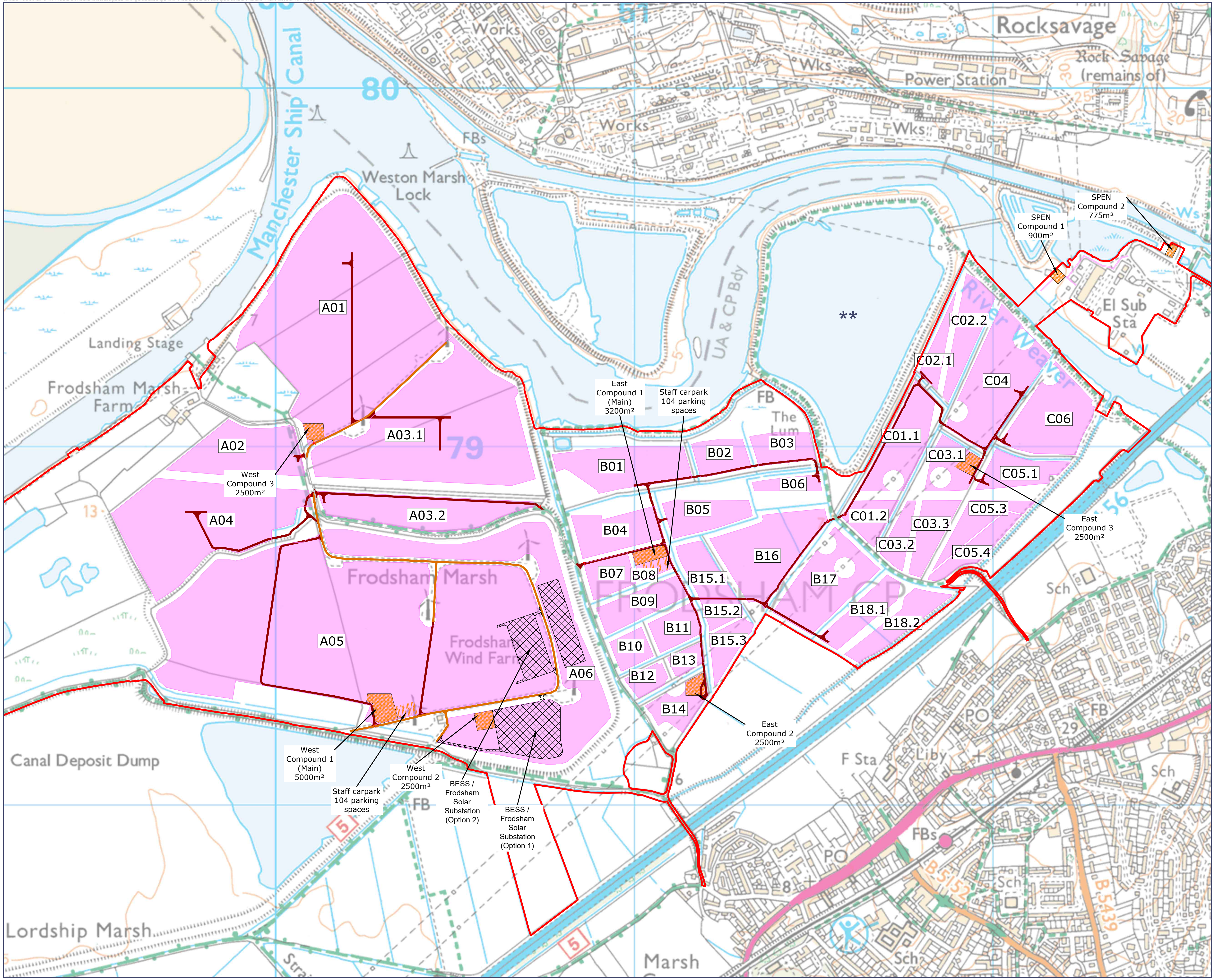
Project
FRODSHAM SOLAR

Figure Number
Figure 1-2

Figure Title
The Proposed Development Areas

Scale
1:25000@A3

Date
May 2025



N

0 500 750 1000m

Order Limits

Solar PV Array Areas

Access Track - Existing

Indicative Proposed Access Track Positions

Temporary Access Track for SPEN Substation

Indicative Location of Principal Construction Compounds

** Not open water - area now covered with grassland and scrub, see Figure 1-4

Case Reference: EN010153
Document Reference: EN010153/DR/6.3
Regulation 5(2)(a) Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Environmental Statement: Volume 3

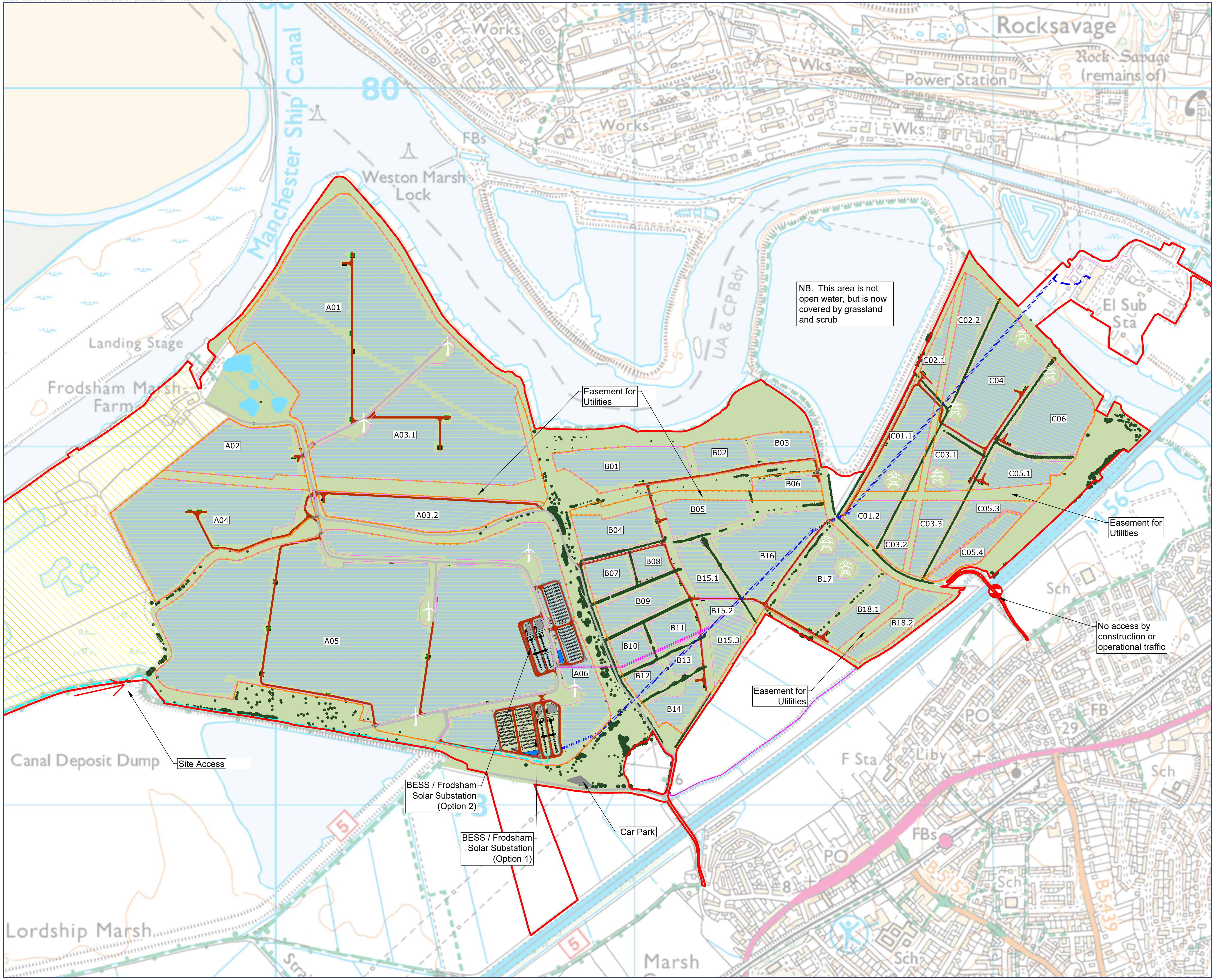
Project
FRODSHAM SOLAR

Figure Number
Figure 2-1

Figure Title
Indicative Construction Compound and Access Track Layout

Scale
1:10,000 @A3

Date
May 2025



Order Limits

Permanent Fencing

Access Track - Existing

Access Track - Proposed

Solar PV Tables

A00.0 Panel Reference Area

Power Conversion Unit (Inverter / Transformer Station)

Proposed 132kV Overhead Line to SPEN Substation (Option 1)

Proposed 132kV Overhead Line to SPEN Substation (Option 2)

Proposed 132kV Underground Line to SPEN Substation

Proposed 132kV Underground Line to nearby businesses

Non-Breeding Bird Mitigation Area

Existing Trees and Hedgerows

Areas of landscape management and habitat creation

Case Reference: EN010153
Document Reference: EN010153/DR/6.3
Regulation 5(2)(a) Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Environmental Statement: Volume 3

Project
FRODSHAM SOLAR

Figure Number
Figure 2-2

Figure Title
Indicative Operational Site Layout

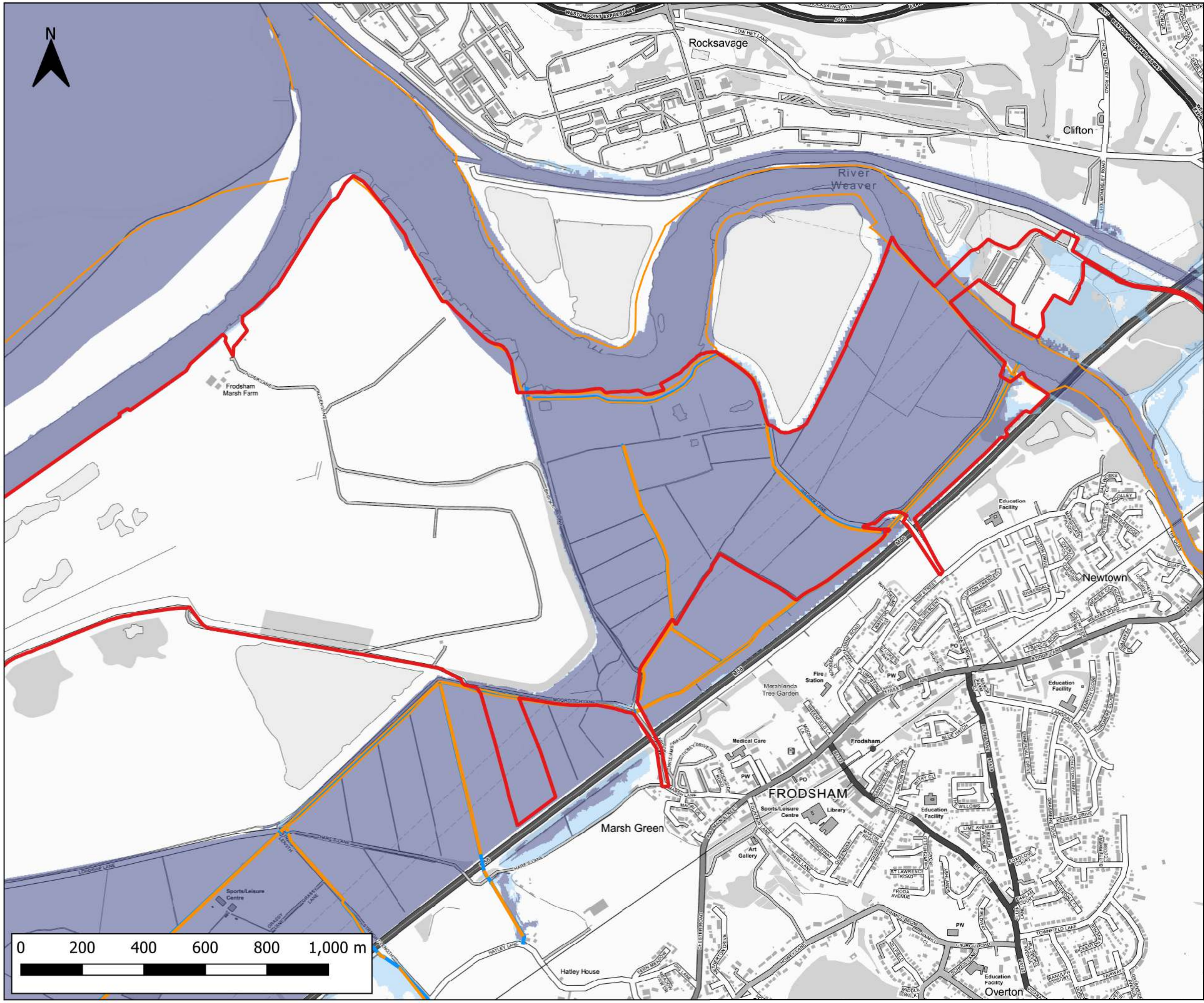
Scale
1:10,000 @A3

Date
May 2025

N

0 500 750 1000m

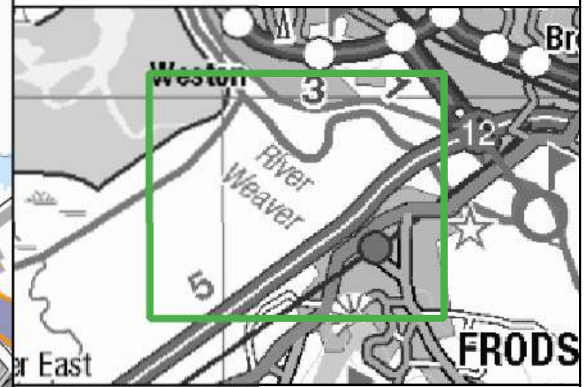
Appendix D EA Flood Maps



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- AIMS Spatial Flood Defences
- Main River
- Flood Zone 1
- Flood Zone 2
- Flood Zone 3



