Lime Down D – Hydraulic Modelling Report (Tracked)

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Lime Down D - Hydraulic Modelling Report

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Site: Lime Down Solar Farm

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~~Issue-01~~

Issue-02

Schedule of Changes

Revision	Section	Description of Change(s)
2	Throughout	Model refresh at Deadline 5 to address EA comments provided at Deadline 4.

Contents

Tables

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Appendices

Reference of Terms

Annual Exceedance Probability (AEP)

The AEP is the chance or probability of a natural hazard event (usually a rainfall or flooding event) occurring annually and is usually expressed as a percentage.

Aquifers

- Principal Aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.
- Secondary A Aquifers are 'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers'.
- Secondary B Aquifers are 'predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers'.
- Secondary Undifferentiated Aquifers are assigned in 'cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type'.
- Unproductive Strata are 'rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow'.

Canal Failure

Canal failure can occur due to high-intensity rainfall or structural failure and can be dangerous due to the rapid release of large volumes of water. It is typically limited to raised canal reaches and can result in a rapid peak in flow followed by a gradual reduction.

Climate Change

A change in global or regional climate patterns. For flood risk, climate change is assessed in terms of allowances which are predictions of anticipated change for peak river flow, peak rainfall intensity, sea level rise and offshore wind speed and extreme wave height. Climate change scenario data exists across different epochs (time periods) to determine the needs for climate resilience measures. Climate change data is requested as part of an EAPD request. If a separate Environmental, Social, and Governance (ESG) Flood Risk and Climate Change Assessment is needed, additional climate change data will be required.

Environment Agency (EA) and EA Product Data (EAPD)

The EA is the lead organisation for providing flood and coastal risk management and warnings of flooding from Main Rivers and on the coast. For sites within or in close elevational proximity to Flood Zone 2 or Flood Zone 3, EAPD is ordered to obtain more detailed flood risk data such as flood depths, breach and overtopping mapping and fluvial/tidal risks associated with climate change.

Fluvial Flooding

Fluvial flooding typically occurs when a river's capacity is exceeded, and the excess water overtops the riverbanks. It can also occur when the watercourse has a high level downstream, perhaps due to structures or blockage, thus limiting conveyance. This creates a backup of water which can overtop the banks. Typical flooding issues occur when the natural floodplain has been urbanised and the river has been confined. EA mapping defines three zones of different flood risk, the third of which is subdivided into two categories:

- Zone 1 “Low probability of flooding” – This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%);
- Zone 2 “Medium probability of flooding” – This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year;
- Zone 3a “High probability of flooding” – This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year; and
- Zone 3b “Functional floodplain” – A sub-part of Zone 3, this zone comprises land where water has to flow or be stored in times of flood. This zone is not normally included within the national Flood Map for Planning and is calculated where necessary using detailed hydraulic modelling.

Groundwater Flooding

Groundwater flooding is caused by the emergence of water from beneath the ground at either point or diffuse locations when the natural level of the water table rises above ground level. This can result in deep and long-lasting flooding of low-lying or below-ground infrastructure such as underpasses and basements. Groundwater flooding can cause significant damage to property, especially in urban areas, and can pose further risks to the environment and ground stability.

Sewer Flooding

Flooding from sewers primarily occurs when flow entering a system exceeds available capacity or if the network capacity has been reduced through blockage or collapse. In the case of surface water sewers that discharge to watercourses, the same effect can be caused as a result of high-water levels in the receiving watercourse. As a result, water can begin to surcharge the sewer network, emerging at ground level through gullies and manholes and potentially causing flooding to highways and properties. If this occurs flooding can represent a significant hazard to human health due to the potential for contaminants in flood water.

Source Protection Zones

Source Protection Zones (SPZs) are areas of land through which water infiltrates into a groundwater borehole, well or spring that is used for public drinking water supply. These zones show the risk of contamination from potential pollution. SPZ’s have been created as public facing boundaries where discrete groundwater bodies within SPZ’s have been dissolved on zone number where common boundaries and overlaps have been removed. SPZs are defined around large and public potable groundwater abstraction sites. The purpose of SPZs is to provide additional protection to safeguard drinking water quality through constraining the proximity of an activity that may impact upon a drinking water abstraction.

- Zone 1 (Inner Protection Zone) is defined by a travel time of 50-days or less from any point within the zone at, or below, the water table. Additionally, the zone has as a minimum a 50-metre radius.
- Zone 2: (Outer Protection Zone) - This zone is defined by the 400-day travel time from a point below the water table. Additionally, this zone has a minimum radius of 250 or 500 metres, depending on the size of the abstraction.
- Zone 3: (Total catchment) - This zone is defined as the total area needed to support the abstraction or discharge from the protected groundwater source. A further Zone 4, or ‘Zone of Special Interest’ was previously defined for some groundwater sources.

Surface Water Runoff

Surface water runoff is defined as water flowing over the ground that has not yet entered a drainage channel or similar. It usually occurs because of an intense period of rainfall which exceeds the infiltration capacity of the ground. Typically, runoff occurs on sloping land or where the ground surface is relatively impermeable. The ground can be impermeable either naturally due to the soil type or geology, or due to development which places impervious material over the ground surface (e.g. paving and roads).

Tidal Flooding

Tidal flooding is caused by high tides coinciding with a low-pressure storm system which raises sea and tidal water levels, overwhelming coastal and river defences. This may be made worse by gale-force winds blowing the raised body of water up tidal river basins some distance from the coast, due to floodwater being forced up the tidal reaches of rivers and estuaries. Such flooding may become more frequent in future years due to rising sea levels.

Reservoirs Failure

Reservoir failure can be a particularly dangerous form of flooding as it results in the sudden release of large volumes of water that can travel at high velocity, causing deep and widespread flooding. The likelihood of this occurring is low as large reservoirs are managed in accordance with the Reservoirs Act 1975. The EA's online reservoir inundation map illustrates the maximum flood extents that could occur in the event of a reservoir.

1. Introduction

1.1 Acknowledgement

1.1.1 This report has been prepared for the sole and exclusive use of Lime Down Solar Park in accordance with the ~~scope~~scopes of work presented via email by Arthian, dated 14/10/2024 and 24/04/2026. This report is based on information and data collected by Arthian. Should any of the information be incorrect, incomplete, or subject to change, Arthian may wish to revise the report accordingly.

1.1.2 Arthian has been instructed to provide hydraulic modelling support to inform the Flood Risk Assessment and Drainage Strategy for **ES Volume 3, Appendix 11-6: Flood Risk Assessment and Drainage Strategy - Lime Down D [~~EN010168/APP/6.3 (Rev 3)]~~.REP4-031].** This modelling forms part of the wider suite of Flood Risk Assessment and Drainage Strategy documents submitted in support of the Lime Down Solar Park DCO application.

1.2 Project Understanding

1.2.1 The development comprises solar PV sites, battery energy storage systems (BESS), and the associated cable route corridor. It is divided into five areas (Lime Down A–E) plus the cable route corridor, with the BESS located within Lime Down D.

1.2.2 For Lime Down A, B, C and E, the developable areas have been positioned using relevant strategic Environment Agency (EA) datasets, including the Flood Map for Planning (FMfP) and NaFRA2[1]. All development lies outside the current and future fluvial flood extents indicated by these datasets, and strategic mapping is considered sufficient to assess fluvial flood risk. Detailed hydraulic modelling is therefore not required for these parts of the site.

1.2.3 In contrast, the developable area within Lime Down D, which includes the proposed BESS, intersects Flood Zones 2 and 3 in both the current and future Flood Map for Planning. The fluvial flood risk to the site is associated with Gauze Brook, an EA main river flowing through the site.

1.2.4 No EA hydraulic model is available for the Gauze Brook, therefore a new site-specific hydraulic model has been built to refine the fluvial flood risk classification for this area and is detailed within this report.

1.2.5 This report takes into account the following guidance documents:

- https://www.gov.uk/guidance/using-modelling-for-flood-risk-assessments - Using modelling for flood risk assessments (2023);
- TUFLOW manual (~~2025~~2026)[2].

1.3 Project Limitations

[1] EA National Flood Risk Assessment 2 – a significant update on national flood risk that delivers enhanced flood modelling, high-resolution mapping, and improved climate change projections.
[2] https://docs.tuflow.com/classic-hpc/manual/~~2025.1~~2026.0/

1.3.1 The wider Arthian limitations are contained within Appendix A.

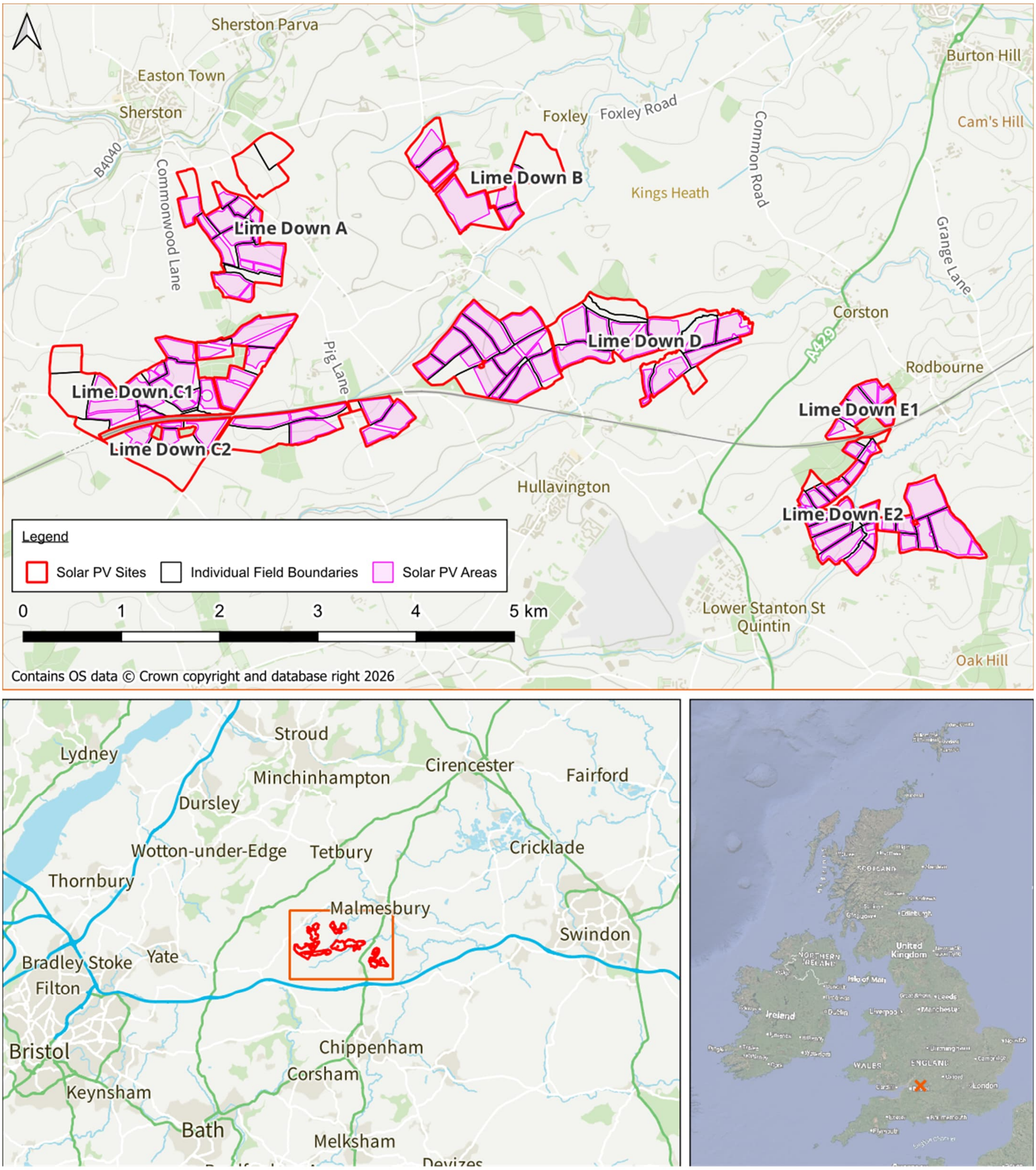


Figure 1: Site location

2. Model Build and Testing

2.1 Model Requirements

2.1.1 A site-specific hydraulic model was developed to quantify fluvial flood behaviour along Gauze Brook within the study area and to generate outputs suitable for Flood Risk Assessment purposes.

2.1.2 The key requirements of the model were to:

- Simulate water levels and flow conveyance along the watercourse for a range of design events;
- Produce flood extents and depths across the model domain;
- Represent in-channel and overbank flow mechanisms influencing floodplain behaviour;
- Assess sensitivity to climate change allowances in accordance with current guidance; and
- Generate mapping and data outputs suitable for informing development layout and flood risk management measures.

2.1.3 The model domain, resolution and parameterisation were selected to provide a stable and hydraulically representative simulation of the watercourse and adjacent floodplain, while remaining proportionate to the scale and purpose of the assessment.

2.1.4 The following section describes the model build, including topographic representation, hydrological inputs, boundary conditions and simulation setup.

2.2 Conceptual Model

2.2.1 The conceptual understanding of flood behaviour at Lime Down D is that fluvial flooding is driven by exceedance of in-channel capacity within Gauze Brook during higher magnitude rainfall events. Overtopping of the channel banks results in shallow floodplain inundation, with flow conveyed along existing topographic depressions and natural overbank storage areas. A potential hydraulic control within the study reach is the culvert beneath the South Wales Main Line, which may influence upstream water levels during larger magnitude events. No formal flood defences are present. Receptors comprise the proposed BESS and associated infrastructure within Lime Down D. The model has therefore been configured to represent in-channel conveyance, culvert control, overbank spill mechanisms and floodplain storage processes in sufficient detail to inform assessment of risk to the developable area.

2.3 Data Sources

Table 1: Data sources used during model development

Data Source	Provider	Date/Age	Comments
Topographic survey	Client	~~Q1~~March 2025	Good ~~coverage of Lime Down D up~~agreement with underlying LiDAR LiDAR used primarily owing to ~~banks of Gauze Brook~~higher resolution
Channel survey	Arthian	~~Q1 2025~~June 2026	Good coverage of Gauze Brook and relevant tributaries throughout the ~~watercourses through the site~~model extent Structure details such as culvert inverts and diameters included
EA Composite LiDAR DTM	EA	November 2020	Full coverage of study/model area at 1m resolution Good agreement with the topographic survey coverage noted

2.4 Model Setup

Table 2: Model details, methodology, and parameters

Arthian Model Reference and Version:	317212_~~ENG/09_v9~~EA/26_v2
Simulation Type:	Fluvial
Model Type:	~~1D-2D~~2D with embedded 1D structures
Software Builds:	~~Flood Modeller 7.3~~ TUFLOW ~~Classic 2025~~HPC 2026.2.~~20~~0 – including Quadtree and sub-grid sampling *(latest ~~builds~~build available at the time of simulation)*
Number of Domains and Extent:	Single domain – the model extent is shown in Figure 2.

DTM Data Sources:	LiDAR flown for the EA in March 2020 ~~was used as~~provided the ~~base~~baseline 1m DTM ~~for this model –~~ across the full model ~~coverage at 1m~~ extent. To fully leverage the high-resolution~~. This remains the latest data available at the time issue.~~ topographic and channel survey, the model was upgraded to a pure 2D TUFLOW HPC Quadtree setup. With sinuous rural channels like Gauze Brook, traditional 1D-2D linked models can introduce localised mass-balance errors, artificial boundary oscillations, and stability constraints along bank lines during overbank spill. Furthermore, during high flow scenarios where overbank storage and floodplain conveyance dominate, enforcing an artificial 1D channel constraint can misrepresent the true 2D hydrodynamics. Eliminating 1D-2D bank links ensures strict momentum conservation and seamless hydraulic transitions between the channel and floodplain. ~~Topographic survey levels showed good correlation with underlying LiDAR DTM data and has been stamped on top where available.~~Cross-section survey data was processed using custom Python scripts to interpolate and triangulate a continuous pseudo-bathymetric channel grid. This surface smoothly blends surveyed thalweg and bank elevations into the surrounding LiDAR DTM, providing a realistic 2D bed profile without artificial steps or link boundaries. The resulting channel DTM was cross-checked against the raw survey data and found to match very well.
Cell Size:	~~2m –~~TUFLOW Quadtree module used to vary cell size from 4m through wide, flat floodplain areas, whilst increasing the resolution 1m along key flowpaths. This is considered suitable to represent key flow paths without significantly impacting model run times
Building Representation:	Very few buildings are present within the model domain, however, OS MasterMap data was used to define land use, including building footprints. High roughness applied to all buildings to represent internal walls and contents – 0.5s/m$^{1/3}$.
Existing Flood Defences:	No known formal flood defences were present within the study area.
Roughness Approach and Values:	Manning's n based on Chow (1959)[3], survey, photographs, and aerial imagery. Land use based on OS MasterMap data. Land Use Type — Roughness (s/m$^{1/3}$) General surface .... 0.030 Industrial land.......... 0.030 Land/gardens .... 0.060 Rough ground/scrub .... 0.080 Roads, tracks, and paths.......... 0.020 Buildings .... 0.500 Inland waters.......... 0.030

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

Boundary Conditions:

Design inflows were derived from a site-specific hydrological assessment for Gauze Brook and a northern tributary using ReFH2 rainfall-runoff and Flood Estimation Handbook (FEH) Statistical methods in line with current EA guidance, with FEH Statistical peaks being higher and therefore taken forward as a more conservative estimate of flood risk at the site. The FEH depth duration frequency (DDF) 22 rainfall dataset has been used in the assessment. Peak flows and hydrographs were calculated at the downstream extent of the delineated catchments and distributed to upstream inflow locations using proportional catchment area weighting. The FEH Calculation Proforma detailing the full assessment and methodology is provided in Appendix C.

