

A photograph of the Staverton Cereal Factory, a large, multi-story stone building with numerous arched windows. The building is situated behind a body of water, with tall green reeds in the foreground. A small bridge or walkway crosses the water in front of the factory. The sky is blue with some clouds.

# Staverton Cereal Factory

December 2025

## Model Report



CPUK  
Cereal Partners,  
Staverton,  
Trowbridge,  
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# 1 Introduction

## 1.1 Overview



Figure 1-1: Location of the site

Edenvale Young was commissioned by Cereal Partners UK (CPUK) to undertake fluvial hydraulic modelling to investigate local flooding and provide advice and understanding of the flood risk to the existing CPUK factory in Staverton. The site of interest, shown in Figure 1-1. Figure 1-3 is located in Staverton, just north of Trowbridge at 385809, 160941. The site is located at CPUK Staverton, Trowbridge, Wiltshire BA14 6PG.

CPUK requires a more detailed assessment of flood risk at the site, as the current EA mapping is based on JFLOW and shows the site inside Flood Zone 2 and partially inside Flood Zone 3 (See Figure 1-2). To address this, they have appointed Edenvale Young to develop a refined hydraulic model to better understand the extent of flood risk, inform appropriate resistance and resilience measures, and support any future site changes. Figure 1-2 shows the current flood zones.

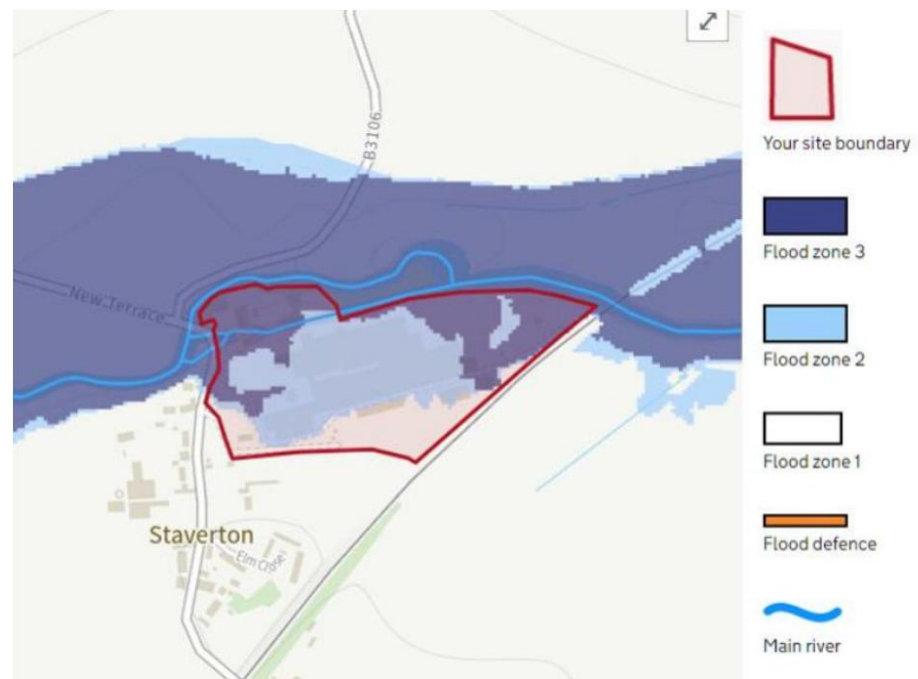


Figure 1-2: Environment Agency Flood Map in the vicinity of the site

The River Avon approaches the site from the east and a weir takes the majority of the water around the north of the site while a shallow leat takes the rest of the water through the site before it reconnects with the main river to the west of the site. At the location of the site, the floodplain for the River Avon primarily falls to the north of the river, on the other side of the channel to the factory.

## 1.2 Scope and Objectives

The aim of this hydraulic modelling project is to inform the client and provide advice regarding flood risk to the existing CPUK factory and footprint over the next 100 years, including potential mitigation measures:

To achieve the project aims, EVY's scope of works included: -

- Building a 1D-2D fluvial model for the Staverton factory and local River Avon. Figure 1-3 shows the model extents in relation to the location of the site.
- Incorporating the survey data to build the 1D river channel, culverts and establish threshold levels.
- Validating the model against observed flooding at the site.
- Hydraulic modelling reporting.

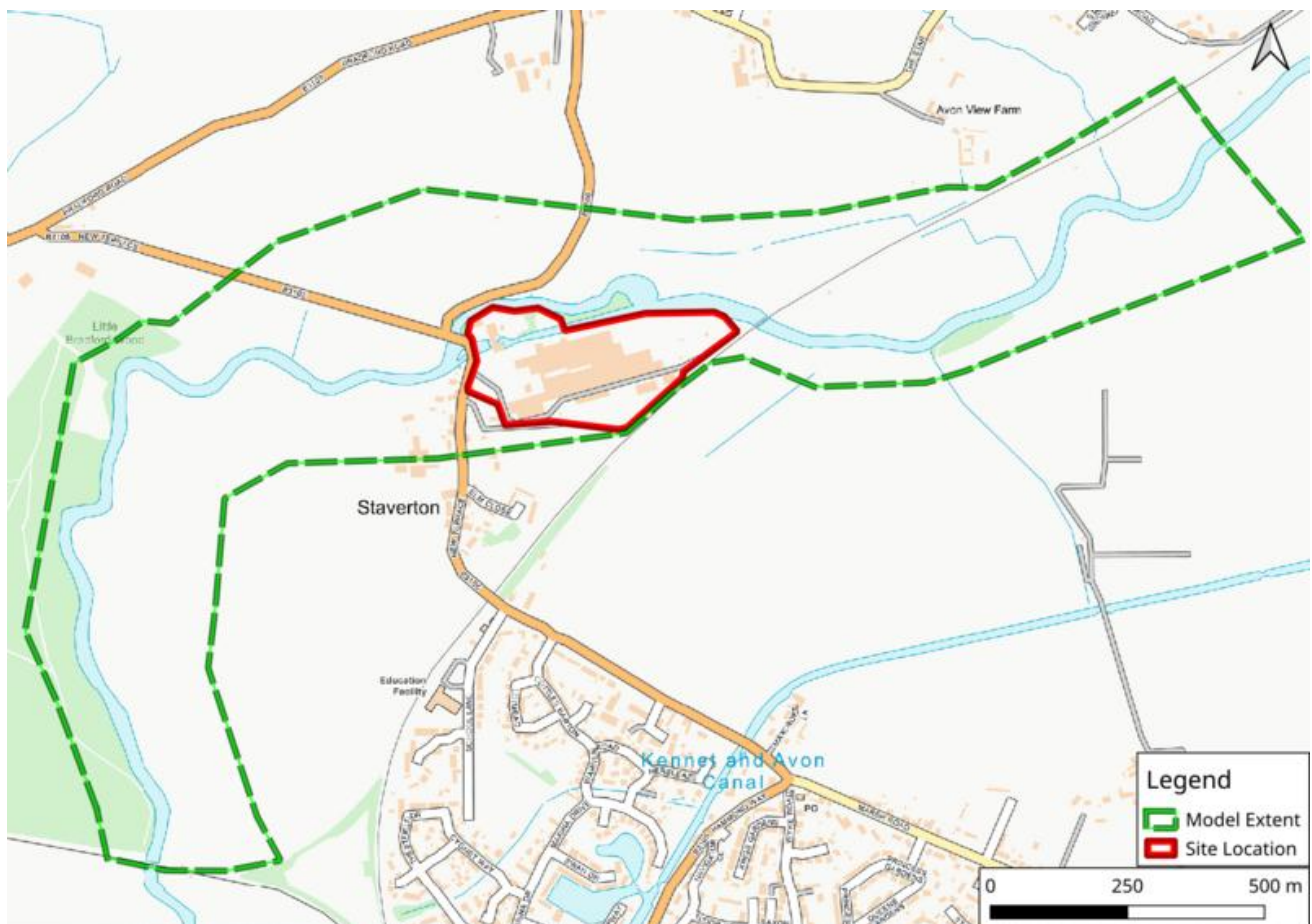


Figure 1-3: Model Extents and location of the CPUK factory in Staverton.

## 2 Hydraulic Modelling

### 2.1 Description of the site

The site of interest as shown in Figure 2-1 is adjacent to the River Avon, and is also divided by a large channel called Weston Cut, fed by the River Avon. Weston Cut may have been used in the past for power and other purposes, but no longer has a use to CPUK.

The River Avon is on the North of the site, which incorporates a weir at the northwest of the site to maintain flows through the Weston Cut. Beyond the River Avon is a wide verge, the B3106 and a wide flood plain leading to Holt on high ground. Southeast of the site is a railway line on an embankment, with low-lying fields beyond. The River Avon passes under the railway line at the eastern point of the site.

South of the site the land rises with housing, farms and the railway leading into Trowbridge. West of the site is the B3105 bridging over the River Avon and Weston Cut, the rejoining of Weston Cut and the River Avon, with the village of Staverton and farmland beyond.

The site is therefore located within the flood plain of the River Avon, with fields mainly around the site and Trowbridge to the south.

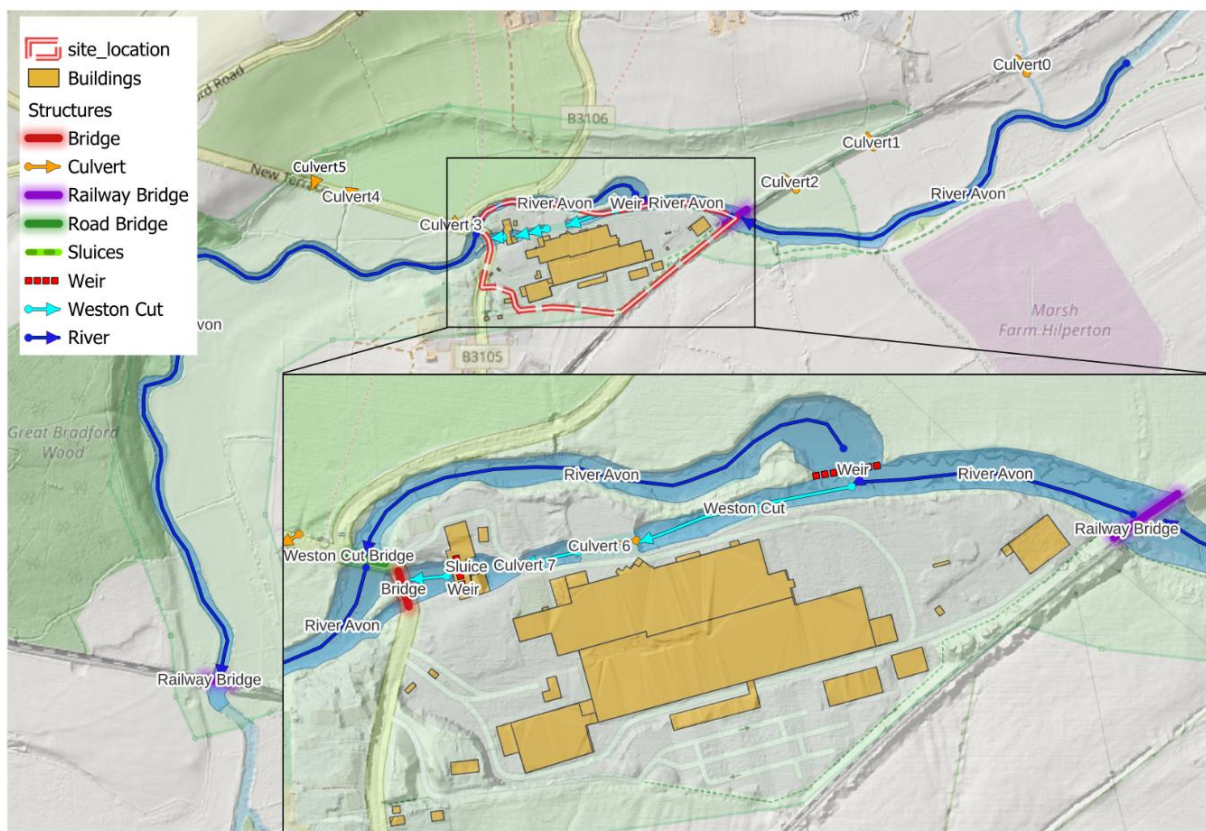


Figure 2-1: Key elements in the site

## 2.2 Model Build

The model was built as a 1D-2D ESTRY-TUFLOW model and run on the latest version of the software: TUFLOW-2025.0.1. The model boundary followed the River Avon floodplain. Figure 2.1 shows the model extent. The model was run for the following return periods:

- 1 in 20-year event (5% AEP)
- 1 in 30-year event (3.33% AEP)
- 1 in 100-year event (1% AEP)
- 1 in 100-year event (1% AEP) + 26% climate change allowance
- 1 in 100-year event (1% AEP) + 71% climate change allowance
- 1 in 1000-year event (0.1% AEP)



Figure 2-2: Railway Bridge  
Weymouth Line

### Survey

Survey of the River Avon was carried out for the purpose of this project, which included cross sections along the River Avon approximately 1km upstream and 1.5km downstream of the site. The relevant culverts, sluices, bridges and weir along the river, the Weston Cut and the floodplains were also surveyed. The locations of the cross sections are shown in Figure 2-4. Threshold levels were also taken as part of the survey and included in the hydraulic model. The survey information is included as Appendix A.



