Stonestreet Green Solar

# Stonestreet Green Solar

## Environmental Statement
## Volume 4: Appendices
## Chapter 10: Water Environment
## Appendix 10.2: Flood Risk Assessment Part 1 of 3

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# 1 Executive Summary

1.1.1 This Flood Risk Assessment '(FRA') has been prepared by SLR Consulting Limited ('SLR') on behalf of EPL 001 Limited in relation to the Development Consent Order ('DCO') Application for Stonestreet Green Solar (the 'Project'). Land within the Order limits is known as the 'Site'.

1.1.2 Environment Agency ('EA') mapping indicates that the majority of the Site is within Flood Zone 1 (low probability of flood risk). Some Fields within the Site are located in areas designated as Flood Zones 2 and 3 (medium and high probability) associated with fluvial flooding along the East Stour River.

1.1.3 EA surface water flood mapping indicates that the majority of the Site is at very low risk of flooding. This mapping does however also identify areas of High, Medium, Low surface water flood risk in parts of the Site.

1.1.4 A flood risk screening undertaken indicates that the Site is at very low risk of flooding from tidal sources, sewers, reservoirs, canals and other artificial sources and infrastructure failure. The assessment infers that the Site is at low risk of groundwater flooding however this is not brought forward for further analysis given that groundwater flooding on the Site would only occur in conjunction with fluvial or surface water flooding locally (i.e., water levels are controlled by fluvial channels). Any subsurface development (underground cables, foundations) will be flood resilient and not impacted by shallow groundwater.

1.1.5 The flood screening assessment highlighted the potentially high risk of flooding from fluvial and surface water sources at the Site. These were therefore brought forward for further assessment.

1.1.6 SLR have undertaken hydraulic modelling of the East Stour River to better understand the prevailing flood risk to the Site and how this might be impacted by any development. The Project layout has been developed in accordance with the findings of the hydraulic modelling report and Surface Water flood mapping to ensure that no PV Arrays are located in areas with flood depths greater than 0.8m and all other sensitive infrastructure is located out of the floodplain. The Project design therefore ensures that the development will remain safe throughout its lifetime.

1.1.7 The residual risk posed to the construction and demolition of the Project and staff involved in the construction, operation and demolition of the facility will be managed through the preparation and implementation of Emergency Flood Response Plans ('EFRP'). Outline details of EFRPs are provided in the **Outline Construction Environmental Management Plan ('Outline CEMP') (Doc Ref. 7.8)** the **Outline Operational Management Plan ('Outline OMP') (Doc Ref. 7.11)** and the **Outline Demolition Environmental Management Plan ('Outline DEMP') (Doc Ref. 7.14)**.

1.1.8 The Project design has also been developed to ensure that the development does not exacerbate flood risk. This includes avoiding uplift in ground levels within the floodplain and the provision of compensation storage to offset the small loss of flood storage arising from the legs of PV panels located in the floodplain. Modelling confirms that with these measures and considering changes in flood conveyance arising from PV panels, fences and hedges, the impact of the Project on flood levels within and downstream of the Site will be negligible.

1.1.9 The principles of how storm water runoff will be managed within the Site such that flood risk is not exacerbated are set out in the **Outline Operational Surface Water Drainage Strategy (‘Outline OSWDS’) (Doc Ref. 7.14)**.

1.1.10 Whilst the risks of flooding are mitigated as far as reasonably practicable, there are still residual risks associated with fluvial and surface water sources, as well as the potential of failure from large, raised reservoirs (Aldington Flood Storage Area (‘AFSA’)). The likelihood of failure from the AFSA is however very low.

# 2 Introduction

## 2.1 Introduction

2.1.1 This Flood Risk Assessment ('FRA') has been prepared by SLR Consulting Limited ('SLR') on behalf of EPL 001 Limited ('the Applicant') in relation to the Development Consent Order ('DCO') application ('Application') for Stonestreet Green Solar ('the Project'). This FRA has been prepared to consider the risk of flooding to the Project in line with national planning policy and practice. The FRA also considers the impact of the Project on the risk of flooding elsewhere.

2.1.2 This FRA has been prepared under the direction of a Technical Director of Hydrology at SLR who specialises in flood risk and associated planning matters.

2.1.3 Reporting has been completed in accordance with policy/guidance presented within the relevant section of the Overarching National Policy Statement ('NPS') for Energy (EN-1)[1] as well as the National Planning Policy Framework ('NPPF')[2] and its associated Planning Practice Guidance[3] ('PPG'). Due account is also taken of current best practice documents relating to the assessment of flood risk published by the British Standards Institution ('BSI') BS 8533[4] and local planning policies.

## 2.2 The Project

2.2.1 The Project comprises the construction, operation, maintenance, and decommissioning of solar photovoltaic ('PV') arrays and energy storage, together with associated infrastructure and an underground cable connection to the existing National Grid Sellindge Substation.

2.2.2 The Project will include a generating station (incorporating solar arrays) with a total capacity exceeding 50 megawatts ('MW'). The agreed grid connection for the Project will allow the export and import of up to 99.9 MW of electricity to the grid. The Project will connect to the existing National Grid Sellindge Substation via a new 132 kilovolt ('kV') substation constructed as part of the Project and cable connection under the Network Rail and High Speed 1 ('HS1') railway. Further details of the Project are provided in **Section 6** of this FRA.

2.2.3 The location of the Project is shown on **ES Volume 3, Figure 1.1: Site Location Plan (Doc Ref. 5.3)**. The Project will be located within the Order limits (the land shown on the **Works Plans (Doc Ref. 2.3)** within which the Project can be carried out). The Order limits plan is provided as **ES Volume 3, Figure 1.2: Order limits (Doc Ref. 5.3)**. Land within the Order limits is known as the 'Site'. Further details of the Site are provided in **Section 5** of this FRA.

2.2.4 With reference to the *Flood Map for Planning*[5], parts of the Site are shown to have a high probability of fluvial flooding. In addition, the *Check your long term flood risk*[6] mapping indicates the Site is at risk of surface water flooding. Therefore, the DCO Application for the Project is accompanied by an FRA.

## 2.3 Consultation

2.3.1 An initial FRA was undertaken at the Site by Wardell Armstrong titled 'Flood Risk Assessment for PEIR' which was provided as Appendix 9.1 of the PEIR. This report provides a full FRA using hydraulic modelling data prepared by SLR Consulting and addresses the comments in relation to flood risk provided in the Consultation section of **ES Volume 2, Chapter 10: Water Environment (Doc Ref. 5.2)**.

2.3.2 Further meetings and correspondence with the EA, detailed in the Consultation section of **ES Volume 2, Chapter 10: Water Environment (Doc Ref. 5.2),** were used to confirm the scope of the modelling used to inform this FRA.

2.3.3 Draft versions of the hydrology and hydraulic modelling reports (final versions of which are included as **Annex B: East Stour Hydraulic Modelling Report** of this FRA) were shared with the EA for comment in January 2024. In response to the draft modelling reports, the EA confirmed on 23 April 2024 they had undertaken a basic review (i.e. a review of the hydrology and hydraulic model reports, but not the model files) and did not have specific comments on the reports. The EA also stated that the model *'appears to provide a suitable basis for assessing the flood risk'* and that *'from the information so far provided we are unlikely to raise an objection to a formal application on flood risk grounds.'*

2.3.4 Relevant correspondence is included in **Annex E: EA Response to Draft HMR** of this FRA.

## 2.4 Competence

2.4.1 This FRA has been prepared under the direction of a Technical Director of Hydrology at SLR who specialises in flood risk and associated planning matters.

# 3 Planning Policy and Guidance

## 3.1 National Planning Policy

### Overarching National Planning Policy Statement ('NPS') for Energy (EN-1)

3.1.1 The Overarching National Policy Statement ('NPS') for Energy EN-1[1] sets out the Government's planning policy for the development of nationally significant energy infrastructure.

3.1.2 Section 5.8 of NPS EN-1 refers to flood risk, with paragraph 5.8.13 outlining the need for an FRA for all energy projects within Flood Zones 2 and 3.

3.1.3 Paragraphs 5.8.9 to 5.8.11 of NPS EN-1 comment on the application of the Sequential and Exception Tests, stating that the Exception Test can be applied if following application of the Sequential Test, it is not possible to locate a project in an area of lower flood risk. To pass the Exception Test it should be demonstrated that:

- the project would provide wider sustainability benefits to the community that outweigh flood risk; and
- the project will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible will reduce flood risk overall.

3.1.4 The Sequential and Exception Tests for the Project are addressed in Appendix 2 of the **Planning Statement (Doc Ref. 7.6)**.

3.1.5 Paragraph 5.8.14 of NPS EN-1 states that the *'assessment should identify and assess the risks of all forms of flooding to and from the project and demonstrate how these flood risks will be managed, taking climate change into account.'*

3.1.6 Paragraph 5.8.15 lists the minimum requirements of an FRA:

- *'be proportionate to the risk and appropriate to the scale, nature and location of the project;*
- *consider the risk of flooding arising from the project in addition to the risk of flooding to the project;*
- *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;*
- *be undertaken by competent people, as early as possible in the process of preparing the proposal;*

- *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 the vulnerability of those using the site, including arrangements for safe access and escape;*

- *consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and include information on flood likelihood, speed-of-onset, depth, velocity, hazard and duration;*

- *identify and secure opportunities to reduce the causes and impacts of flooding overall, making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management;*

- *consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;*

- *include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that these risks can be safely managed, ensuring people will not be exposed to hazardous flooding;*

- *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:*

  i. *Describe the existing surface water drainage arrangements for the site*

  ii. *Set out (approximately) the existing rates and volumes of surface water run-off generated by the site. Detail the proposals for restricting discharge rates*

  iii. *Set out proposals for managing and discharging surface water from the site using sustainable drainage systems and accounting for the predicted impacts of climate change. If sustainable drainage systems have been rejected, present clear evidence of why their inclusion would be inappropriate*

  iv. *Demonstrate how the hierarchy of drainage options has been followed.*

  v. *Explain and justify why the types of SuDS and method of discharge have been selected and why they are considered appropriate.*

vi. *Explain how sustainable drainage systems have been integrated with other aspects of the development such as open space or green infrastructure, so as to ensure an efficient use of the site*

vii. *Describe the multifunctional benefits the sustainable drainage system will provide*

viii. *Set out which opportunities to reduce the causes and impacts of flooding have been identified and included as part of the proposed sustainable drainage system*

ix. *Explain how run-off from the completed development will be prevented from causing an impact elsewhere*

x. *Explain how the sustainable drainage system has been designed to facilitate maintenance and, where relevant, adoption. Set out plans for ensuring an acceptable standard of operation and maintenance throughout the lifetime of the development*

- *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;*
- *identify and secure opportunities to reduce the causes and impacts of flooding overall during the period of construction; and*
- *be supported by appropriate data and information, including historical information on previous events.'*

3.1.7 Paragraphs 5.8.18 -19 of NPS EN-1 encourage applicants to engage with the EA and other bodies where relevant including the Lead Local Flood Authority, Internal Drainage Boards and sewerage undertakers to identify the likelihood and possible extent and nature of flood risk, scope the FRA and identify the information that will be required. Paragraph 5.8.20 encourages applicants to address concerns and take all reasonable steps to agree ways in which proposals may be amended or additional information provided.

3.1.8 Paragraphs 5.8.21-22 of NPS EN-1 provide commentary on the Sequential Test and technology-specific circumstances where it may not be applicable.

3.1.9 Paragraph 5.8.36 of NPS EN-1 sets out the following criteria for the Secretary of State to be satisfied in their decision making:

- *'the application is supported by an appropriate FRA*
- *the Sequential Test has been applied and satisfied as part of site selection*
- *a sequential approach has been applied at the site level to minimise risk by directing the most vulnerable uses to areas of lowest flood risk*

- *the proposal is in line with any relevant national and local flood risk management strategy*
- *SuDS (as required in the next paragraph on National Standards) have been used unless there is clear evidence that their use would be inappropriate*
- *in flood risk areas the project is designed and constructed to remain safe and operational during its lifetime, without increasing flood risk elsewhere (subject to the exceptions set out in paragraph 5.8.42)*
- *the project includes safe access and escape routes where required, as part of an agreed emergency plan, and that any residual risk can be safely managed over the lifetime of the development*
- *land that is likely to be needed for present or future flood risk management infrastructure has been appropriately safeguarded from development to the extent that development would not prevent or hinder its construction, operation or maintenance.'*

3.1.10 Details of how this flood risk assessment satisfies the requirements of paragraph 5.8.15 of NPS EN-1 is provided in **Annex A:** NPS Compliance of this FRA.

### NPS for Renewable Energy Infrastructure (EN-3)[7]

3.1.11 NPS EN-3 covers 'significant onshore renewable energy infrastructure projects', specifically addressing solar PV generation. Paragraph 2.4.11 requires applicants to consider how solar photovoltaic plant will be resilient to increased risk of flooding.

3.1.12 Paragraph 2.10.84 of NPS EN-3 refers to the need for FRAs for solar projects to consider the impact of drainage within solar developments. Paragraph 2.10.85 provides further detail, requiring permeable tracks for access, and for localised SuDS to control drainage runoff.

3.1.13 Paragraphs 2.10.86 -88 state that given the temporary nature of solar PV farms, sites should be configured or selected to avoid the need to impact on existing drainage systems and watercourses, culverting should be avoided, and where culverting is unavoidable, applicants should demonstrate that no reasonable alternatives exist and where necessary, culverting will only be in place temporarily for the construction period.

3.1.14 NPS for Electricity Networks Infrastructure (EN-5[8]) Paragraph 2.10.154 recognises the value that solar projects can bring through the delivery of drainage and flood attenuation where previous management of the site has involved intensive agricultural practice.

3.1.15 The NPS -5[9] addresses policy for electricity networks infrastructure, including associated infrastructure such as substations. Paragraph 2.3.2 states that as climate change is likely to increase risks to the resilience of some infrastructure, including from flooding, applicants should set out to what extent the proposed development is expected to be vulnerable and how it has been designed to be resilient to:

- flooding, particularly for substations that are vital to the network; and especially in light of changes to groundwater levels resulting from climate change; and
- earth movement or subsidence caused by flooding or drought (for underground cables).

### National Planning Policy Framework

3.1.16 The NPPF[2] provides policy on flood risk and climate change. Section 14 of the NPPF, entitled Meeting the challenge of climate change, flooding and coastal change (paragraphs 157-179), sets out the requirements to assess flood risk and climate change for developments. Paragraph 175 states that *'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate.'* Where development is necessary in high risk areas, the NPPF aims to ensure that the development is safe without increasing flood risk through the application of the Exception Test.

3.1.17 The national Planning Practice Guidance ('PPG')[3] accompanies the NPPF and provides further guidance in relation to flood risk. **Table 3.1** of this FRA defines the levels of Flood Risk in England extracted from the PPG[3].

Table 3.1: Flood Zones

| Flood Zone | Definition |
|---|---|
| Zone 1 - Low Probability | Land having a less than 0.1% annual probability of river or sea flooding. |
| Zone 2 - Medium Probability | Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. |
| Zone 3a - High Probability | Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. |
| Zone 3b - The Functional Floodplain | This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise:<br>▪ land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or<br>▪ land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).<br>Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the EA. |

3.1.18 The PPG states that a site-specific FRA is required for all new development proposals located in Flood Zones 2 and 3, and for any proposal of 1 hectare or greater regardless of its flood zone classification. This is as stated in paragraph 5.8.13 of NPS EN-1. The flood zones as described above are shown on the EA Flood Map for Planning.

3.1.19 Table 2 of the PPG classifies development types based on their vulnerability to flooding (Annex 3: Flood risk vulnerability classification of PPG), ranging from ‘Essential Infrastructure’ which has to be operational in times of flood, through ‘Highly Vulnerable’ (e.g. emergency service stations), ‘More Vulnerable’ (e.g. residential dwellings and establishments), ‘Less Vulnerable’ (e.g. offices/retail), to ‘Water Compatible’ development (e.g. open space, docks, marinas, and wharves).

3.1.20 Based on Table 2 of the PPG, the built components of the Project are classified as 'Essential Infrastructure'. This is defined by Annex 3: Flood risk vulnerability classification of NPPF as: *'Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including infrastructure for electricity supply including generation, storage and distribution systems; including electricity generating power stations, grid and primary substations storage; and water treatment works that need to remain operational in times of flood.'*

3.1.21 Table 2 of the PPG indicates which 'vulnerability classes' are acceptable in each of the Flood Zones, and when the Exception Test should be applied. This is reproduced as **Table 3.2** of this FRA.

Table 3.2: Flood Risk Vulnerability and Flood Zone 'incompatibility'

| Flood Zone (PPG Table 1) | *Flood Risk Vulnerability Classification (PPG Table 2)* | *Essential Infrastructure* | *Highly Vulnerable* | *More Vulnerable* | *Less Vulnerable* | *Water Compatible* |
|---|---|---|---|---|---|---|
| | Zone 1 | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Zone 2 | ✓ | Exception Test Required | ✓ | ✓ | ✓ |
| | Zone 3a | Exception Test Required | × | Exception Test Required | ✓ | ✓ |
| | Zone 3b (functional floodplain) | Exception Test Required | × | × | × | ✓ |

Key: ✓ Development is appropriate
× Development should not be permitted

## Application of Sequential Test and Exception Test

### *Sequential Test*

3.1.22 Paragraph 5.8.36 of the NPS EN-1 advises that the Secretary of State should be satisfied, in determining an application for development consent, that the Sequential Test has been applied and satisfied as part of the site selection.

3.1.23 NPPF Paragraph 168 advises that the aim the Sequential Test is to *'steer new development to areas with the lowest risk of flooding from any source'*.

3.1.24 It is appropriate to refer to the redefined Flood Zones / modelled flood outlines shown on **Figure 10.2.7: Hydraulic Modelling Report Flood Extent Mapping** of this FRA as these have been derived from the best currently available information on flooding.

3.1.25 **Figure 10.2.7: Hydraulic Modelling Report Flood Extent Mapping of this FRA** also shows the Flood Zones superimposed on the Project layout and shows that the majority of PV panels and the Project Substation are located in Flood Zone 1.

3.1.26 A key constraint in locating solar farms is the proximity to a suitable grid connection, which in this case has been secured at the National Grid Sellindge

Substation. Given the location of the Sellindge Substation, there are no reasonably available sites appropriate for the Project in areas with a lower risk of flooding. It is also noted that it is only part of the Project located in Flood Zones 2, 3a and 3b and that the layout of infrastructure has been developed and adapted to preferentially site sensitive infrastructure in Flood Zone 1.

3.1.27 A Sequential and Exception Test Report has been undertaken for the DCO Application and is provided as Appendix 2 of the **Planning Statement (Doc Ref. 7.6)**. The Sequential and Exception Test Report provides an assessment of the area within 5km of the Point Of Connection to the Sellindge Substation. AA 5km Buffer from the Grid Connection Point is shown on **ES Volume 3, Figure 5.1: Potentially Developable Land Locations and Cumulative Schemes (Doc Ref. 5.3)**. Appendix 2 of the **Planning Statement (Doc Ref. 7.6)** demonstrates that there are no more suitable or available alternative sites within this study area that would meet the Project requirements.

3.1.28 On this basis, it is concluded that Sequential Test has been passed for this Project.

*Exception Test*

3.1.29 As set out at Paragraph 169 of the NPPF[2]:

*'If it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied.'*

3.1.30 The exception test is then defined at Paragraph 170 of the NPPF (and also Paragraph 031 of the PPG[3]):

*'-To pass the exception test it should be demonstrated that:*

*a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and*

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

3.1.31 Paragraph 171 of NPPF states *'Both elements of the exception test should be satisfied for development to be allocated or permitted.'*

3.1.32 With reference to Part a) of the exception test, the Project will provide a source of renewable energy to the National Grid which will be distributed via the network providing sustainability benefits to the local community and beyond.

3.1.33 It is therefore considered that the Project passes Part a) of the Exception Test.

3.1.34 With reference to Part b), **Section 9** of this FRA provides details of the measures that will be employed to ensure that the development will be safe for its lifetime taking account of the vulnerability of its users. **Section 10** of this FRA considers the potential impact of the Project on the flood risk elsewhere and describes the measures to be included in the Project to reduce the flood risk overall.

3.1.35 It is therefore considered that the Project passes Part b) of the exception test.

National Planning Practice Guidance

3.1.36 This report has been completed in accordance with the guidance presented in the NPPF and with reference to PPG, taking due account of current best practice documents relating to the assessment of flood risk published by the British Standards Institution BS8533[4] and local planning policies.

## 3.2 Local Planning Policy

3.2.1 The Site is within the administrative area of the Ashford Borough Council ('ABC') Local Plan[10] which was adopted in February 2019 ('Adopted ABC Local Plan'). The Adopted ABC Local Plan aims to provide a policy and delivery framework which will guide matters relating to planning and land use in line with the Council's aims from 2011 to 2030. Relevant policy in relation to flood risk is stated below:

*'Policy ENV6 – Flood Risk*

*Proposals for new development should contribute to an overall flood risk reduction.*

*Development will only be permitted where it would not be at an unacceptable risk of flooding on the site itself, and there would be no increase to flood risk elsewhere.*

*The sequential test and exception tests established by the National Planning Policy Framework will be strictly adhered to across the Borough, with new development preferably being located in Flood Zone 1. Where it is demonstrated development is unable to take place in an area of lower flood risk, essential transport or utility infrastructure, or other development may be allowed as per an exception test if the development is designed to be compatible with potential flood conditions, and:*

*Suitable flood protection and mitigation measures are incorporated into the development appropriate to the nature and scale of risk;*

*Comprehensive management and maintenance plans are in place for its effective operation during the lifetime of the development (taking account of climate change allowances);*

*Adoption arrangements are secured (where applicable) with the relevant public authority or statutory undertaker;*

*The development would make a significant contribution to the overall sustainable development objectives of the Local Plan, such that the wider sustainability benefits of the development outweigh the flood risk; and,*

*It can be demonstrated to the satisfaction of the Council and the Environment Agency that adequate resistance and resilience measures have been put in place to avoid any increase in flooding either on site or elsewhere.*

*A site-specific Flood Risk Assessment (FRA), endorsed by the Environment Agency, appropriate to the scale and nature of the development and the risks involved will be required in line with Planning Practice Guidance and in particular where the Strategic Flood Risk Assessment or Surface Water Management Plan, indicates there are records of historic flooding or other sources of flooding.*

*In all cases, development that would harm the effectiveness of existing flood defences or prejudice their maintenance or management will not be permitted.'*

3.2.2 The following sections of this FRA demonstrate how the Project meets the requirements of Policy ENV6. Other local guidance and policy exists relating to the management of storm water. This local guidance and planning policy is considered in the **Outline Operational Surface Water Drainage Strategy ('Outline OSWDS') (Doc Ref. 7.14)**.

# 4 Methodology

## 4.1 Baseline

4.1.1 **Section 5** of this FRA sets out the baseline context of the Site as relevant to flood risk, describing key aspects of the topography, geology and hydrology as necessary to understand flood risk on and around the Site.

4.1.2 The following tasks were undertaken to ensure that the baseline data provides sufficient information to assess the risk of flooding arising from the Project in addition to the risk of flooding to the Project, taking into account the impacts of climate change;

- Review of Ordnance Survey ('OS')[11] maps to identify surface water features and springs within and adjacent to the Site;
- Review of EA and publicly available LiDAR Survey Data[12] published by Defra to assess the Site's topographic setting;
- Collation of information on climate (including long term average monthly rainfall figures) (Environment Agency)[13], surface hydrology (National River Flow Archive)[14] and EA flood risk mapping[6]; and
- Identification of hydrogeological conditions and groundwater resources (including groundwater vulnerability and productivity) (British Geological Survey[15], Magic Map[16]) together with secondary information relating to:
- bedrock and superficial geology mapping; and
- soil mapping.

4.1.3 A site walkover was undertaken on 24 and 25 July 2023 along the East River Stour corridor. This walkover included visual inspection of the Site to validate the understanding of the hydrological conditions at the Site obtained from a desk-based study, and to establish an understanding of the AFSA and flood defence infrastructure located adjacent to the north-eastern part of the Site. A record of this survey is provided in **Annex A** of **ES Volume 4, Appendix 10.3: Water Framework Directive Assessment (Doc Ref. 5.4)**.

4.1.4 Further site visits to survey the location of existing and proposed watercourse crossings were undertaken on 11 and 23 January 2024, and 7 February 2024. Photographs and findings from those visits are provided in **ES Volume 4, Appendix 10.5: Schedule of Watercourse Crossings (Doc Ref. 5.4).**

## 4.2 Assessment

4.2.1 **Section 8** of this FRA presents a screening assessment of flood risks which are relevant to the Project. This seeks to determine which types of flood risk sources are important at the Site and warrant further detailed assessment.

4.2.2 **Section 9** of this FRA provides a more detailed review of the flood sources that were screened into the assessment. The approach for managing and mitigating these risk in the context of the project is discussed in **Section 10** of this FRA with the corresponding approach for managing and mitigating flood impacts arising from the Project addressed in **Section 11** of this FRA.

4.2.3 The FRA is informed by a Hydraulic Modelling Report ('HMR') which is presented as **Annex B: East Stour Hydraulic Modelling Report (Doc Ref. 5.4)** of this FRA. **Annex B** sets out the approach to the construction of the hydraulic model that has been used to quantify flood risk.

4.2.4 Residual risk of flooding arising from the Project in addition to the risk of flooding to the Project, taking into account the impacts of climate change are considered in **Section 12** of this FRA.

# 5 Baseline Site Appraisal

## 5.1 Site Location and Extent

5.1.1 As shown in **Figure 10.2.1: Site Location Plan,** the Site is located approximately 6.5km to the south east of Ashford Town Centre and approximately 13.7km to the west of Folkestone Town Centre, in the county of Kent. The Site is situated on land located to the north and west of the village of Aldington, centred at Ordnance Survey ('OS') National Grid Reference ('NGR') TR 05898 37766.

5.1.2 The land encompassed by the Order limits shown by **ES Volume 3, Figure 1.2: Site Location (Doc Ref. 5.3)** extends to approximately 192 hectares ('ha').

5.1.3 The Site is bound to the north by the High Speed 1 ('HS1') / Network Rail railways and to the east, west and south by arable fields.

5.1.4 The Site is described using numbered field parcels and the following terms, as shown on **ES Volume 3, Figure 2.1: Field Boundaries and Site Area Plan (Doc Ref. 5.3)**:

- South Western Area (Fields 1 to 9);
- Central Area (Fields 10 to 19 and 23 to 25);
- South Eastern Area (Fields 20 to 22);
- Northern Area (Fields 26 to 29);
- Project Substation (location of the Project Substation, in the north western section of Field 26);
- 'Cable Route Corridor' (export of electricity from the Project at 132 kilovolt ('kV') via underground cables (the 'Grid Connection Cable') to the Sellindge Substation) and 'Cable Route Crossing' (use of an existing cable duct under the High Speed 1 / Channel Tunnel Rail Link ('HS1') railway or through Horizontal Directional Drilling ('HDD') beneath HS1 for the Grid Connection Cable); and
- Sellindge Substation (location of the existing Sellindge Substation).

5.1.5 The East Stour River and the Aldington Flood Storage Area ('AFSA') are located partly within the Site. These features are discussed further in **Section 5.4** of this FRA.

## 5.2 Topography

5.2.1 A topographic survey was completed at the Site by Sensat on the 28 January 2022 and is provided as **Annex C: Topographic Survey** of this FRA. Site walkovers undertaken in 2023 and 2024 confirm that no earthworks or significant changes in landform have occurred since the survey was undertaken.

5.2.2 This topographic survey data has been supplemented by aerial photo grammatic ('LiDAR') data downloaded from the data.gov.uk website[17].The elevation data presented is from a Digital Terrain Model ('DTM') which is a bare earth model and thus excludes features such as built development and vegetation. Ground levels in the vicinity of the Site derived from the DTM are shown on **Annex C: Topographic Survey** and **Figure 10.2.3: Site Topography** of this FRA.

5.2.3 Ground levels are dominated by the local hydrology, particularly the East Stour River which flows in a westerly direction through the Site. The highest ground levels are in the south and west of the Site along the line of a topographic ridge.

5.2.4 Topographically, the Site is lowest at approximately 44m above Ordnance Datum ('AOD') within Field 19 in the north east and is highest on Goldwell Lane Site entrance at 76m AOD.

5.2.5 The water level in the East Stour River adjacent to Field 9 was recorded during the topographic survey (**Annex C: Topographic Survey** of this FRA) as 43.4mAOD.

## 5.3 Land Use

5.3.1 The Site is located in a largely rural area immediately to the north of the village of Aldington and south of the M20. The majority of the existing land within the Site is used for agriculture and arable farming.

5.3.2 Arial imagery of the site is provided in **Figure 10.2.2: Satellite Imagery**. This shows that the majority of the Site comprises natural landscape, avoiding existing developments and buildings. The only parts of the Site which comprise impermeable areas include sections of public highway, access tracks and part of Sellindge Substation.

## 5.4 Hydrology

5.4.1 Watercourses are designated as main rivers or ordinary watercourses. Main rivers are identified on the statutory main river map and are maintained by the Environment Agency ('EA'). Ordinary watercourses are regulated by the LLFA or River Stour (Kent) Internal Drainage Board ('IDB') depending on their location. There is one main river and a number of ordinary watercourses within the Site and study area for the FRA. These are shown in **Figure 10.2.4: Local Hydrology** of this FRA.

5.4.2 Key watercourses of relevance to the FRA are described below, but in addition to these, there are a number of minor drains and channels along field boundaries. The majority of these minor channels fall within areas overseen by the River Stour IDB but are considered as 'riparian drains'. This means that they are not actively managed and the responsibility for maintaining their function rests with the riparian land owners.

### East Stour River

5.4.3 The East Stour River is an EA Main River[18] which flows from east to west through the Site to join the Great Stour approximately 5.7km north west of the Site in Ashford. Upstream of the Site, the East Stour River drains a catchment area[19] of approximately 33.68km$^2$.

5.4.4 The East Stour River drains predominantly arable land (53%)[20] and grassland (34%) with only a small urban extent (<5%). The channel is formed by springs from high permeability Chalk bedrock and flows downstream across varying outcrops of permeable Chalk, followed by an outcrop of less permeable Mudstone confining the permeable Chalk outcrops to the north and permeable Sandstone outcrops to the south. Downstream of the Sandstone outcrop, the channel flows across an outcrop of less permeable Mudstone to the immediate north of the Site. The East Stour River on its approach to the Site, is joined by a number of unnamed tributaries.

### Unnamed Tributary 1 (Pleasuance Dyke)

5.4.5 Unnamed Tributary 1 rises in Brabourne, 3.7km north of the Site. The channel flows in a south westerly direction towards the Site to discharge into the East Stour River via a culvert beneath the HS1 / Network Rail railway, to the west of Sellindge Substation. Upstream of the confluence, the channel drains a catchment area[19] of approximately 8.18km$^2$ of predominantly arable land and grassland with some rural settlements including Brabourne and Brabourne Lees.

5.4.6 This watercourse is actively managed and maintained by the IDB and their reference for the channel is IDB_NO 015.

### Unnamed Tributary 2 (Horton Priory Dyke)

5.4.7 Unnamed Tributary 2 flows in a south westerly direction towards the Site and discharges into the East Stour River via a culvert beneath HS1 / Network Rail mainline railway immediately south east of Sellindge Substation. Upstream of the confluence, Unnamed Tributary 2 drains a catchment area[19] of approximately 13.1km$^2$ of predominantly grassland and arable land with some smallholdings present throughout.

5.4.8 This watercourse is actively managed and maintained by the IDB and their reference for the channel is IDB_NO 017.

### Unnamed Tributary 3 (Aldington Dyke)

5.4.9 Unnamed Tributary 3 rises from a small woodland area (Burch's Rough) approximately 2km south east of the Site and flows in a north westerly direction through the AFSA towards the East Stour River, joining at a confluence approximately 200m downstream of the Evegate Mill impoundment. The Evegate Mill House impoundment is a small body of water sourced via an offtake from the East Stour River. This was likely used historically to support the local agricultural smallholding (Evegate Mill House).

5.4.10 Unnamed Tributary 3 drains a total catchment area[19] of approximately 4.94km$^2$ which is predominantly undeveloped arable land, woodland areas and some small farm holdings.

5.4.11 This watercourse is actively managed and maintained by the IDB and their reference for the channel is IDB_NO 014.

### AFSA

5.4.12 The AFSA is formed by an embankment raised to a crest level of 51.3mAOD with the overflow spillway crest level of 50.2mAOD. The AFSA embankment is designed to impound the East Stour River in times of flood to reduce the risk of flooding downstream to Ashford. The embankment is shown on **Figure 10.2.4: Local Hydrology** of this FRA and runs broadly north south along the eastern side of Fields 23, 24 and 25.

5.4.13 Upstream of the embankment (i.e. to the east), the AFSA provides approximately 1,280,000 m$^3$ of storage below the spillway crest level of 50.2mAOD covering an area of approximately 0.74 km$^2$. The AFSA was originally designed to reduce the flood flows in the East Stour River from a peak of 19m$^3$s$^{-1}$ for what was considered the 1% Annual Exceedance Probability ('AEP')[i] event at the time, to just in excess of 4 m$^3$s$^{-1}$ by means of a vortex flow control device (Hydrobrake), installed on Unnamed Tributary 3 to the south of the East Stour as it passes beneath the embankment.

5.4.14 The East Stour flows through the AFSA embankment via a fish pass with a 300mm diameter orifice restricting flows to the maximum design discharge rate of 0.34 m$^3$s$^{-1}$. Immediately upstream of the embankment flows from the East Stour are diverted into Unnamed Tributary 3 via a side weir when flows along the East Stour River exceed 0.12m$^3$s$^{-1}$.

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i Annual Exceedance Probability. The probability that an event of a given magnitude will occur in any one year. Often referred to as the return period expressed in years.

## 5.5 Geology and Hydrogeology

### Geology

5.5.1 The National Soils Resources Institute, Soilscapes website[21], indicates that soils across the Site comprise of '*Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils'; 'Loamy and clayey floodplain soils with naturally high groundwater*' and '*Freely draining slightly acid but base-rich soils'.*

5.5.2 British Geology Survey ('BGS') mapping[22] indicates that the area is predominantly underlain by the Weald Clay Formation (Mudstone). Outcrops of the Hythe Formation (Sandstone and Limestone) are present in the west, east and south of the Site bound by the Atherfield Clay Formation. Superficial deposits of Alluvium are identified along the course of the East Stour River underlying the loamy and clayey floodplain soils.

5.5.3 The bedrock and superficial geology are shown on Figure 10.2.5: Bedrock Geology and Figure 10.2.6: Superficial Geology of this FRA.

### Hydrogeology

5.5.4 The Hythe Formation is classified as a 'Principal' [23] aquifer system, these are defined by the EA as *'layers of rock or drift deposits that have high intergranular and/or fracture permeability, which usually provide a high level of water storage and therefore may support water supply and/or river base flow on a strategic scale'.*

5.5.5 The remaining bedrock types local to the Site are classified as 'unproductive aquifers' which are rocks which have negligible significance for water supply.

5.5.6 The superficial Alluvium deposits are designated as a 'Secondary A' aquifer, defined by the EA as '*permeable layers capable of supporting water supplies at a local rather than regional scale, and in some cases form an important source of baseflow to rivers'.*

5.5.7 The Site is not located in a Source Protection Zone associated with groundwater abstractions and none are present within 250m of the Site.

# 6 The Project

## 6.1 Description of the Project

6.1.1 The Project comprises the construction, operation and decommissioning of solar PV arrays and energy storage, together with associated infrastructure and an underground cable connection to the existing National Grid Sellindge Substation.

6.1.2 The Project will include a generating station (incorporating solar arrays) with a total capacity exceeding 50 MW. The agreed grid connection for the Project will allow the export and import of up to 99.9 MW of electricity to the grid. The Project will connect to the existing National Grid Sellindge Substation via a new 132 kV substation constructed as part of the Project and cable connection under the Network Rail and HS1 railway.

6.1.3 The Site boundary includes all land required for the construction, operation and maintenance, and decommissioning of the Project.

6.1.4 It is anticipated that the Project will be operational for a 40-year period, and this has been assessed in the EIA and reported in the ES. Construction of the Project is expected to commence in 2026 and be completed over a period of 12 months. Once the Project ceases to operate it would be decommissioned over a period of 12 months with the removal of all physical infrastructure constructed as part of the Project (with the exception of elements of Work No. 4 that are within the Sellindge Substation, any repairs, upgrades or replacements of/to the existing bridge / drain crossings, PRoW footbridges and highway improvements)).

6.1.5 The Project is divided into works packages that are defined by Schedule 1 of the **Draft Development Consent Order (Doc Ref. 3.1)** which defines the precise and complete wording. A summary of the work packages is set out below.

- Work No. 1: ground mounted solar photovoltaic generating station;
- Work No. 2: balance of system and battery energy storage system (‘BESS’);
- Work No. 3: project substation and associated works;
- Work No. 4: works to lay high voltage electrical cables and extend Sellindge Substation to facilitate grid connection;
- Work No. 5: associated works;
- Work No. 6: site access;

- Work No. 7: construction and decommissioning works;
- Work No. 8: works to create, enhance and maintain green infrastructure, boundary treatments and crossing structures; and
- Site Wide Works: further associated development in connection with the Project.

6.1.6 The extent of the proposed works is shown on the **Works Plans (Doc Ref. 2.3)**. A description of the design principles which will apply to the detailed design is provided in the **Design Principles (Doc Ref. 7.5)**. Reference should be made to **ES Volume 2, Chapter 3: Project Description (Doc Ref. 5.2)** for a full description of the Project, including construction, operation and decommissioning.

6.1.7 A summary of the key components of the Project is provided below.

- **Solar PV modules and mounting structures** - The PV panels will have a maximum height of 3.5m Above Ground Level ('AGL') and will be mounted with a minimum clearance of 0.8m AGL. The PV panels will be installed using a fixed tilt arrangement. The angle of elevation will be between 20-25 degrees and will be south facing. The maximum depth of piled foundations for mounting structures will be 3m Below Ground Level ('BGL'). A non-invasive mounting solution that uses pre-cast reinforced concrete blocks or similar to provide ballast to support the PV panels would be used where piled foundations are not appropriate. The distance between each row of PV panels will be between 2m and 5m. A distance of at least 3.2m will be provided between the edge of PV panels and the security fencing to allow for maintenance. There will therefore be a distance of at least 6.4m between PV panels and hedgerows and ditches.
- **Balance of System and BESS:** Inverter Stations are located across the Site and will contain electrical infrastructure including inverters, transformers and switchgear which, together, allow the electricity generated by the PV panels to be inverted and then exported to an Intermediate Substation. Up to 32 Inverter Stations will be required across the Site. Inverter Stations will be surrounded by acoustic barriers. The Project includes an energy storage system and BESS Units will be co-located with the Inverter Stations within bunded enclosures lined with a protective membrane. BESS Units will be distributed across the Site with up to four units at an Inverter Station. No BESS Units DC-DC Converters will be included within Field 9 or Fields 20 to 22. Foundations will have a depth of no greater than 2m BGL. Intermediate Substations are proposed in Fields 3, 15, 20 and 26.
- **Project Substation:** The Project Substation would be sited on a development platform which will be no greater than 56 mAOD and no lower than 55mAOD. The development platform will contain retaining structures. The total impermeable area within the Project Substation will not exceed 0.8ha. The Project Substation will be enclosed by palisade

fencing and acoustic barriers will be provided along the northern and eastern boundaries.

- **Grid Connection Cable:** The Project grid connection will be via a 132kV cable which will be installed underground approximately 2km underground from the Project Substation to Sellindge Substation. The Grid Connection Cable will be sited within the Cable Route Corridor as shown on the **Works Plans (Doc Ref. 2.3)**. The Grid Connection Cable will connect the Project Substation to an area adjacent to the eastern part of Sellindge Substation. The Cable Route Crossing to Sellindge Substation will be achieved either through existing cable ducts beneath HS1 / mainline railway and the East Stour River or new cable ducts will be installed using HDD methods. HDD will be used to install the Grid Connection Cable beneath the East Stour River at a minimum depth of 2m from the bed of the channel. Temporary vehicle bridge crossings will also be required.

- **Sellindge Substation Extension:** Limited extension works will be required at Sellindge Substation to allow the Project to connect. UKPN are expected to be responsible for these works. The Sellindge Substation Extension will use a maximum land area of no more than 0.05ha, with a maximum height of any building or infrastructure being no greater than the existing Sellindge Substation infrastructure. The Sellindge Substation Extension will be constructed at the same level as the existing Sellindge Substation. In line with the **Outline OSWDS (Doc Ref. 7.14)** drainage works will be tied into existing drainage systems within the Sellindge Substation.

