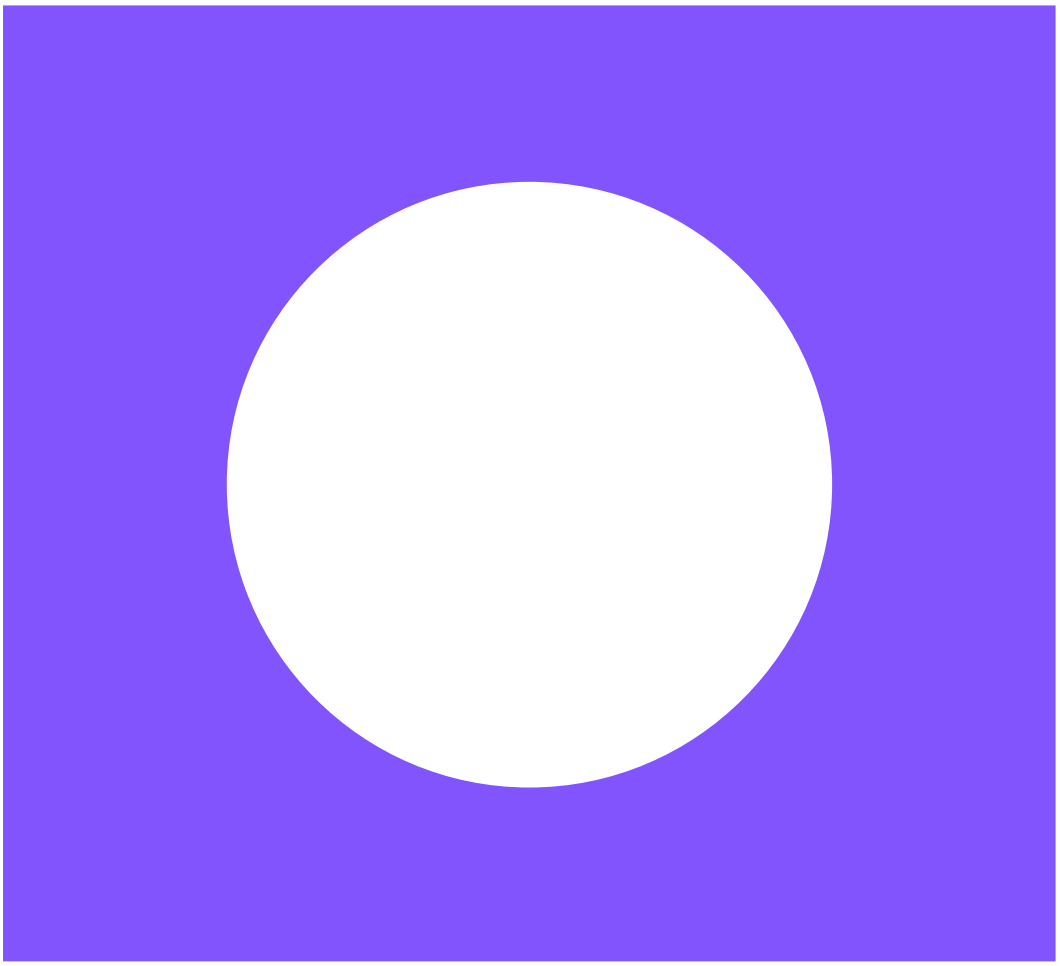
MOTT MACDONALD



A494 River Dee Improvement Scheme

River Dee Hydraulic Modelling Report
Proposed Development Assessment

March 2026

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A494 River Dee Improvement Scheme

River Dee Hydraulic Modelling Report
Proposed Development Assessment

March 2026

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Executive summary

The Welsh Government, through their North and Mid Wales Trunk Road Agent (NMWTRA), appointed Mott MacDonald as their technical and environmental advisors to develop the design of the proposed A494 River Dee Bridge Improvements up to publication of draft Orders.

This hydraulic modelling will be used to inform a flood consequences assessment (FCA) that will be a technical appendix of the Environmental Statement (ES) which will be published alongside the draft Orders. Mott MacDonald has updated the A494 hydraulic model originally used in June 2024, incorporating the latest version of the NRW River Dee model. These updates have been applied to Existing (pre-development) and Proposed (post-development) scenarios.

A range of fluvial and tidal flood events under present day (2025) and future (2100) conditions have been simulated. In line with the previous June 2024 hydraulic modelling, the model runs account for a development lifetime of 75 years (in line with TAN15 guidance for “less vulnerable” developments). The runs use the Coastal Flood Boundary 2018 data and methods for the tidal boundary and fluvial inflows agreed with the NRW prior to the modelling stage. Both riverbank overtopping and defence breach scenarios have been considered in order to provide detailed information on flood mechanisms and risk to the Proposed Development, as well as assessing the impact of the proposed works on flood risk to the wider floodplain.

The assessed fluvial scenarios do not pose flood risk to the Proposed Development, as there is no risk of flooding within the proposed site boundary.

The assessed tidal scenarios do not pose flood risk to the Proposed Development up to the 0.1% AEP 2100 event. The flooding for this event does not reach the new A494 road, however, is predicted to flood the low-lying areas in the River Dee floodplain. The Proposed Development significantly reduces flood extent on the right floodplain immediately upstream of the proposed A494 bridge, however, some increases in flood extent/depth are predicted for the 0.1% AEP 2100 event in areas between the Jubilee Bridge and new A494 bridge.

If a breach of the River Dee defences were to occur, the Proposed Development is predicted to flood. The modelling has indicated that breaches along the left bank of the River Dee close to the Scheme allow flood water to reach the A494 road and Proposed Development. The Proposed Development has an impact on the shallow flood plain flows in breach scenarios, and this can subsequently affect the levels of flood risk in some of the adjoining areas of surrounding floodplain. Several potential mitigations have been assessed in this study, including raising riverside embankment to reduce the overtopping and constructing a flood wall along the A494 road south of the North Wales Coastal Line railway line, which could affect the level of flood risk in some of the adjoining areas of surrounding floodplain.

1 Introduction

1.1 Background

The Welsh Government (WG) have appointed Mott MacDonald, through their North and Mid Wales Trunk Road Agent (NMWTRA), as their technical partner and environmental advisor, to develop the design of the proposed A494 River Dee Bridge Improvements up to publication of draft Orders.

The A494 River Dee crossing, which was constructed in 1960, provides a vital connection between North Wales and the Northwest of England. The location of the current A494 River Dee Bridge (Figure 1.1) is in the county of Flintshire, North Wales, NGR: SJ 32376 68597. The crossing carries approximately 61,000 vehicles per day connecting people, communities, and businesses. Due to the age of the bridge, there is evidence of deterioration to key structural features which would be difficult to repair whilst keeping the bridge open to traffic. The bridge's concrete deck is in a poor condition which results in an uneven surface and may in the future affect the crossing's weight capacity. The abutments which support the bridge are also in a poor state of repair. Further details on structural issues can be found in the A494 River Dee Bridge Improvement Report developed in October 2022[1]. A replacement bridge upstream of the existing bridge is therefore proposed.

A hydraulic model is required to assess both the existing flood risk at the Scheme and the impact of the Proposed Option. Figure 1.2 shows the location plan and area of interest.

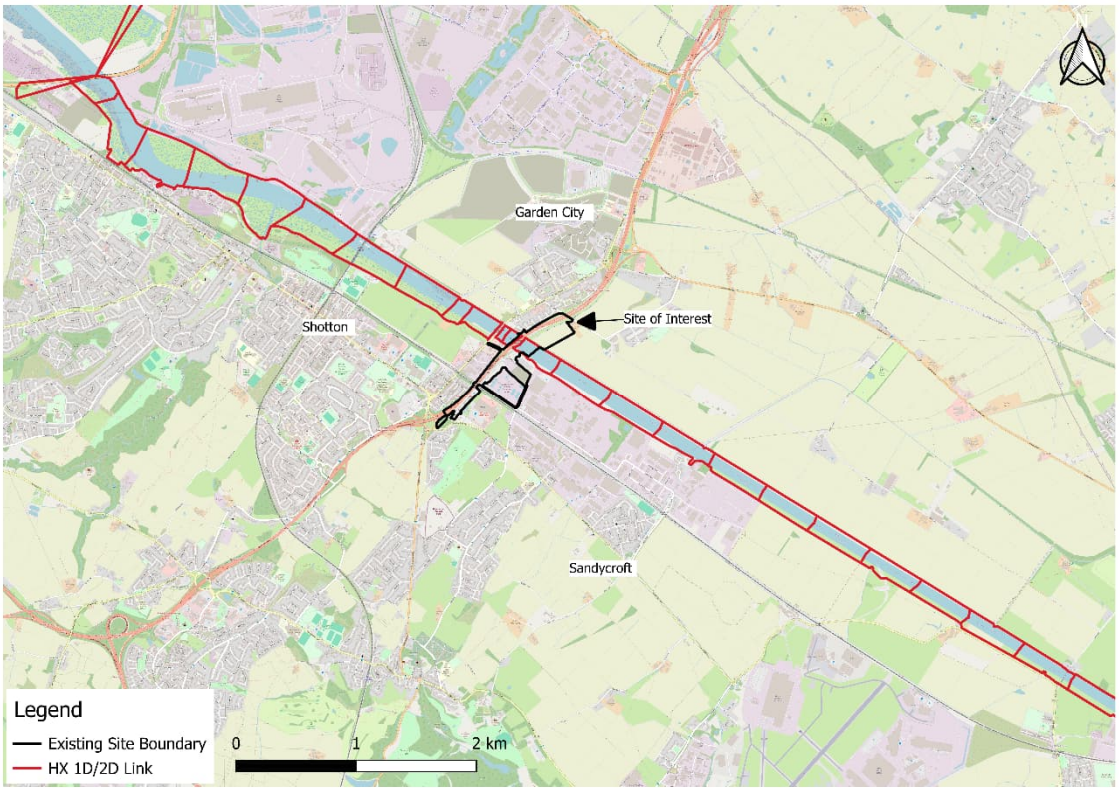
Figure 1.1: Existing A494 River Dee Bridge



Source: Welsh Government: https://gov.wales/a494-river-dee-bridge-overview

[1] 395318-TN-38-F-A494 Bridge Improvements River Dee FCA Modelling Report RevF, Mott MacDonald, October 2022

Figure 1.2: Location Plan



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

1.2 NRW Consultation

The model was first delivered to the NRW for review in September 2025, as part of the draft Orders and associated ES for the Scheme. Comments on the model were provided by NRW on the 2nd December 2025 (as detailed in Appendix A). Following discussions with NRW, the model has been updated from version 23 to version 25 for the Existing scenario and from 33 to 35 for the Proposed scenario.

The key updates to the model following the comments received from NRW are as follows:

- The conveyance curves and panel markers in several 1D cross sections were reviewed and adjusted to achieve smoother conveyance.
- The OSMasterMap used in model versions 23/33 was from 2017 and was found to be outdated, particularly due to the new Northern Gateway development, located to the north of the site. The latest OSMasterMap dataset (January 2026) has been downloaded and used to better represent the latest and ongoing developments in this area.
- To improve the topographical representation of updated areas not captured by the available LiDAR a 2d_zsh file has been created using data from information found on the Flintshire County Council (FCC) planning application portal[2].

The above are not the only updates following the NRW consultation. Full details of all updates are expanded upon in the following two sections of this report.

[2] Spectrum Spatial

2 Existing (Pre-Development) Model Updates

For the purpose of this study, the model used by Mott MacDonald in the previous round of modelling (2024) has been used as starting point to inform this model. The Existing (pre-development model) scenario was further updated as detailed in the Scoping Report[3] using the latest hydraulic model provided by NRW in June 2024. The updates to the Existing (pre-development) scenario are explained in the following sections.

2.1 1D Cross-Sectional Updates

Cross section 00010101720 has been updated to be shorter than in the previous round of modelling. This has been done to bring the 1D cross section in line with the updated 2d_bc for the River Dee which now follows the left bank elevation lines and not the proposed NWTDS crest levels.

The panel markers across the 1D cross sections have also been improved. These updates help smooth the conveyance curves and improve the stability and accuracy of the model.

2.2 1D Structural Updates

The latest model provided by the NRW in June 2024 consisted of several improvements in the 2D surface of the model area. Among these were the inclusion of a number of tidal culverts located in the River Dee floodplain which have been modelled using a series of 1D ESTRY culverts. These culverts as defined in the latest NRW model were included in the updated Existing (pre-development) model.

The existing A494 River Dee crossing and the Queensferry Bascule Bridge have been incorporated into the model as per the previous modelling report. The information for the Bascule Bridge has been taken from the original design drawings of the Queensferry Bascule Bridge dating from 1925. Whilst the existing bridge information has been sourced from the 2018 cross section and bank survey. The full details of the representation of these structures can be found in the October 2022 hydraulic modelling report[4].

2.3 2D Topographical Updates

The existing LiDAR data from 2017 in NRW model has been replaced by latest Lidar data (2022) downloaded from DataMap Wales portal. LiDAR data was spot checked against survey data used to inform the geometry of a number of features along the watercourse and in nearby receptors. These spot checks determined that the 2022 LiDAR data was suitable for large scale use in the hydraulic model.

Where necessary some edits have been made to the Lidar data to improve representation of the floodplain especially in key areas. The Lidar data surrounding the Makro building contained several inconsistencies including high grounds and depressions. As the Makro building is at the critical location of predicted flood extents, the Makro building footprint was imbedded in the DTM as a single elevation of 5.16mAOD (2d_zsh_Makro_store_001_R.shp).

[3] 395318-1015 – A494 River Dee Bridge Replacement Scheme – River Dee Model, Emerging Preferred Option Modelling Scoping Report, by Mott MacDonald, Oct 2024

[4] A494 Bridge Improvements_River Dee FCA Modelling Report_REV_F.pdf

The latest NRW model includes several features in the 2D floodplain not included in the previous Mott MacDonald model. These have been added to the model as 2d_zsh layers to represent a number of floodplain features not previously considered. These include layers to account for watercourses in the floodplain and to account for bridge decks which have been modelled with ESTRY culverts.

New road and rail bridge openings have been added within the 2D floodplain of the previous A494 model. These are located upstream in Chester and are defined by the NRW model to better convey accurate flow under the railway line by Chester racecourse and by the canal under Raymond Street. There a small number of additional bridge opening defined in the 2D floodplain these being located downstream of the A494 River Dee crossing near the Deeside Industrial Park.

Additionally, two new areas have been defined in the 2D floodplain to the northwest of the development. These areas have been added in following consultation with NRW as they were constructed after the 2022 LiDAR survey was undertaken and so are not represented in the floodplain. The information required to set the ground levels in this new 2d_zsh_Additional_Structures_001_R.shp file has been extracted from the FCC planning application portal[5] and from the Flood Consequences Assessment submitted in support of a Reserved Matters application for Phase 1A[6].

The first area added is part of the Northern Gateway development, specifically the flood storage/wetland area located adjacent to the River Dee. This comprises a two-tiered area, with the lower flood storage area set at 3.5mAOD and a surrounding area lowered to 4.12mAOD.

The second area added is the ICTUK warehouse and joined office building which were also constructed after the 2022 LiDAR survey was conducted. The floor level for the office building has been set at 6.15mAOD, and the warehouse floor level has been set at 5.25mAOD as per the information available on the FCC planning application portal.

2.4 Roughness Updates

The roughness material layer has been updated using the latest (January 2026) OSMasterMap data. The material roughness file (2d_mat) has been defined across the model based on the provided feature codes within the OSMasterMap data. As the OSMasterMap has been updated a number of feature codes have been updated/included alongside this.

Manning's n values (taken from NRW guidance[7]) have been used in the tmf file of the updated model runs to define the Manning's roughness values used. Feature codes that are not present in the NRW advice have been carried forward from the previous round of modelling.

2.5 Boundary Conditions Updates

The fluvial inflows have been updated in line with the latest hydrological analysis recorded in the hydrological Performa GN008[8] from March 2025. The year 2025 has been adopted as the 'current day' on this basis that this aligns with the time that the Draft Orders and associated Environmental Statement were published. All inflows have therefore been calculated in line with guidance available at the time of this submission.

The tidal boundaries remain unchanged and based on the extreme sea levels from the CFB 2018 at the Hilbre Island (Chainage 1152) with a 30m^3/s fluvial flow rate in the River Dee. The fluvial

[5] Spectrum Spatial

[6] Enabling Working and associated residential development) of the Northern Gateway Development (prepared by Arcadis, on behalf of Pochin Goodman (Northern Gateway Ltd, dated August 2018.

[7] Natural Resources Wales / Indicative 2D roughness values

[8] 'A494 – River Dee Flood Estimation calculation record GN008 v2' was submitted to NRW in March 2025.

inflow for the tidal runs has been set at 30m^3/s based on the 67033 Dee at Chester Bridge station which shows a mean flow of 34.078m3/s, confirming that the nominal flow of 30m3/s is appropriate. Full details of the calculation of the tidal boundaries are detailed in the River Dee FCA Modelling report submitted in 2022[9].

The inflow at New Crane Street is a legacy inflow from the 2012 model and does not influence the A494 model area. Its value varies between the fluvial and tidal runs within the modelling. The higher value of 1m^3/s is used in tidal runs as this helps improve the stability of the model. Whilst the fluvial scenarios use a lower value of 0.5m^3/s which is more representative and does not compromise stability.

No change has been made to the location of the upstream boundaries in the model from the previous A494 development modelling. However, the downstream boundary has been extended to include an area of the southern bank of the River Dee. This modification improves the downstream outflow of the model as there was an area of water ponding against the model boundary.

2.6 Model Parameters

The model is a 1D-2D linked FMP and TUFLOW model. Most model settings remain at the default values. However there have been some exceptions which have been altered from the default value to improve numerical stability. The values used in the modelling for these parameters fall within an acceptable modelling range and have been incorporated for model stability.

The Automated Preissmann Slot parameter has been used in this model to increase stability. The small inflow used upstream at New Crane Street to represent the inflow from the Shropshire Union Canal. However, this is a very slight inflow and can cause instabilities in the model which the Automated Preissmann Slot has been used to counteract. Similarly, the parameters dflood and Theta have been adjusted slightly from their default values to help improve model stability, with dflood being adjusted from a default value of 3 to 10 and Theta being adjusted from 0.7 to 0.75.

Double Precision has been used instead of Single Precision due to the large floodplains, especially in the cases of breach modelling. This prevents mass-balance errors and reduces numerical instability.

The same model parameters have been used for every run in this assessment regardless of return period or scenario.

[9] A494 Bridge Improvements_River Dee FCA Modelling Report_REV_F

3 Proposed (Post-Development) Model Updates

As with the Existing (pre-development model) scenario Mott MacDonald has previously undertaken hydraulic modelling for the option appraisal of the River Dee Bridge Replacement development in September 2024. An emerging proposed option (hereafter referred to as Proposed (post-development) scenario) for the development was identified during that stage. The following amendments to the updated Existing (pre-development) scenario have been made to build the Proposed (post-development) scenario model.

3.1 1D Cross-Sectional Updates

The same change to cross section 00010101720 has been made in the post-development model as the pre-development model. Additionally, the same improvements to the conveyance curves in the post-development model have been made as in the pre-development model. The locations between bridges which is unique to the post-development model have also had their panel markers and conveyance curves checked and improved where necessary. Otherwise, no further 1D river cross sections have been updated compared to the Existing scenario model.

The proposed bridge is located in the same place as in the previous round of modelling as such no 1D updates of the cross-section profiles were made in FMP. The distanced between the 1D cross sections were adjusted based on the latest measurement in QGIS.

The proposed bridge cross section has been updated with the latest A494 bridge design. This included an update to the abutment-to-abutment distance to 142.2m from 140.21m. The total width of piers in the watercourse has been updated to 4m from 3.04m used in the previous round of modelling. The springing level has increased to 8.08mAOD from 7.210mAOD, and the soffit level has increased to 9.730mAOD from 9.403mAOD. The proposed new cycle path was added to the new bridge profile along the banks by lowering the ground profile.

The piers of the existing A494 bridge are to be left in the River Dee once the main bridge structure has been removed. To model the effects of leaving the piers in the riverbed the existing bridge 1D node has been left in the post-development model. The springing and soffit levels of the exiting bridge have been increased to 15 and 15.5mAOD, respectively, which is above the predicted peak flood levels, thereby the bridge deck does not have any impact on flood levels.