Inflow boundaries were applied at key upstream ~~nodes~~points along Gauze Brook and the ~~northern tributary. An additional southern tributary was represented as a 2D inflow to the model domain to account for its hydrological contribution without explicit in-channel representation~~modelled tributaries.

Climate change uplifts for the Avon Bristol and North Somerset Streams Management Catchment are presented below, with the 2080s higher value of +39% being used to inform the design event for this scheme:

Scenario	2020s	2050s	2080s
Central	+10%	+12%	+26%
Higher	+15%	+19%	**+39%**
Upper	+27%	+38%	+71%

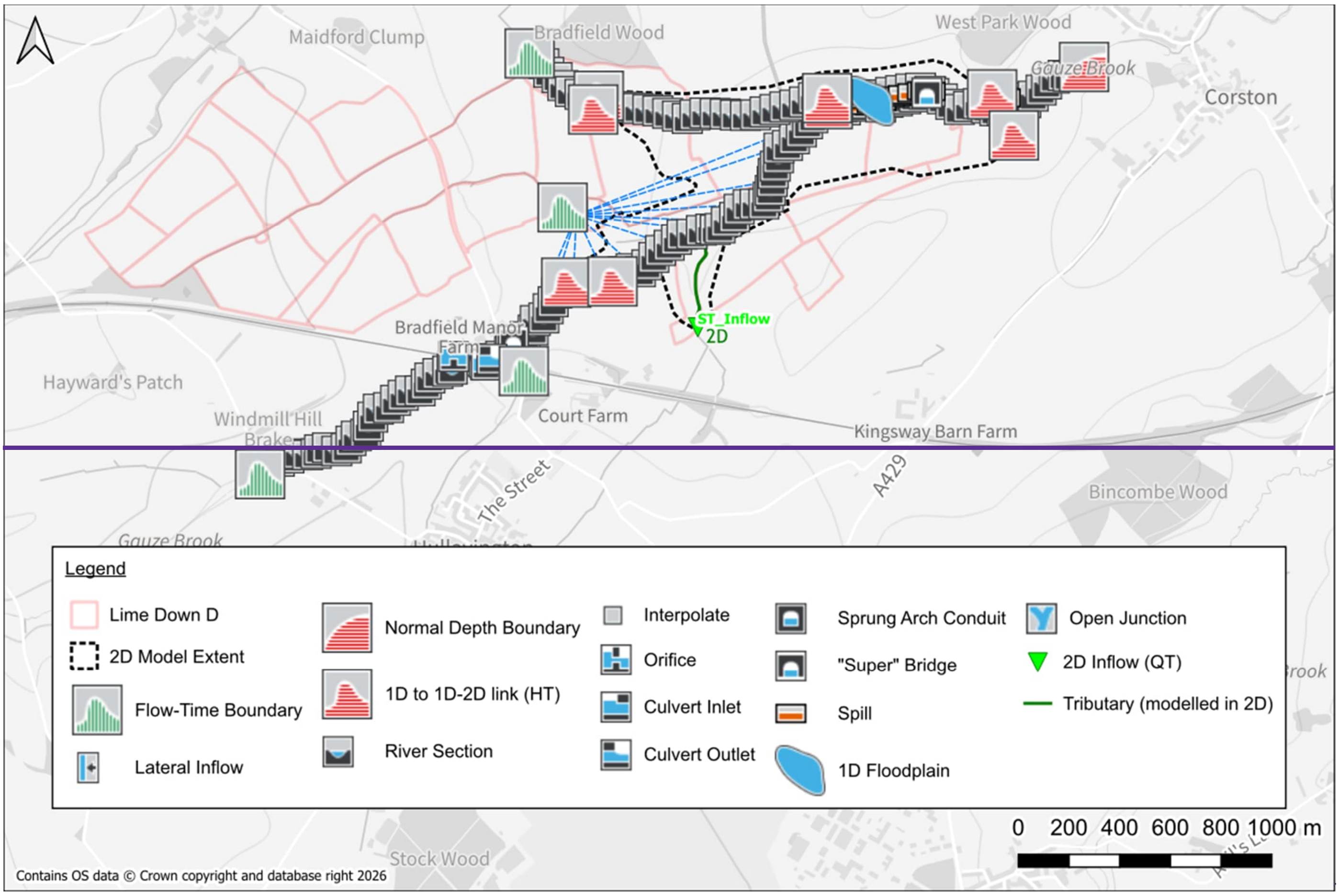
Flows are presented in Table 3.

Downstream conditions were defined using a normal depth boundary based on channel bed gradient.

A separate Flood Estimation Calculation (FEC) Record is available upon request and provides full details of the hydrological assessment, including catchment descriptors, donor station selection, QMED estimation, pooling group composition and ReFH2 design hydrograph derivation.

Structures:	All structures identified during the channel survey were reviewed as part of the model build and included within the model using ESTRY 1D channels embedded in the 2D domain. Features considered likely to influence conveyance and water levels were represented within the model using surveyed or estimated dimensions as appropriate. A ~~number of minor structures, including informal plank footbridges, were not explicitly included. Initial testing indicated that their representation introduced additional instability and unnecessary complexity to the model without materially affecting water levels, flow routes or flood extents. These features were therefore omitted on the basis that they are not hydrodynamically significant at the scale of the assessment and their exclusion does not influence the modelled flood risk outcomes.~~ ~~A~~large culvert conveying Gauze Brook beneath the South ~~West~~ Wales ~~Mainline~~Main Line railway ~~was not accessible~~(survey node GAU01_04753) could not be fully accessed during the channel survey ~~and therefore could not be measured directly. Its dimensions and levels were estimated from site observations, topographic data and engineering judgement and incorporated~~due to the Network Rail boundary constraint. While access to the downstream face was restricted, a detailed survey of the upstream face was successfully undertaken as part of the June 2026 channel survey. The surveyed upstream face geometry, soffit level, and brick barrel details, combined with the measured tunnel length (41.20m) and local bed slope, were used to inform the downstream face parameters and invert levels within the model ~~accordingly. Sensitivity testing was undertaken to understand the influence of reasonable variations in culvert size on upstream water levels and flood extents~~. ~~Orifice "GAU_3290ou" within~~ The model ~~has been included~~also incorporates an overland flowpath through a railway underpass located along the railway embankment parallel to ~~represent~~Gauze Brook, representing potential secondary hydraulic connectivity ~~between the main river channel and~~to an adjacent topographic depression ~~identified from the LiDAR and underlying mapping. The feature is evident as a secondary flow path running broadly parallel to the main river and has the potential to convey flow~~ during ~~higher magnitude~~extreme events. ~~The downstream sill level currently reported for GAU_3290ou contains a typographical error and should be 87.00 mAOD rather than 7.00 mAOD. This discrepancy has been identified through the EA review process. The model is currently being revisited as part of ongoing Natural Flood Management (NFM) investigations, and this minor amendment will be incorporated as part of that update. Given the localised nature of the structure and its function within the model, no material change to the model results or conclusions is anticipated.~~Detailed survey data for the structure (nodes GAU04_00013 downstream face and GAU04_00026 upstream face) confirms a dry, brick-built railway underpass with a tunnel length of approximately 13.3m. This structure has been represented directly within the 2D domain using TUFLOW HPC Quadtree mesh refinement to ensure sufficient geometric detail and hydraulic resolution are retained.
Post-Development Layout:	Discussed in Section 2.5.

Other DTM Adjustments:	Bank elevations have been defined primarily using the available topographic survey data, which focused on the channel corridor and immediate floodplain rather than the entirety of the model domain. Localised differences between the adopted bank elevations and LiDAR data are expected due to differences in survey coverage, data capture methodologies, vegetation effects and the interpretation required during model construction. The surveyed levels have been used in preference where available as they provide the most reliable representation of key hydraulic features. Initial model testing demonstrated good agreement with existing flood mapping, providing confidence that the adopted bank elevations appropriately represent floodplain connectivity and flow routing within the model.None required.
Timestep:	1D – 0.25s 2D – 1sBoth 1D and 2D timesteps were set to 1s initially. TUFLOW HPC uses an adaptive timestep to ensure numerical stability and solution efficiency, automatically adjusting the simulation timestep throughout the run based on local Courant number criteria (C_r≤1.0) and shallow water wave celerity. This adaptive approach maintains strict convergence and mass conservation, dynamically reducing the timestep during sudden high-velocity or rapidly varying flow transitions while optimizing runtime during steady phases of the hydrograph.
Initial Conditions:	Consistent initial conditions for all simulations were generated using a single preceding run with constant inflow applied at all upstream boundaries. This allowed water levels and channel storage to establish across the model domain prior to the design event simulations, improving numerical stability and reducing model warm-up effects. Outputs from this constant flow run were then used to initialise each subsequent event simulation.
Non-Default Parameters:	Numerical solution parameters were reviewed during model development to ensure stable and reliable convergence of the 1D solver. The Preissmann weighting factor (theta) was increased from the default value of 0.7 to 0.8 to introduce additional numerical damping and reduce local oscillatory behaviour observed within the channel network. The iteration weighting parameter (alpha) was reduced to 0.6 and applied alongside an increase in the minimum iteration setting to smooth transitions between successive iterations while allowing sufficient solver refinement at each timestep. These adjustments were implemented to support numerical stability and mass balance performance in a complex fluvial system and were verified through sensitivity testing to have no material influence on predicted water levels, flows or flood extents.None required
Further Comments:	Topographic survey data has been used in preference to LiDAR where available, with LiDAR utilised only in areas not covered by survey. The vicinity of model links “GAU_400FPlu” and “GAU_400FPru” is characterised by dense vegetation, which can adversely affect the accuracy of LiDAR-derived elevations. Consequently, some differences between LiDAR-derived topography and model spill elevations are to be expected. In addition, the implementation of SX connections requires localised modification of the underlying 2D cell elevations to facilitate stable hydraulic connectivity between model domains. These adjustments are highly localised and are not considered to materially affect flood routing or model predictions. The adopted spill elevations are considered appropriate based on the available survey information and provide a realistic representation of floodplain flow routing within the model. As part of the ongoing NFM study, the model is being further developed and refined, and the representation of this area may be reviewed as part of that wider update. None



Maidford Clump
Bradfield Wood
West Park Wood
Gauze Brook
Corston
ST_Inflow
2D
Bradfield Manor Farm
Hayward's Patch
Windmill Hill Brake
Court Farm
Kingsway Barn Farm
The Street
A429
Bincombe Wood
Gauze Brook
Legend
Lime Down D
2D Model Extent
Flow-Time Boundary
Lateral Inflow
Normal Depth Boundary
1D to 1D-2D link (HT)
River Section
Interpolate
Orifice
Culvert Inlet
Culvert Outlet
Sprung Arch Conduit
"Super" Bridge
Spill
1D Floodplain
Open Junction
2D Inflow (QT)
Tributary (modelled in 2D)
0 200 400 600 800 1000 m
Stock Wood
Contains OS data © Crown copyright and database right 2026

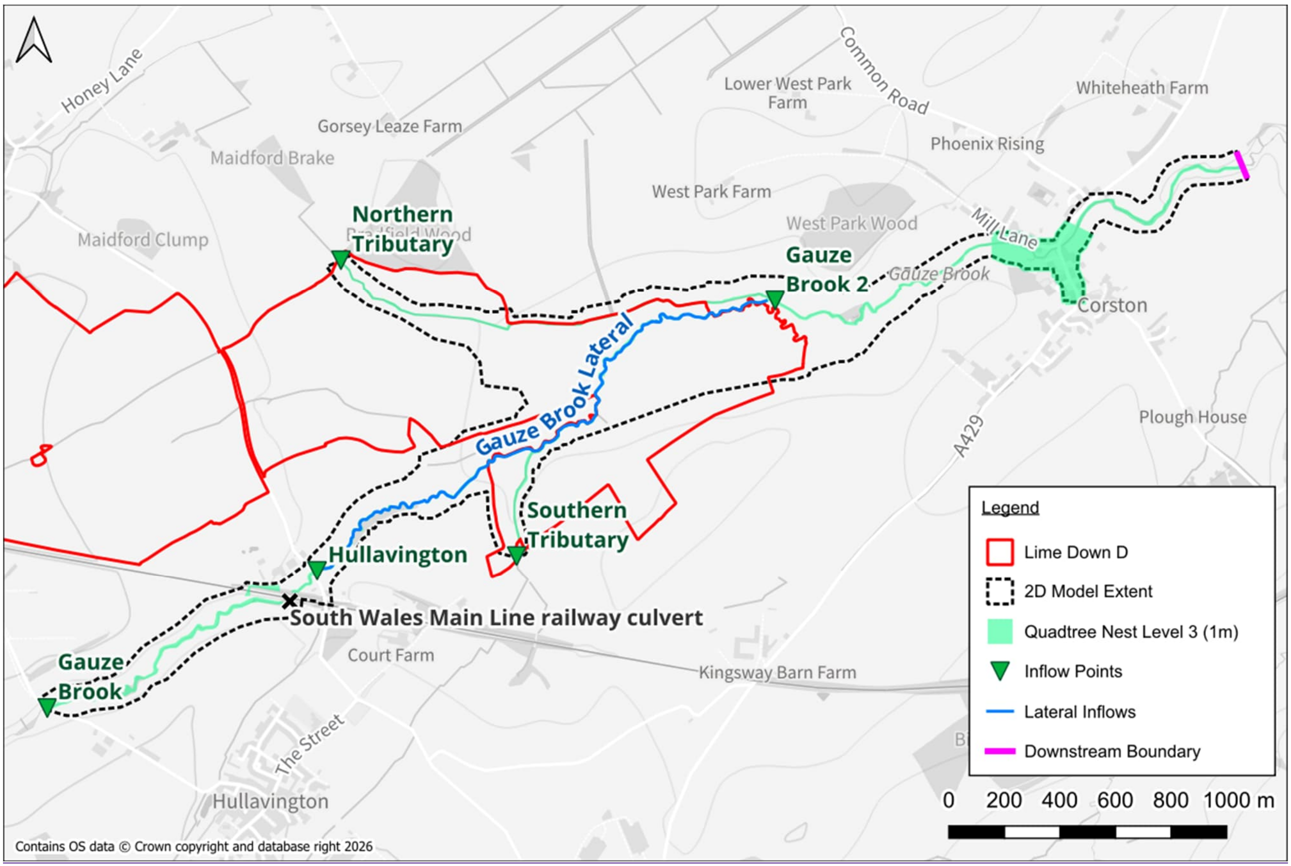


Figure 2: Model extent

Table 3: Modelled inflows (FEH Statistical)

Fluvial Event (AEP)			Gauze Brook Full Catchment Flow (m³/s) Northern Tributary (m³/s) Total (m³/s)
3.3%	8.18	1.96	10.154
1%	10.8	2.65	13.575
0.1%	17.6	4.62	22.224
1% +39%CC (higher)			**15.019.11** **3.68** **18.7**
1% +71%CC (upper)	18.5	4.53	23.051
0.1% +39%CC (higher)	24.5	6.42	30.992
0.1% +71%CC (upper)	30.1	7.90	38.004

2.5 Simulated Flood Events and Scenarios

2.5.1 The model was used to simulate three present-day fluvial events: 3.3%, 1%, and 0.1% Annual Exceedance Probability (AEP) as well as the ~~1% AEP +~~same three events for the central (+26%), higher (+39~~%~~%), and upper (+71%) climate change ~~and 1% AEP +71% climate change events.~~scenarios (2080s epoch).

2.5.2 Only the baseline (pre-development) scenario was modelled, as the proposed solar development and BESS does not involve significant changes to topography, land use, or drainage characteristics that would affect the modelled flood response. As such, the development is not expected to materially alter flood risk within the model domain.

Hydraulic Model Resolution – Purpose and Application

2.5.3 Hydraulic models are typically developed at a scale appropriate to the study objectives, balancing representation of flood behaviour across catchments and floodplains with computational stability and simulation time. As such, models commonly utilise grid resolutions in the order of 2m to 15m (or greater in some applications), depending on the level of detail required and available data.

2.5.4 This scale of modelling is appropriate for:

- Defining flood extents, levels and depths across large areas;
- Supporting planning-level Flood Risk Assessments (FRAs); and
- Identifying broad flow routes and floodplain behaviour.

2.5.5 However, by definition, hydraulic models do not resolve very small-scale features. Elements with dimensions significantly smaller than the model cell size, such as individual solar panel support posts and associated infrastructure, fall below the effective resolution of the model and are not explicitly represented, even where relatively fine grids (e.g. 1-2m) are applied.

2.5.6 This is an inherent and accepted limitation of all hydraulic modelling. Model resolution is selected to balance accuracy, stability and computational practicality, and is not intended to capture sub-grid scale features.

2.5.7 Accordingly, hydraulic models remain entirely suitable for site-specific flood risk assessment where the objective is to define flood levels and inform development design, provided their limitations are appropriately understood and accounted for.

Use of Baseline Model Outputs

2.5.8 The baseline (pre-development) hydraulic model setup provided for this assessment has been used to extract flood levels and depths across the site for the relevant design events.

2.5.9 Baseline outputs from this modelling have been used to:

- Inform the layout of the solar development, both panels and BESS;

- Position infrastructure outside of higher-risk areas where practicable;
- Set finished levels and panel elevations, typically with an appropriate freeboard above the design flood level; and
- Confirm that the panels themselves remain above the modelled flood surface and do not interact with flood flows under design conditions.