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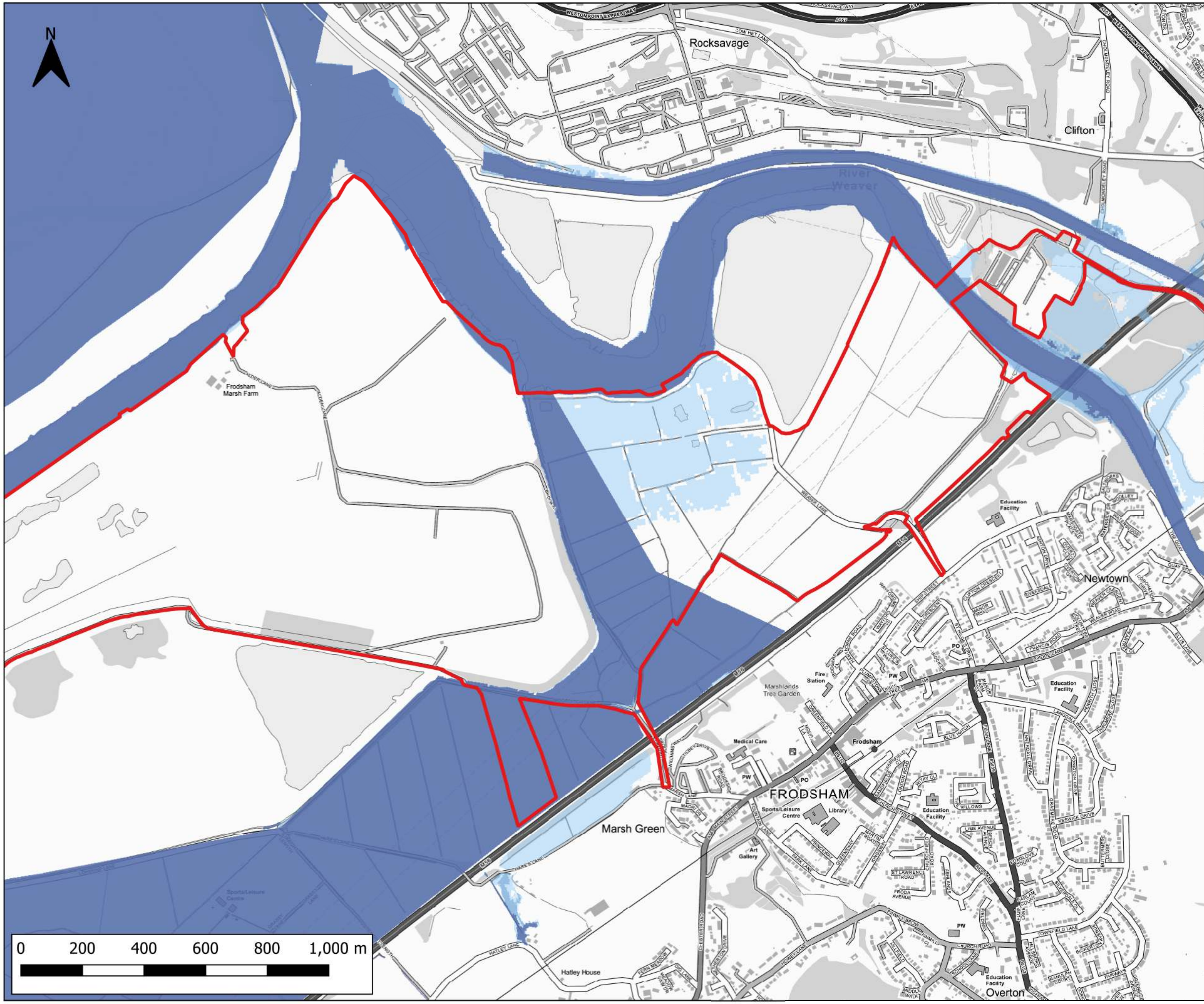
PLOT TITLE:

EA Flood Map for Planning
Data published March 2025

PLOT STATUS:	DATE:
FINAL	30-04-2025

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
JP	AW	NJ	1:12000

PLOT NAME:	REVISION:
14740_EA_FMfP	-



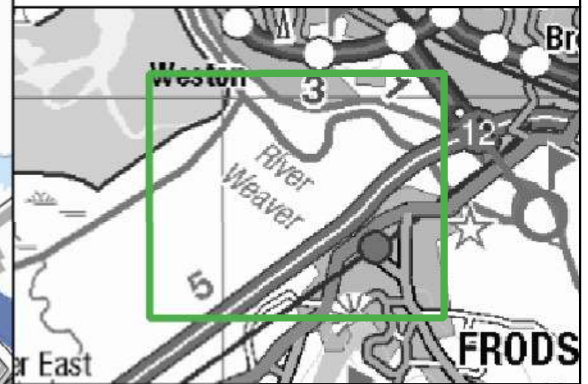
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary

Present Day Extents (defended)

- Rivers and sea 1 in 30
- Rivers 1 in 100, Sea 1 in 200
- Rivers and sea 1 in 1000



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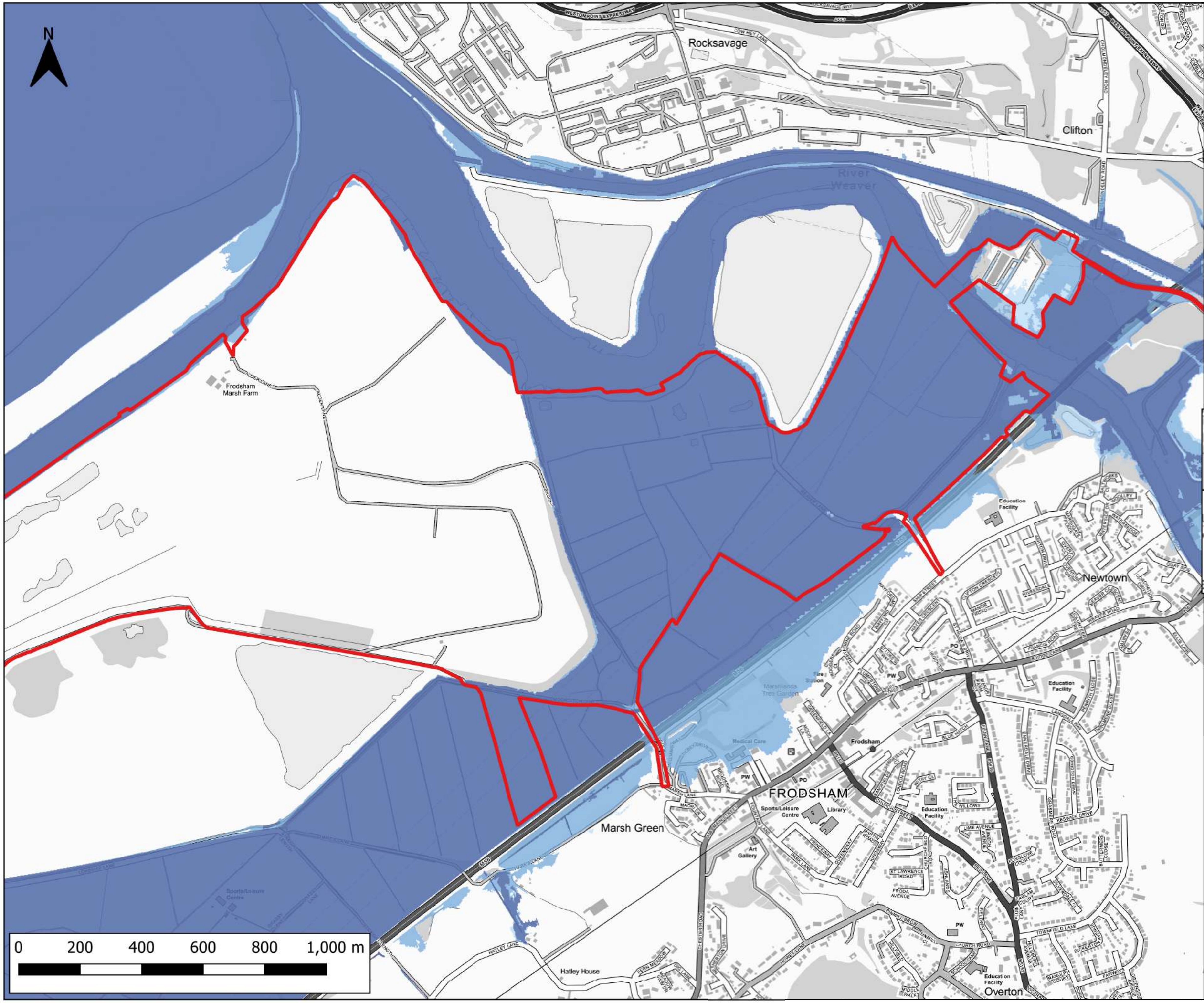
PLOT TITLE:

EA Flood Map for Planning - Present Day Extents - Rivers and Sea (defended) Data published March 2025

PLOT STATUS:			DATE:
FINAL			30-04-2025
DRAWN: JP	CHECKED: AW	APPROVED: NJ	PLOT SCALE AT A3: 1:12000
PLOT NAME: 14740_EA_FMfP_RS_PD_DEF			REVISION: -



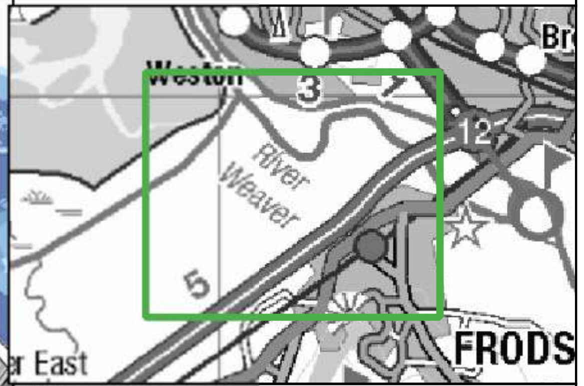
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary

Climate Change Extents (defended)

- Rivers and sea 1 in 30
- Rivers 1 in 100, Sea 1 in 200
- Rivers and sea 1 in 1000



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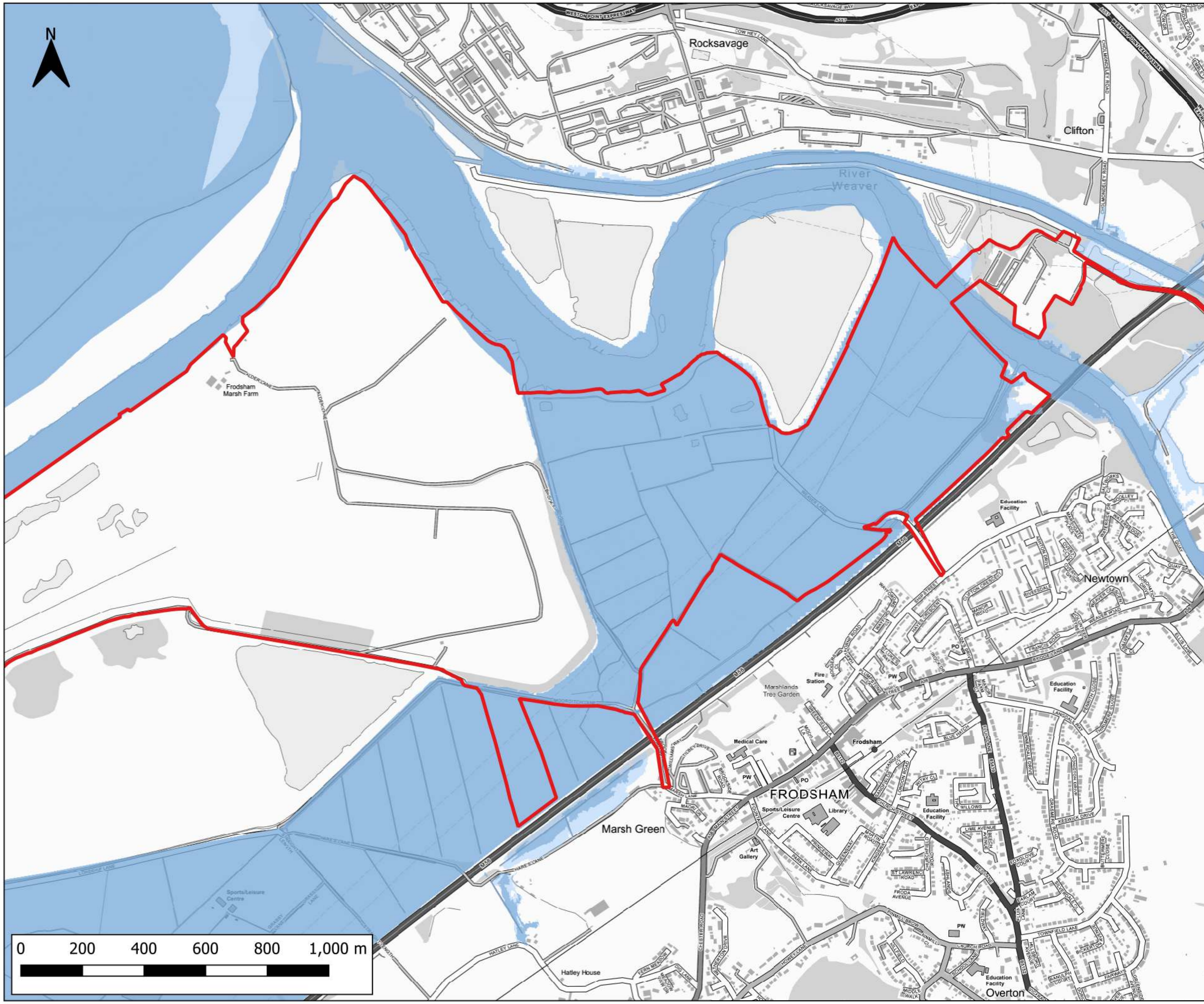
PLOT TITLE:

EA Flood Map for Planning - Climate Change Extents - Rivers and Sea (defended)
Data published March 2025

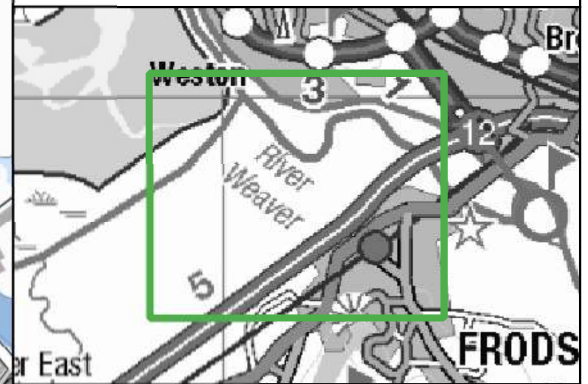
PLOT STATUS:			DATE:
FINAL			30-04-2025
DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
JP	AW	NJ	1:12000
PLOT NAME:			REVISION:
14740_EA_FMfP_RS_CC_DEF			-



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Present Day Extents (undefended)
  - Rivers 1 in 100, Sea 1 in 200
  - Rivers and sea 1 in 1000



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PLOT TITLE:

EA Flood Map for Planning - Present Day Extents - Rivers and Sea (undefended)
Data published March 2025