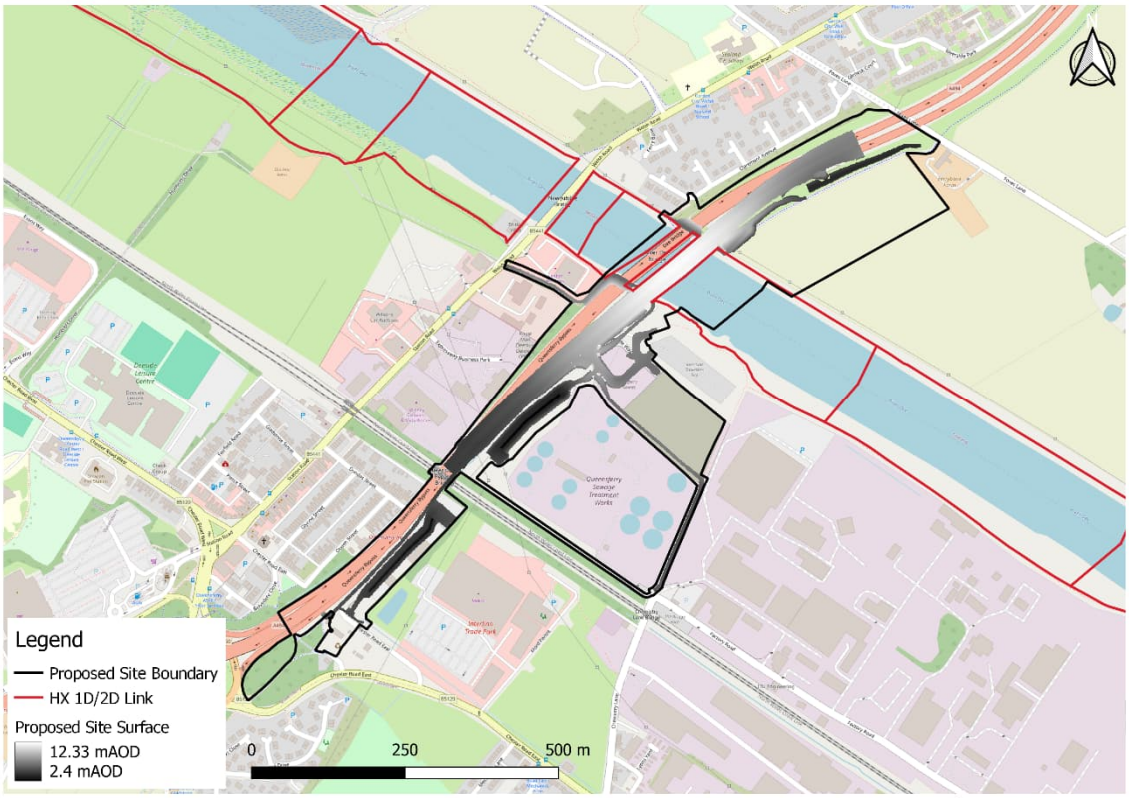
No other 1D structural updates have been made compared to the Existing (pre-development) scenario model.

3.2 2D Topographical Updates

The existing LiDAR data from 2017 in NRW model has been replaced by latest Lidar data (2022) downloaded from DataMap Wales portal.

An asc layer with proposed new ground levels was produced based on drawing 395318-MMD-00-XX-DR-S-5050.pdf. The layer with the proposed ground levels was then superimposed over the LiDAR data from the Existing (pre-development) scenario model across the Scheme footprint. The results of this are detailed in Figure 3.1.

Figure 3.1: Proposed Bridge Topography



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

A patch (2d_zsh_River_020_R.shp) was included over the existing bridge to remove the existing bridge deck levels from the LiDAR data.

The Queensferry Drain channel detailed in the created proposed asc file has been overwritten with a patch (2d_zsh_QFD_Patch_01.shp). It was determined that the proposed asc file was produced before the final drain size was confirmed. As such the drain is defined in the model using a 2d_zsh file (2d_zsh_Watercourse_021_L.shp/2d_zsh_Watercourse_021_P.shp).

Additionally, the Lidar data under the Makro building contained several inconsistencies including high grounds and depressions. To address this, the Makro building footprint was imbedded in the DTM as a single elevation of 5.16mAOD (2d_zsh_Makro_store_001_R.shp).

As in the pre-development model, the 2d_zsh_Additional_Structures_001_R.shp file has been added the 2D floodplain to represent the latest developments in the Northern Gateway area. No additional structures are included in this compared to the pre-development model.

3.3 Roughness Updates

The updated OSMasterMap (dated January 2026) was used to define the roughness as per the Existing scenario. The layer has been modified to include the new A494 bridge location and access roads. The same roughness values have been used on the new bridge as the old bridge.

The proposed Queensferry Drain open channel has also been added in the material layer as it does not exist in the Existing (pre-development) scenario model. Whilst the buildings that are proposed to be demolished have also been removed from the OSMasterMap.

3.4 Boundary Conditions Updates

There are no updates in the location of the fluvial inflow and tidal boundaries to the Proposed (post-development) scenario model boundary conditions compared to the Existing (pre-development) scenario model.

3.5 Tidal Breach Modelling (No Mitigations)

The flood risk change from the Proposed Development, due to potential breaches in the flood embankments of the River Dee have been assessed. Breach modelling information and locations are the same as previously reported[10].

The breaches modelled for this study have been given a width of 50m to adhere to NRW breach modelling guidelines[11] as the embankments are predominately earth banks in an estuary/tidal river. The design tidal events of 0.5% and 0.1% AEP 2100 events have been modelled in this study. Embankment breaches have been simulated for tidal flooding only as this has been proven to be the main flood risk along the channelised section of the River Dee and hence would produce the greatest hydraulic loading and overtopping scour on the tidal embankments.

The breaches have been simulated to occur at 20 hours and develop over 30 minutes within the model, with peak water levels occurring at around 21.5-22 hours within the models. This breach timing has been chosen as it captures the peak tide period with the breach opening fully developed, rather than occurring simultaneously alongside this peak.

There are five breach scenarios which have been assessed as part of this latest round of modelling. The locations of the breaches are shown in Figure 3.2 and are as follows:

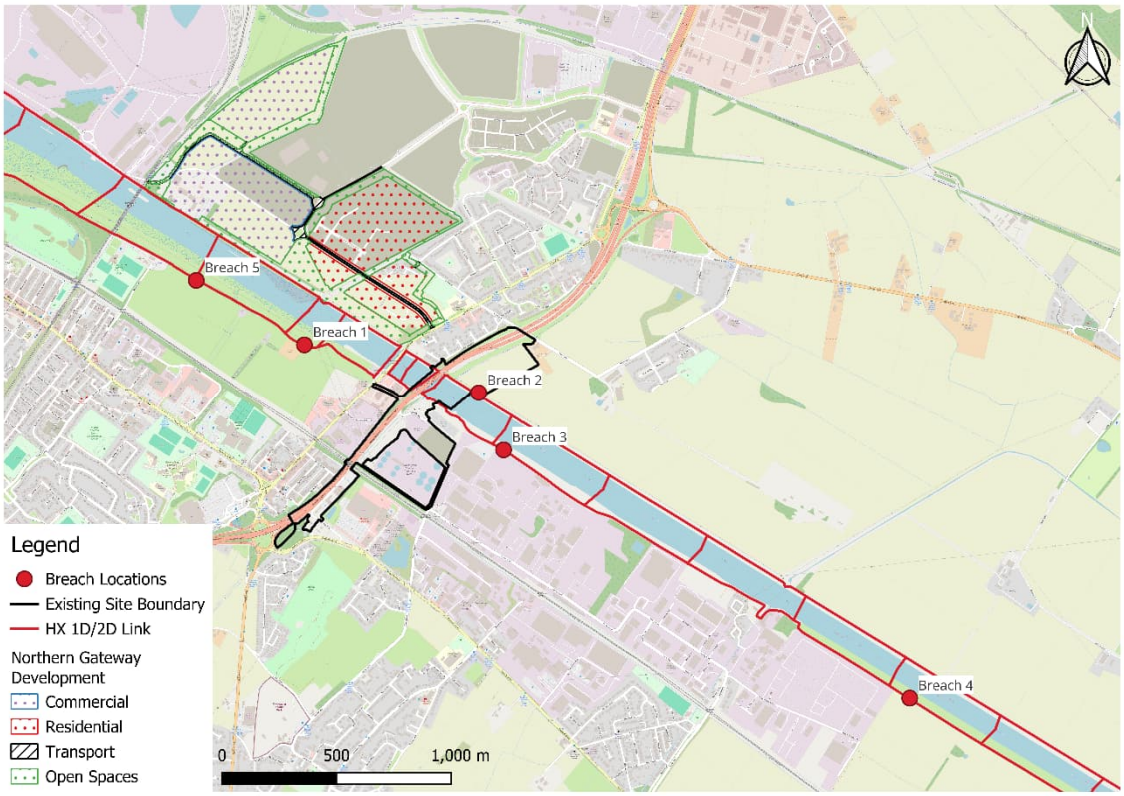
- Tidal Breach One – chosen due to known problems with badger burrowing along the riverbank coupled with a distinct lack of vegetation (as outlined in NRW's 'Tidal Dee Breach Simulations' study, Jan 2017[12]). Located immediately downstream of the Scheme where the riverbank is raised in front of the tidal defence. This location lacks a protective barrier which increases the frequency of hydraulic loading and hence the risk of breaching.
- Tidal Breach Two – chosen due to its proximity to the Scheme on the right-hand bank of the River Dee with residential areas in Sealand and Garden at immediate risk of flooding from this location. There are no known problems on this northern embankment stretch to focus on for vulnerability.
- Tidal Breach Three – chosen due to known low spots created in the embankment by illegal motorbike activity in the past. Located upstream of the Scheme on the left bank of the River Dee at Pentre.
- Tidal Breach Four – chosen as there is a large area of embankment covered by hedge on the landward side leading to low grass and other vegetation cover and led to localised scouring in the region. This breach is located on the left bank further upstream along the River Dee at Sandycroft.
- Tidal Breach Five – chosen due to known defects in the embankment because of badger sets and tunnelling. The area is also covered in dense vegetation which has led to a lack of grass cover on this embankment. Located further downstream of the Scheme at Shotton than Tidal Breach One.

[10] A494 Bridge Improvements River Dee FCA Modelling Report_REV_F.pdf

[11] Guidance note template, external (cyfoethnaturiol.cymru)

[12] Tidal Dee Breach Simulations – Dee Estuary, by NRW, 27/01/2017

Figure 3.2: Tidal Breach Locations



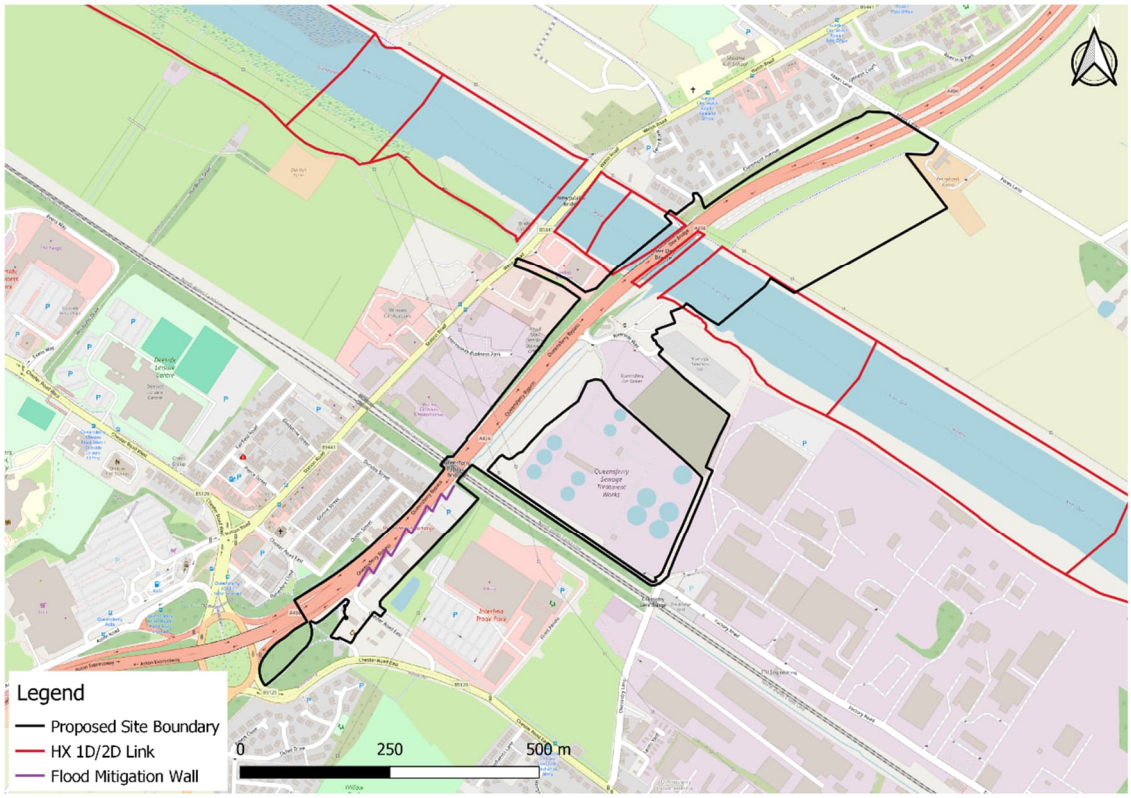
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

3.6 Tidal Breach Modelling (With Mitigations)

A flood mitigation wall has been added into the Proposed scenario model for the 0.1% AEP 2100 event for Tidal Breach events One, Three, and Five, the breaches located along the left bank of the River Dee (as detailed in Figure 3.3).

This wall has been included at the left bank of the River Dee and is located along the A494 south of the North Wales Coast Line railway track. This wall has a top level of 6.2mAOD and spans approximately 230m in the model. There is a 10m gap between the start of proposed wall and the bridge opening under the railway track which has been included to allow flow through the southern side of the railway line at a controlled rate similar to the Existing scenario.

Figure 3.3: Flood Mitigation Wall Location



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

3.7 Tidal Modelling Additional Sensitivity Tests

Additional sensitivity runs were carried out using the 0.1% AEP 2100 event. These sensitivity runs were undertaken on key modelling parameters to determine the impact on the flood levels during this flood event.

3.7.1 Roughness Sensitivity

The material roughness file has been adjusted by 20% to assess the model's sensitivity to roughness values in the 2D floodplain. The roughness values have been increased by 20% and have used model file TidalDee_SEN_UP20_003.tmf and decreased by 20% using model file TidalDee_SEN_DOWN20_003.tmf.

3.7.2 Embankment Modification

A sensitivity test raising the embankment 10mm between the new A494 bridge and the Jubilee Bridge has been conducted to identify the impact on flooding in the urban areas next to the Scheme. This has been done using layer 2d_zsh_Embankment_Mitigation_001_R.shp.

3.7.3 Pier Adjustments

3.7.3.1 Pier Alignment

The skew alignment of the piers of the proposed bridge has been reduced from 20 degrees to 0 degrees to assess the sensitivity of the 1D calculations of the River Dee model. This change has no 2D counterpart as it is just a change in the dat file.

3.7.3.2 Pier Width

The existing bridge has a combined pier width of 3.04m comprised of 2 piers in the riverbed each measuring 1.52m. The proposed bridge has a combined pier width of 4m comprised of 2 piers of 2m each. This sensitivity test looks at reducing the proposed bridge pier width to 3.04m to match the existing bridge pier width to identify any model sensitivity to this factor. This change has no 2D counterpart as it is just a change in the dat file.

4 Modelling Results

4.1 Summary of Modelled Scenarios

Table 4.1 provides a list of all modelled scenarios which have been completed for this assessment. Each listed modelled scenario has been run for the Existing (pre-development) scenario and Proposed (post-development) scenario.

In addition to the key fluvial and tidal scenarios, sensitivity analyses were undertaken on the coastal flood boundary confidence bounds (higher confidence bound of 97.5%) and breach width (reduced breach width from 50m to 20m). In total no.60 standard scenario runs have been completed.

Table 4.1: List of modelled scenarios

Model Run	Hydrological Event
Fluvial Flooding	
Dee_Def_Q100cc20_2100_existing	1% AEP fluvial with Central (20%) climate change allowance until the 2080s (representing the lifetime of the development to 2100)
Dee_Def_Q100cc45_2100_existing	1% AEP fluvial with Upper (45%) climate change allowance until the 2080s (representing the lifetime of the development to 2100)
Dee_Def_Q1000_2025_existing	0.1% AEP fluvial flood event
Dee_Def_Q1000cc05_2100_existing*	0.1% AEP fluvial with Lower (5%) climate change allowance until the 2080s (representing the lifetime of the development to 2100)
Tidal Flooding (Overtopping)	
Dee_Def_T200_2025_existing	0.5% AEP tidal event in 2025
Dee_Def_T1000_2025_existing	0.1% AEP tidal event in 2025
Dee_Def_T200_2100_existing	0.5% AEP tidal event in 2100
Dee_Def_T1000_2100_existing	0.1% AEP tidal event in 2100
Tidal Flooding (Breach Scenarios)	
Dee_Def_T200_2100_existing_breach1	0.5% AEP tidal event in 2100 with breach at location 1
Dee_Def_T200_2100_existing_breach2	0.5% AEP tidal event in 2100 with breach at location 2
Dee_Def_T200_2100_existing_breach3	0.5% AEP tidal event in 2100 with breach at location 3
Dee_Def_T200_2100_existing_breach4	0.5% AEP tidal event in 2100 with breach at location 4
Dee_Def_T200_2100_existing_breach5	0.5% AEP tidal event in 2100 with breach at location 5
Dee_Def_T1000_2100_existing_breach1	0.1% AEP tidal event in 2100 with breach at location 1
Dee_Def_T1000_2100_existing_breach2	0.1% AEP tidal event in 2100 with breach at location 2
Dee_Def_T1000_2100_existing_breach3	0.1% AEP tidal event in 2100 with breach at location 3
Dee_Def_T1000_2100_existing_breach4	0.1% AEP tidal event in 2100 with breach at location 4
Dee_Def_T1000_2100_existing_breach5	0.1% AEP tidal event in 2100 with breach at location 5
Sensitivity Analysis	
Dee_Def_T200_2100_c2_existing**	0.5% AEP tidal event in 2100
Dee_Def_T1000_2100_c2_existing**	0.1% AEP tidal event in 2100
Dee_Def_T200_2100_existing_breach1_20m	0.5% AEP tidal event in 2100 with breach at location 1
Dee_Def_T200_2100_existing_breach2_20m	0.5% AEP tidal event in 2100 with breach at location 2
Dee_Def_T200_2100_existing_breach3_20m	0.5% AEP tidal event in 2100 with breach at location 3
Dee_Def_T200_2100_existing_breach4_20m	0.5% AEP tidal event in 2100 with breach at location 4
Dee_Def_T200_2100_existing_breach5_20m	0.5% AEP tidal event in 2100 with breach at location 5
Dee_Def_T1000_2100_existing_breach1_20m	0.1% AEP tidal event in 2100 with breach at location 1

Dee_Def_T1000_2100_existing_breach2_20m	0.1% AEP tidal event in 2100 with breach at location 2
Dee_Def_T1000_2100_existing_breach3_20m	0.1% AEP tidal event in 2100 with breach at location 3
Dee_Def_T1000_2100_existing_breach4_20m	0.1% AEP tidal event in 2100 with breach at location 4
Dee_Def_T1000_2100_existing_breach5_20m	0.1% AEP tidal event in 2100 with breach at location 5

Source: Mott MacDonald, 2025

* The additional flows in the latter scenario cause the model to become unstable upstream of the development, at Chester, causing the model to become unstable and fail. The Lower climate change allowance for the 2080s has therefore been used for this model instead of the recommended Central allowance.

** Additional sensitivity runs with the higher confidence bound of 97.5% for the tidal level and reduced breach width from 50m to 20m. An additional 11 models have been modelled for the Proposed scenario which have not been run for the existing model. These include no.6 runs including a flood mitigation wall near the North Wales Coast Line underpass modelled for tidal breach scenarios one, three, and five for both the 0.5% and 0.1% AEP 2100 events. As well as no.5 models run for the 0.1% AEP 2100 event to test the sensitivity of different model parameters.