- **Security Fencing/Boundary Treatments:** The PV panels will be set within security fencing comprising deer-proof fencing (wooden posts, metal fencing) with a maximum height of 2.5m AGL. The distance between the security fencing and hedgerows outside of the security fence would be at least 3.2m. Security fence gates will be provided for maintenance, habitat management, passage of mammals, security purposes and fire response access. Security fencing within Fields 19, 23 and 24 will have a minimum clearance space of 0.2m between the bottom of the security fence and the ground, and with minimum mesh spacing of 0.1m to prevent build-up of debris in a flood event.

- **Electrical Cabling:** Cabling will be installed below ground between PV Modules and the Inverter Stations and Intermediate Substations.

- **Water Tanks**: Water tanks for the storage of fire suppression water are proposed with a maximum diameter of 12m and a maximum height of 3.5m AGL. The **Illustrative Project Drawings - Not for Approval: Illustrative Project Layout (Doc Ref. 2.6)** shows five water tanks across the Site.

- **Internal Haulage Road:** An internal off-road haulage road is proposed between the Primary Construction Compounds and the remainder of the Site (excluding the South Eastern Area) to minimise the use of the local road network during construction and decommissioning. The internal haulage road will be located within 8m of the toe of the AFSA for a short section (approximately 40m) between Fields 24 and 25. No excavation is proposed and the internal haulage road will comprise a permeable surface, such as ground protection mats.

- **Green Infrastructure and Boundary Treatments:** This includes landscape and biodiversity enhancements, local depressions / scrapes to increase flood storage and enhance ecology and mitigation planting.
- **Watercourse Crossings:** Temporary vehicle bridge crossings of watercourses will be required to facilitate construction and decommissioning. New PRoW footbridges will be installed to accommodate diverted PRoW. All bridges will be free span crossings with abutments set at least 1m back from the channel bank and soffit levels set 0.6m higher than the channel bank level. Approaches to the crossing will be at grade.
- **Primary Site Access:** The Primary Site Access to the Project from the public highway will be located via access off Station Road and is shown as Work No. 6 on the **Works Plans (Doc Ref 2.3)**. This access is already surfaced with tarmac to an existing gate.
- **Internal Access Tracks:** A series of internal access tracks are included to provide two-way access to the BESS Units for emergency response purposes. As stated in the **Design Principles (Doc Ref. 7.5)** the tracks will be at grade where they approach watercourses and will comprise 90% permeable grass-paving and will be at least 3.7m wide.
- **Site Wide Works:** Further associated development may be carried out comprising such other works as may be necessary or expedient for the purposes of or in connection with the authorised development and which are within the Site and fall within the scope of work assessed by the ES.

# 7 Supporting Information - Climate Change

## 7.1 Introduction

7.1.1 This section provides supporting information relevant to the impacts of climate change in the future which has been applied in the FRA. Paragraph 5.8.15 of NPS EN-1 requires that an FRA must *'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'.*

7.1.2 In May 2022, the EA published guidance referred to as *Flood risk assessments: climate change allowances*[24] which sets out when and how local planning authorities, developers and their agents should use climate change allowances in flood risk assessments.

7.1.3 This EA climate change allowances guidance sets out that peak rainfall intensity, sea level, peak river flow; offshore wind speed and extreme wave heights are all expected to increase in the future as a result of climate change. Consideration of changes to these parameters should use the allowances outlined below based on the anticipated lifetime of the development.

7.1.4 The Site is remote from the coast and therefore changes relating to sea level, wave heights and wind speed are not applicable. The Site is located across Flood Zones 1, 2 and 3 associated with the East Stour River but is also considered to have areas at high risk of surface water flooding.

7.1.5 Changes to peak rainfall intensity and peak river flows are therefore only appropriate in this assessment and these are set out below together with the operational lifetime of the Project, based on the latest EA climate change allowances for FRA[20] published in May 2022 (subsequently referred to in this FRA as the 'EA CCA Guidance').

## 7.2 Operational Lifetime of the Project

7.2.1 The Project is anticipated to have an operational lifetime of 40 years.

## 7.3 Peak River Flow Allowances

7.3.1 The Site is located within the Stour Management Catchment and an extract of the information provided by the EA CCA Guidance[24] for this catchment is reproduced as **Table 7.1** of this FRA.

7.3.2 EA Guidance[24] states that for essential infrastructure in relation to fluvial flows FRAs should assess the '*Upper End*' climate change. A climate change uplift of 55% is required to assess changes to peak fluvial flow over the lifetime of development. This allowance has therefore been applied in the hydraulic modelling included in **Annex B: East Stour Hydraulic Modelling Report** of this FRA and in the assessment of future fluvial flood risk.

Table 7.1: Peak river flow climate change allowances for the Stour Management Catchment

| Epoch | Central Allowance | Higher Central Allowance | Upper End Allowance |
|---|---|---|---|
| 2020s (2015 – 2039) | 18% | 25% | 40% |
| 2050s (2040 – 2069) | 20% | 30% | 55% |
| 2080s (2070 – 2125) | 38% | 55% | 101% |

Source: EA CCA Guidance [24]

## 7.4 Peak Rainfall Intensity

7.4.1 An extract of the climate changes allowances for rainfall for the Stour Management Catchment is provided in **Table 7.2** of this FRA.

7.4.2 EA Guidance[24] states that FRAs should assess both the '*Central*' and '*Upper End*' climate change allowances to consider the range of potential impacts. As shown in **Table 7.2** of this FRA, for rainfall these equate to uplifts of 20% and 45% respectively for a 1% AEP rainfall event for the 2050s and 2070s. An allowance of 45% has therefore been allowed in the surface water drainage modelling and in the assessment of future surface water flood risk at the Site.

Table 7.2: Stour Management Catchment Peak Rainfall Allowances

| Management Catchment | Allowance Category | AEP (%) | Total potential change anticipated for 2050s | Total potential change anticipated for 2070s |
|---|---|---|---|---|
| Stour | Upper End | 3.3 | 40% | 40% |
| | Central | | 20% | 20% |
| | Upper End | 1 | 45% | 45% |
| | Central | | 20% | 20% |

Source: EA CCA Guidance[24]

# 8 Assessment of Potential Sources of Flooding

## 8.1 Introduction

8.1.1 This section sets out the potential sources of flood risk which include:

- Flooding from rivers or fluvial flooding;
- Flooding from sea or tidal flooding;
- Flooding from surface water or pluvial flooding;
- Flooding from groundwater;
- Flooding from sewers;
- Flooding from reservoirs, canals, and other artificial sources; and
- Flooding from infrastructure failure.

8.1.2 The flood risk to the Project from each of these potential sources is discussed in **Sections 7.2** to **7.8** of this FRA. The spatial extent of the flood risk sources screening study is limited to the Order limits (i.e. the Site) unless there is a clear identifiable flood flow route (i.e., from upgradient land) to the Site.

## 8.2 River or Fluvial Flooding

8.2.1 With reference to the EA *Flood Map for Planning*[5], the Site is shown to lie in Flood Zones 1, 2 and 3 associated with the floodplain of the East Stour River. The Flood Zones are defined by *Table 1: Flood Zones* of the PPG Flood risk and coastal change chapter, provided as **Table 3.1** of this FRA.

8.2.2 With reference to the *Reduction in Risk of Flooding from Rivers and Seas due to Defences*[25] mapping, the Site is shown to lie partially within an area that benefits from existing flood defences, in this case, the AFSA. Further details of the AFSA are provided in **Paragraphs 5.4.12** to **5.4.14** of this FRA.

8.2.3 An extract of Flood Map for Planning[5] and Reduction in Risk of Flooding from Rivers and Seas due to Defences[25] is shown on **Figure 10.2.8: Flood Map For Planning** and **Figure 10.2.9: Long Term Flood Risk – Risk of Flooding From Rivers or Sea** of this FRA.

8.2.4 The risk from river or fluvial flooding is considered High and is assessed in further detail in **Section 9.6** of this FRA.

## 8.3 Sea or Tidal Flooding

8.3.1 As discussed at **Section 5.2** of this FRA the lowest part of the Site is at an elevation of circa 44mAOD. Therefore, there is no significant risk of sea or tidal flooding and this risk has not been considered further.

## 8.4 Surface Water or Pluvial Flooding

8.4.1 With reference to the Long Term Flood Risk[6] mapping, the risk of surface water flooding to the majority of the Site is shown to be 'Very Low' defined as 'a less than 0.1% AEP (1 in 1,000 chance) of flooding in any given year'.

8.4.2 However, parts of the Site are shown to lie in areas considered to be at '*Low*', '*Medium*' and '*High*' risk of surface water flooding. The surface water flood risks are defined in **Table 8.1** of this FRA.

Table 8.1: Surface Water Flood Risk

| Risk | Definitions |
|---|---|
| 'Very Low' | less than 0.1% AEP (1 in 1,000 chance) of flooding in any given year |
| 'Low' | between 1% AEP (1 in 100 chance) and 0.1% AEP (1 in 1,000 chance) of flooding in any given year |
| 'Medium' | between 3.3% AEP (1 in 30 chance) and 1% AEP (1 in 100 chance) of flooding in any given year |
| 'High' | a greater than 3.3% AEP (1 in 30 chance) of flooding in any given year |

8.4.3 The flood risk from surface water flooding[6] is shown on **Figure 10.2.10: Long Term Flood Risk Surface Water** (based on the *Long Term Flood Risk*[6] mapping) and which identifies elevated surface water flood risk along the East Stour River corridor and along surface water flow pathways and tributary channels of the East Stour River.

8.4.4 The risks from surface water or pluvial flooding is assessed as High and is considered in further detail in **Section 9.5** of this FRA.

## 8.5 Flooding from Groundwater

8.5.1 As discussed in **Section 5.5** of this FRA, the Site is predominantly underlain by the Weald Clay Formation with outcrops of the Atherfield Clay Formation and Hythe Formation.

8.5.2 The Hythe Formation is classified as a '*Principal*' aquifer, indicating it has high intergranular permeability and therefore could provide a potential source of groundwater flooding. The Hythe Formation outcrops lie in local topographic high spots and any groundwater flows will be intercepted by local ditches along field boundary and conveyed down to lower parts of the Site. Further expression of groundwater from the Hythe Formation at the surface on the Site is considered highly unlikely. This formation therefore provides a low risk as a source of groundwater flooding.

8.5.3 The Weald Clay and Atherfield Clay Formations are considered aquicludes and therefore provide a low risk of providing a source of groundwater flooding.

8.5.4 The bedrock deposits are overlain by Alluvium deposits in the vicinity of the East Stour River. These alluvial deposits are considered a *'Secondary A'* aquifer. Following prolonged rainfall, groundwater in the Alluvium which is perched above clay bedrock may rise; providing a potential source of groundwater flooding. During extreme wet condition groundwater within the Alluvium could emerge from the surface if fluvial flooding was occurring along the East Stour River and restricting onward flow. On this basis, groundwater flooding was screened into the initial FRA included within the PEIR.

8.5.5 Following further review, it is considered it would not be possible to differentiate groundwater and fluvial, and instead areas of flooding would be attributed to fluvial flooding (i.e., the predominant source). The additional land impacted by flooding resulting from groundwater flow would be negligible.

8.5.6 The risk of groundwater flooding within the Site is therefore considered to be Low and is not considered further.

## 8.6 Flooding from Sewers

8.6.1 The Applicant has undertaken a comprehensive services search to inform its own understanding of the Site.

8.6.2 The utilities search indicates a rising main oriented northwest to southeast through Field 19 from a pumping station at the junction of Goldwell Lane and Callywell Lane. Burst of the rising main could result in flows surcharging onto Site, which would flow in line with the local topographic gradient to the north and into the East Stour River.

8.6.3 The utilities search also identifies a distribution main which is routed north through Fields 23, 24 and 25. This main will be diverted to run within a corridor adjacent to the road. In the event of a burst, flows would discharge overland in accordance with the local topography and into the East Stour River. On this basis the risk of flooding from sewers was screened in to the assessment undertaken within the PEIR.

8.6.4 Following further review, it is noted that due to the nature of the proposed infrastructure (i.e. PV panels raised 0.8m off the ground), shallow overland flows through the Site will not impact the Project. Flooding from sewers is assessed as Very Low and therefore not considered further.

## 8.7 Flooding from Reservoirs, Canals and other Artificial Sources

8.7.1 With reference to the *Long Term Flood Risk*[6] mapping, the Site is at risk of flooding from the failure of the AFSA operated by the EA. On this basis the risk of flooding associated with infrastructure failure was screened in to the assessment undertaken for the PEIR.

8.7.2 There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers under the Reservoirs Act 1975. Reservoirs are inspected regularly and essential safety work is carried out which means that the probability of failure is near zero.

8.7.3 Reservoir flood maps are typically used for strategic emergency planning purposes and provide a ‘worst case’ scenario and they are therefore not generally suitable to inform a site-specific FRA.

8.7.4 As the AFSA falls within the scope of the Reservoirs Act 1975 and is maintained and operated by the EA, it is considered that the probability of a failure is negligible and therefore the risk associated with a breach is very low. Flooding as a result of overtopping of the AFSA embankment is however part of the risk of fluvial flooding which is assessed in **Section 9.6**.

8.7.5 There are no canals or other artificial sources of flood risk within the vicinity of the Site.

8.7.6 The flooding from reservoirs, canals and other artificial sources is therefore not considered further in the main body of the assessment. However, as the severity of flooding resulting from a breach of the AFSA embankment would be very high, this is acknowledged in **Section 12** as one of the residual flood risks associated with the Project.

## 8.8 Flooding from Infrastructure Failure

8.8.1 The Site is not afforded protection from flood defences and therefore the risk of failure from a breach is very low. Whilst the ASFA technically provides flood management, this is considered a reservoir, and the risk is discussed in **Section 8.7** of this FRA.

8.8.2 Sellindge Wastewater Treatment Works ('WTW') is located to the east of the Project, adjacent to the existing Sellindge Substation. Failure at the wastewater treatment works would result in flows discharging south, bypassing the Site and discharging into Unnamed Tributary 2 and subsequently the East Stour River.

8.8.3 The risk of flooding from infrastructure failure is assessed as Very Low and is therefore not considered further.

## 8.9 Summary of Sources of Flooding

8.9.1 A summary of the potential sources of flooding and the flood risk arising from them is provided in **Table 8.2** of this FRA. The flood risk screening concludes that the Site is considered to be at risk of flooding from fluvial (rivers) and surface water (pluvial) sources.

Table 8.2: Potential Sources of Flooding

| Potential Source of Flooding | Flood Risk at the Site | Further Assessment Required |
|---|---|---|
| Fluvial (Rivers) | High | Yes |
| Tidal (Sea) | Very Low | No |
| Surface Water or Pluvial | High | Yes |
| Groundwater | Low | No |
| Sewers | Very Low | No |
| Reservoirs, Canals and other Artificial Sources | Very Low | No |
| Infrastructure Failure | Very Low | No |

# 9 Detailed Flood Risk Review

## 9.1 Potential Sources of Flood Risk

9.1.1 The flood risk screening assessment reported in **Section 8** and summarised in **Table 8.2** of this FRA indicates that the Site is potentially at risk of fluvial (rivers) and surface water (pluvial) flooding. These flood risks are therefore considered in further detail below.

## 9.2 Data Sources

9.2.1 In considering the flood risk to the Site, the following external data sources have been considered:

- The *Flood Map for Planning*[5] (EA) (reproduced as **Figure 10.2.8: Flood Map for Planning** of this FRA);
- *Long Term Flood Risk*[6] mapping for the *Risk of Flooding from Rivers or Sea* (EA) (reproduced as **Figure 10.2.9: Long Term Flood Risk Rivers and Sea** of this FRA);
- The *Long Term Flood Risk for the Risk of Flooding from Surface Water*[6] (EA) (reproduced as **Figure 10.2.10: Long Term Flood Risk Surface Water** of this FRA);
- The *Historic Flood Map*[26] (EA) (Reproduced as **Figure 10.2.11: Historic Flood Map** of this FRA);
- Autumn 2000 Great Stour Flood Rarity (JBA 2014)[27];
- 2013-2014 Post Flood Analysis: Kent and South London Area (JBA 2014)[28];
- Aerial Imagery of East Stour Flood Events (provided by EA dated 07/11/2000 and 09/02/2014);
- Ashford Borough Council Strategic Flood Risk Assessment ('SFRA') (JBA 2014)[29];
- Kent County Council Preliminary Flood Risk Assessment (2011)[30];
- South Ashford 2D Modelling Study (2010) (JBA 2012)[31]; and
- Upper Stour hydrological assessment by continuous simulation Draft v3 (JBA 2023)[32].

9.2.2 A detailed hydraulic model of the East Stour River developed by SLR Consulting was developed to inform this FRA. Further details of the modelling approach and outcome is provided in **Annex B: East Stour Hydraulic Modelling Report** of this FRA.

9.2.3 Information of relevance to the detailed assessment of flood risk from the SFRA is discussed in **Section 9.3** and historical flooding information sources are discussed in **Section 9.4** of this FRA.

## 9.3 Ashford Borough Council SFRA

9.3.1 ABC's SFRA[25] was published in 2014 and was commissioned to provide sufficient information to enable ABC to apply the Sequential Test to potential areas of development and to assist in identifying where the application of the Exception Test may be necessary.

### Fluvial Flood Risk

9.3.2 Most of the Northern Area (Fields 26 to 29) and Fields 19, 23 to 25 of the Central Area of the Site are classified by the EA as being in Flood Zone 2 (identified as land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding, which is defined as 'medium' probability) and Flood Zone 3 (identified as land having a 1 in 100 or greater annual probability of river flooding, which is defined as 'high' probability). Parts of the Cable Route Corridor and Sellindge Substation are also located within Flood Zones 2 and 3.

9.3.3 At the Site, the areas considered to be in Flood Zones 2 or 3 are fluvial flood risks and not tidal.

9.3.4 As part of the SFRA[25], Flood Zone 3b (the functional floodplain) has been identified as being the flood extents for the 5% and 4% AEP (1 in 20 and 1 in 25 year) event where these have been modelled and mapped. The SFRA also notes that where Flood Zone 3b extents are not available, a precautionary approach should be followed, and Flood Zone 3 should be considered as equivalent to the functional floodplain.

9.3.5 ABC Flood Mapping from SFRA, presented on **ES Volume 3, Figure 10.8: Delineation between Flood Zone 3a and 3b (Doc Ref. 5.3)**, shows the extent of Flood Zone 3a and Flood Zone 3b at the Site. This indicates that the large majority of the Flood Zone 3 area within the Order limits are considered as Flood Zone 3b.

### Surface Water Flooding

9.3.6 The SFRA states that areas of surface water flooding are typically attributed to urban carriageways or locations where drainage becomes blocked or surcharges preventing free discharge from the sewer into watercourses.

9.3.7 This flood mechanism is however not applicable to the Site which is predominantly rural in nature and is not drained by a local sewer network.

## 9.4 Historic Flooding

9.4.1 Fluvial flooding has historically been a significant problem in the both the rural and urban areas of ABC, with major flood events recorded in 1947, 1967, 1968, 1972, 1973, 1979, 1985, 1988, 1998, 2000, 2001, 2013 and 2014. These events have primarily been focused along the headwater tributaries of the River Stour including the East Stour River.

### Historic Flood Map and Recorded Flood Outlines

9.4.2 The *Historic Flood Map* and *Recorded Flood Outlines* mapping provided by the EA indicate that the Site has historically flooded in 1974, 2000 and 2001. The recorded flood outline for the 1974 event indicates the northern half of Field 19 was inundated. The recorded flood outlines for the 2000 and 2001 events indicate that the northern boundaries of Fields 16 and 18 were inundated, with significant flooding across Fields 19, 23, 24, 26, 27 and 29. It is noted that the flood event in 1974 occurred prior to the construction of the AFSA in 1989.

9.4.3 Mapping of the Historic Flood Events is shown on **Figure 10.2.10: Long Term Flood Risk Surface Water** of this FRA.

9.4.4 The ABC SFRA (JBA 2014) states that the AFSA over spilled in the autumn of 2000 and spring of 2001. Further information provided by the EA in the 2013-2014 Post Flood Analysis: Kent and South London Area (JBA 2014) states that the AFSA reached full capacity over the winter of 2013-2014.

### Autumn 2000 Event

9.4.5 The JBA Autumn 2000 Great Stour Flood Rarity[24] assessed the peak flow on the Great Stour at the Wye gauge, approximately 16km downstream of the Site and the Horton gauge, approximately 30km downstream of the Site. In addition, rainfall accumulations at the Canterbury STW rain gauge were also assessed.

9.4.6 Analysis of the rainfall accumulations against the maximum return periods suggested by the Flood Estimation Handbook ('FEH') Depth Duration Frequency ('DDF') model at the Canterbury STW rain gauge indicated that;

- the annual probability for the event between 8 to 15 October lasting 3.4 days was in the region of 1 in 14;
- over the 2.5 day period between 28 October to 1 November the annual probability was around 1 in 2.3; and
- over the 1.5 day period between 4 to 9 November the annual probability was around 1 in 1.8 years.

9.4.7 It is noted that the Canterbury STW rain gauge is not within the Great Stour at Wye catchment but provides an indication of the regional severity of the Autumn 2000 event.

9.4.8 Analysis by JBA of the peak flows at the Wye gauge using FEH statistical method single site found that:

- between 12 and 13 October, the peak recorded flow of 29.8 $m^3s^{-1}$ had an annual exceedance probability of 1 in 18;
- between 30 and 31 October, the peak recorded flow of 26.9 $m^3s^{-1}$ had an annual exceedance probability of 1 in 9; and
- between November 7 and 8, the peak flow of 32.1 $m^3s^{-1}$ had an annual exceedance probability of 1 in 31.

9.4.9 A summary of the JBA analysis on the Autumn 2000 Great Stour flood events is provided in **Table 9.1** of this FRA.

Table 9.1: Autumn 2000 Great Stour Flood Events

| Date | Canterbury STW Rain Gauge | | Great Stour at Wye Peak Flow Gauge | |
|---|---|---|---|---|
| | Annual Probability 1 in X | Duration (Days) | Annual Probability 1 in X | Peak Flow ($m^3s^{-1}$) |
| 8 – 15 October | 14 | 3.4 | 18 | 29.8 |
| 28 October – 1 November | 2.3 | 2.5 | 9 | 26.9 |
| 4 – 9 November | 1.8 | 1.5 | 31 | 32.1 |

Source: JBA 2014[24]

9.4.10 Aerial imagery provided by the EA indicates that flows overtopped the AFSA spillway in November 2000 with Fields 16, 18, 19, 23, 24, and 26 to 29 affected by flooding during this event.

9.4.11 The JBA post event analysis[24] indicates that the AFSA spillway is now overtopped during events that are now considered to occur more frequently than the intended design standard of the 1% AEP event.

### Winter 2013 – 2014 Event

9.4.12 The 2013-2014 Post Flood Analysis: Kent and South London Area report (JBA 2014)[28] assessed the peak flow and flow volumes on the East Stour at the South Willesborough gauge, approximately 6km downstream of the Site. In addition to this, the rainfall accumulations at the South Willesborough tipping bucket rain gauge were also assessed.

9.4.13 Over a period of 8 days in the winter 2013-2014, 84.8mm was recorded at the South Willesborough tipping bucket rain gauge. Analysis of this rainfall accumulations using the Flood Estimation Handbook ('FEH') Depth Duration Frequency (DDF')[33] method indicates that the annual probability of this event was around 1 in 3.8.

9.4.14 Analysis by JBA[18] of the peak flows on the East Stour River at the South Willesborough gauge found that the peak flow of 13.0 $m^3s^{-1}$, which occurred on 1 February 2014, had an annual exceedance probability of 1 in 4.

9.4.15 Analysis by JBA[18] of the volume of flow on the East Stour River at the South Willesborough gauge found that the annual probability of the event was between 1 in 15 and 1 in 30 for event durations of 1-2 weeks and between 1 in 50 and 1 in 100 for event durations of 4-8 weeks.

9.4.16 During the Winter 2013-2014 events, which were assessed to have an annual exceedance probability of between 1 in 15 and 1 in 30 along the East Stour the AFSA reached full capacity.

### Historic Flooding Summary

9.4.17 Analysis of historic flood events along the East Stour indicate that the AFSA does not provide the design level of protection. The AFSA was designed to provide protection up to 1% AEP event with no overtopping of the spillway. Historic flood information provided by the EA and post event analysis undertaken by JBA in 2014 indicate that the level of protection provided by the AFSA is around a 3.3% AEP event.

9.4.18 The historical flood mapping indicates that Fields 16, 18, 19, 23, 24 and 26 to 29 have been affected by flooding from the East Stour which is consistent with the EA's flood mapping for the area.

## 9.5 Detailed Assessment of Surface Water Flood Risk

### Long Term Flood Risk - Risk of Flooding from Surface Water

9.5.1 The *Long Term Flood Risk* mapping for the *Risk of Flooding from Surface Water*, an extract of which is shown on **Figure 10.2.10: Long Term Flood Risk Surface Water** of this FRA, indicates the extent of the Site at risk of surface water flooding.

9.5.2 In rural areas, the mechanisms that drive surface water flooding are often the same as those that result in fluvial flooding. It is therefore considered that where the mapped areas of surface water flooding align with a watercourse (of the fluvial floodplain), the detailed hydraulic model developed to inform this FRA provides a more robust assessment of the flood risk from both fluvial and pluvial sources.

9.5.3 This is particularly the case for the entire Northern Area where a significant area of flooding is predicted upstream and adjacent to AFSA, as well as Fields 19, 23 and 24 within the Central Area which are bound by fluvial watercourses.

9.5.4 Surface water flood mapping is derived from a coarse scale DTM which in some cases may overestimate the prevailing surface water flood risk by not accurately mapping small, ordinary watercourses which are dominated by surface water flows.

9.5.5 Based on a review of Site topography, the Site sits on the downslope of a northwest to southeast topographic ridge. This ridge is therefore the source point for surface water flows and due to its proximity, on or adjacent to the Site, surface water flows noted in the flood mapping are due to the channelisation of runoff from the Site rather than overland flows from off-site sources. In some instances, such as through Fields 3 and 7, where off-site flows discharge onto the Site, these are typically limited by small upgradient catchment areas.

9.5.6 An assessment of each area of the Site is provided in Paragraphs 9.5.79 to 9.5.17 of this FRA.

### *Northern Area (including Project Substation)*

9.5.7 The Northern Area, in particular Fields 27 and 28, are considered to be at a high risk of flooding from surface water sources. Fields 26 (including the Project Substation area) and 29 are at low to very low risk of surface water flooding.

9.5.8 The areas of surface water flood risk are routed along the East Stour River and floodplain and are clearly representative of fluvial flooding rather than solely surface water sources. The risk of fluvial flooding is assessed in **Section 9.6** of this FRA. Clearly there are significant overland and out of bank flow pathways through the Site which following extreme rainfall, would have a faster speed of onset than fluvial flooding along the East Stour River. Environment Agency surface water flood mapping predicts depths of up to 0.9m. No solar infrastructure is proposed where flood depths exceed 0.8m above ground.

### *South Western Area*

9.5.9 The South Western Area is shown to be predominantly at ‘very low’ risk of surface water flooding, with some small extents at ‘low’ risk of flooding arising from overland flow routes. Localised areas of ‘medium’ and ‘high’ risk are associated with the field drainage ditches and ordinary watercourses running along the boundaries of the fields. Whilst the majority of flow would remain in channel, the surface water modelling predicts out of bank flood depths between 0.3m and 0.6m for the 0.1% AEP event and below 0.3m for the 1% AEP event.

*South Eastern Area*

9.5.10 The South Eastern Area is shown to be predominantly at “very low” risk of flooding, with some small extents of “low” risk of flooding arising from overland flow routes. Localised areas of “medium” and “high” risk are associated with the field drainage ditches and ordinary watercourses running along the boundaries of the fields, including the Spring and Bow cottage properties located at the Laws Lane/Bank Road junction. During the extreme 0.1% AEP event maximum flood depths are shown to be between 0.9m and 1.2m within the drainage ditches, with maximum flood depths between 0.15m and 0.30m outside of these channels. The Project is not expected to worsen effects in this area.

*Central Area*

9.5.11 Within the Central Area, Fields 10 to 17 and 25 are shown to be predominantly at ‘very low’ risk of flooding with some small extents at ‘low’ risk of flooding arising from overland flow routes. In these instances maximum flood depths are shown to be between 0.15m and 0.30m during the extreme 0.1% AEP event.

9.5.12 Field 18 has several overland flow routes that are at ‘low’ risk of flooding, with localised areas of ‘medium’ and ‘high’ risk associated with the field drainage ditches and ordinary watercourses.

9.5.13 The maximum flood depths within Field 18 are shown to be between 0.9m and 1.2m within the drainage ditches, and maximum flood depths between 0.3m and 0.6m along the overland flow route during the extreme 0.1% AEP event.

9.5.14 Surface water flooding within Field 19 clearly shows that the channel along the southern boundary of the field breaches its channel bank and flows overland via a historical paleochannel which is identifiable in the topography. This risk is therefore considered fluvial in nature and is instead assessed in **Section 9.6** of this FRA.

9.5.15 Areas of surface water flooding identified through Fields 23 and 24, which are split by the AFSA outfall watercourse, are also considered fluvial in nature and thus the prevailing risk is better represented in the fluvial modelling (**Section 9.6** of this FRA) rather than coarse scale ground modelling.

*Sellindge Substation*

9.5.16 Sellindge Substation is considered to be at ‘low’ to ‘very low’ risk of flooding from surface water sources and it is assumed that these surface water flows would be intercepted by the existing surface water drainage at the facility.

### *Cable Route Corridor and Cable Route Crossing*

9.5.17 Elevated surface water flood risk is present along the Cable Route Corridor which runs parallel with the East Stour River corridor. Whilst this is technically fluvial in nature, below ground cables are generally designed as water compatible and would not be impacted by standing water at the surface.

### Surface Water Flood Risk Summary

9.5.18 It is concluded that the surface water flood modelling likely overestimates the surface water flood risks, particularly in areas where overland flows would flow in channel or be considered fluvial in nature. Areas where surface water is predicted within the field (i.e., not in channel) generally do not exceed a depth of 0.6m during the 0.1% AEP event.

9.5.19 It is concluded that in areas where surface water flood modelling shows flooding along a watercourse, this flood risk is considered fluvial in nature. This is particularly the case along the East Stour River which is assessed in **Section 9.6** of this FRA.

9.5.20 Overland flow pathways are also noted in areas which, in reality, would be intercepted by known surface water features present on the Site. IIn such instances, flows would be retained in channel and the risk would be considered much lower.

### Climate Change

9.5.21 The *Risk of Flooding from Surface Water* mapping[6] does not include an allowance for the impact of climate change.

9.5.22 Over the anticipated operational lifetime of 40 years for the Project, current EA CCA Guidance indicates that an increase in peak rainfall of 45% can be anticipated. Therefore the risk of flooding from surface water is likely to increase through the lifetime of the Project.

9.5.23 Surface water drainage and improved surface water connectivity is provided as a result of the Project. The **Outline OWSDS (Doc Ref. 7.14)** sets out the principles of the drainage strategy for the Project. Drainage will be provided for any impermeable areas (Project Substation, Inverter Station, Intermediate Substation, PV Array) for the 1 in 100-year rainfall event plus a 45% allowance for climate change.

9.5.24 Whilst solar PV arrays are not considered to increase runoff rates from the Site, depression storage (i.e., swales) will be provided on the Site to increase the surface water flow capacity, as set out in the **Outline OWSDS (Doc Ref. 7.14)**.

9.5.25 The Project will offer a small improvement from the baseline condition and the impact of climate change on surface water flooding as a result of the Project is considered negligible.

9.5.26 Whilst areas within the Project domain are clearly at a high risk of surface water flooding, this risk is can be mitigated to ensure that the Project is safe for its anticipated lifetime. This is demonstrated in **Section 10** of this FRA which details the flood mitigation and management required at the Site.

## 9.6 Detailed Assessment of Fluvial Flood Risk

### Flood Map for Planning

9.6.1 The *Flood Map for Planning*[5], an extract of which is shown on **Figure 10.2.8: Flood Map for Planning** of this FRA, indicates the extent of the Site at risk of fluvial flooding and specifically those areas that lie within the Flood Zones defined by the PPG.

9.6.2 The Site is shown to lie partially in Flood Zone 2 and Flood Zone 3. Whilst the flood maps do not distinguish between the flood risk from tidal and fluvial sources, it is clear from the elevation of the Site that the flood risk is from fluvial sources and in particular the East Stour River and its tributaries.

9.6.3 Parts of the Site also benefit from the protection afforded by the AFSA as shown by the '*Reduction in Risk of Flooding with Rivers and Seas due to Defences*' mapping reproduced as **Figure 10.2.9: Long Term Flood Risk Rivers and Sea** of this FRA.

9.6.4 **Table 9.2** of this FRA identifies Fields which are considered to be in areas at risk of flooding from fluvial sources. Where fields are not listed, these lie in an area designated wholly as Flood Zone 1 (very low risk). In some instances, Fields may fall across all Flood Zones and this is identified below and mapped within **Figure 10.2.8: Flood Map for Planning** of this FRA.

Table 9.2: Flood Zone Designation per Field

| Field | Flood Zone | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| 16 | ✓ | ✓ | ✓ |
| 18 | ✓ | ✓ | ✓ |
| 19 | | ✓ | ✓ |
| 23 | ✓ | ✓ | ✓ |
| 24 | | | ✓ |

| Field | Flood Zone | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| 25 | ✓ | | ✓ |
| 26 (Project Substation) | ✓ | ✓ | ✓ |
| 27* | | | ✓ |
| 28* | | ✓ | ✓ |
| 29* | | ✓ | ✓ |
| Cable Route Corridor | | ✓ | ✓ |
| Sellindge Substation | | ✓ | ✓ |

* No PV panels or other built infrastructure are proposed in Fields 27, 28 and 29.

#### Long Term Flood Risk - Risk of Flooding from Rivers or Sea

9.6.5 The *Long Term Flood Risk* mapping for the *Risk of Flooding from Rivers or Sea*, an extract of which is shown by **Figure 10.2.9: Long Terms Flood Risk Rivers and Sea** of this FRA, indicates the extent of the Site at risk of fluvial/tidal flooding.

9.6.6 The *Risk of Flooding from Rivers or Sea* mapping takes into account the effect of any flood defences in the area. These defences reduce but do not completely eliminate the risk of flooding as they can be overtopped, or fail.

9.6.7 The Site is shown to lie partially in areas at risk of flooding with the risk categories summarised below:

- Very Low – This area has a chance of flooding less than 0.1% each year.
- Low – This area has a chance of flooding between 0.1% and 1% each year.
- Medium – This area has a chance of flooding between 1% and 3.3% each year.
- High – This area has a chance of flooding greater than 3.3% each year.

*Northern Area (including Project Substation)*

9.6.8 Within the Northern Area, the north western corner of Field 26, which includes the proposed foot print of the Project Substation, is shown to lie in an area at 'very low' risk of fluvial with the remainder of the Field at 'medium' and 'high' risk of flooding. Fields 27 and 28 are shown to lie entirely in an area at 'high' risk of flooding. Field 29 lies within an area at 'low' risk of flooding to the south east and 'high' risk of flooding to the north west.

*South Western Area and South Eastern Area*

9.6.9 These areas are shown to lie entirely in an area at 'very low' risk of fluvial or tidal flooding.

*Central Area*

9.6.10 Fields 10 to 14 and Field 17 within the Central Area are shown to lie entirely in an area at 'very low' risk of fluvial. Field 16 is shown to be at 'low' risk of flooding along its northern boundary. Fields 15 and 18 are shown to be at 'medium' risk of flooding along their northern boundaries. Field 19 is shown to be at 'medium' risk of flooding within the eastern half and predominantly at 'low' risk of flooding within the western half with some extents of 'medium' and 'high' risk. Fields 23 and 24lie almost entirely within an area at 'medium' risk of flooding with some small extents at 'high' risk. Field 25 predominantly lies in an area at 'very low' risk of fluvial, with the southern boundary at 'medium' risk of flooding.

*Cable Route Corridor, Cable Route Crossing and Sellindge Substation*

9.6.11 The Cable Route Corridor, the Cable Route Crossing and Sellindge Substation are located in areas considered to be at a 'high' risk of fluvial flooding.

Fluvial Flood Modelling

9.6.12 A detailed hydraulic model of the East Stour River and its associated tributaries has been constructed by SLR to inform this FRA. It should be noted the EA is currently constructing an updated hydraulic model of the East Stour River, however the results of this modelling study are currently unavailable. As such the detailed hydraulic model constructed by SLR to support this FRA is considered the best currently available information on fluvial flood risk to the Site.

9.6.13 A HMR sets out the approach to construction of the hydraulic model and is provided as **Annex B: East Stour Hydraulic Modelling Report** of this FRA. The results of the hydraulic model are summarised below.

9.6.14 The flood extent outputs from the hydraulic model have been compared to the EA's *Flood Map for Planning* Flood Zone mapping. As the Flood Zones are defined in the absence of defences, the model was run with the AFSA removed. The EA's Flood Zone 3 mapping and the modelled 1% AEP undefended flood extent is shown on **Annex B: East Stour Hydraulic Modelling Report, Figure 11 and Figure 12** of this FRA. The EA's Flood

Zone 2 mapping and the modelled 0.1% AEP undefended flood extent is shown on **Annex B: East Stour Hydraulic Modelling Report, Figure 13**. Downstream of the AFSA, the modelled 5% AEP undefended flood extent has been taken as Flood Zone 3b. This is in line with ABC's definition of Functional Floodplain (Zone 3b). However, the PPG states that land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% AEP of flooding) will normally be defined as the Functional Floodplain. In line with the PPG definition of Functional Floodplain, upstream of the AFSA embankment the modelled 0.1% AEP defended flood extent has been defined as Flood Zone 3b.

9.6.15 With reference to **Annex B: East Stour Hydraulic Modelling Report** of this FRA, the Site lies within Flood Zones 1, 2, 3a and 3b. This fluvial flood risk is discussed further in **Paragraphs 9.6.16** to **9.6.28** of this FRA.

### Flood Model Outputs

9.6.16 **Annex B: East Stour Hydraulic Modelling Report** of this FRA concludes that during the 'pre-development' defended scenario, which accounts for the effect of the AFSA scheme, the Central Area and Northern Areas are at risk of flooding during the design flood event. This design flood event is defined as the 1% AEP event allowing for the Upper End estimate of climate change (55%) over the lifetime of the Project taken to be the 2050s epoch.

9.6.17 During the design flood event, flood levels within the AFSA are shown to exceed the spillway crest level of 50.20mAOD, with the maximum flood level upstream of the spillway reaching 50.36mAOD.

#### *South Western Area and South Eastern Area*

9.6.18 No flooding is predicted in the South Western Area or South Eastern Area of the Site.

#### *Central Area*

9.6.19 Within the Central Area, Fields 19, 23 and 24 are shown to be at risk of flooding from floodwaters spilling from the banks of the East Stour River and the Unnamed Tributary 3 prior to the overtopping of the AFSA spillway, with the south eastern boundary of Field 25 also shown to be at risk.

9.6.20 Following the overtopping of the AFSA spillway, flood depths are shown to increase within Fields 19, 23 and 24. Additionally, Fields 15, 16 and 18 are shown to be at risk of inundation. During both the design flood event and the extreme 0.1% AEP flood event, flood depths within the Central Area are shown to remain below 0.8m.

9.6.21 Modelled flood levels through the Central Area are summarised in **Table 9.3** of this FRA. **Table 9.3** of this FRA does not include fields where flooding is not predicted.

Table 9.3: Central Area Flood Risk Summary

| Field | Minimum Ground Level (mAOD) | Maximum Ground Level (mAOD) | 5% AEP Flood Level (mAOD) | 1% AEP Flood Level (mAOD) | 1% AEP + 55% Climate Change Flood Level (mAOD) | 0.1% AEP Flood Level (mAOD) |
|---|---|---|---|---|---|---|
| 15 | 45.0 | 51.0 | No flooding | 44.92 – 45.27 | 45.17 – 45.50 | 45.24 – 45.52 |
| 16 | 44.6 | 46.8 | No Flooding | 44.68 – 44.93 | 44.65 – 45.18 | 44.72 – 45.25 |
| 18 | 45.4 | 47.9 | No Flooding | 45.27 – 45.42 | 45.49 – 46.06 | 45.52 – 46.11 |
| 19 | 44.4 | 45.9 | No Flooding | 44.64 – 45.98 | 44.76 – 46.06 | 44.82 – 46.09 |
| 23 | 45.9 | 46.7 | 45.94 – 46.09 | 46.21 – 46.34 | 46.33 – 46.47 | 46.38 – 46.53 |
| 24 | 45.9 | 46.6 | 45.87 – 46.62 | 46.19 – 46.68 | 46.32 – 46.74 | 46.38 – 46.78 |

*Northern Area (including Project Substation)*

9.6.22 Within the Northern Area, all fields are shown to be at risk of flooding from floodwaters impounded behind the AFSA embankment during the design flood event.