2.5.10 This approach is consistent with standard practice and ensures that the primary development elements do not introduce obstruction to floodplain storage or conveyance.

Limitations of Post-Development Modelling

2.5.11 Explicitly modelling the post-development scenario within the hydraulic model is not considered appropriate or proportionate for the following reasons:

Scale Mismatch

2.5.12 The characteristic dimensions of solar panel support posts (typically on the order of 0.1m) are an order of magnitude smaller than the model grid resolution (2m). As such:

- The supports cannot be resolved explicitly within the model grid; and
- Any attempt to represent them directly would be numerically meaningless.

Use of Proxy Methods

2.5.13 Alternative approaches sometimes used include:

- Storage reduction factors;
- Artificial flow constrictions; and
- Increased roughness coefficients.

2.5.14 Whilst each of these methods appears simple initially, they often bring significant assumptions and uncertainty.

- They operate at the scale of the model cell and can therefore vastly over-represent the physical obstruction;
- They may introduce disproportionate and non-physical changes to flow behaviour;
- They can be highly sensitive to subjective parameter selection such as roughness increases and therefore lack robustness; and
- They are likely to significantly overestimate impacts rather than provide a realistic representation as a result.

2.5.15 Given the extremely small scale of the supports relative to the floodplain and model resolution, these methods would reduce model reliability rather than improve it.

Quantitative Assessment of Displacement

2.5.16 In lieu of inappropriate model manipulation, a direct volumetric assessment of displacement has been undertaken where necessary.

2.5.17 The methodology used in this assessment is as follows:

1) Identification of Locations

Proposed panel support locations are overlaid onto the baseline model outputs.

2) Extraction of Flood Depths

Flood depths at each support location are obtained from the baseline results.

3) Calculation of Displaced Volume

The flood depth at each location is multiplied by the cross-sectional area of the support to determine the displaced volume.

4) Summation and Conservatism

The total displaced volume is summed across all supports and conservatively rounded up.

5) Redistribution of Volume

The total volume is distributed across an appropriate flooded area, selected based on local hydraulic conditions (e.g. areas of comparable flood level or the wider flood extent within the development boundary).

6) Resulting Level Change

The predicted change in flood level is calculated as:

$$Level\ increase = \cancel{Volume/Area}\ \frac{Displaced\ Volume}{Flooded\ Area}$$

2.5.18 This approach provides a transparent, physically representative and conservative estimate of potential impact.

2.6 Model Assumptions and Limitations

2.6.1 The hydraulic model has been developed using industry-standard methods in accordance with current EA guidance. Nevertheless, all models are simplifications of real-world systems, and several assumptions and limitations apply.

Topography and survey data: The model ~~topography~~DTM is ~~based on~~constructed using detailed topographic and channel cross-section survey data ~~where available, supplemented~~provided by Storm Geomatics, merged with EA 1m Composite LiDAR ~~(1m resolution)~~DTM elsewhere. ~~This is~~A continuous pseudo-bathymetric channel grid generated via Python spatial interpolation scripts from the survey data has been stamped directly into the DTM to accurately reflect in-channel conveyance and bank geometry. Ground levels are assumed to be representative of current ~~ground levels.~~baseline conditions. Small-scale features such as minor embankments, field boundaries, or ~~minor~~ micro-topographic drainage channels outside the ~~topographic~~direct survey coverage and below the effective resolution of the ~~LiDAR~~DTM may not be fully ~~captured~~resolved. However, ~~a~~ desktop ~~review of the~~ catchment reviews and comparison ~~with existing~~against strategic flood mapping datasets ~~indicate~~confirm that the overall hydraulic model ~~is performing appropriately~~performance and floodplain routing are realistic and appropriate.

Hydrological inputs: Hydrological inflows were derived using ReFH2 rainfall-runoff modelling and FEH Statistical analysis in line with current EA guidance, with ReFH2 used to define hydrograph shape and FEH methods used to inform peak flow estimation. Catchment losses were accounted for within the hydrological assessment and not represented explicitly within the hydraulic model. Design flows were applied at model inflow locations and distributed using proportional catchment area weighting, which is considered appropriate given the relatively small, predominantly rural catchment and the proportionate scope of the assessment.

Downstream boundary condition: Downstream water levels are controlled using a normal depth boundary condition derived from the local channel slope at the downstream extent of the model. This approach was adopted due to limited survey coverage beyond the model domain and the absence of known hydraulic controls further downstream. Sensitivity testing was undertaken to assess the influence of reasonable variations in the assumed slope on modelled water levels and flood extents~~;~~. Results indicated no material change within the study area, and the adopted boundary condition is therefore considered appropriate and proportionate for the purposes of this assessment.

~~**Railway culvert:** The culvert conveying Gauze Brook beneath the South Wales Main Line was not accessible during survey and therefore its dimensions, levels and condition could not be confirmed directly. The structure was assumed to comprise a brick-built sprung arch culvert based on the age of the railway and typical construction practice, with dimensions estimated from visual interpretation of the channel cross-section (approximately 2.5m base width, 1.5m springing height above bed level and 1.0m arch rise). Sensitivity testing was undertaken to assess the influence of reasonable variations in culvert size on modelled water levels and flood extents; results indicated no material change within the study area, and the adopted representation is therefore considered appropriate and proportionate for the purposes of this assessment.~~

Railway culvert: The culvert conveying Gauze Brook beneath the South Wales Main Line railway (survey node GAU01_04753) could not be fully accessed during the channel survey due to Network Rail boundary constraints. While the downstream face was inaccessible, a detailed survey of the upstream face was completed. The surveyed upstream geometry, barrel details, and measured tunnel length were used to project the downstream parameters and invert levels.

2.7 Model Health and Stability

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

~~2.7.2 Mass balance error statistics show the 1D model achieves between ±1% mass balance error for all primary simulations.~~

~~2.7.3 The 2D mass balance error peaks at over -5% during the initial wetting phase of each primary simulation, when a relatively small number of cells first become active and total water volumes within the domain are low. At this stage, small absolute differences between inflow, outflow and storage can translate into a larger percentage value. As flooding becomes established and the overall water volume within the model increases, the mass balance percentage reduces and remains close to zero for the main duration of the event. This indicates that the higher percentage is associated with the early activation of isolated floodplain cells rather than widespread hydraulic behaviour, and that mass conservation during the primary flooding phase is good. Mass balance error during the simulation peak is within ±1%.~~

2.7.2 Cumulative mass balance error statistics confirm excellent volume conservation across all primary simulations, remaining well within ±1% throughout the design events. Because TUFLOW HPC utilises a finite volume solver scheme, the 2D domain achieves near-zero mass balance error. Minor, localised mass balance fluctuations are restricted to the 1D culvert structures, as can be expected.

2.7.3 The simulation logs record a negligible number of adaptive timestep control adjustments across localised cells (WARNING 2550, with a maximum of 9 instability timestep corrections recorded at isolated cells). These minor automated timestep reductions are standard behaviour within TUFLOW HPC when resolving localised, high-velocity flow transitions through complex geometry. They occur without impacting computational progression or mass conservation.

2.7.4 There are no noticeable water surface oscillations or negative depths reported in any primary simulations. Overall, the model demonstrates high numerical stability and provides a robust, reliable technical basis for assessing flood risk across the site.

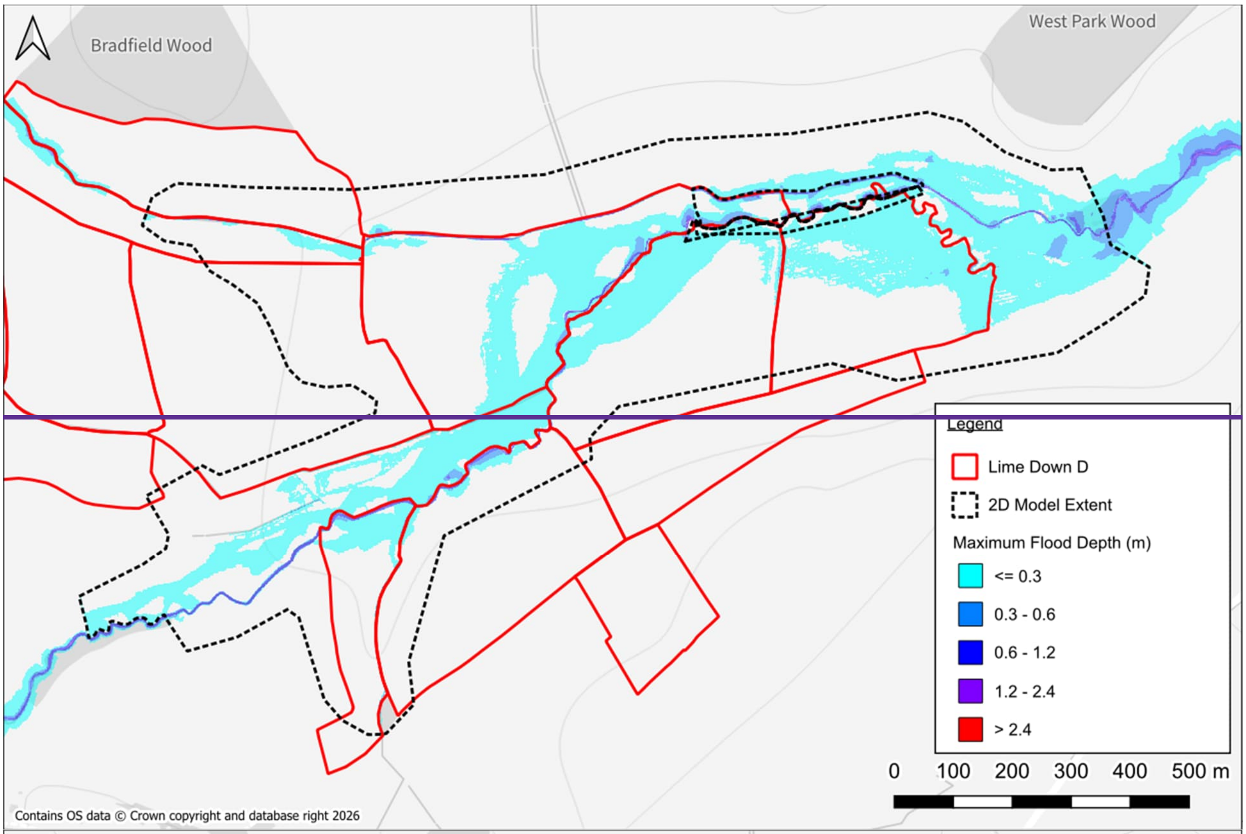
2.8 Results Summary

2.8.1 Shallow depth flooding (<300mm) is present across Lime Down D during the present day 3.3% AEP event, showing parts of Lime Down D to lie within the functional floodplain.

2.8.2 During the 1% AEP +39% climate change event (the design event – higher climate change scenario), floodplain inundation across Lime Down D ~~is~~remains generally shallow, with depths typically less than 300mm over much of the site. Areas of greater depth are largely confined to the main watercourse corridor and immediate overbank margins. Predicted flow velocities across the wider floodplain are generally low (typically <0.5 m/s), with only localised increases within the channel and defined conveyance routes where velocities marginally exceed 1.0 m/s. The overall hydraulic response across the developable area is therefore characterised by shallow, low-energy overbank flow rather than deep or fast-flowing conditions.

~~2.8.3 Flood depths remain shallow (< 300mm) across Lime Down D during the 1% AEP +71%CC event.~~

~~2.8.4~~2.8.3 Maximum flood depths during the 3.3% AEP~~, 1% AEP +39%CC,~~ and 1% AEP +~~71~~39%CC events are presented in Figure 3~~, Figure 4,~~ and ~~Figure 5~~ Figure 4 respectively.


Bradfield Wood
West Park Wood
Legend
Lime Down D
2D Model Extent
Maximum Flood Depth (m)
<= 0.3
0.3 - 0.6
0.6 - 1.2
1.2 - 2.4
> 2.4
0 100 200 300 400 500 m
Contains OS data © Crown copyright and database right 2026

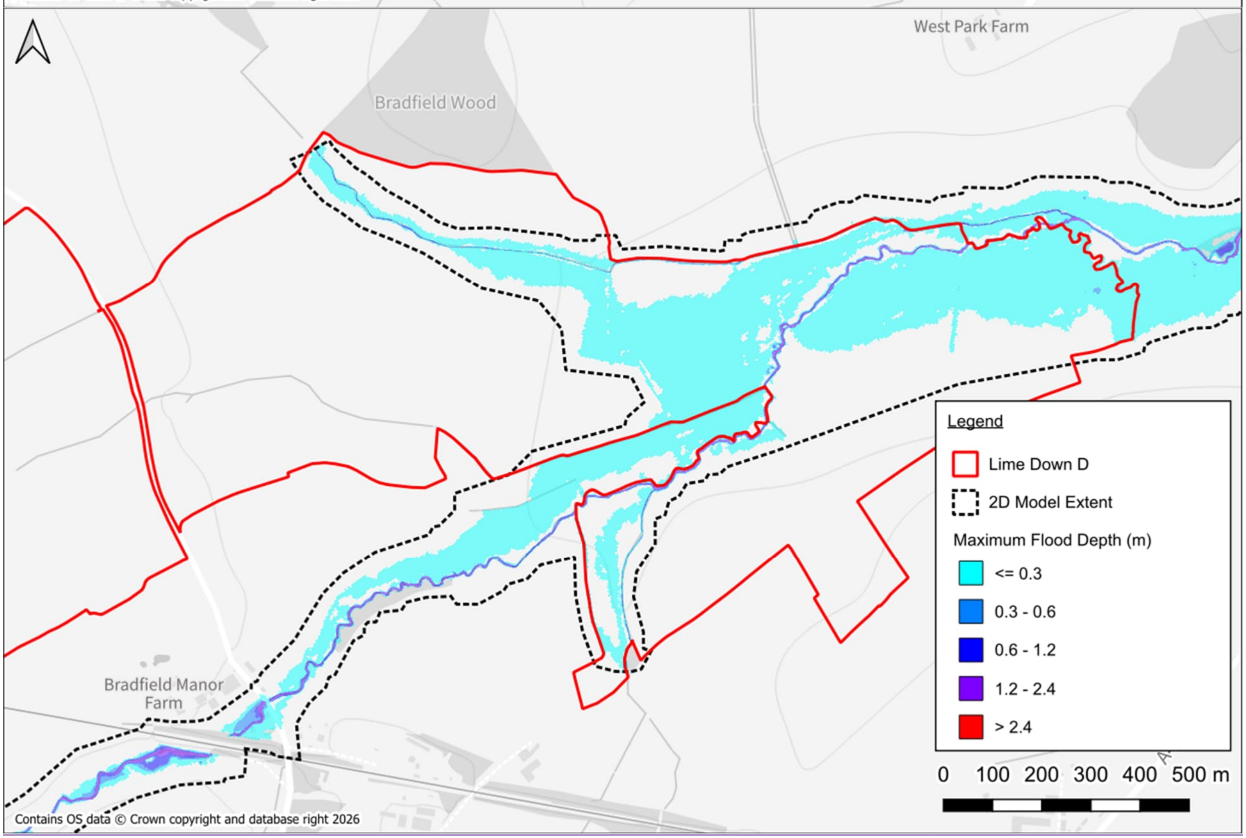

West Park Farm
Bradfield Wood
Bradfield Manor Farm
Legend
Lime Down D
2D Model Extent
Maximum Flood Depth (m)
<= 0.3
0.3 - 0.6
0.6 - 1.2
1.2 - 2.4
> 2.4
0 100 200 300 400 500 m
Contains OS data © Crown copyright and database right 2026

Figure 3: Maximum flood depths at Lime Down D, 3.3% ~~AEP~~present day fluvial event, baseline site layout