Table 4.2: List of additional sensitivity analysis modelled scenarios

Additional Sensitivity Analysis* **	
Makro Wall Flood Mitigation	
Dee_Def_T200_2100_Proposed_breach1_Makro_Wall_6.2mAOD_Gap	0.5% AEP tidal event in 2100 with breach at location 1 including a flood mitigation wall
Dee_Def_T200_2100_Proposed_breach3_Makro_Wall_6.2mAOD_Gap	0.5% AEP tidal event in 2100 with breach at location 3 including a flood mitigation wall
Dee_Def_T200_2100_Proposed_breach5_Makro_Wall_6.2mAOD_Gap	0.5% AEP tidal event in 2100 with breach at location 5 including a flood mitigation wall
Dee_Def_T1000_2100_Proposed_breach1_Makro_Wall_6.2mAOD_Gap	0.1% AEP tidal event in 2100 with breach at location 1 including a flood mitigation wall
Dee_Def_T1000_2100_Proposed_breach3_Makro_Wall_6.2mAOD_Gap	0.1% AEP tidal event in 2100 with breach at location 3 including a flood mitigation wall
Dee_Def_T1000_2100_Proposed_breach5_Makro_Wall_6.2mAOD_Gap	0.1% AEP tidal event in 2100 with breach at location 5 including a flood mitigation wall
Parameter Sensitivities	
Dee_Def_T1000_2100_Proposed_Roughness_Up20	0.1% AEP tidal event in 2100 with roughness increased 20%
Dee_Def_T1000_2100_Proposed_Roughness_Down20	0.1% AEP tidal event in 2100 with roughness decreased 20%
Dee_Def_T1000_2100_Proposed _Embankment	0.1% AEP tidal event in 2100 with embankment raised 10mm between the Proposed and Jubilee bridge
Dee_Def_T1000_2100_Proposed _Pier_Alignment	0.1% AEP tidal event in 2100 with pier skew set to 0
Dee_Def_T1000_2100_Proposed _Pier_Width	0.1% AEP tidal event in 2100 with pier width reduced from 4m to 3.04m

Source: Mott MacDonald, 2025

*** These additional sensitivity analyses are conducted only on the proposed model

4.2 Key Notes

The Scheme boundary displayed in the figures has been determined by the extents of works done which will affect ground levels and the laydown sites needed during the construction phase. All maps related to the Existing (pre-development) scenario in Appendix B have the Scheme boundary named Existing Site Boundary. The Scheme boundary for the Proposed (post-development) scenario is referred to as the Proposed Site Boundary in Appendix C.

All fluvial models have been designed in line with the NRW's guidance for climate change consideration[13]. The Central allowance (20% uplift) in fluvial flows by the 2080s has been chosen to assess the potential impact of climate change on flood risk. Additionally, an assessment of risk using the Upper allowance (45% uplift) has also been undertaken to aid the planning of mitigation measures to ensure the long-term resilience of the development against more severe flooding. An additional sensitivity run with the 0.1% AEP 2100 fluvial flood event has also been assessed,

[13] Flood Consequences Assessments: Climate change

including the future scenario with the Lower allowance (5% uplift). This lower climate change allowance for the 0.1% AEP 2100 fluvial flood event is applied due to the model stability issues at the upstream Chester structures.

In the sections which follow, please note that for all depth difference flood maps the calculation used has been Proposed minus Existing, **hence a positive value indicates an increase in water levels.** Any areas which have been added or removed from flood risk have been highlighted separately denoting flood extent differences under the Proposed and the Existing bridge scenarios.

4.3 Breakdown of Results

A full breakdown of the results of the modelled scenarios can be found in the Appendices of this document:

- Appendix B contains the pre-development model results including depth maps.
- Appendix C Proposed (Post-Development) Flood Risk Assessment contains results of the post-development including depth and velocity maps as well as depth difference maps comparing the Proposed to the Existing scenario. Including depth and depth difference maps for all sensitivity tests.

A comparison of model results can be found in Section 5.

5 Impact Summary

This section presents a comparative analysis of each option under both fluvial and tidal scenarios, as well as five tidal breach scenarios. It should be noted that sensitivity scenarios—specifically the 20m tidal breach simulations and the c2 coastal flood confidence level assessment—are excluded from this comparison.

Further details, including flood maps, are provided in Appendix B and Appendix C of this document.

5.1 Fluvial Overtopping

No fluvial bank overtopping is predicted at the Scheme for any of the modelled flood events under the Proposed (post-development) scenario. There are some changes predicted within the channel where the existing bridge is removed and the proposed structure introduced. The impact within the channel is consistent across all four modelled fluvial scenarios at the Scheme.

Upstream of the Scheme there are some minor differences in in-channel depths for the most extreme event, 0.1% AEP 2100 event with the Lower climate change uplift (see Figure C.1). At Chester there are some increases in flood depth within the racecourse and across some nearby residential areas when comparing the Existing and Proposed scenarios (see Figure C.2). It is important to note that the upstream fluvial watercourse is modelled in 1D as a straight line. This is not representative of the sharp bends that actually exist in the river upstream at Chester and does not account for the losses which naturally occur as a result of these.

Downstream of the Scheme at Wepre Gutter there are also some difference seen between the Existing and Proposed scenarios for the 0.1% AEP 2100 event with the Lower climate change allowance (see Figure C.3). The Proposed scenario sees additional flooding compared with the Existing scenario with water breaking the bank of Wepre Gutter and water covering some residential and commercial areas. However, there is no current representation of the flood defences located along Wepre Gutter which may impact the extent of any flooding. Additionally, this location is far outside the area of interest and has not previously been deemed necessary to inspect in further detail.

5.2 Tidal Overtopping

5.2.1 Tidal Downstream at Scheme

5.2.1.1 0.5% AEP Events

0.5% AEP 2025 Event

Under the modelled 0.5% AEP 2025 event for the present-day scenario there are only minimal reductions in flood extents near the proposed bridge when comparing the Existing and Proposed scenarios. These changes are due to the relocation of the Queensferry Drain outfall closer to the main channel. Minor reductions in flood depth are predicted within the channel upstream of the Scheme, but these have no impact on out-of-bank flow.

0.5% AEP 2100 Event

For the 0.5% AEP 2100 event, the model predicts some reductions in flood extent along the left bank of the River Dee, immediately downstream of the Scheme. Minor improvements in flood depth are also observed downstream of the Jubilee bridge; however, these are in an open space

and does not impact any urban areas. There are no notable differences in flood depth in the river channel up or downstream of the development under this scenario. A detailed breakdown of these impacts is provided in Appendix C (see Figure C.4).

5.2.1.2 0.1% AEP Events

0.1% AEP 2025 event

Under the modelled 0.1% AEP 2025 event there are minimal reductions in flood extents under the Proposed scenario compared to the Existing scenario. These reductions are limited to the area surrounding the proposed bridge and are attributed to geometry changes of the River Dee channel between the two scenarios as floodwaters do not extend out of channel.

0.1% AEP 2100 event

The 0.1% AEP 2100 event is predicted to result in a significant reduction in flood extent upstream of the Scheme under the post-development scenario. Flood depths in this location are also significantly lower compared to the Existing scenario where flooding persists. A detailed breakdown of these impacts is provided in Appendix C (see Figure C.5).

Along the right bank, downstream of the proposed bridge, some areas are predicted to experience increased flood extents, including a small increase over a residential area adjacent to Welsh Road (see Point 3 in Figure 5.1). Slight increases in flood depths are also predicted in the low ground in the open space just downstream of the Jubilee Bridge (see Point 2 in Figure 5.1). However, it is acknowledged that this area is currently undergoing development into a residential area and the ground levels have modified accordingly.

On the left bank, downstream of the proposed bridge, the post-development scenario results in increased flood extents affecting some commercial areas within Queensferry. Flood depths west of Station Road are also slightly increased under the post-development scenario (see Point 4 in Figure 5.1).

A minor increase in flood depth in the channel of the River Dee is predicted between the Existing and the Proposed scenarios. This change in channel occurs between the Jubilee bridge and the location of the proposed bridge and is in the order of approximately 0.009m.

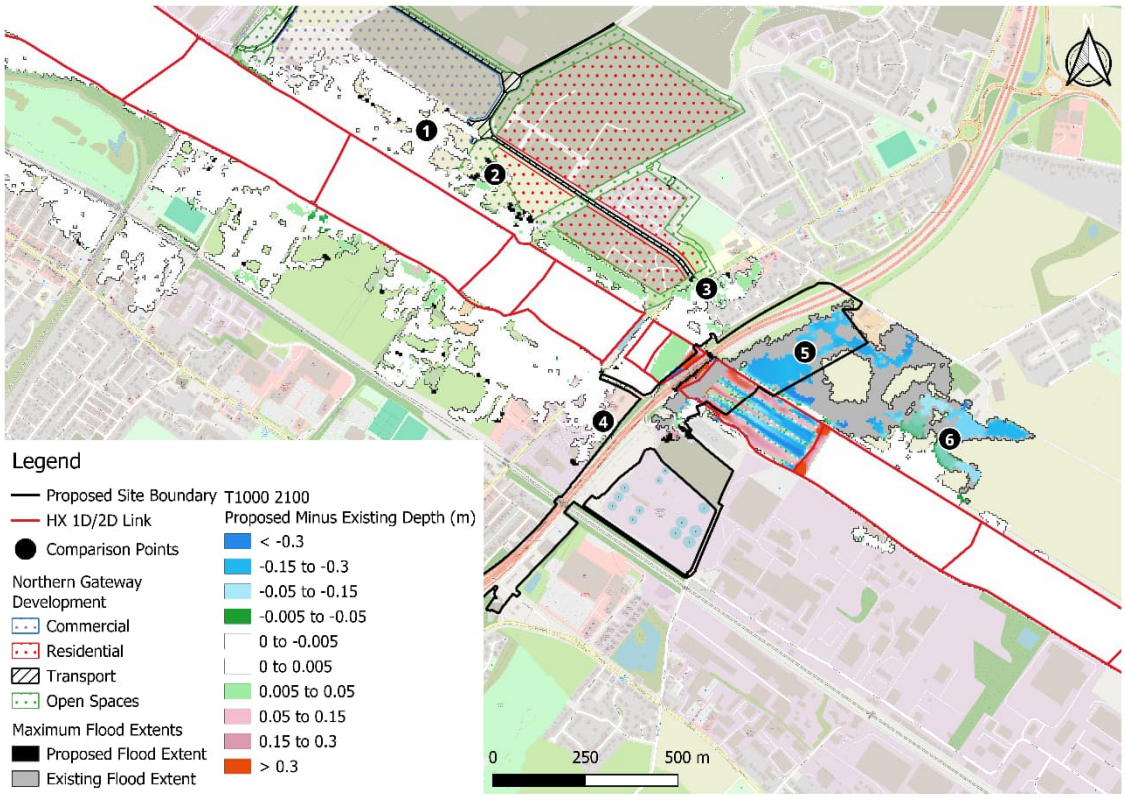
The changes in flood depth between the Existing (pre-development) scenario and the Proposed (post-development) scenario are primarily attributed to the movement of the new A494 bridge crossing upstream compared to the existing bridge. The raised embankments and ground modifications in this area are higher than the existing ground levels and so affect the location of overtopping.

Figure 5.1 illustrates the locations of 6 points selected for a detailed assessment of the Proposed scenario's impact on the out-of-bank flood depths for the 0.1% AEP 2100 event. These points have been distributed across the flood extents to provide a representation of the affected area.

Table 5.1 gives the location of 6 number points, representing nearby residential, commercial and open space receptors, have been selected for producing tabulated data of the changes to flood depths between the pre-development and post-development scenarios for the 0.1% AEP 2100 event.

Please note that for all flood depth difference values the calculation used as been Proposed minus Existing, **hence a positive value indicated an increase in water levels.**

Figure 5.1: Comparison Points for the Impacts of the Proposed Development on Flood Depth



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Table 5.1: Impact of the Proposed Development on Flood Depth (m)

0.1% AEP 2100 Flood Event			
Comparison Site No	**Existing**	**Proposed**	**Depth Difference (m)**
1	0.117	0.119	0.002
2	0.023	0.033	0.010
3	0.268	0.274	0.006
4	0.149	0.151	0.002
5	0.262	0.117	-0.145
6	**0.189**	**0.114**	**-0.075**

Source: Mott MacDonald, 2025

5.2.2 Tidal Upstream at Chester

5.2.2.1 0.5% AEP Events

Under the modelled 0.5% AEP 2025 event there are some minimal reductions in flood extent and depth in the Proposed (post-development) scenario compared to the Existing (pre-development) scenario.

Under the 0.5% AEP 2100 event there are no noticeable differences in flood extents between the two modelled scenarios. However, the predicted flooding at Chester is lower under the Proposed (post-development) scenario compared to the Existing (pre-development) scenario.

5.2.2.2 0.1% AEP Events

The 0.1% AEP 2025 event predicts that there are some minimal reductions in flood extents compared to the Existing scenario. Overall, the predicted flooding is lower under the post-development scenario.

Similar to the 0.5% AEP 2100 event, the 0.1% AEP 2100 event predicts no noticeable differences in flood extents between the Existing and Proposed scenarios. However, under the post-development scenario, flood depths are reduced in both out-of-bank and in-channel areas until past the Chester Wastewater Treatment Works.

5.3 Tidal Breach (No Mitigations)

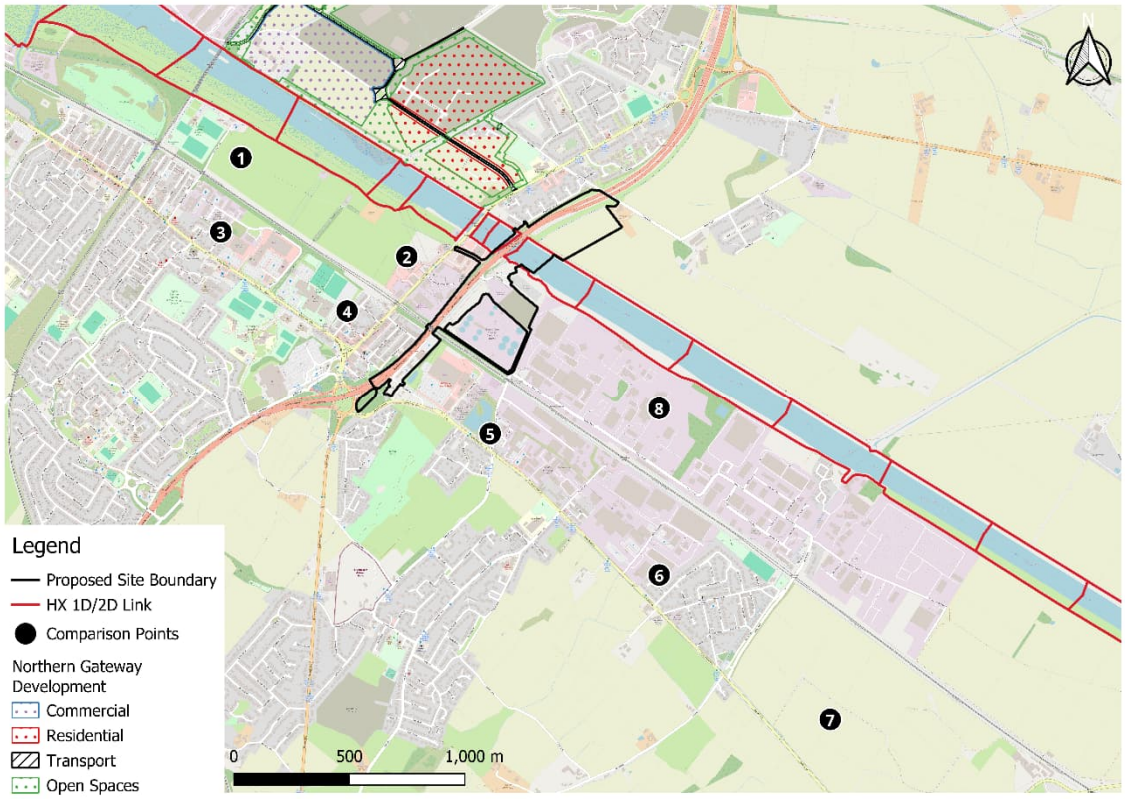
5.3.1 Tidal Breach Assessment Process

The Tidal Breach scenarios were run for the 0.5% and 0.1% AEP 2100 tidal events. Tidal Breach scenarios One, Three, and Five on the left bank of the River Dee show the greatest differences in flood risk impact caused by the post-development scenario.

Tidal Breach Two, located on the right bank, shows minimal if any increase in flood risk impact between the Existing and Proposed scenarios. Tidal Breach Four is located too far upstream on the left bank to be impacted by any changes to the Scheme. As a result, Tidal Breaches Two and Four have been excluded from this summary, as they show virtually no difference in flood extent or depth between the two scenarios.

Figure 5.2 details the location of eight points chosen for a detailed inspection of the impacts to flood depths that the Proposed (post-development) scenario has on the out of bank flow for Tidal Breaches One, Three, and Five. The points have been distributed over the flood extents to give a representation of the whole area affected. Four points are located around the Shotton area and four are located around the Sandycroft area. These points are used to measure the values from the depth difference maps, and these are displayed in Appendix C. In the sections which follows, please note that for all flood depth difference values the calculation used as been Proposed minus Existing, **hence a positive value indicated an increase in water levels.**

Figure 5.2: Comparison Points for the Impacts of the Proposed Development on Flood Depth on the Left Bank



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

5.3.2 Tidal Breach One

5.3.2.1 Impact Summary

Table 5.2 gives the location of 8 numbered points, representing nearby residential, commercial and open space receptors, which have been selected for producing tabulated data of the changes to flood depths. These points detail the differences in flood depths between the pre-development and the post-development scenarios for Tidal Breach One for both the 0.5% and the 0.1% AEP 2100 events at the selected comparison locations. Under the post-development scenario Tidal Breach One predicts an increase in flood depth across Sandycroft and a decrease around Shotton. Under both AEP scenarios flood depths are predicted to increase by over 0.10m in areas around Sandycroft whilst decreasing by less than half that amount in areas around Shotton.

The changes in the predicted flood extents and flood depths during Breach 1 are caused by the ground modifications between the proposed new A494 road and Queensferry Drain channel. The proposed ground levels are lower and allow a large exchange of flood water flow between the Shotton and Sandycroft areas in the case of flood event due to the tidal breach.

Figure C.14 and Figure C.15 in Appendix C detail the flood depth difference for the entire area during the Tidal Breach One scenario for the 0.5% and 0.1% AEP 2100 events, respectively.

Table 5.2: Impact of the Proposed Development on Flood Depth (m) – Tidal Breach One

0.5% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.319	1.302	-0.017
	2	1.504	1.489	-0.015
	3	0.823	0.769	-0.054
	4	0.997	0.942	-0.055
Sandycroft	5	0.413	0.570	0.157
	6	0.177	0.329	0.152
	7	0.842	0.962	0.120
	8	No Data	No Data	No Data
0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.440	1.424	-0.016
	2	1.616	1.599	-0.017
	3	0.970	0.924	-0.046
	4	1.146	1.097	-0.049
Sandycroft	5	0.490	0.637	0.147
	6	0.224	0.397	0.173
	7	0.892	1.016	0.124
	8	No Data	No Data	No Data

Source: Mott MacDonald, 2025

5.3.3 Tidal Breach Three

5.3.3.1 Impact Summary

Table 5.3 gives the location of 8 numbered points, representing nearby residential, commercial and open space receptors, which have been selected for producing tabulated data of the changes to flood depths. These points detail the differences in flood depths between the pre-development and the post-development scenarios for Tidal Breach Three for both the 0.5% and the 0.1% AEP 2100 events. Tidal Breach Three is the only breach of the three focused breaches located upstream of the Scheme, as such the changes made within the Scheme boundary have different impacts compared to Tidal Breaches One and Five. The most notable of these changes is the similarity to the Existing scenario with only minor fluctuations in flood depth for areas across Sandycroft and Shotton.

Figure C.34 and Figure C.35 in Appendix C detail the flood depth difference for the entire area during the Tidal Breach Three scenario for the 0.5% and 0.1% AEP 2100 events, respectively.

Table 5.3: Impact of the Proposed Development on Flood Depth (m) – Tidal Breach Three

0.5% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	0.119	0.124	0.005
	2	0.457	0.457	0
	3	No Data	No Data	No Data
	4	0.290	0.273	-0.017

Sandycroft	5	0.571	0.558	-0.013
	6	0.421	0.408	-0.013
	7	0.960	0.955	-0.005
	8	0.393	0.390	-0.003
0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	0.191	0.234	0.043
	2	0.522	0.510	-0.012
	3	No Data	No Data	No Data
	4	0.318	0.304	-0.014
Sandycroft	5	0.711	0.691	-0.020
	6	0.609	0.602	-0.007
	7	1.067	1.062	-0.005
	8	0.470	0.467	-0.003

Source: Mott MacDonald, 2025

5.3.4 Tidal Breach Five

5.3.4.1 Impact Summary

Table 5.4 gives the location of 8 numbered points, representing nearby residential, commercial and open space receptors, which have been selected for producing tabulated data of the changes to flood depths. These points detail the differences in flood depths between the pre-development and the post-development scenarios for Tidal Breach Five for both the 0.5% and the 0.1% AEP 2100 events. For Tidal Breach Five flood depths in areas around Sandycroft are increased significantly compared to the Existing scenario. Under the Proposed scenario Tidal Breach Five for both the 0.5% and 0.1% AEP 2100 events predict an increase in flood depth of over 10cm across Sandycroft. However, flood depth remains similar to those in the Existing scenario in areas around Shotton with only minor changes in flood depth of less that 5cm predicted at the comparison points used in this assessment.

The reasons for the predicted changes are the same as in Breach 1 and 3, i.e. the ground modifications with the Scheme boundary.

Figure C.44 and Figure C.45 in Appendix C detail the flood depth difference for the entire area during the Tidal Breach Five scenario for the 0.5% and 0.1% AEP 2100 events, respectively.