Figure 2-3: Railway Bridge  
Wessex Mainline

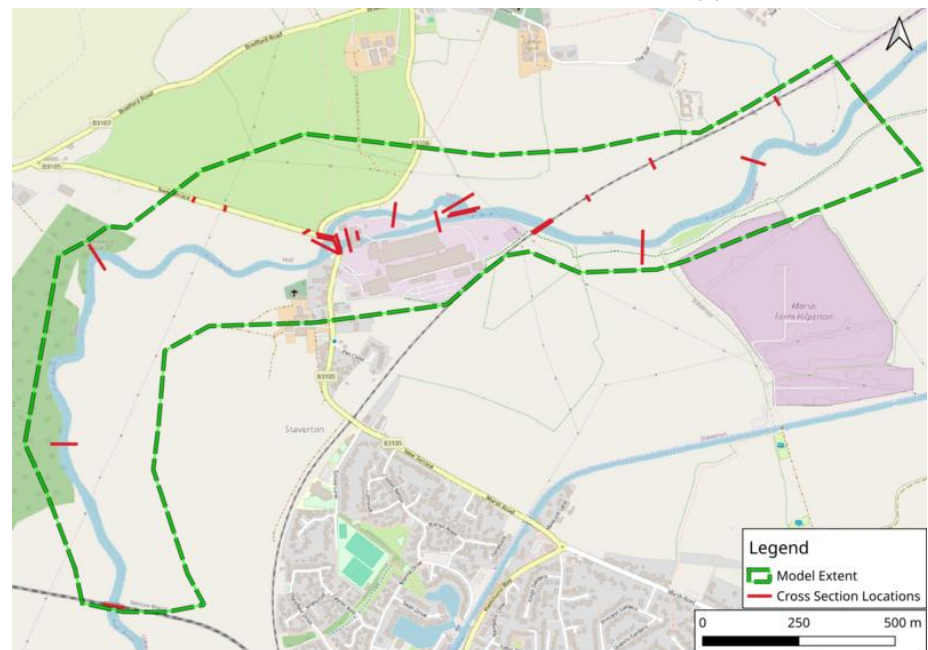


Figure 2-4: Locations of the surveyed cross sections.

### Hydraulic Structures

The current model includes 2 railway bridges, the Weymouth Line Bridge located upstream of the site is a multi-span bridge with 4 openings, as shown in Figure 2-2. The second railway bridge is the Wessex Mainline Bridge located in the Lower Avon is a Multi-Span Plate Girder Railway Bridge, as shown in Figure 2-3.

There are 3 culverts under the Weymouth Rail Line embankment, shown in Figure 2-1 and labelled as Culvert 0 (See Figure 2-5), Culvert 1 (See Figure 2-6) and Culvert 2 (Figure 2-8). The culverts beneath the railway embankment were originally represented within the model as irregular conduits to convey flow between the floodplains of the River Avon. However, to adopt a conservative modelling approach, these structures were removed so that all flows were retained within the floodplain to the south of the railway embankment. A sensitivity analysis was subsequently undertaken to test this assumption, the results of which are presented in Section 4.4.

The weir located in the junction between the River Avon and the Weston Cut has been schematised as a WD weir. The coefficients used are representative of a broad crested weir.



Figure 2-5: Culvert 0, Mason Arch Culvert



Figure 2-6: Culvert 1, Mason Arch Culvert



Figure 2-8: Culvert 2, Mason Arch Culvert



Figure 2-7: Weir

Culvert 6 shown in Figure 2-1 has been included in the model as a 15m wide, 2.5m high rectangular conduit with the overtopping represented in 2D. Culvert 7 shown in Figure 2-1 has been included in the model as a 7.66m wide, 2.0m high rectangular conduit with the overtopping represented in 2D. The following structures downstream two openings under a building (see Figure 2-9), and shown in the surveyed section in Figure 2-10. Both of these openings have been included as SG ETRY Units 4.5m wide by 0.76m high and 3.03m wide by 1.49m high.



Figure 2-9: Sluices under building



Figure 2-11: Weston Cut Bridge



Figure 2-12: Road Arch Bridge on the River Avon

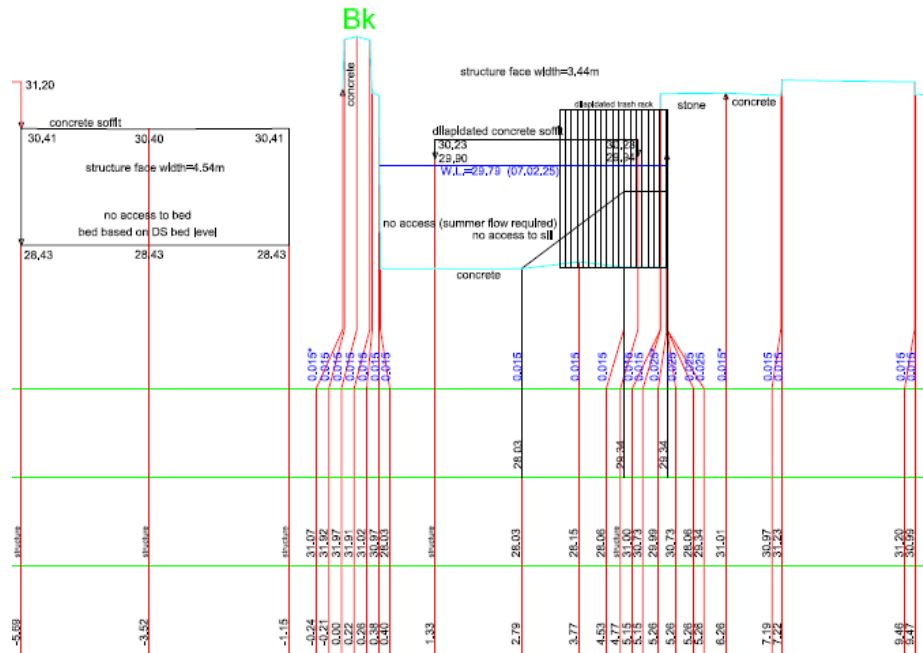


Figure 2-10: Surveyed Section Weston Cute Leat, CS0096

Following downstream is an arch masonry bridge that has been included in the model as ESTRY Irregular Conduits. These two arches are shown in Figure 2-11

There is another section of this bridge on the side of the River Avon. This bridge has been included in the model as 4 Irregular Conduit Units. See Figure 2-12.

There are three culverts under the railway, as shown in

### Elevation

1m digital terrain model (DTM) 2022 LiDAR data has been obtained from the [Department for Environment, Food and Rural Affairs](#). Figure 2-14 shows the extent of LiDAR used for the hydraulic modelling assessment. The floodplain can be clearly seen in dark blue. The terrain in the model has been defined by the LiDAR data as it is sufficiently recent and of good quality, so no further refinements for the bulk of the terrain were necessary, except for the bridge decks for the road and railway. LiDAR data produces an underlying DTM for each grid cell, which TUFLOW translates into single point elevation. The model was run on a 2m resolution grid.

Z-shapes were used to model the buildings. These z-shape regions were set at the threshold levels surveyed. The threshold levels are shown in Figure 2-13.

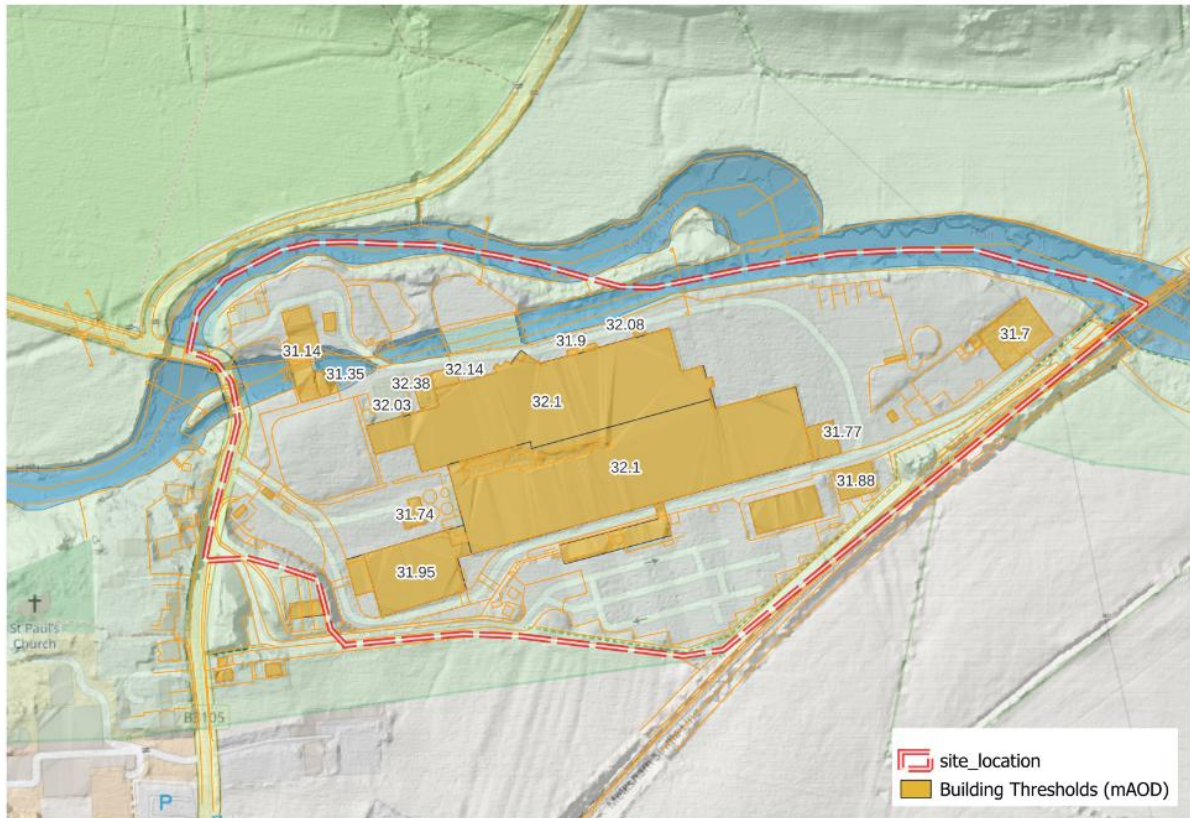


Figure 2-13: Building threshold levels

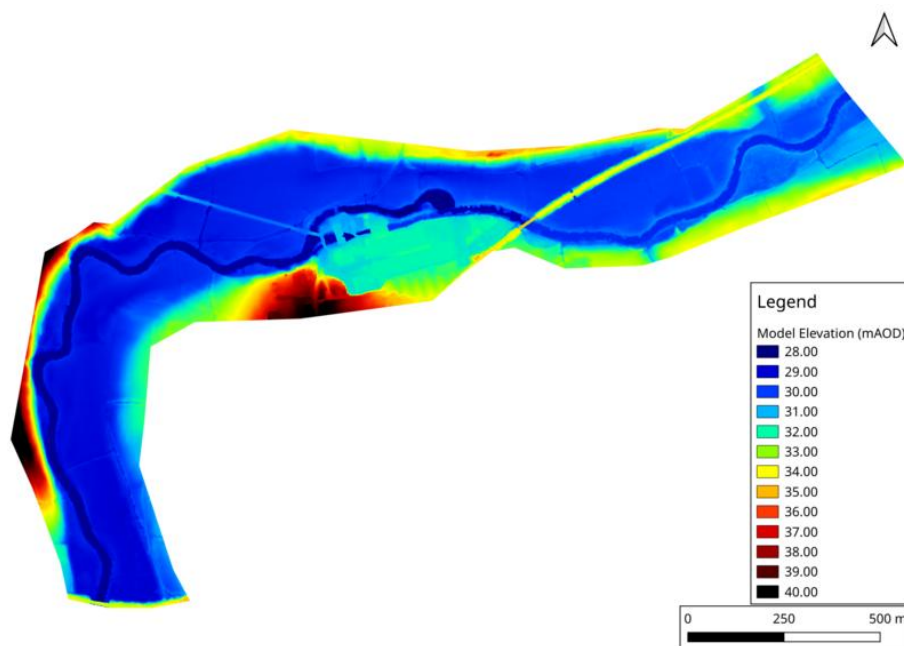


Figure 2-14: LiDAR elevations within the hydraulic model extent.

## Flood Defences

There are no official flood defences in the vicinity of the site, Figure 2-15 shows the Flood defence data obtained from the Environment Agency's Asset Information Management System (AIMS), provided as the "AIMS Spatial Flood Defences (including standardised attributes)" dataset via [environment.data.gov.uk](https://environment.data.gov.uk)

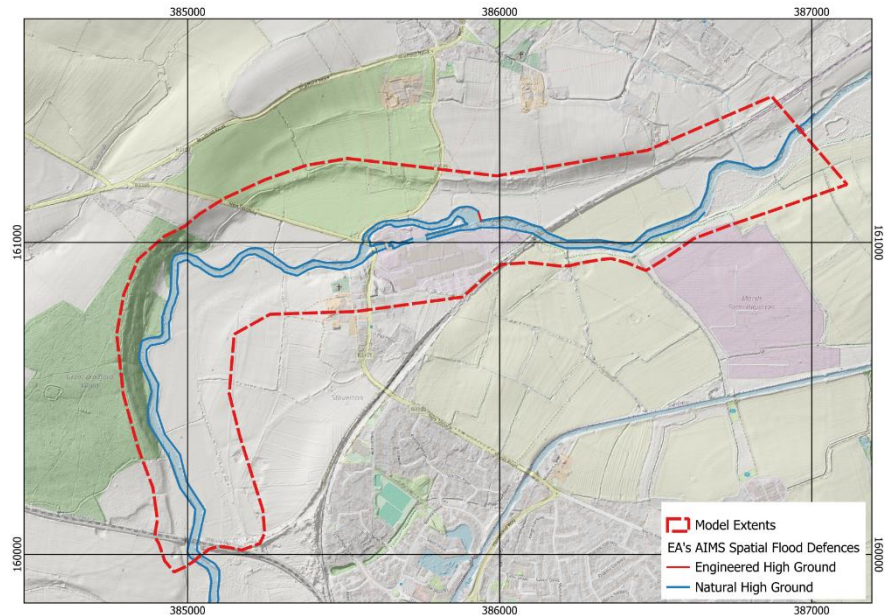


Figure 2-15: AIMS Spatial Flood Defences (including standardised attributes)  
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A review of the Environment Agency's Asset Information Management System (AIMS) Spatial Flood Defences dataset shows that the site is not protected by formal flood defence assets. The mapped features comprise predominantly natural high ground, with only a very short section of engineered high ground associated with the existing weir structure. As these features do not constitute a formal or continuous flood defence system, no distinction between defended and undefended flood risk scenarios is applicable, and flood risk is therefore assessed on an undefended basis. The current hydraulic model is based on LiDAR data supplemented by detailed topographical survey of the site, ensuring that bank levels and local ground variations are appropriately represented.