PLOT STATUS:		DATE:	
FINAL		30-04-2025	
DRAWN: JP	CHECKED: AW	APPROVED: NJ	PLOT SCALE AT A3: 1:12000
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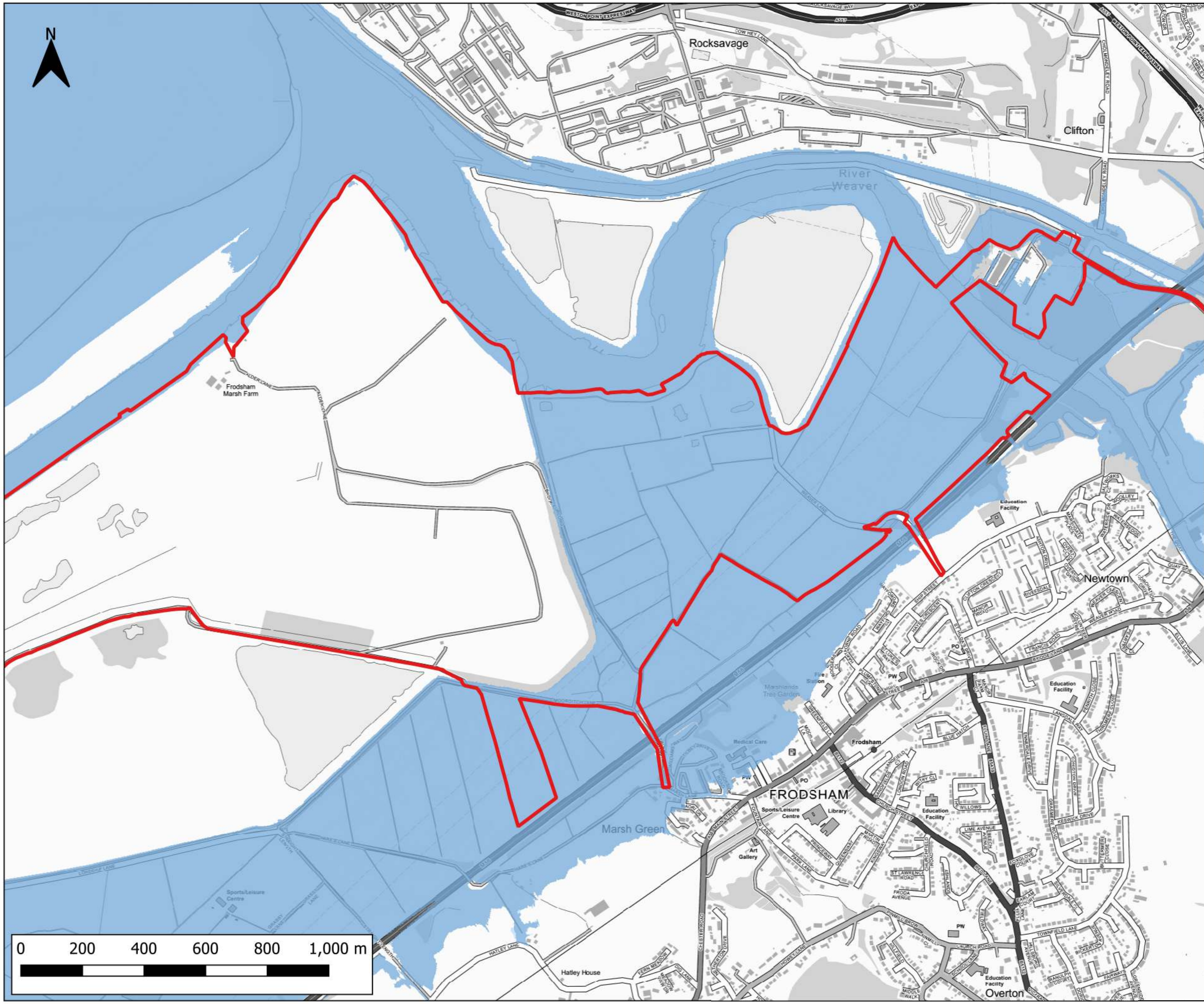


Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

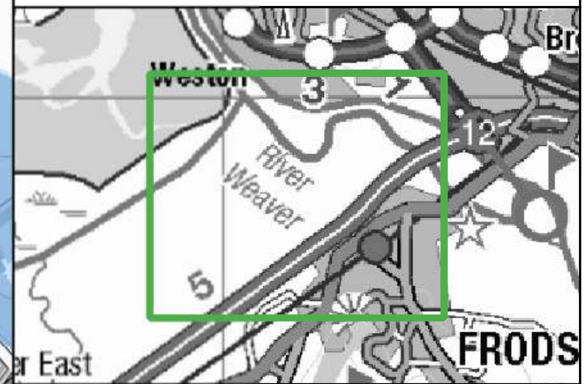
LEGEND

Site Boundary

Climate Change Extents (undefended)

Rivers 1 in 100, Sea 1 in 200

Rivers and sea 1 in 1000



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PLOT TITLE:

EA Flood Map for Planning - Climate Change Extents - Rivers and Sea (undefended)
Data published March 2025

PLOT STATUS:			DATE:
FINAL			30-04-2025
DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
JP	AW	NJ	1:12000
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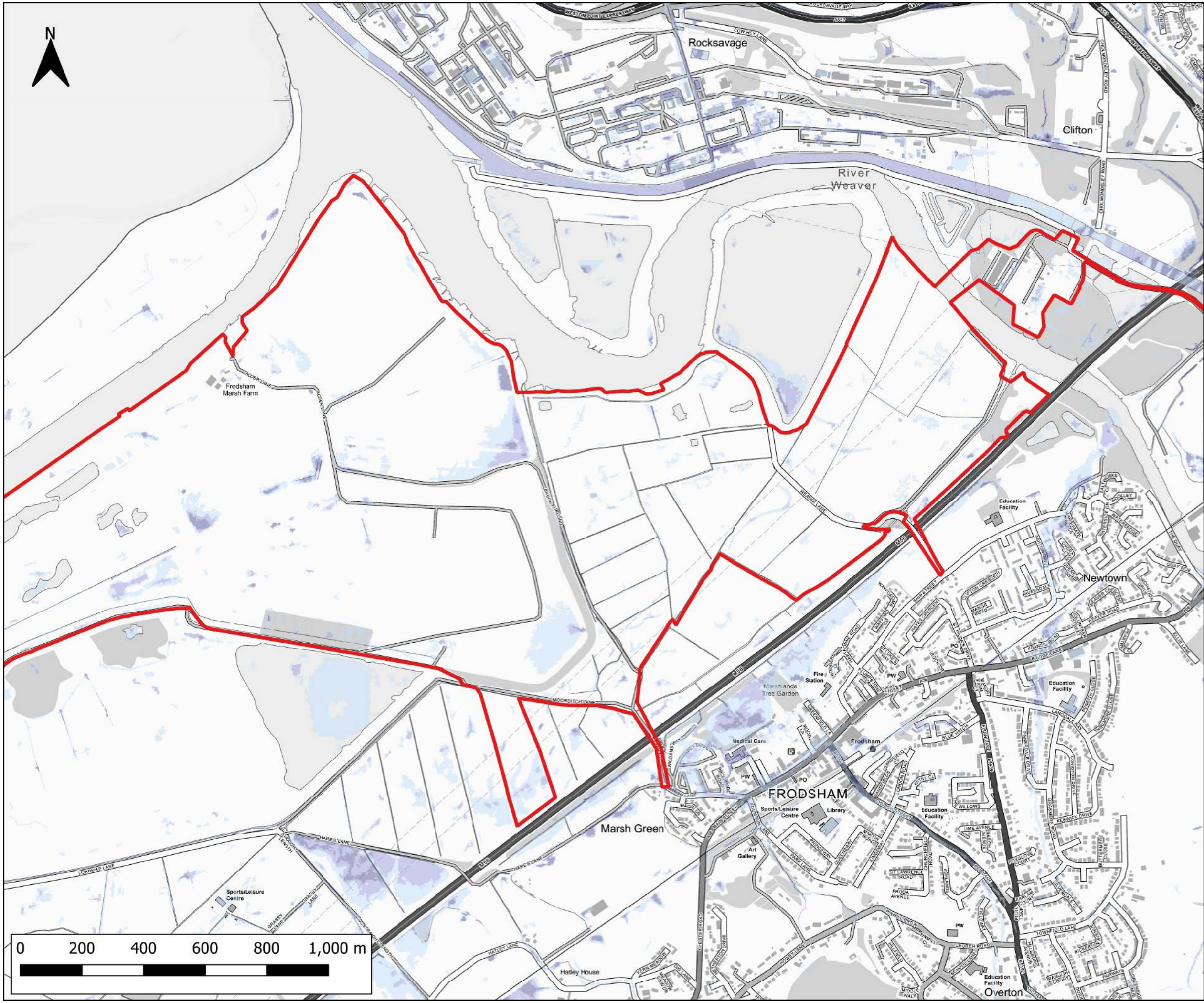
14740_EA_FMfP_RS_CC_UNDEF			-



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

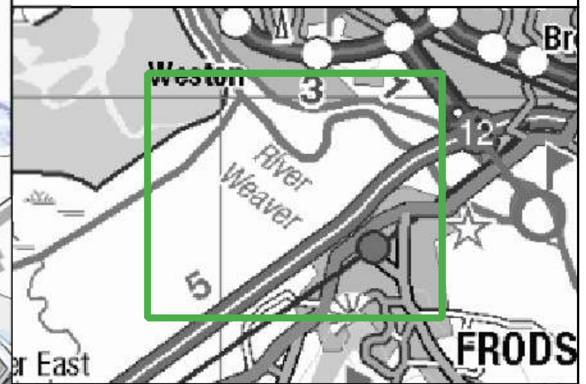
Site Boundary

Annual Likelihood of Flooding

1 in 30

1 in 100

1 in 1000



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SCHEME:

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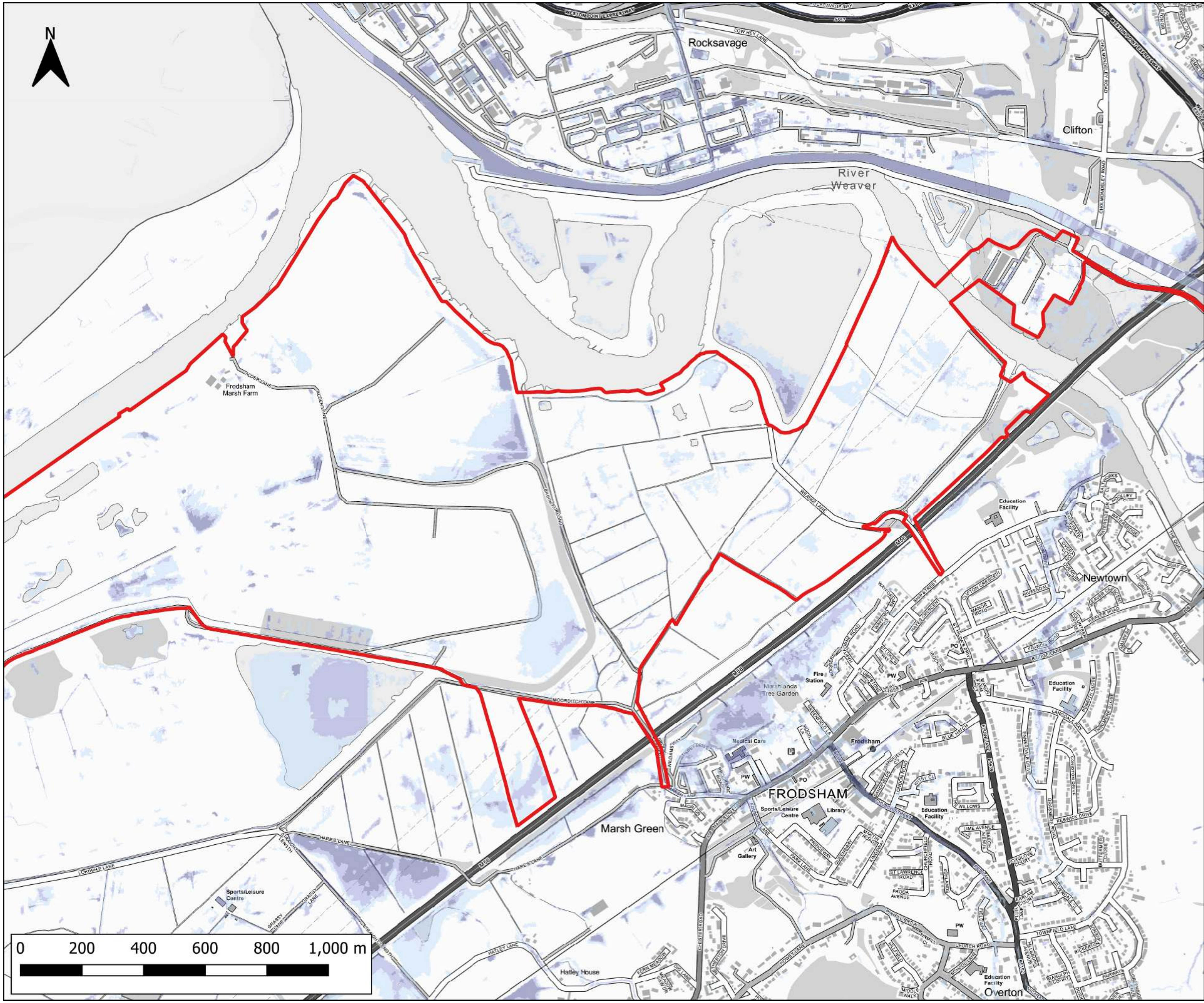
PLOT TITLE:

EA Flood Map for Planning - Present Day Extents - Surface Water Data published January 2025