Table 5.4: Impact of the Proposed Development on Flood Depth (m) – Tidal Breach Five

0.5% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.610	1.603	-0.007
	2	1.757	1.742	-0.015
	3	1.097	1.064	-0.033
	4	1.282	1.242	-0.040
Sandycroft	5	0.512	0.641	0.129
	6	0.253	0.414	0.161
	7	0.918	1.022	0.104
	8	No Data	No Data	No Data

0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.761	1.741	-0.020
	2	1.906	1.889	-0.017
	3	1.303	1.266	-0.037
	4	1.481	1.439	-0.042
Sandycroft	5	0.574	0.722	0.148
	6	0.335	0.497	0.162
	7	1.043	1.158	0.115
	8	No Data	No Data	No Data

Source: Mott MacDonald, 2025

5.4 Tidal Breach (With Mitigations)

The same comparison points used to identify flood depth differences between the Existing and Proposed scenarios have been used to identify the flood depth difference between the Existing and Proposed scenarios with flood mitigations in place, i.e. with the wall near the A494 south of the North Wales Coast Line railway track.

A full breakdown of the results of the Tidal Breach scenarios with the mitigation wall modelled can be found in Appendix C of this report.

5.4.1 Impact Summary

5.4.1.1 Tidal Breach One

Table 5.5 gives the location of 8 numbered points, representing nearby residential, commercial and open space receptors, which have been selected for producing tabulated data of the changes to flood depths. These points detail the flood depth differences between the Existing scenario and the Proposed scenario with mitigations in place, i.e. the flood wall for the 0.5 and 0.1% AEP 2100 events. For Tidal Breach One flood depths in areas around Sandycroft are not present in the post-development scenario with flood mitigation in place. Flood depths do increase in areas around Shotton as a result of the significant decrease in flood depths across areas of Sandycroft as the wall prevent water from flowing south across the floodplain. Additionally, flood extents for Tidal Breach One are reduced significantly across all areas of Sandycroft compared to the Existing scenario for both AEP events.

Table 5.5: Impact of the Proposed Development with Mitigation on Flood Depth (m) – Tidal Breach One

0.5% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.319	1.332	0.013
	2	1.504	1.516	0.012
	3	0.823	0.851	0.028
	4	0.997	1.025	0.028
Sandycroft	5	0.413	No Data	-0.413
	6	0.177	No Data	-0.177
	7	0.842	No Data	-0.842
	8	No Data	No Data	No Data
0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.440	1.453	0.013
	2	1.616	1.630	0.014
	3	0.970	0.983	0.013
	4	1.146	1.161	0.015
Sandycroft	5	0.490	No Data	-0.490
	6	0.224	0.097	-0.127
	7	0.892	0.799	-0.093
	8	No Data	No Data	No Data

Source: Mott MacDonald, 2025

5.4.1.2 Tidal Breach Three

Table 5.6 gives the location of 8 numbered points, representing nearby residential, commercial and open space receptors, which have been selected for producing tabulated data of the changes to flood depths. These points detail the flood depth differences between the Existing scenario and the Proposed scenario with mitigations in place, i.e. the flood wall for the 0.5 and 0.1% AEP 2100 events. For Tidal Breach Three flood depths are largely similar under the Proposed scenario with mitigation when compared to the Existing scenario. Flood depths decrease most significantly to the northwest of the breach to the north of the railway line above Shotton whilst the areas closest to the breach locations predict slight fluctuations in flood depths as the flood paths are affected by the mitigating wall.

Table 5.6: Impact of the Proposed Development with Mitigation on Flood Depth (m) – Tidal Breach Three

0.5% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	0.119	0.102	-0.017
	2	0.457	0.450	-0.007
	3	No Data	No Data	No Data
	4	0.290	0.296	0.006
Sandycroft	5	0.571	0.563	-0.008
	6	0.421	0.407	-0.014
	7	0.960	0.955	-0.005
	8	0.393	0.390	-0.003
0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	0.191	0.143	-0.048
	2	0.522	0.518	-0.004
	3	No Data	No Data	No Data
	4	0.318	0.325	0.007
Sandycroft	5	0.711	0.706	-0.005
	6	0.609	0.602	-0.007
	7	1.067	1.062	-0.005
	8	0.470	0.467	-0.003

Source: Mott MacDonald, 2025

5.4.1.3 Tidal Breach Five

Table 5.7 gives the location of 8 numbered points, representing nearby residential, commercial and open space receptors, which have been selected for producing tabulated data of the changes to flood depths. These points detail the flood depth differences between the pre-development and the post-development scenarios with mitigations (flood wall) in place for the 0.5 and 0.1% AEP 2100 events. Under Tidal Breach Five, flood depths are shown to increase in certain areas across Shotton, whilst significant reductions in flood depths are observed across Sandycroft compared to the Existing scenario.

Table 5.7: Impact of the Proposed Development with Mitigation on Flood Depth (m) – Tidal Breach Five

0.5% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.610	1.618	0.008
	2	1.757	1.764	0.007
	3	1.097	1.104	0.007
	4	1.282	1.286	0.004
Sandycroft	5	0.512	0.372	-0.140
	6	0.253	0.168	-0.085
	7	0.918	0.857	-0.061
	8	No Data	No Data	No Data
0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.761	1.764	0.003
	2	1.906	1.911	0.005
	3	1.303	1.297	-0.006
	4	1.481	1.469	-0.012
Sandycroft	5	0.574	0.506	-0.068
	6	0.335	0.289	-0.046
	7	1.043	1.092	0.049
	8	No Data	No Data	**No Data**

Source: Mott MacDonald, 2025

5.4.1.4 Summary

The assessed flood mitigation (new flood wall) could limit the impact of the Proposed Development in breach scenarios but does not remove it completely.

5.5 Tidal Scenario Additional Sensitivity Tests

The post-development scenario for the A494 River Dee crossing has been assessed under a number of different modelling sensitivities for the 0.1% AEP 2100 tidal event. The results of these additional sensitivity tests are detailed in the sections which follow. A full breakdown of results including maps can be found in Appendix C.5.

5.5.1 Roughness Sensitivity

5.5.1.1 Roughness Increased by 20%

Increasing the material roughness file by 20% predicts a reduction in flood extent compared to the regular material file along the left bank of the River Dee with flood extents not extending across commercial areas within Queensferry with the increased roughness values. On the right bank of the River Dee between the proposed bridge location and the Jubilee bridge there are small variations in the flood path with some areas changing from flooded to flood free and flood free to flooded with the increased roughness values but there are no significant changes in flood extent.

5.5.1.2 Roughness Decreased by 20%

Decreasing the material roughness file by 20% predict a very minor change in flood extent compared to the regular material file. Along the left bank there are small areas around commercial areas in Queensferry are predicted to see shallow depths of additional flooding. There are minor changes in the flow paths of flooding on the right bank between the proposed bridge and the Jubilee bridge which change some areas of flooding, but these are minimal.

5.5.1.3 Summary

The A494 River Dee model is sensitive to changes in roughness values. The roughness values provided by NRW and used in this model are deemed appropriate for the modelling undertaken.

5.5.2 Embankment Modification

Increasing the height of both the embankments of the River Dee by 10mm between the proposed bridge location and the Jubilee bridge does not cause the Proposed (post-development) scenario model to predict any significant changes in flood extent and depth. Flooding under this scenario is not predicted to change significantly compared to the unmodified Proposed scenario.

5.5.2.1 Summary

The hydraulic model is not sensitive to the minor changes in the embankment crests (by 10mm) and these changes do not significantly impact the flood extents and depths in overtopping scenarios.

5.5.3 Pier Adjustments

5.5.3.1 Pier Alignments

The skew angle of the bridge piers of the proposed bridge has been reduced from 20 degrees to 0 degrees under this scenario. This change has no noticeable impact on flood depth or extent compared to the 20-degree skew angle.

5.5.3.2 Pier Width

The width of the bridge pier has been modified from 4m to 3.04m to reflect the width of the piers of the existing A494 bridge in the proposed bridge. This change predicts only a minor change in the extent of flooding in the 2D floodplain along the right bank of the River Dee. This change is less than 5mm. As such it is deemed insignificant.

5.5.3.3 Summary

The A494 River Dee model is not sensitive to the changes made to the piers in the 1D domain of the model.

6 Model Assumptions and Limitations

Several assumptions and limitations have been applied in the redevelopment of this hydraulic model. These are based on the previous A494 modelling work and updates incorporated from the latest NRW model provided for model improvement. The key assumptions are as follows:

- **Existing Geometry:** The geometry of the Existing (pre-development) scenario is based on the previous 2024 hydraulic model of the River Dee[14] and the latest NRW model provided in June 2024. Further details are provided in Sections 2, 3, and 4 of this report and the accompanying Scoping Report[15]. No new topographical or bathymetry survey has been incorporated into the pre-development model at this stage.
- **Proposed Design:** Topographic modifications for the Proposed (post-development) scenario were supplied by the design team in April 2025 and are assumed to reflect the latest design. Any subsequent design changes may influence model outcomes.
- **Roughness Values:** The roughness values used in the Existing (pre-development) scenario are taken directly from the NRW guidance[16]. For any feature codes not represented in this guidance have had their values sourced from the NRW model provided in June 2024. These values are assumed to be accurate and have not been further reassessed. For the Proposed (post-development) scenario material layers have been manually adjusted to incorporate the proposed new bridge and remove the existing structure. Any future alterations to the post-development scenario design may affect model results.
- **Existing Bridge Elements:** While the existing A494 bridge deck has been removed from the hydraulic model, the approach embankments and in-channel piers have been retained are assumed to remain in place.
- **Construction Phase:** The Construction Phase of the River Dee bridge replacement has not been modelled as part of this hydraulic modelling report. This phase closely resembles the Proposed (post-development) scenario, with the exception that the bridge deck and springing level remain at their current elevations. As the predicted water levels for the Q1000cc05, T200_2025, and T1000_2025 models are all below the existing bridge's springing level, these runs have not been progressed further in the analysis.
- **NRW Guidance:** The NRW released new guidance on the development of hydraulic models (dated 8 January 2026)[17] and on modelling for FCA's (dated 23 December 2025)[18]. These were released after the publication of the Draft Orders and Environmental Statement which have determined the 'present-day' scenario, i.e. 2025 and so have not been used in this assessment. Future assessments should follow the latest available guidance.
- **Model uncertainties:** During subsequent design development, it is recommended that further work is undertaken to the River Dee model in the Wepre and Chester Racecourse areas, to address known limitations in those areas, and improve confidence in the model results.

[14] 395318-0195 A494 River Dee Bridge Improvement - Hydraulic Modelling of Options

[15] 395318-1015 - A494 River Dee Scoping Report

[16] Natural Resources Wales / Indicative 2D roughness values

[17] Natural Resources Wales / Developing hydraulic models for flood risk (2026), Last accessed by Mott MacDonald: February 2026

[18] Natural Resources Wales / Modelling for Flood Consequence Assessments (2025), Last accessed by Mott MacDonald: February 2026

7 Conclusions

7.1 Approach

The hydraulic modelling of the River Dee was undertaken with three main objectives:

- Quantify flood risk associated with the proposed A494 bridge improvement development under present day conditions (2025) and over the 75-year lifetime of the development (to 2100).
- Assess the impact of the Proposed Development on flood risk across the surrounding floodplain during extreme tidal and fluvial events.
- Evaluate residual risk to the development from potential breaches of the NRW tidal embankment along the channelised reach of the River Dee.

7.2 Modelling Findings

7.2.1 Fluvial Scenarios

The 1% AEP (or 1 in 100 year) 2100 scenario, for both the Central and Upper climate change allowances, shows no change to the existing flood risk at the Scheme under the Proposed Development. There are some minor variations in flood depths downstream around Wepre Gutter for these two events, but these do not extend out of bank.

The 1% AEP 2100 with the Central climate change allowance sees some increase in flood depths upstream of the Scheme in Chester. These increases are seen within the area of Chester racecourse and the Parade Ring with some slight increase also persisting onto New Crane Street. There is no increase in flood extent in this area. Under the 1% AEP 2100 event with Upper climate change allowance there are some in channel differences in flood depth, but these do not cause any additional overtopping along the river.

Under the 0.1% AEP (or 1 in 1000 year) 2025 fluvial event, no differences in flood extent are observed between the Existing and Proposed development scenarios. There are some slight increases in in-channel depths upstream of the bridge location, however, these do not lead to any out of bank flooding. Flooding is slightly less extensive than in the 1% AEP 2100 event with the Upper climate change allowance, with extensive flooding expected upstream of the development in Chester.

Under the 0.1% AEP 2100 fluvial event with the Lower climate change allowance flooding is more extensive than the 1% AEP 2100 fluvial event with Upper climate change allowance scenario with several residential areas north of The Cop and along parts of Sealand Road predicted to be at risk of flooding. There is also some increased risk of flooding downstream around Wepre Gutter under the Proposed scenario. Flooding in these areas becomes more extensive affecting a mix of residential and commercial areas. However, the hydraulic model is less reliable in these distant areas, and a more detailed representation would be required to improve confidence in the predicted impacts.

7.2.2 Tidal Scenarios

The present-day scenario (2025) for both the 0.5% and 0.1% AEP scenarios, the Proposed (post-development) scenario shows no notable changes in flood extents compared to the Existing (pre-development) scenario. Under the 0.5% AEP event there are some minor reductions in flood depth in channel, however these are not evident in the 0.1% AEP event. No out-of-bank flows are

predicted for the main River Dee channel, except for a minor overtopping downstream at Wepre Brook and upstream at the Chester Racecourse.

There is only a minimal amount of flooding to the Scheme under the 0.5% AEP 2100 tidal event. There is flooding further downstream of the Scheme under both the Existing and the Proposed scenarios at Wepre Brook and the surrounding residential areas. Areas upstream of the Scheme at Chester are also at the same risk of flooding predicted in the fluvial scenarios. Whilst there are some minor differences in depth between the Existing and the Proposed scenarios the Proposed scenario has the lower flood depths in this area.

During the 0.1% AEP 2100 tidal event, out-of-bank flooding at the Scheme, affecting both banks of the River Dee and impacting commercial and residential areas. The extent of flooding at the right bank upstream of the development is largely reduced under the Proposed scenario due to the new road embankment partially obstructing the overtopping flood path. However, there are some areas downstream of the development where flooding is increased, this increase affects a small area of Garden City at the right bank, where a small increase in flooding (up to 0.010m) to the residential area is predicted. There are other areas along the right bank where the Proposed scenario model shows a slight increase in flood, but these are rural areas. On the left bank downstream of the development there are some areas, most notably in commercial areas adjacent to the Queensferry Bypass, where some increases in flooding are predicted (up to 0.016m).

Under the c2 conditions[19] there is a significant increase in the flood extent predicted for both the 0.5% and 0.1% AEP 2100 events due to the higher tidal levels. The 0.5% AEP 2100 event under c2 conditions predicts bank overtopping on both sides of the river however the Scheme stays largely flood free. The Proposed scenario also shows significant reductions in the flood extent on the right bank of the River Dee upstream of the development, with some minor increases downstream of the development. The 0.1% AEP 2100 under the c2 scenario predicts significant overtopping and flooding across the Scheme and significantly into the floodplains on either side of the river. The flood extent covers significant commercial and residential areas in Shotton, Garden City, Mancot, Sandycroft, Sealand, and Chester. Similar to the 0.5% AEP 2100 scenario, the Proposed scenario significantly reduces flooding on the right bank upstream of the development, with some increases downstream of the development.

7.2.3 Tidal Breach Scenarios (no flood mitigations)

Five breaches have been modelled for the River Dee, details of which can be seen extensively in Section 3.5. The key findings are reported as follows:

- Tidal Breach One (Queensferry) – A breach on the left bank immediately downstream of the A494 River Dee crossing which causes significant inundation over the Scheme as well as areas from Shotton down through Sandycroft. Under the Proposed scenario flooding is improved across Shotton and areas to the northwest of the Scheme. Water levels are predicted to increase to the southeast of the Scheme (in Sandycroft), with the Proposed scenario increasing flood extent compared to the Existing scenario.
- Tidal Breach Two (Sealand) – A breach on the right bank of the River Dee immediately upstream of the A494 crossing works. Flooding from this breach extends across Garden City and Sealand, however compared to the Existing scenario the Proposed scenario predicts a minimal change or improvement to the extent of flooding.
- Tidal Breach Three (Pentre) – A breach on the left bank of the River Dee immediately upstream of the A494 crossing by the Queensferry Sewage Treatment Works. Flooding from this breach location poses a flood risk to large areas of the left bank of the Scheme. Flooding is similar to

[19] 97.5% confidence interval for extreme sea levels

the Existing scenario on the same side of the Scheme as the breach with some improvements located at the furthest southeast point of the flood extent compared to the Existing scenario. Flooding to the northwest of the Scheme predicts a fluctuation in flood waters with improvements to the south of the railway line and increases in depth to the north. This is most prevalent in the 0.1% AEP 2100 scenario which predicts the largest increase in water levels to the north of the railway line.

- Tidal breach Four (Sandycroft) – A breach on the left embankment of the River Dee a significant way upstream of the Scheme. This breach location poses no flood risk to the Scheme but floods a significant area of southeast Sandycroft. There are insignificant differences in flooding between the Existing and the Proposed scenario for this breach location.
- Tidal Breach Five (Shotton) – A breach located on the left bank downstream of the A494 crossing Scheme. This breach location poses a similar flood risk to the left bank floodplain as Breach One. Breach Five causes higher flood depths around northern areas of Shotton but is affected in the same ways as Tidal Breach One with flooding improving in areas around Shotton and flood depth increasing across areas of Sandycroft.

7.2.4 Tidal Breach Scenarios (with flood mitigations)

Three breaches have been modelled, incorporating flood mitigation measures in the form of a flood wall located to the south of the A494 bridge opening under the North Wales Coast Line. Full details of the mitigation design are provided in Section 3.6. The key findings for these 'with mitigations' breach scenarios are as follows:

- Tidal Breach One (Queensferry) – Flooding from this breach causes significant inundation to areas of Shotton and across significant portions of the Scheme on the left bank. However, the inclusion of the flood wall limits the flow of water across the floodplain towards Sandycroft, thereby reducing flooding in this area. Flood depths do increase slightly around areas of Shotton; however, flood depths are already above 1m in the Existing scenario in this area.
- Tidal Breach Three (Pentre) – Flooding from this breach is similar to the exiting scenario with flooding extending across significant areas of both Sandycroft and Shotton. Flood depths are predicted to be reduced across areas to the north of Shotton whilst areas to the south of the development do not see any notable change in flood depths compared to the Existing scenario.
- Tidal Breach Five (Shotton) – Flooding from this breach affects areas of Shotton, Queensferry, and Sandycroft with areas to the north of the Scheme predicting significant inundation with flood depths well in excess of 1m. Flood depths and extents are reduced to the south of the Scheme with areas across Sandycroft predicting a significant reduction in flooding.

Overall, the inclusion of the flood mitigation wall reduces the impact of the Proposed Development on flooding in the breach scenarios. This is due to the fact, that the flood mitigation wall controls the overflow of breach flood water between the north and south of the A494 road and provides similar overflow volumes as the Existing (pre-development) scenario.

7.2.5 Tidal Scenarios (Additional Sensitivity Tests)

7.2.5.1 Roughness Sensitivity

The A494 River Dee model is sensitive to changes in roughness values. The roughness values provided by NRW and used in this model are deemed suitable for hydraulic modelling.

7.2.5.2 Embankment Modification

The Proposed scenario with the 0.1% AEP 2100 tidal scenario predicted a slight increase in the water level of the River Dee and in the floodplain between the Jubilee Bridge and proposed A494 Bridge. As such, increasing the embankment of the River Dee between the proposed bridge and the Jubilee bridge by 10mm is not predicted to impact the amount overtopping onto the floodplain.

7.2.5.3 Pier Adjustments

The A494 River Dee model is not sensitive to changes made to the piers in the 1D domain of the model.

7.3 Summary

The updated modelling indicates that the Scheme remains flood free up to the 0.1% AEP 2100 overtopping event.

Under the 0.1% AEP 2100 tidal overtopping event, a significant reduction in flooding is observed on the right floodplain immediately upstream of the Proposed Development. This is primarily due to the new road embankment, which partially obstructs the overtopping flood path, thereby limiting floodwater spread. Conversely, minor increases in flood extent and depth are predicted downstream of the Proposed Development, between the Jubilee Bridge and the new A494 bridge.

The primary flood risk to the Scheme arises from potential breaches along the left bank of the River Dee, as these allow floodwaters to reach the A494 road and Scheme. While each location presents a low individual probability of occurrence, they have been included to assess the residual risk to the River Dee A494 bridge crossing.