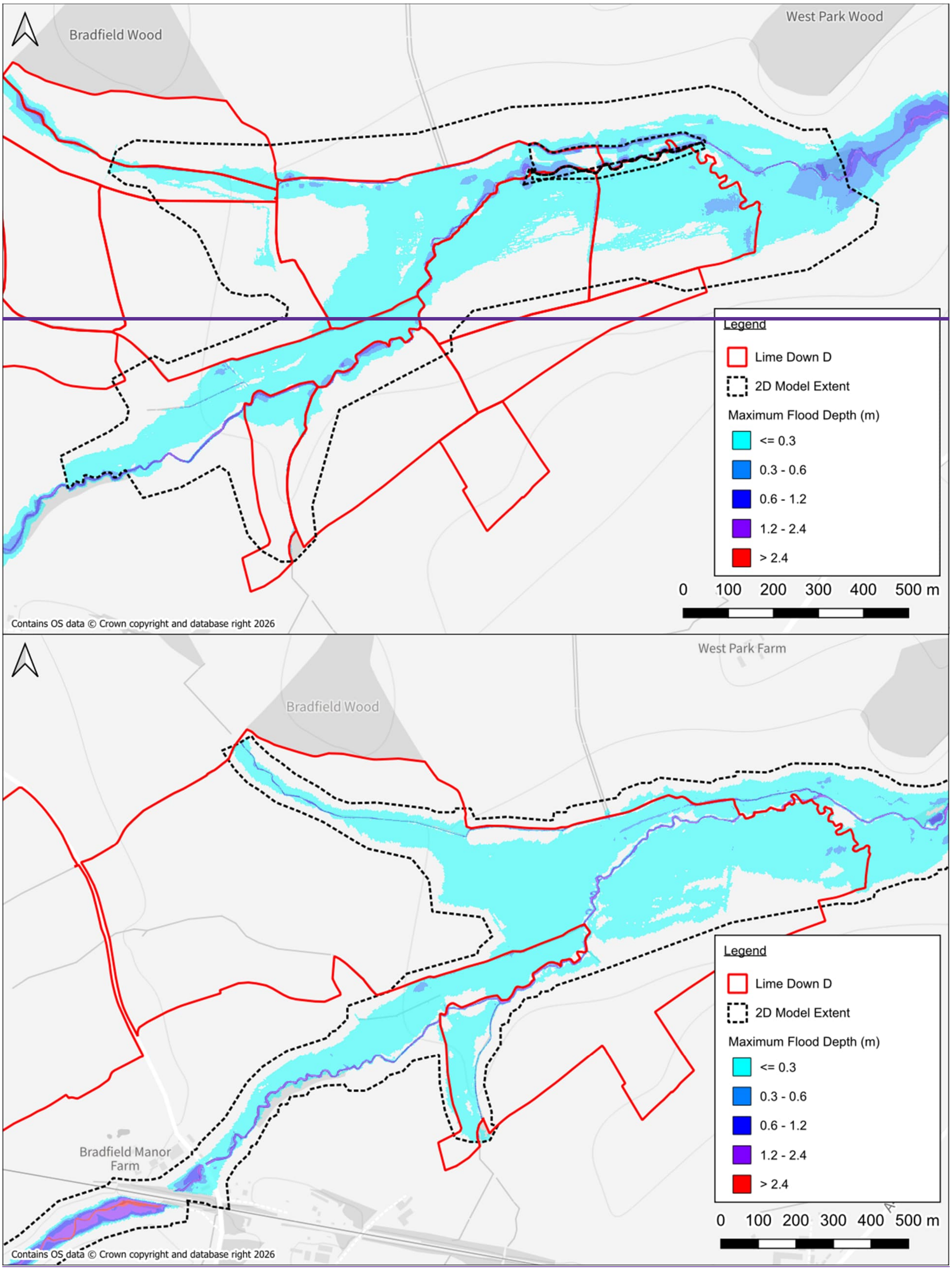
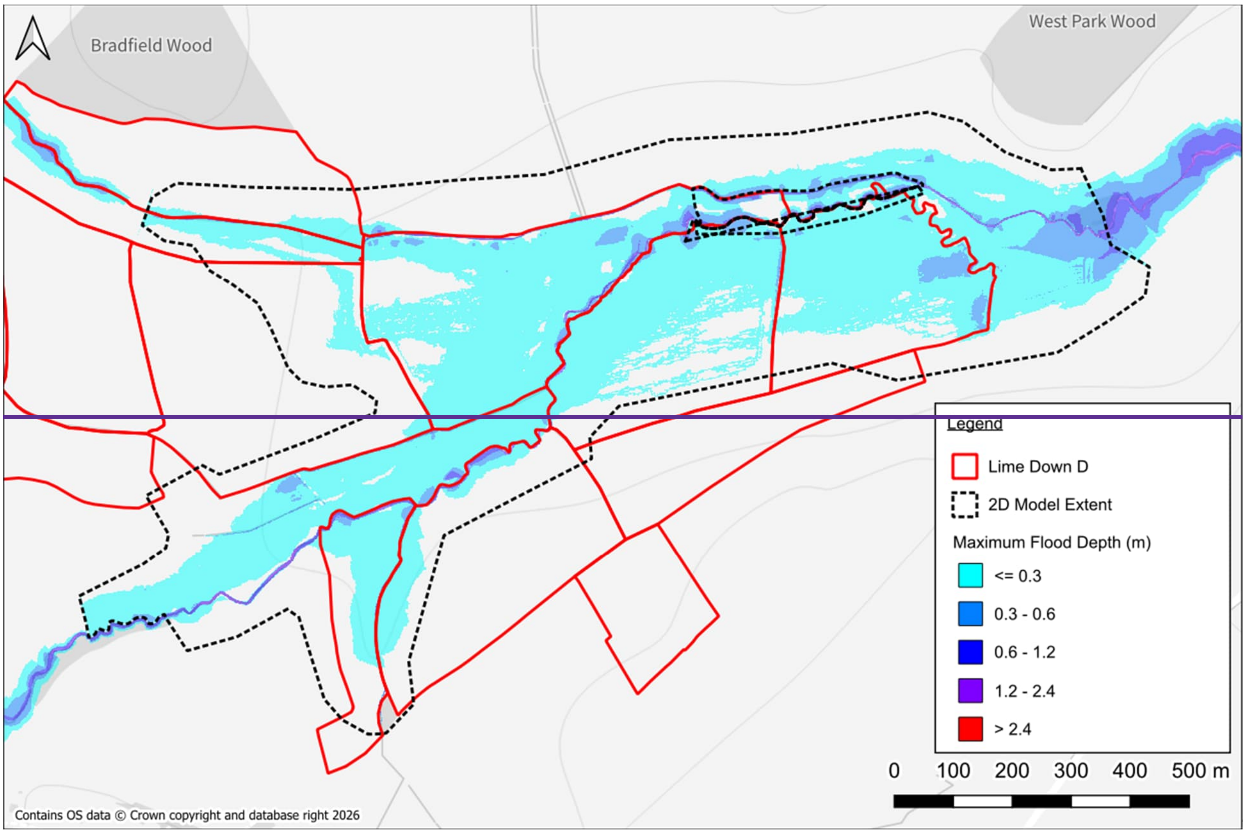


Figure 4: Maximum flood depths at Lime Down D, 1% AEP +39% ~~climate change~~CC fluvial event, baseline site layout



~~**Figure 5: Maximum flood depths at Lime Down D, 1% AEP +71% climate change fluvial event, baseline site layout**~~

2.9 Model Verification and Sensitivity Testing

2.9.1 A comparison has been undertaken between the 1% AEP +39% climate change modelled flood extent and the EA FMfP + climate change extent. The results demonstrate a good overall level of agreement in terms of the spatial distribution of flooding and the general extent of inundation along the main watercourse corridor. Minor localised differences are present, which are expected given differences in model resolution, topographic representation and underlying hydraulic assumptions. However, there is no material divergence in the predicted floodplain behaviour across Lime Down D, and the site-specific modelling is considered to provide a robust and proportionate refinement of the strategic Flood Map for Planning dataset. This comparison can be seen in Figure 5~~Figure 5~~.

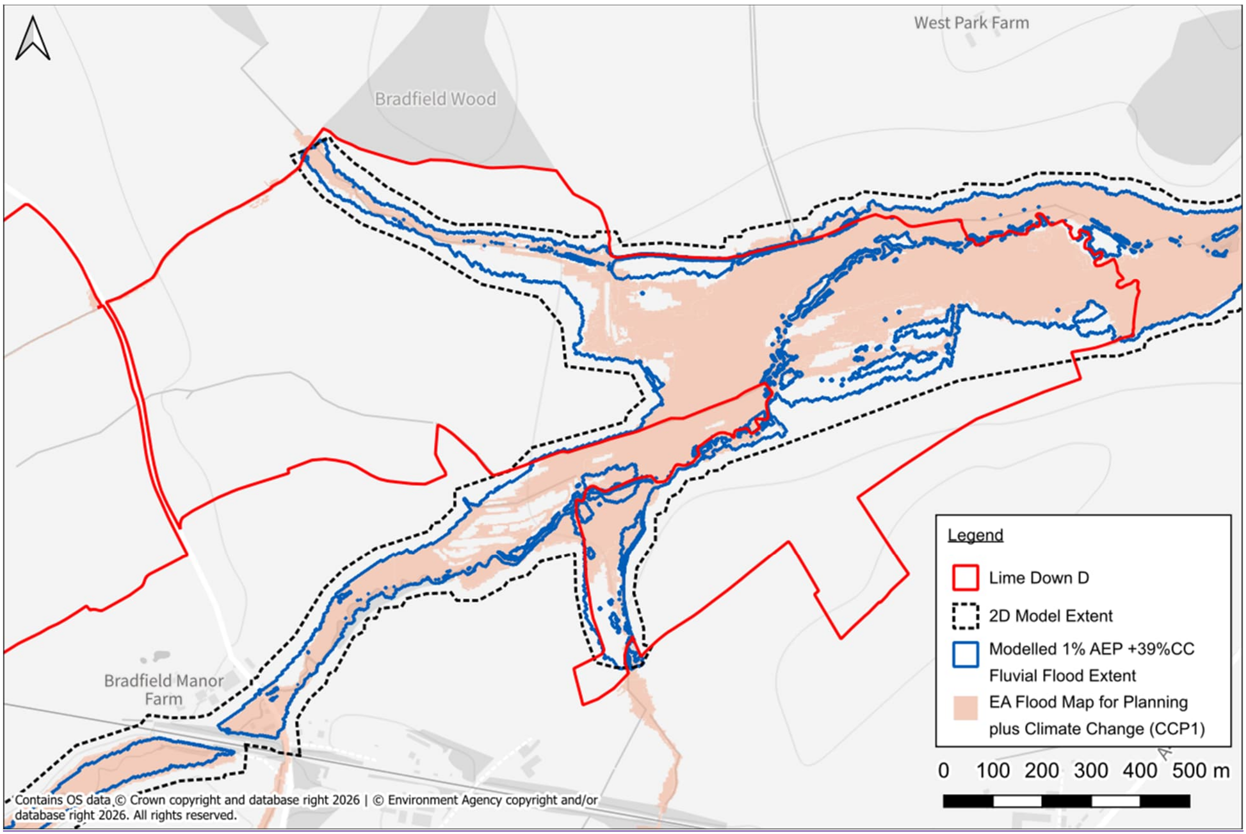


Figure 5: Modelled 1% AEP +39%CC maximum flood extent vs EA Flood Map for Planning (+CC)

2.9.2 Sensitivity testing was undertaken on key model parameters to assess the robustness of results. The following variations were applied to the 1% AEP +39% climate change simulation:

- ST1 and ST2 – roughness: ±20%
- ST3 and ST4 – inflows: ±20%
- ST5 and ST6 – downstream boundary condition slope: ±30%
- ST7 and ST8 – ~~South Wales Main Line culvert – width: ±20% (±0.5m)~~TUFLOW control number factor: ±20%

2.9.3 The adopted sensitivity ranges (±20% for roughness~~ and~~, inflows, ~~±~~and stability factors and ±30% for downstream boundary slope~~, and ±20% for culvert dimensions~~) are considered proportionate and representative of reasonable uncertainty in hydrological estimation~~,~~ and roughness parameterisation ~~and assumed structure geometry~~ for a rural catchment of this scale. A larger variation was applied to the downstream boundary slope to reflect the greater uncertainty associated with extrapolating channel gradient beyond the surveyed model extent. As slope influences the stage–discharge relationship through the square root term within Manning’s equation, a modest increase in slope can produce a proportionally smaller change in conveyance; the ±30% range was therefore selected to provide a meaningful test of boundary condition sensitivity while remaining within realistic hydraulic bounds.

2.9.4 The model outputs were not found to be particularly sensitive to any of the tested parameters, with relatively minor variations observed in peak flow and flood extent for all tests across much of the model. This suggests that the model is reasonably robust to typical uncertainties in input data and configuration.

2.9.5 Key statistics from the sensitivity tests are presented in Table 4~~Table 4~~.

Table 4: Sensitivity test outcomes vs baseline

Sensitivity Test	Differences in Water Level Whole Model (mm)		Differences in Water Level ~~Adjacent to Site~~ Within 50m of Lime Down D (mm)	
	Maximum	10th-90th %ile range	Maximum	10th-90th %ile range
ST1	+~~249~~345	~~0~~+1 to +~~73~~50	~~+249~~-327	+~~4~~1 to +~~75~~26
ST2	-~~139~~378	-~~8~~72 to ~~0~~-55	~~-139~~+349	~~-92~~ -1 to -~~14~~28
ST3	+~~255~~736	~~0~~+2 to +~~80~~71	+~~110~~302	+~~16~~1 to +~~44~~28
ST4	-~~301~~764	-~~10~~12 to ~~0~~-75	~~-115~~+359	~~-77~~ -2 to -~~19~~39
ST5	~~-51~~+130	0	~~-1~~+134	0
ST6	+~~77~~177	0~~ to +1~~	~~-1~~+136	0
ST7	-~~218~~238	~~-1~~0 to ~~0~~+2	-~~1~~238	~~-1 to~~ 0
ST8	~~+304~~-709	-3 to 0	-~~1~~209	-1 to 0

2.9.6 The sensitivity testing shows that model results respond to changes in key parameters, with roughness and flow uplifts having the greatest influence on flood depths across the model as expected. However, the magnitude and spatial extent of these changes are generally limited, particularly within and adjacent to Lime Down D, where variations in predicted depths are typically small and localised. The largest differences associated with the railway culvert sensitivity tests (ST7/ST8) occur upstream of the structure. Changes within the site itself are negligible, with differences typically close to zero. The downstream boundary condition was also shown to have negligible influence on flood levels across the site.

2.9.7 Flood mapping comparing the sensitivity tests flood extents against baseline is presented in Appendix B.

2.9.8 Overall, the sensitivity testing demonstrates that the model responds in a hydraulically realistic manner to changes in key parameters, while the principal conclusions regarding flood behaviour and depth across Lime Down D remain consistent. The model is therefore considered robust and appropriate for informing **ES Volume 3, Appendix 11-6:**the **Flood Risk Assessment and Drainage Strategy -for Lime Down D [(Appendix 11-6, EN010168/APP/6.3 (Rev 3)].).**

3. Conclusions and Recommendations

3.1 Conclusions

3.1.1 A ~~new~~ site-specific ~~1D-~~2D hydraulic model has been developed to assess fluvial flood risk to Lime Down D, where the proposed solar infrastructure and BESS intersect Flood Zones 2 and 3 associated with Gauze Brook. The model has been constructed using detailed topographic and channel survey data, supported by EA LiDAR, and represents the hydraulic behaviour of the main watercourse and adjacent floodplain at a resolution proportionate to the scale of the catchment and development.

3.1.2 Hydrological inputs were derived using ReFH2 rainfall-runoff modelling and FEH Statistical methods in accordance with current EA guidance, with conservative FEH Statistical peak flows adopted. Inflows were applied using a catchment-based approach and the model configuration incorporates appropriate boundary conditions, structures and parameterisation to simulate both in-channel and overbank processes. Model health checks, mass balance performance and numerical stability testing indicate that the model performs reliably and is suitable for assessment purposes.

3.1.3 Predicted flooding across Lime Down D during the 1% AEP +39% climate change design event is generally shallow, with depths typically less than 300mm across much of the site and low velocities (typically <0.5m/s) across the floodplain. Areas of deeper or faster flow are largely confined to the existing watercourse corridor and localised low-lying areas. The overall hydraulic response across the developable area is therefore characterised by shallow, low-energy overbank flooding rather than deep or fast-flowing conditions.

3.1.4 Comparison of the modelled flood extent with the EA FMfP + climate change extents shows good overall agreement, indicating that the model provides an appropriate refinement of the strategic mapping for this location. Sensitivity testing demonstrates that the model responds realistically to variations in key parameters, while the principal conclusions regarding flood behaviour and depth across Lime Down D remain consistent.

3.1.5 On this basis, the hydraulic modelling provides a robust and proportionate technical evidence base for assessing fluvial flood risk to the proposed development and informing the Flood Risk Assessment.

3.2 Recommendations

3.2.1 The site-specific hydraulic model and associated outputs should be used to inform **ES Volume 3, Appendix 11-6: Flood Risk Assessment and Drainage Strategy - Lime Down D [~~EN010168/APP/6.3 (Rev 3)]~~,REP4-031],** including refinement of Gauze Brook flood extents, depth mapping and consideration of the proposed BESS location within Lime Down D.

3.2.2 The modelling results indicate that flood risk across the developable area is dominated by shallow floodplain interaction. It is recommended that the development layout continues to consider these findings, including appropriate siting, finished levels and management of residual flood risk in accordance with national planning policy and EA guidance.