9.6.23 No flooding is predicted on the higher ground to the north of Field 26 where the Project Substation is proposed.

9.6.24 Flood levels within or adjacent to each field in the Northern Area are summarised in **Table 9.4** of this FRA.

Table 9.4: Northern Area Flood Risk Summary

| Field | Minimum Ground Level (mAOD) | Maximum Ground Level (mAOD) | 5% AEP Flood Level (mAOD) | 1% AEP Flood Level (mAOD) | 1% AEP + 55% Climate Change Flood Level (mAOD) | 0.1% AEP Flood Level (mAOD) |
|---|---|---|---|---|---|---|
| 26 | 47.7 | 60.8 | 50.25 | 50.29 | 50.36 | 50.39 |
| 27 | 47.7 | 50.0 | 50.25 | 50.29 – 50.30 | 50.36 – 50.38 | 50.39 – 50.42 |
| 28 | 46.7 | 48.6 | 50.25 | 50.29 | 50.36 | 50.39 |
| 29 | 47.7 | 64.0 | 50.25 | 50.29 – 50.30 | 50.36 | 50.39 |

*Sellindge Substation Extension*

9.6.25 Electrical infrastructure will be required to connect the Project to the existing National Grid Sellindge Substation. This will be sited on an area of land northeast of the existing platform for National Grid’s Sellindge Substation. This extension area will extend to up to 0.05ha and will be constructed to the same ground level as the existing substation which is approximately 51.45mAOD.

9.6.26 The model outputs from the **Annex B: East Stour Hydraulic Modelling Report** of this FRA indicate that during the 1% AEP flood event with a 55% uplift to account for climate change, flood levels in this area could reach 51.59mAOD. This would equate to maximum potential flood depths on the newly constructed platform of 0.14m.

9.6.27 Standard design will mean that infrastructure within the Sellindge Substation will be sited on metal frames and the equipment are assumed to be raised above the ground. On this basis the infrastructure would not be affected by extreme fluvial flooding and the risk posed to this infrastructure is assessed to be low.

*Grid Connection Cable (and Cable Route Crossing)*

9.6.28 Flood risk to the proposed Grid Connection Cable is considered negligible given that this is subsurface development designed to be flood resilient. Whilst there will inherently be a risk of flooding during construction this will be mitigated as part of an EFRP (secured through the **Outline CEMP (Doc Ref. 7.8)**). Once the Grid Connection Cable is in-situ, flooding from any source will not have an adverse impact.

## 9.7 Climate Change

9.7.1 As discussed in **Section 7.3** of this FRA, this FRA considers a 55% increase in peak fluvial flows though the lifetime of the Project.

9.7.2 The Project design has considered the design flood level through the Site using the modelled 1% AEP plus 55% climate change flood levels as extracted from the SLR HMR. Appropriate design measures are secured through the **Design Principles (Doc Ref. 7.5)**, **Works Plans (Doc Ref. 2.3)** and **Outline OSWDS (Doc Ref. 7.14)**. On this basis, the impact of climate change on fluvial flows is considered within the Project design to have a negligible impact.

9.7.3 Due to the AFSA attenuating and limiting downstream flows only minor increases in flood depths and extent are shown during the credible maximum climate change scenario (Upper End allowance). Flood levels are shown to remain below the proposed PV panels levels and all Inverter Stations remain outside of the flood extent for the lifetime of the Project during the 1.0% AEP flood event including the credible maximum impact (55%) of climate change.

## 9.8 Ashford Hydraulic Model

9.8.1 The conclusions of **Annex B: East Stour Hydraulic Modelling Report** of this FRA differ somewhat to those reached by the Ashford Fluvial Model study 2012[31]. In the Ashford Fluvial Model study, the earlier hydraulic model predicted reduced flood flows and hence lower flood levels downstream of the AFSA.

9.8.2 A detailed assessment of the Ashford Fluvial Model is provided as part of the HMR provided as **Annex B: East Stour Hydraulic Modelling Report, Section 5.4** of this FRA. However, the key points that may explain the discrepancy between the two studies are provided below:

- The focus of the Ashford Fluvial Model was the entire River Stour catchment and as such, hydrological inputs were calculated for the critical flood events in Ashford and not at the Site. Additionally, the hydrology assessment was undertaken prior to recent improvements in FEH methods for permeable catchments.
- Overtopping flows of bridge structures have not been represented in the Ashford Fluvial Model and as such it is likely that the model is overestimating energy losses at these structures.
- The stage-discharge relationship for the AFSA fish pass overestimates flows with a peak discharge rate of 2.7 $m^3s^{-1}$ compared to the peak design discharge rate of 0.34 $m^3s^{-1}$.
- The modelled AFSA spillway weir coefficient of 0.25 appears to be unreasonably low for the spillway structure.

# 10 Flood Risk to the Project

## 10.1 Introduction

10.1.1 The Project comprises the construction, operation and decommissioning of solar photovoltaic arrays and energy storage, together with associated infrastructure and an underground cable connection to the existing National Grid Sellindge Substation. Further information on the Project is provided in **Section 2.2** of this FRA.

10.1.2 This Section sets out how the flood risks highlighted by the assessment in **Section 9** will be controlled through the mitigation and management measures that form part of the Project.

## 10.2 Avoidance

10.2.1 The Project has undergone several iterations, influenced by the development of the hydraulic model, principally to avoid locating sensitive infrastructure in areas at risk of flooding and to remove solar arrays from areas where excessive depths of flooding are predicted. The principal steps to avoid flood risks are secured by the **Works Plans (Doc Ref. 2.5)** and **Design Principles (Doc Ref. 7.5)** and are as follows:

- The main development areas of the Project are sited within Flood Zone 1.
- Standoffs apply along all watercourses to avoid corridors where deep and fast flowing flood water is most likely (i.e. minimum 10m buffer as measured from the East Stour River and IDB-managed Ordinary Watercourses from the top of bank or channel edge under normal flows. No new physical infrastructure other than essential works (such as cable crossings, watercourse crossings, drainage and PRoW footbridges) will be developed in this buffer).
- The Project Substation has been designed to ensure the development platform is sited outside the design flood extent (the development platform will be no greater than 56mAOD and no lower than 55mAOD which is appropriately above the design flood level).
- PV panels are not proposed in the Northern Area which is within the AFSA.
- PV panels will be installed on PV mounting structures and will be a minimum of 0.8m above the ground.
- No PV panels are located in areas where the depth of flooding could exceed 0.8m.
- Electrical infrastructure at Sellindge Substation Extension are expected to

be raised above the ground level and thus above the design flood level (56m AOD).

10.2.2 Additional measures are secured through the **Outline OSWDS (Doc Ref. 7.14)** including ensuring that associated storm water controls are sited outside the design flood extent.

10.2.3 Given these controls included in the design, once constructed the risk of flooding posed to the Project from both fluvial and surface water flooding will be low.

## 10.3 Flood Management

10.3.1 The risks relating to fluvial and surface water flooding at the Site have been mitigated as far as practicable through the design principles and layout of the Project. The Site may however still be impacted by fluvial flooding from the East Stour River and its tributaries with flooding potentially cutting off access to areas of the Site. Parts of the Site may also be impacted by surface water flooding following extreme heavy rainfall.

10.3.2 While flooding of the nature expected would not damage the infrastructure, it could disrupt construction and decommissioning activities or pose a risk to equipment, activities and workers.

10.3.3 The main contractor and the Site operator will prepare, maintain, and implement robust EFRP for the construction, operation and decommissioning phases respectively. These documents will set out actions to minimise the risk posed to staff and operatives. The **Outline CEMP (Doc Ref. 7.8),** the **Outline OMP (Doc Ref 7.11)** and the **Outline DEMP (Doc Ref 7.14)** include the commitment to prepare EFRP for each stage, which will form part of the detailed CEMP(s), the OMP and DEMP(s) and will include:

- Details of roles and responsibility for maintaining, updating and implementing the plan;
- Overview of the local flood risk;
- Details of the local EA flood warning service;
- Specific action that will be undertaken in response to the issuing of a flood alter or flood warning; and
- Details of access and egress routes onto the Site for period in advance and during a flood event.

10.3.4 The construction and decommissioning EFRP(s) will include measures to adapt works plans in response to both the risk of fluvial flooding and also extreme rainfall events. Measures such as halting and rescheduling works in high-risk areas and removing unsecured equipment and infrastructure from areas of flood risk will form part of the approach.

### *Flood Alert and Warning*

10.3.5 During the construction, operation and decommissioning of the Project, there is a risk of flooding in parts of the Site from principally from the East Stour River, its tributaries and overland flow following extreme heavy rainfall.

10.3.6 However, the Site falls within an area covered by the EA's *Floodline* flood warning service. The service provides three levels of warning, Flood Alert, Flood Warning and Severe Flood Warning plus a Three-day flood risk forecast. The information provided by the currently available system is summarised in **Table 10.1** of this FRA.

Table 10.1: Floodline flood warning system

| Warning | When it is used | What it means |
|---|---|---|
| Three-day forecast | Daily forecasts of flood risk on the website www.environment-agency.gov.uk. These are updated more frequently for higher flood risk situations. | Be aware. Think ahead. Keep an eye on the weather situation. |
| Flood Alert | Two hours to two days in advance of flooding. | Flooding is possible. Be prepared. |
| Flood Warning | Half an hour to one day in advance of flooding. | Flooding is expected. Immediate action required. |
| Severe Flood Warning | When flooding poses a significant risk to life or significant disruption to communities. | Severe flooding. Danger to life. |

10.3.7 The Site falls within both a Flood Alert and Flood Warning area:

- The '*Upper River Stour*' Flood Alert area covers communities on the Great Stour from Charing Heath to the A2070 including Ashford, communities on the East Stour, communities on the Whitewater and Ruckinge Dykes and the Aylesford Stream.
- The more detailed '*East Stour from Sellindge to South Ashford*' Flood Warning area includes the East Stour from Sellindge to South Ashford including Barrowhill, Mersham and Sevington.

10.3.8 The EFRP will require the main contractor (construction) and the Site operator (operation) to sign up to the *Floodline* service (or equivalent service in the future).

10.3.9 With regards to extreme heavy rainfall, the EFRP will require the main contractor (construction) and the Site operator (operation) to subscribe to Met Office extreme weather warnings. These will provide early notification of potential heavy rainfall and surface water flooding at the Site.

*Safe Access and Egress*

10.3.10 The provision of safe access and escape for flood risk during construction and decommissioning will be considered within the detailed CEMP(s) and DEMP(s). The provision of safe access and escape for flood risk during operations will be considered within the detailed OMP.

10.3.11 In the event of uncertainty about the provision of safe and dry access to any areas of the Site, these areas would be evacuated. In the event that significant flooding is predicted the entre Site would be evacuated.

10.3.12 Should operatives be required to evacuate the entire Site in response to a flood alert or warning, it is anticipated that the evacuation route would be to the south of the Site (i.e. Bank Road) which would provide an egress route east to the M20, Folkstone and Hythe or west towards the A2070.

*Vulnerability of People*

10.3.13 The main risks to the people associated with the Project and with regards to flooding arise during the construction and decommissioning phases, alongside personnel undertaking maintenance works during operation.

10.3.14 Personnel working on or accessing the Site are likely to be healthy, able bodied and had prior experience / training. Given the physical ability of personnel, awareness of flood response procedures and available forecasting and notification of extreme rainfall and fluvial flooding along watercourses locally, the vulnerability of people is considered to be low.

# 11 Flood Impacts Arising from the Project

11.1.1 Without mitigation, development can increase the flood risk elsewhere. The following potential mechanisms for exacerbating flood risk at this Site have been identified:

- Changes in flood conveyance;
- Reduction in floodplain storage;
- Increases in surface water runoff; and
- Physical disturbance or damage to AFSA.

11.1.2 These potential off-Site flood risk impacts as a consequence of the Project are considered in **Sections 11.2** to **11.5** of this FRA.

## 11.2 Changes in Flood Conveyance

11.2.1 Flood flow velocities upstream of the AFSA embankment are low as water is impounded or held back by the raised structure. As a result, there is no potential for significant impacts on flood conveyance. Downstream of the embankment changes delivered as part of the Project could conceptually impact conveyance. The potential impact of the Project on the obstruction of fluvial and surface water flood flows is therefore discussed below in **Paragraphs 11.2.2** to **11.2.15.**

### PV Arrays

11.2.2 The **Design Principles (Doc Ref. 7.5)** require that all PV panels are south facing, This means they will be installed in rows running east to west roughly along the primary direction of the floodplain flow (so that the wide gap between banks of arrays is available for flood flow / debris).

### Security Fencing and Hedges

11.2.3 Fences are required around operational areas and new hedges are proposed as part of the landscape proposals. In places, these will extend into the floodplain. In concept these features will increase the roughness of the floodplain and create a small potential for accumulation of debris and associated blockage of flood flows.

11.2.4 To prevent obstructions to flood flows, such as blockage, the **Design Principles (Doc Ref. 7.5)** secure that security fencing within Fields 19, 23 and 24 will have a minimum clearance space of 0.2m between the bottom of the security fence and the ground, and with minimum mesh spacing of 0.1m. The distance between the security fencing and hedgerows or ordinary watercourses (referred to as drains or channels) outside of the security fence would be at least 3.2m.

11.2.5 The impact of debris building up against the proposed fences and forming a blockage has been assessed within **Annex B: East Stour Hydraulic Modelling Report, Section 6.3** of this FRA. This shows that blockage at the fences and hedges will only result in very small and localised uplifts in flood levels (<0.02m). These minor changes do not extend beyond the Order limits.

### Primary Site Access Track, Internal Haulage Road and Internal Access Tracks

11.2.6 The internal haulage road and internal access track will be at grade with no raise or uplift from the existing ground level. All proposed internal access tracks and haulage roads will therefore not have any impact on flood flows. The Primary Site Access track is located outwith areas at risk of flooding.

### Construction Compounds

11.2.7 Two  Secondary Construction Compounds in Fields 19 and will be located within the fluvial floodplain. No uplift in ground levels and built structures are proposed in these areas which would only be used for temporary storage of materials prior to distribution for installation. On this basis, the compound will not impact or obstruct flood flows.

### Watercourse Crossings

11.2.8 **ES Volume 4, Appendix 10.5: Schedule of Watercourse Crossings** sets out the proposed watercourse crossings associated with the Project and their locations. These include temporary vehicle bridge crossings as follows:

- Ordinary Watercourse (Riparian Drain): between Field 18 and Field 19;
- IDB Managed Ordinary Watercourse: between Field 23 and Field 24.
- East Stour River: between Field 24 and Field 25;
- East Stour River: between Field 27 and Field 28; and
- East Stour River: Field 27 and cable route corridor.

11.2.9 Permanent footbridges will be installed at the end of the construction phase to accommodate diverted PRoW. This will occur at two of the locations where temporary vehicle crossings are required during construction and decommissioning. These will be at the following locations, neither of which are over the East Stour River:

- Ordinary Watercourse (Riparian Drain): between Field 18 and Field 19; and
- IDB Managed Ordinary Watercourse: between Field 23 and Field 24.

11.2.10 As required by the **Design Principles (Doc Ref. 7.5)** vehicle bridge crossings will be installed to avoid impact to the channel and minimise on-site engineering. The bridge soffits will be set at least 600mm above the adjacent bank level and the bridge supports will be set at least 1m back from the edge of the top of the bank. The track approach to the watercourse crossing will be kept at grade.

11.2.11 The temporary vehicle bridge crossings will comprise pre-engineered modular structures of ‘Bailey’ type construction, i.e. open lattice sides. For the temporary bridge structures, the raising of the proposed soffit level to 600mm above the banks of the watercourse will ensure that the structures remain above the design 1% AEP plus upper end climate change flood level and that there is a significant freeboard to the current day 1% AEP flood level.

11.2.12 The temporary bridge crossings will be used mainly during the construction and decommissioning phases. However, at limited times during the operation and maintenance phase temporary bridges may be required to be reinstalled to provide access for maintenance, repair and replacement activities. The temporary bank to bank bridges will be pre-engineered modular steel bridges which will be delivered to the Site via HGV and installed for the construction and decommissioning periods and removed once construction / decommissioning is complete. This type of temporary bridge means that there is no construction work required within the watercourse as the bridges span the width of the watercourse.

11.2.13 The permanent footbridges will be lightweight, free span structures with open lattice sides. These will be similar in nature to existing PRoW footbridges on the Site.

11.2.14 The top of bank and design flood levels at the proposed watercourse crossing locations is summarised in **Table 11.1** of this FRA.

Table 11.1: Watercourse crossing indicative design and flood levels

| Watercourse Crossing | Top of Bank Level (mAOD) | Indicative Bridge Soffit Level (mAOD) | 1% AEP + 55% Climate Change Flood Level (mAOD) |
|---|---|---|---|
| Field 18 to 19 | 45.79 | 46.39 | 46.00 |
| Field 23 to 24 | 45.93 | 46.53 | 46.34 |
| Field 24 to 25 | 47.47 | 48.07 | 47.29 |
| Field 27 to 28 | 47.73 | 48.33 | 50.35 |
| Field 27 to cable route | 49.74 | 50.34 | 50.36 |

## 11.3 Reduction of Floodplain Storage

11.3.1 The potential impact of the Project on floodplain storage is discussed below.

### PV panels

11.3.2 No raising of ground levels is proposed associated with the proposed PV panels that will be within the floodplain.

11.3.3 Following consultation, the EA requested that level for level flood storage analysis is undertaken to assess the loss in flood storage from the PV mounting structures.

11.3.4 Analysis shows that the volume of floodplain storage lost as a result of the PV Array structures would be c. 2m$^3$. Possible changes in the design of the frame footing can be accommodated without any uplift in ground level. As such this will not impact the volume of flood storage lost.

11.3.5 Through the addition of scrapes and a large wetland basin within the floodplain compensatory storage will be provided resulting in a net increase in flood storage of c. 1,541m$^3$ with no net loss of floodplain volume at any level when considered on a level for level basis. Further details of these depressions are provided and their inclusion in the Project is secured through the **Outline OSWDS (Doc Ref 7.14)**.

11.3.6 Details of the level for level flood storage analysis on land downstream of the AFSA embankment is provided in **Annex D: Floodplain Compensation Level for Level Calculations** of this FRA.

### Landscaping works in AFSA

11.3.7 Habitat scrapes and ponds are proposed within the AFSA as part of the Illustrative Landscape Drawings (Doc Ref. 2.6). A wetland area is also proposed within the AFSA, as described in the **Outline OSWDS (Doc Ref. 7.14)**. These scrapes / depressions will provide compensatory flood storage capacity for the Project. Based on the current illustrative layout these features will increase the available flood storage within the AFSA by approximately 1,698m$^3$ and not adversely impact on flood risk.

11.3.8 Review of the Illustrative Landscape Drawings (Doc Ref. 2.6) with regards to the modelled Flood Zone 2, 3a and 3b extents shows that the proposed stock fencing within Field 29 lies wholly within Flood Zone 1. No other features proposed as part of the landscaping works within the AFSA would reduce flood storage volumes.

11.3.9 Materials excavated to create the scrapes, ponds and wetland area will all be removed from the AFSA. Vegetation clearance within the AFSA will also be managed on an ongoing basis to avoid the accumulation of material within areas liable to flooding. Therefore there will be no loss of flood storage within the ASFA as a result of the Project. Instead, flood storage is increased within the ASFA by 1,684m$^3$.

11.3.10 Details of the level for level flood storage analysis on land upstream of the AFSA embankment (i.e. within the AFSA) is provided in **Annex D: Floodplain Compensation Level for Level Calculations** of this FRA.

### Inverter Stations and Intermediate Substations

11.3.11 The Intermediate Substations and Inverter Stations will not be located in a floodplain and thus will have no impact on flood flows.

### Project Substation and Associated Drainage Infrastructure

11.3.12 The Project Substation, located in Field 26, will be levelled using cut and fill to create a flat development platform. At the toe of the platform, a surface water attenuation swale is proposed which will outfall into a pond / wetland area prior to discharge into surface waters (as secured through the **Outline OSWDS (Doc Ref. 7.14)**).

11.3.13 The Project Substation platform and associated surface water drainage swale, which provides hydraulic control and attenuation of stormwater runoff, are located outside of the fluvial floodplain. Ground level changes associated with the substation platform and swale which are located outside of the flood plain will have no impact on flood risk.

11.3.14 The **Outline OSWDS (Doc Ref. 7.14)** proposes that a wetland basin which receives flow from the swale (purely for water quality purposes) will be located in the fluvial floodplain. No ground level raise is proposed in this area and instead the wetland provides extra compensation flood storage from the existing situation. On this basis, the Project Substation would not increase the risk of flooding.

### Sellindge Substation Extension

11.3.15 The extension to the Sellindge Substation will extend to up to 0.05ha on the north eastern extent of the existing platform. The platform will be set at the same level as the existing platform. To achieve a level platform in that area of the Site, ground levels would need to be lowered and there would be no uplift.

11.3.16 Given that there are no proposed uplifts in existing ground level there can be no loss in flood storage associated with this element of the Project.

## 11.4 Increases in Surface Water Runoff

11.4.1 An Outline Operational Surface Water Drainage Strategy has been developed for the Project as part of the DCO Application and this is provided as the **Outline OSWDS (Doc Ref 7.14)**. This strategy sets out the principles for surface water management at the Site which will ensure there is no impact on runoff rates and flood risk as a result of the Project.

11.4.2 The principles of the storm water drainage system as set out in the **Outline OSWDS (Doc Ref 7.14)** are designed to ensure that there is no uplift in peak rates. The strategy is also designed to accommodate volumes of storm water runoff for all events up to, and including, the 1% annual probability storm with a 45% allowance for climate change.

### PV Arrays

11.4.3 PV panels will not increase runoff rates as surface water runoff will discharge from the panel onto the vegetated strip between rows. Water will then infiltrate to the soils and / or flow overland replicating the greenfield situation.

11.4.4 While no change is expected in runoff rates, the **Outline OSWDS (Doc Ref 7.14)** proposes areas of depression storage which will be provided across the Site down gradient of areas where PV panels are proposed. These are intended to intercept and slow surface runoff from the Site and encourage infiltration.

11.4.5 Prior to construction investigations will be undertaken to ensure that these depressions, mostly excavated into the shallow alluvium, will be free draining. In the event that this will not be passively achieved permeable material will be installed along one flank to allow water to gradual drain down and ensure capacity if available for repeat storms. Details of this are provided within the **Outline OSWDS (Doc Ref 7.14).**

11.4.6 As a result of the additional depression storage created, the Project will result in a small reduction in peak rates and total volume of surface water runoff from the area of PV panels. There will be a corresponding increase in filtration and shallow baseflows towards the river from these areas.

### Inverter Stations

11.4.7 As set out in the **Outline OSWDS (Doc Ref. 7.14),** stormwater which falls on the Inverter Station platforms will percolate into the void space of gravel compound. Onward discharge will be restricted to at or below 1l/s (as low as practicably possible) using a hydrobrake. Storage or excess flow will be provided within the subbase.

11.4.8 Flows from the Inverter Station compounds will discharge via unlined filter drain into adjacent surface waters. These filter drains will promote infiltration and clean flows.

### Project Substation

11.4.9 As detailed in the **Outline OSWDS (Doc Ref. 7.14)**, stormwater which falls on the Project Substation platform will percolate into the void space of the gravel compound. Water will percolate through the gravel subbase draining towards an outfall. Discharges via this outfall (for the gravel subbase within the compound) will be restricted by an orifice. Water will then pass via a series of gabion baskets, located at the toe of the platform, for energy dissipation before entering an attenuation swale.

11.4.10 Discharge from the swale will be restricted to greenfield rates by an orifice. Water will then flow into a wetland feature which serves to encourage infiltration and provide the final tier of water quality treatment.

### Sellindge Substation Extension

11.4.11 This will likely be constructed as a compacted gravel compound which be an extension to the existing platform of up to 0.05ha in area. Much of the rainfall falling on this surface will continue to discharge to the ground, particularly in drier summer periods.

11.4.12 Storm water drainage will be provided to capture and mange excess flow with runoff directed into National Grid’s existing drainage networks. As secured through the **Outline OSWDS (Doc Ref. 7.14)**, if considered necessary at the detailed design stage minor upgrades would be implemented to ensure that there is no net uplift in runoff and no increase in flood risk.

## 11.5 Physical Disturbance to AFSA

11.5.1 **ES Volume 4, Appendix 10.4: AFSA Risk Assessment (Doc Ref. 5.4)** provides information to evidence that construction, operation and decommissioning of the Project would not compromise the function or efficacy of the AFSA. This is primarily delivered by ensuring appropriate standoffs are applied from the AFSA embankment both with the Project design and through the construction and decommissioning.

11.5.2 Elements of the Project will involve works within the buffer areas around the AFSA embankment. This is however restricted to approximately 40m of internal haulage road and the Primary Access Track and Cable Route into the Project Substation. These aspects will not impact the integrity of the AFSA embankment in any way or the ability of the EA to access the embankment for maintenance. In addition, all details of these element of work will be subject to being issued with a Flood Risk Activity Permit from the EA.

11.5.3 **Annex B: East Stour Hydraulic Modelling Report** of this FRA details hydraulic modelling both with and without the Project. This confirms that the extent of flooding upstream of the AFSA embankment will not be increased by the Project.

## 11.6 Flood Impact Summary

11.6.1 As set out in **Table 11.2** of this FRA, it is concluded that there are no adverse flood risk impacts arising from the Project.

Table 11.2: Summary of Flood Impacts

| Flood Impact | Discussions | Impact |
|---|---|---|
| Changes in flood conveyance | Minor impacts on conveyance possible from solar PV Arrays, fences and hedges. These impacts have been modelled and confirmed to be negligible.<br><br>Other aspects of the Project will be constructed out of the floodplain or without uplift to ground surfaces. | Negligible |
| Reduction in floodplain storage | All major changes of ground level required will be in areas out of the floodplain.<br><br>Minor losses of flood storage associated with the frame of PV Arrays will be more than offset by depression storage created as a part of the Project. | Negligible |
| Increases in surface runoff | Use of SuDS will ensure that there is no uplift in peak rates or volumes of storm water runoff from the Site. | Negligible |
| Physical disturbance or damage to AFSA | Appropriate standoffs are applied from the AFSA embankment both with the Project design, construction, operation and decommissioning. | Negligible |

# 12 Residual Risk

12.1.1 The residual risks of flooding associated with the Project are:

- Fluvial Flooding;
- Surface Water Flooding; and
- Reservoir Failure (Breach of ASFA).

12.1.2 This assessment has quantified the risks of fluvial and surface water flooding at the Site and provided relevant mitigation to ensure there is no adverse impact to flood risk as a result of the Project but also to mitigate the impacts to equipment and personnel as far as reasonably possible.

12.1.3 **Section 10** of this FRA details all relevant flood mitigation and management measures incorporated at the Site to reduce this inherent risk as far as reasonably practicable. This includes the implementation of EFRP to manage the risks and impact during periods of fluvial or surface water flooding on the Site.

12.1.4 Irrespective of this there is still a residual risk of flooding from both fluvial and surface water associated with:

- Events that are greater than the design standards assessed and applied in the assessment design process;
- A failure by the contractor or operator to correctly implement the EFRP; and
- A failure in the process of flood warning from either the EA or Met Office.

12.1.5 As discussed in **Section 8.7** of this FRA, the Site is located adjacent to AFSA reservoir which is recognised and maintained under the Reservoir Act 1975. Reservoir flood mapping produced by the EA indicates that the Site is at risk of flooding following failure of AFSA.

12.1.6 The hydraulic modelling provided in **Annex B: East Stour Hydraulic Modelling Report** did not explicitly model a breach of the AFSA. It is acknowledged that if a breach did occur this could result in deep and high velocity flood flows passing through areas of the Site.

12.1.7 Flooding of this nature would damage and destroy some of the PV Arrays; however, the layout of the Project would ensure that key elements including the Project Substation and most of the Inverter Stations were not impacted. In addition, the implementation of the EFRP would adequately protect staff and personnel from harm.

12.1.8 Following this review, it is concluded that the residual flood risks are suitably low, and that further mitigation or management is not required.

# 13 Conclusions

## 13.1 Background

13.1.1 SLR has been appointed by the Applicant to provide a FRA in support of a DCO Application.

13.1.2 With reference to the Flood Map for Planning, the Site is considered to lie within Flood Zones 1, 2, 3a and 3b as defined in Table 1 of PPG.

13.1.3 Operational elements of the Project proposed in Flood Zone 3a and 3b are as follows;

- PV panels – limited to locations whereby the design flood depth is below 0.8m;
- Sellindge Substation - The design flood depth in this area is shallow and not sufficient to damage electric equipment which will be appropriately raised;
- Below ground electric cables which will extend through areas of Flood Zone 3a and 3b. Once in place these will not be impacted by flooding and will not have any effect on flood risk;
- Security fencing – raised by 0.2m off of ground and with mesh sized >0.1m to minimise risk of conveyance impacts; and
- Internal access tracks – 90% permeable and constructed at grade to avoid impact on runoff and conveyance.

## 13.2 Vulnerability Classification and Flood Zone Compatibility

13.2.1 The Project is classed as ‘Essential Infrastructure’ development type which is defined as ‘Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including infrastructure for electricity supply including generation, storage and distribution systems; including electricity generating power stations, grid and primary substations storage; and water treatment works that need to remain operational in times of flood’.

13.2.2 ‘Essential Infrastructure’ development types are subject to the Exception Test when located in areas designated as Flood Zone 3a and 3b.

## 13.3 Sequential and Exception Tests

13.3.1 The sequential and exception tests have been applied to the Project and are passed. This FRA demonstrates that the Project can be made safe throughout its anticipated lifetime.

## 13.4 Flood Risk Management

13.4.1 The Project layout has been informed by detailed hydraulic modelling of the East Stour River undertaken by SLR Consulting. Design principles have been adopted which ensure that the Project will be able to operate without significant damage even during severe flood conditions.

13.4.2 EFRPs will be in place for all stages of the Project (construction, operation and maintenance, and decommissioning). These will adopt the EA Flood Alert and Warning system and Met Office severe weather warnings, with evacuation protocols in place as necessary.

## 13.5 Off-site Impacts

13.5.1 The Project will not detrimentally affect flood risk elsewhere but instead will result in a small net benefit on flood risk through the increases in the flood storage capacity available on Site both upstream and downstream of the AFSA embankment as a result of the Project.

## 13.6 Residual Risk

13.6.1 It is acknowledged that residual risks of flooding will exist associated with:

- fluvial and surface water flooding events that are greater than the design standards assessed and applied in the assessment design process;
- a failure by the contractor or operator to correctly implement the EFRP;
- a failure in the process of flood warning from either the EA or Met Office; and
- a failure of the embankment of the AFSA.

13.6.2 Following this review, it is concluded that the residual flood risks are suitably low and that further mitigation or management is not required.

# 14 References


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1.1.1 This Annex to **ES Volume 4, Appendix 10.2: Flood Risk Assessment (Doc Ref. 5.4)** ('FRA') provides background information on how the FRA for the Stonestreet Green Solar DCO Project is compliant with Paragraph 5.8.15 of NPS EN-1, which sets out the minimum requirements for FRAs.

1.1.2 For ease, the requirements listed in Paragraph 5.8.15 of NPS EN-1 are reproduced in **Table 1**. The 'FRA Compliance' column indicates how these requirements have been addressed.

**Table 1: NPS EN-1 Compliance**

| NPS EN-1 Requirements | FRA Compliance |
|---|---|
| *be proportionate to the risk and appropriate to the scale, nature and location of the project;* | The information presented in the FRA is considered to be proportionate to the risk and appropriate to the scale, nature and location of the Project. The FRA assesses the potential flood risk to the Site within the Order limits but also considers key receptors including the AFSA. The scope of the assessment has been agreed through consultation with key stakeholders including the EA, the LLFA (Kent County Council) and the River Stour (Kent) IDB. Details on the consultation process with these bodies and how this has been reflected in the assessment and **Outline OSWDS (Doc Ref. 7.14)** is set out in **Tables 10.1 to 10.4** of **ES Volume 2, Chapter 10: Water Environment (Doc Ref. 5.2)**. |

| NPS EN-1 Requirements | FRA Compliance |
|---|---|
| *consider the risk of flooding arising from the project in addition to the risk of flooding to the project;* | **ES Volume 4, Appendix 10.2: FRA, Section 8 (Doc Ref. 5.4)** provides a screening assessment of potential sources of flood risk at the Site. The risk posed by potentially significant sources is then considered in detail in **ES Volume 4, Appendix 10.2: FRA, Sections 9 and 10 (Doc Ref. 5.4)** with the changes in flood risk arising from the Project considered in **ES Volume 4, Appendix 10.2: FRA, Section 11 (Doc Ref. 5.4)**. Residual flood risk is considered in **ES Volume 4, Appendix 10.2: FRA, Section 12 (Doc Ref. 5.4)**.<br>A hydraulic model has been produced by SLR and is provided as **Annex B: East Stour Hydraulic Modelling Report** ('HMR') of **ES Volume 4, Appendix 10.2: FRA (Doc Ref. 5.4)**. The model enables the assessment of the risk of fluvial flooding to the Project (**ES Volume 4, Appendix 10.2: FRA, Sections 9.6** and **Section 10 (Doc Ref. 5.4)**) but also the risk of fluvial flooding arising from the Project (**ES Volume 4, Appendix 10.2: FRA Section 11 (Doc Ref. 5.4)**). |
| *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;* | Climate change allowances in line with relevant EA guidance are detailed in **ES Volume 4, Appendix 10.2: FRA, Section 7 (Doc Ref. 5.4)** and are applied in the analysis of surface water flood risk (in **ES Volume 4, Appendix 10.2: FRA, Section 9.5 (Doc Ref. 5.4)**) and fluvial flood risk (**ES Volume 4, Appendix 10.2: FRA, Section 9.6 (Doc Ref. 5.4)**).<br>The operational lifetime of the Project, which has then been applied to the assessment of climate change impacts, is stated in **ES Volume 4, Appendix 10.2: FRA, Section 7.2 (Doc Ref. 5.4)** (i.e. 40 years). |

| NPS EN-1 Requirements | FRA Compliance |
|---|---|
| *be undertaken by competent people, as early as possible in the process of preparing the proposal;* | The FRA has been undertaken by competent hydrologists at SLR with relevant qualifications and an array of experience.<br>Details are provided in **ES Volume 4, Appendix 1.5: Statement on Expertise and Qualifications of Competent Experts (Doc Ref 5.4).** |
| *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;* | The HMR provided as **ES Volume 4, Appendix 10.2: FRA, Annex B (Doc Ref. 5.4)** assesses both the defended (i.e., inclusion of AFSA) and undefended scenario.<br>An assessment of the residual risks to the Site (i.e., failure of the AFSA, surface water flooding and fluvial flooding) is provided in **ES Volume 4, Appendix 10.2: FRA, Section 12 (Doc Ref. 5.4)** and considers these to be suitably low. |
| *consider the vulnerability of those using the site, including arrangements for safe access and escape;* | **ES Volume 4, Appendix 10.2: FRA, Section 9 (Doc Ref. 5.4)** provides details of the measures that will be employed to ensure that the development will be safe for its lifetime taking account of the vulnerability of its users. Arrangements for safe access and escape will be detailed in Emergency Flood Response Plans ('EFRP') that will be prepared for each phase of the Project.<br>An outline of the contents of the EFRPs is provided within the **Outline Construction Environmental Management Plan ('Outline CEMP') (Doc Ref. 7.8)**, the **Outline Operational Management Plan ('Outline OMP') (Doc Ref. 7.11)** and the **Outline Decommissioning Environmental Management Plan ('Outline DEMP') (Doc Ref. 7.12)**. |

| NPS EN-1 Requirements | FRA Compliance |
|---|---|
| *consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and include information on flood likelihood, speed-of-onset, depth, velocity, hazard and duration;* | The HMR provided as **ES Volume 4, Appendix 10.2: FRA, Annex B (Doc Ref. 5.4)** details modelling that numerically assesses the speed of onset, depth, velocity and duration of fluvial flood risk and based on this it is clear that the Flood Hazard will be low in key areas of the site. This has then been fed through into the detailed assessment of fluvial flood risk contained in **ES Volume 4, Appendix 10.2: FRA, Section 9.6 and 10 (Doc Ref. 5.4)**.<br><br>For other flood sources the nature of flooding has been considered qualitatively based on available data sources. This has been fed through into the assessment of flood risk contained in **ES Volume 4, Appendix 10.2: FRA, Sections 8, 9 and 10 (Doc Ref. 5.4)**. |
| *identify and secure opportunities to reduce the causes and impacts of flooding overall, making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management;* | **ES Volume 4, Appendix 10.2: FRA, Section 11 (Doc Ref. 5.4)** assesses the flood impacts that could arise from the Project and details how these are avoided through design and layout. **ES Volume 4, Appendix 10.2: FRA, Table 11.2 (Doc Ref. 5.4)** concludes that all potential impacts are negligible.<br><br>**The Outline Operational Surface Water Drainage Strategy (‘OSWDS’) (Doc Ref. 7.14)** sets out measures to manage storm water runoff from the Site. This includes restricting runoff through the use of SuDS to the greenfield runoff rates and the introduction of depression storage to better manage runoff from the land and provide addition fluvial flood storage on the Site. |
| *consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;* | **ES Volume 4, Appendix 10.2: FRA, Section 8 (Doc Ref. 5.4)** provides a preliminary assessment of the risk of flooding from all potential sources. **ES Volume 4, Appendix 10.2: FRA, Section 9 (Doc Ref. 5.4)** provides a detailed review of flood sources that are considered significant (surface water and fluvial) analysing a range of return period flood events to the Project. |

| NPS EN-1 Requirements | FRA Compliance |
|---|---|
| *include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that these risks can be safely managed, ensuring people will not be exposed to hazardous flooding;* | **ES Volume 4, Appendix 10.2: FRA, Section 12 (Doc Ref. 5.4)** provides an assessment of the residual risks to the Site (i.e. failure of the AFSA, surface water flooding and fluvial flooding) and concludes these to be suitably low and that they will be safely managed through the implementation of EFRPs (see **Outline CEMP (Doc Ref. 7.8)**, **Outline OMP (Doc Ref. 7.11)** and **Outline DEMP (Doc Ref. 7.12)** for details. |
| *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:*<br>*i. Describe the existing surface water drainage arrangements for the site* | The existing surface water drainage arrangements are provided in the **Outline OSWDS, Section 2 (Doc Ref. 7.14)**. |
| ii. Set out (approximately) the existing rates *and* volumes of surface *water* run-off generated by the site. Detail the proposals for restricting discharge rates | The existing rates and volumes of surface water runoff of the Site are provided in the **Outline OSWDS, Section 4.2 (Doc Ref. 7.14)** and **Outline OSWDS, Appendix A (Doc Ref. 7.14)**. Details for restricting discharge rates are provided in the **Outline OSWDS, Section 4.6 (Doc Ref. 7.14)**. |
| *iii.* Set *out proposals for managing and discharging surface water from the site using sustainable drainage systems and accounting for the predicted impacts of climate change. If sustainable drainage systems have been rejected, present clear evidence of why their inclusion would be inappropriate* | Proposals for managing and discharging surface water runoff from the Site are detailed in **Outline OSWDS, Section 4.6 (Doc Ref. 7.14).** These proposals incorporate sustainable drainage systems and account for projected uplifts in peak rainfall associated with climate change over the lifetime of the Project. |

| NPS EN-1 Requirements | FRA Compliance |
|---|---|
| *iv. Demonstrate how the* hierarchy *of drainage options has been followed.* | This information is provided in the **Outline OSWDS, Section 4.5 (Doc Ref. 7.14).** |
| *v. Explain and justify why the types of SuDS and method of discharge have been selected and why they are considered appropriate.* | This information is provided in the **Outline OSWDS, Section 4.5 (Doc Ref. 7.14).** |
| *vi. Explain how sustainable drainage systems have been integrated with other aspects of the development such as open space or green infrastructure, so as to ensure an efficient use of the site* | This information is provided in the **Outline OSWDS, Section 4.6 (Doc Ref. 7.14)**. |
| *vii. Describe the multifunctional benefits the sustainable drainage system will provide* | This information is provided in the **Outline OSWDS, Section 4.6 (Doc Ref. 7.14)**. |
| *viii. Set out which opportunities to reduce the causes and impacts of flooding have been identified and included as part of the proposed sustainable drainage system* | This information is provided in the **Outline OSWDS, Section 4.6 (Doc Ref. 7.14)**. |
| *ix. Explain how run-off from the completed development will be prevented from causing an impact elsewhere* | This information is provided in the **Outline OSWDS, Section 4.6 (Doc Ref. 7.14)**. |

| NPS EN-1 Requirements | FRA Compliance |
|---|---|
| x. *Explain how the sustainable drainage system been designed to facilitate maintenance and, where relevant, adoption. Set out plans for ensuring an acceptable standard of operation and maintenance throughout the lifetime of the development* | This information is provided in the **Outline OSWDS, Section 4.6 (Doc Ref. 7.14)** with further details relating to the ongoing operation and maintenance of the proposed SuDS included in the **Outline OSWDS, Section 4.9 (Doc Ref. 7.14)**. |
| • *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;* | **ES Volume 4, Appendix 10.2: FRA, Section 10.3 (Doc Ref. 5.4)** details design measures at the Site to mitigate, manage or avoid flood risk and ensure the development will remain operational during a flooding event throughout the Project's lifetime with no impact on flood risk elsewhere (**ES Volume 4, Appendix 10.2: FRA, Section 11 (Doc Ref. 5.4)**).<br>EFRPs (see the **Outline CEMP (Doc Ref. 7.8)**, **Outline OMP (Doc Ref. 7.11)** and **Outline DEMP (Doc Ref. 7.12)**) will ensure the safety of staff and personnel on the Site. |
| • *identify and secure opportunities to reduce the causes and impacts of flooding overall during the period of construction; and* | The **Outline CEMP (Doc Ref. 7.8)** provides measures that will be implemented during construction to manage ground condition, avoid uplifts in storm water runoff and protect the AFSA embankment. A surface water drainage scheme will also be developed as part of surface water management measures as secured by the **Outline CEMP (Doc Ref. 7.8)**.<br>The **Outline CEMP (Doc Ref. 7.8)** states that the Principal Contractor will be required to produce an EFRP with the detailed CEMP(s) and sets out the information that this will be required to include. The EFRP will be in place for the construction phase.<br>The implementation of these measures will reduce the impact from flooding. |

| NPS EN-1 Requirements | FRA Compliance |
|---|---|
| • *be supported by appropriate data and information, including historical information on previous events.* | Refer to relevant data sources listed in **ES Volume 4, Appendix 10.2: FRA, Section 9.2 (Doc Ref. 5.4)** and **ES Volume 4, Appendix 10.2: FRA, Section 9.4 (Doc Ref. 5.4)** on Historic Flooding. |

# Annex B: East Stour Hydraulic Modelling Report

## Stonestreet Green Solar Farm

### EPL 001 Limited

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Making Sustainability Happen

## Revision Record

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# Basis of Report

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# Acronyms and Abbreviations

| | |
|---|---|
| 1D | 1-Dimensional |
| 2D | 2-Dimensional |
| AEP | Annual Exceedance Probability |
| AFSA | Aldington Flood Storage Area |
| DCO | Development Consent Order |
| DTM | Digital Terrain Model |
| EA | Environment Agency |
| ES | Environmental Statement |
| FEH | Flood Estimation Handbook |
| FRA | Flood Risk Assessment |
| GPS | Global Positioning System |
| ha | Hectares |
| HC | Higher Central |
| HMR | Hydraulic Modelling Report |
| HR | Hydrology Report |
| HS1 | High Speed 1 |
| kV | Kilovolt |
| LiDAR | Light Detecting and Ranging |
| mAOD | m Above Ordnance Datum |
| MW | Megawatt |
| NGR | National Grid Reference |
| NPPF | National Planning Policy Framework |
| PPG | Planning Practice Guidance |
| PV | Photovoltaic |
| ReFH2 | Revitalised Flood Hydrograph 2 |
| UE | Upper End |
| UK | United Kingdom |

# 1.0 Introduction

## 1.1 Background

This Hydraulic Modelling Report ('HMR') has been prepared by SLR Consulting Limited ('SLR') on behalf of EPL 001 Limited ('the Applicant') in relation to the Development Consent Order ('DCO') application for Stonestreet Green Solar ('the Project'). This HMR has been prepared to summarise the construction of a linked 1-Dimensional ('1D') / 2-Dimensional ('2D') hydraulic model of the East Stour and its associated tributaries, developed to inform the Flood Risk Assessment ('FRA') for the Project.