The Proposed scenario does impact flood depths and extents in breach scenarios as it effected the shallow flow of flood water throughout the floodplain. The extent to which flood depths increase or decrease varies with breach location. The assessed flood mitigation (new flood wall) could limited the impact but does not remove it completely.

Appendices

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A. GN028 Flood Model Checklist

Table A.1: Approach Comments

		Y/N	Modeller Comment	RAG	1st QA Comments	1st Modeller Response (18/12/2025)	2nd QA Comments (13/01/26)	2nd Modeller Response (10/02/26)
1	**General**							
1.1	Has there been contact with NRW prior to modelling? If yes, please give details.	Y	Part of an extended model development for the A494 project since 2019. Latest baseline in line with the Scoping Report submitted to NRW on 14/10/2024.	G				
1.2	Is there an NRW model at the site? If no, go to 1.4.	Y	The latest NRW model provided to Mott MacDonald in July 2024. The model is described in the Scoping Report (from 14/10/2024)	G				

1.3	Was the NRW model used and licenced?	Y	Model updates from the NRW model have been incorporated into MM model in line with the Scoping Report (from 14/10/2024)	G				
1.4	Was any other data requested from NRW and used in the model?	N	No additional information requested	G				
1.5	Has the Welsh Government Climate Change guidance been adopted?	Y	A climate change uplift of 20% and 45% used for central and upper estimates	G				
1.6	Is there any historical flood data for the area? If yes, model validation and calibration is reviewed in	N	Historic flood outlines available at NRW website. However, there is insufficient data to calibrate and verify the baseline model. No calibration/verificat	G				

	more detail in the MODEL CONFIDENCE tab.		ion proposed in the Scoping Report (14/10/2025)					
2	**Methodology and Reporting**							
2.1	New build models: does the report contain sufficient details on model build, decisions and assumptions made?	N/A	Not a new model build. Details of the Proposed scenario model build have been provided in the Hydraulic Modelling Report.	N/A				
2.2	NRW model: have all changes made to the original NRW model been noted and sufficiently documented in the report?	Y	A scoping report was prepared and issued to NRW on 14/10/2024. Further details provided in the Hydraulic Modelling Report.	G				

2.3	Is there evidence of site visit(s)?	Y	Several site visits undertaken by Mott MacDonald from the commencement of the project in 2019. The photos from the site visit will be included in the Modelling Report.	G				
2.4	Are the objectives of the analysis clearly set out?	Y	Objectives are to assess an impact on flood risk based upon the latest scheme design for the A494 river crossing	G				
2.5	Is the analysis appropriate to meet these objectives?	Y	The hydraulic modelling outputs from the pre scheme and post scheme models will be compared to assess the impact of the A494 scheme.	G				
3	**Fluvial / Hydrology**							

3.1	Has a new hydrology assessment been undertaken?	Y	Yes a new hydrology assessment has been undertaken using the latest software and available data. The Proposed Scenario Model has the same inflow boundaries as Existing Scenario Model.	G				
3.2	Has the hydrology Flood Estimate Calculation (FEC) Record been completed?	Y	The GN008 Flood Estimation Calculation Record issued on 13/01/2025. This includes the latest hydrology estimates.	G				
3.3	Was the flood estimate calculation record agreed with NRW before you began any detailed hydraulic modelling?	Y	Yes flood estimation record agreed during baseline model submission	G				

3.4	Do the NRW hydrology team accept the hydrology?	Y	Yes, hydrology was accepted at time of baseline model submission	G	Hydrology has been reviewed and accepted by NRW's hydrology team.	No further response		
4	**Tidal inflows**							
4.1	Has the tidal boundary been derived in accordance with the 'Coastal flood boundary conditions for the UK: update 2018'?	Y	Tidal boundaries based on the CFB2018 at the Hilbre Island (Chainage 1152).	G	It is not clear if the tidal calculations have been updated for 2025, present day levels appear to be the same as 2019. Guidance is that base year should be updated to the present day. Cross	The present day tidal boundaries are based on the 2019 level. This is consistent with the 2022 flood modelling for the A494 scheme undertaken by Mott MacDonald (MM). These levels were reviewed against the NRW model levels in the MM's Scoping Report (October 2024), which has been provided and reviewed by NRW in pre-application consultation. This approach is also confirmed in the Hydrological proforma dated 10/01/2025, which states that the tidal boundary will remain unchanged, with only the fluvial boundary being updated. We therefore propose to retain the present day tidal boundaries and include further explanation in the Hydraulic Modelling report.	Levels acceptable as comparable with recent NRW modelling. No further modelling work required but it would be useful to clarify the values used and how these have	This will be documented in the next revision of the hydraulic modelling report.

					check of modelled boundary levels against recent NRW modelling suggest values are appropriate (slightly more conservative than those recently calculated).		been derived in the modelling report.	
4.2	Have the calculations been provided?	Y	The calculation provided in the previous Mott MacDonald's report, namely 395318-TN-38-F A494 Bridge Improvements River Dee FCA	G	Calculations not provided, method used and key levels in the 2022 modelling	See above. We propose to revise Section 2.5 of the Hydraulic Modelling report to include details on the tidal boundaries calculation.	As above. Agree it would be useful to add the calculation details to the report.	This will be documented in the next revision of the hydraulic modelling report.

			Modelling Report, October 2022		report. This information should be documented in the latest modelling report.			
4.3	Is there wave overtopping? If so, have the calculations been provided and are they suitable?	N/A	Wave overtopping not included	N/A				
5	**Survey**							
5.1	Is data source stated?	Y	Data sources for the hydraulic model build stated in the previous hydraulic modelling reports (Mott MacDonald, Oct 2022 and June 2024). Also stated in the Scoping Report	G	Previous review suggested survey sources were clearly listed in the modelling report but	Topographical survey data and drawings used were uploaded to the NRW ShareFile portal on 09/06/2025 (please refer to the email to Sion Williams, Mon 2025-06-09 11:50).		

			(Mott MacDonald, Oct 2024). Further details will be provided in the new modelling report for the River Dee Hydraulic Modelling Report - Proposed Development Assessment.		has not been included.			
5.2	Is method stated?	N	This is unknown. However, the model uses the topo survey data previously accepted by NRW.	G				
5.3	Is survey current? If no see 5.4, If yes, has the date been provided?	Y	The latest available topo survey/Lidar data used to build the model.	G	1D survey used is old (2003 bathymetry). North Wales Tidal Defence survey also quite old (2016). Site survey more	No further response		

					recent (2018 & 2019). Listed in assumptions & limitations in modelling report.			
5.4	Has check survey been performed?	Y	Sense check carried out comparing the topo survey data, Lidar data, OS map, Aerial photos and site visit photos.	G				
5.5	Are E stations listed?	N	E stations not listed.	N/A				
5.6	Has sufficient data been collected?	Y	Yes, topo survey along the costal flood defences and bank levels used in the model. Latest Lidar covers the area of 2d domain.	G				

5.7	Are levels to Ordnance Datum?	Y	Yes levels are to OD	G				
5.8	Is data in electronic format?	Y	Some topo survey is available in electronic format.	G				
5.9	Is data georeferenced? If not provide location plan	Y	British National Grid coordinate system	G				
5.10	Is LiDAR data current? If yes, has the date been provided?	Y	2022 LiDAR, downloaded from DataMapWales portal.	G				
5.11	Is the resolution of the LiDAR suitable?	Y	1m resolution Lidar downloaded from DataMapWales portal	G				
5.12	Does the LiDAR used pick up all recent topographical changes in the model extent that	Y	The 2022 Lidar is deemed suitable for the project objectives.	G	LiDAR data quality checks not documented but patch used to	We propose adding comments on the quality check of Lidar data into the next revision of the hydraulic modelling report.		

	could influence the model results?				better represent Makro building.			

Table A.2: Model Build Comments

		Y/N	Modeller Comment	RAG	1st QA Comments	1st Modeller Response (18/12/2025)	2nd QA Comments (13/01/26)	2nd Modeller Response (10/02/26)
6	**General**							
6.1	Is the model the correct type?	Y	1D-2D type model suitable to assess flooding risk both in and outside the channel.	G				
6.2	Has the recommended data management structure for the software package been used?	Y	Standard data management structure for the FMP and TUFLOW used,	G	Model uses legacy commands and files e.g. zln rather than the recommended zsh functionality. '2d_zln_NWTDS_Asset_Crests' contains a lot of data which is not needed as it is outside of the model domain, and also contains duplicated points, but not	We propose updating of the control file comments in the next model update.		

					affecting results. Comments in the control files could be improved to easily identify the purpose of layers.			
6.3	Have any non-default settings been used 1d & 2d?	N	No changes made to the default settings	A	Some non-default values present - Automated Preissmann slot, dflood set to 10, double precision. Unlikely to change results but should be documented for transparency.	The non-default settings originate from the previous model development and have been retained to maintain model stability. We propose to provide an explanation of these non-default values (such as automated Preissmann slot, dflood of 10, theta of 0.75, and the use of double precision) in the modelling report.	Accepted but please justify use in the report as proposed.	Will be documented in the next revision of the hydraulic modelling report.

						These parameters fall within an acceptable modelling range and we recommend retaining them in the final model.		
6.4	Is model timestep appropriate?	Y	10m grid size used in 2d domain. 5s timesteps in 2d domain and 2.5s timesteps in 1d domain used.	G				
6.5	Do the reach lengths match survey data and/or 2d representation?	Y	Reach lengths in line with	G	Minor differences in some sections.	No further response		

			the previous NRW model.					
6.6	Is the model run time sufficient to ensure the water levels have peaked across the model domain?	Y	80hr runtime applied. The runtime was assessed as sufficient for modelling of the A494 scheme in the previous stage of the project.	G	All runs are 80 hours but in some tidal runs downstream boundary curve only extends to 50 hours. No impact on results since peak occurs before 50 hrs.	No further response		
6.7	Have waterbodies been considered and modelled appropriately?	Y	River Dee channel is the dominant flood source. Additional streams in the floodplain have been detailed	G				

			as per the latest NRW model. Flood risk at the Queensferry Drain is assessed in a stand-alone hydraulic model.					
7	**Inflows and boundary conditions**							
7.1	Are the inflow locations in the correct place within the model domain?	Y	There has been no change to inflow locations. A single upstream inflow for the River Dee used. Also, a small tributary (New Crane) at Chester added with a constant	G				

			flow of 0.5m3/s.					
7.2	Are the inflows the same as those stated in the report?	Y	The inflows are in line with the hydrological analysis presented in GN008 Flood estimation calc record from 10/01/2025	G	Fluvial inflows in the model match those in the calculation record. Constant fluvial inflow of 30m3/s for the tidal runs which appears to be a nominal flow carried forward from the 2012 study. No comment on whether this has been reviewed or is still considered appropriate. FEH calculation record mentions the constant inflow of 0.5m3/s at New Crane Street. This is the value used in the fluvial	Yes, the 30m3/s fluvial inflow is a nominal flow from the 2012 study. This is also in line with the NRW model. The 67033 Dee at Chester Bridge station shows a mean flow of 34.078m3/s, confirming that the nominal flow of 30m3/s is appropriate. The inflow at New Crane Street is a legacy inflow from the 2012 model and does not influence the A494 model area. It is understood that the higher value of 1m3/s in tidal runs	Thanks for clarification. Please include inflow information & assumptions in the modelling report.	Will be documented in the next revision of the hydraulic modelling report.

					model but 1.0m3/s is used for tidal runs. Reason for inflows & differences should be documented.	improves stability of the model (the fluvial scenarios use a lower value of 0.5m3/s). As the same values were applied in the baseline and post-scheme model, they will have no impact on the impact assessment. We propose the retain the New Crane inflows as they are and will provide further explanation in the Hydraulic Modelling report.		
7.3	Has the appropriate range of flows/tides been modelled?	Y	The models scenarios in line with the Scoping Report,	G				

			i.e. No18 scenarios models in total, including fluvial, tidal and breach flood mechanism.					
7.4	Are the upstream and downstream boundary types appropriate?	Y	Upstream/ downstream boundary unchanged and in line with the previous NRW model. This is deemed appropriate for the A494 project.	A	There is no 2D downstream boundary to allow water to leave the 2D domain from the floodplain. It appears that the model is glass walling on the left bank. This may be realistic if road is acting as a barrier but unclear if this is the case. Could affect floodplain results.	Although some ponding occurs on the left bank at the downstream end of the model, this area is not near the site of interest and is hydraulically disconnected from the main river, as overflow occurs only in one direction—from the river to the floodplain. Therefore, it does not affect the scheme's impact assessment. We propose to review the glass walling in this area during the	Accept that this is likely to have minimal impact on results at the site of interest (~4km upstream). Should be reviewed and updated in any future updates to the model, as proposed.	The downstream boundary has now been updated to address NRW's comments. This will be documented in the next revision of the hydraulic modelling report.

						next model review and add an HX line connected to the last 1D node to simulate the tidal mechanism. These changes will be subject to model stability.		
7.5	Does model extend far enough upstream and downstream?	Y	Upstream/ downstream extent unchanged and in line with the previous NRW model. This is deemed appropriate for the A494 project.	G				

7.6	Tidal only - How has the wave overtopping been applied? Is it appropriate?	N	No wave overtopping considered in the River Dee tidal model. This is in line with the previous NRW model and Scoping Report.	N/A				
7.7	Pluvial - How has rainfall been applied? Is it appropriate?	N	Only fluvial, tidal and breach flood mechanism assessed.	N/A				
7.8	Has infiltration been considered? If so, how and is it appropriate?	N	No soil infiltration of urban drainage considered in the model. This is in line with the previous	N/A				

			NRW model and Scoping Report and it will provide conservative estimates of flood water levels.					
8	**1D model**							
8.1	Are the initial conditions appropriate?	Y	Initial conditions appropriate. No impact on modelling results and provide stable starts to simulations.	G	Some oscillations at start of some runs e.g. Q1000, but settles down quickly.	No further response		
8.2	Are model cross-sections widths appropriate?	Y	1d model cross sections in line with the previous NRW model. The	G				

			Proposed scenario model includes additional cross sections immediately upstream and downstream of the proposed A494 bridge. These are in line with the previous 2019 model.					
8.3	Is model cross-section spacing appropriate?	Y	1d model cross sections in line with the previous NRW model.	G				
8.4	Have interpolated sections been kept to a minimum?	Y	1d model cross sections in line with the previous	G				

			NRW model.					
8.5	Are 1d roughness (Manning's) values sensible?	Y	1d model cross sections in line with the previous NRW model.	G	Roughness values have not been reviewed and updated. Manning's n values are quite generalised. Cross sections at the site of interest are a uniform value of 0.021. Values in the estuary downstream of the A548 is set to 0.010, which seems on the low side. Unlikely to change overall outcome but reduces model confidence.	The roughness in 1d is in line with the NRW model. Given the man-made (canalised), uniform river channel, these values were assessed as appropriate. We have already conducted a sensitivity analysis on the roughness values with a ±20% variation. This had an insignificant impact on the results, as the flooding is primarily tidally controlled. Therefore we propose to retain the existing channel roughness values.	Accepted.	No further response.

8.6	Are structures modelled appropriately?	Y	A494 bridge crossing (existing + proposed) and Jubilee Lift Bridge added to the NRW model as 1d USBPR bridge units.	G	It is not clear how the dimensions for the Bascule Jubilee Bridge have been derived from the 1925 drawings or whether any recent survey has been used to check the representation of the bridge.	As stated in the Scoping Report (which NRW reviewed in 2024 via pre-application consultation) the representation of Bascule Jubilee Bridge has been taken forward as per the previous round of modelling conducted by Mott MacDonald. The details of the bridge modelling are documented in the previous hydraulic modelling report dated 25 October 2022. We will pull these details out and update the Hydraulic Modelling Report. The bridge drawings have been uploaded to the NRW ShareFile portal, please refer to the email to Sion	Accepted. Please update the modelling report as suggested.	The Bascule Jubilee Bridge details will be included in the updated hydraulic modelling report.

						Williams on Monday 2025-06-09 11:50.		

8.7	Does conveyance look smooth in cross section plots?	Y	1d model cross sections in line with the previous NRW model. Conveyance looks smooth.	A	There are many sections where conveyance curves are not smooth. May affect stability or accuracy slightly.	Acknowledged. We have carried out a sensitivity test on the T1000 2100 Proposed scenario using improved conveyance curves. The maximum in-channel impact at the area of interest has been assessed as 0.012m, with maximum changes of over 0.05m predicted in the upstream section in Chester. If NRW confirm that this change is considered significant, we propose to re-run the remaining scenarios with the same conveyance curves improvements. The updated results will be included in the	Difference considered significant. Agree model should be re-run with improvements. .	The conveyance curves have been refined and adopted for the latest hydraulic model. This will be documented in the next revision of the hydraulic modelling report.

						new revision of the report.		
8.8	Have panel markers and floodplain markers been used appropriately?	Y	1d model cross sections in line with the previous NRW model.	A	Panel markers not used appropriately and would address improve conveyance (issue in 8.7 above) and improve model accuracy.	As above in 8.7	As above.	The panel markers have been updated in the latest hydraulic model. This will be documented in the next revision of the hydraulic modelling report.
9	**2D model**							
9.1	Is grid/mesh size and orientation appropriate?	Y	Grid size (10m) and orientation in line with the	G				

			previous NRW model and deemed appropriate.					
9.2	Is grid representative of the DTM?	Y	Grid in line with the previous NRW model and deemed representative for the purpose of the hydraulic model.	G	Some of the topo modifications are too detailed to be picked up in the 10m grid e.g. layer '2d_zln_LB_crest_US_2019_topo_L.shp'. Have layers with levels taken from LiDAR previously been reviewed against the new LiDAR and updated? e.g. rifle range banks. There seem to be some differences.	The 10 m grid and level of detail were specified in the Scoping Report (provided and reviewed by NRW in 2024). The DTM has been updated using 2022 LiDAR data. No further adjustments have been made to individual layers in relation to the new LiDAR dataset. the Rifle Range lies outside the area of interest and is hydraulically disconnected. Therefore we propose to retain the existing 2D layers, as any further updates are considered	Accepted but should be reviewed for any future model updates.	No further response.

						insignificant to the impact assessment.		
9.3	Are the initial conditions appropriate?	Y	Initial conditions defined in 1d FMP domain.	G				
9.4	Is the model domain appropriate?	Y	In line with latest NRW model	G				

9.5	Have buildings been represented appropriately?	Y	The buildings will be represented by OSMaster Map and increased roughness of 0.300. This is in line with the previous NRW model and Scoping Report	R	Some buildings have not been captured in the materials layer e.g. the Northern Gateway development area. This impacts on the T1000 climate change runs and the Breach 2 runs. Manning's n value of 0.3 used for buildings - NRW normally recommend 0.5. No building sensitivity has been carried out. Missing key features / incorrect roughness could affect flood extents.	The OSMasterMap and the roughness value of 0.3 for buildings is taken from the latest NRW model. This approach is in line with the Scoping Report which NRW reviewed via pre-application consultation in 2024. We propose to undertake a sensitivity analysis (increased building roughness of 0.5) and present the findings in the sensitivity analysis section of the updated Hydraulic Modelling report.	Roughness value is a little low but acceptable. Main issue is the buildings which have not been represented to the north of the development site. Affects the Breach 2 runs (ex & proposed) and the T1000 climate change (central & upper) runs.	Buildings that are associated with the Northern Gateway development have been incorporated into the latest hydraulic model. This has been based on what is shown in the most recent OSMasterMap dataset dated 10/12/2025. The roughness values have been updated in the latest revision of the hydraulic model to align with NRW's published recommended values for 2D hydraulic modelling https://naturalresources.wales/flooding/indicative-2d-roughness-values/?lang=en#:~:text=2D%20roughness%20values-,Table%20of%202D%20roughness%20values,0.5%20(to%20be%20confirmed. This update also includes an adjustment of the building roughness coefficient from 0.3 to 0.5. This will be documented in the next revision of the hydraulic modelling report.