Appendices

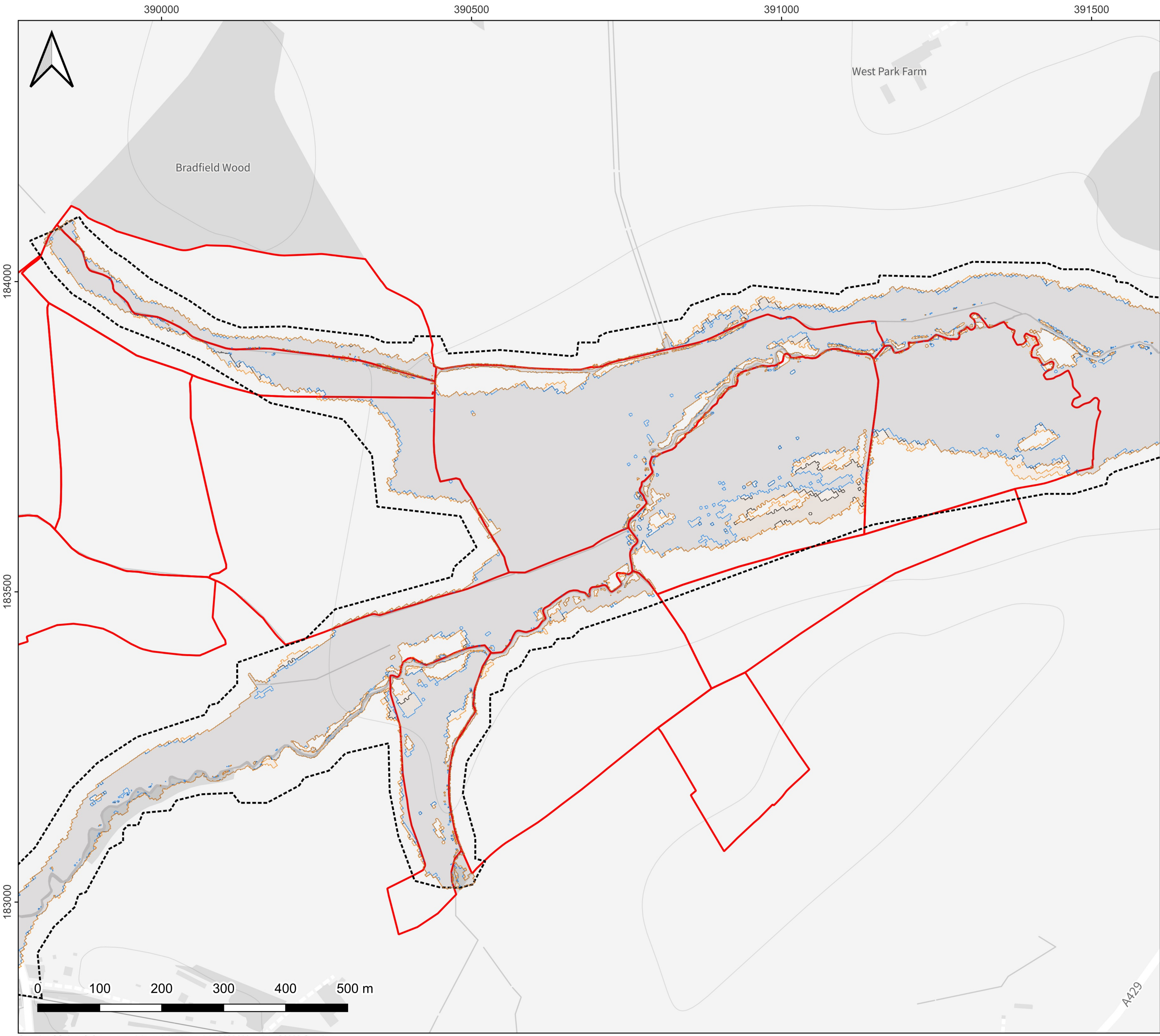
Appendix A – Limitations

Limitations

This report contains recommendations from Arthian, which are based on the information listed in the report and reflect the professional opinions of an experienced Environmental Consultant. Arthian obtained, reviewed, and evaluated information from the Client and others to prepare this report. The conclusions, opinions, and recommendations presented in this report are based on this information. However, Arthian does not guarantee the accuracy of the information provided and will not be held responsible for any opinions or conclusions reached based on information that is later proven to be inaccurate.

This report was prepared exclusively for the Client and for the specific purpose for which Arthian was instructed. It is not intended for use by anyone other than the Client without Arthian's written consent. Any unauthorized use of this report is at the sole risk of the user. Anyone using or relying on this report, other than the Client, agrees to indemnify and hold harmless Arthian from any claims, losses, or damages arising from the performance of the work by the Consult

Appendix B – Sensitivity Test Mapping



Project Reference:

317212 Lime Down Solar Farm

Client:

Island Green Power

Lime Down Solar Park

Drawing Title:

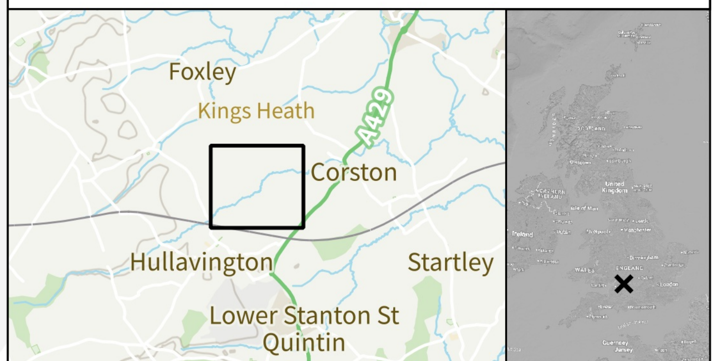
Maximum Flood Extent Comparison
Baseline: 1% AEP +39%CC fluvial event
ST1: Manning's 'n' +20%
ST2: Manning's 'n' -20%

Drawing Name:	Revision:	Date:
317212-ENG-MOD-01	A	05 Aug 2026

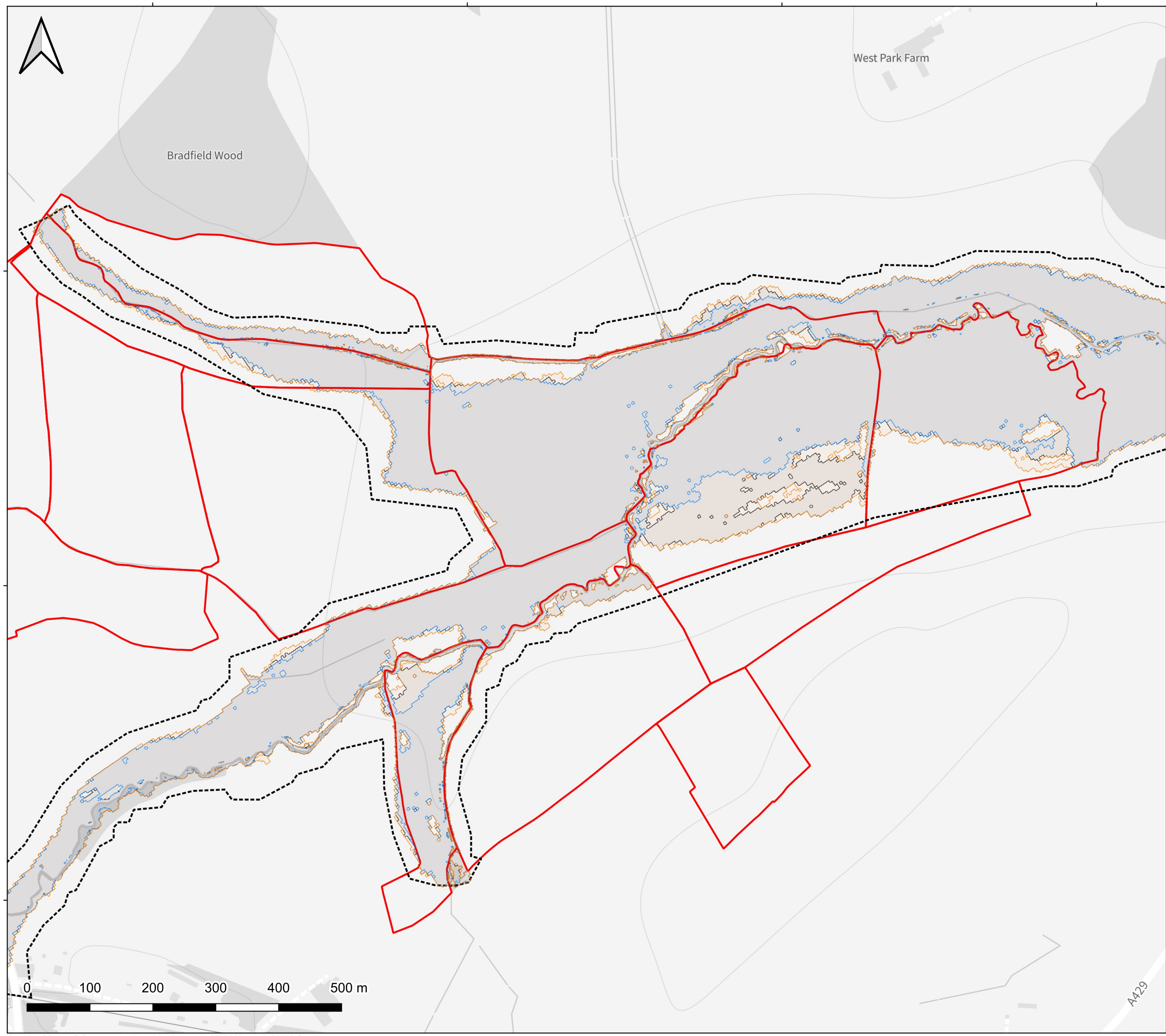
Drawing Scale (A3):	Drawing Status:	Drawn:	Checked:	Approved:
1:6000	Final	DH	JR	JR

Legend

- Lime Down D
- 2D Model Extent
- Baseline Flood Extent (1% AEP +39%CC)
- ST1 Flood Extent (Manning's n +20%)
- ST2 Flood Extent (Manning's n -20%)



Arthian



Project Reference:

317212 Lime Down Solar Farm

Client:

Island GREEN POWER

Lime Down Solar Park

Drawing Title:

Maximum Flood Extent Comparison
Baseline: 1% AEP +39%CC fluvial event
ST3: Inflows +20%
ST4: Inflows -20%

Drawing Name:	Revision:	Date:
317212-ENG-MOD-02	A	05 Aug 2026

Drawing Scale (A3):	Drawing Status:	Drawn:	Checked:	Approved:
1:6000	Final	DH	JR	JR

Legend

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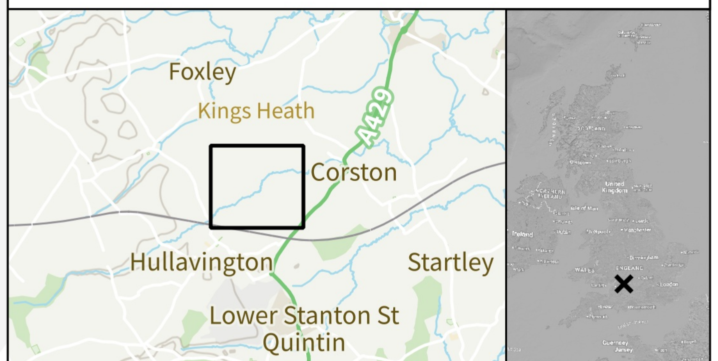
- 2D Model Extent
- Baseline Flood Extent (1% AEP +39%CC)
- ST3 Flood Extent (Inflows +20%)
- ST4 Flood Extent (Inflows -20%)



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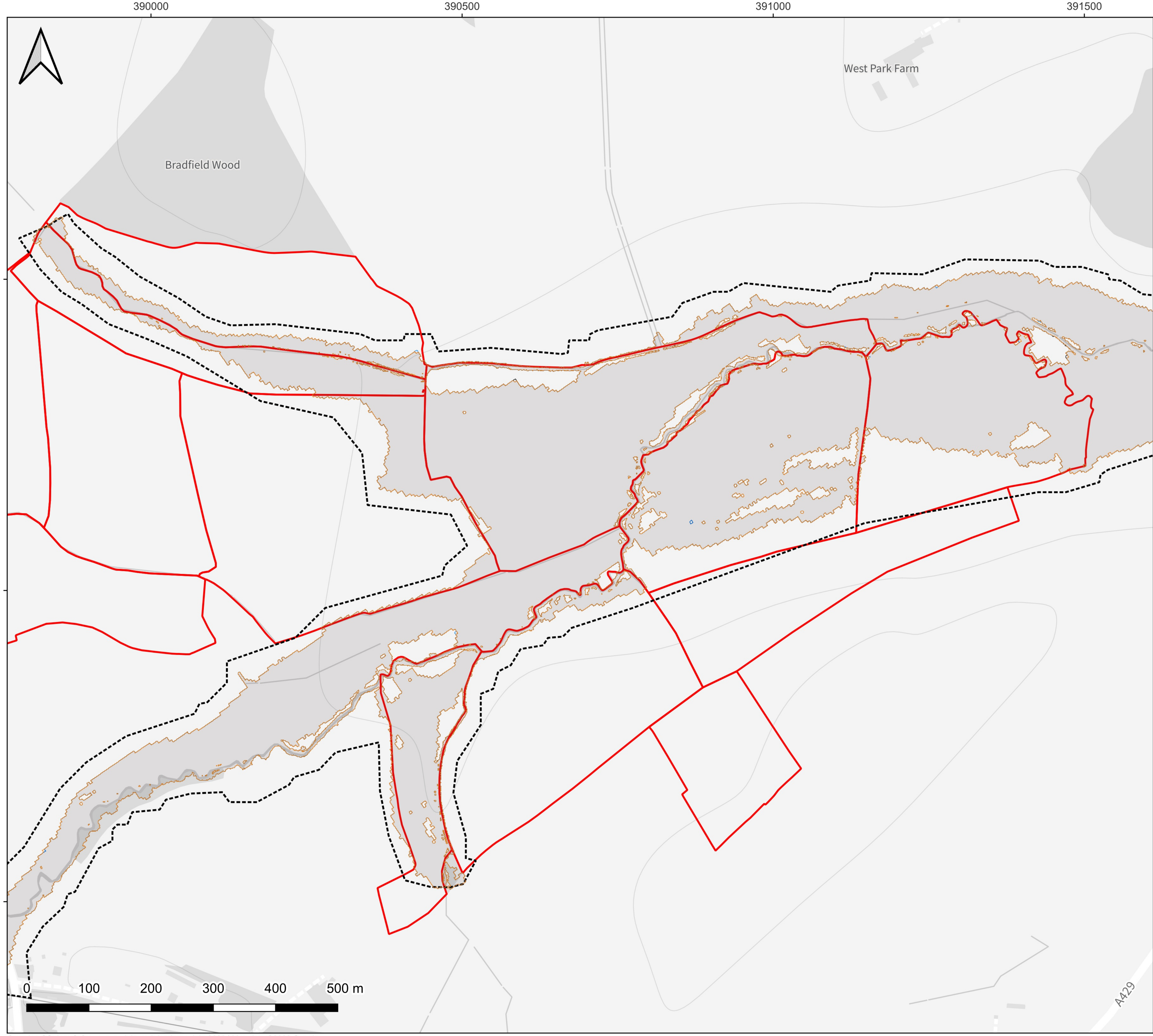

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Project Reference:

317212 Lime Down Solar Farm

Client:

Island Green Power

Lime Down Solar Park

Drawing Title:

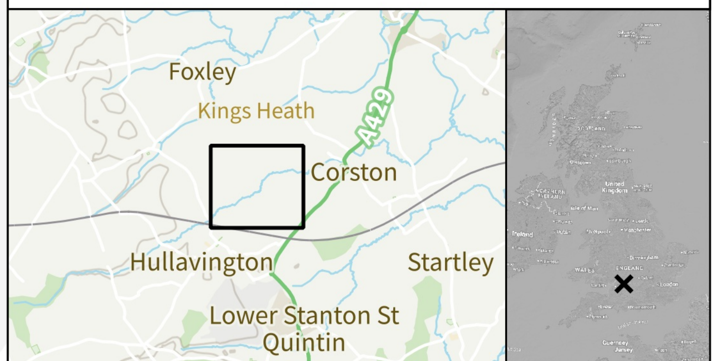
Maximum Flood Extent Comparison
Baseline: 1% AEP +39%CC fluvial event
ST5: DSBC Slope +30%
ST6: DSBC Slope -30%

Drawing Name:	Revision:	Date:
317212-ENG-MOD-03	A	05 Aug 2026

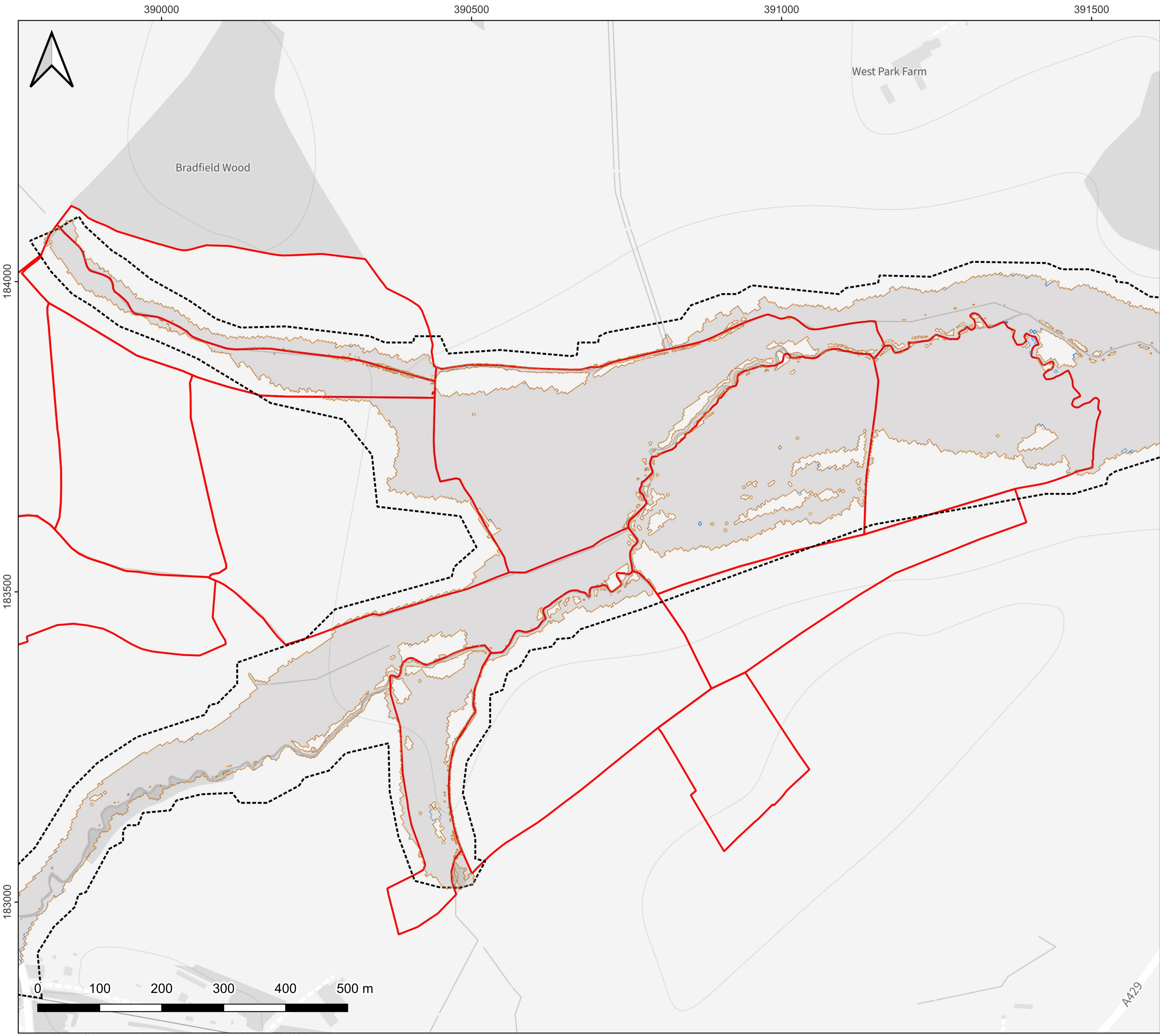
Drawing Scale (A3):	Drawing Status:	Drawn:	Checked:	Approved:
1:6000	Final	DH	JR	JR