PLOT STATUS:	DATE:
FINAL	30-04-2025

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
JP	AW	NJ	1:12000

PLOT NAME:	REVISION:
14740_EA_FMfP_SW_PD	-



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

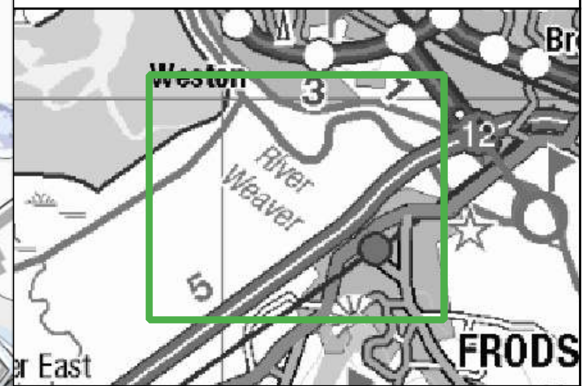
Site Boundary

Annual Likelihood of Flooding

1 in 30

1 in 100

1 in 1000



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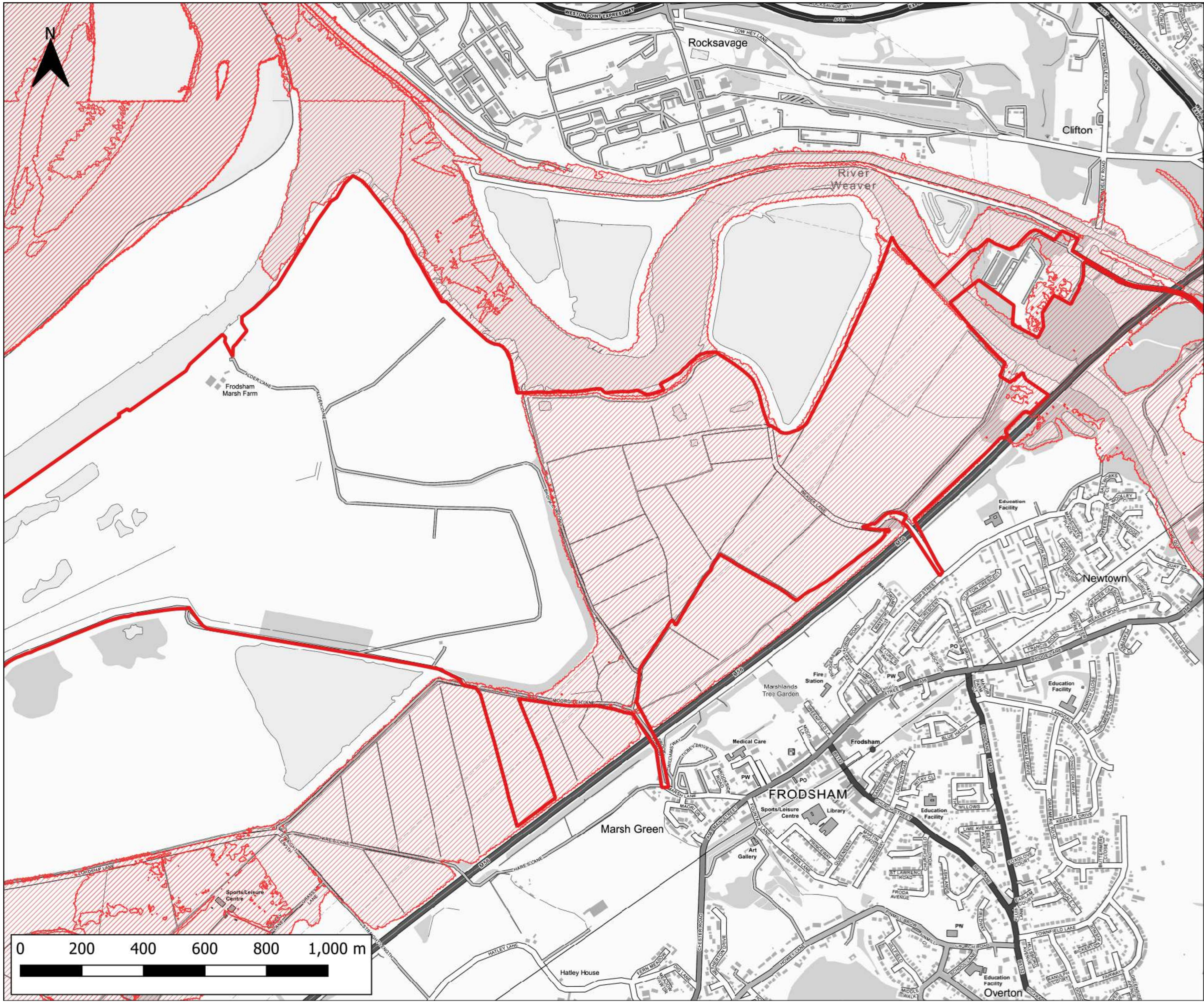
SCHEME:

Frodsham Solar

PLOT TITLE:

EA Flood Map for Planning - Climate Change Extents - Surface Water
Data published January 2025

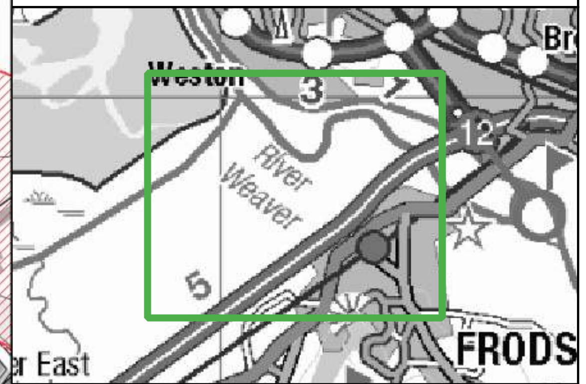
PLOT STATUS:			DATE:
FINAL			30-04-2025
DRAWN: JP	CHECKED: AW	APPROVED: NJ	PLOT SCALE AT A3: 1:
PLOT NAME: 14740_EA_FMfP_SW_CC			REVISION: -



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- When river levels are normal
- When there is also flooding from rivers



CLIENT:
Frodsham Solar Ltd

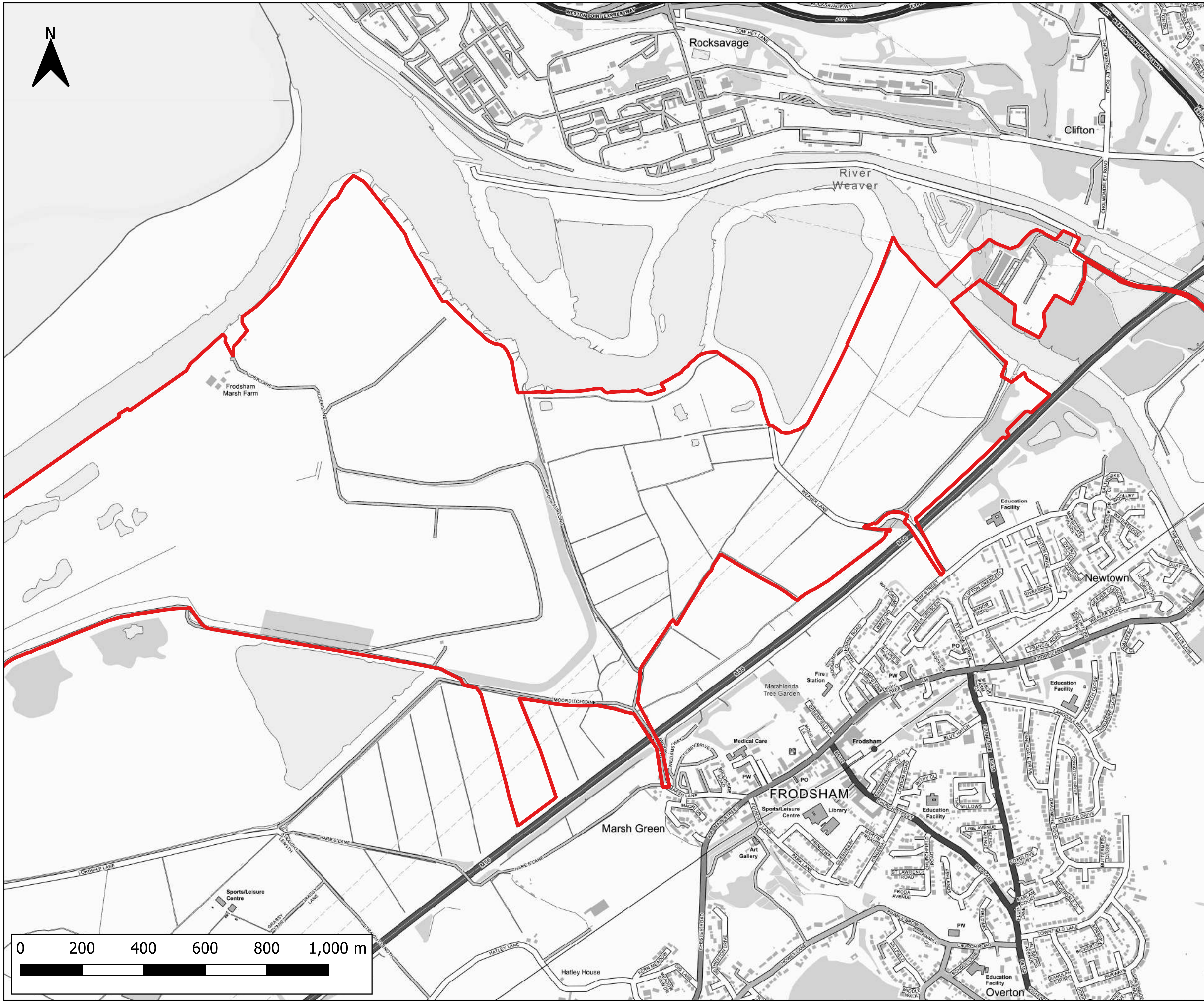
www.waterco.co.uk

SCHEME:
Frodsham Solar

PLOT TITLE:
EA Flood Risk from Reservoirs
Data revised March 2025

PLOT STATUS:			DATE:
FINAL			30-04-2025
DRAWN: JP	CHECKED: AW	APPROVED: NJ	PLOT SCALE AT A3: 1:12000

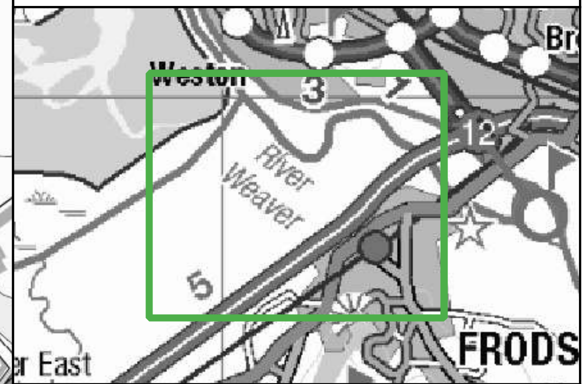
PLOT NAME:	REVISION:
14740_EA_Flood_Risk_from_Reservoirs	-



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise
2) The Historic Flood Map is a GIS layer showing the maximum extent of individual Recorded Flood Outlines from river, the sea and groundwater springs that meet a set criteria. It shows areas of land that have previously been subject to flooding in England. This excludes flooding from surface water, except in areas where it is impossible to determine whether the source is fluvial or surface water but the dominant source is fluvial.
3) If an area is not covered by the Historic Flood Map it does not mean that the area has never flooded, only that the EA do not currently have records of flooding in this area that meet the criteria for inclusion.
4) The Historic Flood Map takes into account the presence of defences, structures, and other infrastructure where they existed at the time of flooding. It will include flood extents that may have been affected by overtopping, breaches or blockages.

LEGEND

- Site Boundary
- Historic Flood Map



CLIENT:
Frodsham Solar Ltd

waterco
www.waterco.co.uk

SCHEME:
Frodsham Solar

PLOT TITLE:
EA Historic Flood Risk
Data revised February 2025

PLOT STATUS:	DATE:
FINAL	30-04-2025

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
JP	AW	NJ	1:12000

PLOT NAME:	REVISION:
14740_EA_Historic_Flood_Risk	-

Appendix E EA Correspondence

Environment Agency
By email only: NITeam@environment-agency.gov.uk

15/07/2024

Scheme: **Frodsham Marshes (Frodsham Solar)**

Subject: **FRA Advice**

EA Reference: XA/2024/100097/01-L01

Dear Morgan Haringman,

Thank you for providing the Environmental Agency review of the draft Flood Risk Assessment for the Frodsham Solar Scheme. Further to the FRA review we would like to clarify points raised which will influence the design of the site and seek to agree the scope of an updated FRA.

1. Climate Change and Flood Events

Your response clearly sets out which climate change allowances should be assessed. We propose to update the existing EA Mersey and Lower Weaver hydraulic models with the correct climate change allowances. We will also consider a defence breach as requested. Please could you confirm that the flood events detailed in the following tables are satisfactory:

Table 1 – Tidal Mersey Flood Events

Watercourse / Source	Scenario	Event (% AEP)
Mersey Tidal	Defended	0.5% AEP (year 2024)
		0.1% AEP (year 2024)
		0.5% AEP Higher Central CC to the year 2100
		0.5% AEP Upper End CC to the year 2100
		0.5% AEP H++ Scenario (+1.9m of sea level rise)
	Breach (of the Mersey defences only)	0.5% AEP (year 2024)
		0.1% AEP (year 2024)
		0.5% AEP Higher Central CC to the year 2100
		0.5% AEP Upper End CC to the year 2100
		0.5% AEP H++ Scenario (+1.9m of sea level rise)

For the River Mersey Breach, there are flood defences along the River Mersey with secondary defences bordering the site (along the River Weaver). We propose to only consider a breach of the River Mersey defences in a tidal event as the probability of a breach of the River Mersey and River Weaver defences occurring simultaneously is very low. Please advise if this approach is acceptable.

Figure 1 shows the proposed breach location. Please can you confirm the breach location is acceptable.

Figure 1 – Mersey Breach Location

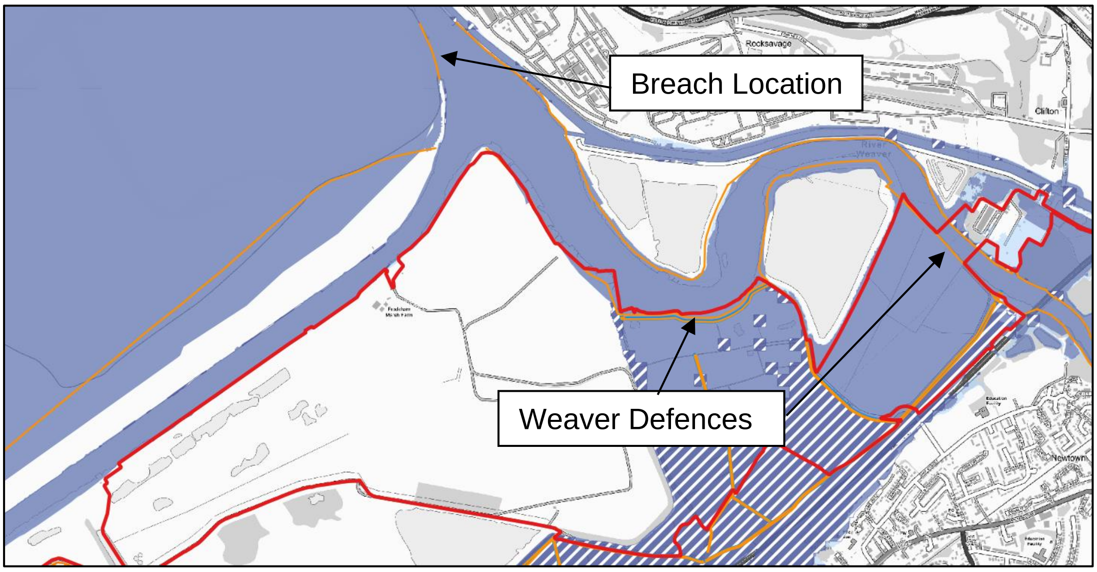


Table 2 – Lower Weaver Flood Events

Watercourse / Source	Scenario	Event (% AEP)
Lower Weaver Fluvial	Defended	1% AEP present day
		0.1% AEP present day
		1% AEP plus 67% CC event
		1% AEP plus 106% CC event (sensitivity test)
		Joint probability 1% AEP plus 67% CC fluvial event with 0.5% AEP Upper End CC (year 2100) tidal event.