9.6	Is the Manning roughness representation adequate?	Y	Manning roughness represented by the OSMaster Map. This is in line with the previous NRW model and Scoping Report	A	Model using 2017 MasterMap, more recent MasterMap is available. Roughness values have not been reviewed and updated. Most recent data recommended for model accuracy.	As above in 9.5	Most recent MasterMap data recommended for model accuracy.	As above in 9.5
9.7	Are structures and floodplain features modelled appropriately?	Y	Structures in the floodplain modelled in line with the previous NRW model.	G				
10	**1D-2D linked model**							
10.1	Does the 1D cross section width and levels match the 2D representation?	Y	1d model cross sections and 2d boundaries in line with the 2d domain.	G				

10.2	How have the 1D/2D models been coupled, is it appropriate?	Y	The coupling along the River Dee bank levels. Topo survey data used to define the bank levels.	G	Features in layer '2d_bc_BAS_DEE_021' do not have default attributes recommended by TUFLOW. Unlikely to affect results but should follow best practice.	The HX line FLC value of 0.5 falls within an acceptable modelling range value. A sensitivity test on the T1000 2100 Existing scenario has been run to assess an impact of the layer 2d_bc_BAS_DEE_021 with default attributes. The impact of changes is not deemed significant. We propose to present the sensitivity test in the Hydraulic Modelling report however retain the current FLC values of 0.5 in the model and confirm the use of non-default value in the Hydraulic Modelling report.	Accepted.	No further response.
10.3	Is the digitisation of the links acceptable?	Y	The link follows the River	G				

			Dee bank levels.					
10.4	Have 1D outputs been represented appropriately in the 2D domain	Y	WLL lines used to add the 1D outputs in the 2d results.	G	Gap in 1D outputs at Crane St confluence but not impacting area of interest.	No further response		
10.5	Have any default link parameters been changed (i.e. to improve stability)?	N	No changes made to default parameters	G				

Table A.3: Model Confidence Comments

		Y/N	Modeller Comment	RAG	1st QA Comments	1st Modeller Response (18/12/2025)	2nd QA Comments (13/01/26)	2nd Modeller Response (10/02/26)
11	**General / House keeping**							
11.1	Does the model run?	Y	Yes model runs to completion	G				
11.2	Have all superseded files and results been removed?	Y	All superseded files / results removed	G				
11.3	Are model run-time log/check files included?	Y	Log/check files included	G	Log files not provided for proposed scenario. Fundamental for model QA.	The log files will be submitted together with this spreadsheet.	Logs files provided and reviewed. No issues.	No further response.
11.4	Has a full set of 1D and 2D raw and processed results been provided?	Y	Raw results are provided. No processing carried out.	G	No results for the Q1000+cc as noted.	No further response		

11.5	Do the model and outputs pass a reality check?	Y	Yes the model and outputs pass a reality check.	G				
11.6	Do the model flows reconcile with the hydrology flow estimates as the downstream boundary or area of interest?	N	No flow reconciliation at the downstream end carried out. The River Dee is a single well defined channel, no further flow reconciliation at the downstream end carried out. The peak flows and tidal peaks have been synchronised to model the worst case scenario.	G				
12	**Stability**							
12.1	Are there any model stability issues?	N	Model is stable and performs well up to Q1000yr fluvial flood event. The Q1000yr + 20cc also tested, but the model is unstable for this flood magnitude,	G	Some oscillations at start of runs but settle down quickly. Log files for proposed have not	The log files will be submitted together with this spreadsheet.	Logs files provided and reviewed. No issues.	No further response.

			which is a known incumbent issue with model and anticipated, accepted limitation as identified in the Scoping Report		been provided for checking.			
12.2	Have stability patches been applied, if so are they appropriate?	Y	Stability patches from the previous NRW model used, these are away from the A494 site location. A patch has been added over the location of the Queensferry Drain to better define the impact of excavation. No additional patches have been included.	G	High roughness patch applied in two small areas of the floodplain to mitigate for negative depths causing instabilities.	No further response		
12.3	Have Errors / Comments / Warnings flags been addressed / minimised?	Y	Model stable, low Final Cumulative ME.	G	Several warnings/check messages (duplicate points, snapping issues); unlikely to	No further response		

					impact results but best practice would be to clean these. Any remaining warnings should be detailed and justified in the modelling report.			
12.4	Has the volume across the model been checked with PO lines?	N	No additional checks of volumes with PO lines.	G				
13	**Verification**							
13.1	Have the model outputs been verified against a recorded	N	No verification has been completed for this model. Insufficient data for calibration/verification.	G				

	extent and / or anecdotal information, such as flow routes, wrack marks, inundation times etc.?							
13.2	Are the outputs/results realistic?	Y	Results are realistic	G				
14	**Calibration**							
14.1	Is there suitable data available for calibration and had it been used?	N	Insufficient data for calibration/verification.	G				
14.2	Have calibration runs been undertaken?	N	No calibration runs undertaken	G				
14.3	Is the data used for	N/A	No calibration runs undertaken	N/A				

	model calibration appropriate ?							
14. 4	Have any changes made to the model during this process appropriate and realistic?	N/ A	No calibration runs undertaken	N/A				
14. 5	How many events have been used during calibration are they suitable to use?	N/ A	No calibration runs undertaken	N/A				
14. 6	Does the model calibrate?	N/ A	No calibration runs undertaken	N/A				
14. 7	Are the simulated hydrograph peaks and shape reasonably similar to	N/ A	No calibration runs undertaken	N/A				

	the recorded peaks?							
15	**Sensitivity**							
15.1	Have appropriate sensitivity tests been run?	Y	Sensitivity tests on breach size and climate change uplift for the tidal scenarios have been completed. Additional sensitivity tests including a flood wall near the Makro site, roughness increased and decreased by 20%, embankments between proposed bridge and jubilee bridge raised 10mm, pier skew angle reduced from 20 to 0 degrees, and pier width adjusted from 4m to 3.04m.	G				
15.2	Have appropriate model parameters	Y	Yes appropriate model parameters chosen for sensitivity testing	G	.			

	been chosen for sensitivity testing?							
15.3	Do the results of the tests show the model to be significantly sensitive to certain parameters?	Y	Model results sensitive to breach size and embankment raising. Model is not sensitive to roughness or pier adjustments (considering the T1000_2100 scenario).	G				
16	**Uncertainty**							
16.1	Have the model limitations and assumptions been justified?	Y	Limitations/assumptions discussed in the previous and also latest A494 Hydraulic Modelling Report.	G				
16.2	Have uncertainty limits for model results (+/- mm) been presented? How were	N	Uncertainty limits not derived. The model used for a relative comparison of pre and post scheme scenarios.	N/A				

	they derived and does this seem sensible?							
16.3	Has a freeboard allowances been considered? Is it reasonable in the context of the uncertainty limits?	N	No freeboard consideration required. The model used for a relative comparison of pre and post scheme scenarios.	N/A				
16.4	Was an explicit statement of any concerns about the accuracy of the model or its ability to represent reality provided?	N	The model is based on the previous A494 model and NRW model. The results looks similar and realistic.	N/A				

Table A.4: FCA Comments

		Y/N	Modeller Comment	RAG	1st QA Comments	1st Modeller Response (18/12/2025)	2nd QA Comments (13/01/26)	2nd Modeller Response (DATE)
17	**General**							
17.1	Have both the 'As Existing' (baseline) and 'With Development' (proposed scheme) models been submitted?	Y	The provided model files are for proposed scenarios only. The baseline scheme scenarios were previously provided. Both will be provided in the final Modelling Report and FCA report	G				
17.2	Are the proposed development plans provided and of sufficient detail?	Y	The details of Proposed scenario Model build are given in the Hydraulic					

			Modelling report.					
18	**Proposed Development Model**							
18.1	Has the topography of the proposed development been represented in the model with sufficient detail?	Y	The 2D topography of the Proposed scenario Model is modelled using a ASCII file from the Civil3D proposed scenario model. The open channel sections are based on the 2003 bathymetry survey of the River Dee and proposed scenario drawings.	G				

18.2	Has the Manning's roughness been updated for the proposed model?	Y	Manning's roughness layer has been updated to reflect the removal of the existing bridge and the implementation of the proposed scenario. The new Queensferry Drain channel is also defined in the proposed scenario model.	G				
19	**Site Specific Model Requirements**							
19.1	Has a blockage assessment been undertaken? (if no, move to 19.4)	N	No blockage assessment undertaken	N/A				

19.2	Has the blockage/s been applied correctly to the model?	N/A	No blockage assessment undertaken	N/A				
19.3	Do the blockages applied in the model match those documented in the FCA?	N/A	No blockage assessment undertaken	N/A				
19.4	Has a breach assessment been undertaken? (if no, move to section 20)	Y	No5 breach locations identified and assessed	G				

19.5	Has the breach/es been applied correctly to the model?	Y	Breach locations and modelling approach in line with the previous A494 model.	G	Breach timing - the model breaches initiate at 20 hours and develop over 0.5 hours. However overtopping or peak water level at the breach locations appear to occur at around 21.5 - 22 hours when water level is higher. Timing mismatch could underestimate breach impacts.	No changes have been made to breach modelling from previous stage of modelling conducted by Mott MacDonald and extensively discussed with NRW. We have carried out sensitivity tests on the T1000 2100 runs for breaches 1, 3, 5 to compare the impacts of the breach timing if they were to occur at 21hrs. This showed that the breach at 20hrs provided a 'worse case' scenario in terms of the predominant flood depth / volumes impacts, as they capture the peak tide with the breach opening fully developed. We propose to continue to use the 20hr scenario, however add the findings from these sensitivity runs into the Hydraulic Model report.	Thanks for clarification. Please add comments on breach timing to the report.	Breach timing will be documented in the next revision of the hydraulic modelling report.
19.6	Is the breach/es applied in the model match those	N/A	Only proposed scenarios provided in this check	G				

	documented in the FCA?							
20	**Mitigation Modelling**							
20.1	Are mitigation option/s proposed as part of the development scheme? If no, move to section 21.	Y	A mitigation wall near the Makro site has been included as a mitigation test for the breach scenarios. This wall is set at a height of 6.2mAOD and extends approximately 230m from the south side of the North Railway Coast Line bridge along the A494	G				
20.2	Is there sufficient information detailing the proposed option(s)?	Y	The proposed mitigations (a wall near the Makro site) modelled as a high-level	G				

			representation in 2D domain.					
20.3	Have these been applied to the model correctly?	Y	Yes, location and sizing in line with actual reasonable wall size and location	G				
20.4	Has an assessment of their impact been undertaken for all events?	N	Makro wall mitigation has only been tested for flood tidal breach scenarios 1, 3, and 5 as these are the only floods which extend to the mitigation wall location.	G				
21	**FCA Outputs**							
21.1	Have third party impacts been displayed correctly?	Y	The baseline and proposed scenario model outputs compared and the results	G				

			presented in the Hydraulic Modelling report.					
21.2	Is impact off-site less than or equal to 5mm? If not, is the impact justified sufficiently?	Y	The baseline and proposed scenario model outputs compared and the results presented in the Hydraulic Modelling report. Considering the overtopping T1000_2100 scenario, large areas show betterments, very limited areas show a detriment over 5mm. The impact in breach scenarios varies for each breach locations.	G				

			The impact justified in the Hydraulic Modelling report.					
21.3	Are mapped outlines supplied?	Y	The model package includes the maximum flood extents	G				
21.4	Do the mapped outputs match the raw results?	Y	The maximum flood extents shapefiles match well with the ASCII grid files	G				

Table A.5: FMC Comments

		Y/N	Modeller Comment	RAG	1st QA Comments	1st Modeller Response (DATE)	2nd QA Comments	2nd Modeller Response (DATE)
22	**Intellectual Property Rights**							
22.1	Is the model intended to be used to update the NRW mapping or flood risk products?	N/A	Flood Map Challenge not anticipated at this time					
22.2	Has a change note form been completed?	N/A	Flood Map Challenge not anticipated at this time					
22.3	Has the appropriate IPR been granted to NRW?	N/A	Flood Map Challenge not anticipated at this time					
22.4	Are details provided to enable	N/A	Flood Map Challeng					

	running of the model (i.e. naming convention and run switches)		e not anticipated at this time					
23	**General**							
23.1	Is the area / layer being challenged clearly communicated?	N/A	Flood Map Challenge not anticipated at this time					
23.2	Does the model offer new evidence which improves on the existing standard of evidence?	N/A	Flood Map Challenge not anticipated at this time					
23.3	Can the upstream and downstream extents tie into the national flood maps?	N/A	Flood Map Challenge not anticipated at this time					

24	**Events and Scenarios**							
24.1	Have the correct events and scenarios been simulated and outputs provided?	N/A	Flood Map Challenge not anticipated at this time					
24.2	Defended Model - Does the defended model include appropriate defences only?	N/A	Flood Map Challenge not anticipated at this time					
24.3	Undefended Model - Have all Risk Management Authority, private and defacto (informal) defences been removed from the model?	N/A	Flood Map Challenge not anticipated at this time					

B. Existing (Pre-Development) Flood Risk Assessment

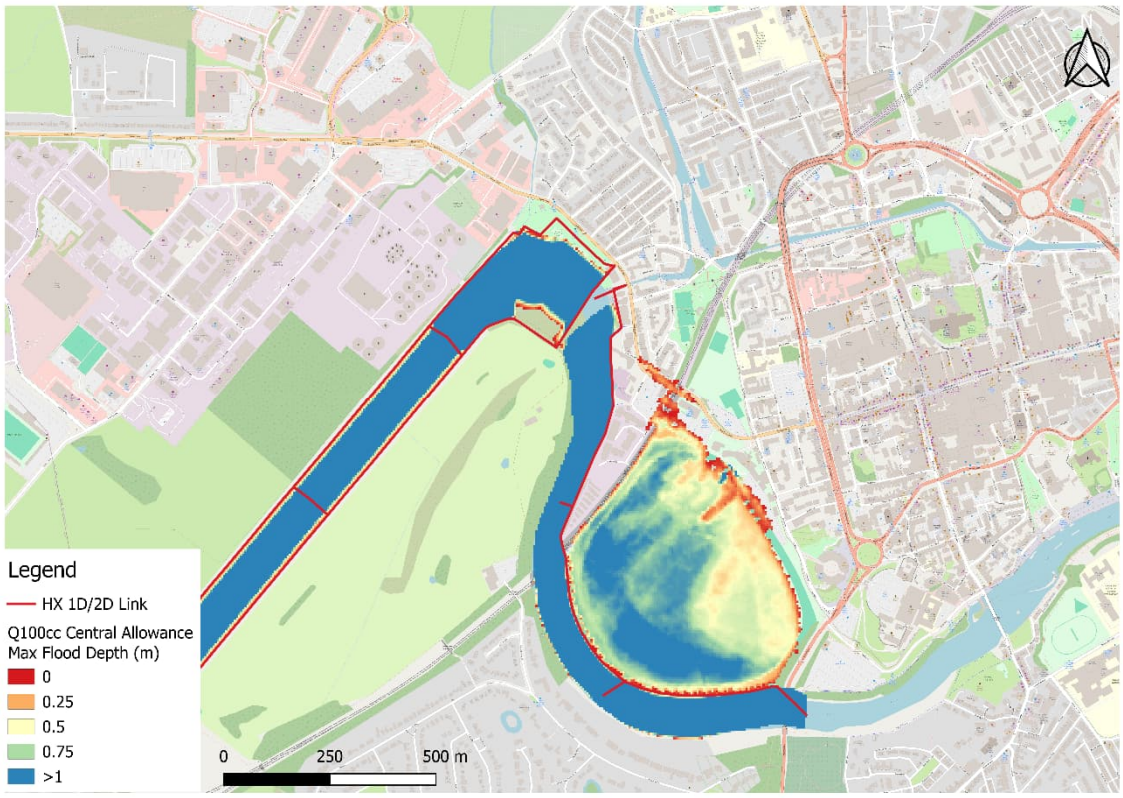
This section outlines the predicted existing flood risk to the A494 crossing Scheme and the surrounding floodplain, based on the current modelling outputs.

B.1 Fluvial Overtopping

B.1.1 1% AEP 2100 Fluvial (Central Climate Change Allowance)

No flooding is predicted along the channelised section of the River Dee apart from upstream at Chester. Flooding extends north of the Chester racecourse into residential areas (see Figure B.1). Flood depths exceed 1m for much of the area around Chester racecourse as well as across Towergate.

Figure B.1: 1% AEP 2100 Fluvial (Central Climate Change Allowance) Existing Scenario Flood Depth



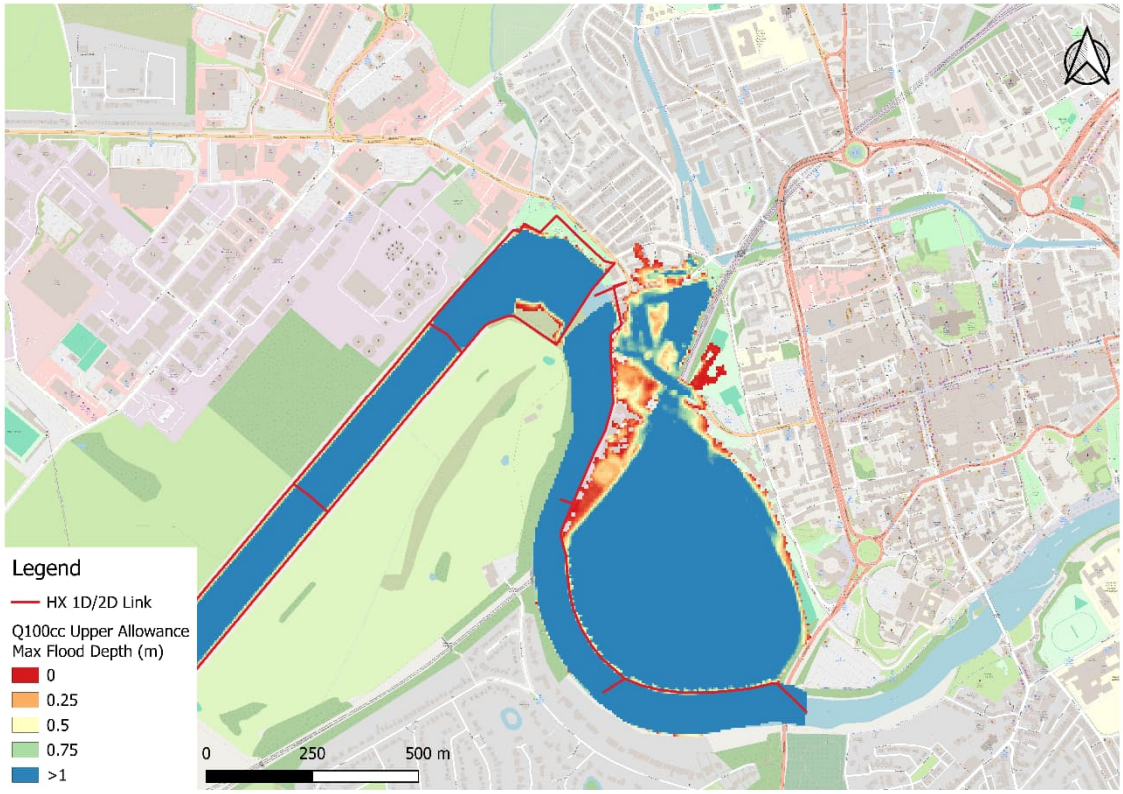
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

B.1.2 1% AEP 2100 Fluvial (Upper Climate Change Allowance)

No flooding is predicted along the channelised section of the River Dee apart from upstream at Chester. This extent is further than that caused by the Central allowance due to higher river levels and flooding extends north of Chester racecourse into residential areas north of New Crane Street

and Sealand Road (see Figure B.2). Flood depths are predicted to be above 1m for most of the area in Towergate under this scenario.

Figure B.2: 1% AEP 2100 Fluvial (Upper Climate Change Allowance) Existing Scenario Flood Depth

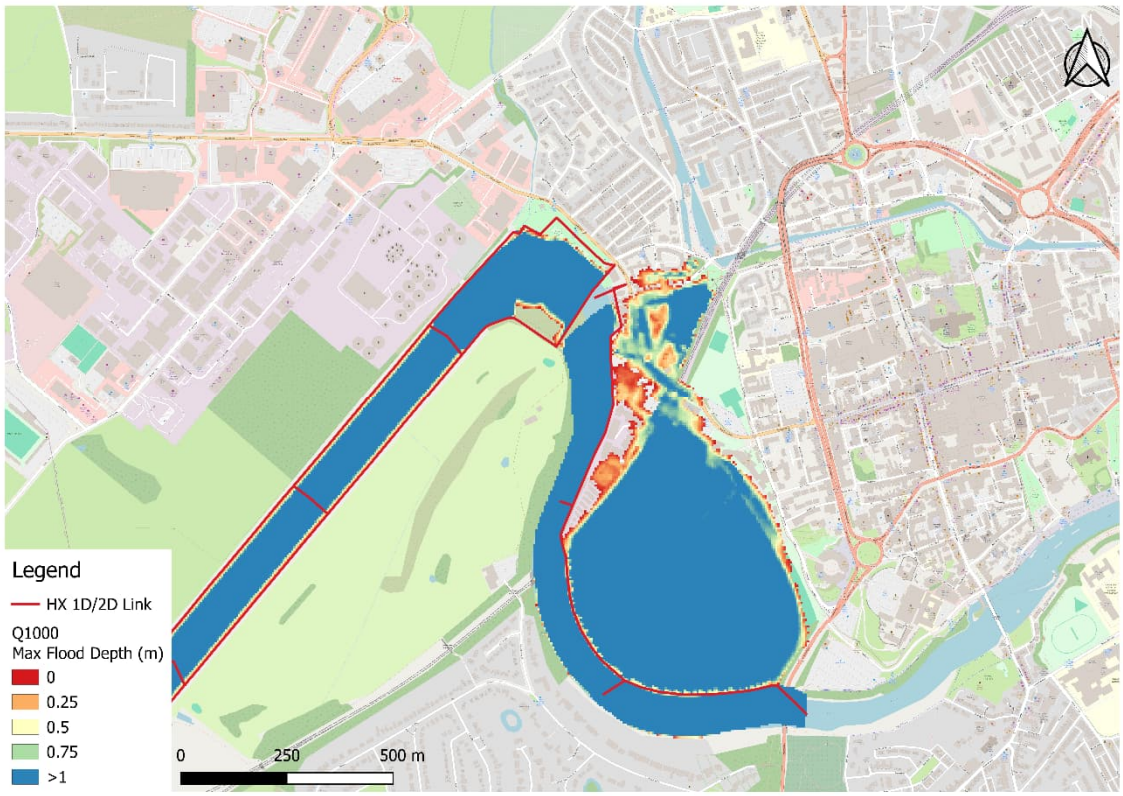


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B.1.3 0.1% AEP 2025 Fluvial

No flooding is predicted along the channelised section of the River Dee apart from upstream at Chester. Flooding extends north of Chester racecourse into residential areas north of New Crane Street and Tower Road. Flood depths across Chester Racecourse and Water Tower Gardens are predicted to be in excess of 1m (see Figure B.3).