The aim of the model is to evaluate the fluvial flood risk to the Site from the East Stour and its associated tributaries for specific flood events corresponding to the risk categories defined by both the Development Plan Policy and the National Planning Policy Framework[1] ('NPPF') and its associated Planning Practice Guidance[2] (PPG). The model has been used to assess the fluvial flood risk including the effect of flood defences ('the Defended scenario') and without the effect of flood defences ('the Undefended scenario'). In addition, the impact of climate change has been considered.

The output of the hydraulic model is considered to provide the best currently available information on flood risk to the Project.

This HMR should be read in conjunction with the other documents submitted within the Application.

## 1.2 The Project

The Project comprises the construction, operation, maintenance, and decommissioning of solar photovoltaic ('PV') arrays and energy storage, together with associated infrastructure and an underground cable connection to the existing National Grid Sellindge Substation.

The Project will include a generating station (incorporating solar arrays) with a total capacity exceeding 50 megawatts ('MW'). The agreed grid connection for the for the Project will allow the export and import of up to 99.9 MW of electricity to the grid. The Project will connect to the existing National Grid Sellindge Substation via a new 132 kilovolt ('kV') substation constructed as part of the Project and cable connection under the Network Rail and High Speed 1 ('HS1') railway.

The location of the Project is shown on **ES Volume 3, Figure 1.1: Site Location Plan (Doc Ref. 5.3)**. The Project will be located within the Order limits (the land shown on the **Works Plans (Doc Ref. 2.3)** within which the Project can be carried out). The Order limits plan is provided as **ES Volume 3, Figure 1.2: Order Limits (Doc Ref. 5.3)**. Land within the Order limits is known as the 'Site'. A general Site location plan is provided by **HMR Figure 1**.

## 1.3 Model Selection

A linked 1D/2D hydraulic model has been selected to quantify the extent and depth of flooding at the Site as this type of model is better able to represent the two-dimensional flow characteristics associated with the expected 'out of bank' flows compared with a full 1D model.

The model has been constructed using the ESTRY/TUFLOW[3] linked hydraulic modelling package. This package is developed and distributed by BMT and is widely used in the UK.

The Site is primarily at risk of flooding from the East Stour River, including from the impounded area of the Aldington Flood Storage Area ('AFSA'). The East Stour River flows generally in a westerly direction through the northern extent of the Site, with the northwestern extremities of the Site lying within the AFSA. Downstream of the AFSA embankment the channel has been modelled using the 1D ESTRY hydraulic model package which is linked to the 2D TUFLOW hydraulic model package. The AFSA, channels upstream of the AFSA embankment, and out-of-bank overland flow paths have been modelled using TUFLOW.

The TUFLOW 2D computational engine represents flow paths by dividing the floodplain into a grid of individual cells. The flow of water between cells is then computed repeatedly at regular timesteps by solving the 2D shallow-water equations to simulate the passage of the flood wave and estimate the spread of flooding. As each cell contains information on the ground level, flood flows can be routed in any direction and will naturally tend to follow the local topography. These models are therefore ideally suited to cope with topographical variations in the floodplain and areas with complex flow paths.

## 1.4 Extent of Study Area

The 2D hydraulic model has been constructed to include all the hydraulically significant features in the vicinity of the Site. Some of the key features include the following:

- AFSA embankment and control structures;
- HS1 railway embankment and culverts; and
- Station Road bridge crossings and sluice gate.

The lateral extent of the model was selected to ensure that it encompassed the full extent of the 0.1% Annual Exceedance Probability (‘AEP’) flood event. The extent of the study area and location of the modelled watercourses is shown on **HMR Figure 2**.

Within the study area is the AFSA which forms part of the Ashford Flood Alleviation Scheme, completed in 1989 to reduce the frequency and intensity of flooding in both the rural and urban areas of Ashford and nearby villages. The works at Aldington were designed to reduce the flood flows from a peak of 19m$^3$/s for the 1.0% AEP event to just in excess of 4m$^3$/s for the peak outflow. This was achieved by means of a vortex flow control device located on an unnamed tributary (‘Unnamed Tributary 3’) south of the East Stour channel, in combination with the construction of an embankment to create a flood storage area which provides temporary detention of the flood volume for discharge at the reduce flow rate over a longer timescale. Upstream of the AFSA embankment flows are diverted into Unnamed Tributary 3 via by a weir located at approximately NGR: TR 06720 38136. The weir ensures that the fish pass through the AFSA embankment remains operational and that the downstream mill wheel can be operated. At Evegate Mill House a sluice gate at approximately NGR: TR 06381 38133 and weir at approximately NGR: TR 06386 38093 control water levels within the East Sour River and divert flows into the Mill Race. The Mill Race and Unnamed Tributary 3 flow back into the East Stour at approximately NGR: TR 06190 38081.

The upstream model boundaries have been set at Harringe Lane, approximately 1km upstream of the Site boundary on the East Stour. On Unnamed Tributaries 1 and 2 the upstream boundary has been set at the A20, approximately 330m northeast of the Site, this is to ensure that any attenuating effects of the M20 road and HS1 railway embankments downstream are represented within the model. On Unnamed Tributary 3 the upstream boundary has been set at Church Lane, approximately 390m east of the AFSA impoundment area. The downstream boundary of the model is set at NGR: TR 05292 38607, approximately 600m northwest of the Site boundary where the local topography constricts the floodplain.

# 2.0 Data Collection

## 2.1 2-Dimensional Model Requirements

The construction of 2D hydraulic models requires a number of data sets and parameters which include the following:

- Channel topographic cross-sections;
- Floodplain topography in the form of a digital terrain model (DTM);
- Hydraulic structures;
- Hydrological inputs;
- Hydraulic boundaries; and
- Hydraulic roughness (Manning's n)

### 2.1.1 Channel Topographic Cross-Sections

#### 2.1.1.1 SLR Topographic Survey

Cross-sections of the river channel were survey by the Land Surveying team at locations specified by the Hydraulic Modelling team. A TS15 total station (Theodolite) was used principally for the survey of the river cross-sections and the elevations of bridges, culverts and other structures. This was supplemented by a Zenith 40 GPS where no line of sight from the Theodolite was available.

Georeferenced ground levels were taken along 13 cross-sections within the study section of the river. To enable the channel to be accurately represented in the 1D domains, cross-sections were specified where a significant change in the river morphology occurred, such as a change in direction, channel width or channel depth.

In addition to the cross-sections, spot level elevations were recorded along Church Lane to the north and south of the M20 and HS1 embankment underpasses, which form a key flow path within the study area. Spot level elevations were also recorded along Evegate Mill Lane immediately north of Unnamed Tributary 3, where the LiDAR DTM showed an unrealistic depression in road levels.

The SLR topographic survey is enclosed at **Annex A**.

#### 2.1.1.2 Environment Agency Supplied Topographic Survey

In addition to the topographic survey undertaken by the Land Surveying team, river channel survey data[4] for the East Stour River and Tributaries were provided by the Environment Agency (EA). The topographic survey included 95 cross-sections within the study section of the river, which were incorporated into the model to accurately represent the East Stour in both the 1D and 2D domains.

J01058 East Stour, Ashford to Stanford Channel Survey undertaken by Maltby Land Surveys Ltd between December 2017 and March 2018 is enclosed at **Annex B**.

### 2.1.2 Floodplain Topography (DTM)

The 1m composite 2022 filtered aerial photogrammetry (LiDAR) data[5] for the wider study area was obtained from the Defra Website which has been used for the DTM of the wider study area. However, within the land encompassed by the Order limits, UAV Photogrammetry and LiDAR point cloud topographic survey data (obtained by Sensat in January 2022) has been used to define the DTM.

The topography of the study area is shown on **HMR Figure 3** and the topographic survey completed by Sensat is enclosed at **Annex C**

### 2.1.3 Hydraulic Structures

A number of hydraulic structures cross the East Stour and its associated tributaries within the study area. Details of these structures were obtained as part of the topographic surveys.

The location of the hydraulic structures within the model area is shown on **HMR Figure 4**.

### 2.1.4 Hydrological Inputs

The derivation of the hydrological inputs used in the model is detailed within Hydrology Report (HR) enclosed at **Annex D** The study area was broken down into five catchments, consisting of four lumped catchment estimates at the upstream extents of the East Stour, Unnamed Tributaries 1, 2 and 3 within the study area. The remaining intervening catchment was split into ten sub-catchments based on the study area topography and watercourses. The study area catchments and sub-catchments are illustrated on **HMR Figure 5**.

For the four lumped catchments peak flows were estimated using a Hybrid Method approach. For the 5% AEP event up to and including 1% AEP event, peak flows were estimated based on the Flood Estimation Handbook (FEH) Statistical Method, utilising single site donor adjusted QMED estimates and pooling group analysis. For the 0.1% AEP event, peak flows were estimated by applying the uplift from the 0.1% AEP event to 1% AEP event peak flow estimate from the FEH Revitalised Flood Hydrograph 2 (ReFH2) method to the Statistical Method 1% AEP event peak flow estimate. As the Statistical Method does not provide a hydrograph, the inflow hydrographs have been derived from ReFH2 method and factored so the critical storm duration winter event matches the final peak flow estimates.

For the intervening catchments, peak flows were estimated using the ReFH2 method.

Flow-Time hydrographs derived for the lumped catchments have been used at the upstream boundaries for the Hydraulic model, with Flow-Time hydrographs derived for the intervening catchment distributed across the reach of the watercourse flowing through the respective sub-catchment.

The final peak flow estimates for the 27.25hr event are set out in **Table 2-1**.

**Table 2-1 Model Inflows (27.25hr Event)**

| Site Code | Annual Exceedance Probability | | | | | |
|---|---|---|---|---|---|---|
| | 5.0 % Peak Flow ($m^3/s$) | 3.3% Peak Flow ($m^3/s$) | 1.0% Peak Flow ($m^3/s$) | 1.0% + HC CC[1] Peak Flow ($m^3/s$) | 1.0% + UE CC[2] Peak Flow ($m^3/s$) | 0.1% Peak Flow ($m^3/s$) |
| ESUS | 5.61 | 6.25 | 8.59 | 11.17 | 13.32 | 17.65 |
| TRIB1 | 3.6 | 4.06 | 5.89 | 7.66 | 9.13 | 11.57 |
| TRIB2 | 3.39 | 3.79 | 5.21 | 6.78 | 8.08 | 10.80 |
| TRIB3 | 2.20 | 2.49 | 3.88 | 5.04 | 6.01 | 7.19 |
| IES1 | 1.21 | 1.33 | 1.99 | 2.59 | 3.09 | 3.69 |
| IES2 | 1.43 | 1.58 | 2.36 | 3.07 | 3.66 | 4.38 |
| ITRIB1a | 0.25 | 0.27 | 0.41 | 0.54 | 0.64 | 0.77 |
| ITRIB1b | 0.14 | 0.15 | 0.23 | 0.30 | 0.36 | 0.44 |
| ITRIB2a | 0.10 | 0.12 | 0.18 | 0.23 | 0.27 | 0.33 |

| Site Code | Annual Exceedance Probability | | | | | |
|---|---|---|---|---|---|---|
| | 5.0 % Peak Flow ($m^3/s$) | 3.3% Peak Flow ($m^3/s$) | 1.0% Peak Flow ($m^3/s$) | 1.0% + HC CC[1] Peak Flow ($m^3/s$) | 1.0% + UE CC[2] Peak Flow ($m^3/s$) | 0.1% Peak Flow ($m^3/s$) |
| ITRIB2b | 0.08 | 0.09 | 0.14 | 0.18 | 0.21 | 0.26 |
| ITRIB3 | 0.71 | 0.79 | 1.18 | 1.53 | 1.83 | 2.18 |
| ICULV1 | 0.24 | 0.27 | 0.41 | 0.53 | 0.63 | 0.76 |
| ICULV2 | 0.37 | 0.41 | 0.63 | 0.82 | 0.97 | 1.17 |
| ICHL | 0.13 | 0.15 | 0.22 | 0.29 | 0.35 | 0.42 |

**Notes:**

[1]Higher Central (HC) 2050s epoch climate change allowance for the Stour Management Catchment.

[2]Upper End (UE) 2050s epoch climate change allowance for the Stour Management Catchment.

### 2.1.5 Hydraulic Boundaries

Hydraulic boundaries were defined sufficiently far enough upstream and downstream of the site ensure that all significant hydraulic features affecting the Site were incorporated into the model. The locations of the upstream and downstream model boundaries is illustrated on **HMR Figure 6**.

#### 2.1.5.1 Upstream Boundaries

The upstream boundaries were selected such that they were sufficiently upstream of the site, and for Unnamed Tributaries 1 and 2 upstream of both the M20 and HS1 embankments. This ensured that any attenuating effects of these embankments would be represented in the hydraulic model.

#### 2.1.5.2 Downstream Boundary

The downstream boundary was selected such that it was well downstream of the Site and any local flow paths suggested by the topography.

A Head-Flow boundary has been selected as the downstream boundary, with the 1D Head-Flow relationship derived from using the conveyance of the downstream model cross-section and slope of the 1D channel immediately upstream of the boundary. The 2D Head-Flow relationships have been derived automatically in TUFLOW by specifying the slope perpendicular to the boundary line.

### 2.1.6 Hydraulic Scenarios

The hydrological scenarios modelled are summarised in **Table 2-2**, with the critical duration events shown in **bold**.

**Table 2-2 Hydraulic Scenarios**

| Event Duration (Hours) | Annual Exceedance Probability (%) | | | | | |
|---|---|---|---|---|---|---|
| | 5.0 | 3.3 | 1.0 | 1.0 + HC CC | 1.0 + UE CC | 0.1 |
| 7.25 | | | | | | |
| 8.25 | Undefended | | | | | |
| 17.25 | **Undefended** | | Undefended | | | Undefended |
| 24.25 | Undefended | | **Undefended** | | | Defended<br>**Undefended** |
| 27.25 | | | Undefended | | Defended | **Defended**<br>Undefended |
| 36.25 | | | | Defended | **Defended Proposed Sensitivity** | Defended |
| 48.25 | | | Defended | **Defended** | Defended | |
| 60.25 | | | **Defended** | Defended | | |
| 72.25 | | | Defended | | | |
| 84.25 | Defended | Defended | | | | |
| 96.25 | **Defended** | **Defended** | | | | |

### 2.1.7 Hydraulic roughness

Channel and floodplain roughness was represented within the model by Manning's n. Values were initially chosen from those in published texts such as Chow (1959)[6] by comparison with photographs of the river and floodplain taken during the topographic survey.

A universal Manning's n value of 0.040 within the 1D domain of the model was initially selected to represent the river channel under '*normal*' conditions described in published texts as a '*clean, winding, some pools, shoals'*.

Floodplain roughness was represented by the Manning's n values shown in **Table 2-3**. Again these values were selected with reference to standard texts, photographs and engineering judgement.

**Table 2-3: Floodplain Manning's n Coefficients**

| Description | Manning's n value |
|---|---|
| Default Value | 0.035 |
| Buildings | 0.300 |
| General Surface (Natural) | 0.040 |
| Inland Water | 0.035 |
| Landform Slope | 0.025 |
| Natural Environment (Woodland) | 0.100 |
| Path | 0.035 |
| Railway Surfaces | 0.035 |
| Roads | 0.020 |

| Description | Manning's n value |
|---|---|
| Roadside | 0.035 |
| Unclassified | 0.035 |
| Main Channel, clean, winding, some pools and shoals, some weeds and stones | 0.045 |
| Main Channel, sluggish reaches, weedy, deep pools | 0.070 |
| Scattered Brush and Heavy Weeds | 0.050 |
| Light Brush and Trees | 0.060 |
| Medium to Dense Brush | 0.100 |

# 3.0 Model Construction

## 3.1 Software Version

In line with best practice, the hydraulic model was constructed with the latest ESTRY/TUFLOW software version 2023-03-AB.

## 3.2 Grid Size and Timestep

A 2D domain was constructed with a 2m grid which was considered an appropriate grid size for the extent of the study area. The model used TUFLOW HPC solver which uses an adaptive timestep. The time stepping used by the HPC solver during the model runs is discussed in **Section 5.4**.

## 3.3 1D Network

The 1D network was built using a combination of cross-section data from the surveyed cross-sections. The cross-sections were trimmed to the top of banks such that the 1D domain includes only the width of the river channel.

The upstream extents of the 1D network are at the AFSA control structures at NGR: TR 06703 38141 and NGR: TR 06679 37920 extending for an approximate 2.15km reach to the downstream extent of the model at TR 05292 38607. In addition to the 1D network the culverts through the embankments within the study area were modelled in 1D and embedded in the 2D domain.

### 3.3.1 Structures

A summary of the 1D structures modelled is provided in **Table 3-1** below.

**Table 3-1 Modelled 1D Structures**

| Structure | Location (Easting, Northing) | Details |
|---|---|---|
| Church Lane Bridge | 608147, 138125 | Arch bridge, EA survey section ESTO01_12172.<br>Modelled as I type culvert with default loss parameters.<br>Flow over deck modelled in 2D. |
| Access Bridge | 607801, 138125 | Arch bridge, EA survey section ESTO01_11808.<br>Modelled as I type culvert with default loss parameters.<br>Flow over deck modelled in 2D. |
| Fish Pass | 606687, 138135 | Culvert with 300mm diameter orifice, EA survey section ESTO01_10574.<br>Orifice dimensions provided by EA separately.<br>Modelled as C type culvert with default loss parameters.<br>Middle interpolate section representing orifice. |
| Footbridge | 606612, 138123 | Footbridge, EA survey section ESTO01_10482.<br>Modelled as BB type bridge with default loss parameters.<br>Flow over deck modelled as 1D weir. |
| Footbridge | 606391, 138108 | Footbridge, EA Survey Section ESTO10_0028.<br>Modelled as BB type bridge with default loss parameters.<br>Flow over deck modelled as 1D weir. |

| Structure | Location (Easting, Northing) | Details |
|---|---|---|
| Station Road Sluice Gate | 606372, 138135 | Sluice Gate, EA Survey Section ESTO01_10236.<br>Opening between top of sluice gate and soffit of culvert modelled as dual barrelled R type culverts, with default loss parameters.<br>Flow over deck modelled in 2D. |
| Station Road Culvert | 606372, 138135 | Culvert, EA Survey Section ESTO01_10236.<br>Modelled as dual barrelled R type culvert with default loss parameters.<br>Flow over deck modelled in 2D. |
| Weir | 606335, 138130 | Weir, EA Survey Section ESTO01_10192. Modelled as a WW type Weir with default loss parameters. |
| Weir | 606330, 138125 | Weir, EA Survey Section ESTO01_10190. Modelled as a WR type Weir with default loss parameters. |
| Access Bridge | 606081, 138141 | Access Bridge, EA Survey Section ESTO01_09835. Modelled as BArch type bridge with default loss parameters.<br>Flow over deck modelled in 2D. |
| Footbridge | 605670, 138276 | Footbridge, EA Survey Section ESTO01_09305. Modelled as BB type bridge with default loss parameters.<br>Flow over deck modelled as 1D weir. |
| Footbridge | 606386, 138096 | Footbridge, EA Survey Section ESTO06_0307.<br>Modelled as BB type bridge with default loss parameters.<br>Flow over deck modelled as 1D weir. |
| Disused Mill Wheel | 606381, 138093 | Weir, EA Survey Section ESTO06_0301. Modelled as a WW type Weir with default loss parameters. |
| Station Road Bridge | 606333, 138043 | Arch bridge, EA survey section ESTO06_0229.<br>Modelled as I type culvert with default loss parameters.<br>Flow over deck modelled in 2D. |
| Footbridge | 606488, 137839 | Footbridge, EA survey section ESTO07_0534.<br>Modelled as BB type bridge with default loss parameters.<br>Flow over deck modelled as 1D weir. |
| Station Road Culvert | 606368, 137877 | Culvert, EA survey section ESTO07_0354.<br>Modelled as R type culvert with default loss parameters.<br>Flow over deck modelled in 2D. |
| Hydrobrake | 606677, 137919 | Hydrobrake, stage discharge curve derived from gauge data provided by the EA.<br>Modelled as Q type depth discharge channel. |
| Railway Embankment Culvert | 607107, 138381 | Culvert, SLR survey section CULV1.<br>Modelled as C type culvert with default loss parameters.<br>Upstream invert level based on LiDAR data. Downstream invert level based on survey. |
| Ditch Connection | 606845, 138213 | Assumed culvert connection.<br>Modelled as C type culvert with default loss parameters.<br>500mm assumed diameter based on engineering judgement.<br>Invert levels based on LiDAR data. |

| Structure | Location (Easting, Northing) | Details |
|---|---|---|
| Ditch Connection | 606850, 138198 | Assumed culvert connection.<br>Modelled as C type culvert with default loss parameters.<br>500mm assumed diameter based on engineering judgement.<br>Invert levels based on LiDAR data. |
| Railway Embankment Culvert | 607417, 138282 | Culvert, SLR survey section CULV2.<br>Modelled as C type culvert with default loss parameters. |
| M20 Embankment Culvert | 608154, 138696 | Culvert, SLR photo TRIB1_002_P5.<br>Modelled as R type culvert with default loss parameters.<br>Height: 3.5m, Width: 3.0m, estimated dimensions from site walkover.<br>Invert levels based on LiDAR data. |
| Railway Embankment Culvert | 607689, 138274 | Culvert, SLR photos TRIB1_005_P1 and TRIB1_005_P2.<br>Modelled as C type culvert with default loss parameters.<br>2.4m diameter based on downstream channel width.<br>Upstream invert level based on LiDAR data. Downstream invert level based on surveyed downstream bed level. |
| Church Lane Ditch Connection | 608341, 138600 | Assumed culvert connection.<br>Modelled as C type culvert with default loss parameters.<br>500mm assumed diameter based on engineering judgement.<br>Invert levels based on LiDAR data. |
| Church Lane Ditch Connection | 608303, 138510 | Assumed culvert connection.<br>Modelled as C type culvert with default loss parameters.<br>500mm assumed diameter based on engineering judgement.<br>Invert levels based on LiDAR data. |
| Church Lane Ditch Connection | 608111, 138270 | Assumed culvert connection.<br>Modelled as C type culvert with default loss parameters.<br>500mm assumed diameter based on engineering judgement.<br>Invert levels based on LiDAR data. |
| Church Lane Ditch Connection | 608085, 138241 | Assumed culvert connection.<br>Modelled as C type culvert with default loss parameters.<br>500mm assumed diameter based on engineering judgement.<br>Invert levels based on LiDAR data. |
| M20 Embankment Culvert | 608668, 138387 | Culvert, SLR photos TRIB2_001_P1 and TRIB2_001_P2.<br>Modelled as R type culvert with default loss parameters.<br>Height: 2.5m Width: 3.5m, estimated dimensions from site walkover.<br>Invert levels based on LiDAR data. |
| Railway Embankment Culvert | 608570, 138100 | Culvert, SLR survey section TRIB2_002b.<br>Modelled as R type culvert with default loss coefficients.<br>Upstream invert level based on LiDAR data. Downstream invert level based on survey. |

| Structure | Location (Easting, Northing) | Details |
|---|---|---|
| Railway Embankment Culvert | 608589, 138098 | Culvert, no line of sight for survey.<br>Modelled as R type culvert with default loss coefficients.<br>Height: 2.0m Width: 3.0m, based on other railway embankment culverts and engineering judgement.<br>Invert levels based on LiDAR data. |

## 3.4 2D Domain

### 3.4.1 Topography Updates

A number of topographic features were reinforced or represented in the 2D domain using TUFLOW z shape layers. The details of which are as follows:

- AFSA embankment levels – Embankment and spillway crest levels were reinforced using a wide z shape line at 51.3mAOD and 50.2mAOD respectively. In line with the embankment crest level information provided by the EA.
- Bridge deck levels – Where the 2D ground levels were between bridge soffit and top of deck levels, surveyed top of deck levels have been reinforced using z shape regions, to represent the obstruction to flows.
- Parapet and head walls – Parapet and headwalls have been represented in the 2D domain using thin z shape lines with surveyed top of wall levels.
- Spill levels – Where structure overtopping flows have been modelled in 2D, surveyed spill or road crest level have been reinforced using z shape regions.
- East Stour side weir – For the East Stour River side weir just upstream of the fish pass, crest level have been reinforced using thin z shape line with surveyed levels. The downstream toe of weir has been reinforced using z shape regions with surveyed levels.
- Drainage ditches – Small drainage ditches within the model domain have been reinforced with wide z shape breaklines, from sampled minimum LiDAR levels within a 2m radius of the line.
- National Grid Bund – The bund running along the northern and eastern boundary of the National Grid Sellindge substation has been reinforced using a wide z shape breakline, from sampled maximum LiDAR levels within a 2m radius of the line.
- Top of bank levels – Top of bank levels along the 1D-2D boundaries of the model have been reinforced using wide z shape breaklines, from sampled maximum LiDAR levels within a 2m radius of the line.
- Road levels – Road levels along the Church Lane underpasses under the M20 and railway have been reinforced with surveyed road crest levels using z shape regions. Additionally, road levels along Station Road immediately north of Unnamed Tributary 3 have been reinforced with a z shape region using surveyed road crest levels, to fill a topographic low spot in the underlying LiDAR DTM.
- Smoothing – In order to smoothly tie in the areas of the DTM defined by the Sensat Topographic Survey with those defined by the LiDAR data z shape regions have been digitized around the boundary of the Sensat Topographic survey to smooth any differences in Surveyed and LiDAR level.

### 3.4.2 Buildings and Dense Vegetation

The obstruction to flood flows by buildings within the model domain has been represented by updating the manning's n coefficient for the building footprints to be 0.300.

Hedges, woodlands, and other dense stand of vegetation within the model domain have been represented by updating the manning's n coefficients for areas to values between 0.050 and 0.100 based on aerial imagery, observations from the site walkover, and engineering judgement.

### 3.4.3 Structures

A summary of the 2D structures modelled is provided in **Table 3-2** below.

**Table 3-2 Modelled 2D Structures**

| Structure | Location (Easting, Northing) | Details |
|---|---|---|
| Footbridge | 608816, 137925 | Footbridge, EA survey section ESTO01_12946.<br>Modelled using BG loss layer, with a peak form loss coefficient of 0.281. |
| Footbridge | 608570, 138029 | Footbridge, EA survey section ESTO01_12641.<br>Modelled using BG loss layer, with a peak form loss coefficient of 0.286. |
| Footbridge | 608496, 138049 | Footbridge, EA survey section ESTO01_12552.<br>Modelled using BG loss layer, with a peak form loss coefficient of 0.260. |
| Footbridge | 607359, 138176 | Footbridge, EA survey section ESTO01_11320.<br>Modelled using BG loss layer, with a peak form loss coefficient of 0.255. |
| Footbridge | 607201, 138173 | Footbridge, EA survey section ESTO01_11157.<br>Modelled using BG loss layer, with a peak form loss coefficient of 0.259. |
| Footbridge | 606809, 138209 | Footbridge, EA survey section ESTO01_10723.<br>Modelled using BG loss layer, with a peak form loss coefficient of 0.254. |
| Weir | 606719, 138147 | Weir, EA survey section ESTO07_0986.<br>Weir geometry reinforced in 2D domain using ZSH layers. |

| Structure | Location (Easting, Northing) | Details |
|---|---|---|
| Footbridge | 607675, 138205 | Footbridge, SLR survey section TRIB1_006.<br>Modelled using BG loss layer, with a peak form loss coefficient of 0.279. |

## 3.5 1D/2D boundary

The upstream 1D boundaries were defined using TUFLOW SX regions set within the upstream 2D channels immediately upstream of the AFSA embankment. Within the 1D modelled reach the 1D/2D boundaries were defined using TUFLOW HX lines set at the top of banks.

## 3.6 Inputs

The inputs to the model were applied as Flow-Time boundaries at the upstream boundaries of the model and as distributed lateral inflows throughout the modelled reaches. Head-Flow boundaries were applied at the downstream boundary in both the 1D and 2D domains to prevent any glass walling effects.

## 3.7 Post Development Scenarios

A number of new hedges are proposed as part of the landscaping strategy. The new hedges have been incorporated into the post development scenario using a manning's n value of 0.100 to represent the increased obstruction to flood flows.

The locations of the new proposed hedges is illustrated on **HMR Figure 7**.

### 3.7.1 Fence Blockage Scenarios

In addition to the impact assessment of the new proposed hedges, the potential impact of debris build up against the proposed fences within the floodplain has been assessed. Potentially debris sources and pathways were qualitatively assessed using engineering judgement to identify locations most at risk of blockage.

Two post development blockage scenarios were assessed, one consisting of a 25% blockage ratio and one consisting of a 50% blockage ratio. These were modelled using Cell Width Factor ('CWF') units, with a 0.75 CWF and 0.5 CWF applied for the 25% blockage and 50% blockage scenario respectively. Both blockage scenarios also include the new proposed hedges.

The location of the blockages assessed is illustrated on **HMR Figure 7**.

# 4.0 Sensitivity Analysis

In line with good practice, the following parameters and variables for the model for the 1% AEP event + UE CC have been varied by +/- 20%:

- Model inflows;
- Downstream boundary conditions; and
- Channel and floodplain roughness.

Additionally, cell size convergence was assessed by running the model with a 1m cell size.

## 4.1 Model Inflows

A sensitivity analysis has been undertaken on the model inflow to ensure that the model is not overly sensitive to the flow selected. The inflow was adjusted by +/- 20% and the results are summarised below:

- A 20% increase in model inflows, resulted in minor increases in flood extents within the AFSA, with more substantial increases in flood extent seen along the southern floodplain downstream of the AFSA. Within the AFSA, flood depths are shown to increase by approximately 30mm, with increases downstream of the AFSA generally between 40mm to 70mm.
- A 20% decrease in model inflows, resulted in minor decreases in flood extents within the AFSA, with more substantial decreases in flood extent seen along the southern floodplain downstream of the AFSA. Within the AFSA, flood depths are shown to decrease by approximately 30mm, with decreases downstream of the AFSA generally between 40mm to 90mm.
- The change in modelled flood extents and depths in response to a variation in model inflow show the expected relationship. The model results are not shown to be overly sensitive to the model inflows selected.

The variation on modelled flood extents in response to a variation in model inflow is illustrated on **HMR Figure 8**.

## 4.2 Downstream Boundary Conditions

A sensitivity analysis has been undertaken on the downstream boundary condition to ensure the model is not overly sensitive to the downstream boundary condition selected. The slope of the downstream boundary was adjusted by +/-20% and the results are summarised below:

- Variations in downstream boundary slope resulted in negligible changes in modelled flood extents.
- A 20% increase in downstream boundary slope reduced water levels at the downstream boundary by 65mm. With no change in water level shown from 250m upstream of the downstream boundary.
- A 20% decrease in downstream boundary slope increased water levels at the downstream boundary by 28mm. With no change in water level shown from 290m upstream of the downstream boundary.
- The change in modelled water levels in response to variation in downstream boundary slope show the expected relationship. The model results are not overly sensitive to the downstream boundary condition selected with the model results at the Site unaffected by variations in downstream boundary slope.

## 4.3 Hydraulic Roughness

A sensitivity analysis has been undertaken on the manning's n roughness coefficient selected to ensure the model is not overly sensitive to changes in manning's n coefficient. The manning's n coefficient was adjusted by +/- 20% and the results are summarised below:

- A 20% increase in manning's n coefficients resulted in minor increase in modelled flood extents. Within the AFSA, no changes in modelled flood depths can be seen. Downstream of the AFSA, increases in flood depths are generally shown between 30mm to 50mm.
- A 20% reduction in manning's n coefficients resulted in minor decreases in modelled flood extents. Within the AFSA, no changes in modelled flood depths can be seen. Downstream of the AFSA, decreases in flood depths are generally shown between 30mm to 70mm.
- The change in modelled flood extents and depths in response to a variation in model roughness show the expected relationship. The model results are not shown to be overly sensitive to the manning's n coefficients selected.

The variation in modelled flood extent in response to a variation in model roughness is illustrated on **HMR Figure 9**.

## 4.4 Cell Size Convergence

A sensitivity analysis has been undertaken on the model cell size selected to ensure that the cell size selected is sufficiently detailed to accurately represent the flow paths present. The cell size resolution was adjusted from 2m to 1m. Only minor changes in modelled extent can be seen as a result of increase the cell size resolution to 1m grid, as such the 2m model resolution is sufficient to accurately represent the flow paths present.

The variation in modelled flood extent in response to model cell size is illustrated on **HMR Figure 10**.

## 4.5 Summary

Sensitivity testing was undertaken on key model, including model inflows, downstream boundary condition, model roughness and model cell size. The model results demonstrate the expected relationships in response to variations in the key modelling parameters and are not shown to be overly sensitive to the key modelling parameters selected.

# 5.0 Model Validation and Health

## 5.1 Validation against Ashford Borough Council SFRA Mapping

The Ashford Borough Council ('ABC') Strategic Flood Risk Assessment ('SFRA')[7] mapping for Flood Zone 3b, considered as the 5% AEP or 4% AEP flood extent where modelled, and precautionarily the EA Flood Zone 3 extent where not mapped. The validation process using these flood extents has been undertaken as follows:

- For areas of the model downstream of the AFSA, comparison of model results for the 5% AEP Undefended event; and
- For areas within and upstream of the AFSA: the modelled 0.1% AEP Defended flood extent has been used in line with the definition of Flood Zone 3b. This aligns with the definition of flood zones in the PPG which states that land that is design to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% AEP of flooding) will normally be defined as the Functional Floodplain.

ABC's mapping of Flood Zone 3b and equivalent modelled flood extents are illustrated on **HMR Figure 11.**

As can be seen on **HMR Figure 11,** downstream of the confluence of the East Stour River and Mill Race at NGR: TR 06194 38085, where the Flood Zone 3b has been based on the 5% AEP modelled extent for the Ashford Fluvial Modelling[8] study, the modelled extent for the 5% AEP Undefended scenario is broadly similar to the mapped extent for Flood Zone 3b.

Upstream of the confluence within the AFSA, Flood Zone 3b has been based on the EA Flood Map for Planning[9] Flood Storage Areas extent. The modelled 0.1% AEP Defended extents are shown to be larger, particularly to the north of the AFSA. With reference to **ES Volume 4, Annex 10.2 Flood Risk Assessment (Doc Ref. 5.4), Section 7.12** there are a number of key points of difference between the Ashford Fluvial Model and this study which may explain the discrepancy in extent. In particular, stage discharge gauge data for the AFSA hydrobrake indicate that current peak discharge rate modelled is lower than specified in the original design.

Upstream of the AFSA, Flood Zone 3b has been precautionarily based on the EA Flood Zone 3 mapping. As expected, the modelled flood extents for the 5% AEP Undefended scenario are shown to be substantially smaller.

The similarity of the extents downstream of the AFSA indicates that the model is representative of the current understanding of flood risk in the area. Upstream of the AFSA, the differences in flood extent are expected and as such not a cause of concern.

## 5.2 Validation against Environment Agency Mapping

To validate the modelled flood extents, the 1% AEP and 0.1% AEP Undefended modelled flood extents were compared to the EA Flood Map for Planning Flood Zones 3 and 2 respectively.

### 5.2.1 Flood Zone 3

The EA mapping of Flood Zone 3 and equivalent modelled 1% AEP Undefended flood extent are illustrated on **HMR Figure 12.**

As can be seen on **HMR Figure 12**, downstream of the confluence of the East Stour River and Mill Race, where it is understood that Flood Zone 3 is based on the Ashford Fluvial Modelling study, the modelled extents are shown to closely match the Flood Zone 3 mapping.

Upstream of the confluence it is understood that Flood Zone 3 is based on coarse national scale flood zone mapping. Between the confluence and the AFSA, the modelled extents are broadly similar to the Flood Zone 3 mapping. Within the AFSA, modelled extents are similar particularly to the north, with reductions in extent seen to the south. Upstream of the AFSA significant reductions in extent are seen. The discrepancy in modelled extent upstream of the AFSA embankment may be due to improved representation of channel conveyance in finer scale model developed for this study, the representation of the Undefended scenario, and the hydrological inputs for this study calculated for critical flood events at the site.