## Materials

In hydraulic modelling, the material specifies the hydraulic roughness of the terrain (energy lost due to friction) in addition to the fraction of the ground surface which is considered to be impervious to infiltration. The hydraulic roughness of a material is commonly measured using the Manning roughness coefficient 'n' parameter.

For the 2D floodplain domain, Manning's  $n$  values were applied spatially using land-cover data derived from OS Open Map, as shown in Figure 2-16. This dataset classifies land into categories such as buildings, roads, grassland, water bodies, woodland and other surface types. Each category was assigned a Manning's  $n$  value consistent with best-practice guidance and commonly accepted spatial distributed roughness ranges. Table 2-1 shows the values included in the tmf file in TUFLOW, not all of the values in the table are applicable in the model.

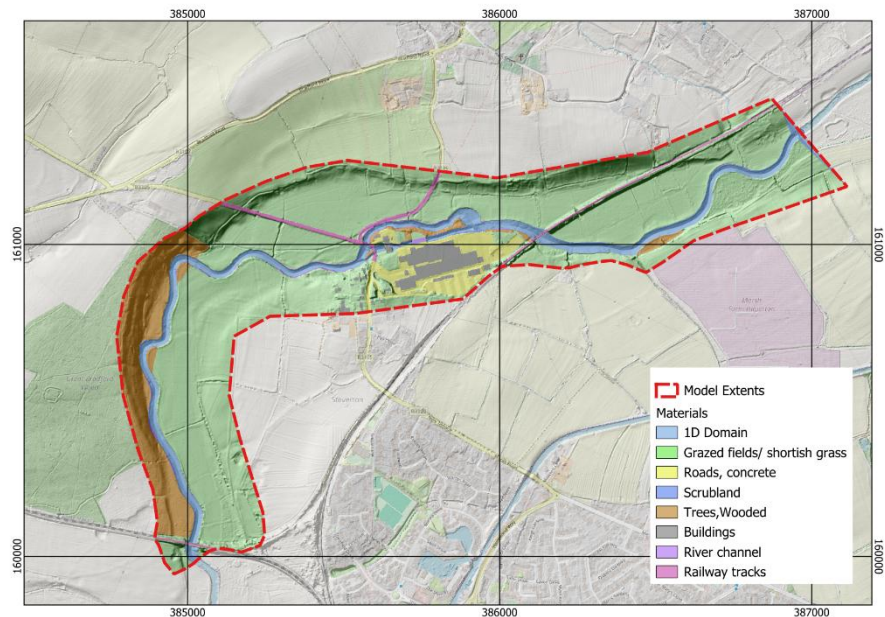


Figure 2-16: Materials used in the 2D domain

| no | $n$   | Description                            |
|----|-------|----------------------------------------|
| 1  | 0.050 | Default. Grazed fields/ shortish grass |
| 2  | 0.020 | Roads; concrete                        |
| 3  | 0.040 | Kept fields (playing fields etc)       |
| 4  | 0.080 | Covers Urban primarily                 |
| 5  | 0.055 | Scrubland                              |
| 6  | 0.100 | Trees/Wooded                           |
| 9  | 0.300 | Buildings                              |
| 10 | 0.035 | River channel                          |
| 11 | 0.040 | Storage basins / ditches               |
| 12 | 0.040 | Railway tracks                         |
| 13 | 0.020 | Foreshore / tidal water                |

Table 2-1: Manning's Roughness Coefficient ( $n$ ) values used in the 2D domain



Figure 2-17: River Avon, photograph of surveyed section AVON\_1948C1

Within the 1D river channels, Manning's  $n$  roughness coefficients were derived from detailed topographic and geomorphological information collected during the channel survey. Surveyors recorded bed materials including gravel, cobbles, silt, and engineered linings, with each material type assigned an appropriate Manning's  $n$  value in accordance with established ranges published in standard hydraulic literature. In particular, roughness values were selected with reference to Chow (1959), *Open-Channel Hydraulics*. The selected coefficients were further validated using site photographs provided by the surveyor and observations made during site visits.

This approach ensures that local channel characteristics—such as substrate composition, vegetation growth, and structural elements—are accurately represented within the 1D model, supporting robust simulation of in-bank flow conveyance. Figure 2-17 shows a typical river channel location.

### Boundary Conditions

The hydraulic model has been constructed as a coupled 1D–2D TUFLOW model, with the 1D river network represented using the ESTRY solver. This modelling approach requires the definition of inflow hydrographs at the upstream boundaries and suitable hydraulic boundary conditions at the downstream extent of the model.

At the downstream boundary, separate normal depth conditions were applied to the 1D and 2D domains: a 1D normal depth boundary within ESTRY for the river channel and a 2D normal depth boundary for the floodplain.

Normal depth is calculated internally by TUFLOW and ESTRY based on the specified bed slope, which was set to 0.002, as shown in Figure 2-18. This value represents a conservative assumption and results in slightly elevated downstream water levels, thereby avoiding any artificial drawdown at the model boundary.

The downstream boundaries were positioned downstream of the railway structure to ensure that the hydraulic influence of this significant constriction on floodplain flows and upstream water levels is fully captured within the model domain and not affected by boundary condition assumptions.



Figure 2-18: Downstream boundary

## 2.3 Scenarios

The proposed strategy to improve flood resilience comprises the following elements shown in Error! Reference source not found. and described below:

- New reinforced concrete (RC) wall to tie in with the high ground located southwest of the flood gate (1).
- Build a new RC wall parallel to the existing wall to the right level (3).
- Replace existing kerbs with a new RC wall, that might include trief kerbs on the traffic-facing side (4, 5, 10).
- Install light-duty sheet piling as part of the flood defence system (7).
- Construct a shallow flood defence around the electricity substation, including trief kerbs on the traffic side if necessary (8).
- Construct a shallow flood over the access road to the electricity substation (9).

- Install flood gates at designated access points to complete a continuous line of flood defence along the Weston Cut (2, 11).

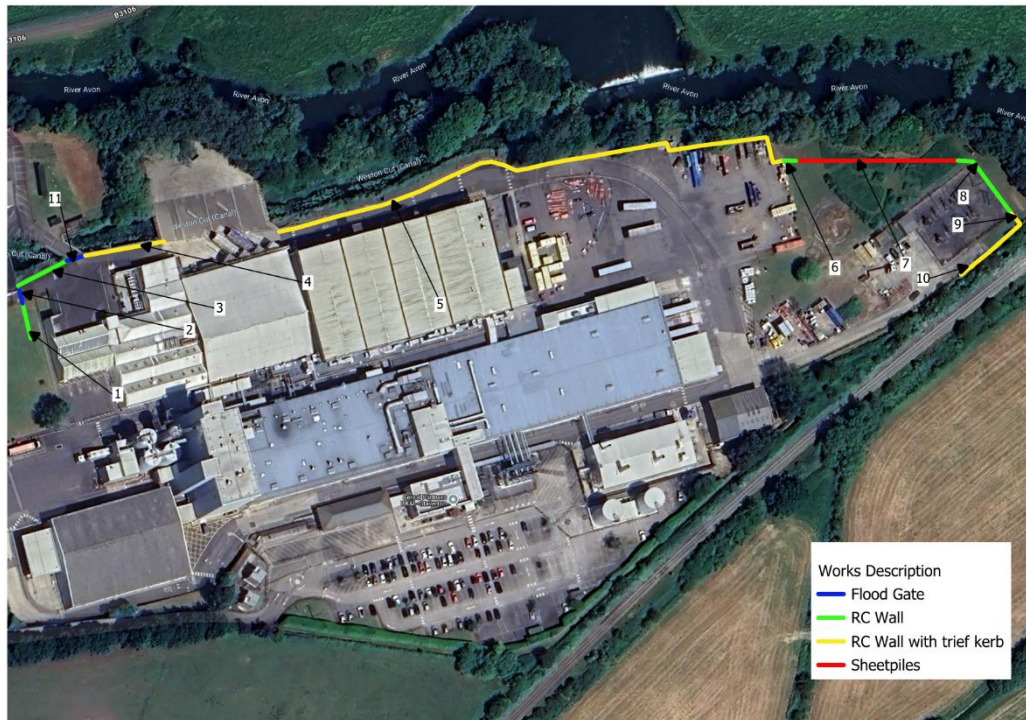


Figure 2-19: Elements of the proposed flood defences

These measures are designed both to improve site safety and enhance the flood resilience of the factory. It is important to note that the main service yard will not be protected and will be allowed to flood during extreme events.

Detail Design Drawings and details of these structures are included in Appendix D.

## 3 Hydrology

### 3.1 Overview

This section provides a summary of the hydrological analysis undertaken to derive the hydrological boundaries required as input to the hydraulic model of the River Avon. Design hydrological estimates have been derived for the lumped catchment of the River Avon at NGR 385050 160050. The selected Hydrological Estimation Point (HEP) has been identified at the d/s extent of the hydraulic model and is considered appropriate given the purposes of the study. Design peak flow estimates and hydrographs are required for the following Annual Exceedance Probabilities (% AEPs): 50, 5, 1, and 0.1. In addition, the impact of climate change on flood risk is assessed by applying to the 1%AEP peak flow estimate the 2080s central and upper end allowances for the Avon Bristol and North Somerset Streams Management Catchment. These are equal to, respectively, 26% and 71%, in accordance to current climate change guidance [1]. The catchment boundaries defined on the FEH web service and the selected HEP are shown in figure 3.1 and figure 3.2.

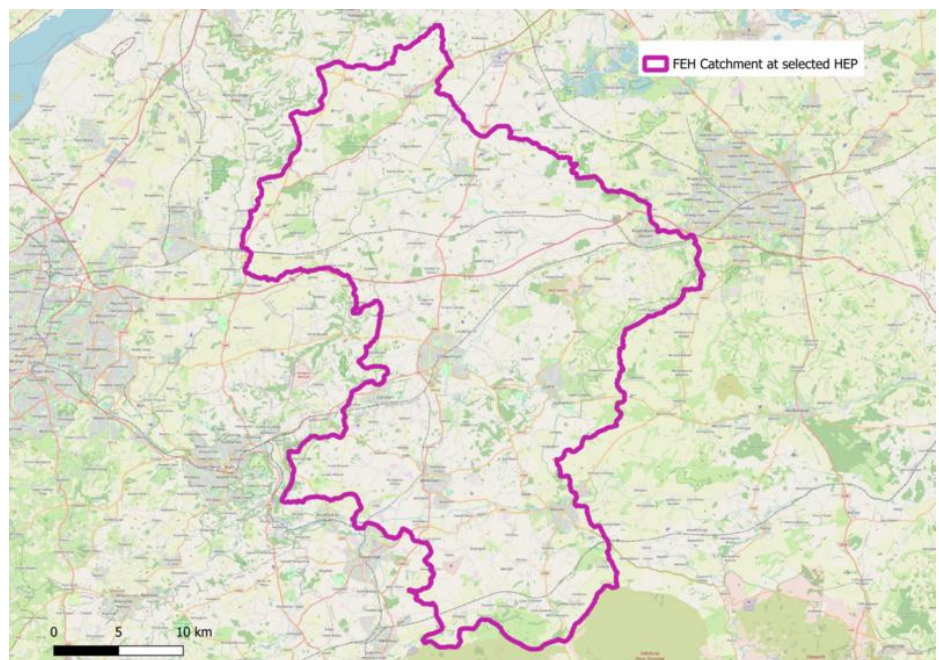


Figure 3-1: River Avon catchment boundaries defined on the FEH web service at the selected HEP.

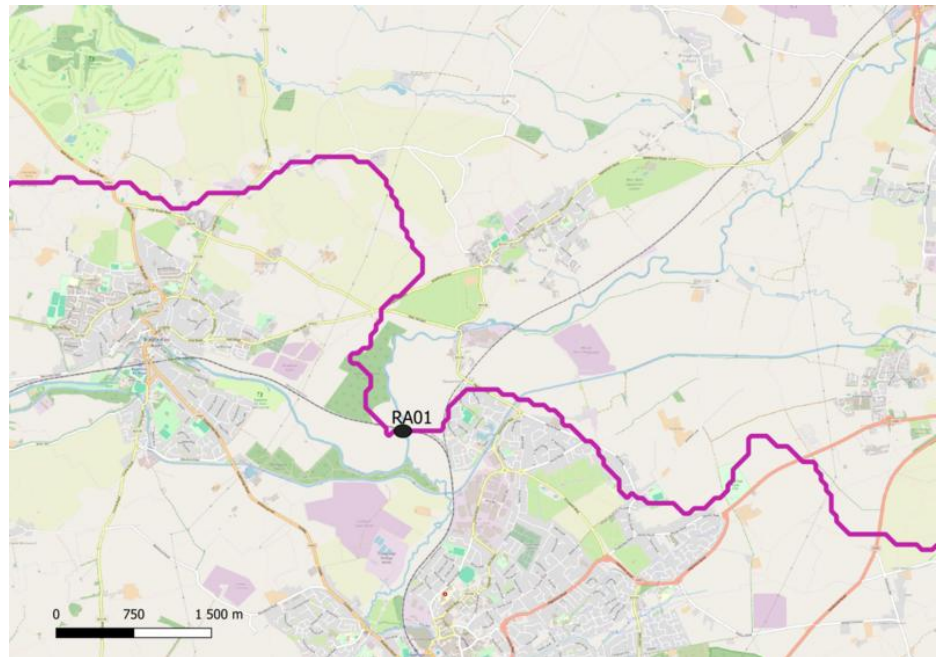


Figure 3-2: Selected HEP (RA01) on the River Avon at the d/s extent of the hydraulic model.