Legend

- Lime Down D
- 2D Model Extent
- Baseline Flood Extent (1% AEP +39%CC)
- ST5 Flood Extent (DSBC Slope +30%)
- ST6 Flood Extent (DSBC Slope -30%)



Arthian



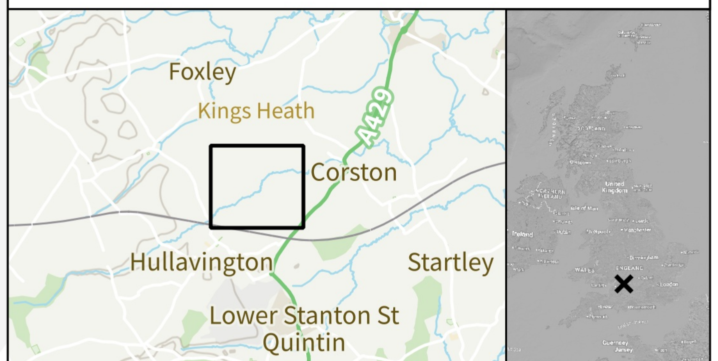
Project Reference:	317212 Lime Down Solar Farm
Client:	Island GREEN POWER / Lime Down Solar Park
Drawing Title:	Maximum Flood Extent Comparison Baseline: 1% AEP +39%CC fluvial event ST7: TUFLOW Control Number Factor +20% ST8: TUFLOW Control Number Factor -20%

Drawing Name:	Revision:	Date:
317212-ENG-MOD-04	A	05 Aug 2026

Drawing Scale (A3):	Drawing Status:	Drawn:	Checked:	Approved:
1:6000	Final	DH	JR	JR

Legend

- Lime Down D
- 2D Model Extent
- Baseline Flood Extent (1% AEP +39%CC)
- ST7 Flood Extent (TUFLOW Control Number Factor +20%)
- ST8 Flood Extent (TUFLOW Control Number Factor -20%)



Arthian

Appendix C – FEH Calculation Method

Hydrology Assessment

Prepared by: Jamie Eden

For: Island Green Power UK Ltd

Site: Lime Down Solar Farm Parcel D

Date: 10/06/2026

Document Ref: 320560

Issue-01

Contents

Abbreviations

AEP	annual exceedance probability
AM	Annual Maximum
AREA	Catchment area (km^2)
BFI	Base Flow Index
BFIHOST	Base Flow Index derived using the HOST soil classification
CPRE	Council for the Protection of Rural England
FARL	FEH index of flood attenuation due to reservoirs and lakes
FEH	Flood Estimation Handbook
FSR	Flood Studies Report
HOST	Hydrology of Soil Types
NRFA	National River Flow Archive
OS	Ordnance Survey
POT	Peaks Over a Threshold
QMED	Median Annual Flood (with return period 2 years)
ReFH	Revitalised Flood Hydrograph method
ReFH2	Revitalised Flood Hydrograph 2 method
SAAR	Standard Average Annual Rainfall (mm)
SPR	Standard percentage runoff
SPRHOST	Standard percentage runoff derived using the HOST soil classification
Tp(0)	Time to peak of the instantaneous unit hydrograph
URBAN	Flood Studies Report index of fractional urban extent
URBEXT1990	FEH index of fractional urban extent
URBEXT2000	Revised index of urban extent, measured differently from URBEXT1990
WINFAP-FEH	Windows Frequency Analysis Package – used for FEH statistical method

1. Summary of Assessment

1.1 Summary

Catchment location	The study catchment for Gauze Brook is located in the Avon Bristol and North Somerset Streams Management Catchment, northeast of Bristol and west of Swindon. The catchment flow estimation point is located at National Grid Reference (NGR) ST 93083 84428, a short distance downstream of Corston.
Purpose of study and scope	Hydrological analysis has been carried out to derive peak flow estimates for flow estimation points along Gauze Brook. This study aims to derive peak flow estimates for a range of AEP events to inform hydraulic modelling of the watercourse.
Key catchment features	Key catchment characteristics for Gauze Brook are outlined below: • The catchment predominantly consists of rural land. Hullavington and Corston fall within the catchment and make up the majority of the small extent of urban area; • Smaller tributaries split off from Gauze Brook upstream of Corston, with two sub-catchment areas identified within the study catchment; • The catchment is moderately steep with a consistent gradient along its length; • Catchment geology comprises a mix of moderately permeable and impermeable soils, consisting of a mix of slowly permeable seasonally wet loamy and clayey soils with impeded drainage or shallow soils over limestone; and, • No notable reservoirs or larger waterbodies are located in the catchment.
Flooding mechanisms	Flood mapping from the EA's NAFRA2 dataset indicates that flooding along Gauze Brook and its tributaries is largely confined to the low lying land immediately adjacent to the channels, reflecting the generally channelised nature of the watercourses and the capacity of the adjoining functional floodplain to contain out of bank flows.

Gauged / ungauged	The Rodbourne river gauge station (53020 Gauze Brook @ Rodbourne) is located a short distance downstream of the study area; however, this is designated as a low flow station to monitor the impact of groundwater abstraction/recharge on river flow and is not indicated as being suitable for QMED estimates or pooling. Gauze Brook is therefore considered to be ungauged within the study area.
Final choice of method	The statistical method is preferred for the catchment and sub-catchment peak flow estimates.
Key limitations / uncertainties in results	As the catchment is ungauged and there is inherent uncertainty in the estimated QMED value.

1.2 Note on Flood Frequencies

The frequency of a flood can be quoted in terms of a return period, which is defined as the average time between years with at least one larger flood, or as an annual exceedance probability (AEP), which is the inverse of the return period.

The results presented in this document are quoted in terms of return period. The table below provides a quick conversion between return periods and annual exceedance probabilities.

AEP (%)	50	20	10	5	4	3.33	0	1.33	1	0.5	0.2	0.1
Return Period (yrs)	2	5	10	20	25	30	50	75	100	200	500	1000

2. Method Statement

2.1 Requirements for Flood Estimates

Overview	This study aims to derive peak flow estimates for flow estimation points along Gauze Brook. This study aims to derive peak flow estimates for a range of AEP events to inform hydraulic modelling of the watercourse. The study catchment for Gauze Brook is located in the Avon Bristol and North Somerset Streams Management Catchment, northeast of Bristol and west of Swindon The content and level of detail provided in this section will depend on the scope of the study. The following should be included as a minimum: • Purpose of study • Peak flows or hydrographs? • Design events for which flow estimates are to be made given as AEP (%) • Climate change allowances with reference to relevant guidance • Potential number of locations for flow estimation • The purpose of the document
Project Scope	The catchment flow estimation point (GB01) is located at NGR ST 93083 84428, a short distance downstream of Corston. Additional sub-catchment estimation points have been defined to generate flows at the confluence of the unnamed watercourse (GB02) and Gauze Brook (GB03), situated at NGR ST 91550 83897, the area of interest and proposed hydraulic modelling within the study catchment. • • Review of existing studies? • • Rating reviews / updates? • • Simple / detailed flood history review? • • ReFH model parameter estimation? • • Joint probability?

2.2 The Catchment

Description	The FEH derived catchment for Gauze Brook and its tributaries drains an area of 23.17km^2. The FEH catchments for the flow estimation points are illustrated in Annex A. The Gauze Brook catchment predominantly consists of rural land. Hullavington and Corston fall within the catchment and make up the majority of the small extent of urban area. Smaller tributaries split off from Gauze Brook upstream of Corston, with two distinct sub-catchment areas identified within the study catchment. The catchment is moderately steep with a consistent gradient along its length. Catchment geology comprises a mix of moderately permeable and impermeable soils, consisting of a mix of slowly permeable seasonally wet loamy and clayey soils with impeded drainage or shallow soils over limestone. No notable reservoirs of large waterbodies are located in study catchment.

2.3 Source of Flood Peak Data

Overview	NRFA peak flows dataset, Version 14.0.1, released August 2025. This contains data up to water year 2024.

2.4 Gauging Stations (flow or level)

Watercourse	Station Name	Gauging Authority Number	NRFA Number	Catchment area (km^2)	Type (rated / ultrasonic / level...)	Start of record and end if station closed

The Rodbourne river gauge station (53020 Gauze Brook @ Rodbourne) is located a short distance downstream of the study area; however, this is designated as a low flow station to monitor the impact of groundwater abstraction/recharge on river flow and is not indicated as being suitable for QMED estimates or pooling. Gauze Brook is therefore considered to be ungauged within the study area.

2.5 Data Available at Gauging Stations

Station Name	Start and end of NRFA flood peak record	Updated for this study?	Suitable for QMED?	Suitable for Pooling?	Data quality check needed?	Other comments on station and flow data quality
No gauge data available.						

2.6 Rating Equations

Station Name	Type of rating	Rating review needed?	Comments and link to any rating reviews
No gauge data available.			

2.7 Other Data Available

Type of data	Data relevant to this study?	Data available?	Source of data	Details
Check flow gaugings (if planned to review ratings)	Yes.	No.	N/A.	N/A.

Historical flood data	Yes.	No.	N/A.	N/A.
Flow or river level data for events	Yes.	No.	N/A.	N/A.
Rainfall data for events	Yes.	No.	N/A.	N/A.
Potential evaporation data	No.	No.	N/A.	N/A.
Results from previous studies	Yes.	No.	N/A.	N/A.
Other data or information	No.	No.	N/A.	N/A.

2.8 Hydrological Understanding of Catchment

Plots of flow data and interpretation	No gauge data available.
Plots of flood peak data and interpretation	

Unusual catchment features	Gauze Brook is predominantly rural, covers an area with soils of mixed permeability, is moderately steep with a consistent gradient along the length of the catchment, and no notable reservoirs of large waterbodies are located within the catchment. No unusual catchment features are noted for the study area.

2.9 Initial Choice of Approach

Is FEH appropriate?	Yes.
Initial choice of method(s) and reasons **How will hydrograph shapes be derived if needed?** **Will the catchment be split into subcatchments? If so, how?**	Both the ReFH2 and Statistical methods are appropriate noting no significant influence from attenuation within the catchment. A lumped sum peak flow estimates have been produced for Gauze Brook (GB01). Peak flow estimates have also assessed for two sub catchment areas (GB02 and GB03) illustrated in Annex A. Catchment and Sub-catchment flow estimates have also been assessed and used to derive flow for the intervening area illustrated in Annex A.
Software to be used (with version numbers)	FEH Web Service[1] / WINFAP 5.3[2] / ReFH2.3.

[1] CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, UK.
[2] WINFAP 5.3 © Wallingford HydroSolutions Limited 2012.

3. Locations of Flood Estimates

3.1 Summary of Subject Sites

The table below lists the locations of subject sites. The site codes listed below are used in all subsequent tables.

Site code	Type of estimate L: Lumped catchment AW: Area Weighted[3]	Watercourse	Description of site	Easting	Northing	AREA on FEH Webservice (km²)	Revised AREA if altered
GB01	L	Gauze Brook	Rural catchment	393083	184428	23.17	26.53
GB02	L (Sub-catchment)	Unnamed Watercourse	Rural catchment	391347	183964	2.07	2.27
GB03	L (Sub-catchment)	Gauze Brook	Rural catchment	391348	183935	15.86	20.23

3.2 Important Catchment Descriptors at Each Site

Site code	FARL2015	PROPWET	BFIHOST2019 Scaled	DPLBAR [4](km)	DPSBAR (m/km)	SAAR 9120 (mm)	URBEXT2015	FPEXT
GB01	1.00	0.34	0.619	6.79	24.4	865	0.012	0.117
GB02	1.00	0.34	0.535	1.85	20.0	872	0.0	0.122
GB03	1.00	0.34	0.642	6.23	25.9	876	0.010	0.112

[3] Proxy site used for area weighting detailed in Annex A
[4] Where FEH Webservice catchment area has been updated, DPLBAR has been updated using the Adjusting DPLBAR Values formula, FEH Volume 5

3.3 Check Catchment Descriptors

Record how catchment boundary was checked and describe any changes	Initial catchment extents were generated by FEH web service. Rolling ball analysis, using 1m EA LiDAR data, was performed in QGIS to confirm the rural extents for the catchment and sub catchments. This assessment showed a moderate increase in catchment area for GB01 and sub-catchment areas GB02 and GB03, with an additional elongated section of catchment being shown to drain to Gauze Brook from the west. A small increase in area was also observed to the north in the lower reach of the Gauze Brook catchment. The FEH catchment and updated catchment area are illustrated in in Annex A. Given the rural nature of the study catchment, the catchment boundary has been validated against available topographical data, which should reasonably represent the true contributing area. In the absence of significant urban development, sewer networks are unlikely to extend or reduce the topographic catchment, and therefore are not expected to materially influence the delineation. Given the mix of permeable and impermeable geological conditions across the catchment, flow behaviour is not expected to be materially influenced by groundwater conditions or by any potential differences between the topographic catchment and the groundwater body catchment. As such, the delineated surface water catchment is considered an appropriate representation of the contributing area for hydrological assessment.
Record how other catchment descriptors were checked and describe any changes.	As updates to the catchment area have resulted in a more elongated catchment form, the mean distance to the outlet is correspondingly affected. The DPLBAR parameter has therefore been revised to reflect the increased distance to the catchment outlet, ensuring that the hydrological descriptors remain consistent with the updated catchment geometry.

	Aerial mapping, LiDAR data and British Geological Survey mapping were used to reaffirm the existing catchment descriptor values. As the extended catchment areas exhibit similar gradients and geological characteristics, updates to DPSBAR and BFIHOST were not considered necessary. All remaining descriptors continue to provide a reasonable fit to the updated catchment extent.
Source of URBEXT	URBEXT2015.
Method for updating of URBEXT	URBEXT2015 was updated to 2025 using the formula outlined in The FEH 2025 Statistical Method Update (v1.2).

4. Statistical Method

4.1 Application of Statistical method

What is the purpose of applying this method? Brief summary of the reasons, specific to this study, for applying the method. For example, lumped estimates at key locations for the purpose of checking modelled peak flow estimates.	To derive peak flow estimates for a range of AEP events for Gauze Brook and for comparison against ReFH2 peak flow estimates.

4.2 Overview of estimation of QMED at each subject site

Site code	QMED (rural) from CDs (m^3/s)	Final method	Data transfer				Urban Adjustment Factor, UAF	Final estimate of QMED (m^3/s)
			NRFA numbers for donor sites (see 4.3)	Distance between centroid, d_{sg} (km)	Moderated QMED adjustment factor, (A/B)[a]	If more than one donor: Weighted ave. adjustment		
GB01	4.03	DT	8	-	-	1.176	Study catchment is rural. UAF not applied.	4.74
GB02	0.71	DT	8	-	-	1.164		0.82
GB03	3.0	DT	8	-	-	1.185		3.55
Are the values of QMED spatially consistent?						Yes. Catchment estimate (GB01) larger than sub catchment estimates (GB02 and GB03).		

Method used for urban adjustment for subject and donor sites	WINFAP v5.3[5]

4.3 Search for donor sites for QMED (if applicable)

Comment on potential donor sites Provide details regarding how potential donors were selected and the reasons why they were chosen / rejected. Include a map if necessary, which shows the location of the study catchment and donor stations under consideration. Section 4 of the Flood Estimation Guidelines provides guidance on selecting a donor(s) for data transfer.	WINFAP5 was used to identify suitable donors. A review of WINFAP's initial donor selection for the catchment and sub catchments, and the potential donor sites were considered. For GB01, GB02 and GB03, station 53008 (Avon @ Great Somerford) was initially considered as the sole donor station due to its close proximity, its location within the same wider watershed catchment, and its broadly comparable SAAR, FARL2015 and BFIHOST19Scaled values. However, although the station shares similar catchment characteristics, its catchment area is substantially larger than both the main study catchment and its sub-catchments. As the default donor station selection provides a set of gauges with a range of contributing areas closer to the study catchment and its sub-catchments, this provides greater confidence that a QMED adjustment ratio appropriately reflecting local hydrological behaviour is captured. Retaining the default set of eight donor stations also represents a precautionary approach, as it results in a larger adjusted QMED estimate, ensuring conservatism in subsequent flow calculations. Noting the above, WINFAP's default donor station selections have been retained. Default donor sites are outlined in Section 4.4 below.