Within the areas of the site where development is proposed, the modelled extents indicate that the model is representative of the current understanding of flood risk in the area.

### 5.2.2 Flood Zone 2

The EA mapping of Flood Zone 2 and equivalent modelled 0.1% AEP Undefended flood extent are illustrated on **HMR Figure 13**.

As can be seen on **HMR Figure 13**, downstream of the confluence of the East Stour River and Mill Race, where it is understood that Flood Zone 2 is based on the Ashford Fluvial Modelling study, the modelled extents are shown to closely match the Flood Zone 2 mapping.

Upstream of the confluence, it is understood that Flood Zone 2 is based on a combination of historic flood outlines and coarse national scale flood zone mapping. Between the confluence and the AFSA the modelled extents are shown to be broadly similar. Within the AFSA, where Flood Zone 2 is understood to be based on historic flood outlines, the modelled extents are shown to be substantially smaller. This discrepancy is likely due to the AFSA restricting flows during the historic flood event, leading to a larger flood extent. Additionally it is noted that the Flood Zone 2 extent to the south of the confluence of Unnamed Tributary 1 and the East Stour River at NGR: TR 07680 38219, does not follow the local topography, demonstrated by Flood Zone 2 extending over a hill.

Upstream of the AFSA, where Flood Zone 2 is understood to be based on coarse national scale flood zone mapping, the modelled extents are shown to be broadly similar.

Within the areas of the site where development is proposed and upstream of the AFSA, the modelled extents indicate that the model is representative of the current understanding of flood risk in the area.

## 5.3 Validation against Historic Flood Information

In order to validate the Defended scenario model, the modelled flood extents have been compared to aerial imagery of the November 2000 flood event illustrated on **HMR Figure 14**.

During the November 2000 flood event, peak flow at the South Willesborough gauge[10] reached 17.30m$^3$/s, which is located approximately 5km downstream of the study area. Adjusting for the approximate 13% increase in catchment area between the gauge and the downstream extent of the model a peak flow of 15.27m$^3$/s is expected at the downstream extent of the model for a similar event. This peak flow is between the peak flow of 13.4m$^3$/s for the 27.25 hour 1% AEP event and 16.9m$^3$/s for 36.25 hour 1% AEP event.

As can be seen on **HMR Figure 14**, the flood extents for these events are broadly similar to aerial imagery of flooding, with good agreement of the overland flow routes through the floodplain downstream of the AFSA. Additionally, good agreement can be seen between the modelled extent impounded by the AFSA and aerial imagery.

During the February 2014 flood events, peak flood levels are the AFSA gauge reached 50.3mAOD on the 15$^{th}$ February, with peak flows at the South Willesborough gauge reaching 11.50m$^3$/s. Adjusting for the increase in catchment area, a peak flow of 10.15m$^3$/s is expected at the downstream extent of the model for a similar event. This peak flow is the same as for the 96.25 hour 3.3% AEP event, where peak flood levels at the AFSA reached 50.26mAOD. JBA's analysis[11] found that the event had an annual probability of occurrence between 3.3% and 6.7% along the East Stour.

The modelled flood extents and peak flows for the defended scenario show good agreement with the historic flood information, indicating that the model is representative of the current day flood risk to the Site.

## 5.4 Model Health

The TUFLOW HPC solver is an explicit solution which conserves volume, as such the adaptive timestep selected and three key control numbers are used to assess model stability.

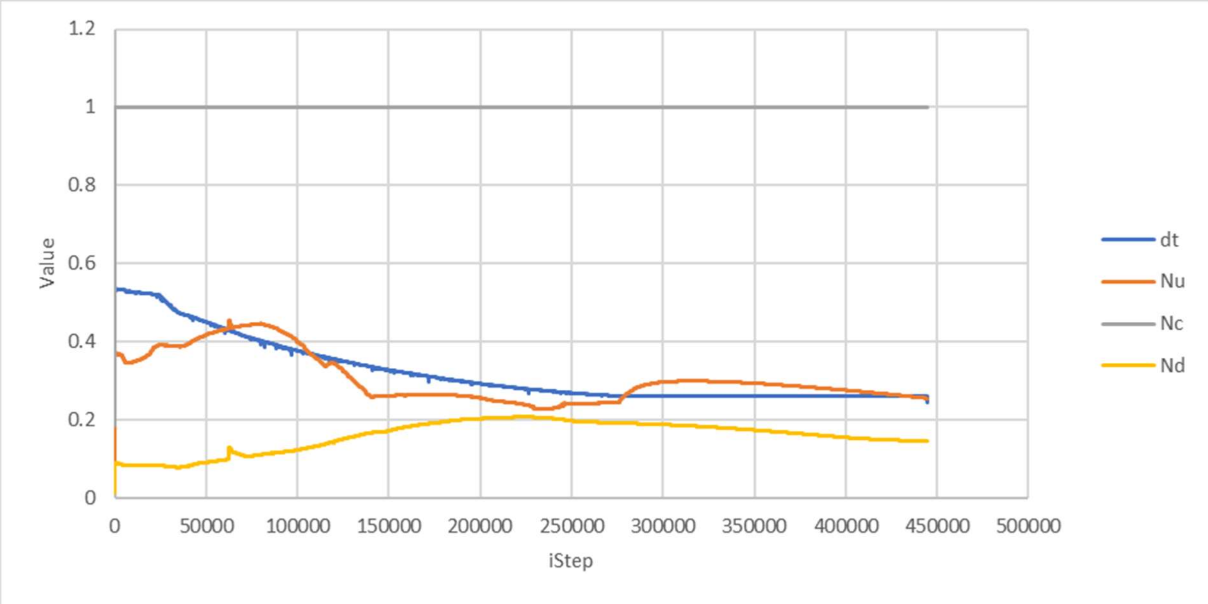
### 5.4.1 Defended Scenario

For the Defended scenario cumulative mass error remains below 0.3% as is expected when using a volume conserving solver. The adaptive timestep selected and Nu, Nc, and Nd control numbers for the pre-development 1% AEP + UE CC event are plotted in **Figure 5-1**. Referring to these model parameters and values plotted in **Figure 5-1**:

- The timestep (dt) selected by the HPC solver should not fall below 1/10$^{th}$ of the timestep value that would be selected for a TUFLOW Classic model. In the case of a model with a 2m cell size the HPC timestep should not fall below 0.04 seconds. As can be seen in **Figure 5-1**, dt remains above 0.04 seconds for the duration of the modelled event.
- Courant number (Nu) should not exceed 1.0, as can be seen Nu remains below 1.0 for the duration of the modelled event.
- Wave speed number (Nc) should not exceed 1.0, as can be seen Nc remains at 1.0 for the duration of the modelled event.
- Moment diffusion number (Nd) should not exceed 0.3, as can be seen Nd remains below 0.3 for the duration of the modelled event.

The timesteps selected by the HPC solver and control number outputs indicate that the model is healthy and stable.

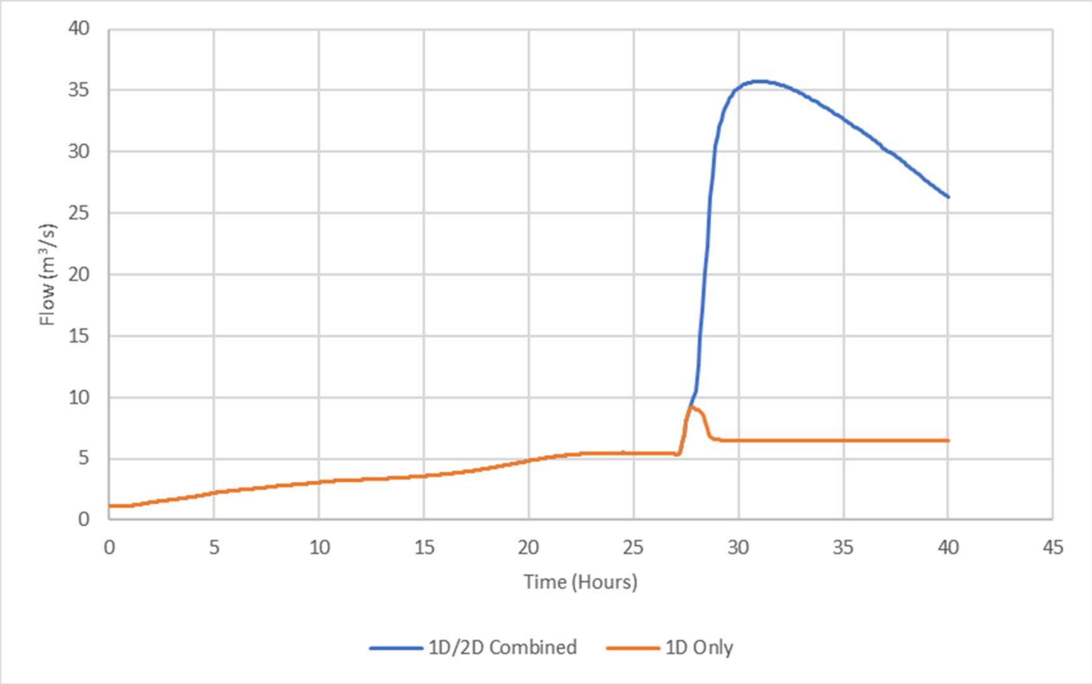
**Figure 5-1: Plot of Defended Scenario HPC Timestep and Control Numbers**




A review of the modelled flows, show that a spike in 1D flows can be observed at the footbridge structures when upstream water levels reach the soffit level. The increase in flow occurs as a result of pressure flow occurring initially when the upstream water levels reach the bridge soffit, as the downstream water levels increase the flow regime transitions to drowned flow which has higher energy losses and therefore reduced flow.

A plot of the 1D and combined 1D-2D flows at the footbridge at NGR: TR 05664 38273 (EA survey section ESTO01_09305) is shown in **Figure 5-2**. This shows the spike in 1D flows and that this spike in flow does not impact the peak 1D-2D combined flow, as such the spike in 1D flows is not expected to affect the modelled maximum flood depths, extent or flows when considering the whole 1D-2D model.

**Figure 5-2: ESTO01_09305 Modelled Flows**




### 5.4.2 Undefended Scenario

For the Undefended scenario cumulative mass error reaches 1.46%, which is associated with the 1D-2D model boundaries. It is noted that a 2% to 3% cumulative mass error can be considered acceptable in TUFLOW depending on the objectives of the modelling. Given that the design flood levels have been based on the Defended scenario not the Undefended scenario, the cumulative mass error in the Undefended results has no impact on the Project design. Additionally, the location of the 1D upstream boundary has been optimised for the Defended scenario, and retained in the Undefended model to ensure the representation of the different scenarios is as similar as possible.

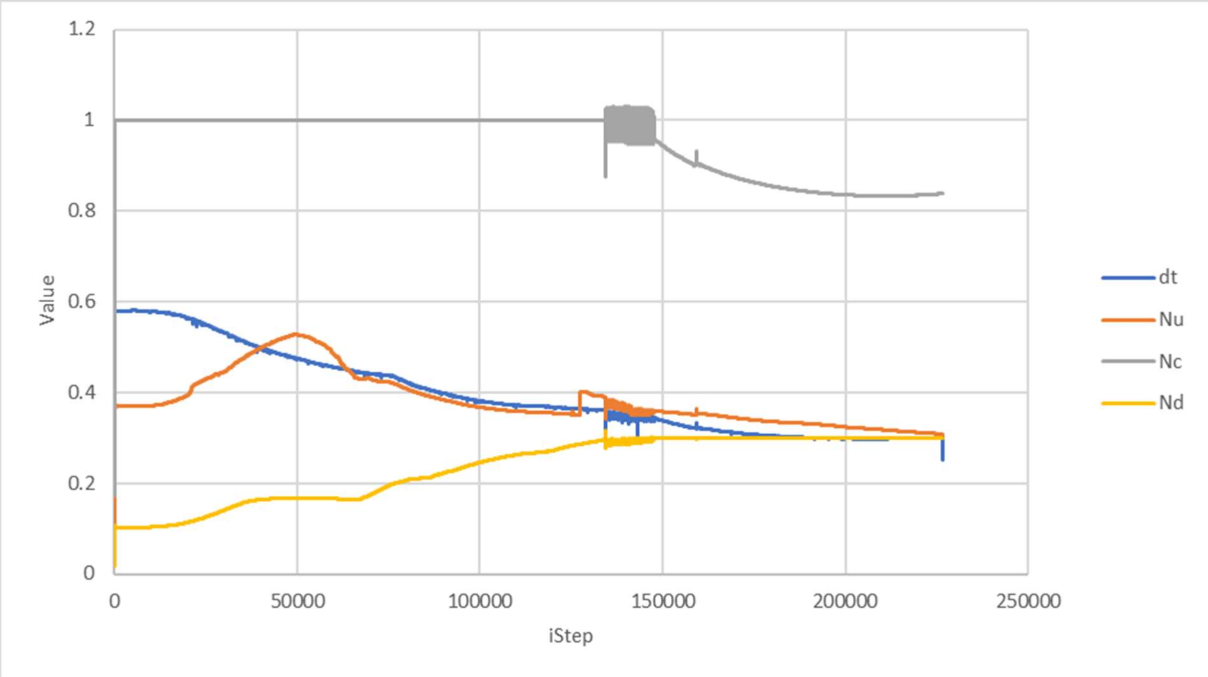
The adaptive timestep selected and Nu, Nc, and Nd control numbers for the pre-development Undefended scenario 0.1% AEP event are plotted in **Figure 5-3**. Referring to these model parameters and values plotted in **Figure 5-3**:

- dt remains above 0.04 seconds for the duration of the modelled event.
- Courant number (Nu) should not exceed 1.0, as can be seen Nu remains below 1.0 for the duration of the modelled event.
- Wave speed number (Nc) should not exceed 1.0, as can be seen Nc oscillates above and below 1.0 during the modelled event. Exceedances in control numbers are to be expected while model timestep is reducing and are an indicator that the initial timestep selected by the HPC solver was too large. This indicates that the model timesteps are limited by wave speed number, given that dt remains above 0.04 seconds the model remains healthy and stable.
- Moment diffusion number (Nd) should not exceed 0.3, as can be seen Nd remains at or below 0.3 for the duration of the modelled event.

The timesteps selected by the HPC solver and control number outputs indicated the model is healthy and stable.

The same spike in 1D flows at footbridge structures observed for the Defended scenario model are also present in the Undefended scenario. As for the Defended scenario model this spike is not expected to affect the modelled maximum flood depths, extent or flows when considering the whole 1D-2D model.

**Figure 5-3: Plot of Undefended Scenario HPC Timestep and Control Numbers**




## 5.5 Summary

Validation of the modelled flood extents and flows for the Defended scenario has been undertaken against historic flood information and found good agreement in modelled extents and flows for similar annual probability of occurrence historic events. This indicates that the Defended model is representative of the current day flood risk.

Validation of the modelled flood extents for the Undefended scenario has been undertaken against ABC's and the EA Flood Zone mapping and found good agreement in modelled flood extents where Flood Zones have been based on detailed modelling. Where Flood Zones have been based on coarse national scale modelling broad agreement with modelled flood extents can be seen. Where Flood Zones have been based on historical flood outlines poor agreement can be seen, which is due to the AFSA impounding flows during the recorded flood events increasing flood extents. Outside of the AFSA the Undefended model is representative of the current understanding of flood risk in the area.

The cumulative mass error, HPC timesteps and control numbers for Defended scenario indicate the model is healthy and stable.

There is slightly higher cumulative mass error for the Undefended scenario results compared with the Defended model. However, given the Undefended model has not been used for the Project's design this result is considered acceptable. The HPC timesteps and control numbers indicate the model is healthy and stable.

# 6.0 Model Results

## 6.1 Pre-Development Defended Model

### 6.1.1 5.0% AEP

The extent and depth of flooding expected in response to the 5.0% AEP event is illustrated on **HMR Figure 15.**

During the 5.0% AEP event, the AFSA is shown to reach full capacity during the critical duration 96.25 hour event, with the peak flow of 4.1$m^3$/s over the spillway.

Downstream of the AFSA, almost the entirety of Field 24 is shown to be inundated with flood depths predominantly below 100mm. In Field 23 a small overland flow route can be seen with flood depths remaining below 100mm. The remainder of the Project downstream of the AFSA is shown to remain flood free, and only small extents of out of bank flooding can be seen downstream of Station Road.

### 6.1.2 3.3% AEP

The extent and depth of flooding expected in response to the 3.3% AEP event is illustrated on **HMR Figure 16**.

During the 3.3% AEP event, the AFSA is shown to reach full capacity, with a peak flow of 6.3$m^3$/s over the spillway.

Downstream of the AFSA, almost the entirety of Field 24 is shown to be inundated with flood depths predominantly below 100mm. In Field 23 flood depths are shown to remain below 300mm. In Field 19 some overland flow routes can be seen with flood depths remaining predominantly below 100mm.

### 6.1.3 1.0% AEP

The extent and depth of flooding expected in response to the 1.0% AEP event is illustrated on **HMR Figure 17**.

During the 1.0% AEP event, the AFSA is shown to reach full capacity, with a peak flow of 14.5$m^3$/s over the spillway.

Downstream of the AFSA, the entirety of Field 24 is shown to be inundated with flood depths predominantly between 100mm to 200mm. In Field 23 flood depths are predominantly between 100mm to 300mm. The majority of Field 19 is shown to be inundated with the flood depths predominantly below 100mm, however deeper extents of flooding reaching approximately 400mm can be seen along the primary overland flow routes.

### 6.1.4 1.0% AEP + HC CC

The extent and depth of flooding expected in response to the 1.0% + HC CC AEP event is illustrated on **HMR Figure 18**.

During the 1% AEP + HC CC event, the AFSA is shown to reach full capacity, with a peak flow of 23.5$m^3$/s over the spillway.

Downstream of the AFSA, the entirety of Field 24 is shown to be inundated with flood depths predominantly between 200mm to 300mm. In Field 23 flood depths are predominantly between 200mm and 400mm. The majority of Field 19 is shown to be inundated with flood depths predominantly below 200mm, however deeper extents of flooding reaching approximately 500mm can be seen along the primary overland flow routes. Small extents of flooding can also be seen along the northern boundaries of Fields 16 and 18 remaining below 100mm.

### 6.1.5 1.0% AEP + UE CC

The extent and depth of flooding expected in response to the 1.0% + UE CC AEP event is illustrated on **HMR Figure 19**.

During the 1% AEP + UE CC event, the AFSA is shown to reach full capacity, with a peak flow of 30.8$m^3$/s over the spillway.

Downstream of the AFSA, the entirety of Field 24 is shown to be inundated with flood depths predominantly between 300mm and 400mm. In Field 23 flood depths are predominantly between 200mm and 400mm. The majority of Field 19 is shown to be inundated with flood depths predominantly below 300mm, however deeper extents of flooding reaching approximately 550mm can be seen along the primary overland flow routes. Small extents of flooding can also be seen along the northern boundaries of Fields 16 and 18 remaining below 200mm.

### 6.1.6 0.1% AEP

The extent and depth of flooding expected in response to the 0.1% AEP event is illustrated on **HMR Figure 20**.

During the 0.1% AEP event, the AFSA is shown to reach full capacity, with a peak flow of 41.4$m^3$/s over the spillway.

Downstream of the AFSA, the entirety of Field 24 is shown to be inundated with flood depths predominantly between 300mm and 400mm. In Field 23 flood depths are predominantly between 200mm and 500mm. The majority of Field 19 is shown to be inundated with flood depths predominantly between 100mm and 400mm, however deeper extents of flooding reaching approximately 600mm can be seen along the primary overland flow routes.

An analysis of the results indicate that the flooding extent is very similar to the 1% HC CC AEP event, with an increase in flood inundation reaching across into Field 18 where a maximum depth of 0.2m is modelled at the northern extent. A maximum depth of 0.6m and 3.9m is modelled in Field 19 and Field 28 during this event. Small extents of flooding can be seen along the northern boundaries of Fields 16 and 18 predominantly below 200mm, with some small extents between 200mm and 300mm.

## 6.2 Pre-Development Undefended Model

### 6.2.1 5.0% AEP

The extent and depth of flooding expected in response to the 5.0% AEP event is illustrated on **HMR Figure 21**.

During the 5.0% AEP event, the model shows in the absence of the existing defences, the majority of Fields 19, 23 and 24 are at risk of flooding.

### 6.2.2 1.0% AEP

The extent and depth of flooding expected in response to the 1.0% AEP event is illustrated on **HMR Figure 22**.

During the 1.0% AEP event, the model shows in the absence of existing defences, the majority of Fields 19, 23 and 24 are at risk of flooding. Additionally, small extents of flooding can be seen along the northern boundaries of Field 16 and 18.

### 6.2.3 0.1% AEP

The extent and depth of flooding expected in response to the 0.1% AEP event is illustrated on **HMR Figure 23**.

During the 0.1% AEP event, the modelling shows in the absence of the existing defences, the majority of Fields 19, 23 and 24 are at risk of flooding. Additionally, Fields 16 and 18 are shown to be partially inundated along their northern boundaries.

## 6.3 Impact Assessment

### 6.3.1 Hedges

The change in modelled flood depths and extent as a result of the proposed hedges for the design 1% AEP + UE CC event is illustrated on **HMR Figure 24**.

As can be seen, there proposed hedges only have small localised impacts on flood depths around Fields 23 and 24, with increases remaining below 5mm.

The proposed hedges have minimal impacts on local flood risk.

### 6.3.2 Fence Blockage

The change in modelled flood depth and extent as a result of the 25% blockage scenario is illustrated on **HMR Figure 25**, with the change as a result of the 50% blockage scenario illustrated on **HMR Figure 26**.

As can be seen, the 25% blockage scenario results in minor increases in modelled flood depths around Fields 23 and 24 and to the north of Field 19. Increases in flood depths are shown to remaining below 5mm.

The 50% blockage scenario results in increases in flood depths remaining below 5mm around Fields 23 and 24 and to the north of the eastern half of Field 19. To the north of the western half of Field 19 increases in flood depths are shown to remain below 10mm.

The potential blockage of proposed fences have minimal impacts on local flood risk.

# 7.0 Conclusion

This HMR has been prepared by SLR on behalf of EPL 001 Limited ('the Applicant') in relation to the DCO application for Stonestreet Green Solar ('the Project'). This HMR has been prepared to summarise the construction of a linked 1D-2D hydraulic model of the East Stour and its associated tributaries, developed to inform the FRA for the Project.

A detailed linked 1D-2D hydraulic model has been developed to quantify the flood risk to the Site based on detailed topographic survey data of the East Stour River and LiDAR data.

The modelled flood extents for the Defended scenario have been validated against historic flood information, included AFSA level gauge data, South Willesborough flow gauge data, and aerial imagery of flood extents. The results of this show that the Defended model is representative of the current day flood risk.

The modelled flood extents for the Undefended scenario have been validated against ABC and EA Flood Zone mapping. The results of this show that the model is representative of the current day understanding of the flood risk in absence of defences.

Sensitivity testing and review of key model health indicators show that the model is stable and healthy, with effects of varying various model parameters showing the expected relationship.

The Defended model shows that the standard of protection for the AFSA is below a 5% AEP event. This is in line with the flood history provided for the area, with the AFSA reaching full capacity on two occasions since it's construction in 1989 in 2000 and 2014.

Analysis of the impact of the Project on local flood risk, shows that there are minimal impacts with maximum increases in flood depths remaining below 5mm. Additionally, analysis was undertaken assessing two blockage scenarios, these also resulted in minimal impacts with maximum increases in flood depths remaining below 5mm for the 25% blockage scenario and 10mm for the 50% blockage scenario.

The flood risk to the Project and impacts on flood risk is discussed in further detail in **ES Volume 4, Appendix 10.2: Flood Risk Assessment (Doc Ref. 5.4)**.

In conclusion, the model is stable and shows good agreement with historic and existing flood risk data for the area. The model is considered to be robust and to provide the best currently available information on the flood risk to the Site.

# 8.0 References

[1] Department for Levelling Up, Housing and Communities, (2023). *National Planning Policy Framework.*

[2] Department for Levelling Up, Housing & Communities (2021), *Planning practice guidance*

[3] BMT Commercial Australia Pty Ltd (2023), *TUFLOW*. https://www.tuflow.com/products/tuflow/

[4] Maltby Land Surveys Ltd (2017 – 2018), *J01058 – East Stour, Ashford to Stanford Channel Survey – C00322*

[5] Environment Agency (2023), *LIDAR Composite Digital Terrain Model (DTM) -1m [online]*. Available at: https://environment.data.gov.uk/dataset/13787b9a-26a4-4775-8523-806d13af58fc (Accessed July 2023)

[6] Chow, V.T. (1959), *Open Channel Hydraulics*. McGraw-Hill, New York

[7] Jeremy Benn Associates Ltd (2014), *Ashford Borough Council – Strategic Flood Risk Assessment [online]*. Available at: https://www.ashford.gov.uk/planning-and-development/planning-policy/adopted-development-plan-documents/adopted-local-plan-to-2030/local-plan-2030-evidence-base/local-plan-natural-and-built-environment-background-documents/ (Accessed September 2023)

[8] Jeremy Benn Associates Ltd (2012), *South Ashford 2D modelling Study 2010*

[9] Environment Agency (2023), *Flood Map for Planning [online]*. Available at: https://flood-map-for-planning.service.gov.uk/ (Accessed September 2023)

[10] Environment Agency (2023), *Open Hydrology Data – 15min Flow time series for South Willesborough [online]*. Available at: https://environment.data.gov.uk/hydrology/station/4d26d073-72fd-433d-811c-c964779ac260 (Accessed September 2023)

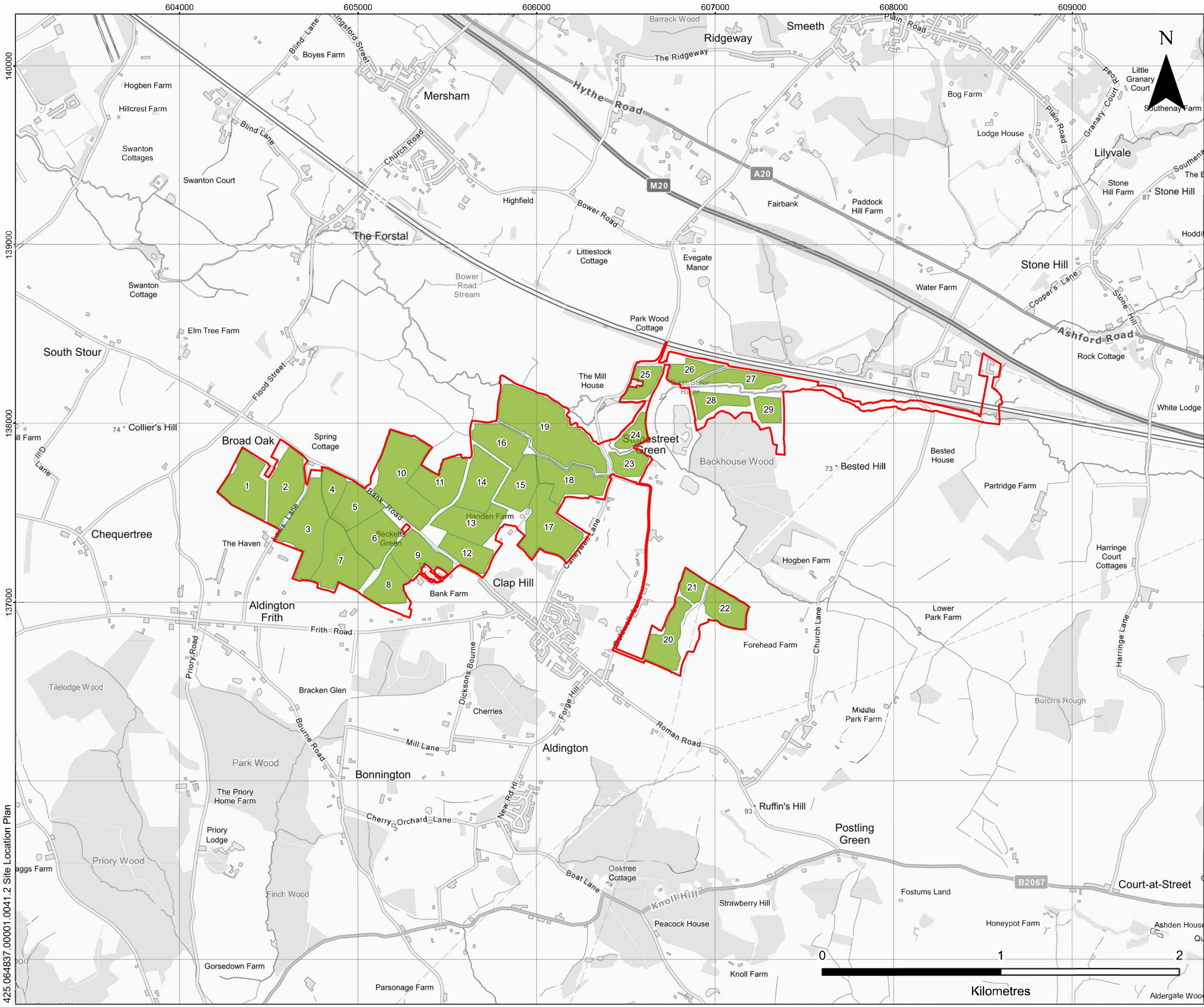
[11] Jeremy Benn Associates Ltd (2014), *2013 – 2014 Post Flood Analysis: Kent & South London Area*

# Figures

## Annex B: East Stour Hydraulic Modelling Report

### Stonestreet Green Solar Farm

EPL 001 Limited




LEGEND

Order limits

Field

APFP Regulation: 5(2)(o)


SLR

STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**SITE LOCATION PLAN**

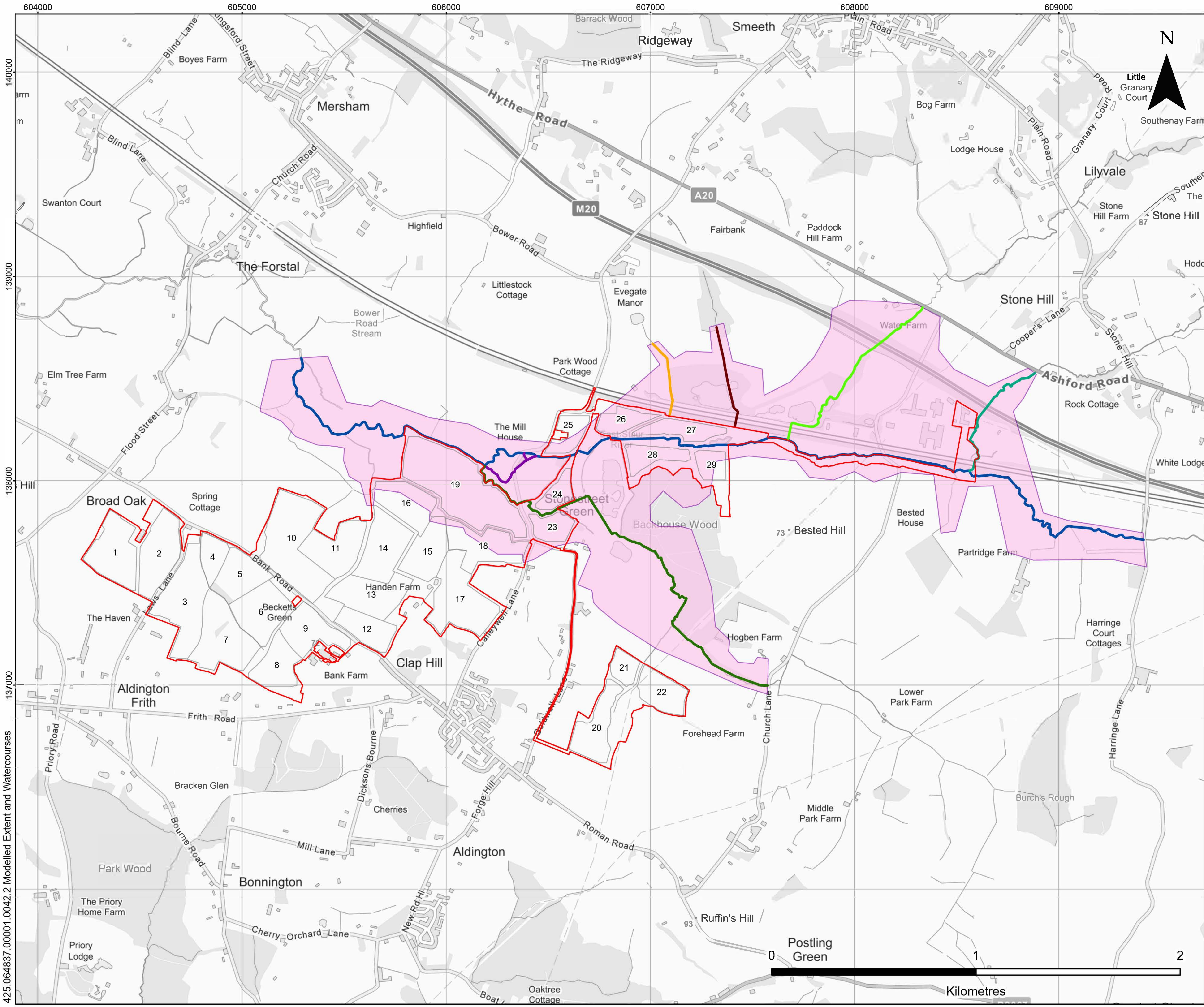
**HMR Figure 1**

0 1 2

Kilometres

| Scale | Date |
|---|---|
| 1:20,000 @ A3 | MAY 2024 |

425.064837.00001.0041.2 Site Location Plan




LEGEND

| | |
|---|---|
| Order limits | |
| Field | |
| **Modelled Water Courses** | |
| Culvert 1 | |
| Culvert 2 | |
| East Stour River | |
| Mill Race | |
| Unnamed Tributary 1 | |
| Unnamed Tributary 2 | |
| Unnamed Tributary 3 | |
| Model Extent | |

**APFP Regulation: 5(2)(i)(iii)**


SLR

STONESTREET GREEN SOLAR

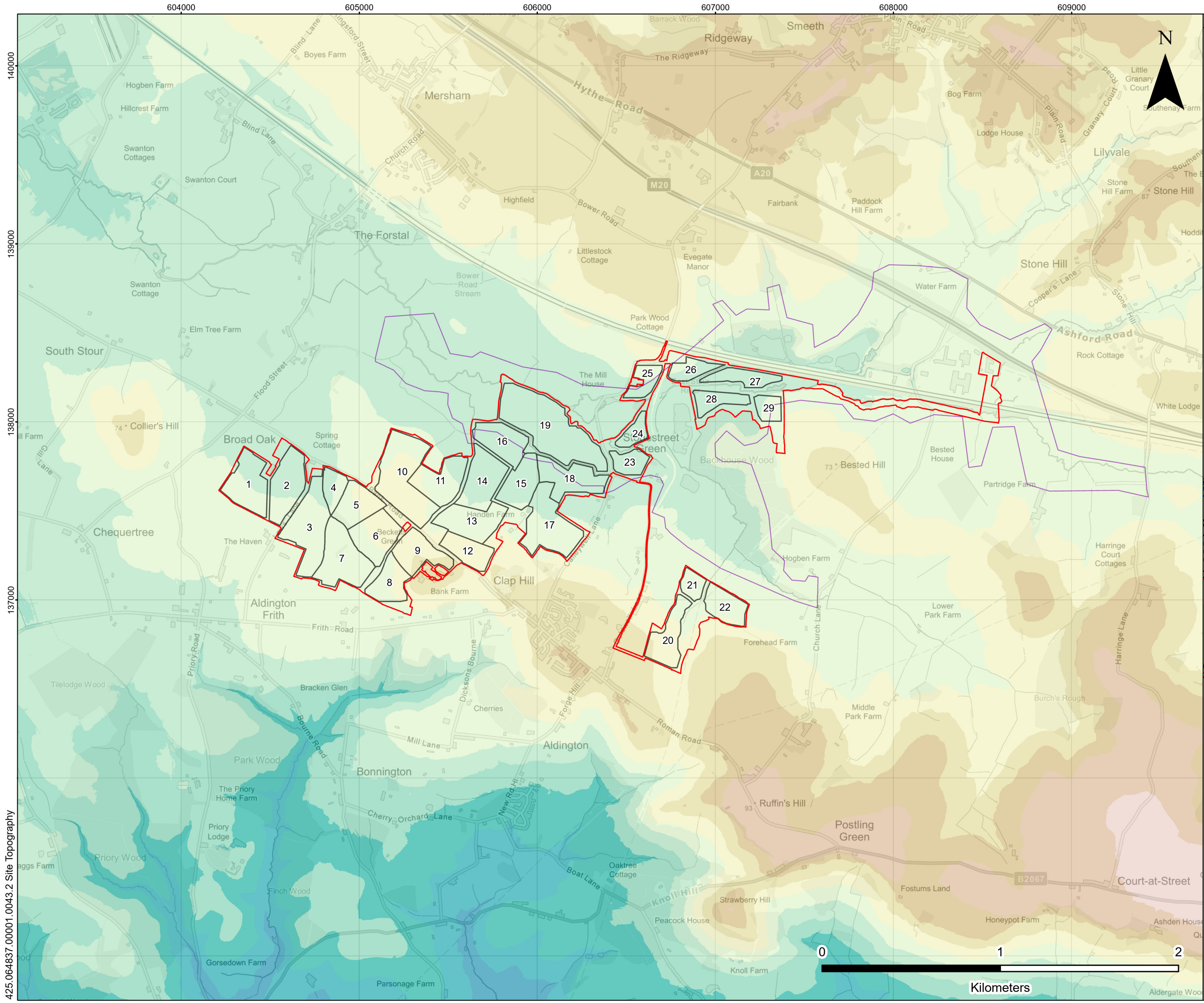
HYDRAULIC MODELLING REPORT

**MODELLED EXTENT AND WATERCOURSES**

**HMR Figure 2**

| Scale | Date |
|---|---|
| 1:17,500 @ A3 | MAY 2024 |

425.064837.00001.0042.2 Modelled Extent and Watercourses




LEGEND

Order limits

Field

Model Extent

**Elevation (m)**

<10

10 - 20

20 - 30

30 - 40

40 - 50

50 - 60

60 - 70

70 - 80

80 - 90

90 - 100

>100

**Note**

The digital terrain and surface models (DTM/DSM) have been derived from DEFRA National LiDAR (2m) dataset with an accuracy of (+/- 15 cm Root Mean Square Error [RMSE]).