Approximately 800 m upstream of the railway bridge, a small unnamed watercourse discharges into the River Avon at OS National Grid Reference 386777, 161246. The contributing catchment area of this tributary is approximately 1.98 km<sup>2</sup>. At the point of confluence, the River Avon has a catchment area of 888.08 km<sup>2</sup>, giving a total catchment area of 893.18 km<sup>2</sup> for this assessment. The tributary therefore represents approximately 0.22% of the total catchment area used in the flow estimation and, due to its negligible contribution, has not been included in the primary flood risk analysis for the site.

Notwithstanding this, and given the proximity of the tributary to the site, a sensitivity analysis was undertaken in which the inflow from this watercourse was incorporated into the 2D model domain. The results of this sensitivity test are presented in Section 4.4.

## 3.2 FEH Analysis

### Catchment Descriptors

A selection of catchment descriptors at the HEP identified for the purposes of this study is detailed in 3.1. URBEXT2025 is the default URBEXT2000 value updated to present day using the national average Urban Expansion Factor (UEF) according to current FEH guidelines [2]. The catchment is classified as essentially rural.

| HEP  | Area(km <sup>2</sup> ) | BFIHOST19 | FARL | SAAR | URBEXT2025 |
|------|------------------------|-----------|------|------|------------|
| RA01 | 893.185                | 0.575     | 0.99 | 755  | 0.0263     |

Table 3-1: Selection of catchment descriptors at RA01

## Q Peak Estimates

The FEH Statistical method and ReFH2 rainfall-runoff approach are both applicable to the subject catchment, according to current flood estimation guidelines<sup>1</sup>. Both methods have been applied to derive and compare peak flow estimates for the required AEPs. The ReFH2 approach produces peak flow estimates that are lower than the Statistical estimates for all %AEPs except the 0.2 and 0.1% AEPs. It should be noted that the Statistical method is based on the use of a larger dataset of peak flow records which, due to the catchment being essentially rural, not permeable and not particularly affected by attenuation, can be considered reasonably reliable. In order to reconcile the ReFH2 and FEH Statistical results at %AEPs lower than 1, the following approach has been adopted in order to derive the final peak flow estimates:

- For %AEPs larger than or equal to 1, peak flow estimates are from the FEH Statistical method.
- For %AEPs smaller than 1, the ReFH2 ratio method has been adopted (i.e. the ratio of ReFH2 peak to the 1%AEP ReFH2 peak is multiplied by the 1%AEP FEH Statistical peak).

QMED at RA01 has been derived from catchment descriptors and adjusted by donor transfer and for urbanisation, according to current FEH guidelines [2]. A summary of the QMED estimation process is provided in table 3.2, where:

- DONORS are the NRFA gauges selected for the purposes of the donor adjustment.
- QMED CDS is QMED estimated from catchment descriptors (in m<sup>3</sup>/s).
- QMED donor adj is QMED CDS adjusted by donor transfer (in m<sup>3</sup>/s).
- Final QMED is QMED donor adj further adjusted for urbanisation (in m<sup>3</sup>/s).

| HEP  | DONORS                           | QMED CDS | QMED donor adj | Final QMED |
|------|----------------------------------|----------|----------------|------------|
| RA01 | 53013 (Marden@Stanley)           | 78.680   | 90.131         | 93.360     |
|      | 53018 (Avon@Bathford)            |          |                |            |
|      | 53028 (By Brook@Middlehill)      |          |                |            |
|      | 53008 (Avon@GreatSomerford)      |          |                |            |
|      | 53023 (Sherston Avon@Fosseway)   |          |                |            |
|      | 53002 (SemingtonBrook@Semington) |          |                |            |

Table 3-2: QMED estimation at RA01. All QMED values are in m<sup>3</sup>/s.

Statistical Pooled analysis at RA01 has provided growth factors to obtain flows at lower AEPs. The GEV distribution has been selected in order to derive the growth curve as it had the best fit to the pooling group data. The

growth curve has also been adjusted for urbanisation following current guidance [2]. A summary of final peak flow estimates is provided in table 3.3.

| HEP/%AEP | 50     | 5       | 1       | 0.1     | 1+26%cc | 1+71%cc |
|----------|--------|---------|---------|---------|---------|---------|
| RA01     | 93.360 | 158.884 | 197.010 | 323.750 | 248.233 | 336.887 |

Table 3-3: Final design peak flow estimates at RA01 in m<sup>3</sup>/s.

### Design Hydrographs

A single storm representative of the River Avon at RA01 has been selected to derive a representative hydrograph shape. The recommended storm duration (33 hours), ARF (Area Reduction Factor) and SCF (Seasonal Correction Factor) for the catchment at RA01 have informed the ReFH2 lumped model at this location. Design hydrographs at RA01 have been obtained by fitting ReFH2 hydrographs to match final peak flow estimates in table 3.3. Final design hydrographs are shown in figure 3.3.

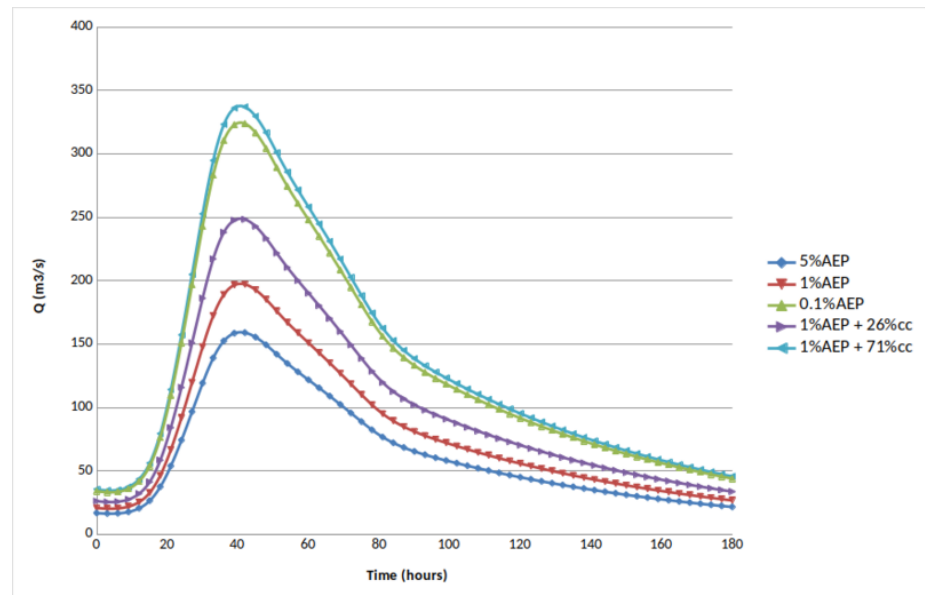


Figure 3-3: Hydrographs showing the calculated flow over different return periods.

### Climate Change

Climate change allowances of 26% and 71% were applied to the 1 in 100-year event (1% AEP) in accordance with the central allowance for the 2080s. [UK Centre for Ecology and Hydrology](#).

Appendix B includes the Flood Estimation Report carried out for this analysis.

## 4 Hydraulic Modelling Results

### 4.1 Overview

Earlier phases of the study included a series of 2D-only sensitivity tests undertaken to identify and understand the dominant flood mechanisms at the site. These tests showed that, during flood events, the majority of flow is conveyed across the floodplain, with the River Avon channel and the Weston Cut carrying a comparatively small proportion of the total flow. This behaviour reflects the low-gradient nature of the system and the extensive floodplain within the study area. As a result, the hydraulic capacity of in-channel structures such as sluices, weirs, and bridges has a limited influence on overall flood conveyance across the site. Nevertheless, all principal hydraulic structures were surveyed and explicitly represented within the model to ensure robust and reliable results.

Zoomed in area North of the site, 1 in 20-year return period maximum water levels

The current model is a fully linked 1D–2D ESTRY TUFLOW hydraulic model, with hydraulic structures represented in 1D.

The latest detailed hydraulic modelling predicts reduced flood extents compared with the JFLOW Flood Zone outlines. This reflects the use of site-specific topographic survey data and a more refined hydraulic representation of the system.

To provide additional context, an earlier version of the hydraulic model (Version 16) was submitted to the Environment Agency's charged pre-application service for technical review (ENVPAC/1/WSX/00406 – Charged Pre-Application Advice: Review of Hydraulic Modelling Report, April 2025). The Environment Agency Evidence and Risk Team concluded that the hydrological inputs and hydraulic modelling approach were acceptable and fit for purpose for assessing flood risk at the site. The reviewer spreadsheets are included as Appendix E to this report, and all comments and recommendations have been addressed in the current model version (Version 26), with supporting documentation updated accordingly.

### 4.2 Analysis of the results

Water Level Maps are presented in Figure 4-8, Figure 4-9, Figure 4-10, Figure 4-11, Figure 4-12 and Figure 4-13 for the 1 in 20 year, 1 in 30 year, 1 in 100 year, the 1 in 100 year plus 26% Climate Change Allowance, the 1 in 100 year plus 71% Climate Change Allowance and the 1 in 1000 year return period respectively.

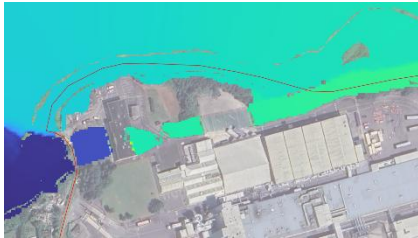


Figure 4-2: Zoomed in area North of the site, 1 in 20-year return period maximum water levels

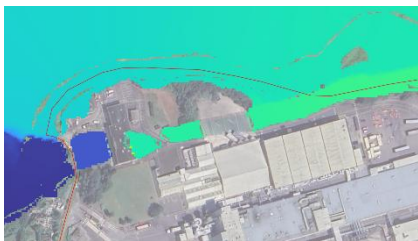


Figure 4-1: Zoomed in area North of the site, 1 in 30-year return period maximum water levels

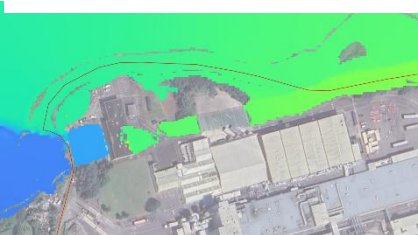


Figure 4-3: Zoomed in area North of the site, 1 in 100-year return period maximum water levels

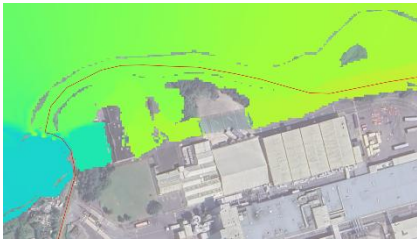


Figure 4-4: Zoomed in area North of the site, 1 in 100-year return period plus 26% Climate Change Allowance maximum water levels

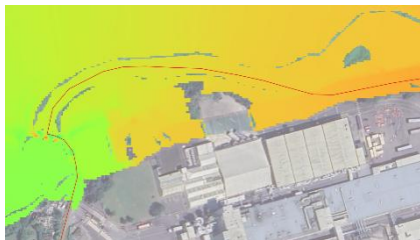


Figure 4-6: Zoomed in area North of the site, 1 in 100-year return period plus 71% Climate Change Allowance maximum water levels

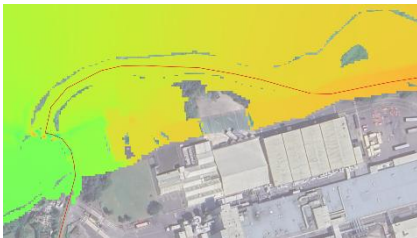


Figure 4-5: Zoomed in area North of the site, 1 in 1000-year return period maximum water levels

The most severe event modelled is the 1 in 100-year return period plus 71% climate change, since, as shown in Table 3-3, peak water levels for this event exceed those predicted for the 1 in 1000-year return period.

The results indicate flooding in limited areas to the north of the site, along the right bank of the Weston Cut. However, for all modelled return periods, flood levels remain below the threshold required to overtop the left bank of the Weston Cut, and no flooding of this area is predicted. Figure 4-1 to Figure 4-5 present zoomed-in views of the modelled maximum water levels for the baseline scenario.

As noted previously, the predicted flood extents are significantly smaller than those shown in the Environment Agency Flood Zone mapping. This reduction reflects the use of detailed, site-specific topographic survey data and an enhanced hydraulic representation of the system. The improved level of detail provides a more accurate characterisation of flood mechanisms at the site and increases confidence in the modelling results.

## Model Stability

The model shows some Mass Balance slightly above 2%, as shown in Figure 4-7, at the start of the model runs but it improves after 10 hours and remains within the acceptable limits (-1%,+1%) for the rest of the model run. This is caused by initial conditions and has no impact in the maximum water levels.