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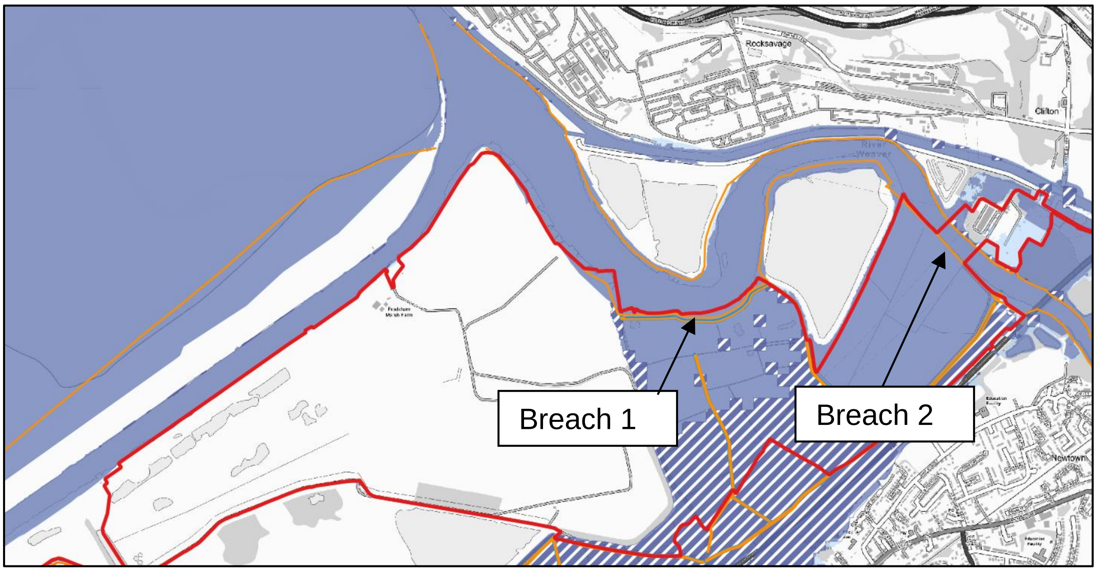
	Breach (2no. breach scenarios allowed for, one of the flood defence on the eastern site boundary and one of the flood defence on the northern site boundary)	1% AEP plus 67% CC event
		1% AEP plus 106% CC event (sensitivity test)
		Joint probability 1% AEP plus 67% CC fluvial event with 0.5% AEP Upper End CC (year 2100) tidal event.

For the River Weaver breach scenario, we propose 2no. breaches in separate locations shown in Figure 2 below. Please can you confirm that the breach locations are acceptable?

Figure 2 – Weaver Breach Location



We do not intend to update the Ince and Frodsham Hydraulic Model. The justification for this is:

- The water levels are significantly lower for the Ince and Frodsham flood events when compared with the Lower Weaver and Mersey Estuary flood levels. As such, the Ince and Frodsham flood events will not inform the design levels of infrastructure on site.

Please advise if it is acceptable to not update the Ince and Frodsham hydraulic model.

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2. Sensitivity Scenarios

We note that there is a requirement to consider sensitivity scenarios for fluvial and tidal flood events (106% climate change on fluvial flows, and the +1.9m sea level rise allowance). Please can you confirm how you will view the sensitivity scenario modelling on the basis that in the tidal H++ event, the lower eastern extent of the site is likely to be inundated to a significant depth. The +1.9m sea level rise is almost 1m above the upper end climate change sea level rise to the year 2100.

Please can you confirm that mitigation design is not expected to accommodate the flood depths in the sensitivity scenario events? We are happy to detail in the FRA how the site would be managed in such an event i.e. how the site would recover to become operational, what equipment would need replacing etc.

3. Flood Risk Activity Permits

In your response its states that *'We note that the developer intends to disapply Flood Risk Activity Permits (FRAPs). However we would need a level of detail within the FRA in order to allow for their disapplication'.* Please can you confirm what information you would require for FRAP's to be disapplied. Multiple watercourse crossings are proposed. Would a typical cross-sectional drawing of a proposed watercourse access road crossing be acceptable?

4. Flood Storage Compensation

In your response you request that flood compensation storage would be required for all structures within the design flood event, including the mounting structures for the panels, the inverter stations and changes in level from the roads.

We consider that any proposed structures within the design flood event would have negligible impact on flood storage.

Figures 3 and 4 show examples of the typical inverter and panel sections (design heights to be confirmed). Structures within the design flood event would be limited to the foundation supports of the inverters and mounting structures of the panels. Both have a minimal footprint and would have negligible impact on flood storage and flood flows (flood water can flow and be stored beneath the structures).

Would the EA accept a limited assessment of impact on flood risk elsewhere, whereby:

- The total footprint of structures (foundation supports of the inverters and mounting structures of the panels) is calculated.
- A simple calculation is provided demonstrating what the water level increase would be when accounting for the relationship between the volume of flood storage displaced and the area

of the associated floodplain. The aim is to demonstrate that any water level increase caused by flood water displacement is negligible. By way of an example calculation only: if 100m³ of flood storage was displaced, and the impact of this displacement was considered across a 1km² flood extent, then the water level increase (volume in m³ divided by area of flood extent in m²) would be 0.0001m (0.1mm).

Figure 3 – Typical Inverter Section

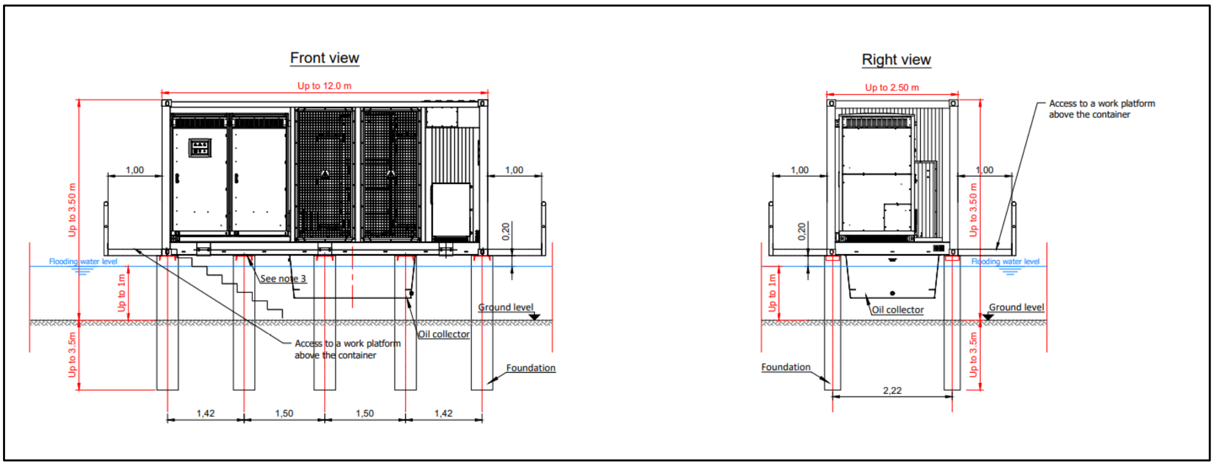

Figure 4 – Typical Solar Panel Mounting Structure

5. Design of Access Crossings

In relation to the proposed watercourse access road crossings, the EA response states: *'These proposed crossings may require modelling to consider flow routes in a flood scenario, and flood storage compensation if within the design flood plus climate change flood extent. A bridge should be designed to a soffit of 600mm above design flood level, with a consideration of climate change.'*

We propose open span crossings which will not impact on the channel capacity. The bridge crossings will be similar to existing (see Figure 5) and simple in nature i.e. a slab tying in with existing ground levels either side of the watercourse as to avoid any ground raising. As the crossings will not impact the channel capacity or flood flows, please confirm that modelling of the proposed crossings will not be required.

Figure 5 – Existing Watercourse Crossing

The watercourses on site ultimately drain to an EA pumping station which pumps flows into the River Weaver. The watercourses have very limited fall, and limited flow is witnessed in the watercourses due to their shallow gradient. The water levels in the watercourses are influenced by the EA pumping station (water levels rise following heavy rain and fall as the EA pump operates). Given the unique characteristics of the watercourse on site, please advise if there is room for reduction on the 600mm freeboard requirement? Ideally, we request a limited freeboard of 150mm – 300mm as:

- The preference is for the bridge deck to tie in with existing ground levels either side of the

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watercourse (negating the need for ground raising).

- There is no out of channel flooding from the watercourses at the access road crossing locations.
- There is no discernible flow in the watercourses meaning the risk of debris being conveyed in the watercourse and blocking the bridge is very low.

6. Offsets

As requested, we will provide a 16m offset to the flood defences adjoining the River Weaver. We note that there are designated flood defences along the watercourses within the site. The flood defences along the watercourses within the site are classified as both fluvial and tidal defences. From visiting the site, the 'defences' along the watercourses within the site are not embankments or formal structures. Figure 6 shows a watercourse on site (main river) which is classified as having formal flood defences along it. The 'defences' appear to be slightly higher ground on the watercourse bank. We would therefore consider the flood defences on site as being 'fluvial' as they would serve no benefit in a tidal inundation event. Please could you therefore advise if an 8m offset is acceptable for all defences along the watercourses within the site.

Figure 6 – Main River Within the Site

7. Surveys

The EA response states *'The development site is located in an area which benefits from flood defences. The developer should survey the flood defences within the Order Limits, which will protect the proposed development and consider remediation.'*

Please could you expand on why the surveys are required i.e. to confirm the crest heights, structural condition etc, and which defences should be surveyed? Are surveys required at pre-application stage or pre-construction?

With the design of flood mitigation being made against extreme scenarios i.e. breach events, and the defences being maintained by the EA, we are trying to establish why the survey is required and if it is essential for the application.

8. Culverts

We will install open span crossings and avoid the use of culverts. On the basis that open span bridge crossings will be used (meaning there will be no impact on the watercourse channel or capacity), please confirm that there is no requirement for a study on effects on hydrology and geomorphology for the watercourse crossings (no work within the river channel will take place).

9. Surface Water Drainage

The EA response states that *'We require more information on how surface water from inverters will be managed. The loss of footprint for runoff may require an engineered solution.'*

As shown in Figure 3, the inverters will be minimal in footprint ($30m^2$) and as such rainfall runoff quantities will be minimal. The inverters will not have a formal rainwater collection system (no guttering or downpipes) and we propose a simple drainage solution for the inverters whereby rainfall runoff will be directed to a stone surround (filter trench or similar). Please advise if this approach is acceptable.

Any discharge from the BESS will be made at the 1 in 1 year limited greenfield runoff rate, ensuring no increase in runoff rates to the receiving watercourse or downstream pumping station. A 45% climate change (upper end allowance for 2070's epoch) will be applied for the design of the BESS drainage system.

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Yours sincerely,

Aled Williams

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Andrew Russell
AXIS
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Bretton
Chester
CH4 0DH

Our ref: XA/2024/100097/01-L01
Your ref: 01FRA

Date: 01 July 2024

Dear Andrew Russell

Flood Risk Assessment draft review (non-statutory)

Frodsham Marshes, Frodsham, Cheshire West and Chester

Thank you for consulting us on the "*Flood Risk Assessment & Drainage Strategy"* (dated 15 May 2024 reference: 14740-FRA & Drainage Strategy-02) by Waterco.

Planning policy

The Overarching National Policy Statement for Energy (EN-1) states under section 5.8.15 that a Flood Risk Assessment (FRA) should:

- *"Take the impacts of climate change into account, across a range of climate scenarios, clearly stating the development lifetime over which the assessment has been made"*
- *"Consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels, flood storage areas and other artificial features, together with the consequences of their failure and exceedance"*
- *"Consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems. Information should include..."*

- *“Detail those measures that will be included to ensure the development will be safe and remain operational during a flooding event throughout the development’s lifetime without increasing flood risk elsewhere”*

Climate change uplift and epoch

The FRA states that:

“A climate change allowance up to the year 2065 has been considered in this report. Modelled outputs with climate change up to the year 2115 has also been provided by the EA (and included in Appendix K) however are not considered further in this report, as the climate change amount (year 2115) exceeds the estimated decommission year (2070) by 45 years.”

We appreciate that in previous advice provided by the Environment Agency (dated 10 February 2023, Reference: SO/2022/122782/01-L01) a climate change uplift of +30% was proposed. A +30% climate change allowance reflects the central estimate for the 2050’s epoch for the Weaver Gowy Management catchment. However, this does not adequately consider flood risk throughout the lifetime of the development. Fluvial flood risk would therefore be underestimated based on the type of development proposed.

As the proposal is essential infrastructure, this means that climate change projections should conform to the following:

- the developer should use the 2080s higher central allowance for the climate change projections pertaining to peak river flow. The credible maximum scenario is the upper end allowance
  - the 2050s epoch is not appropriate, as the development’s design life is 40 years. Using the 2080s epoch would include an uplift of +67% on fluvial flows
  - the Upper scenario should be run as a sensitivity test
  - ensure the corresponding tidal boundary conditions for the fluvial events within the Weaver model are uplifted to account for sea level rise, as a result of climate change
- the developer should use the higher central and upper end allowances for sea level rise. The credible maximum scenario is the H++ scenario and is based on sea level rise of 1.9 metres plus an allowance for surge
- regarding peak rainfall intensity, the developer should consider the 1% and 3.3% annual exceedance probability events using the central allowance for the 2070s epoch (2061 to 2125). In some locations the allowance for the 2050s epoch is higher than that for the 2070s epoch. If so, and development has a lifetime beyond 2061, use the higher of the two allowances

More information can be found here: [Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)]

Flood Risk

General

The FRA has not addressed flood risks associated with the construction and decommissioning phases. Within the FRA we would need to see details of specific risks associated with activities during these phases, and how these risks will be managed to avoid increasing flood risk on site. The issues we raise in this response letter should be considered in the assessment of those activities and the risks they pose.