4.4 Donor sites chosen and QMED adjustment factors

When QMED is estimated from POT data, it should also be adjusted for climatic variation; this is not the same as climate change. Climatic variability can result in flood-rich or flood-poor periods. A short record might only include flood-rich years or flood-poor years, this will distort the QMED estimate.

[5] WINFAP 5.3 Urban adjustment procedures.

FEH Volume 3, Chapter 20, provides the methodology to adjust QMED for climatic variation. It is recommended that this carried out if the station record is shorter than 14 years.

QMED from catchment descriptors is the 'as rural' value (for rural donors), i.e. with no urban adjustment factor applied.

The adjustment ratio is the adjustment in full, with no distance factor applied.

NRFA no.	Method (AM or POT)	Adjustment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)
53008	AM	No	39.241	29.495	1.291
53023	AM	No	7.396	6.610	1.086
53028	AM	No	10.703	8.252	1.236
53017	AM	No	13.946	9.856	1.363
39037	AM	No	3.183	3.180	0.941
43017	AM	No	5.486	2.967	1.726
43014	AM	No	3.844	4.416	0.821
43028	AM	No	1.965	1.783	1.087
53004	AM	No	21.413	14.471	1.431
39020	AM	No	3.610	5.411	0.645

4.5 Derivation of Pooling Groups

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged? (enhanced single site analysis)	Changes made to default pooling group, with reasons	Weighted average L-moments L-CV and L-skew (before urban adjustment)
GB01	GB01	No	Several sites removed due to high BFIHOST values, negative skew, and high discordancy. Additional gauges with a low number of data years were also excluded, as they were not required to achieve the	L-CV: 0.255 L-SKEW: 0.189

			recommended 800 years of pooled data. Adjusted pooling group gives improved distribution fit with a negligible change in growth curve values.	
GB02	GB02	No	Adjusted pooling group reviewed, removing stations with high BFIHOST values, negative skew, and high discordancy. However, distribution fit did not improve and adjusted pooling group results in lower growth curve values. Default pooling therefore group retained.	L-CV: 0.266 L-SKEW: 0.232
GB03	GB03	No	Adjusted pooling group reviewed, removing stations with high BFIHOST values, negative skew, and high discordancy. However, distribution fit did not improve and adjusted pooling group results in lower growth curve values. Default pooling therefore group retained.	L-CV: 0.270 L-SKEW: 0.189
Note: Pooling groups were derived using the redeveloped pooling method outlined in The FEH 2025 Statistical Method Update (June 2025).				

4.6 Derivation of flood growth curves at subject sites

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters for distribution (location, scale and shape after adjustments)	Growth factor for 100-year return period
GB01	P	GB01	General logistic – gives larger growth curve values.	NA	Location: 1 L-CV: 0.255 L-SKEW: 0.189	2.902
GB02	P	GB02	General logistic – gives larger growth curve values.	NA	Location: 1 L-CV: 0.266 L-SKEW: 0.232	3.215
GB03	P	GB03	General logistic – gives larger growth curve values.	NA	Location: 1 L-CV: 0.270	3.029

					L-SKEW: 0.189	

Notes:

Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis. Urban adjustments are all carried out using the method of Kjeldsen (2010). Growth curves were derived using the procedures from Science Report SC050050 (2008).

4.7 Flood Estimates from Statistical Method

Site code	Flood peak (m^3/s) for the following return periods (in years)										
	2	5	10	20	25	30	50	75	100	200	1000
GB01	4.75	6.69	8.09	9.59	10.10	10.54	11.82	12.92	13.75	15.94	22.24
GB02	0.82	1.19	1.46	1.76	1.87	1.96	2.23	2.47	2.65	3.14	4.62
GB03	3.55	5.11	6.23	7.43	7.84	8.18	9.21	10.09	10.75	12.50	17.55

Site code	Flood peak (m^3/s) for the following return periods (in years)	
	100 +CC(19%)	100 +CC(38%)
GB01	16.36	18.97
GB02	3.15	3.65
GB03	12.79	14.84

5. Revitalised Flood Hydrograph 2 (ReFH2) method

5.1 Application of the ReFH2 method

What is the purpose of applying this method? Brief summary of the reasons, specific to this study, for applying the method. For example, lumped estimates at key locations for the purpose of checking modelled peak flow estimates, distributed approach to apply inflows to a hydraulic model, deriving hydrograph shapes only, extending the flood frequency curve out to extreme events (long return periods).	To derive peak flow estimates for a range of AEP events for Gauze Brook and for comparison against ReFH2 peak flow estimates.

5.2 Parameters for ReFH2 model

Site code	Method	Tp (hours)	Cmax (mm)	PR_{imp} % runoff for impermeable surfaces	BL (hours)	BR*
GB01	CD	7.42	560.78	70	58.76	2.41
GB02	CD	3.71	447.35	70	40.20	2.41
GB03	CD	7.17	590.68	70	59.56	2.48

Brief description of any flood event analysis carried out (further details should be given in the annex)	NA.

Methods: OPT: Optimisation, BR: Baseflow recession fitting, CD: Catchment descriptors, DT: Data transfer (give details)

* For the 100 year scenario

5.3 Design events for ReFH2 method: Lumped catchments

Site code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours)	Reason for selecting storm duration
GB01	Rural	Winter	13.00	An assessment of a range of storm durations for the study catchments shows a small variation in peak flow estimates. GB01 and GB03 both indicate a default critical duration of 13 hours, while GB02 has a shorter default critical duration of 6.5 hours. However, peak flows from this smaller tributary are relatively minor compared with the larger contributing catchment area. Flooding within the study area is therefore expected to be driven primarily by longer duration storm events, consistent with the larger, elongated catchment form. On this basis, a critical duration of 13 hours has been taken forward for subsequent hydraulic assessment.
GB02	Rural	Winter	13.00	
GB03	Rural	Winter	13.00	

5.4 Flood estimates from the ReFH2 method

Site code	Flood peak (m^3/s) for the following return periods (in years)										
	2	5	10	20	25	30	50	75	100	200	1000

GB01	2.62	3.43	4.05	4.78	5.05	5.28	5.99	6.65	7.16	8.53	12.19
GB02	0.49	0.64	0.76	0.90	0.95	0.99	1.12	1.24	1.33	1.58	2.22
GB03	1.91	2.50	2.96	3.50	3.69	3.86	4.39	4.87	5.26	6.28	9.01

Site code	Flood peak (m^3/s) for the following return periods (in years)	
	100 +CC(19%)	100 +CC(38%)
GB01	8.52	9.89
GB02	1.59	1.84
GB03	6.26	7.25

6. Discussion and summary of results

6.1 Comparison of results from different methods

Site code	2 year			100 year		
	Statistical peak flow (m^3/s)	ReFH2 peak flow (m^3/s)	Ratio (Stats/ReFH2)	Statistical peak flow (m^3/s)	ReFH2 peak flow (m^3/s)	Ratio (Stats/ReFH2)
GB01	4.75	2.62	1.81	13.75	7.16	1.92
GB02	0.82	0.49	1.67	2.65	1.33	1.99
GB03	3.55	1.91	1.86	10.75	5.26	2.04

6.2 Final choice of method

Choice of method and reasons	The Statistical method is preferred as it provides more liberal estimates of QMED for GB01, GB02, and GB03, offering a precautionary basis for design. As these estimates are derived from observed gauge data rather than solely from catchment descriptor based estimates, there is greater confidence that they more accurately reflect the catchment's hydrological behaviour. The three pooling groups produced comparable growth curves, all of which are similar to, but slightly greater than those derived using the ReFH2 method. This provides confidence in the assessment results and supports the selection of the FEH Statistical method as the preferred approach. Noting that sub-catchment GB02 and GB03 growth curves are slightly steeper than the overall catchment growth curve for GB01, the former have been used to derive peak flow estimates at the respective sub-catchment flow estimation points.

	Given the rural nature of catchment and sub-catchments, rural peak flow estimates have been taken forwards. Final pooling groups are provided in Annex B. Growth curve and flood frequency curve comparison plots are provided in Annex C.
How will the flows be applied to a hydraulic model?	Peak flow estimates have been used to derive hydrographs for the sub catchments and intervening area, which will be applied to the hydraulic model upstream inflows and lateral inflows. As the Statistical method has been selected as the preferred approach, the associated storm duration and hydrograph profile have been based on those generated by the ReFH2 method for the overall catchment (GB01). Given the rural nature of catchment and sub-catchments, rural peak flow estimates and winter storm duration and profile has been taken forwards. GB02 flow estimates will be applied as lumped sum at the head of the unnamed watercourse tributary to Gauze Brook. The application of GB03 peak flow estimates will be split via area weighting, with flows applied at the head of the Gauze Brook hydraulic model extent and lateral inflows across the watercourse reach for the sub catchment area as required by the hydraulic model schematisation. Flow estimates for the intervening area downstream of GB02 and GB03 will be applied as a lateral inflow along the lower reach of the hydraulic model. Peak flow estimates for this intervening area, provided in Annex C, have been derived by comparing the flows from the main catchment (GB01) with those from the two sub-catchments (GB02 and GB03). A figure illustrating the GB03 area weightings and the extent of the intervening area is included in Annex A. Additional details outlining the application of hydrographs are providing in the hydraulic modelling note.

6.3 Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	• It is assumed the default ReFH2 parameters for Tp scaling factor are suitable for this study. • It is assumed that a uniform storm duration is appropriate. • It was not possible to sensibility check catchment boundaries on the ground. It is assumed that the catchment boundaries, checked using LiDAR and OS mapping, are accurate. • It is assumed that all the gauging stations used in the analysis are stationary. Non-stationarity has not been considered in the analysis. • It is assumed the groundwater catchment extent mirrors the topographical catchment.
Discuss any particular limitations	The lack of gauge data is a limitation to providing confidence in the flow estimates.
Provide information on the uncertainty in the design peak flow estimates and the methodology used	The lack of gauge data for the study catchments leads to increased uncertainty in the derived peak flows. Uncertainty in peak flow estimates is discussed further in Section 6.6.
Comment on the suitability of the results for future studies	The results could be easily replicated and/or updated for future studies in the study catchments. However, the results of the analysis should be considered in the context of the needs of this study. Future users of this assessment should, at the very minimum, satisfy themselves that the flows are suitable for use in their work. Site specific studies may require new estimates. Additionally, if hydrometric data becomes available or the methods are updated, the estimates should be revisited.
Give any other comments on the study	No additional comments.

6.4 Checks

<table>
<tr><td>Are the results consistent, for example at confluences?</td><td>Lumped approach. Combined inflows of sub catchments GB02 and GB03 are realistic for their area and tie in with overall estimates for catchment GB01.</td></tr>
<tr><td>What do the results imply regarding the return periods / frequency of floods during the period of record?</td><td>No gauged record for Gauze Brook and its tributaries.</td></tr>
<tr><td>What is the range of 100-year growth factors? Is this realistic?</td><td>100-year growth factors fall in typical range and realistic.</td></tr>
<tr><td>If 1000-year flows have been derived, what is the range of ratios for 1000-year flow over 100-year flow?</td><td>The 1000/100 ratio for the statistical method and ReFH2 method are outlined below.
<table>
<tr><th>Site Code</th><th>Statistical 1000/100 ratio</th><th>ReFH2 1000/100 ratio</th></tr>
<tr><td>GB01</td><td>1.62</td><td>1.70</td></tr>
<tr><td>GB02</td><td>1.75</td><td>1.66</td></tr>
<tr><td>GB03</td><td>1.63</td><td>1.71</td></tr>
</table></td></tr>
<tr><td>How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.</td><td>No previous study is available for comparison.</td></tr>
<tr><td>Are the results compatible with the longer-term flood history?</td><td>No detailed historic flood data is available for comparison.</td></tr>
<tr><td>Describe any other checks on the results,</td><td>NA.</td></tr>
</table>

6.5 Final Results

Site code	Method	Flood peak (m^3/s) for the following return periods (in years)										
		2	5	10	20	25	30	50	75	100	200	1000
GB01	Stats	4.75	6.69	8.09	9.59	10.10	10.54	11.82	12.92	13.75	15.94	22.24
GB02	Stats	0.82	1.19	1.46	1.76	1.87	1.96	2.23	2.47	2.65	3.14	4.62
GB03	Stats	3.55	5.11	6.23	7.43	7.84	8.18	9.21	10.09	10.75	12.50	17.55

Site code	Flood peak (m^3/s) for the following return periods (in years)	
	100 +CC(19%)	100 +CC(38%)
GB01	16.36	18.97
GB02	3.15	3.65
GB03	12.79	14.84

6.6 Uncertainty

Uncertainty in peak flow estimates	Uncertainty is not currently shown for pooled analysis in WINFAP5, except for the factorial standard error (fse) of QMED. As outlined in the UK Centre for Ecology and Hydrology *Uncertainty in FEH Methods* (Issue 2), applying the donor transfer method provides a notable reduction in FSE, with the use of multiple donor stations offering a clear advantage over using no donors. In the absence of site-specific gauge data to support single site or enhanced single site analysis, the default eight donor stations have been retained to provide greater confidence in the QMED estimate and the resulting flood frequency curve.

	While there may be some variation in the 'true' peak flow estimate values, those outlined in this report are considered likely to be near the estimates reported in Section 6.5.

If flood hydrographs are needed for the next stage of the study, where are they provided?	Full hydrographs are provided in hydraulic modelling files.