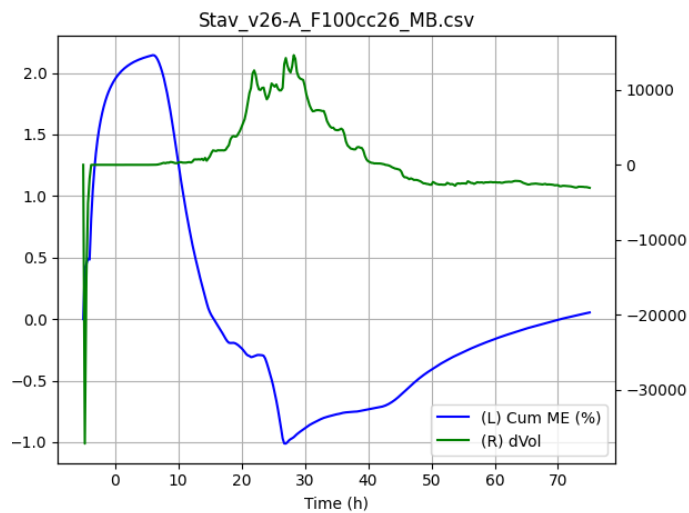
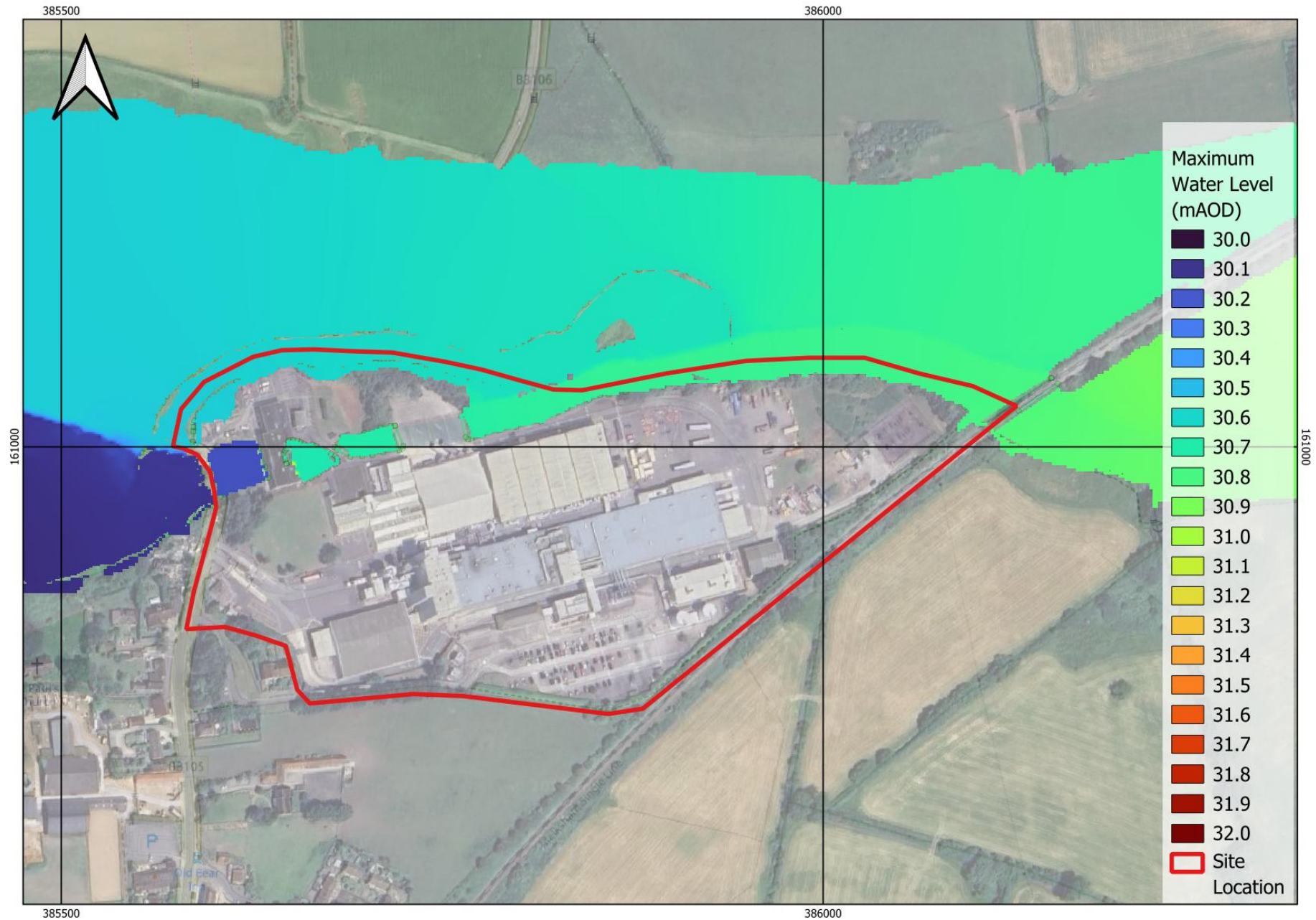


Figure 4-7: Mass Balance 1%AEP+26%CC

The log files show negative depths before 0 hours at the most upstream node. The model starts running at -5hours with the intention of help the initial conditions settle and improve as the channel finds a steady state. This is in line with the observed mass balance issues and does not impact the peak water levels or the confidence in the model results.