We note that the developer intends to disapply Flood Risk Activity Permits (FRAPs). However we would need a level of detail within the FRA in order to allow for their disapplication.

The Environmental Permitting (England and Wales) Regulations 2016 require a permit to be obtained for any activities which will take place:

- on or within 8 metres of a main river (16 metres if tidal)
- on or within 8 metres of a flood defence structure or culverted main river (16 metres if tidal)
- on or within 16 metres of a sea defence
- involving quarrying or excavation within 16 metres of any main river, flood defence (including a remote defence) or culvert
- in the floodplain of a main river if the activity could affect flood flow or storage and potential impacts are not controlled by a planning permission

The developer should state what is included within the "Do Minimum" scenario (page 12).

The developer should state whether the proposed development may alter the risk category of the nearby reservoir(s) (pages 23 and 24).

The developer should consider how the porosity of the proposed roads will be maintained, in the context of compaction from vehicular use, throughout the lifetime of the development. This could be included within the maintenance schedule for permeable surfacing (pages 27 and 28).

The developer should assess future flood zones with consideration of climate change in the application of a sequential approach for components of the development.

Flood Storage Compensation

The developer will need to consider flood storage compensation for all structures within the design flood plus climate change flood extent. This includes the mounting structures / post for solar panels, the inverter stations, and changes in level from the roads. The developer should also consider the fluvial-tidal interaction. Flood storage compensation should:

- be level for level

- be volume for volume
- be localised
- achieve net gain where possible
- not disrupt flood flow routes

Please provide a crossing register for the proposed crossings, stating the type and precise position. These proposed crossings may require modelling to consider flow routes in a flood scenario, and flood storage compensation if within the design flood plus climate change flood extent. A bridge should be designed to a soffit of 600mm above design flood level, with a consideration of climate change (page 29).

Vertical offset

There is no vertical threshold over a main river beyond which a permit would not be needed (e.g., 20 metres above the river or bank would require a FRAP). There exists an exemption for power lines which are proposed to cross a main river, with a minimum acceptable height. This can be found here:

Guidance Exempt Flood Risk Activities: Environmental Permits

The developer should provide a freeboard of 600mm above the design flood level with consideration of climate change for sensitive equipment. The design flood is the more extreme event of either the 1 in 200-year tidal event, or the 1 in 100-year fluvial event; therefore the fluvial-tidal interaction may need to be considered.

Offset

The River Weaver is a main river until it approaches the confluence with the Manchester Ship Canal, and has tidal flood defences running alongside it. We would therefore require a 16-metre offset from these defences to ensure that there is appropriate access for maintenance, inspection, future raisings and replacement when required. A FRAP would be required for any works on or within 16-metres of tidal flood defences.

Structures need to be setback from the flood defences to allow for access, inspection, maintenance, replacement, and future raisings.

The FRA states that:

"Maintenance access to the Main Rivers and Ordinary Watercourses on site will be retained. Maintenance access will be secured by providing a minimum 8m buffer either side of the watercourses."

Please clarify how 8m has been derived to be sufficient setback for access, inspection, maintenance, replacement, and future raisings. As mentioned above, a permit will be required for any works within 16m of tidal flood defences.

Surveys

The development site is located in an area which benefits from flood defences. The developer should survey the flood defences within the Order Limits, which will protect the proposed development and consider remediation.

Culverts

We would oppose the culverting of any watercourses and instead prefer the installation of a clear-span bridge crossing. This is in line with the Environment Agency's anti-culverting policy. We will normally only grant a permit for a culvert if there is no reasonably practical alternative, and if the detrimental effects would be sufficiently minor that a more costly alternative would not be justified, or there are reasons of overriding public/economic interest. The developer should consider the effects of proposed crossings on hydrology and geomorphology. The developer will need to model the hydrology of culvert installation and how this relates to flood risk.

Drainage Strategy

The drainage strategy should ensure that surface water flood flow routes are not adversely affected, such as with the placement of inverters and receiving watercourse(s) from formal surface water management for the BESS and substation. It is unclear whether the discharge to pumping stations from the development will increase. The Lead Local Flood Authority or Internal Drainage Board should be consulted on the proposed management of surface water.

We require more information on how surface water from inverters will be managed. The loss of footprint for runoff may require an engineered solution.

We require more information on the proposed watercourse into which the formal drainage for the substation and BESS will discharge into. An increase in discharge to the pumping stations would not be acceptable.

The FRA states that:

"Attenuation will be provided in the sub-grade of the compound's stone surfacing and will be sized to accommodate the 1 in 100 year plus 30% CC event."

We require more information on how this will work.

Modelling

General

The developer should consider the following scenarios:

- pump failure
- breach scenario - residual flood risk can lead to a different flood extent when compared with the undefended scenario
- the interaction between fluvial and tidal flood risks, for example the Lower Weaver (2020 model considered the impact of a 1% (1 in 100) annual

exceedance probability flow with a 0.5% (1 in 200) annual exceedance probability tide. Such scenarios can lead to greater flood depths and wider extents

If the developer utilises an existing model, it is important to check that it:

- represents current risk
- uses the latest available datasets
- complies with current modelling standards
- is at a scale suitable for the assessment being undertaken
- captures the detail required for a site-specific assessment
- makes use of current climate change allowances

We require access to the models for scrutiny to ensure that they are a sufficient evidence base for the FRA.

Please be aware that:

- Environment Agency models are not designed to assess third-party developments. The developer should not assume that the model is suitable for assessing the flood risk associated with the proposed development
- it is the developer's responsibility to assess the suitability of a model for the project
- the developer should provide evidence of any modelling checks and subsequent updates and document these in the FRA model reporting

It is always important to review hydraulic modelling information that is used for site specific FRAs. Recent guidance has been produced (December 2023) which is available online at: [Using modelling for flood risk assessments - GOV.UK (www.gov.uk)](https://www.gov.uk). In the case of the River Weaver, Manchester Ship Canal, Mersey Estuary, and Ince and Frodsham hydraulic models, please see further details which are provided below.

Manchester Ship Canal Hydraulic Model (Ch2m, 2018)

Despite a 30% climate change allowance being applied to the Manchester Ship canal model, given the freeboard available between the 100 year plus 30% climate change water levels and defence crest levels, updating the fluvial climate change uplifts within the model is not likely to change the flood risk to the site from the Manchester Ship Canal. Even for the 100 year plus 70% climate change scenario, there is still reasonable freeboard to top of bank levels as illustrated in **figure 1** within the appendix. We agree with the statement noted on page 19 of the Flood Risk Assessment that Flood Risk from the Manchester Ship Canal is very low.

Lower Weaver

The Lower Weaver Flood Mapping Study Hydraulic Model (JBA, 2020) has been reviewed recently by the Environment Agency (July, 2023), and is considered reasonable for assessing fluvial flood risk to the site from the River Weaver.

Mersey Estuary Hydraulic Model (JBA, 2016)

This model has been reviewed by the Environment Agency in September 2023. The tidal boundary conditions applied in the Mersey Estuary hydraulic model (JBA, 2016) have since been superseded by updated coastal flood boundary conditions (CFB, 2018) and updated climate change allowances for sea level rise.

Tidal flood risk to the proposed development site from the Mersey Estuary could be underestimated. The 200-year tidal level applied to the Mersey Estuary hydraulic model (JBA, 2016) peaks at a level of 6.13 metres above Ordnance Datum (mAOD). In comparison, the latest Coastal Flood Boundary data (CFB, 2018) suggests a 200-year tidal level of 6.42 mAOD at the outlet of the Mersey Estuary (chainage 1168). **Table 1** in the appendix outlines the differences in tidal water levels across a range of scenarios in further detail.

Please re-run the Mersey Estuary hydraulic model (JBA, 2016) with boundary conditions which reflect the latest available coastal boundary conditions and climate change uplifts, so that the impact to the proposed development site can be understood. **Table 1** provides some detail on tidal levels across a range of scenarios. Please also consider running an Upper and H++ scenario for sea level rise to test the resilience of your proposed development. Further guidance is available online at https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#credible-maximum-scenarios

Ince and Frodsham hydraulic model (Halcrow, 2011).

The Ince and Frodsham (2011) model may need to be updated to represent future flood risk (2080's epoch higher central and upper scenarios), particularly if the future flood risk has the potential to exceed the future flood risk from the River Weaver and Mersey Estuary.

Whilst the Ince and Frodsham model is over 10 years old and hydrological methods have been updated since this modelling was undertaken, the do-nothing water level modelling, where the Ince and Frodsham pumping stations are turned off, shows much lower water levels when compared to the tidal design (defended) scenario and River Weaver undefended scenarios.

Yours sincerely

[redacted]
Planning Specialist

Direct e-mail NITeam@environment-agency.gov.uk

Appendix 1

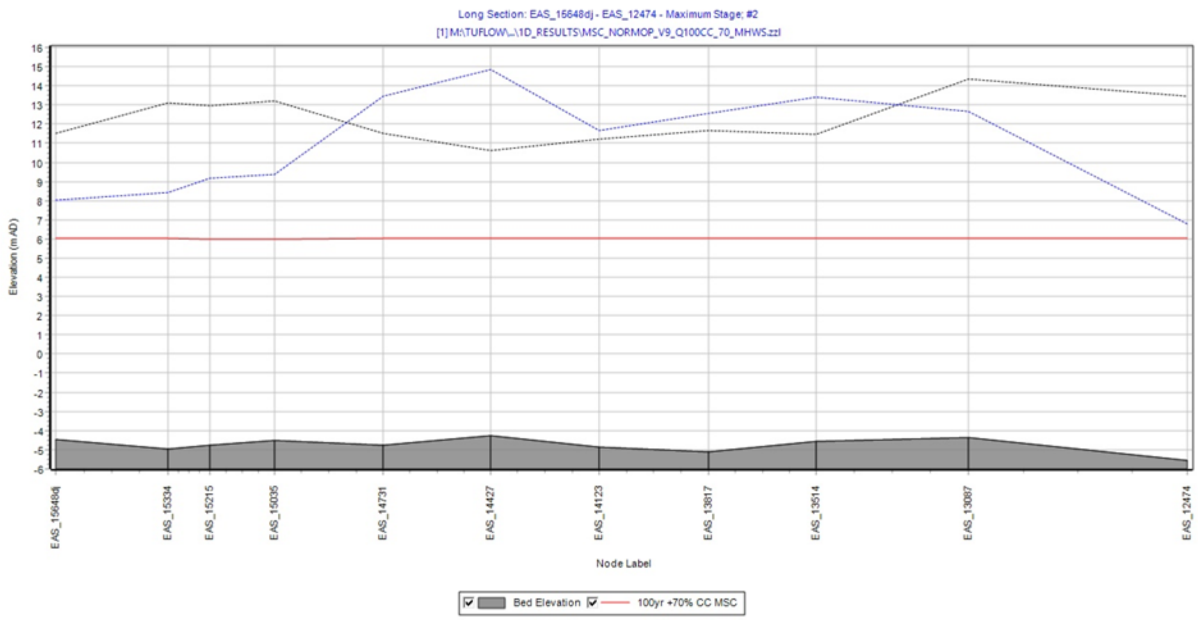
***Table 1**: Tidal downstream boundary conditions for the Mersey Estuary taken from the Mersey Estuary hydraulic model (JBA, 2016) and the Coastal Flood Boundary dataset (2018). Sea level uplifts for different time periods are also shown (table 2) which have been added onto the CFB 200-year water level to determine updated climate change levels.*

Annual Exceedance Probability tide	**Mersey Estuary 2016 model downstream Boundary level (mAOD)**	**Coastal Flood Boundary (CFB, 2018) level at chainage 1168 (mAOD)**
0.5% (1 in 200)	6.13	6.42
0.5% (1 in 200) sea level rise to 2065	6.42	6.72
0.5% (1 in 200) sea level rise to 2070	Not applicable	6.77
0.5% (1 in 200) sea level rise to 2100	Not applicable	7.08
0.5% (1 in 200) sea level rise to 2115	6.83	7.24

***Table 2**: Sea level rise estimates from 2018 based on uplifts presented for the North West river basin available online at:* Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)

Year	**Sea level rise from 2018 higher central climate change (metres)**
2065	0.30
2070	0.35
2100	0.66
2115	0.82

Figure 1*: Manchester Ship Canal 100 year plus 70% climate change water levels between cross sections EAS_15648dj and EAS_12474 which represents the reach adjacent to the proposed Frodsham Marshes solar farm.*



Andrew Russell
AXIS
Unit 11 (Well House Barns)
Bretton
Chester
CH4 0DH

Our ref: XA/2024/100097/02-L01
Your ref: 01FRA

Date: 01 August 2024

Dear Andrew Russell

Re-consultation flood risk assessment draft review (non-statutory)

Frodsham Marshes, Frodsham, Cheshire West and Chester

We have reviewed the documents titled *"14740-EA FRA Letter-01"* (dated 15 July 2024) by Waterco. We respond as follows.

Table 1 page 1 – Tidal Mersey Flood Events

The scenarios presented in table 1 for the Mersey Tidal events are reasonable. For the sea level rise uplifts for future climate change, please see table 1 within the climate change guidance available online at Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk). This provides the sea level uplifts for the Northwest to apply for different epochs.

Figure 1 page 2 - Mersey Breach location

The approach and location with regards breaching of the Mersey Estuary Flood Defences is considered reasonable. Please note, the defences at the suggested breach location are represented in the Mersey Estuary hydraulic model (JBA, 2016) using a Flood Modeller Spill unit, rather than a Tuflow elevation (z) line. The Flood Modeller spill unit will need to be edited to account for the breach. With regards to representing breaches within the hydraulic model, please refer to the attached guidance on undertaking breach assessments (LIT 56413). Table 1 within this document suggests breach widths and closure times for different defence types.