Annex A – Study Catchments

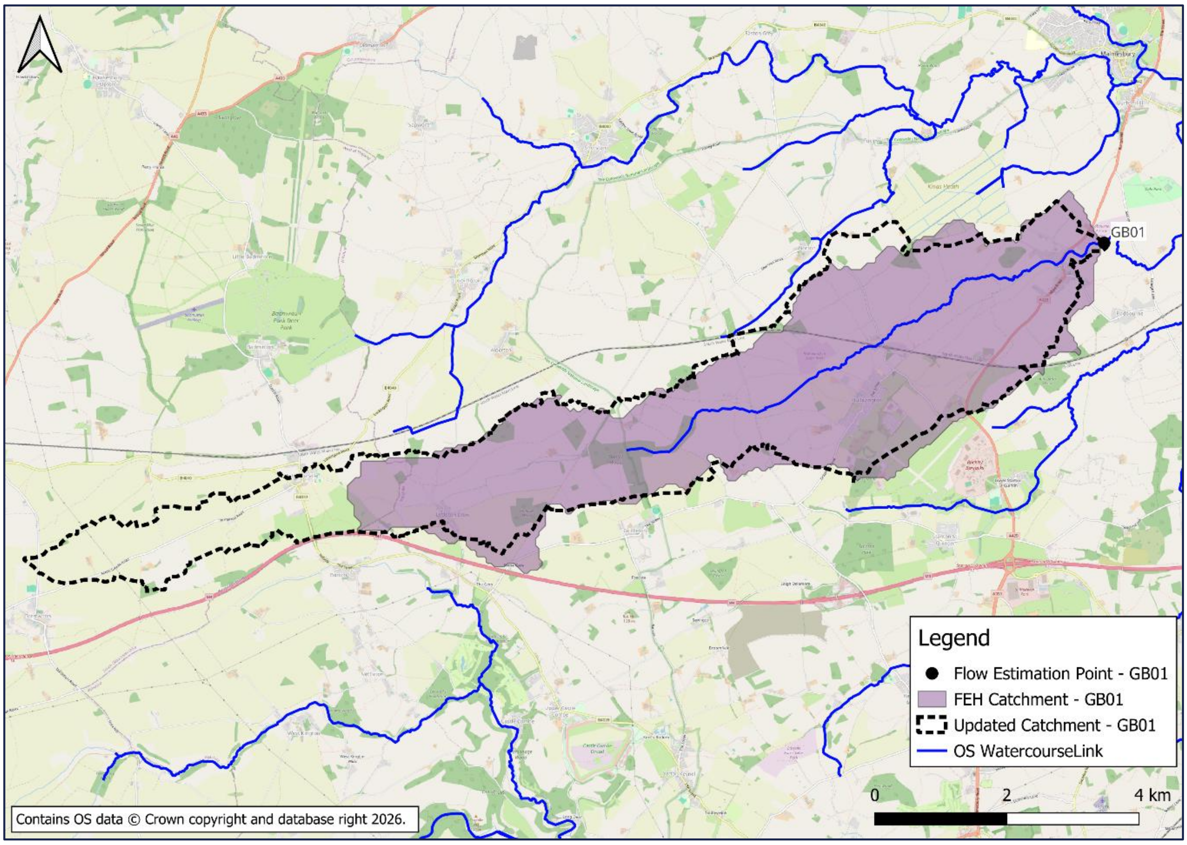


Figure 1: Study Catchment

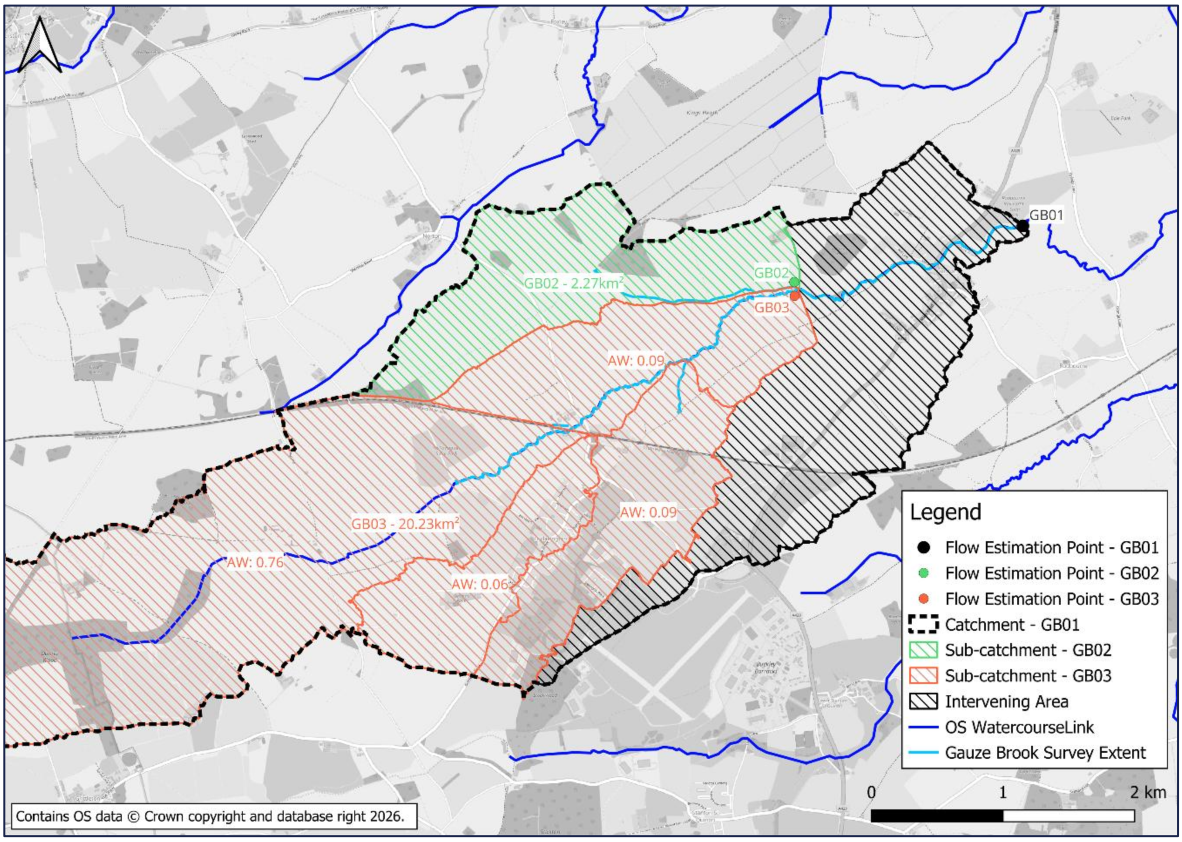


Figure 2: Study Sub-catchments

Annex B – Pooling Groups

Table 1: GB01 Adjusted Pooling Group

BD01 Adjusted Pooling Group							
Station	Distance (SDM)	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
7009 (Mosset Burn @ Wardend Bridge)	0.995	26	7.486	0.358	0.358	0.324	0.324
53023 (Sherston Avon @ Fosseway)	1.383	48	7.396	0.231	0.232	0.133	0.133
7010 (Muckle Burn @ Brodie)	1.428	19	17.674	0.219	0.219	0.153	0.153
53017 (Boyd @ Bitton)	1.436	51	13.946	0.235	0.239	0.084	0.084
43014 (East Avon @ Upavon East)	1.505	54	3.844	0.214	0.216	0.08	0.08
27073 (Brompton Beck @ Snainton Ings)	1.516	44	0.816	0.213	0.215	0.025	0.025
30004 (Lymn @ Partney Mill)	1.521	62	7.184	0.225	0.227	0.029	0.029
76019 (Roe Beck @ Stockdalewath)	1.55	25	42.852	0.251	0.252	0.387	0.387
41022 (Lod @ Halfway Bridge)	1.579	54	16.755	0.29	0.292	0.157	0.157
39042 (Leach @ Priory Mill Lechlade)	1.605	52	3.2	0.194	0.195	0.064	0.064
42003 (Lymington @ Brockenhurst)	1.664	29	27.4	0.289	0.292	0.38	0.38
73015 (Keer @ High Keer Weir)	1.672	34	12.59	0.201	0.202	0.174	0.174
39033 (Winterbourne Stream @ Bagnor)	1.694	62	0.401	0.346	0.348	0.39	0.39
54036 (Isbourne @ Hinton on the Green)	1.725	52	13.996	0.321	0.325	0.298	0.298
72014 (Conder @ Galgate)	1.746	57	16.912	0.227	0.229	0.14	0.14
44011 (Asker @ Bridport East Bridge)	1.765	29	16.566	0.216	0.218	0.136	0.136
41020 (Bevern Stream @ Clappers Bridge)	1.789	55	13.9	0.197	0.201	0.161	0.161
51001 (Doniford Stream @ Swill Bridge)	1.803	56	13.094	0.311	0.314	0.352	0.352

Weighted Means	0.0277		
H2 Value	4.8471		
Goodness of Fit	Generalised Logistic	Generalised Extreme Value	Kappa 3

	1.5692	-0.9751	0.6395

Table 2: GB02 Default Pooling Group

BD02 Default Pooling Group							
Station	**Distance (SDM)**	**Years of data**	**QMED AM**	**L-CV Observed**	**L-CV Deurbanised**	**L-SKEW Observed**	**L-SKEW Deurbanised**
27073 (Brompton Beck @ Snainton Ings)	1.655	44	0.816	0.213	0.215	0.025	0.025
45816 (Haddeo @ Upton)	2.54	31	3.456	0.283	0.283	0.41	0.41
25019 (Leven @ Easby)	2.575	46	5.384	0.337	0.337	0.367	0.367
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	2.69	14	4.057	0.268	0.27	0.323	0.323
26016 (Gypsey Race @ Kirby Grindalythe)	2.745	27	0.101	0.314	0.314	0.233	0.233
7009 (Mosset Burn @ Wardend Bridge)	2.754	26	7.486	0.358	0.358	0.324	0.324
27051 (Crimple @ Burn Bridge)	2.754	52	4.641	0.215	0.216	0.132	0.132
72014 (Conder @ Galgate)	2.995	57	16.912	0.227	0.229	0.14	0.14
73015 (Keer @ High Keer Weir)	3.007	34	12.59	0.201	0.202	0.174	0.174
76011 (Coal Burn @ Coalburn)	3.032	47	1.813	0.17	0.17	0.3	0.3
28033 (Dove @ Hollinsclough)	3.038	49	4.15	0.233	0.233	0.359	0.359
44008 (South Winterbourne @ Winterbourne Steepleton)	3.099	33	0.6	0.403	0.404	0.235	0.235
41020 (Bevern Stream @ Clappers Bridge)	3.128	55	13.9	0.197	0.201	0.161	0.161
7011 (Black Burn @ Pluscarden Abbey)	3.132	12	4.752	0.474	0.474	0.558	0.558
95004 (Abhainn a'Chnocain @ Elphin)	3.292	16	11.649	0.135	0.135	0.199	0.199
47022 (Tory Brook @ Newnham Park)	3.292	29	6.176	0.239	0.241	0.142	0.142
28058 (Henmore Brook @ Ashbourne)	3.302	13	10.6	0.145	0.147	-0.046	-0.046
53017 (Boyd @ Bitton)	3.303	51	13.946	0.235	0.239	0.084	0.084
7012 (Lossie @ Ballachraggan)	3.329	10	8.264	0.465	0.465	0.625	0.625
33054 (Babingley @ Castle Rising)	3.365	48	1.132	0.253	0.255	0.281	0.281
41022 (Lod @ Halfway Bridge)	3.383	54	16.755	0.29	0.292	0.157	0.157
26014 (Water Forlornes @ Driffield)	3.396	26	0.431	0.321	0.322	0.189	0.189
48004 (Warleggan @ Trengoffe)	3.399	55	9.799	0.251	0.252	0.265	0.265

Weighted Means	0.0316		
H2 Value	3.9572		
Goodness of Fit	Generalised Logistic	Generalised Extreme Value	Kappa 3
	2.208	0.0227	1.444

Table 3: GB03 Default Pooling Group

BD03 Default Pooling Group							
Station	**Distance (SDM)**	**Years of data**	**QMED AM**	**L-CV Observed**	**L-CV Deurbanised**	**L-SKEW Observed**	**L-SKEW Deurbanised**
7009 (Mosset Burn @ Wardend Bridge)	0.958	26	7.486	0.358	0.358	0.324	0.324
27073 (Brompton Beck @ Snainton Ings)	1.241	44	0.816	0.213	0.215	0.025	0.025
7011 (Black Burn @ Pluscarden Abbey)	1.335	12	4.752	0.474	0.474	0.558	0.558
26003 (Foston Beck @ Foston Mill)	1.349	63	1.797	0.253	0.255	0.033	0.033
26013 (Driffield Trout Stream @ Driffield)	1.379	14	2.778	0.268	0.269	0.212	0.212
33054 (Babingley @ Castle Rising)	1.444	48	1.132	0.253	0.255	0.281	0.281
53017 (Boyd @ Bitton)	1.522	51	13.946	0.235	0.239	0.084	0.084
53023 (Sherston Avon @ Fosseway)	1.541	48	7.396	0.231	0.232	0.133	0.133
7010 (Muckle Burn @ Brodie)	1.603	19	17.674	0.219	0.219	0.153	0.153
26016 (Gypsey Race @ Kirby Grindalythe)	1.611	27	0.101	0.314	0.314	0.233	0.233
33032 (Heacham @ Heacham)	1.616	56	0.442	0.3	0.302	0.138	0.138
43014 (East Avon @ Upavon East)	1.67	54	3.844	0.214	0.216	0.08	0.08
30004 (Lymn @ Partney Mill)	1.674	62	7.184	0.225	0.227	0.029	0.029
73015 (Keer @ High Keer Weir)	1.675	34	12.59	0.201	0.202	0.174	0.174
9006 (Deskford Burn @ Cullen)	1.692	14	19.727	0.293	0.293	0.119	0.119
76019 (Roe Beck @ Stockdalewath)	1.698	25	42.852	0.251	0.252	0.387	0.387
41022 (Lod @ Halfway Bridge)	1.7	54	16.755	0.29	0.292	0.157	0.157
25019 (Leven @ Easby)	1.702	46	5.384	0.337	0.337	0.367	0.367
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	1.717	14	4.057	0.268	0.27	0.323	0.323
39033 (Winterbourne Stream @ Bagnor)	1.72	62	0.401	0.346	0.348	0.39	0.39
39042 (Leach @ Priory Mill Lechlade)	1.755	52	3.2	0.194	0.195	0.064	0.064

Weighted Means	0.029

<table>
<tr><td>H2 Value</td><td colspan="3">5.7366</td></tr>
<tr><td rowspan="2">Goodness of Fit</td><td>Generalised Logistic</td><td>Generalised Extreme Value</td><td>Kappa 3</td></tr>
<tr><td>3.1651</td><td>0.3329</td><td>2.1204</td></tr>
</table>

Annex C – Data Comparison

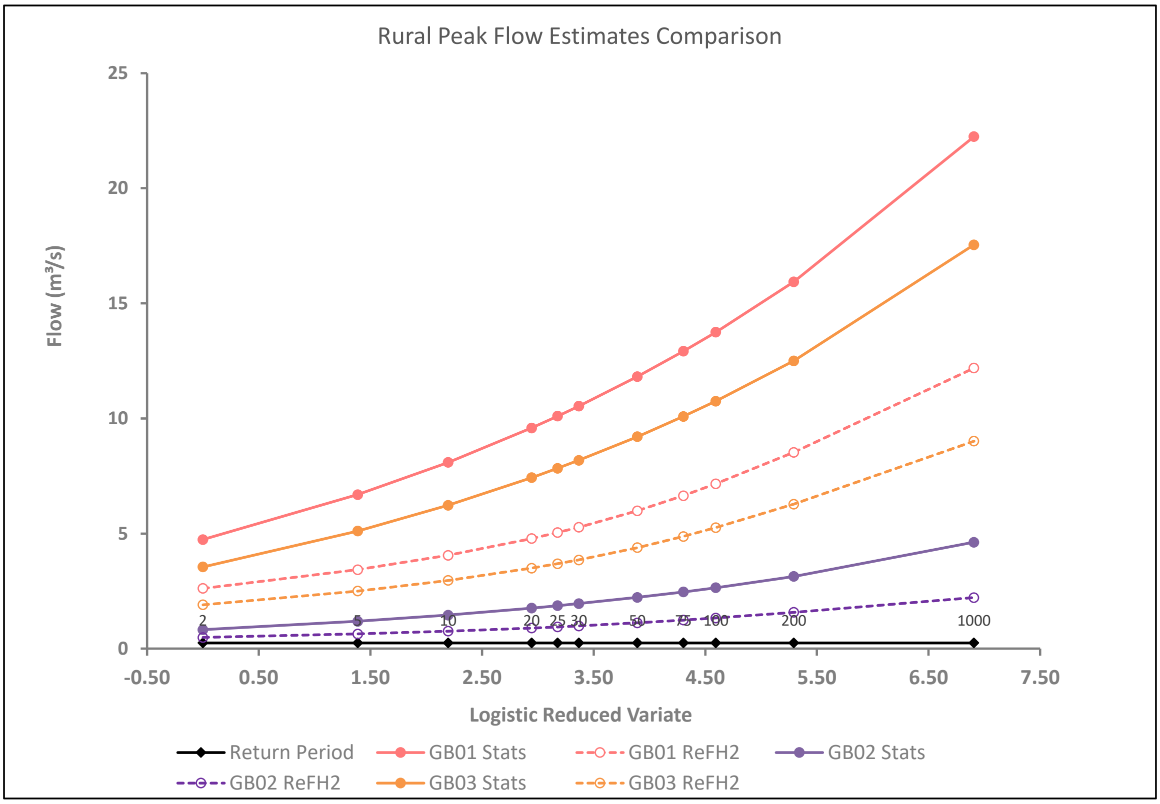


Figure 3: Rural Peak Flow Estimates Comparison

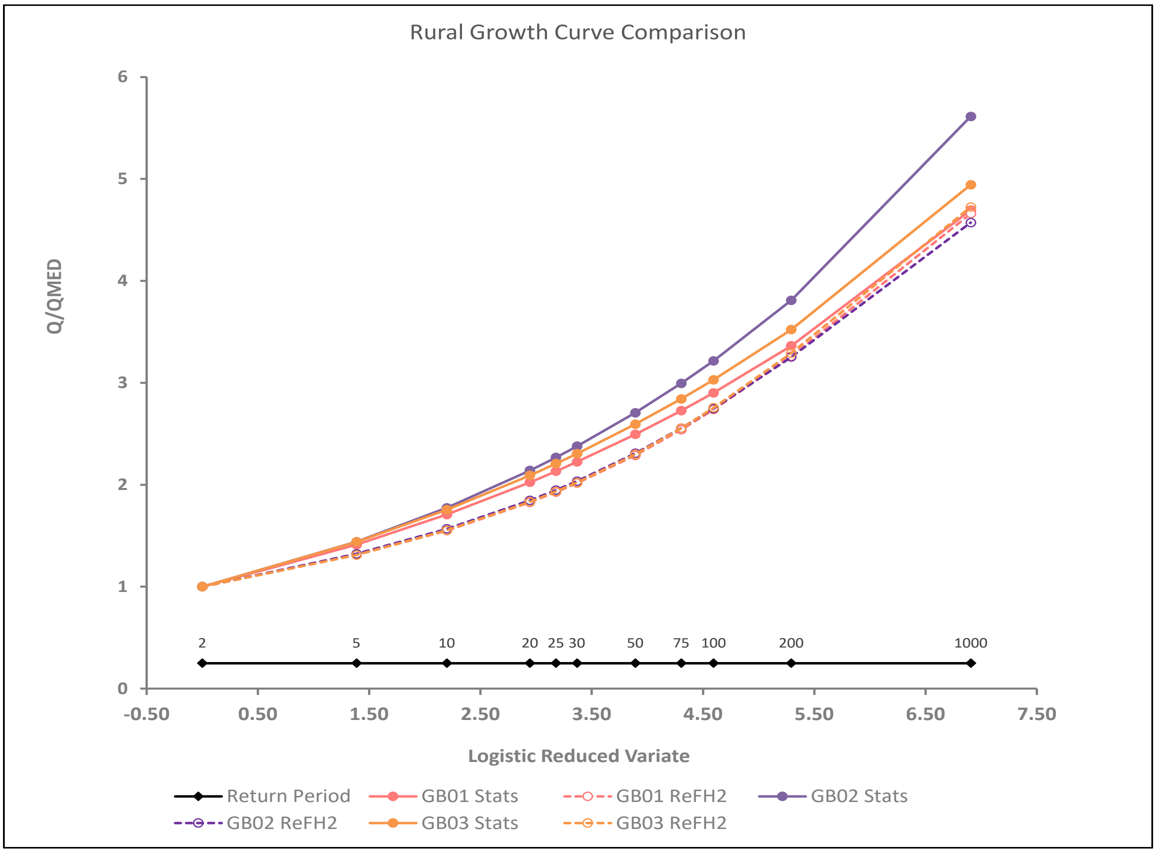


Figure 4: Rural Growth Curve Comparison

Table 4: Intervening Area Peak Flow Estimates

Site code	Flood peak (m^3/s) for the following return periods (in years)										
	2	5	10	20	25	30	50	75	100	200	1000
GB01 (A)	4.75	6.69	8.09	9.59	10.10	10.54	11.82	12.92	13.75	15.94	22.24
GB02 (B)	0.82	1.19	1.46	1.76	1.87	1.96	2.23	2.47	2.65	3.14	4.62
GB03 (C)	3.55	5.11	6.23	7.43	7.84	8.18	9.21	10.09	10.75	12.50	17.55
Intervening Area (A minus B minus C)	0.37	0.39	0.40	0.40	0.40	0.40	0.38	0.37	0.35	0.30	0.07