**APFP Regulation: 5(2)(o)**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STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

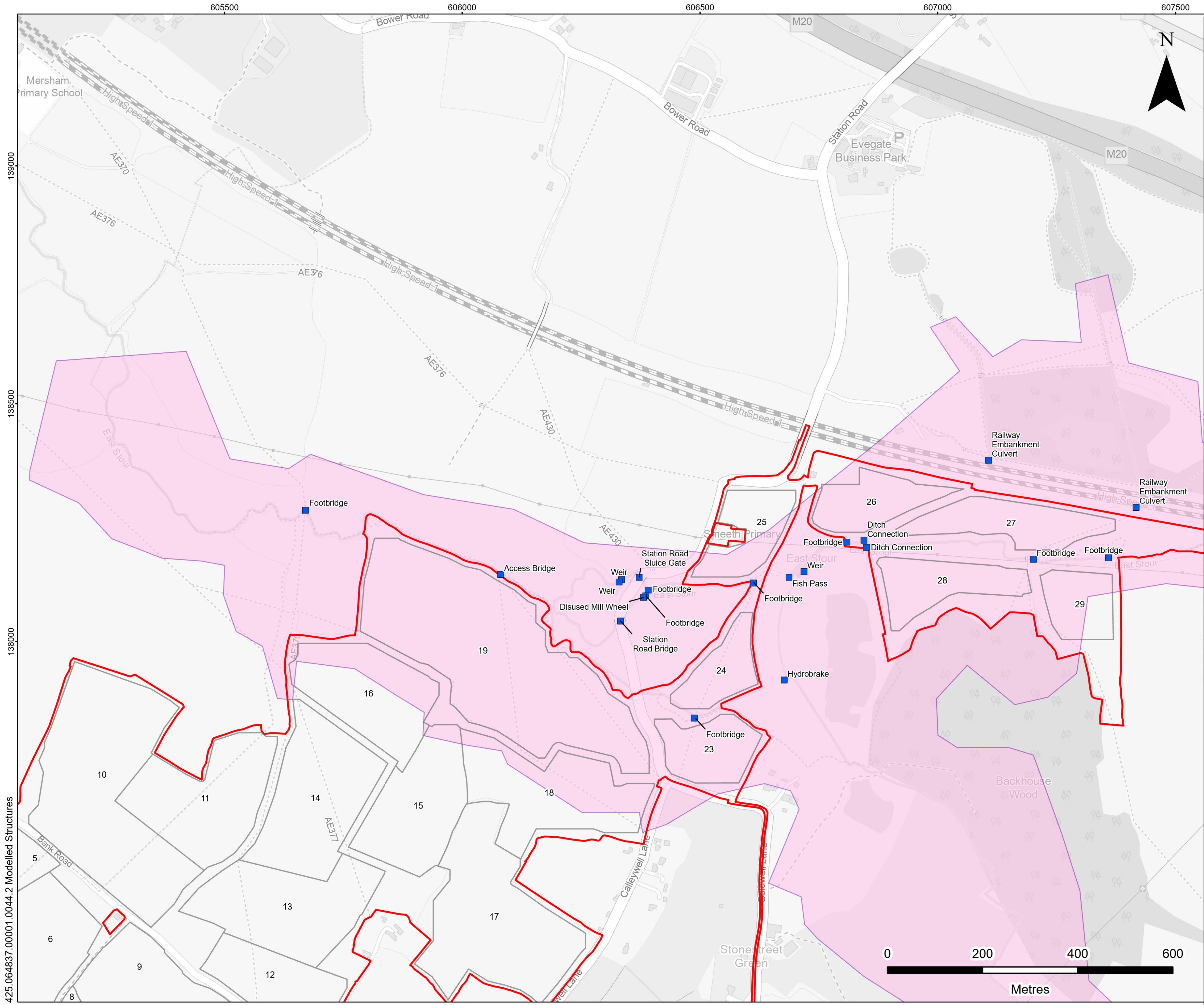
**SITE TOPOGRAPHY**

**HMR Figure 3**

Scale 1:20,000 @ A3

Date MAY 2024

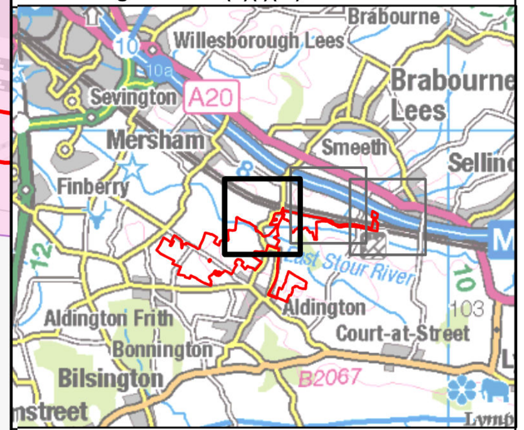
425.064837.00001.0043.2 Site Topography




LEGEND

- Order limit
- Field
- Modelled Structures
- Model Extent

APFP Regulation: 5(2)(i)(iii)

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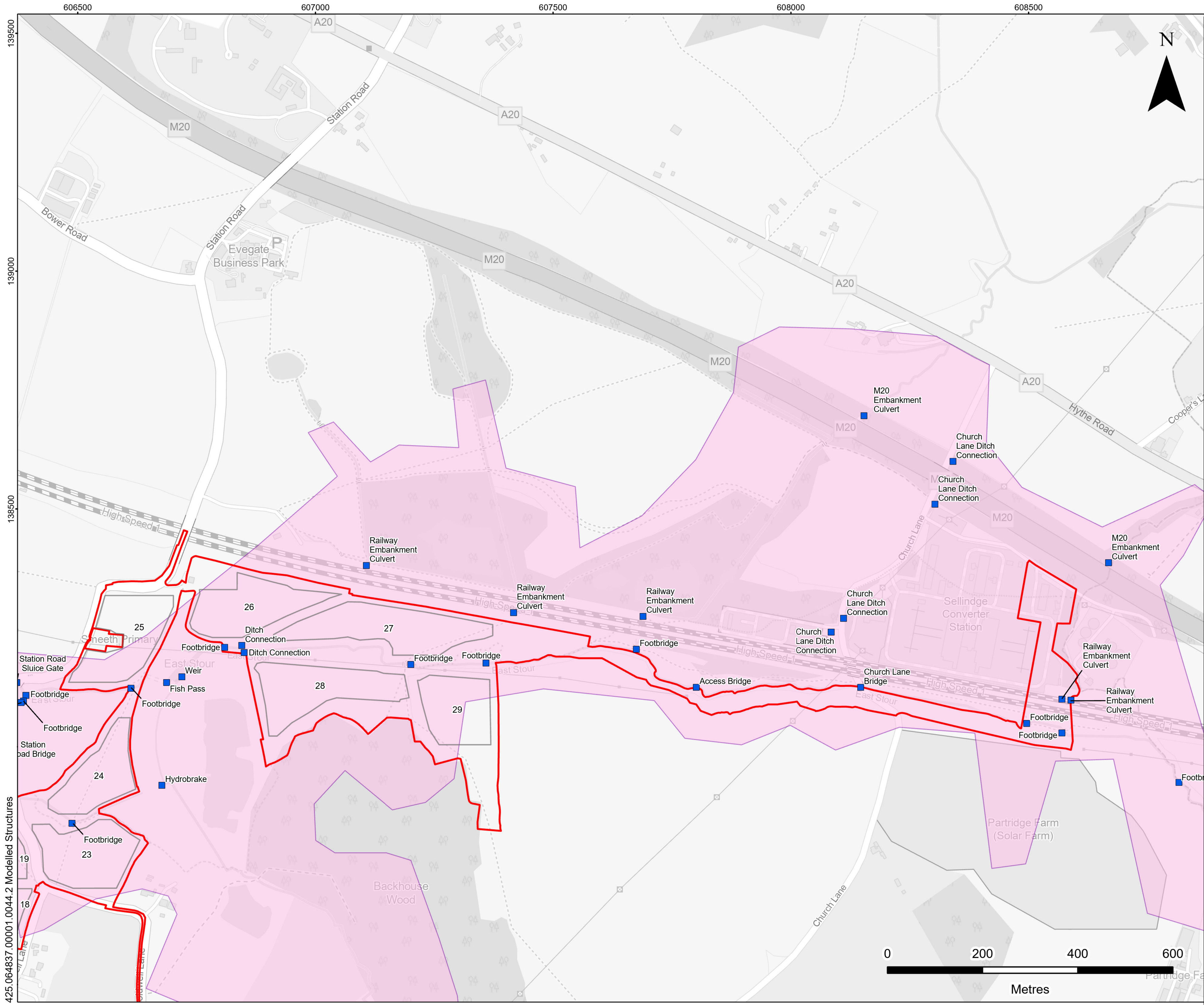
STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**MODELLED STRUCTURES**

**HMR Figure 4.1**

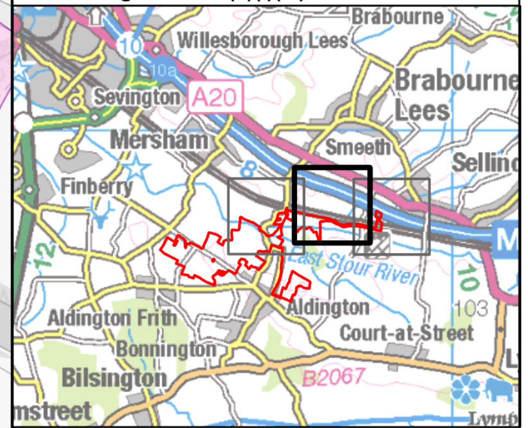
| Scale | Date |
| --- | --- |
| 1:7,500 @ A3 | MAY 2024 |




LEGEND

- Order limit
- Field
- Modelled Structures
- Model Extent

APFP Regulation: 5(2)(i)(iii)

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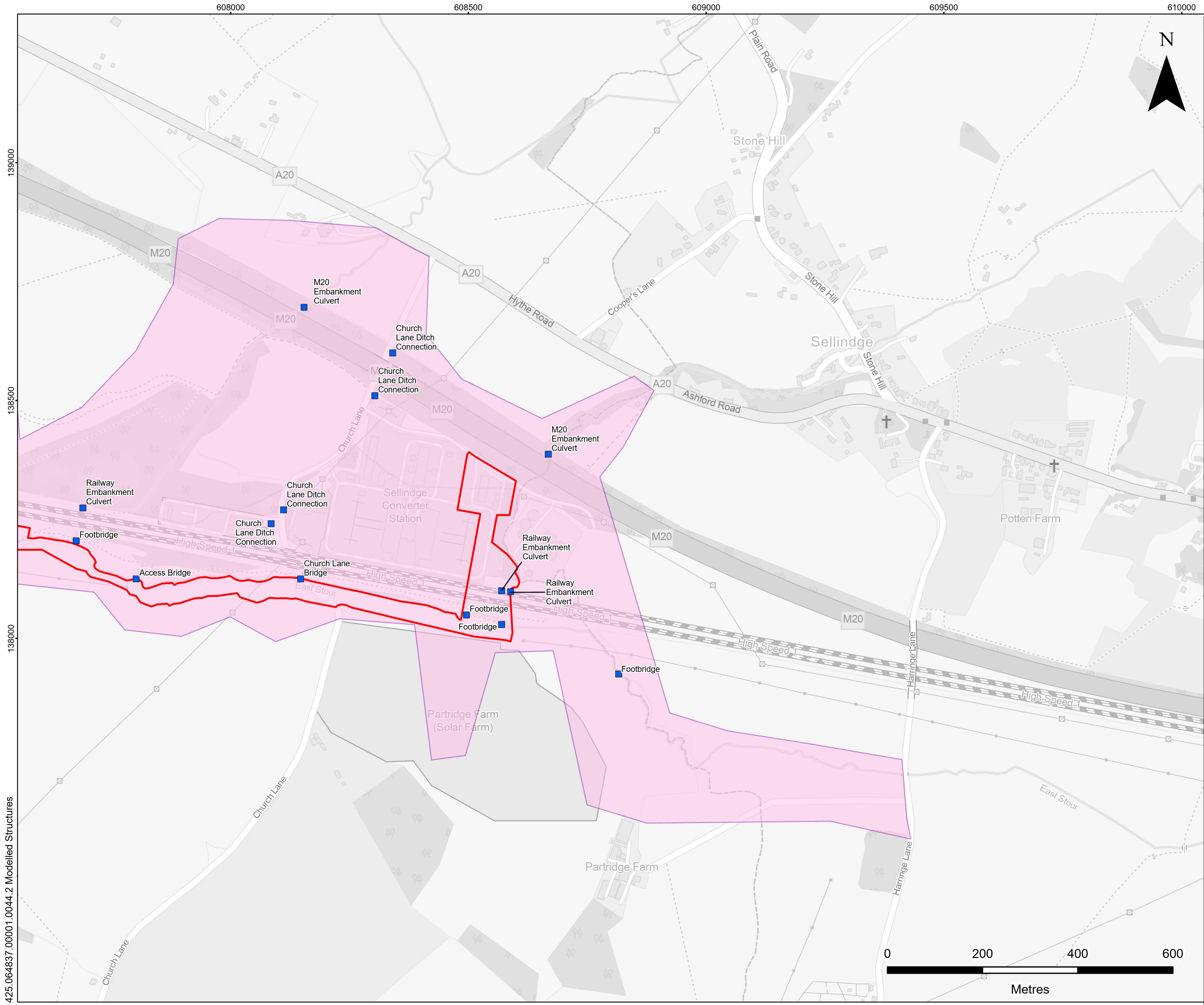
**MODELLED STRUCTURES**

**HMR Figure 4.2**

| Scale | Date |
|---|---|
| 1:7,500 @ A3 | MARCH 2024 |

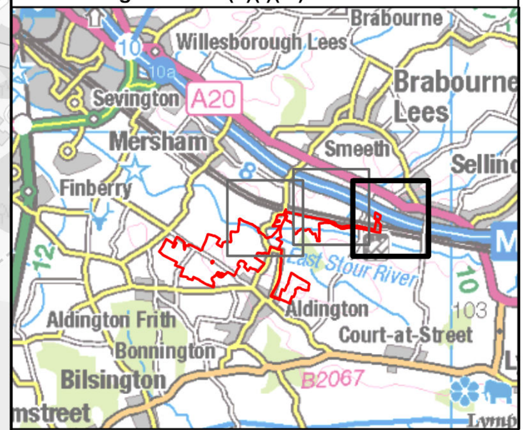
425.064837.00001.0044.2 Modelled Structures




LEGEND

- Order limit
- Modelled Structures
- Model Extent

APFP Regulation: 5(2)(i)(iii)

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STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**MODELLED STRUCTURES**

**HMR Figure 4.3**

| Scale | Date |
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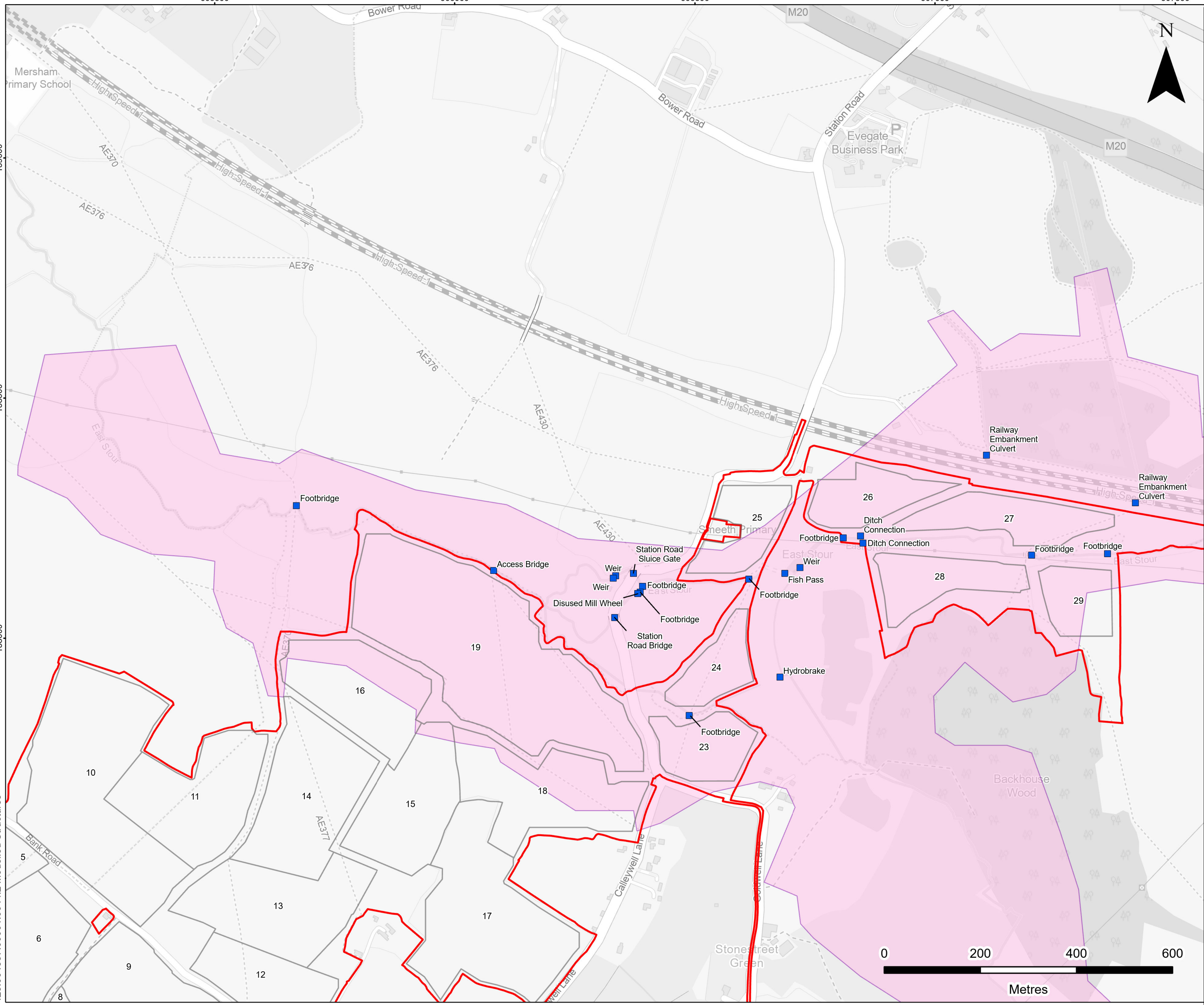
| 1:7,500 @ A3 | MAY 2024 |

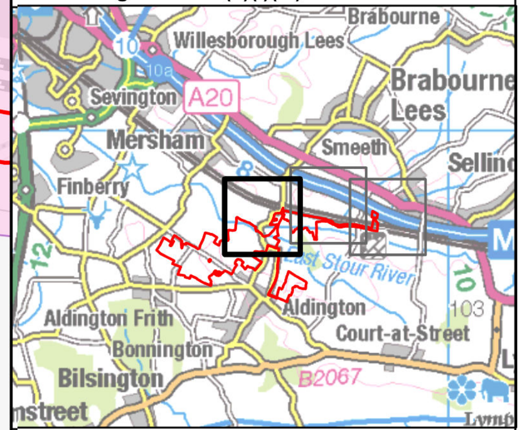
425.064837.00001.0044.2 Modelled Structures




LEGEND

- Order limit
- Field
- Modelled Structures
- Model Extent

APFP Regulation: 5(2)(i)(iii)

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STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**MODELLED STRUCTURES**

**HMR Figure 4.1**

| Scale | Date |
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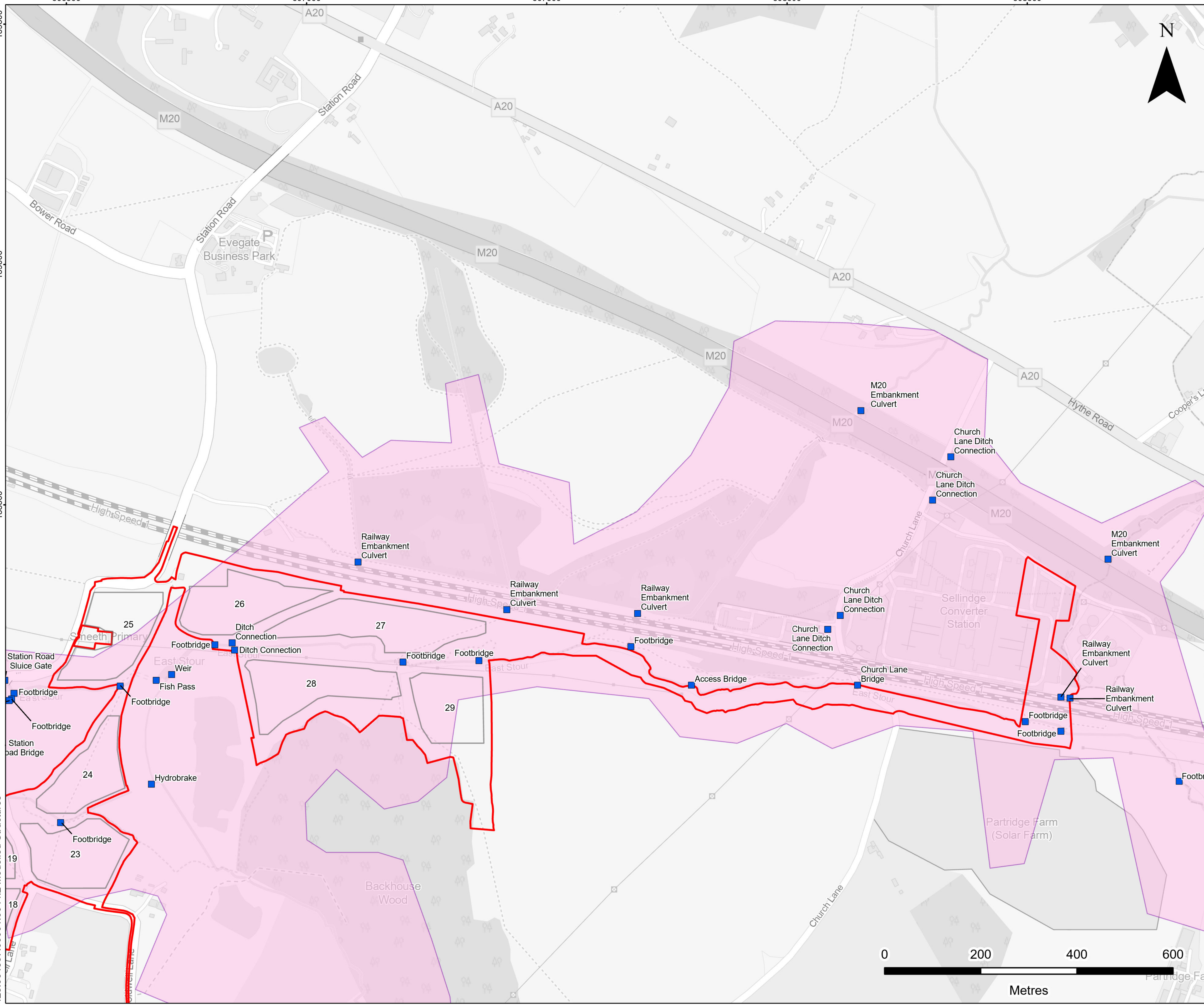
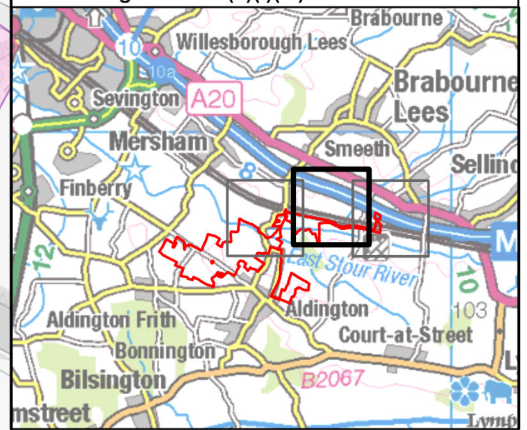
| 1:7,500 @ A3 | MAY 2024 |




## LEGEND

- Order limit
- Field
- Modelled Structures
- Model Extent

**APFP Regulation: 5(2)(i)(iii)**

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STONESTREET GREEN SOLAR

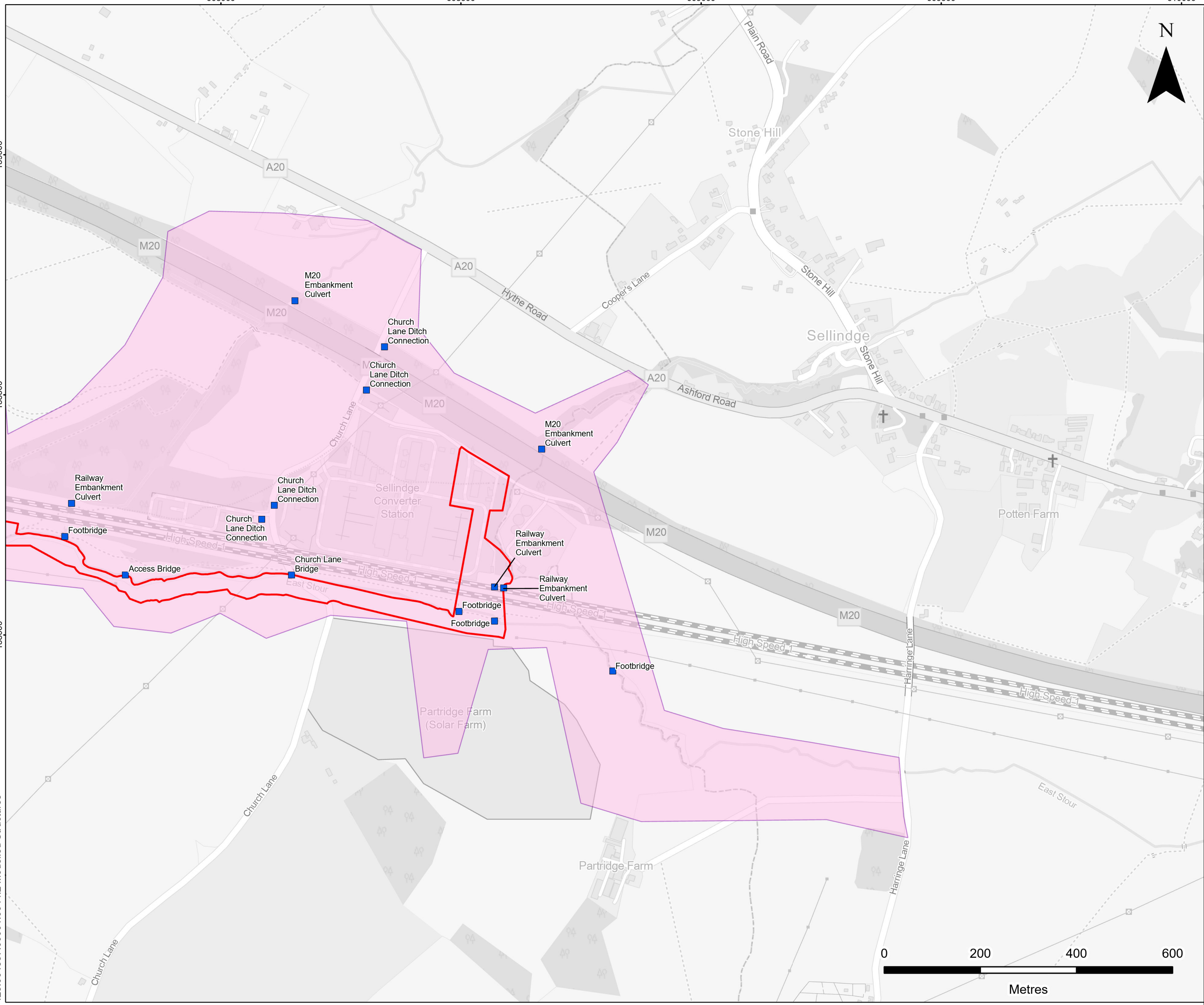
HYDRAULIC MODELLING REPORT

**MODELLED STRUCTURES**

## HMR Figure 4.2

| Scale | Date |
|---|---|
| 1:7,500 @ A3 | MARCH 2024 |

425.064837.00001.0044.2 Modelled Structures

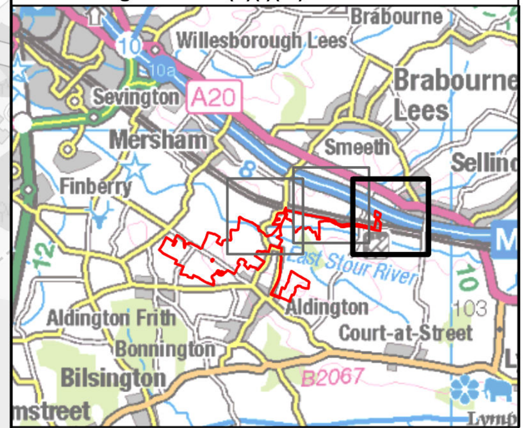



425.064837.00001.0044.2 Modelled Structures

LEGEND

- Order limit
- Modelled Structures
- Model Extent

APFP Regulation: 5(2)(i)(iii)

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STONESTREET GREEN SOLAR

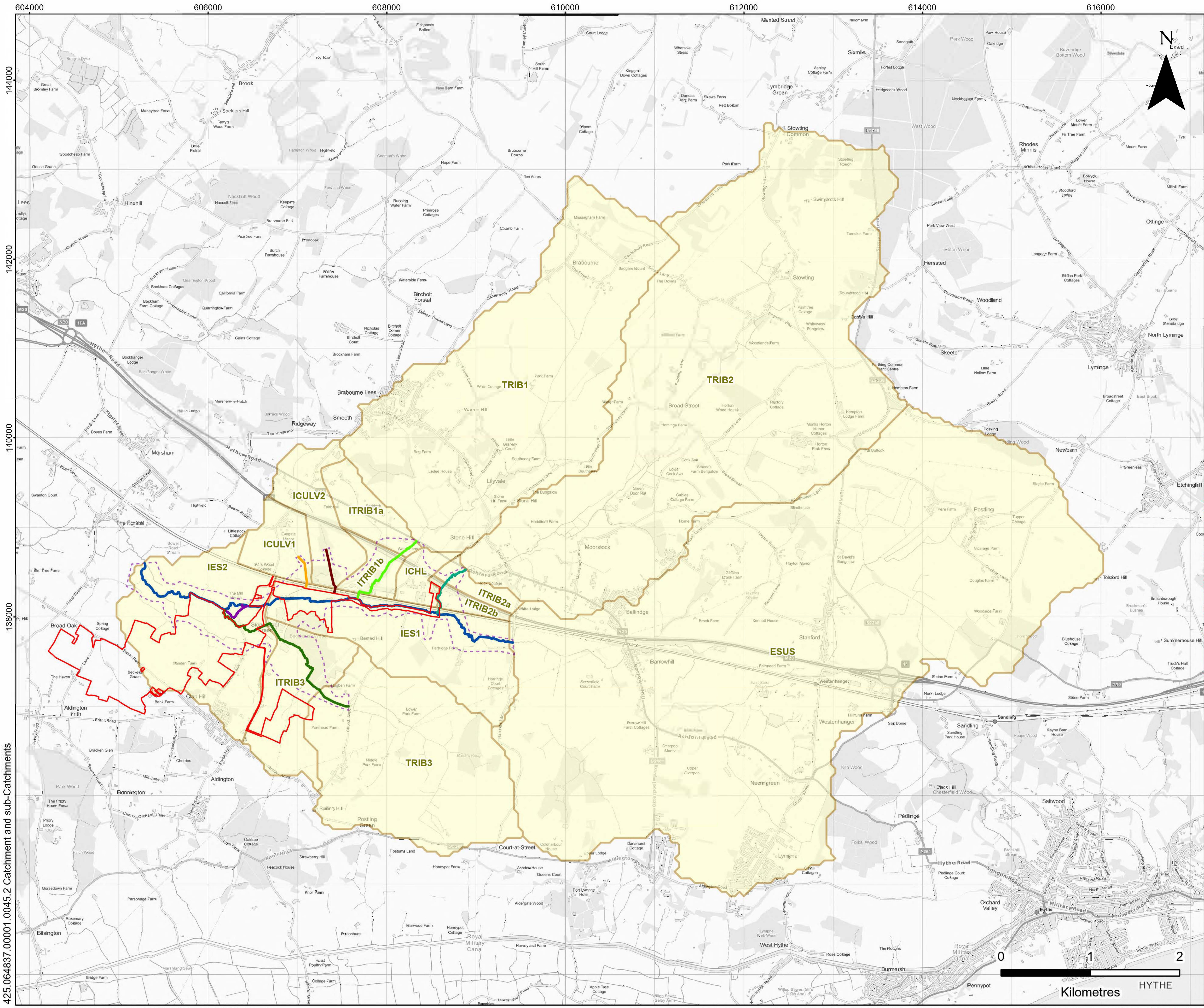
HYDRAULIC MODELLING REPORT

**MODELLED STRUCTURES**

**HMR Figure 4.3**

Scale 1:7,500 @ A3

Date MAY 2024



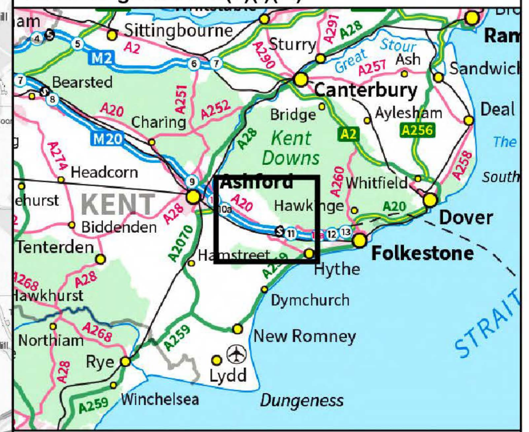

LEGEND

| | |
|---|---|
| Red outline | Order limit |
| Yellow fill | Catchment |
| Purple dashed outline | Model Extent |

**Modelled Water Courses**

| | |
|---|---|
| Orange line | Culvert 1 |
| Dark red line | Culvert 2 |
| Blue line | East Stour River |
| Purple line | Mill Race |
| Light green line | Unnamed Tributary 1 |
| Teal line | Unnamed Tributary 2 |
| Dark green line | Unnamed Tributary 3 |

APFP Regulation: 5(2)(i)(iii)

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STONESTREET GREEN SOLAR

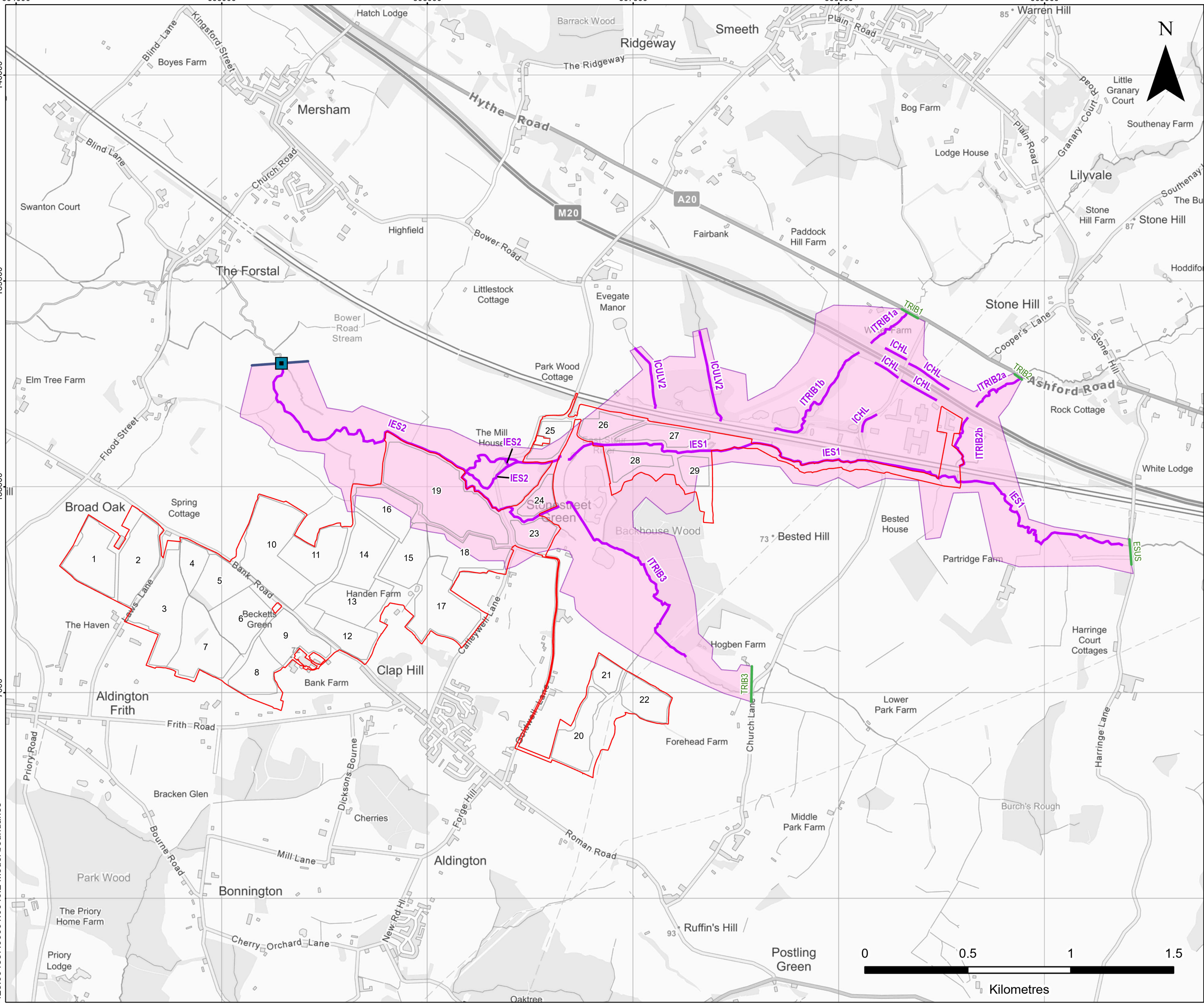
HYDRAULIC MODELLING REPORT

**CATCHMENT AND SUB-CATCHMENT**

**HMR Figure 5**

| Scale | Date |
|---|---|
| 1:40,000 @ A3 | MAY 2024 |

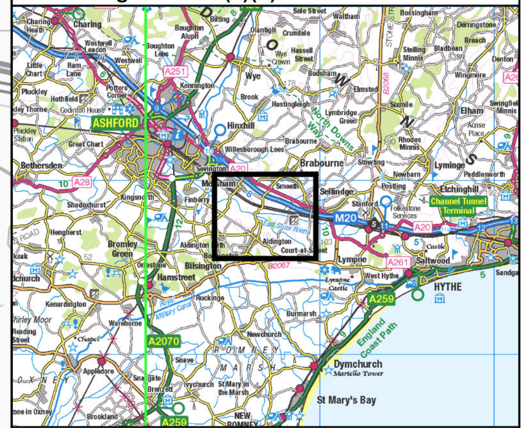
425.064837.00001.0045.2 Catchment and sub-Catchments




LEGEND

- Order limit
- Field
- Downstream 1D Boundary
- Upstream 2D Boundary
- Downstream 2D Boundary
- Lateral Inflow
- Model Extent

APFP Regulation: 5(2)(o)