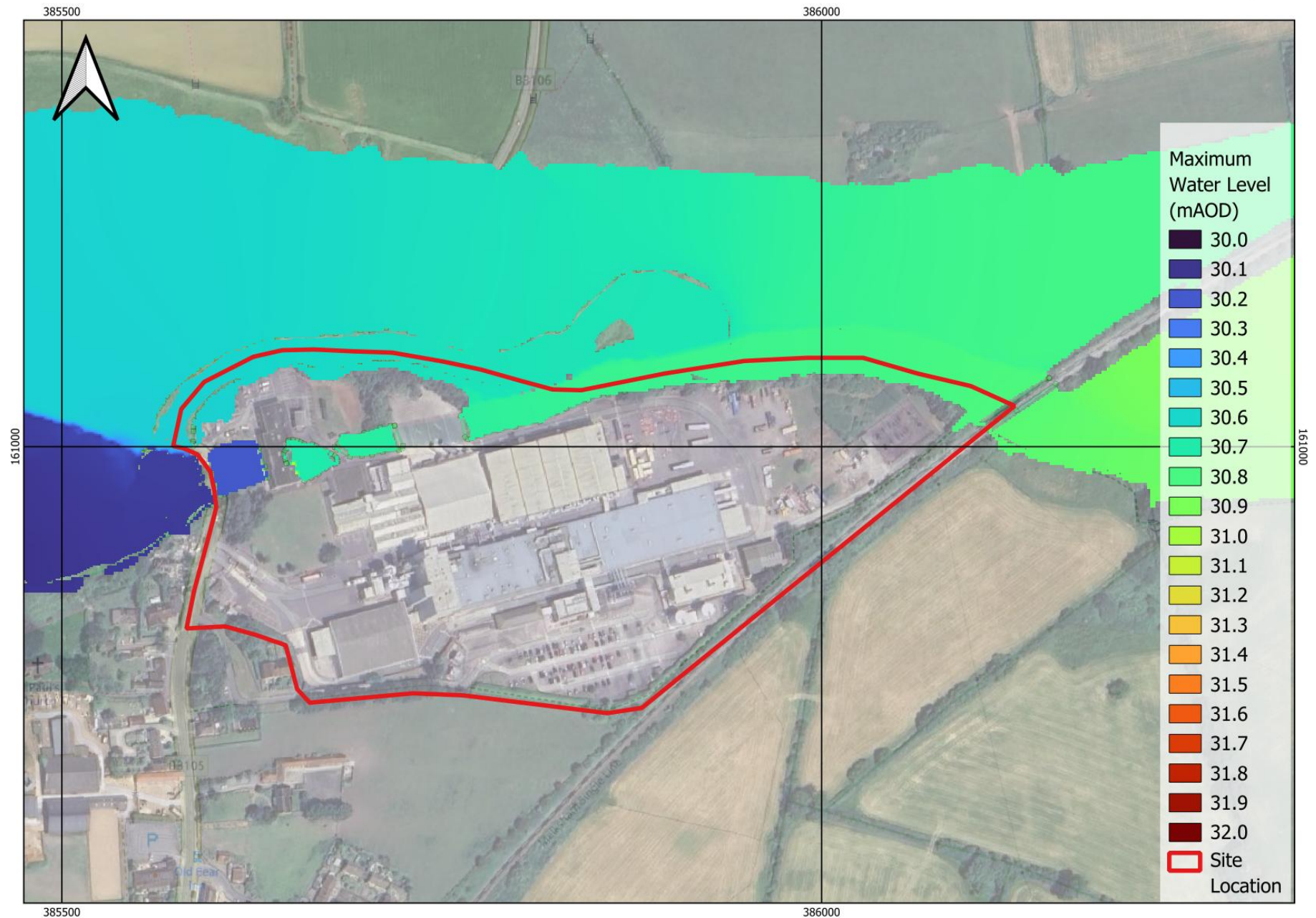


Figure 4-9: Maximum Water Levels 1 in 30-year Return Period

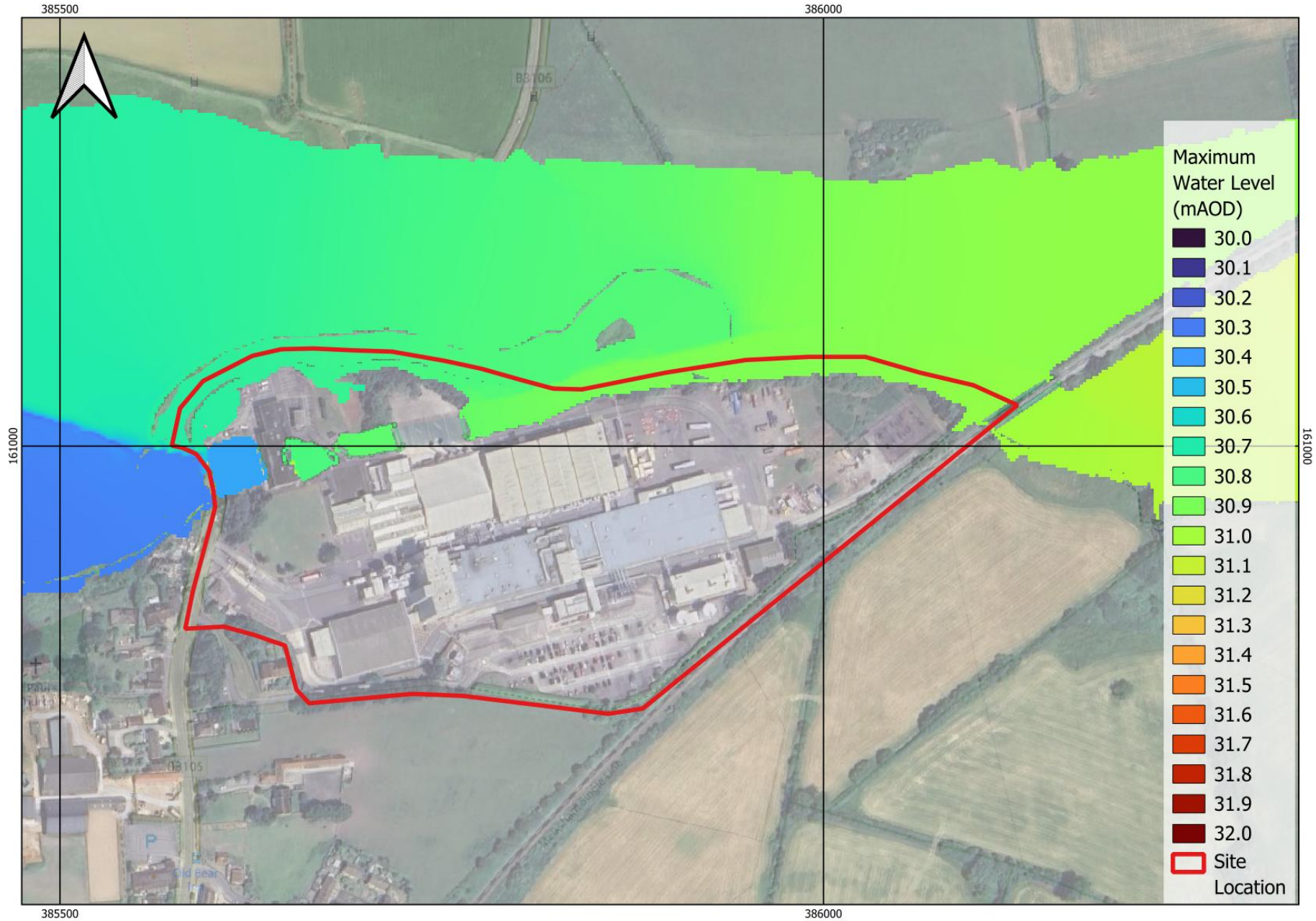


Figure 4-10: Maximum Water Levels 1 in 100-year Return Period

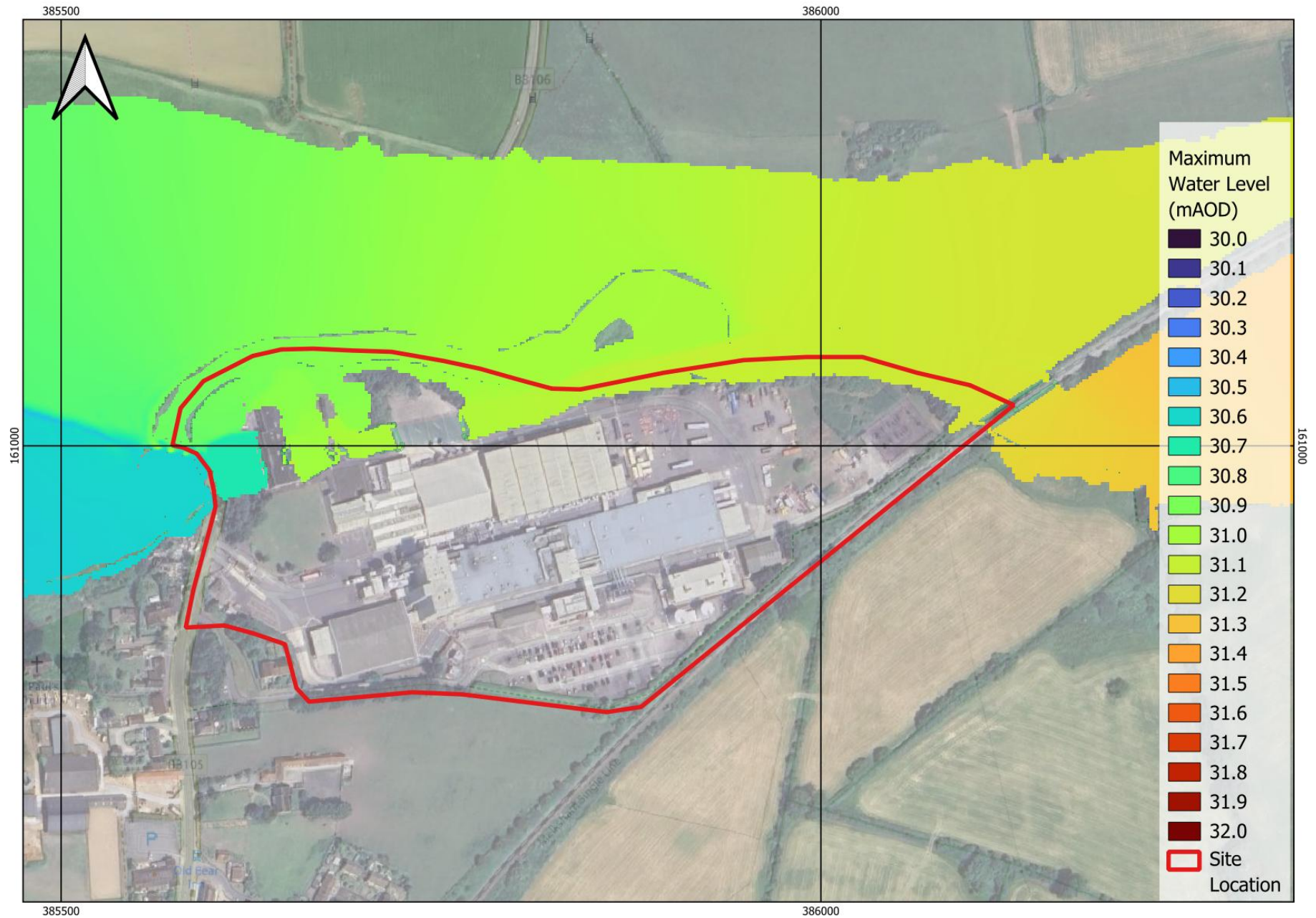


Figure 4-11: Maximum Water Levels 1 in 100-year Return Period plus 26% Climate Change Allowance

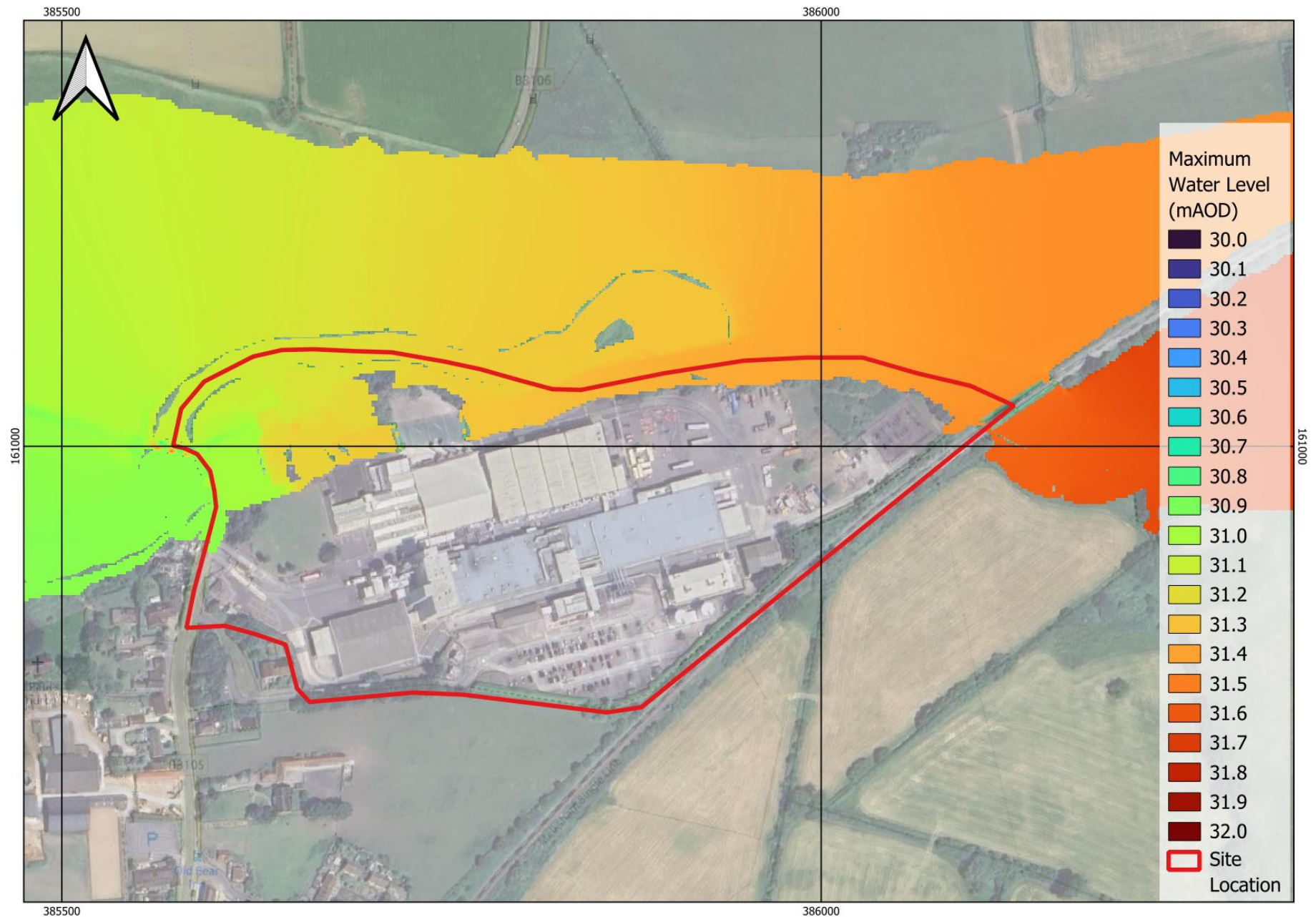
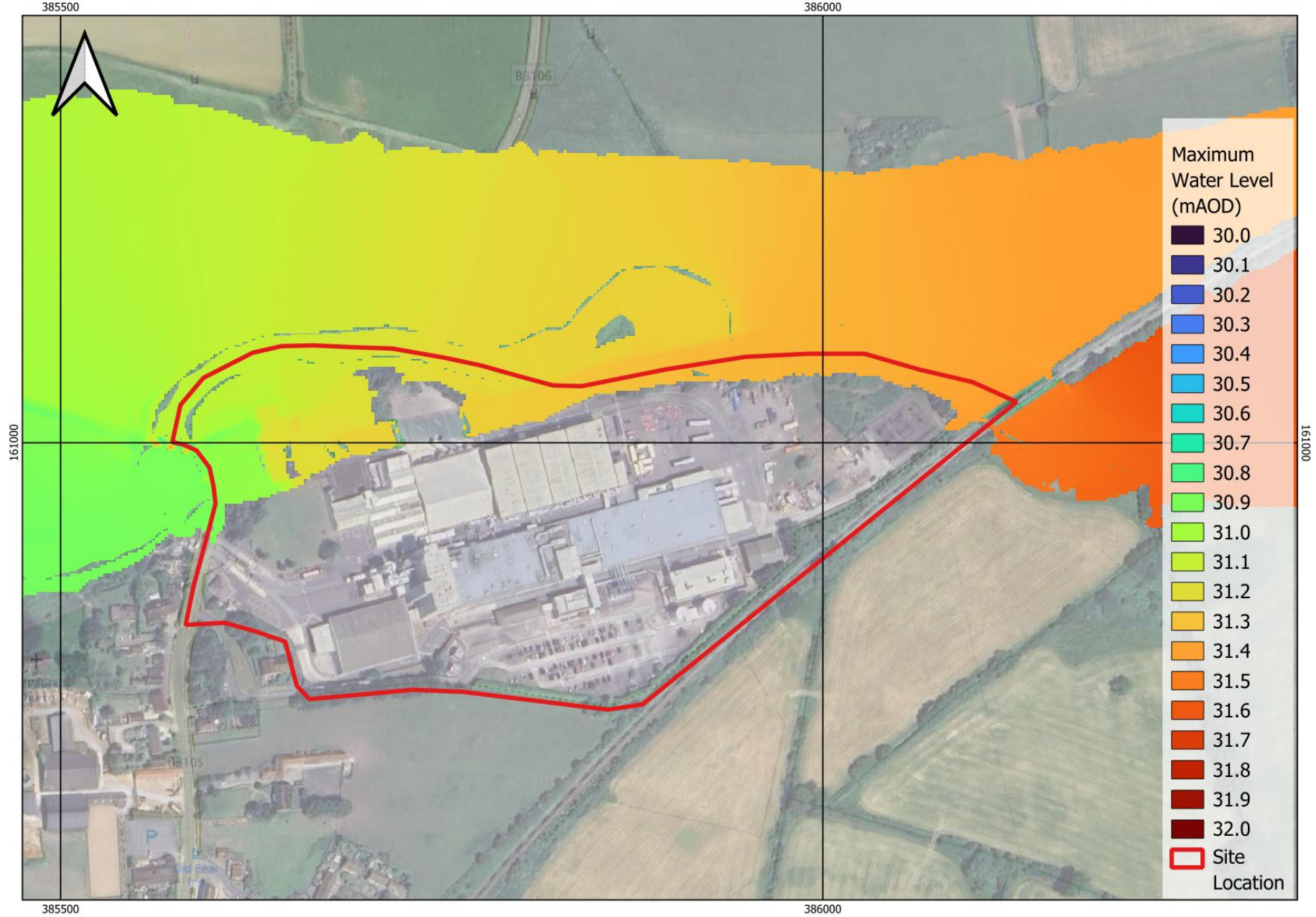


Figure 4-12: Maximum Water Levels 1 in 100-year Return Period plus 71% Climate Change Allowance



### 4.3 Calibration/Validation

The hydraulic model has not been formally calibrated, as there are no flow or water level gauges within the model extents. Instead, a qualitative validation has been undertaken by comparing modelled flood extents for the 1 in 100-year event with observed flooding associated with the November 2024 flood event in the vicinity of the site. Overall, the predicted flood extents show good agreement with the areas of flooding observed during this event.

The Environment Agency (EA) has confirmed that flooding has historically occurred in the area in 1900, 1925, 1979, 1982, 1999, 2012 and 2014. The EA also notes a record of possible flooding prior to 2012, although the date and source cannot be confirmed. The EA Historic Flood Map is shown in Figure 4-14.

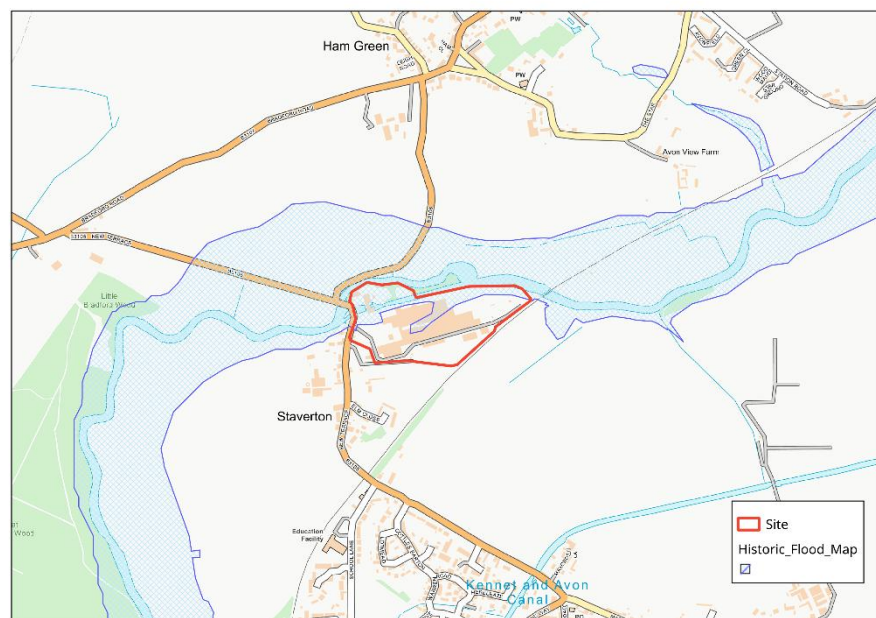


Figure 4-14: EA Historical Flooding

Internal flooding of the Mill Building is understood to have occurred in December 2012, resulting in damage to carpets. This flooding was relatively shallow and is consistent with an expected depth of approximately 10 mm. In addition, there have been several recent occasions when high water levels have caused concern to CPUK staff but did not result in flooding to the site. Notably, the November 2024 event—recorded as a flood of record at Bradford on Avon—did not flood the factory site. While flooding did occur on the B3105 at the site entrance, water levels remained below site ground levels.

A small number of localised flooded areas visible in site photographs were not reproduced by the hydraulic model. These are considered likely to be the result of surface water ponding, temporary exceedance of local drainage capacity, or blockage of drainage infrastructure, rather than fluvial processes represented within the model. As such, no further assessment was undertaken to replicate these highly localised effects.

For additional context, peak flow data from the Environment Agency Bradford-on-Avon gauging station on the River Avon indicates a recorded peak flow of approximately 230 m<sup>3</sup>/s during the November 2024 event. Although this gauging station lies outside the modelled reach and cannot be used for direct calibration, the magnitude of the recorded flow is broadly consistent with a high-return-period flood. This provides additional confidence that the modelled flood magnitudes are reasonable.