Table 2 page 2 and 3 – Lower Weaver Flood Events

The Lower Weaver scenarios presented in table 2 are reasonable. The climate change scenarios are the 1% (1 in 100) plus 67%, which reflects the higher central allowance for the 2080's epoch for the Weaver and Gowy management catchment. In addition, an upper end scenario is proposed which is the 1% (1 in 100) plus 106%. This is reasonable. A joint probability scenario is also proposed which is welcomed. This combines the 1% (1 in 100) plus 67% higher central scenario with the 0.5% (1 in 200) tidal level plus upper end sea level rise to 2100. Whilst the fluvial and tidal uplifts do not align for the joint probability scenario, this combination is considered precautionary and therefore reasonable.

Figure 2 page 3 - Weaver Breach location

The location of breaches 1 and 2 on the River Weaver are considered reasonable. Embankments along the River Weaver within the Lower Weaver hydraulic model (JBA, 2020) are represented within Tuflow. Incorporating breaches within the Lower Weaver hydraulic model at the proposed locations should be achievable using variable elevation (V_zsh) shapes. Please refer to the guidance on undertaking breach assessments (LIT 56413) for breach widths and closure times for earth embankments.

Page 3 - River Ince and Frodsham modelling

The justification to not update the Ince and Frodsham hydraulic model is considered reasonable. Design water levels for the Mersey Estuary defended scenario are higher than both the defended and pump station failure water levels, from the Ince and Frodsham modelling.

Page 4 - Sensitivity Scenarios

Running a credible maximum scenario is required, so that the resilience of the site to more severe climate change can be understood. There is no requirement to design to accommodate the credible maximum scenario; although testing a credible maximum scenario helps us to understand the resilience of the development, and helps you to understand how the site would be managed if more severe climate change were to occur. Some potential purposes of the sensitivity testing are as follows:

- This allows us to find areas where a small increase in level would cause inundation of a large area – the "cliff edge" effect.
- It may help to inform the placement of infrastructure to ensure resilient design.
- It may help to inform the access routes to ensure safe ingress and egress during a flood event.

The CCA .gov page states that you should check the relevant National Policy Statements to see if it is necessary to assess a credible maximum scenario. Most energy generating development will need to consider a credible maximum scenario, and demonstrate how proposals can be adapted to remain resilient in such a scenario.

Page 4 - Flood risk Activity Permits

We would require site-specific details for works within 16 metres of tidal defences, or 8 metres of fluvial defences, as measured from the most landward extent of the flood assets or within the channel itself. As a starting point, we need a comprehensive list of works within this buffer and the proposed methodology. We can then advise further on the appropriate level of details needed, to help manage flood risks within the context of disapplying FRAPs.

The constraints at each crossing (vehicular or cable) are distinct and the design is likely to depend on site-specific hydraulic modelling, we would therefore require site-specific technical drawings of each crossing proposed and a Crossing Register showing the coordinates and type. Additionally, we will require:

- A pre-works and post-works survey of flood assets adjacent to the proposed crossing locations and a commitment to remediate defects identified.
- The developer should obtain as-built drawings of flood assets to help inform their proposed design and methodology, this may need to be informed by site investigation (e.g., trial pits).
- The developer should assess vibration from proposed works within close proximity to the flood assets.
    - They may need to install real-time monitoring of vibration to ensure that works are within a safe threshold such that there is no detriment to the flood assets.
    - Further to this, the developer should assess whether changes in level such as ground raising, or excavation, could have a detrimental effect on flood assets.
    - The surcharge caused by vehicles and plant would need to be assessed if in close proximity to flood assets.

Ultimately, we require more details about the activities proposed, to form a view of what information we will require to help manage the flood risks.

Our legal department is currently reviewing our wording for the disapplication of FRAPs. If you wish to proceed with disapplying the FRAPs for your project, please be aware that we will need to use this current wording, and therefore we may need to review it in due course.

Page 4 - Flood Storage Compensation

The proposed calculation to assess the displaced volume from the mounting supports for the solar panels and inverters is considered reasonable and is a good starting point.

In line with paragraph 165 of the National Planning Policy Framework, we cannot allow an increase in flood risk on site or elsewhere. Flood storage compensation is required even if the increase in level is relatively small. This should be considered in the context of climate change throughout the lifetime of the development.

Flood storage compensation should:

- Be level for level.
- Be volume for volume.
- Be localised.
- Achieve net gain where possible.
- Not disrupt flood flow routes.

Page 6 - Design of access crossings

We require a crossing register to help us understand the risks at each crossing location. The crossing design should be informed by site-specific hydraulic modelling. This will allow the developer to accurately assess the appropriate bridge soffit level, ensuring that there is appropriate freeboard (i.e., 600mm) above the design flood plus climate change flood level. Without hydraulic modelling it is not clear how the developer has determined *"There is no out of channel flooding from the watercourses at the access road crossing locations."* Please provide evidence in support of this position.

Page 7 - Offsets

In line with the Environment Agency's Condition Assessment Manual, "high ground" is categorised as a type of flood defence. As the defence is categorised as both fluvial and tidal, we would require an offset of 16 metres.

The asset data and an estimate of the crest line is available online at Asset Information and Maintenance Programme (data.gov.uk). We would suggest that for assets categorised as "high ground", that the developer use the crest level data here to help inform the measurement of horizontal offset. Otherwise, the horizontal offset should be measured from the most landward extent of the flood defence.

Page 8 - Surveys

Where crossings of the watercourse are proposed, we will require a pre-works and post-works condition survey of adjacent flood assets, and a commitment to remediate defects identified.

Page 8 - Culverts

The use of open span crossings over culverts is welcomed. Please see the response to the design of access crossings above for further details.

Page 8 - Surface Water Drainage

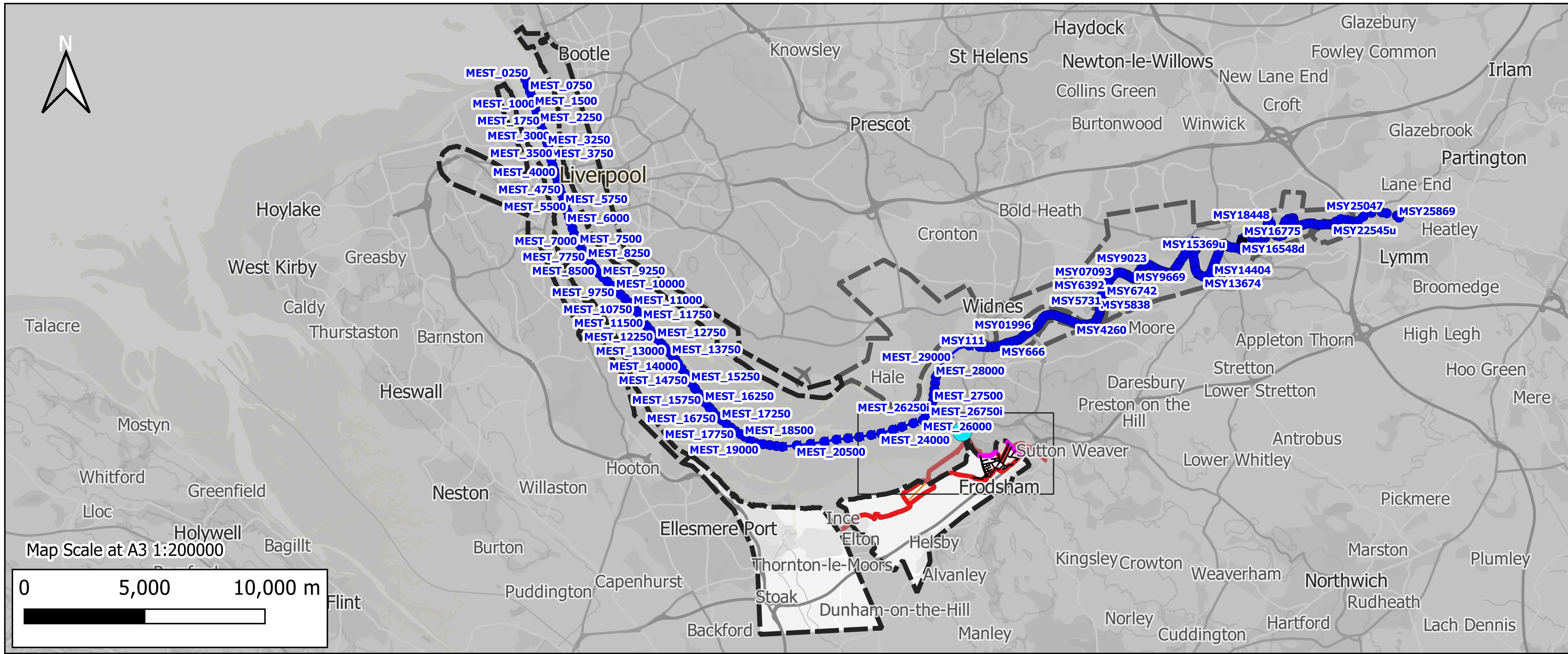
We are concerned about the FFL of the inverters. Sensitive equipment should be 600mm above the design flood plus climate change level. The site must remain operational in a flood event.

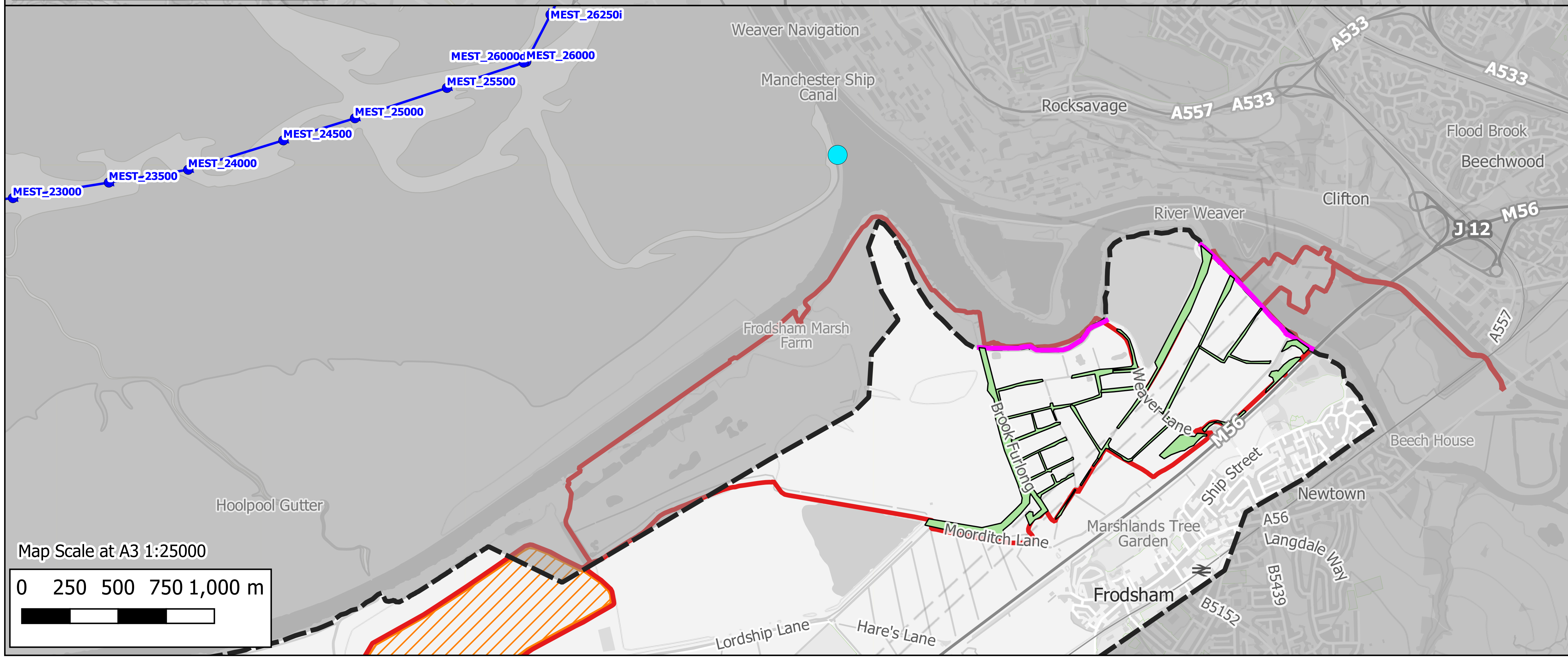
Raising the inverters off the ground level may negate the influence on surface water flood risk by minimising the impermeable area. As this area has pumped drainage surface water flood risk has direct implications on fluvial flood risks. We would encourage the developer to seek the LLFA's "buy-in" on surface water management.

Yours sincerely

[redacted]
Planning Specialist
Direct e-mail NITeam@environment-agency.gov.uk

Appendix F 1D/2D Model Extents





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Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Land Not Within Site Boundary
- 2D Model Extent
- 1D Node
- 1D Network
- Breach Location
- River Weaver Flood Defences
- Existing Hedgerows

CLIENT:

Frodsham Solar Ltd

waterco
www.waterco.co.uk

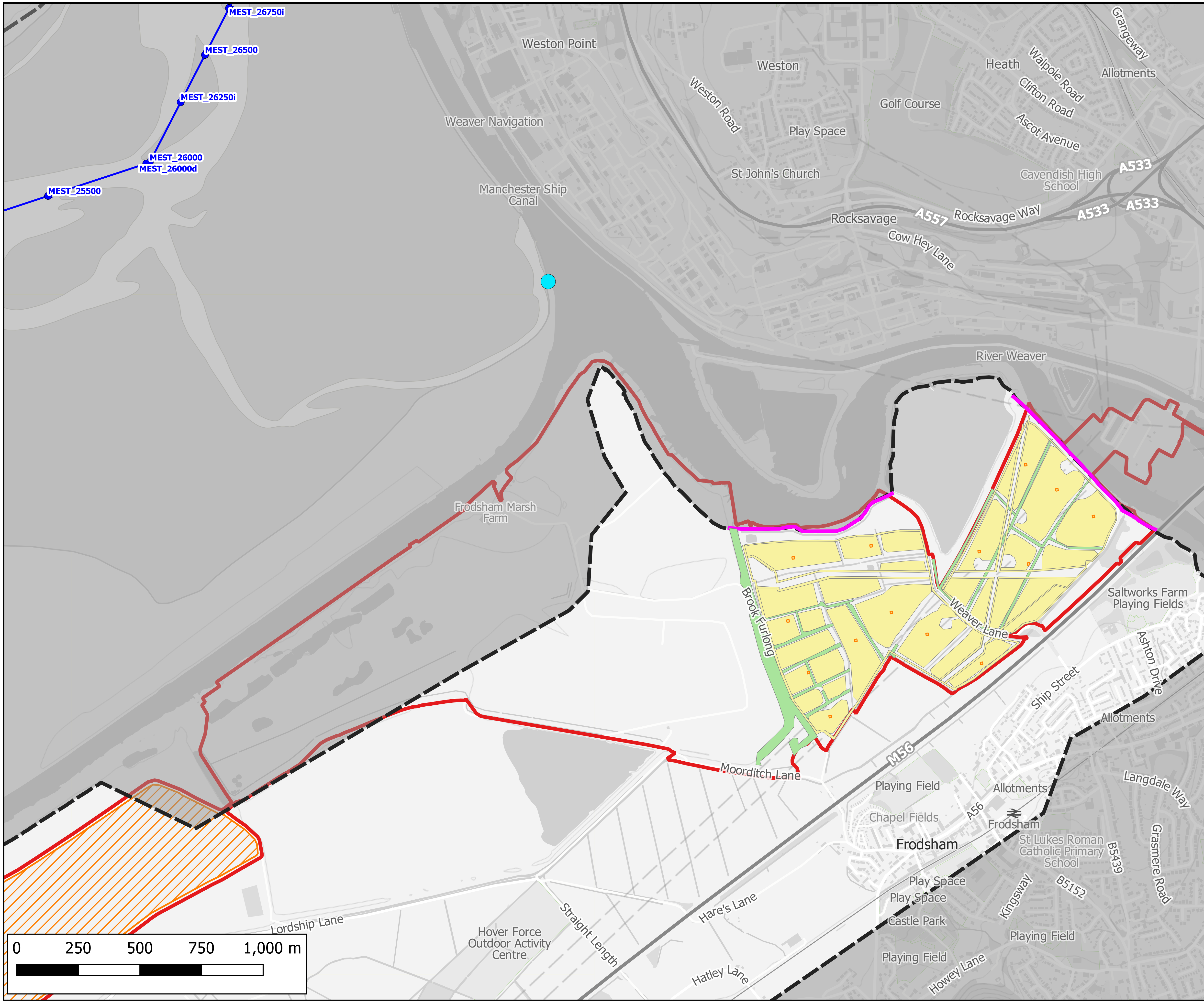
SCHEME:

Frodsham Solar

PLOT TITLE:

Model Extent
River Mersey Model

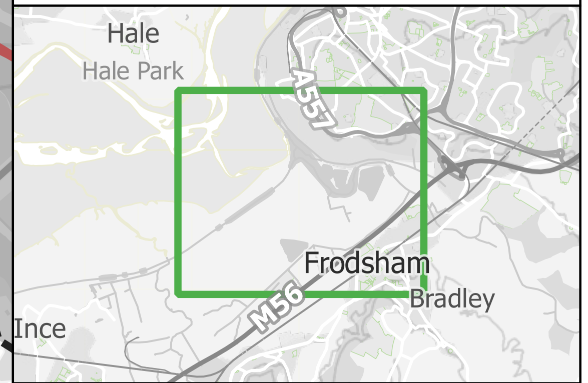
PLOT STATUS:			DATE:
FINAL			05-02-2025
DRAWN: MH	CHECKED: AP	APPROVED: LS	PLOT SCALE AT A3: 1:200000
PLOT NAME: 14740_Model_Extent_Mersey			REVISION: -



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Land Not Within Site Boundary
- 2D Model Extent
- 1D Node
- 1D Network
- Breach Location
- River Weaver Flood Defences
- Proposed Hedgerows
- Proposed Solar Panels and Fences
- Proposed Volume Displacement



CLIENT:

Frodsham Solar Ltd

waterco
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SCHEME:

Frodsham Solar

PLOT TITLE:
Proposed Development
Model Extent
River Mersey Model

PLOT STATUS:			DATE:
FINAL			06-02-2025
DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
MH	AP	LS	1:15000
PLOT NAME:			REVISION:
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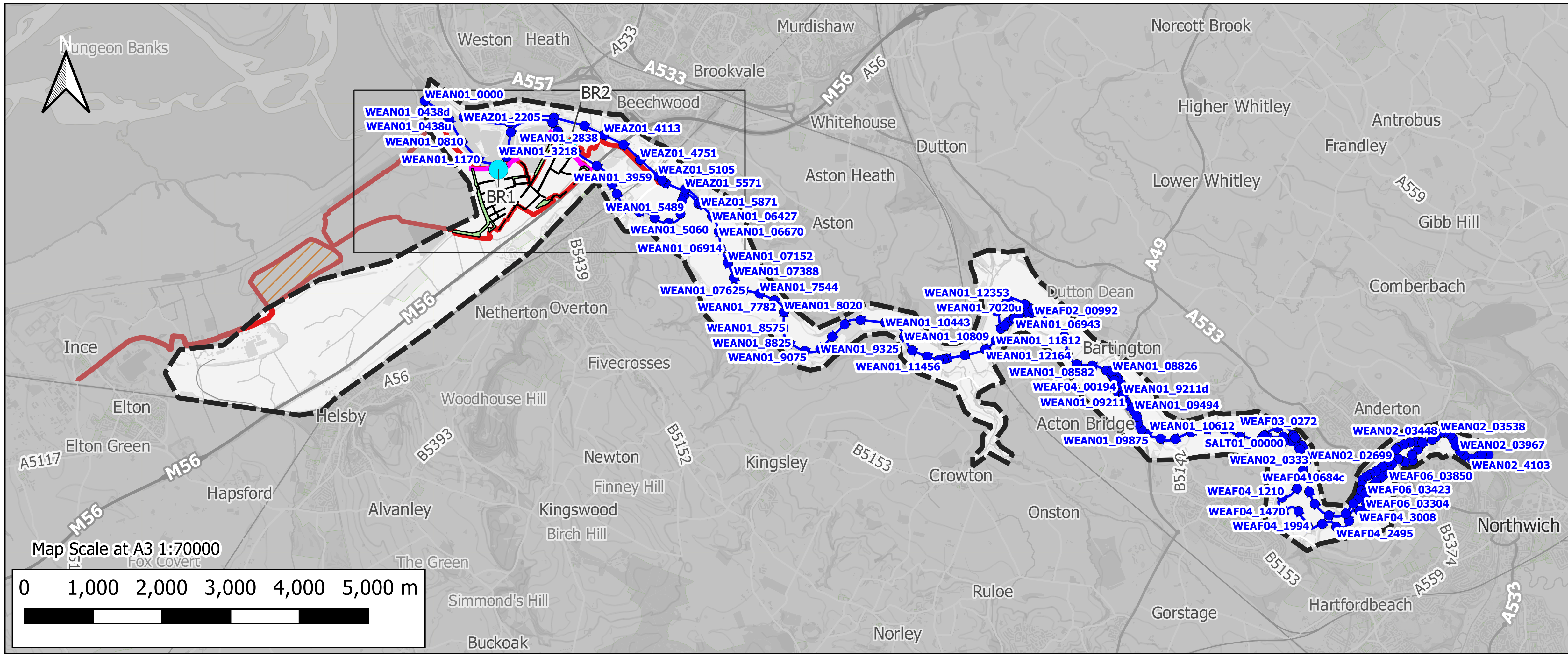

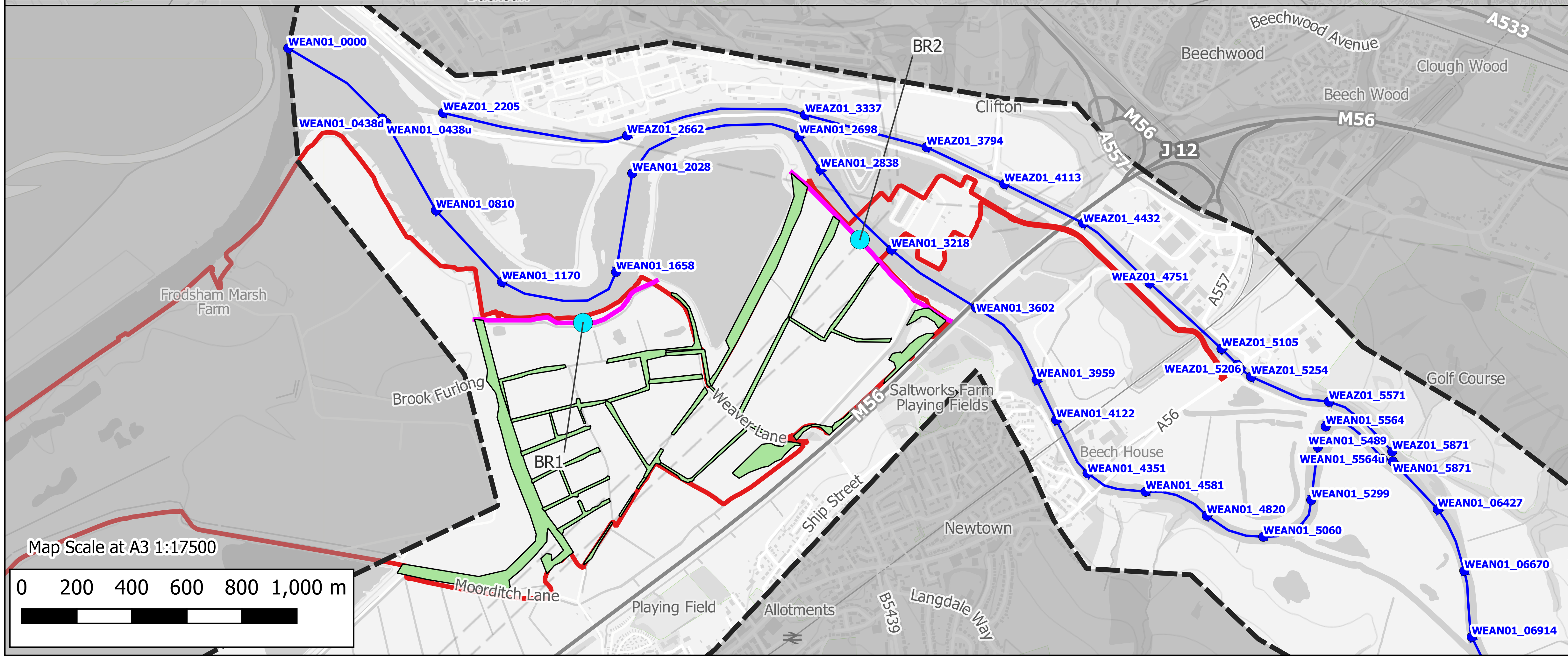

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Land Not Within Site Boundary
- 2D Model Extent
- 1D Node
- 1D Network
- Breach Location
- River Weaver Flood Defences
- Existing Hedgerows

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Frodsham Solar

PLOT TITLE:
Model Extent
River Weaver Model

PLOT STATUS:			DATE:
FINAL			05-02-2025
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PLOT NAME:	REVISION:
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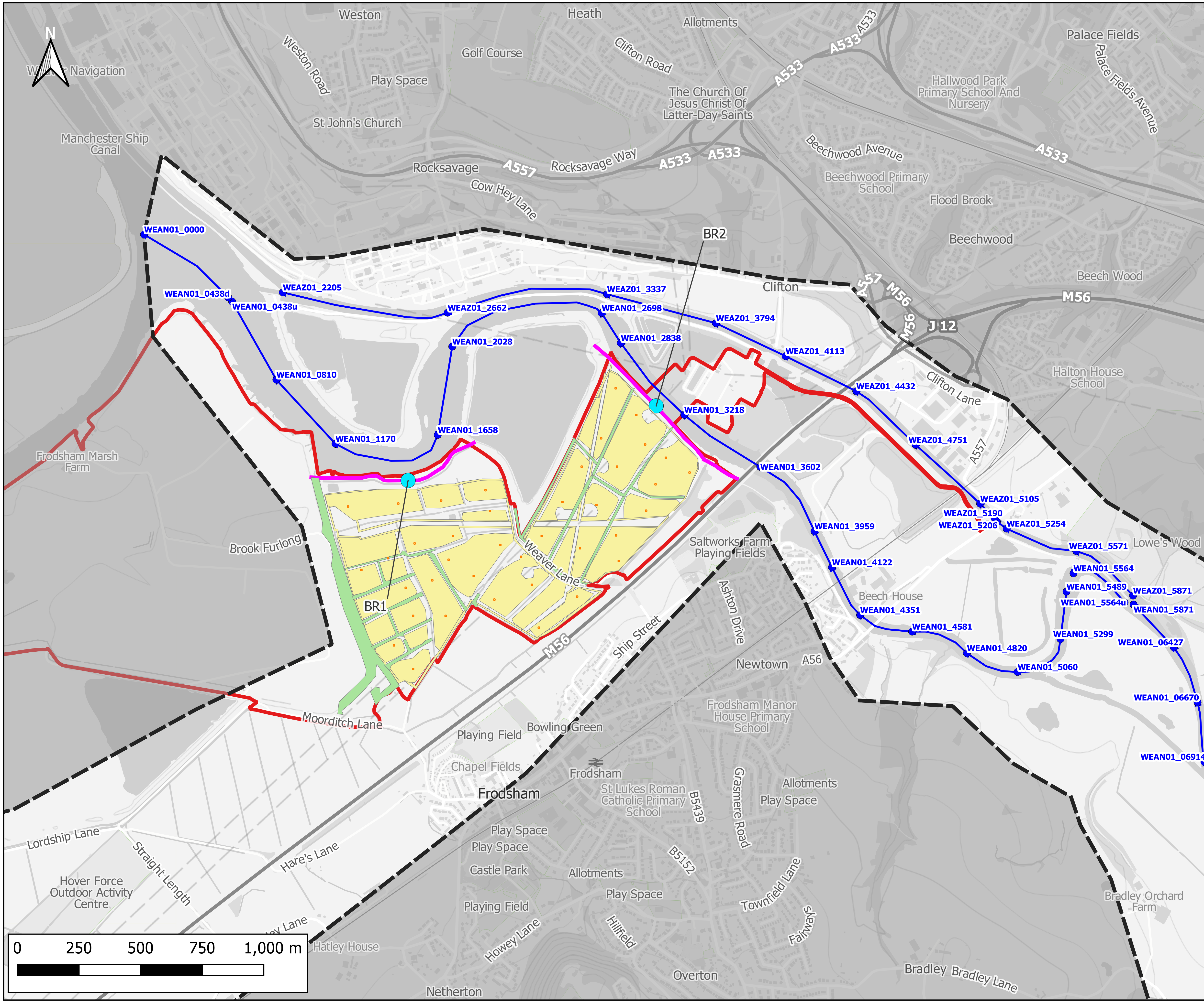

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
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SCHEME: Frodsham Solar

PLOT TITLE: Proposed Development Model Extent River Weaver Model

PLOT STATUS:	DATE:
FINAL	06-02-2025

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
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