SLR

STONESTREET GREEN SOLAR

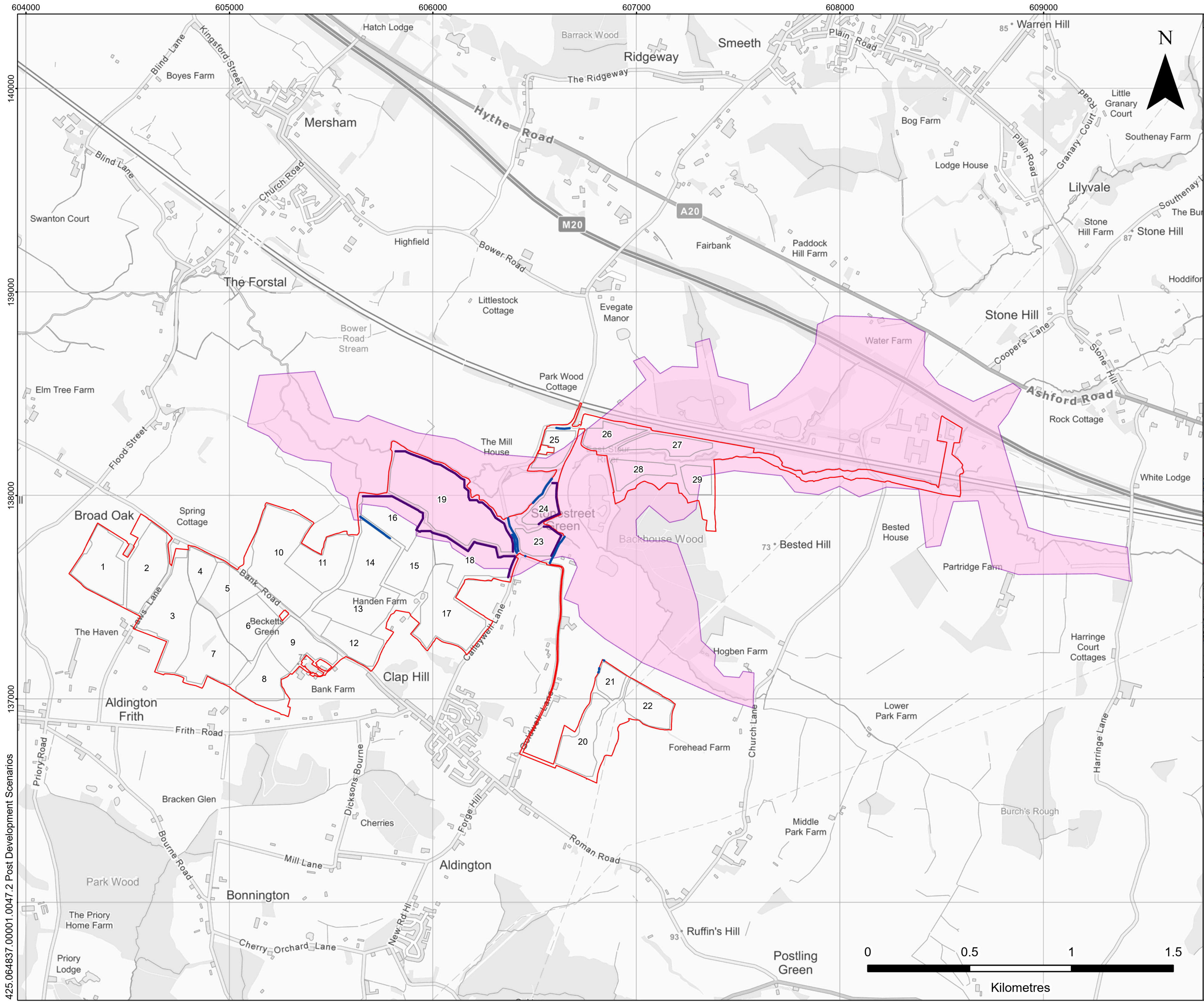
HYDRAULIC MODELLING REPORT

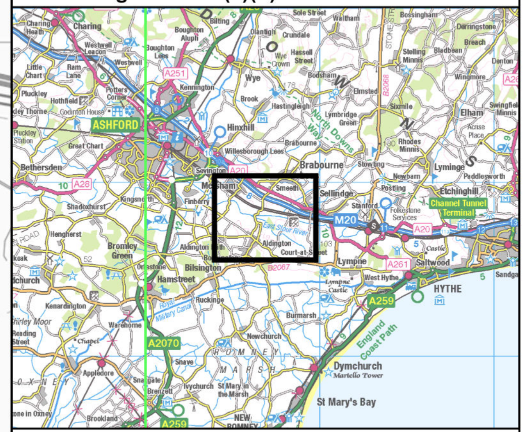
**MODEL BOUNDARIES**

**HMR Figure 6**

| Scale | Date |
|---|---|
| 1:17,500 @ A3 | MAY 2024 |

425.064837.00001.0046.2 Model boundaries



SLR

STONESTREET GREEN SOLAR

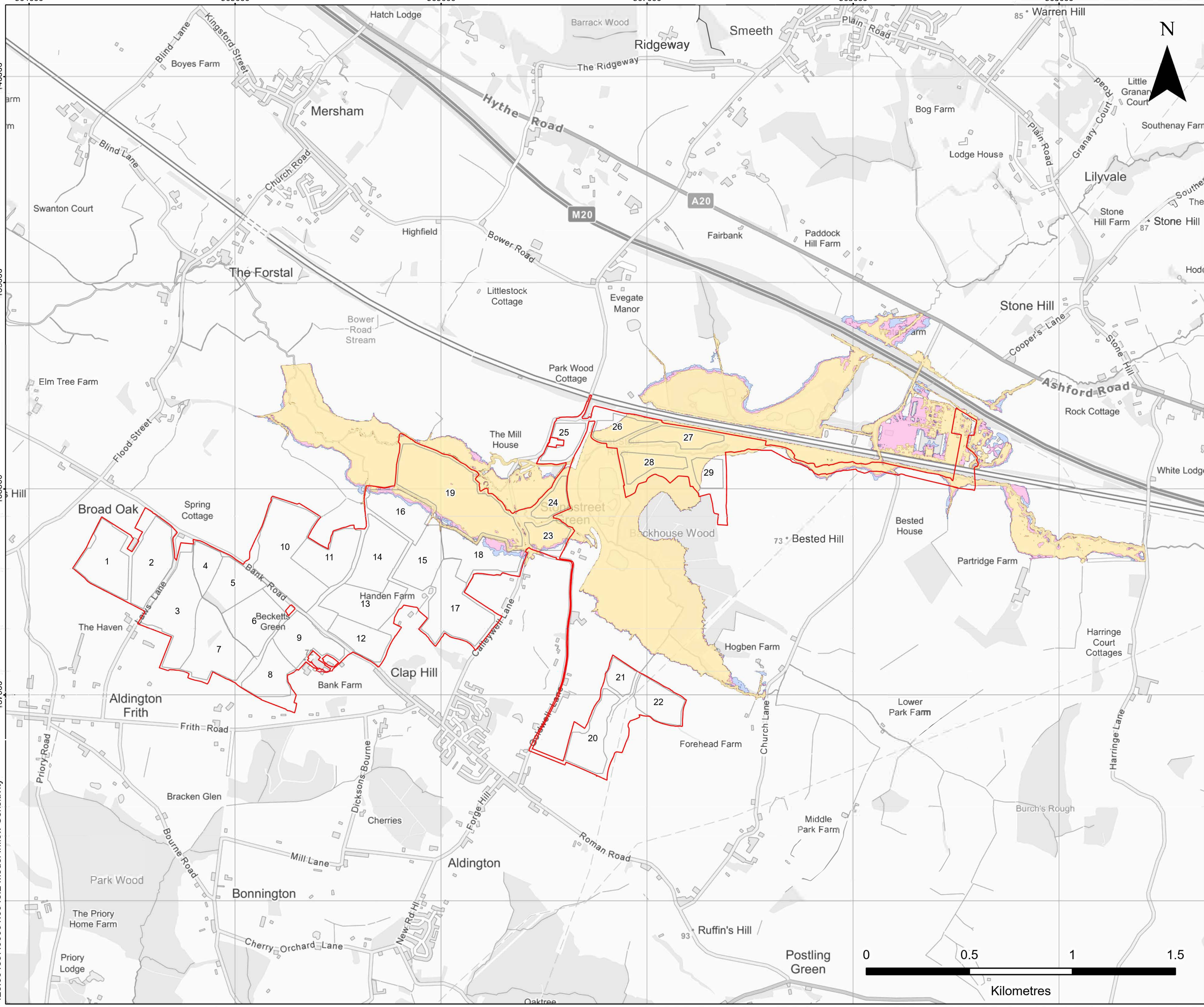
HYDRAULIC MODELLING REPORT

**POST-DEVELOPMENT SCENARIOS**

**HMR Figure 7**

Scale 1:17,500 @ A3

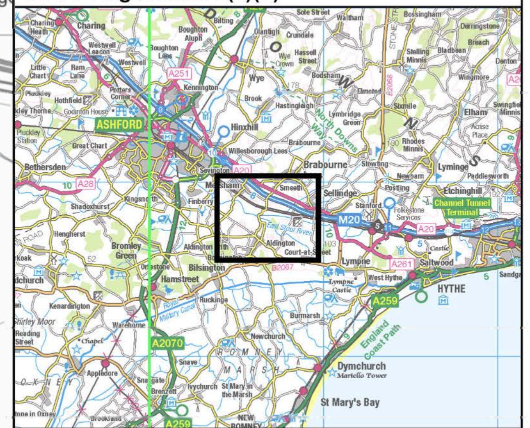
Date MAY 2024




LEGEND

| | |
|---|---|
| Order limit | |
| Field | |
| -20% Model Inflows Flood Extent: Defended 1:100 Upper End Allowance - 36.25 hr Rainfall Event - 2 m Grid | |
| Baseline Model Flood Extent: Defended 1:100 Upper End Allowance - 36.25 hr Rainfall Event - 2 m Grid | |
| +20% Model Inflows Flood Extent: Defended 1:100 Upper End Allowance - 36.25 hr Rainfall Event- 2 m Grid | |

APFP Regulation: 5(2)(o)




SLR

STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

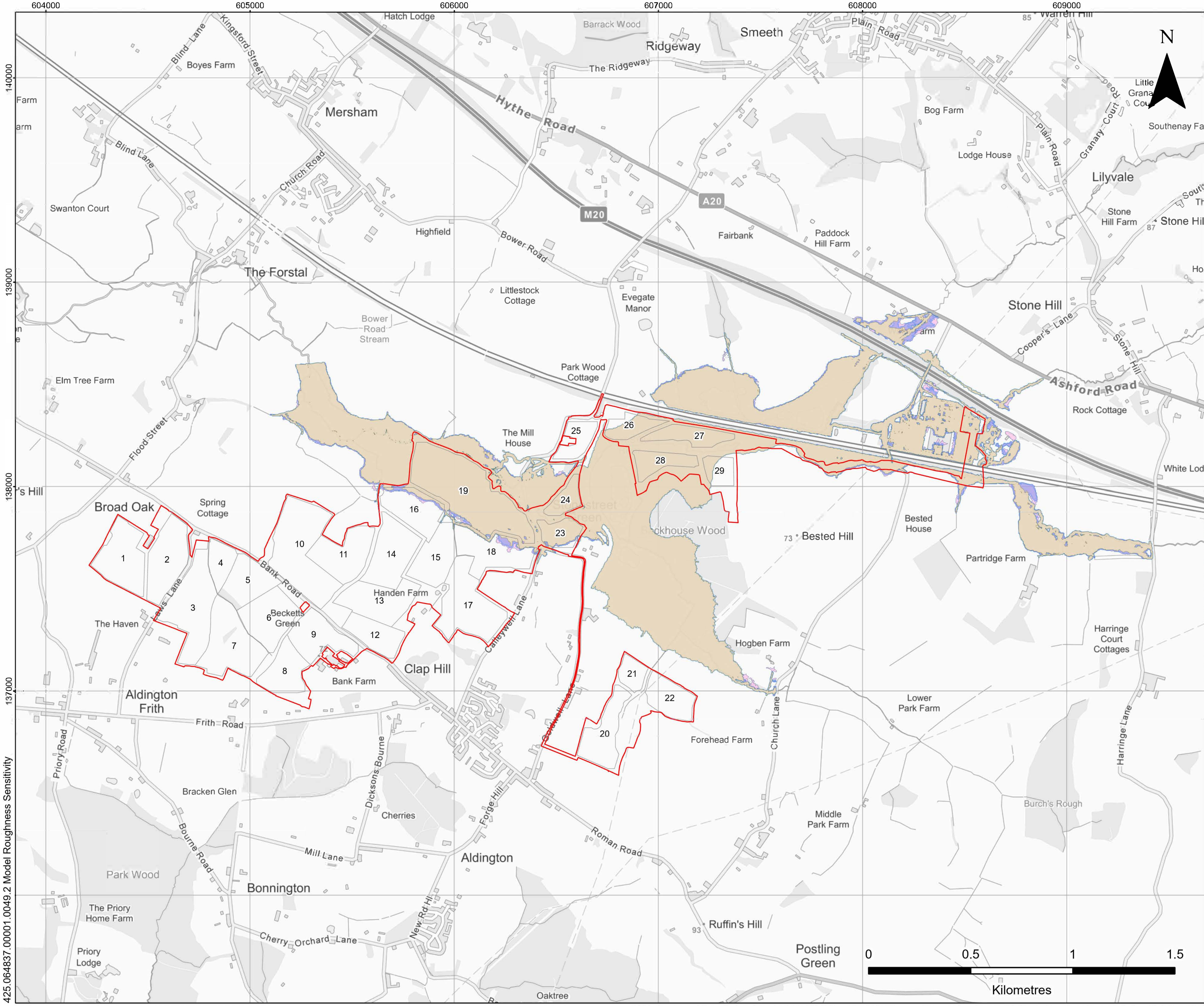
**MODEL INFLOW SENSITIVITY**

**HMR Figure 8**

Scale 1:17,500 @ A3

Date MAY 2024

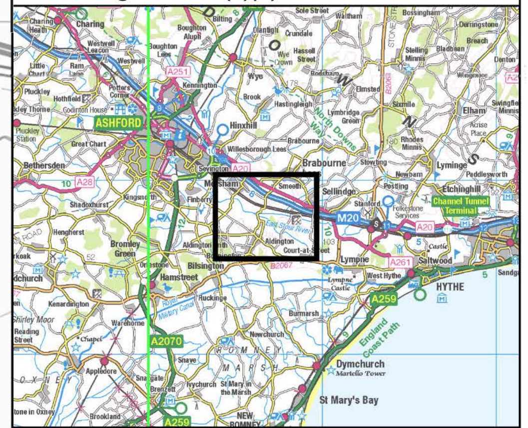
425.064837.00001.0048.2 Model Inflow Sensitivity




LEGEND

- Order limit
- Field
- -20% Manning's n Coefficient (Roughness) Flood Extent: Defended 1:100 Upper End Allowance - 36.25 hr Rainfall Event - 2 m Grid
- Baseline Model Flood Extent: Defended 1:100 Upper End Allowance - 36.25 hr Rainfall Event - 2 m Grid
- +20% Manning's n Coefficient (Roughness) Flood Extent: Defended 1:100 Upper End Allowance - 36.25 hr Rainfall Event - 2 m Grid

APFP Regulation: 5(2)(o)




SLR

STONESTREET GREEN SOLAR

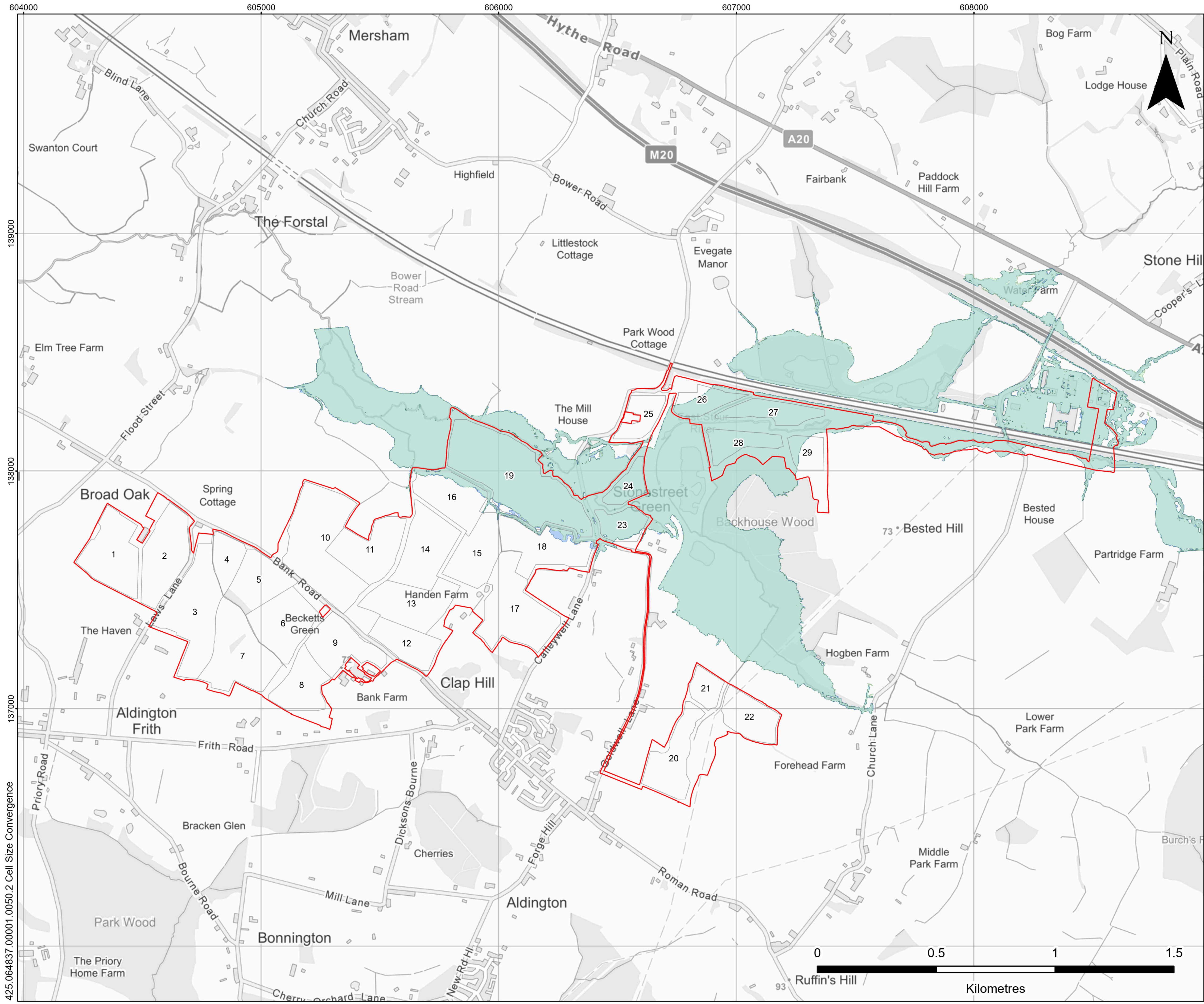
HYDRAULIC MODELLING REPORT

**MODEL ROUGHNESS SENSITIVITY**

**HMR Figure 9**

| Scale | Date |
|---|---|
| 1:17,500 @ A3 | MAY 2024 |

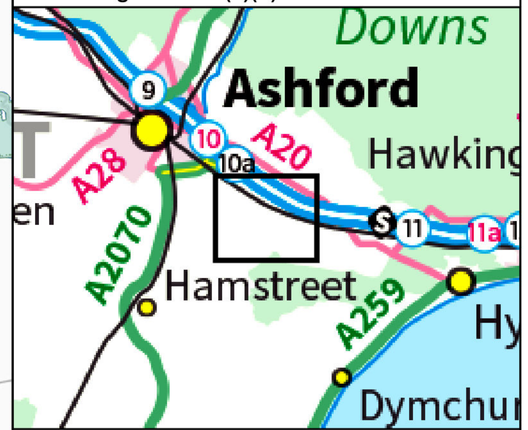
425.064837.00001.0049.2 Model Roughness Sensitivity




LEGEND

- Order limit
- Field
- Baseline Model Flood Extent: Defended 1:100 Upper End Allowance - 36.25 hr Rainfall Event - 2 m Grid
- Sensitivity Test Flood Extent: Defended 1:100 Upper End Allowance - 36.25 hr Rainfall Event - 1 m Grid

APFP Regulation: 5(2)(o)




SLR

STONESTREET GREEN SOLAR

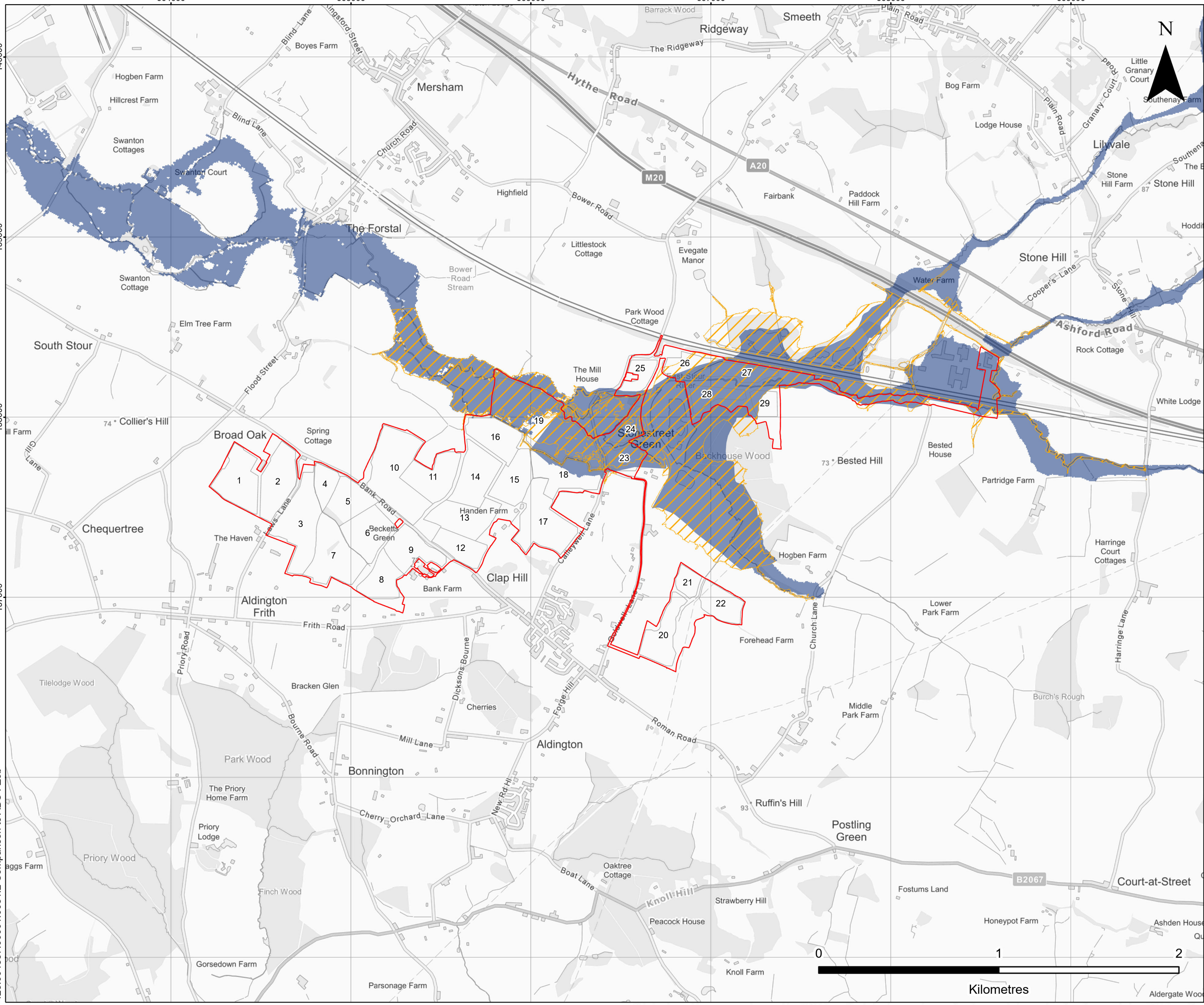
HYDRAULIC MODELLING REPORT

**CELL SIZE CONVERGENCE**

**HMR Figure 10**

Scale 1:15,000 @ A3

Date MAY 2024




LEGEND

- Order limit
- Field
- Ashford Borough Council Flood Zone 3b
- SLR Modelled Flood Zone 3b

APFP Regulation: 5(2)(o)


SLR

STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

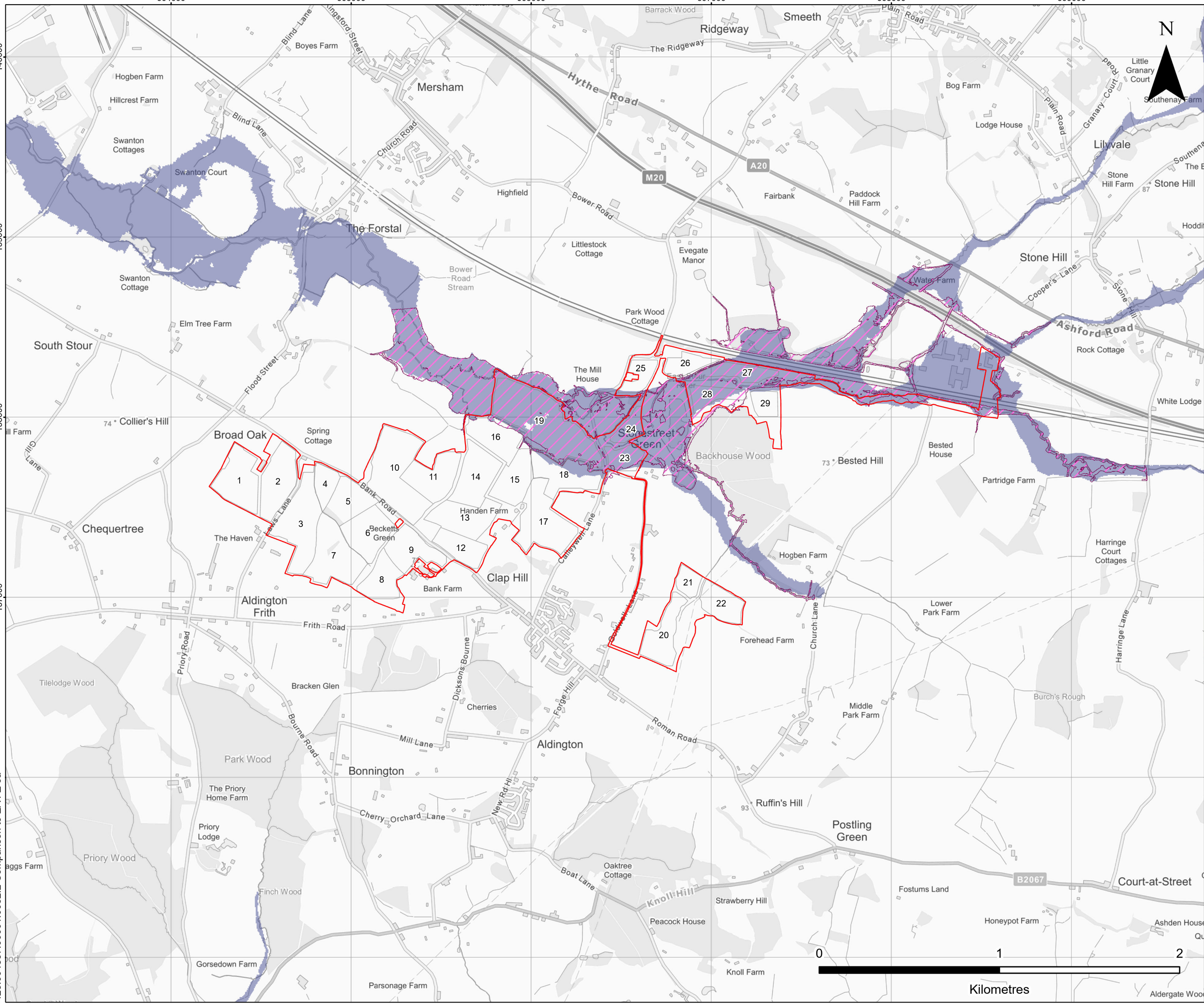
**COMPARISON TO ASHFORD BOROUGH COUNCIL FLOOD ZONE 3B**

**HMR Figure 11**

Scale 1:20,000 @ A3

Date MAY 2024

425.064837.00001.0051.2 Comparison to ABC FZ3b




LEGEND

- Order limit
- Field
- Environment Agency Flood Zone 3
- SLR Modelled Flood Zone 3a

APFP Regulation: 5(2)(o)


SLR

STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**COMPARISON WITH ENVIRONMENT AGENCY FLOOD ZONE 3A**

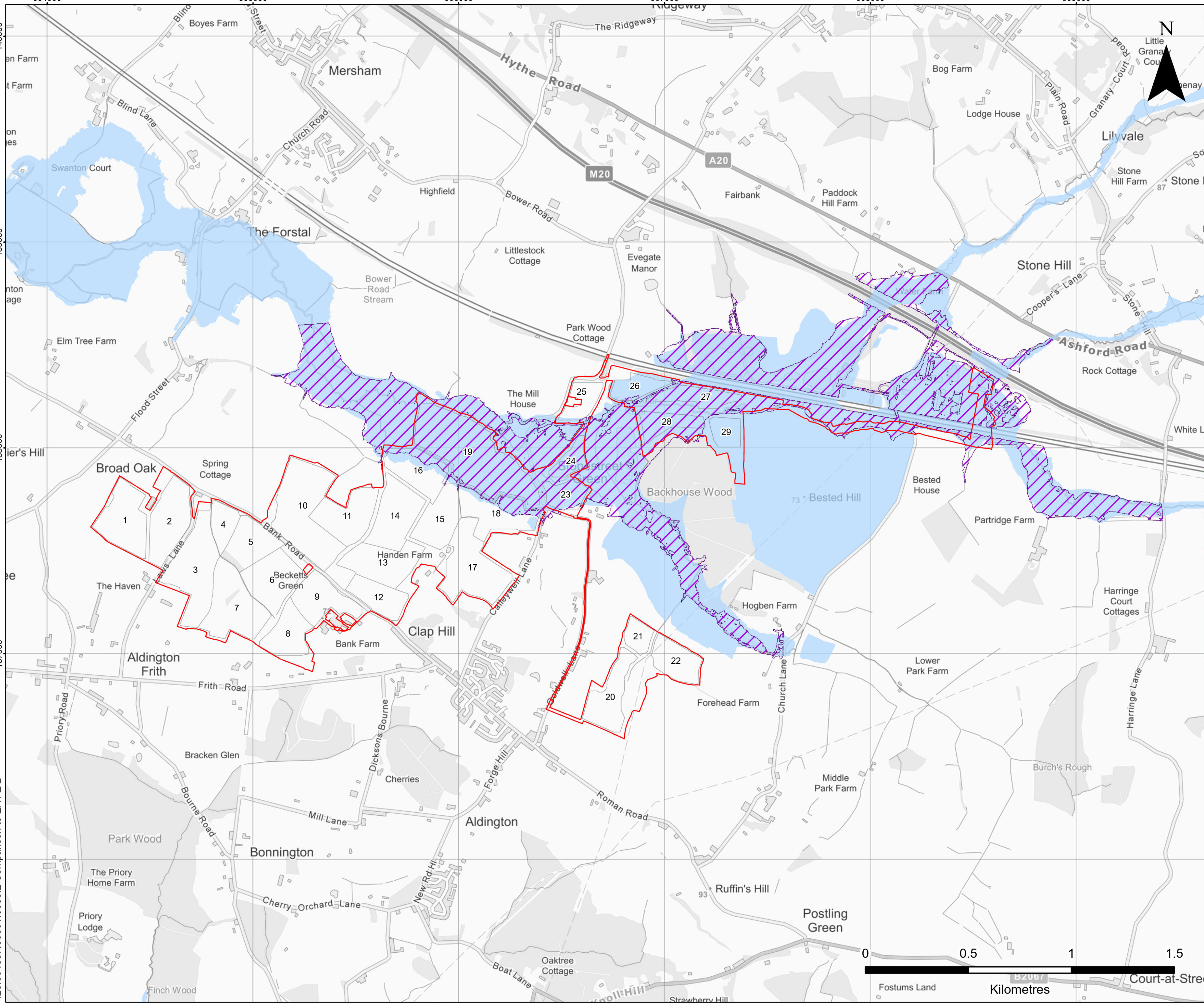
**HMR Figure 12**

| Scale | Date |
|---|---|
| 1:20,000 @ A3 | MAY 2024 |

425.064837.00001.0052.2 Comparison to EA FZ 3a

LEGEND

- Order limit
- Field
- Environment Agency Flood Zone 2
- SLR Modelled Flood Zone 2




APFP Regulation: 5(2)(o)


SLR

STONESTREET GREEN SOLAR

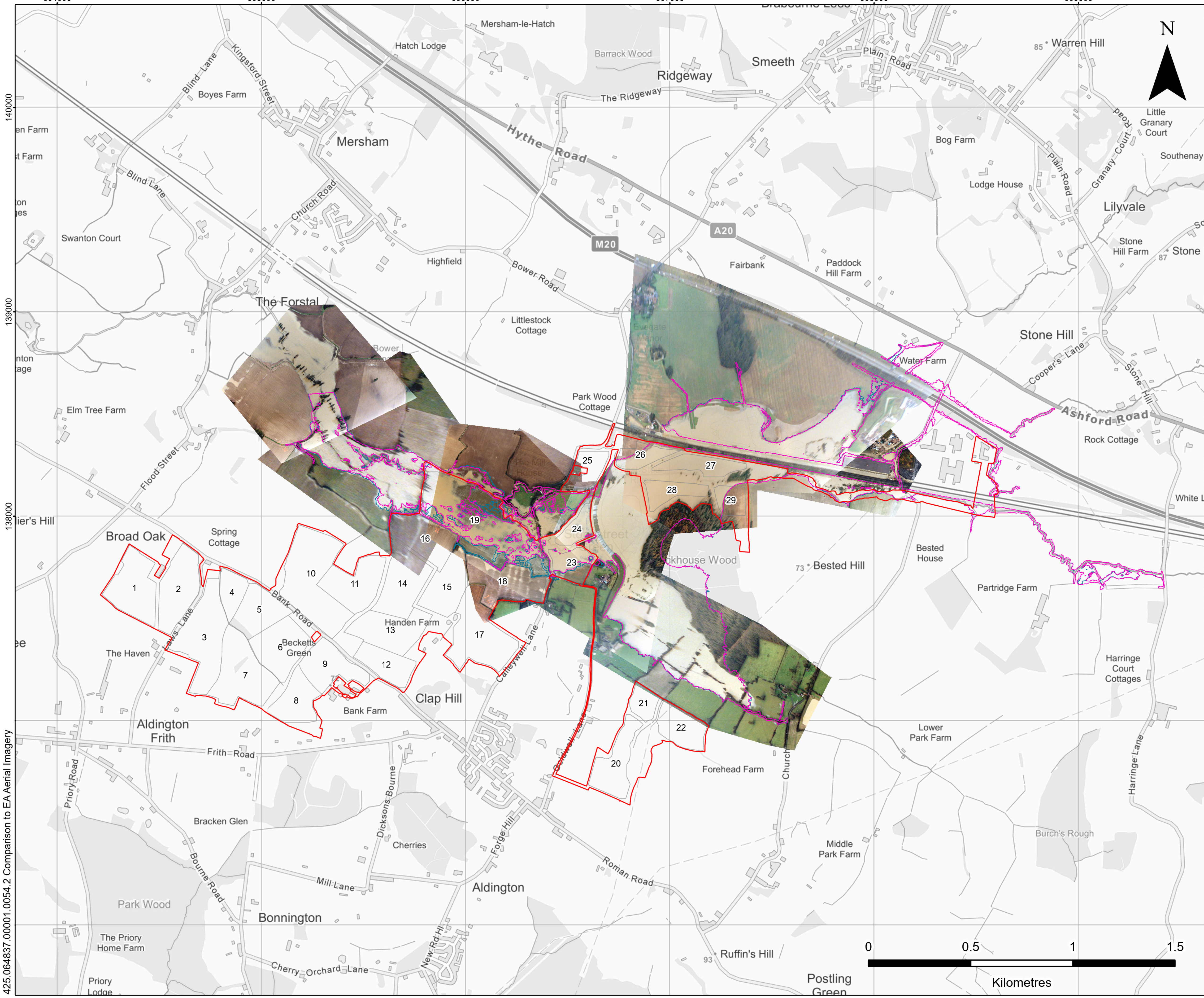
HYDRAULIC MODELLING REPORT

**COMPARISON TO ENVIRONMENT AGENCY FLOOD ZONE 2**

**HMR Figure 13**

| Scale | Date |
|---|---|
| 1:17,500 @ A3 | MAY 2024 |

425.064837.00001.0053.2 Comparison to EA FZ 2



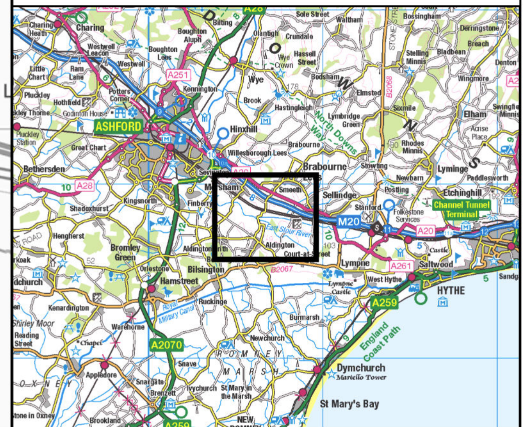

LEGEND

- Order limit
- Field
- Baseline Model Flood Extent: Defended 1:100 Upper End Allowance - 27.25 hr Rainfall Event - 2 m Grid
- Baseline Model Flood Extent: Defended 1:100 Upper End Allowance - 36.25 hr Rainfall Event - 2 m Grid

**APFP Regulation: 5(2)(o)**

NOTES

1. Flood extents shown on Environment Agency imagery are provided for indicative and comparative purposes only.

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STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

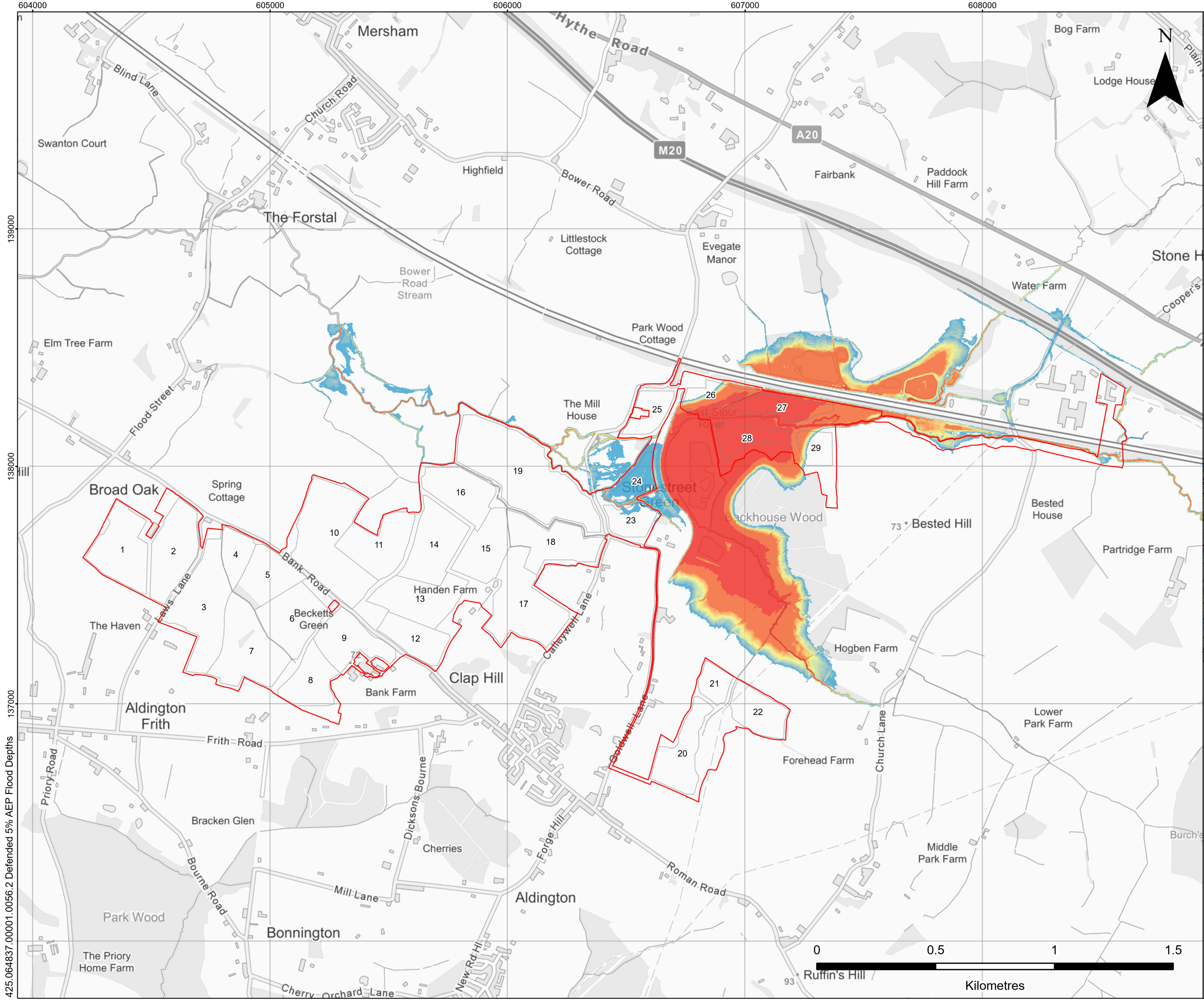
**COMPARISON WITH ENVIRONMENT AGENCY FLOOD AERIAL IMAGERY**

**HMR Figure 14**

Scale 1:17,500 @ A3

Date MAY 2024

425.064837.00001.0054.2 Comparison to EA Aerial Imagery




LEGEND

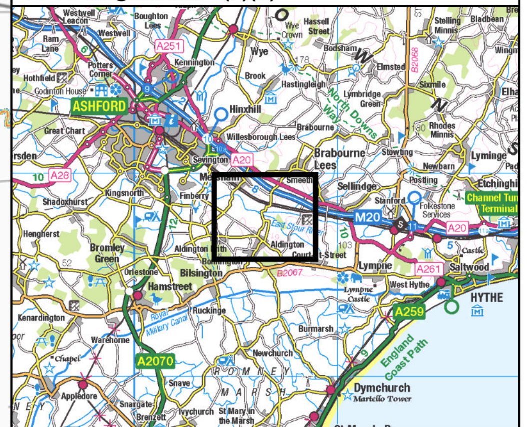
| | |
|---|---|
| | Order limit |
| | Field |

**Flood Depth (m)***

- <0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3- 0.4
- 0.4- 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
- 1.0 - 2
- >2.0