Figure B.3: 0.1% AEP 2025 Fluvial

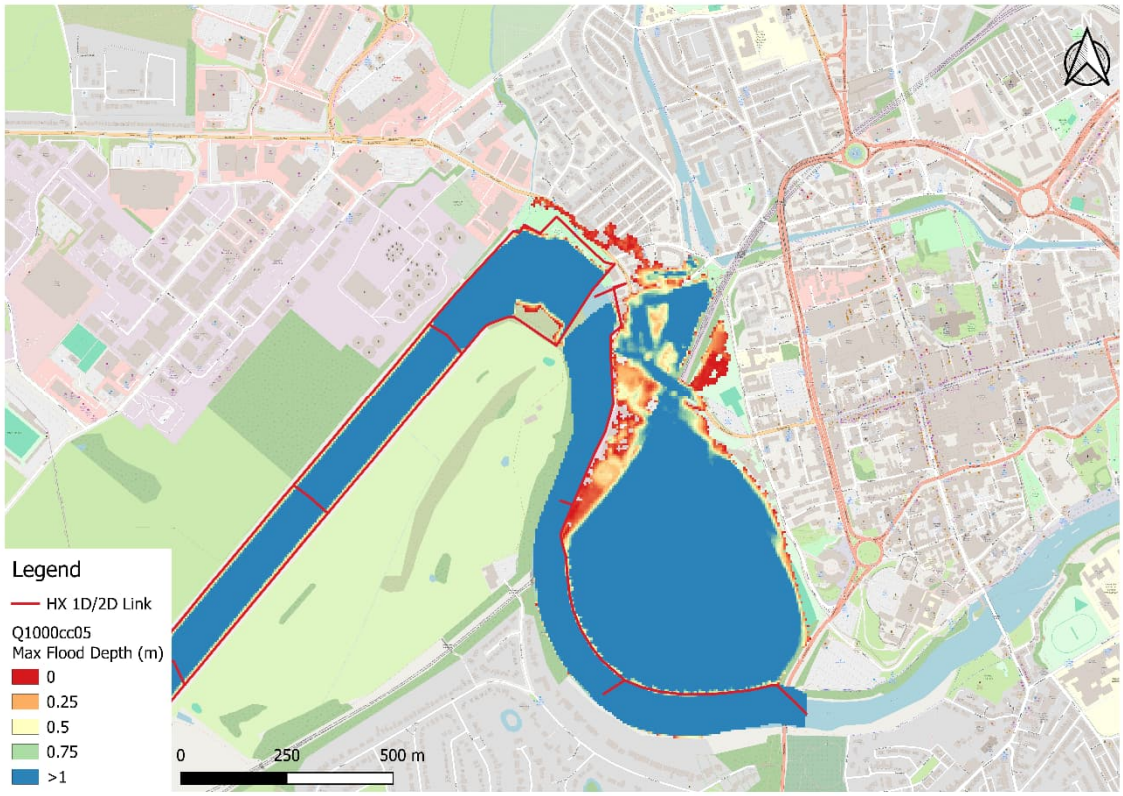


Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

B.1.4 0.1% AEP 2100 Fluvial (Lower Climate Change Allowance)

No flooding is predicted along the channelised section of the River Dee apart from upstream at Chester. Flooding extends north of Chester racecourse into residential areas north of Tower Road across South View Road and onto Sealand Road. Flood depths along Sealand Road and across the nearby residential areas is on average around 0.3m. Flood depths across Chester Racecourse, as well as some nearby residential areas are predicted to be in excess of 1m (see Figure B.4).

Figure B.4: 0.1% AEP 2100 Fluvial (Lower Climate Change Allowance) Existing Scenario Flood Depth



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B.2 Tidal Overtopping

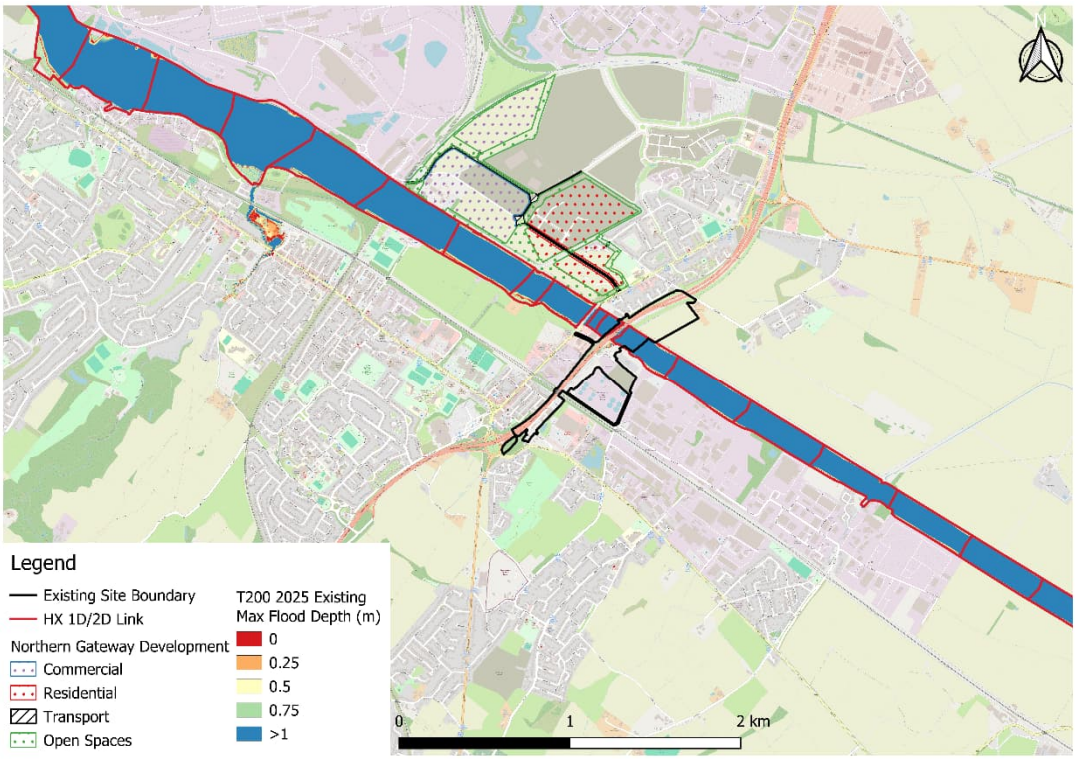
Tidal flood risk has been assessed for the 0.5% and 0.1% AEP overtopping events for both the present day (2025) and considering sea level rise in the future (2100s), representing the end of the lifetime of the developments (75 years).

B.2.1 0.5% AEP 2025 Tidal

There is no predicted bank overtopping at the Queensferry bridge in the Existing scenario. However, approximately 2.25km downstream at Wepre Brook there is flooding predicted on the left bank of the River Dee (see Figure B.5). This is a small, localised flood which affects parkland to the south of the North Wales Coast Line railway tracks. Flooding is not predicted to affect any residential area in the Connah Quay area.

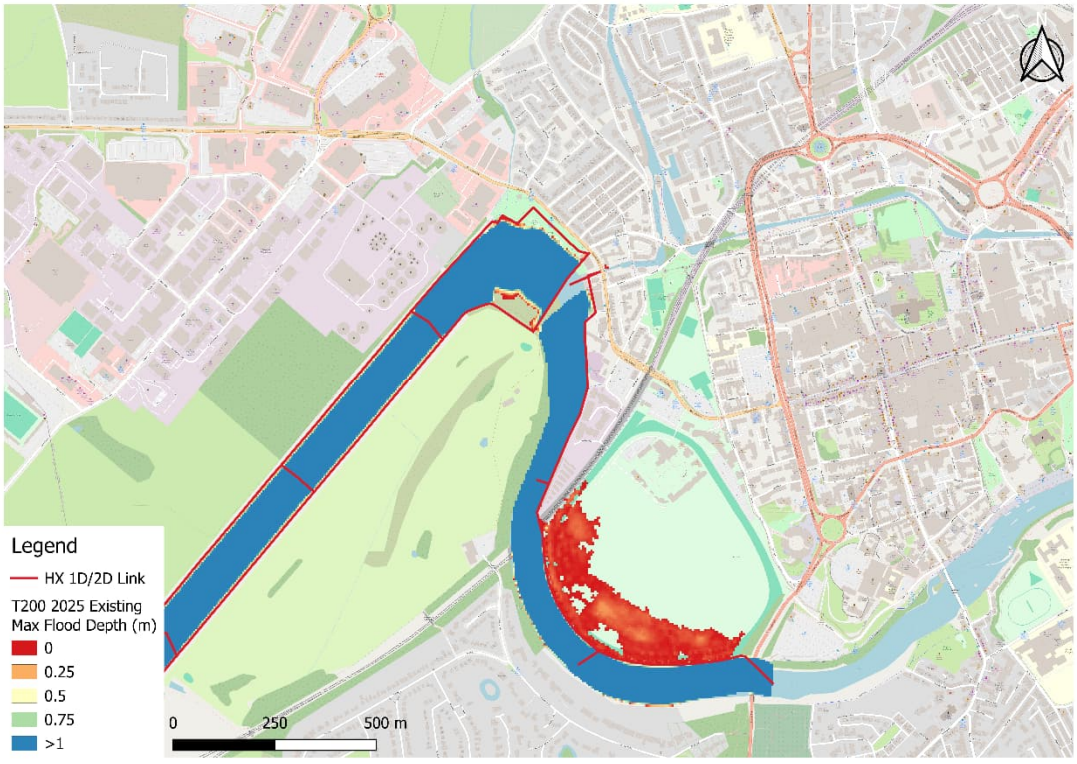
There is also some minor predicted flooding in Chester however this is only predicted to affect a small area of the Chester racecourse and does not affect any residential or road developments in the upstream portion of the river (see Figure B.6).

Figure B.5: 0.5% AEP 2025 Tidal Existing Scenario Flood Depth at Connah Quay



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Figure B.6: 0.5% AEP 2025 Tidal Existing Scenario Flood Depth at Chester



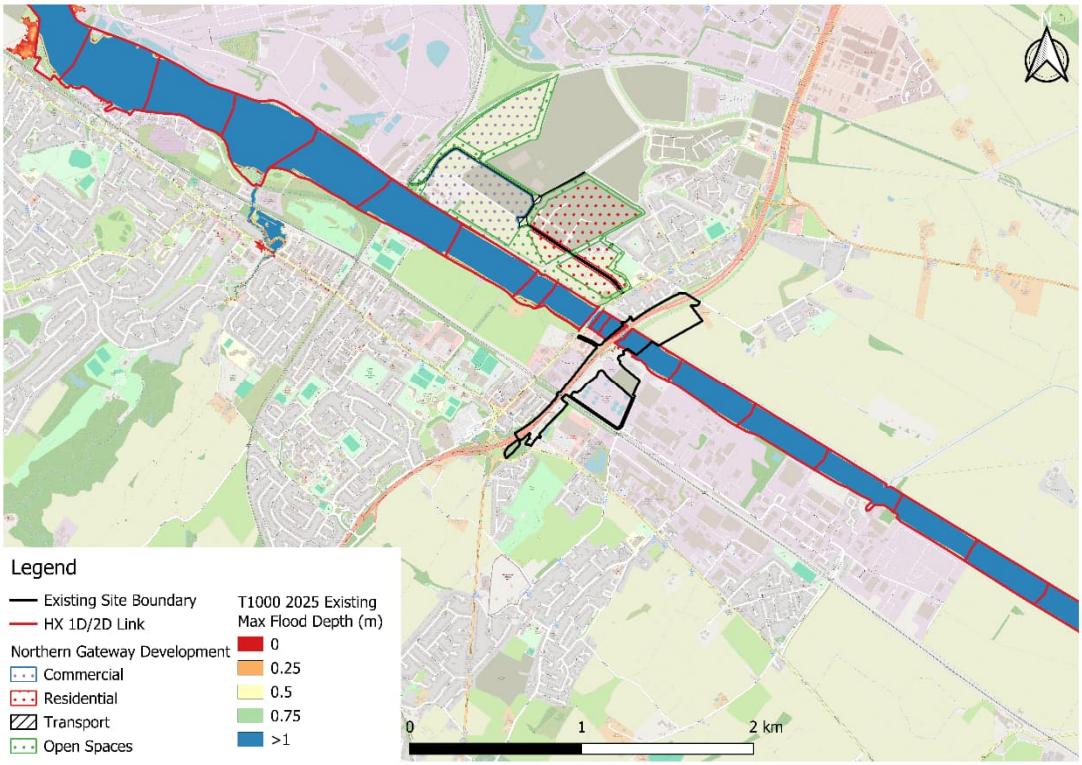
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

B.2.2 0.1% AEP 2025 Tidal

In the 0.1% AEP 2025 flood scenario (see Figure B.7) there is some additional flooding along the left bank of the River Dee by Wepre Brook and Connah Quay. The additional flooding from the Wepre Brook watercourse is predicted to flood onto the High Street There is also predicted flooding on both riverbanks further downstream close to the Flintshire bridge. The flooding here does propagate across the Connah Quay substation and nearby electricity pylons.

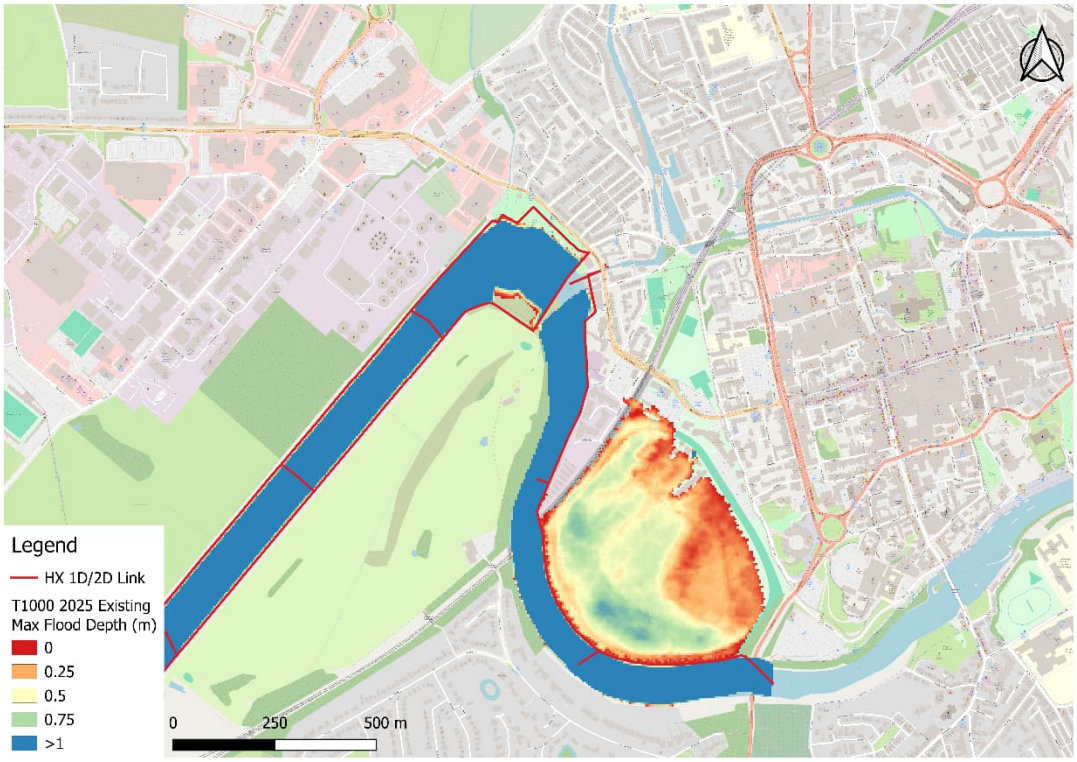
Comparative to the 0.5% AEP 2025 event flooding in Chester the 0.1% AEP 2025 event has more extensive flooding across the Chester racecourse. This flooding does extend to buildings within the Chester racecourse area including the parade ring and parking lot; however, it does not extend to any residential areas outside of the racecourse (see Figure B.8).

Figure B.7: 0.1% AEP 2025 Tidal Existing Scenario Flood Depth at Connah Quay



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Figure B.8: 0.1% AEP 2025 Tidal Existing Scenario Flood Depth at Chester



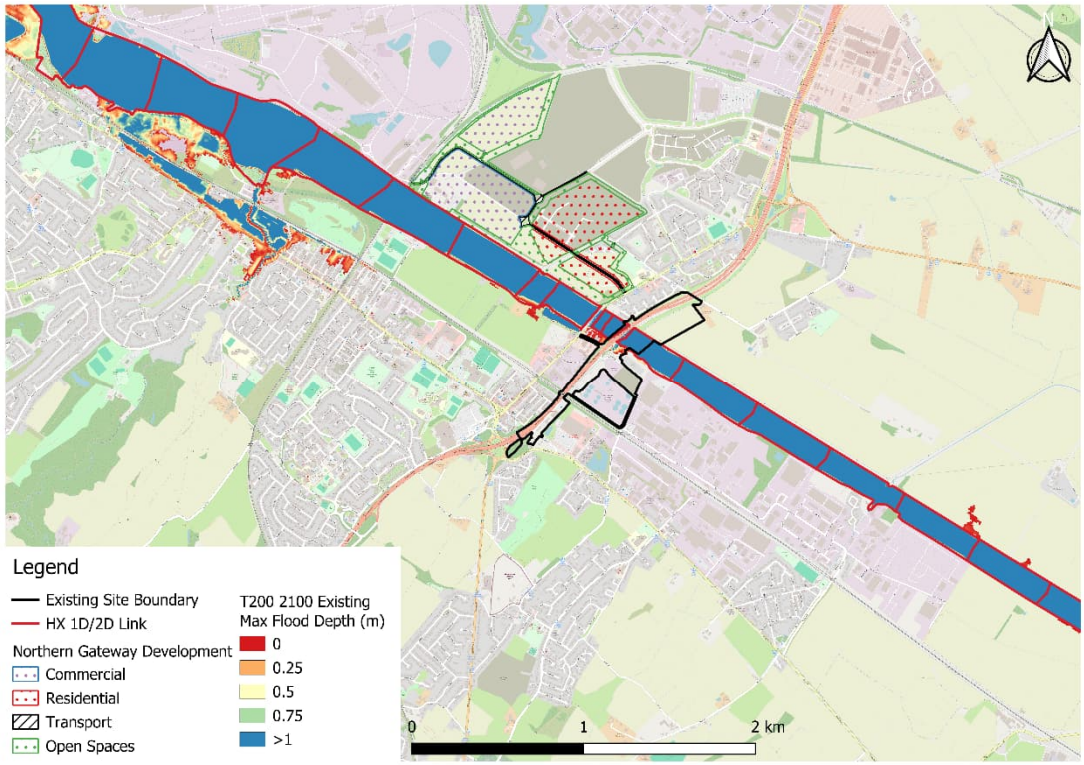
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

B.2.3 0.5% AEP 2100 Tidal

In the 0.5% AEP 2100 event (see Figure B.9) the model predicts flooding along the left bank of the River Dee into some areas of Connah Quay, as well as some overtopping from the Wepre Brook watercourse exacerbating flood depths along the south side of the railway line. There is also a small amount of predicted out of bank flow within the Scheme boundary on the left bank (see Figure B.10). Upstream there is a large area of Chester racecourse where flooding is predicted. Flooding is also predicted to extend into some developments north of the railway line on Tower Road and west along areas of Sealand Road (see Figure B.11).