It is acknowledged that, in the absence of in-reach calibration data, some uncertainty remains. However, the comparison with observed flooding, consideration of regional gauged flow data, and the use of detailed site-specific topographic and hydraulic information together provide an appropriate and proportionate level of confidence in the model results for the purposes of flood risk assessment.

#### 4.4 Sensitivity Analysis

A series of sensitivity tests were undertaken to assess the robustness of the hydraulic modelling results to reasonable variations in key modelling assumptions and parameters. The sensitivity scenarios tested include variations in hydraulic roughness, downstream boundary conditions, structural blockage at key crossing. These tests were carried out to understand the influence of uncertainty in model inputs on predicted water levels and flood extents, and to confirm that the conclusions of the flood risk assessment are not unduly sensitive to these assumptions.

All sensitivity tests were undertaken for the 1 in 100 year return period event, with the exception of the tributary representation and the inclusion of culverts, which were assessed for the largest modelled event (1 in 100 year plus 71% climate change).

##### Roughness sensitivity

Industry standard sensitivity tests have been run on roughness, downstream boundaries and blockage. A +/- 20% change to the Manning's n roughness coefficient to the 1D channels and the floodplains. Figure 4-15 and Figure

4-16 show difference plots of these results. Red indicates new flooding as a result of the change in roughness; blue indicates flooding removed.

An increase in the roughness coefficients of 20% produces water levels between 0.06m and 0.11m near the site. A reduction of the roughness coefficient of 20% produces a water level reduction between 0.09m and 0.09m near the site.

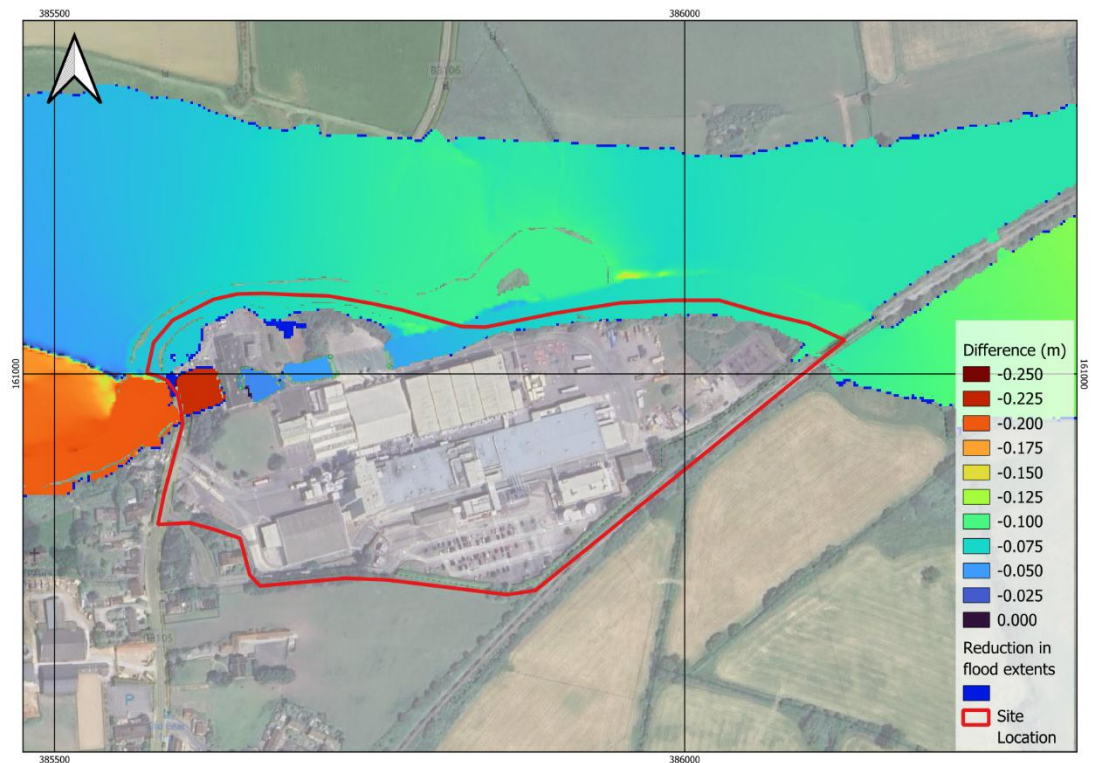


Figure 4-15: Water Level Differences sensitivity test 1%AEP (20% decrease in roughness coefficient)

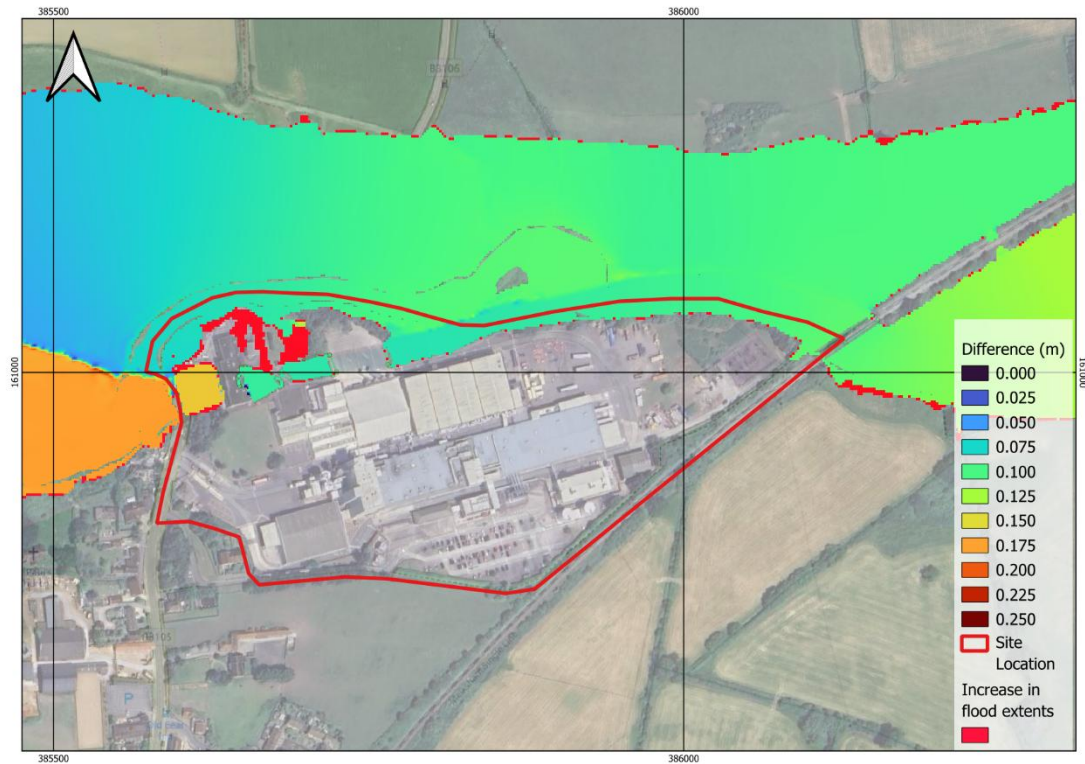


Figure 4-16: Water Level Differences sensitivity test 1%AEP (20% increase in roughness coefficient)

### Downstream Boundaries

Downstream boundaries have been analysed increasing and decreasing the normal depth slope by 50%. There is a variation on water levels that increases the water levels in the vicinity of the site of approximately 0.013m when reducing the downstream slope and a lesser reduction of approximately 0.006m when the slope downstream is increased. Changes in the flood extents are negligible and have no impact on the conclusions of this analysis. Figure 4-18 and Figure 4-17 show difference plots of these results.

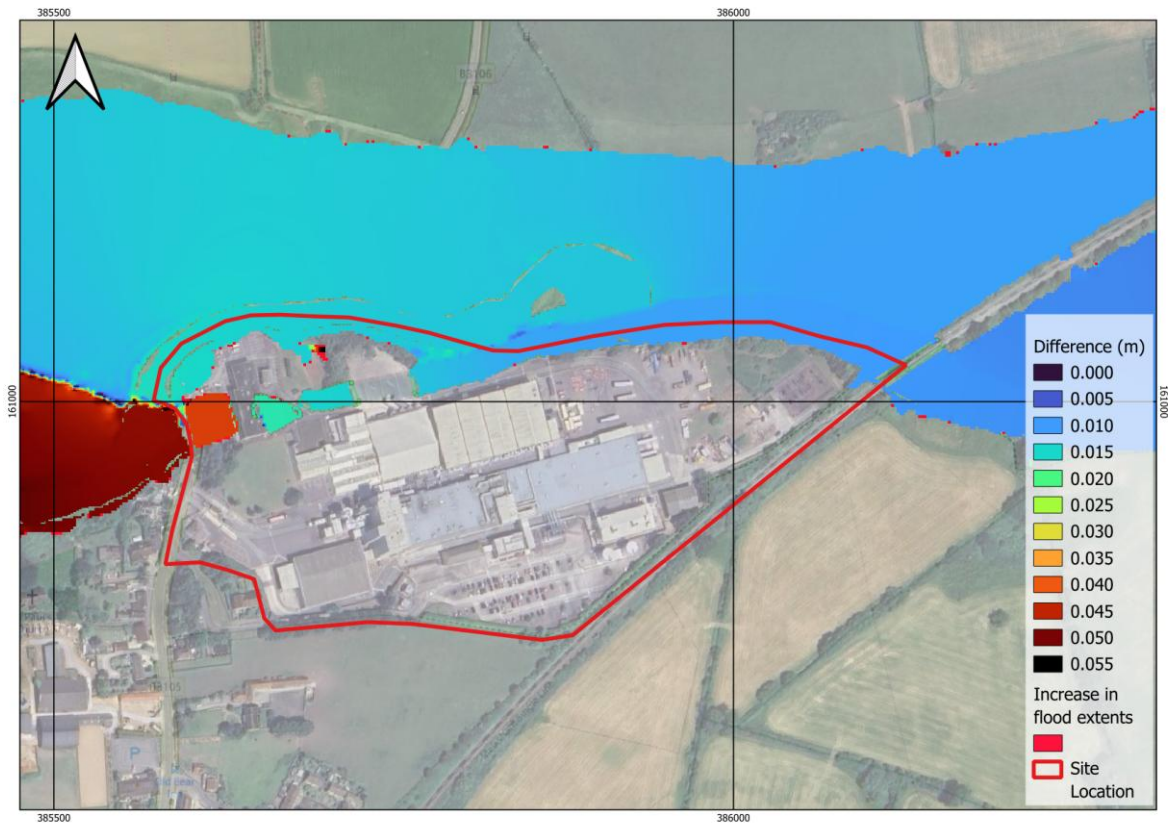


Figure 4-18: Water Level Differences sensitivity test 1%AEP (50% increase in downstream boundary slope)



Figure 4-17: Water Level Differences sensitivity test 1%AEP (50% decrease in downstream boundary slope)

### Blockage Sensitivity

Blockage sensitivity testing was undertaken by reducing the effective flow width of the four arches of the Road Arch Bridge on the River Avon, located to the west of the site. This scenario results in a localised increase in water levels of approximately 0.126 m immediately upstream of the bridge.

The results also indicate a more pronounced and spatially extensive increase in floodplain water levels, of up to approximately 0.11 m. This rise is greater than would typically be expected for this type of blockage and may be associated with local instabilities along the right bank adjacent to the bridge. Notwithstanding this increase, flood levels remain below the threshold required to overtop the left bank of the Weston Cut, and no flooding of this area is predicted under the blockage scenario. Overall, while the blockage test results in elevated water levels within parts of the floodplain, it does not alter the conclusions of the assessment or increase flood risk to the site.

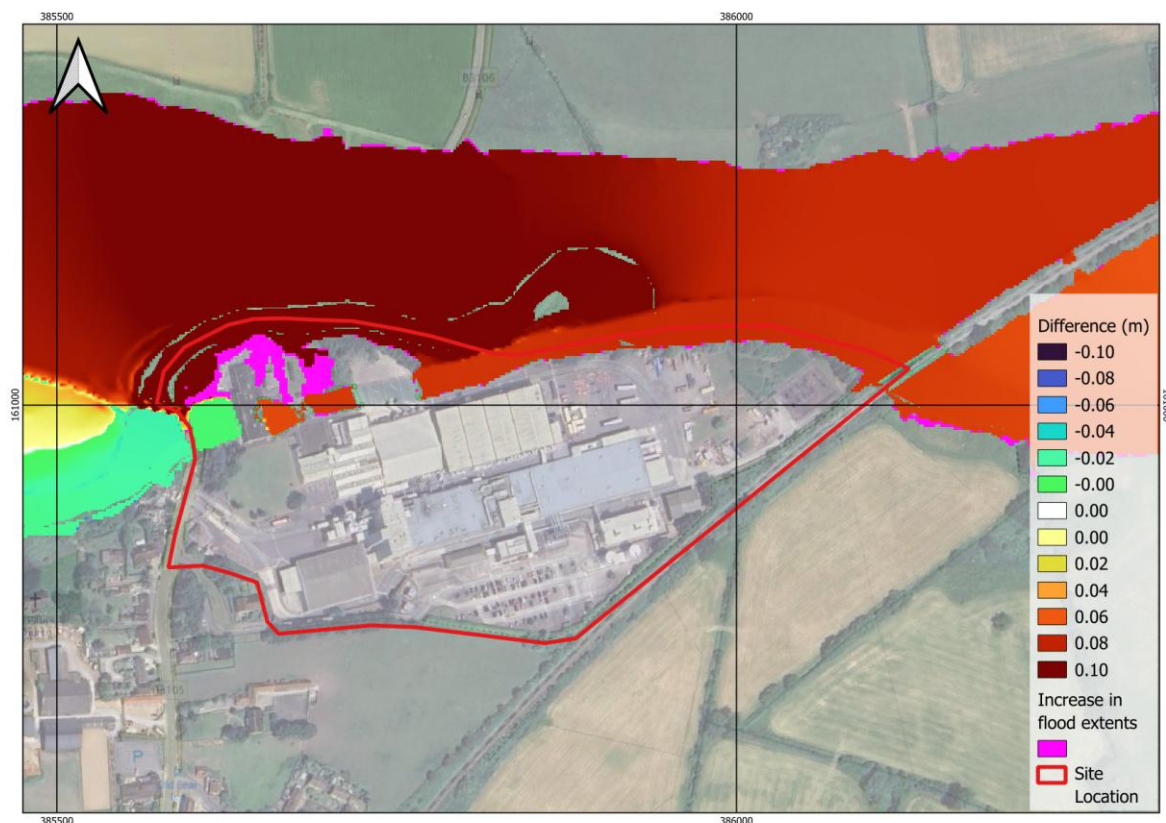


Figure 4-19: Water Level Differences sensitivity test 1%AEP (50% Blockage)

### Tributary and railway culverts

A sensitivity test was undertaken on the tributary referenced in Sections 2 and 3 to assess its potential influence on flood risk at the site. Approximately 800 m upstream of the railway bridge, a small unnamed watercourse discharges into the River Avon at OS National Grid Reference 386777, 161246. The contributing catchment area of this tributary is approximately 1.98 km<sup>2</sup>. At the point of confluence, the River Avon has a catchment area of 888.08 km<sup>2</sup>, giving a total catchment area of 893.18 km<sup>2</sup> for this assessment. The tributary therefore represents approximately 0.22% of the total catchment area used in the flow estimation and, due to its negligible contribution, was not included in the primary flood risk analysis.