*Baseline Model Flood Depth: Defended 1:20 - 96.25 hr Rainfall Event - 2 m Grid

**APFP Regulation: 5(2)(o)**

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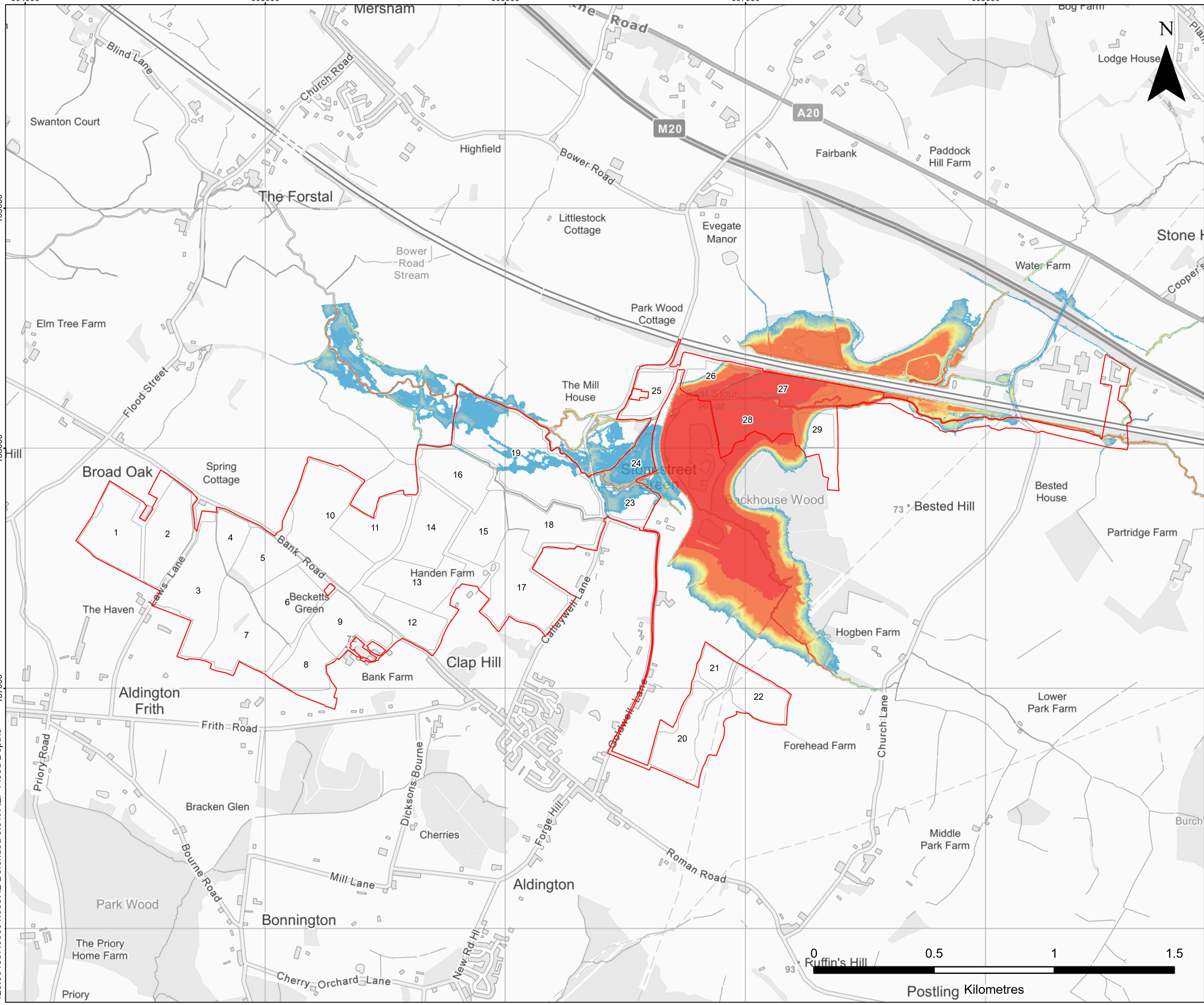
STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**DEFENDED 5% ANNUAL EXCEEDANCE PROBABILITY FLOOD DEPTHS**

**HMR Figure 15**

| Scale | Date |
|---|---|
| 1:15,000 @ A3 | MAY 2024 |




425.064837.00001.0057.2 Defended 3.3% AEP Flood Depths

LEGEND

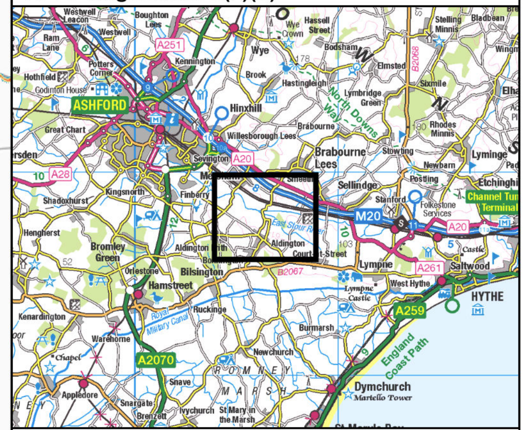
- Order limits
- Field

**Flood Depth (m)***

- <0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3- 0.4
- 0.4- 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
- 1.0 - 2
- >2.0

*Baseline Model Flood Depth: Defended 1:30 - 96.25 hr Rainfall Event - 2 m Grid

**APFP Regulation: 5(2)(o)**



SLR

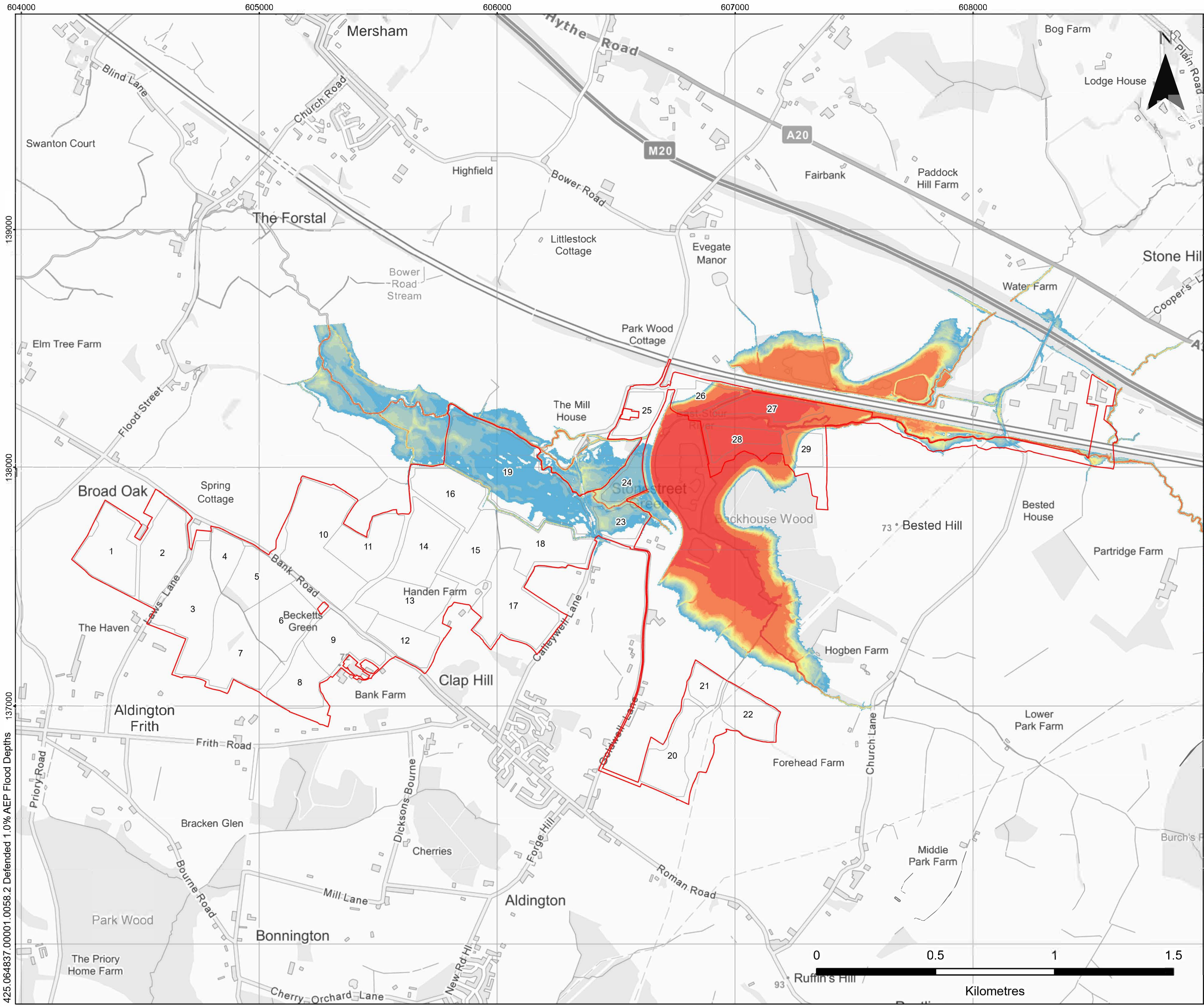
STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**DEFENDED 3.3% ANNUAL EXCEEDANCE PROBABILITY FLOOD DEPTHS**

**HMR Figure 16**

| Scale | Date |
|---|---|
| 1:15,000 @ A3 | MAY 2024 |




425.064837.00001.0058.2 Defended 1.0% AEP Flood Depths

LEGEND

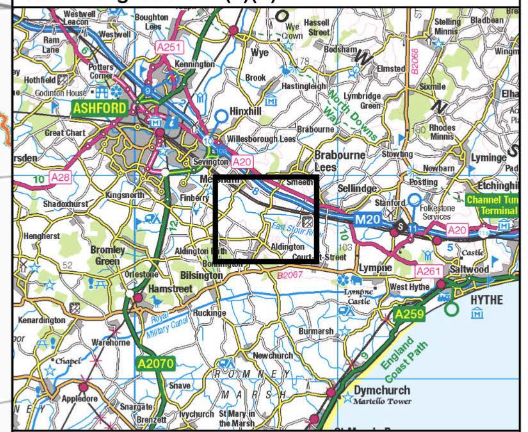
- Order limits
- Field

**Flood Depth (m)***

- <0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3- 0.4
- 0.4- 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
- 1.0 - 2
- >2.0

*Baseline Model Flood Depth: Defended 1:100 - 60.25 hr Rainfall Event - 2 m Grid

**APFP Regulation: 5(2)(o)**




SLR

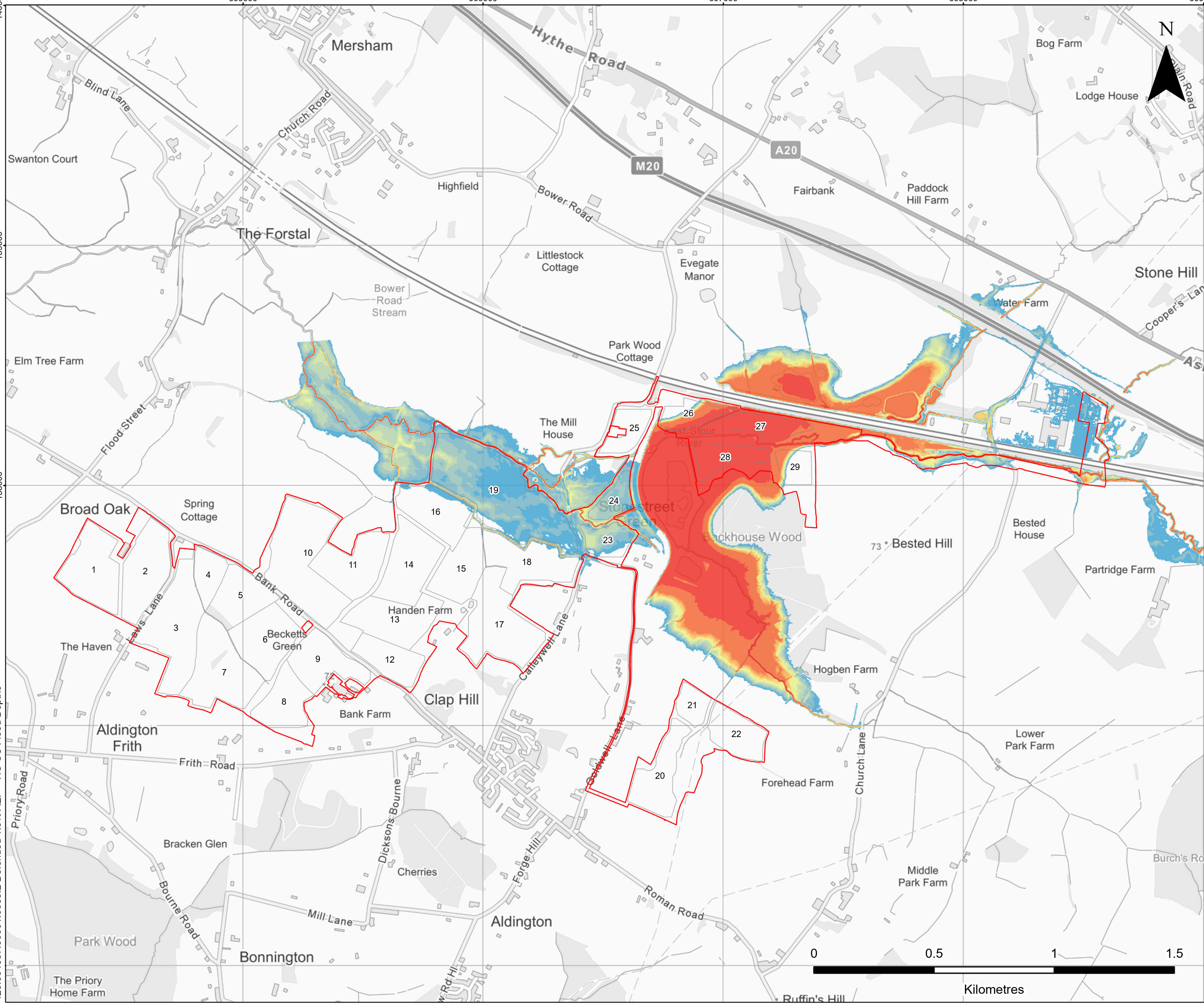
STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**DEFENDED 1.0% ANNUAL EXCEEDANCE PROBABILITY FLOOD DEPTHS**

**HMR Figure 17**

| Scale | Date |
|---|---|
| 1:15,000 @ A3 | MAY 2024 |




LEGEND

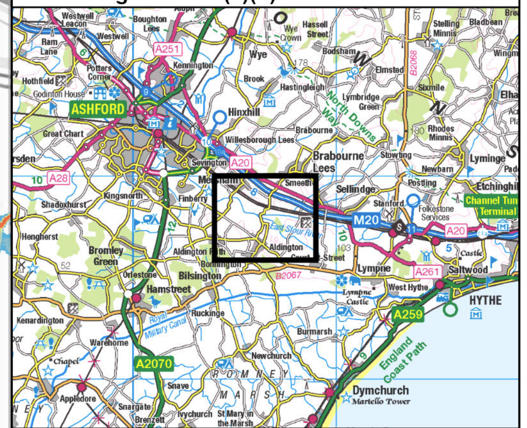
- Order limits
- Field

**Flood Depth (m)***

- <0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3- 0.4
- 0.4- 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
- 1.0 - 2
- >2.0

*Baseline Model Flood Depth: Defended 1:100 - 48.25 hr Rainfall Event - 2 m Grid

**APFP Regulation: 5(2)(o)**




SLR

STONESTREET GREEN SOLAR

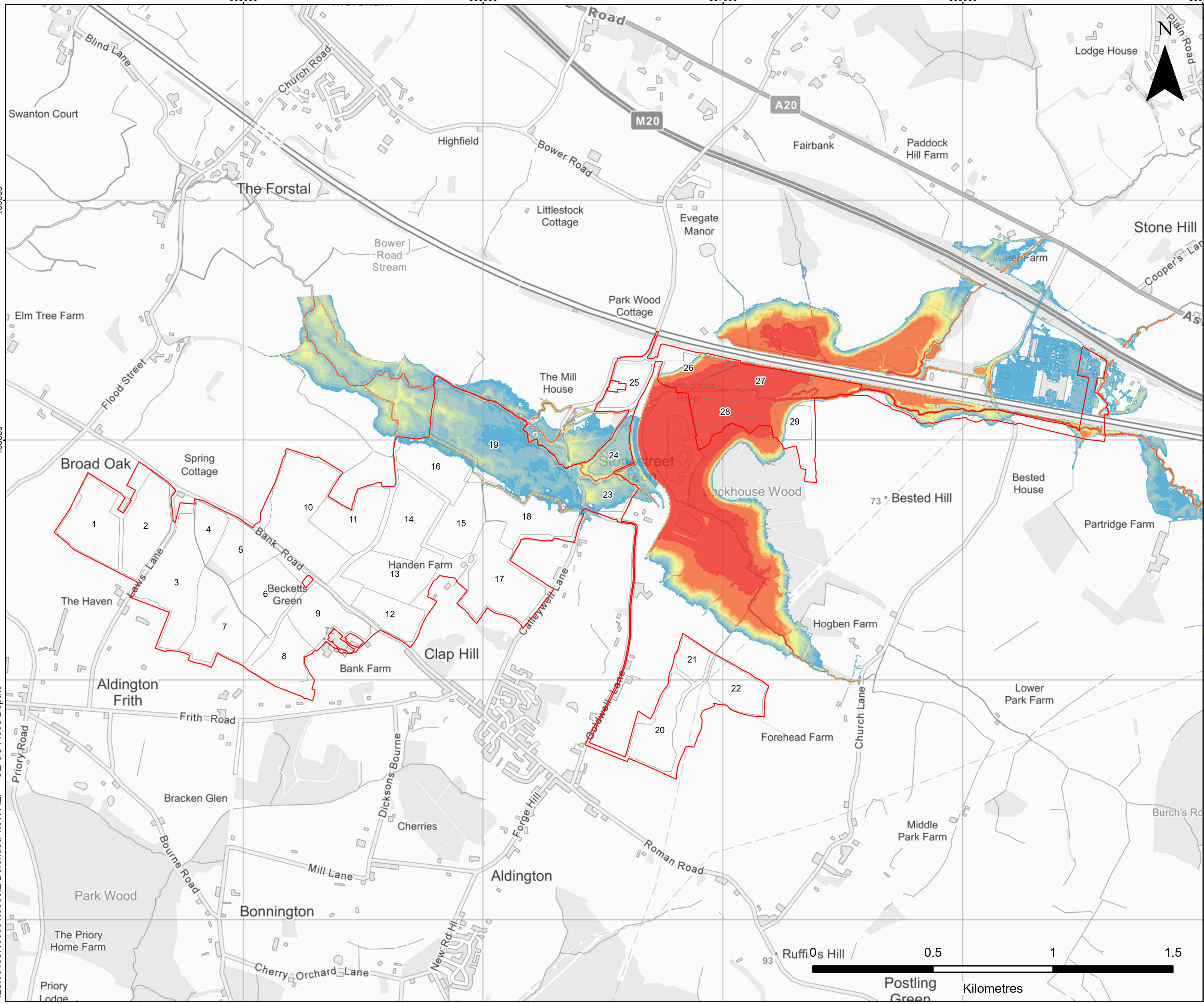
HYDRAULIC MODELLING REPORT

**DEFENDED 1.0% ANNUAL EXCEEDANCE PROBABILITY HIGHER CENTRAL CLIMATE CHANGE ALLOWANCE FLOOD DEPTHS**

**HMR Figure 18**

Scale 1:15,000 @ A3

Date MAY 2024




425.064837.00001.0060.2 Defended 1.0% AEP + UE CC Flood Depths

LEGEND

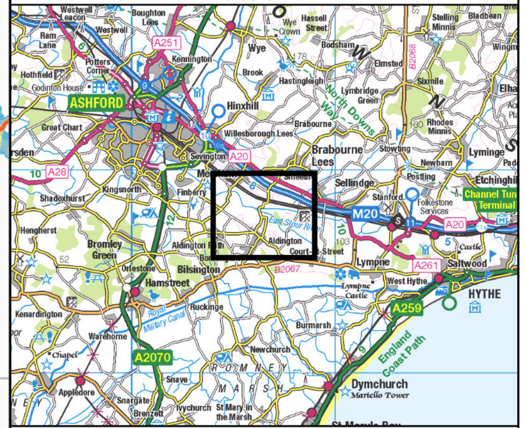
- Order limits
- Field

**Flood Depth (m)***

- <0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3- 0.4
- 0.4- 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
- 1.0 - 2
- >2.0

*Baseline Model Flood Depth: Defended 1:100 - 36.25 hr Rainfall Event - 1 m Grid

**APFP Regulation: 5(2)(o)**



SLR

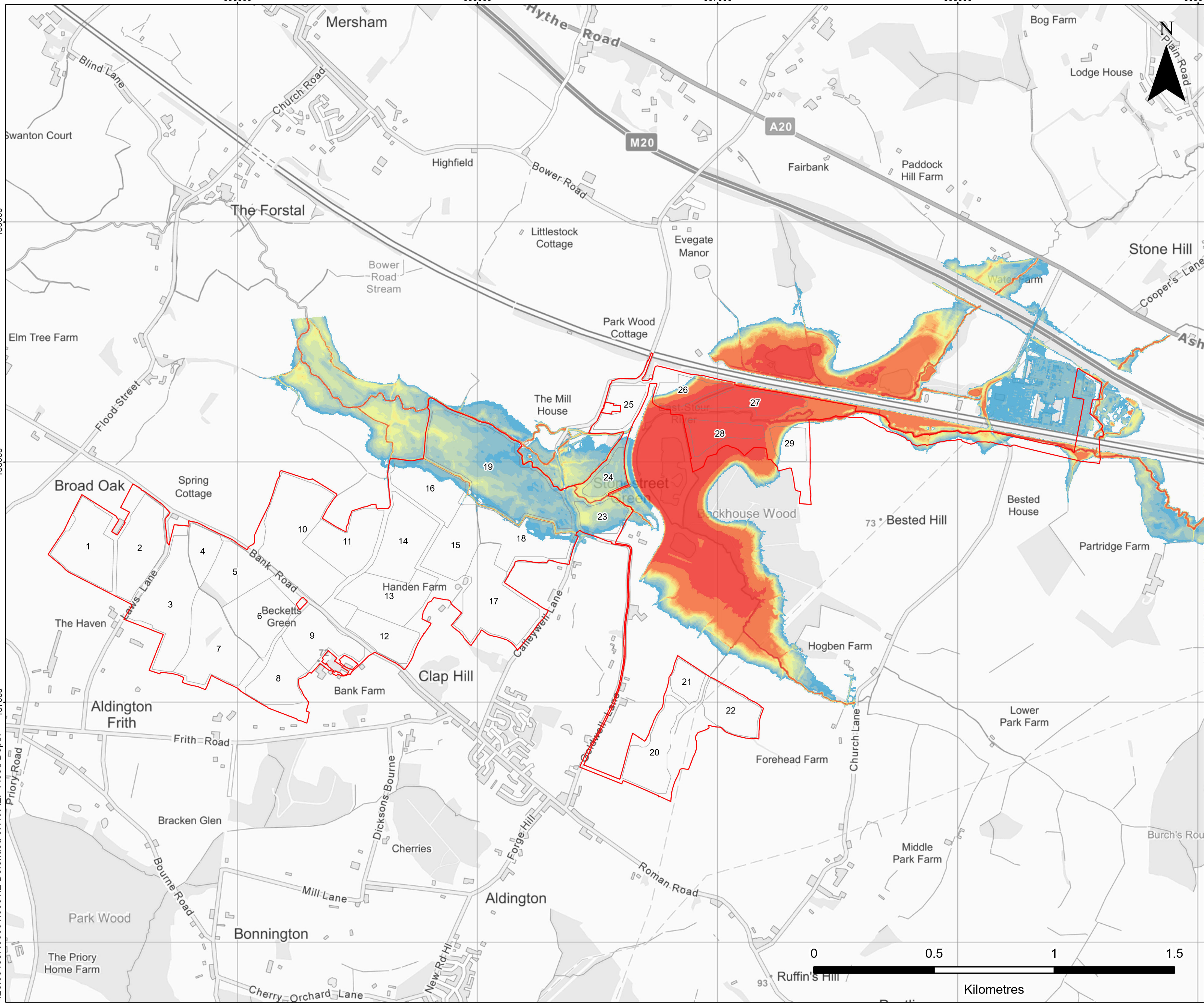
STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**DEFENDED 1.0% ANNUAL EXCEEDANCE PROBABILITY UPPER END CLIMATE CHANGE ALLOWANCE FLOOD DEPTHS**

**HMR Figure 19**

| Scale | Date |
|---|---|
| 1:15,000 @ A3 | MAY 2024 |




425.064837.00001.0061.2 Defended 0.1% AEP Flood Depth

## LEGEND

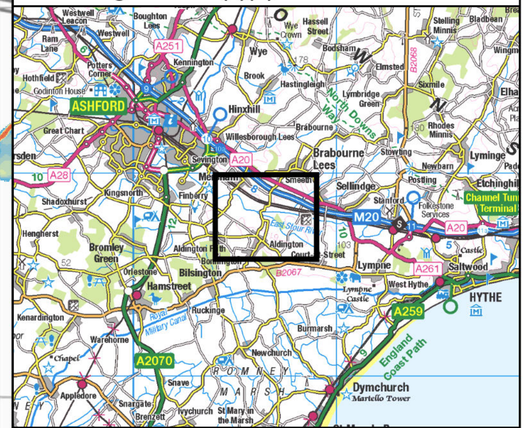
- Order limits
- Field

**Flood Depth (m)***

- <0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3- 0.4
- 0.4- 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
- 1.0 - 2
- >2.0

*Baseline Model Flood Depth: Defended 1:1000 - 27.25 hr Rainfall Event - 2 m Grid

**APFP Regulation: 5(2)(o)**

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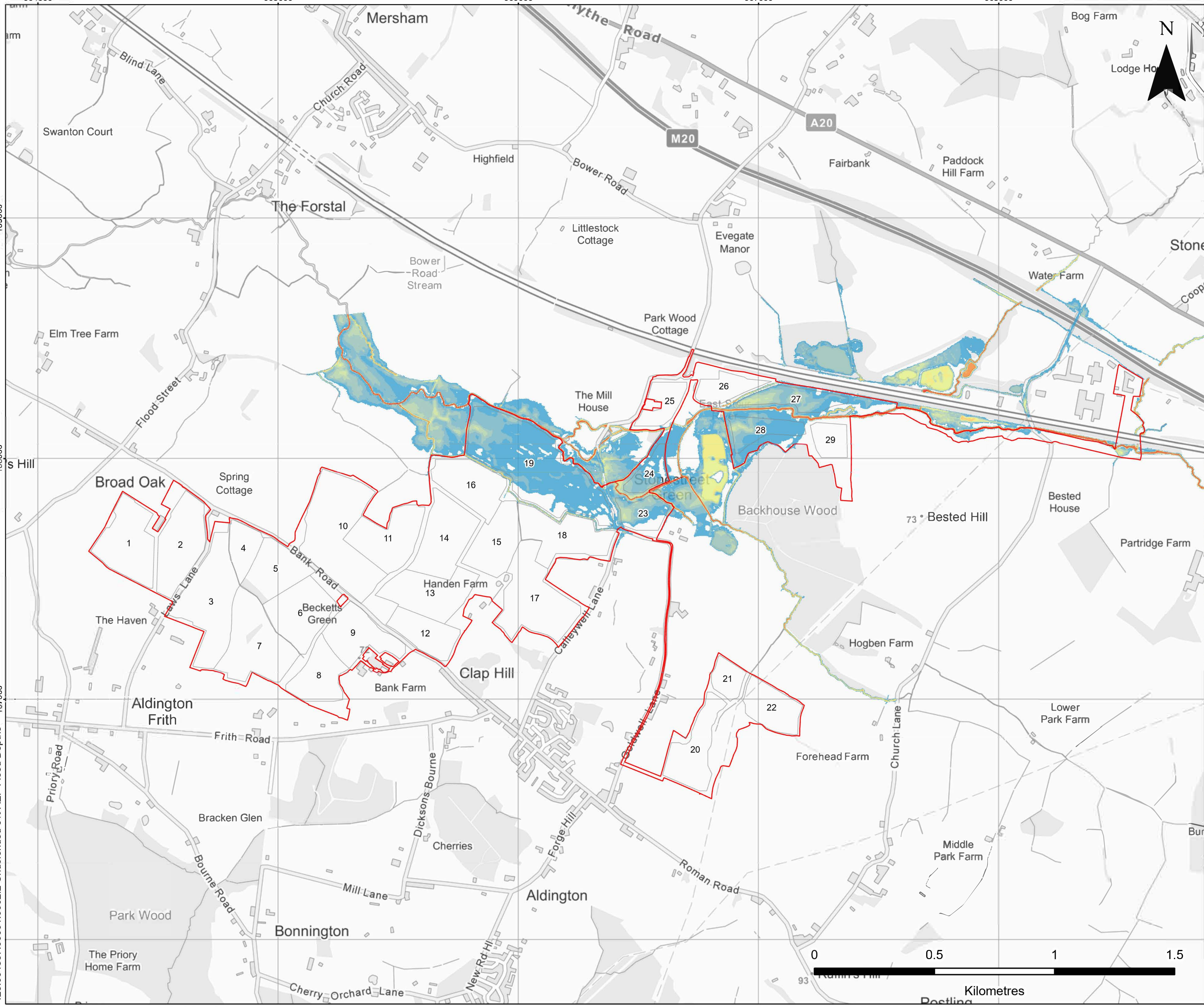
STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**DEFENDED 0.1% ANNUAL EXCEEDANCE PROBABILITY FLOOD DEPTHS**

**HMR Figure 20**

| Scale | Date |
|---|---|
| 1:15,000 @ A3 | MAY 2024 |




425.064837.00001.0062.2 Undefended 5% AEP Flood Depths

LEGEND

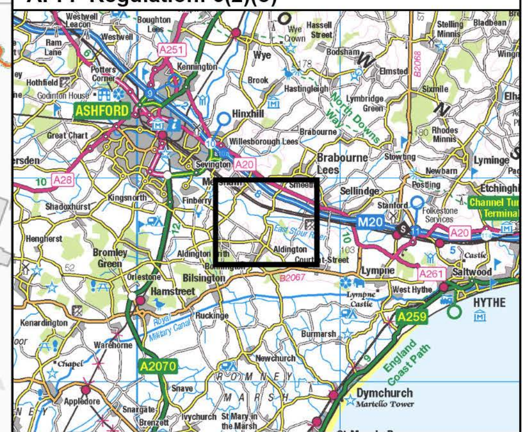
- Order limits
- Field

**Flood Depth (m)***

- <0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3- 0.4
- 0.4- 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
- 1.0 - 2
- >2.0

*Baseline Model Flood Depth: Defended 1:20 - 17.25 hr Rainfall Event - 2 m Grid

**APFP Regulation: 5(2)(o)**

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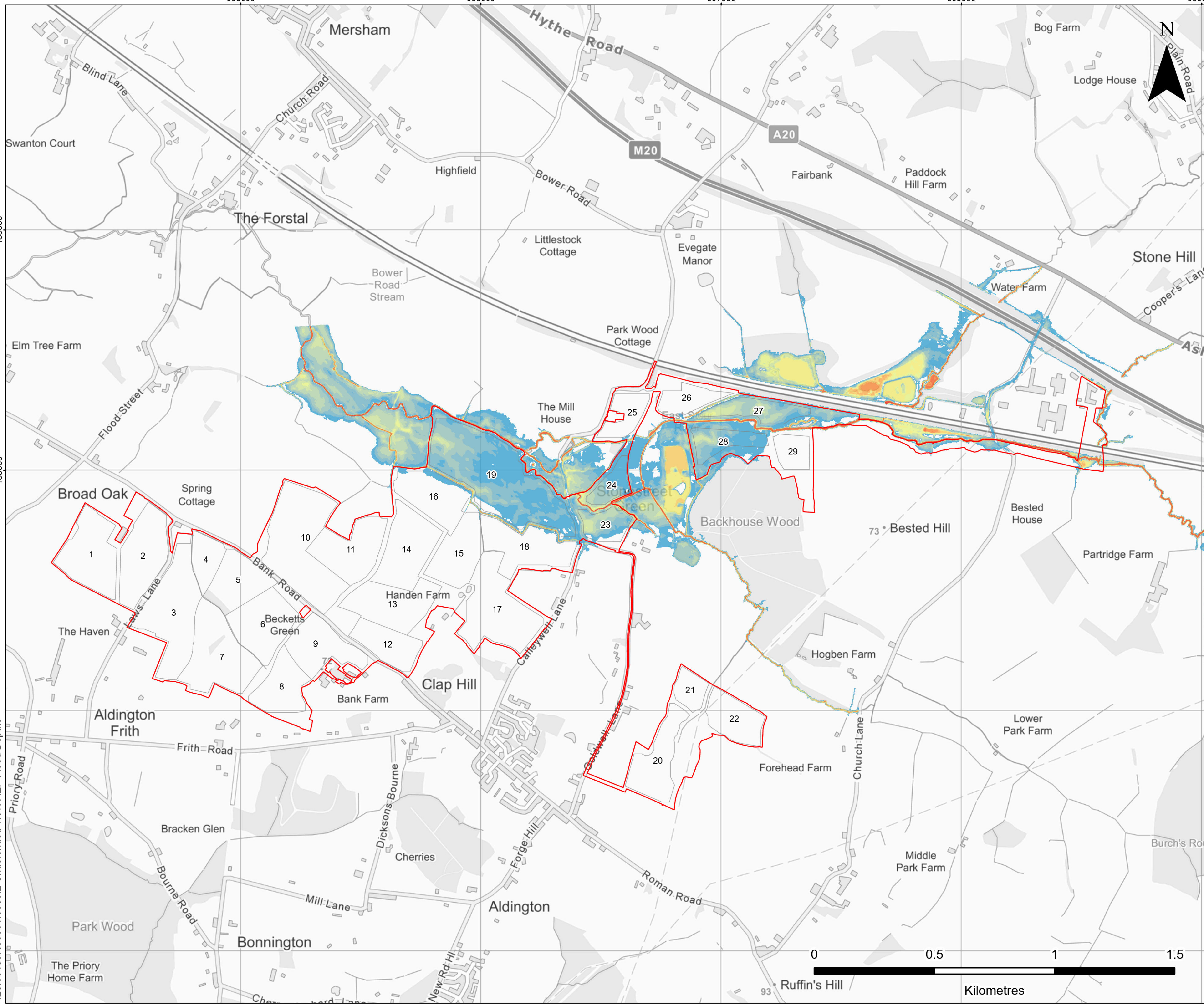
STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**UNDEFENDED 5% ANNUAL EXCEEDANCE PROBABILITY FLOOD DEPTHS**

**HMR Figure 21**

| Scale | Date |
|---|---|
| 1:15,000 @ A3 | MAY 2024 |




LEGEND

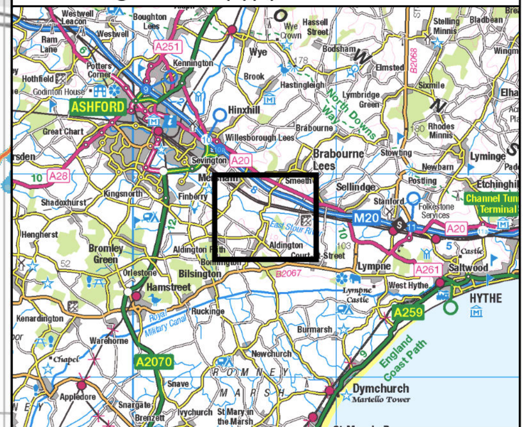
- Order limits
- Field

**Flood Depth (m)***

- <0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3- 0.4
- 0.4- 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
- 1.0 - 2
- >2.0

*Baseline Model Flood Depth: Defended 1:100 - 24.25 hr Rainfall Event - 2 m Grid

**APFP Regulation: 5(2)(o)**

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STONESTREET GREEN SOLAR

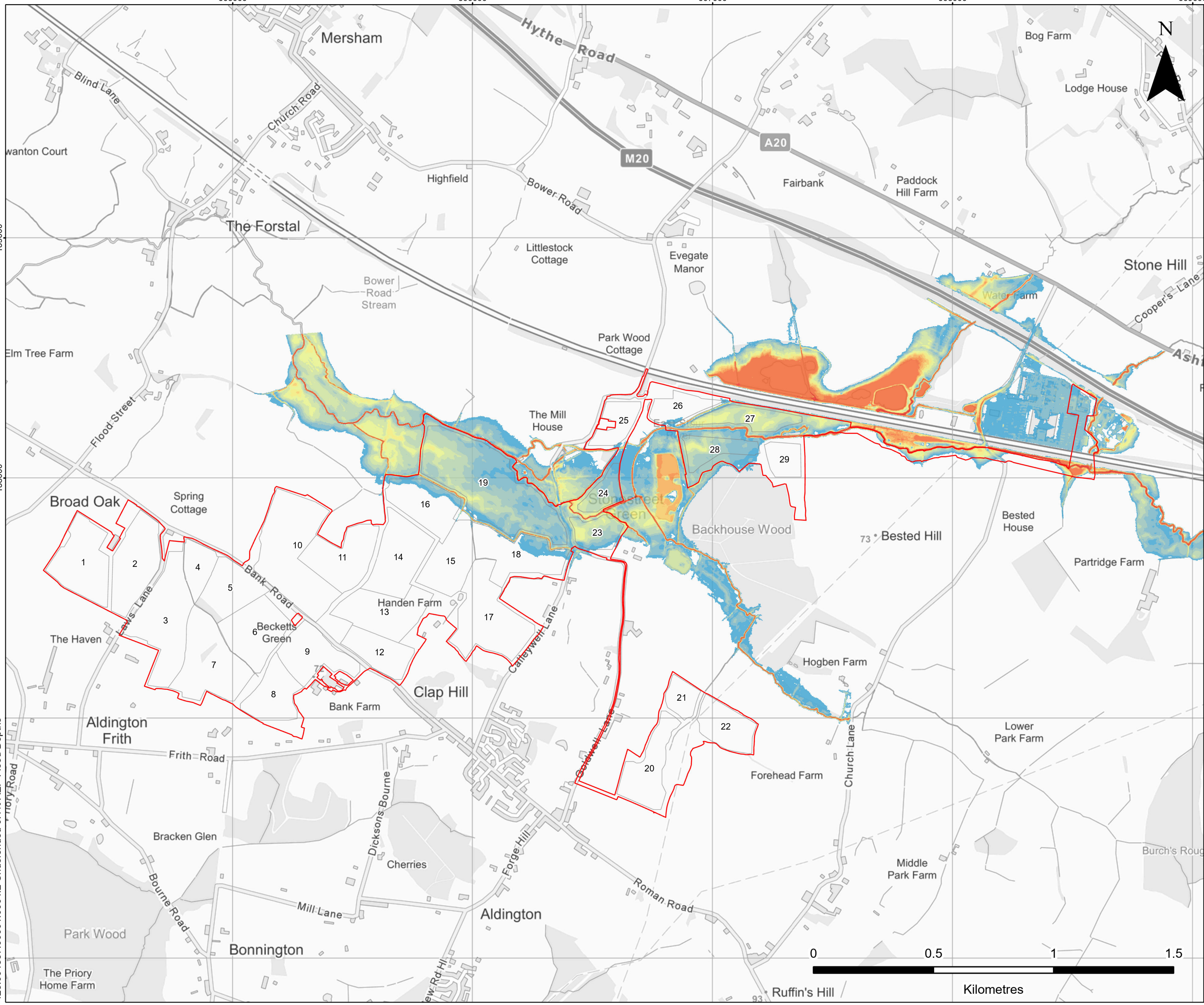
HYDRAULIC MODELLING REPORT

**UNDEFENDED 1.0% ANNUAL EXCEEDANCE PROBABILITY FLOOD DEPTHS**

**HMR Figure 22**

| Scale | Date |
|---|---|
| 1:15,000 @ A3 | MAY 2024 |

425.064837.00001.0063.2 Undefended 1.0% AEP Flood Depths




425.064837.00001.0064.2 Undefended 0.1% AEP Flood Depths

LEGEND

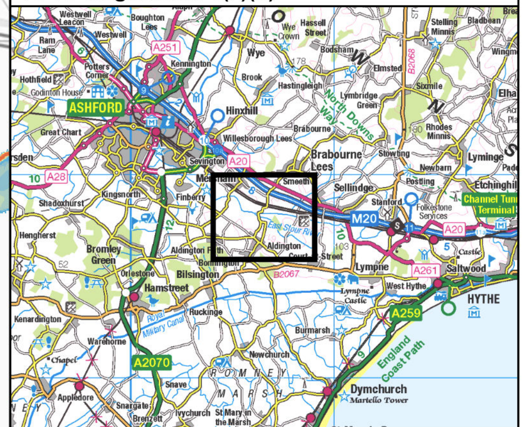
- Order limits
- Field

**Flood Depth (m)***

- <0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3- 0.4
- 0.4- 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1
- 1.0 - 2
- >2.0

*Baseline Model Flood Depth: Defended 1:1000 - 24.25 hr Rainfall Event - 2 m Grid

**APFP Regulation: 5(2)(o)**



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STONESTREET GREEN SOLAR

HYDRAULIC MODELLING REPORT

**UNDEFENDED 0.1% ANNUAL EXCEEDANCE PROBABILITY FLOOD DEPTHS**

**HMR Figure 23**

Scale 1:15,000 @ A3

Date MAY 2024