Notwithstanding this, and given the proximity of the tributary to the site, a sensitivity analysis was undertaken in which the tributary inflow was explicitly represented within the 2D model domain. For the baseline assessment, the three culverts beneath the railway embankment were removed as a conservative assumption, ensuring that all River Avon flows were directed towards the site. However, for the purposes of the sensitivity test, these culverts were reinstated to examine whether flows from the tributary, or potential backwater effects from the River Avon, could utilise a flow route beneath the railway embankment and propagate towards the site on the northern side.

The results of the sensitivity test, presented in Figure 4-20 demonstrate that flows within the tributary do not influence flood risk at the site. Furthermore, the inclusion of the railway culverts does not create a flow pathway that increases flood extents or depths within the site. On this basis, both the tributary and the culverts beneath the railway embankment are confirmed to have no impact on flood risk for the site.

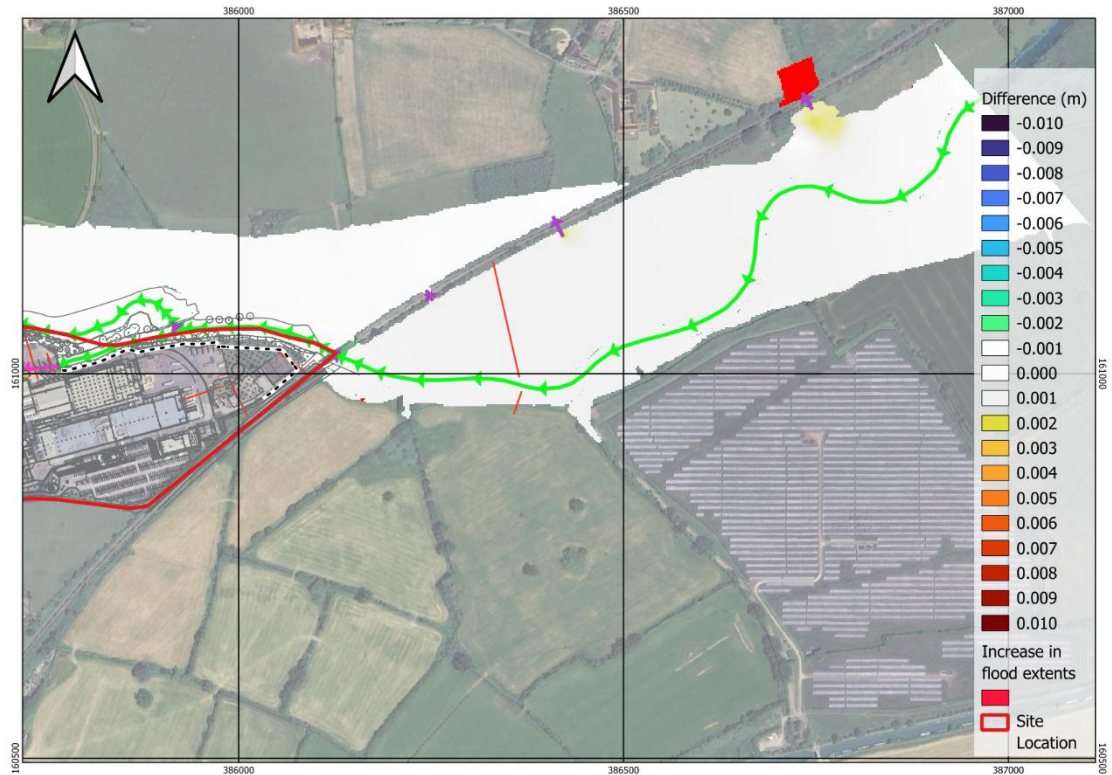


Figure 4-20: Sensitivity analysis explicit representation of tributary and addition of culverts under the railway. Event 1.0% AEP plus 71% Climate Change Allowance

#### 4.5 Post Development Scenario Results

The post-development flood modelling incorporates the proposed flood resilience measures illustrated in Figure 2-19. These measures include new reinforced concrete walls, replacement of existing kerbs, light-duty sheet piling and flood gates, which together form a continuous line of flood protection along the Weston Cut, with additional localised protection to critical infrastructure such as the electricity substation. All of these elements remain outside the 1 in 100-year return period plus 26% Climate Change Allowance maximum flood extents and have therefore not been included in the model.

**Error! Reference source not found.** shows the peak water levels for all return periods modelled at different locations. These locations are shown in Figure 4-21. The empty values in the table show that there is no flooding at that location for the relative return period. All maximum water levels are below the proposed level of the flood resilience measures of 32.0mAOD

| ID | Events (% AEP) |       |       |             |             |       |
|----|----------------|-------|-------|-------------|-------------|-------|
|    | 5.00           | 3.33  | 1.00  | 1.0 + 26%CC | 1.0 + 71%CC | 0.10  |
| 1  |                |       |       |             | 30.95       | 30.90 |
| 2  |                |       |       |             | 30.96       | 30.91 |
| 3  |                |       | 30.44 | 30.68       | 31.00       | 30.96 |
| 4  |                |       |       |             | 31.00       | 30.96 |
| 5  |                |       |       | 30.88       | 31.03       | 31.01 |
| 6  |                |       |       | 30.94       | 31.14       | 31.10 |
| 7  | 30.68          | 30.70 | 30.81 | 30.99       | 31.24       | 31.20 |
| 8  | 30.68          | 30.70 | 30.81 | 30.99       | 31.23       | 31.20 |
| 9  | 30.71          | 30.72 | 30.84 | 31.03       | 31.27       | 31.24 |
| 10 | 30.71          | 30.72 | 30.85 | 31.03       | 31.27       | 31.24 |
| 11 |                |       | 30.73 | 30.94       | 31.22       | 31.18 |
| 12 | 30.63          | 30.65 | 30.80 | 30.98       | 31.24       | 31.20 |
| 13 | 30.72          | 30.73 | 30.86 | 31.04       | 31.29       | 31.25 |
| 14 | 30.73          | 30.75 | 30.88 | 31.06       | 31.30       | 31.27 |
| 15 |                |       | 30.90 | 31.08       | 31.34       | 31.30 |
| 16 | 30.76          | 30.77 | 30.92 | 31.10       | 31.38       | 31.34 |
| 17 | 30.77          | 30.79 | 30.94 | 31.13       | 31.41       | 31.37 |
| 18 |                |       |       | 31.16       | 31.46       | 31.41 |
| 19 |                | 30.81 | 30.96 | 31.16       | 31.46       | 31.41 |

Table 4-1: Peak water levels at different location for all return periods modelled, see Fig to locate the ID reporting points.

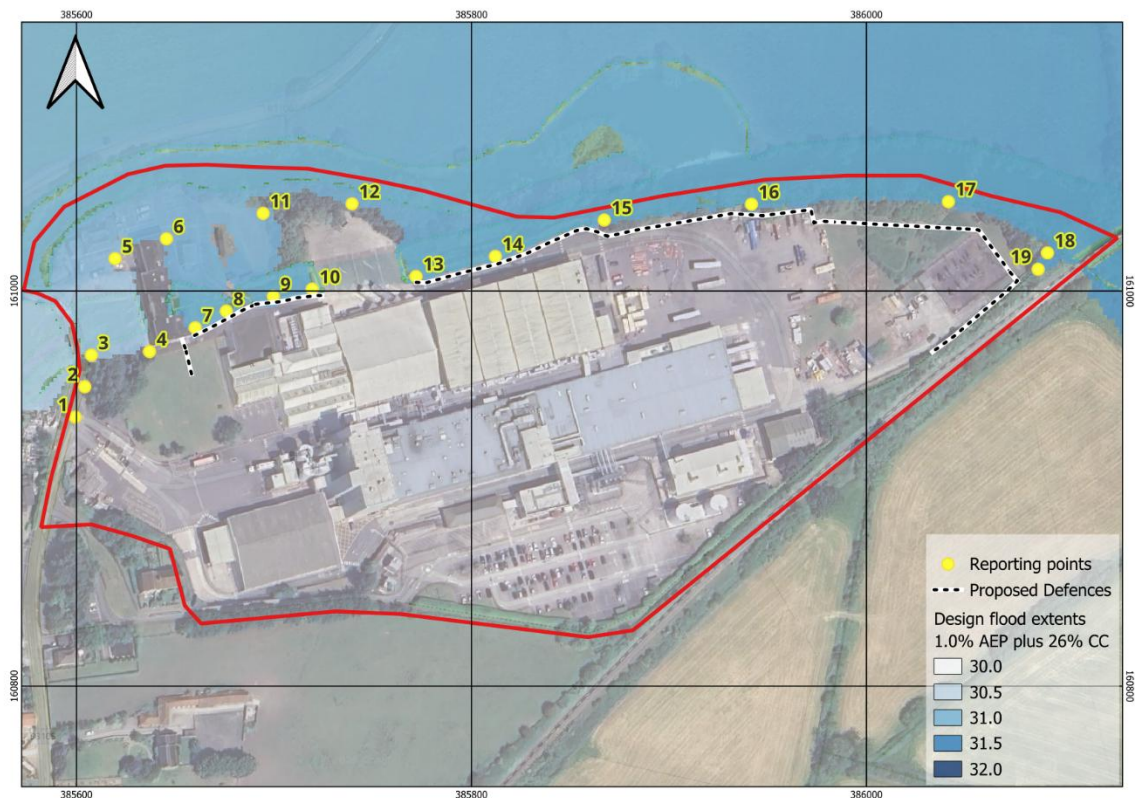


Figure 4-21: Reporting points for Table 4-1, maximum design flood extents and location of flood defences

The model results demonstrate that all proposed flood resilience measures are located outside the maximum design flood extents, for the 1 in 100 years plus 26% climate change allowance event.

No overtopping of the proposed flood defences is predicted, and the measures provide effective resilience to the main factory buildings and essential infrastructure. In line with the proposed strategy, the main service yard is intentionally not protected and is designed to flood during extreme events. This approach ensures that floodplain storage and flow routes are maintained and that the development does not increase flood risk elsewhere.

Overall, the post-development modelling confirms that the proposed flood resilience measures will significantly improve flood resilience at the site, without increasing flood risk on neighbouring land or within the wider floodplain, and are therefore considered acceptable from the flood risk perspective.

## 5 Assumptions and Conclusions

### 5.1 Assumptions

The following assumptions have been adopted in the development of the hydraulic model:

- Where gaps existed in the survey data, dimensions were estimated using LiDAR data and site photographs to ensure continuity and completeness of the hydraulic representation.
- Manning's roughness coefficients applied to river cross-sections were cross-referenced against available .dwg survey information and assigned in accordance with recognised industry guidance.
- Where uncertainty existed in model parameters, conservative assumptions were applied to ensure that predicted flood levels and extents represent a reasonable worst-case scenario.

These assumptions are considered appropriate and proportionate for the purpose of assessing fluvial flood risk at the site.

### 5.2 Conclusions

A fully linked 1D–2D hydraulic model has been developed to assess fluvial flood risk at the site. The model incorporates the most up-to-date hydrological inputs and a detailed hydraulic representation of the river channel, floodplain, and associated structures, providing a robust and reliable assessment of flood behaviour within the study area.

The modelling results demonstrate that the majority of the site, located on the left bank of the Weston Cut, lies outside the predicted flood extents associated with the 1 in 100-year return period event, including a 71% allowance for climate change. This indicates that the site is generally at low risk of fluvial flooding under both current and projected future climate conditions.

The modelling outputs provide a suitable evidence base to inform the flood risk assessment and support the proposed flood resilience strategy for the site.

The proposed flood resilience measures have been designed to provide a robust level of protection for the site while maintaining existing floodplain storage and conveyance routes. The modelling demonstrates that the measures are located outside the predicted flood extents and do not result in any increase in flood levels or flood extents elsewhere within the study area.

On this basis, the proposed flood resilience measures do not increase flood risk to third parties, either upstream or downstream of the site.

## 6 Appendix A: Survey Information

## 7 Appendix B: Flood Estimation Report

## 8 Appendix C: Model Files and Results

## 9 Appendix D: Resilience measures detailed design drawings

## 10 Appendix E: EA Model Review Spreadsheet

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