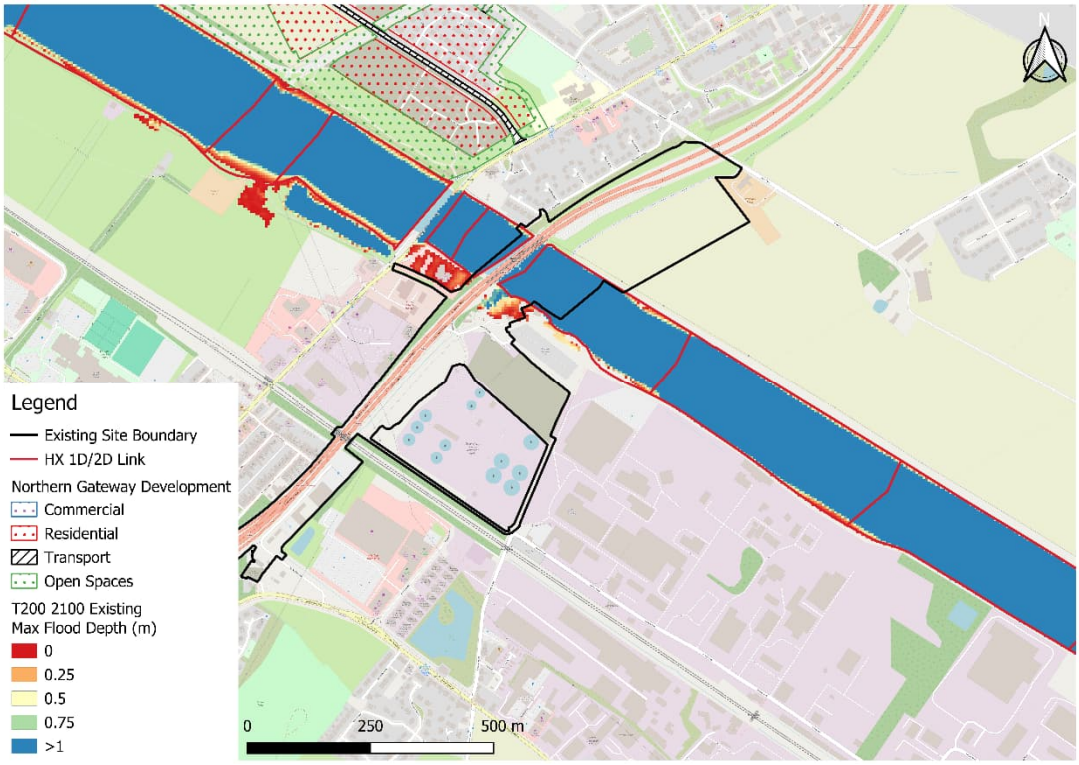
A sensitivity test using the 97.5% confidence bound (or C2 level – upper limit of the likely sea level for a given return period) from the CFB Dataset has been applied to the 2100 scenario. This scenario shows additional out of bank flooding along both banks of the River Dee including immediately up and downstream of the Scheme boundary (see Figure B.12).

Figure B.9: 0.5% AEP 2100 Tidal Existing Scenario Flood Depth at Connah Quay



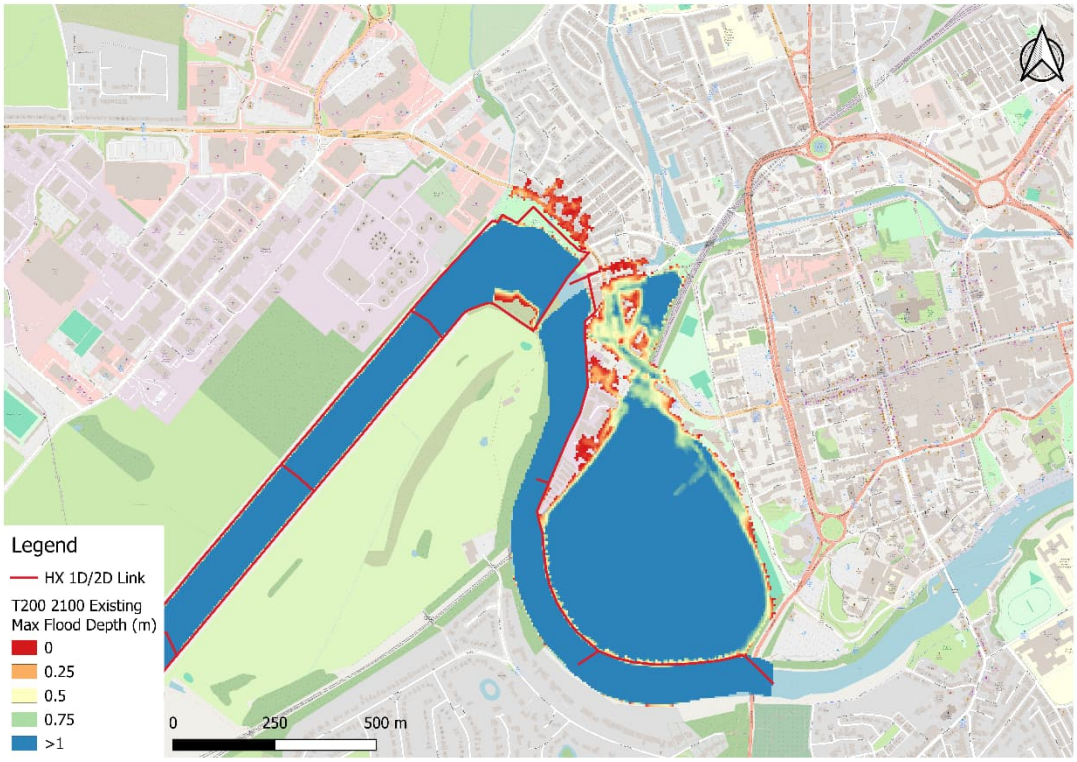
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Figure B.10: 0.5% AEP 2100 Tidal Existing Scenario Flood Depth at Scheme



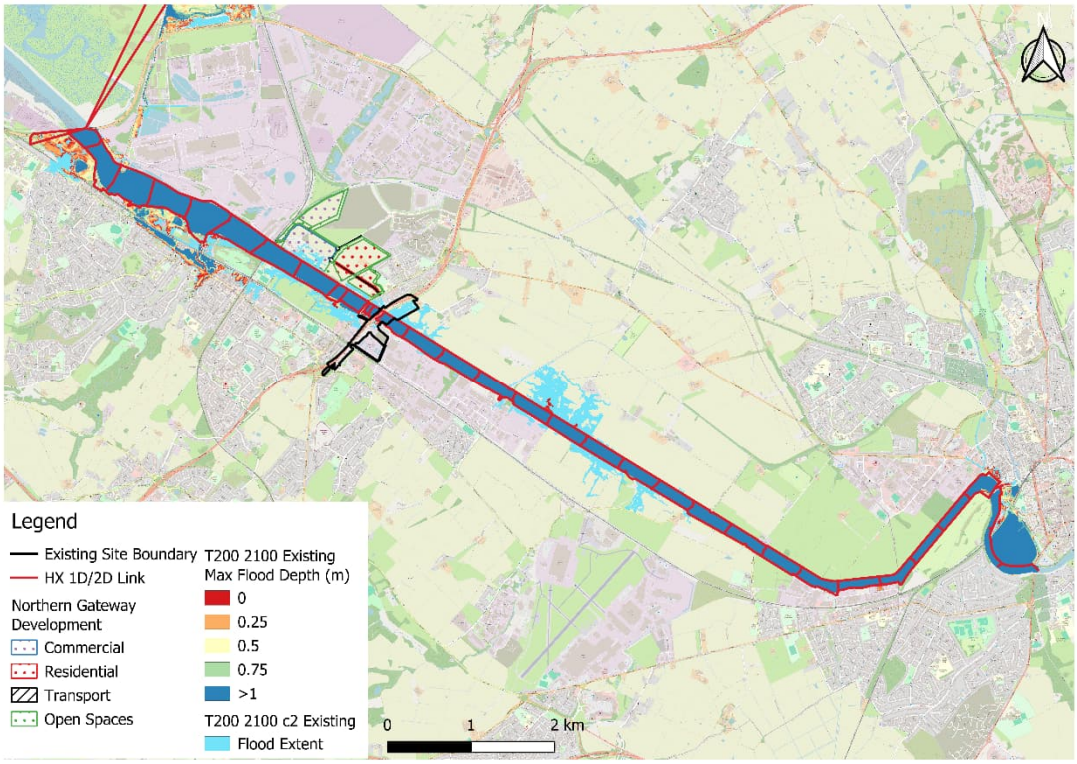
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Figure B.11: 0.5% AEP 2100 Tidal Existing Scenario Flood Depth at Chester



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Figure B.12: 0.5% AEP 2100 Tidal Existing Scenario Flood Depth C2 Confidence Level



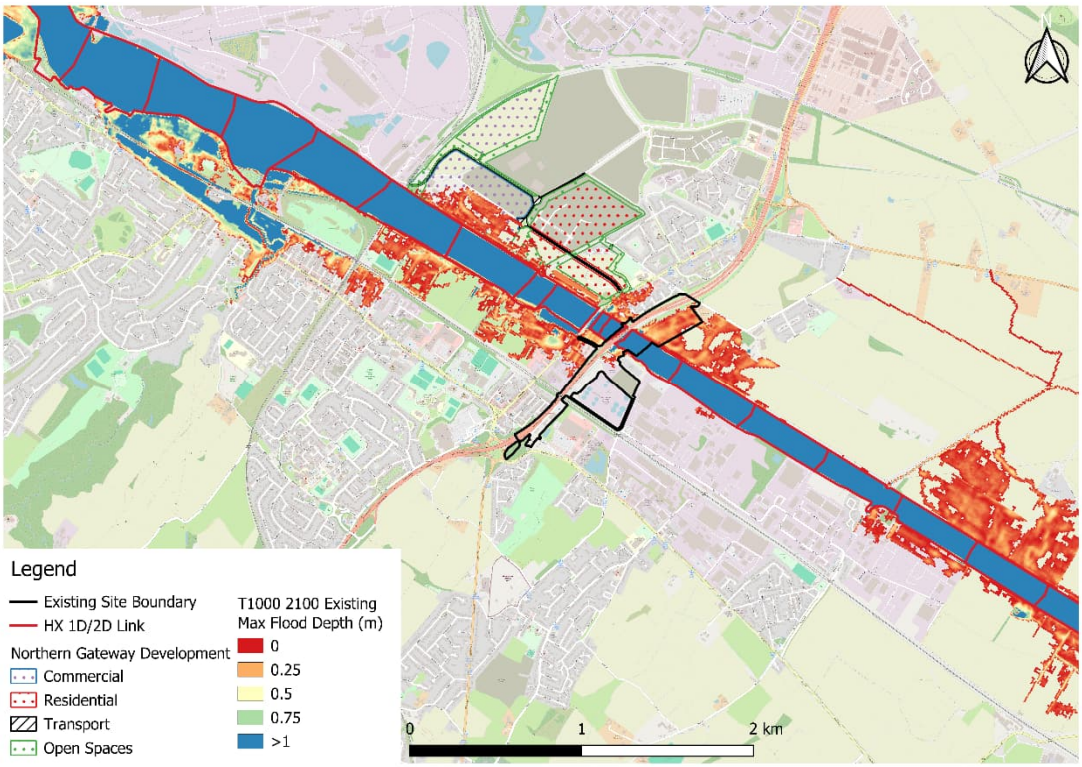
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B.2.4 0.1% AEP 2100 Tidal

In the 0.1% AEP 2100 event (see Figure B.13) the model predicts a higher extent of flooding along the left bank of the River Dee into some areas of Connah Quay as well as flooding on both banks immediately downstream of the Scheme. Flooding is also predicted on the right bank upstream of the Scheme. Out of bank flooding occurs on both sides of the River Dee within the Scheme boundary with flooding on the left bank extending onto parts of Riverside Way as detailed in Figure B.14. Upstream at Chester there is additional out of bank flooding to Chester racecourse as well as some areas to the north along Sealand Road as well as into additional residential areas including along: Gladstone Avenue, Vernon Road, and Catherine Street.

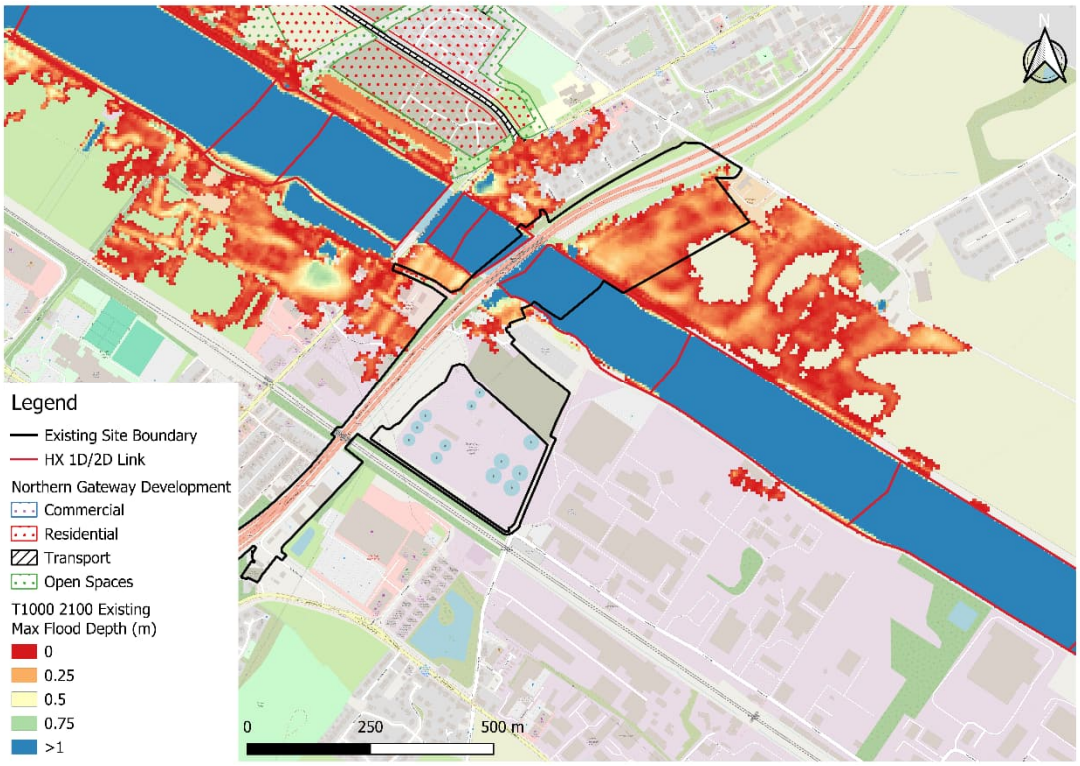
An additional sensitivity test using the 97.5% confidence bound (or C2 level – upper limit of the likely sea level for a given return period) from the CFB Dataset has been applied to the 2100 scenario. Under this scenario there is a significant increase in the extent of flooding for the 0.1% AEP 2100 Tidal scenario with flooding increasing along both banks of the River Dee both upstream and downstream of the existing A494 bridge crossing. Flooding is significantly increased on the right bank in this scenario near the Scheme boundary with flooding extending onto residential areas of both Sealand and Garden City (see Figure B.16).

Figure B.13: 0.1% AEP 2100 Tidal Existing Scenario Flood Depth at Connah Quay



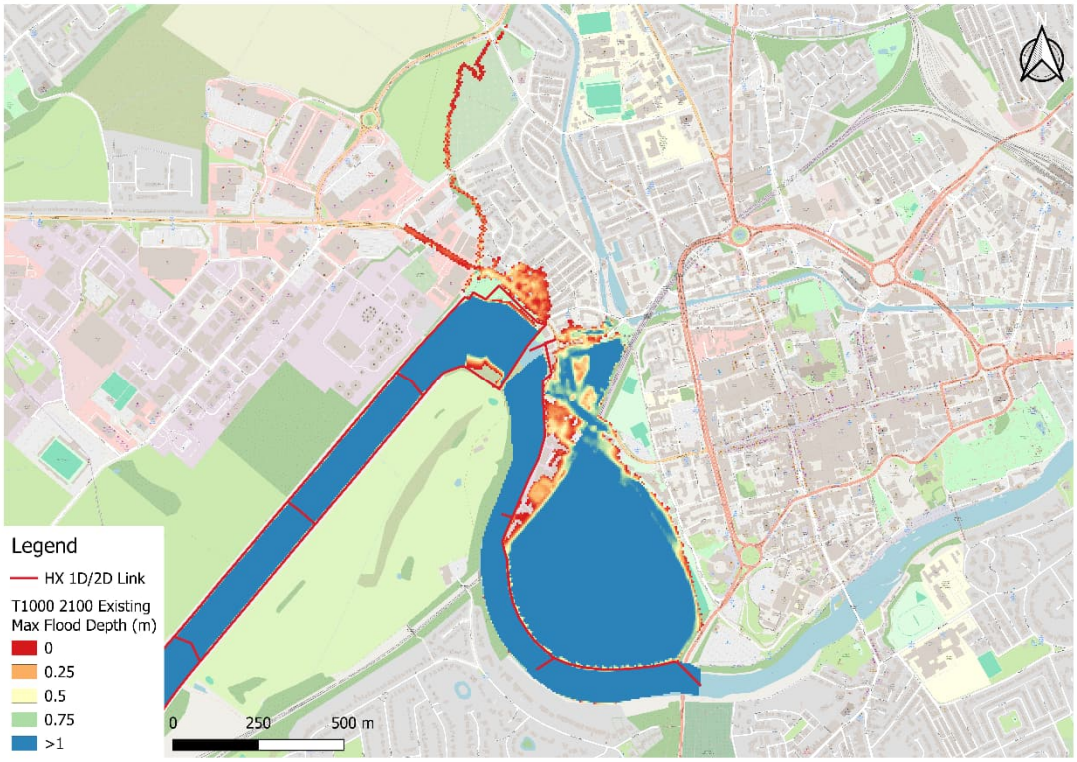
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Figure B.14: 0.1% AEP 2100 Tidal Existing Scenario Flood Depth at Scheme



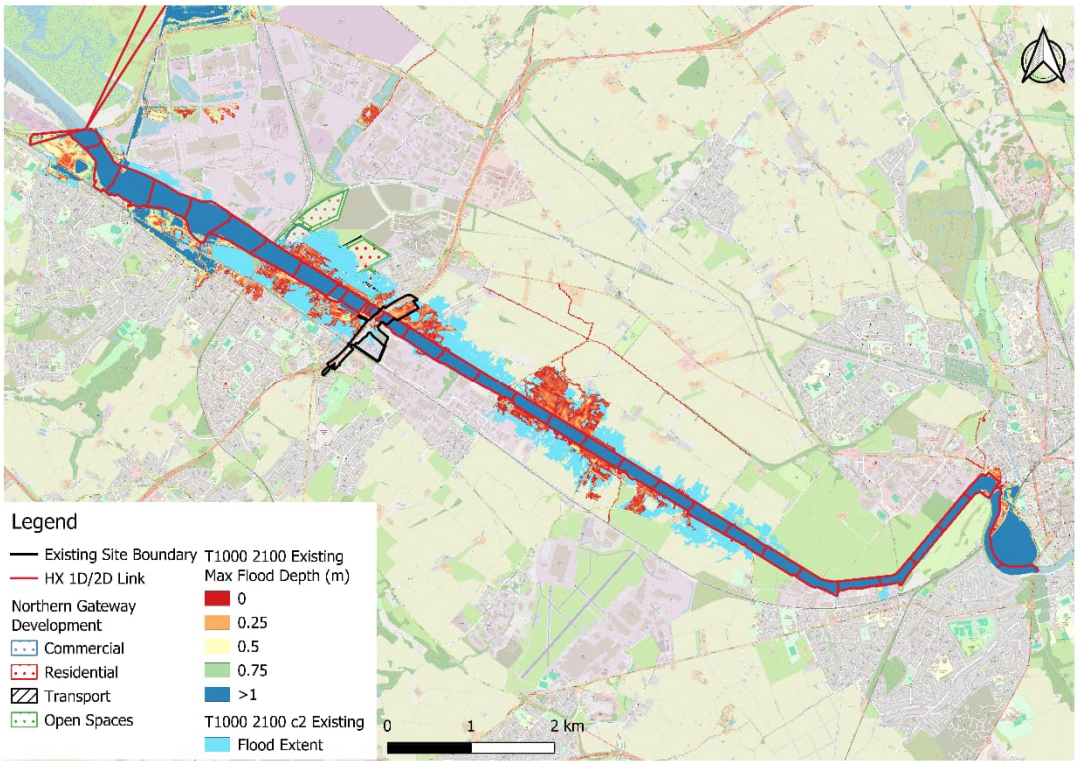
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Figure B.15: 0.1% AEP 2100 Tidal Existing Scenario Flood Depth at Chester



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Figure B.16: 0.1% AEP 2100 Tidal Existing Scenario Flood Depth C2 Confidence Level



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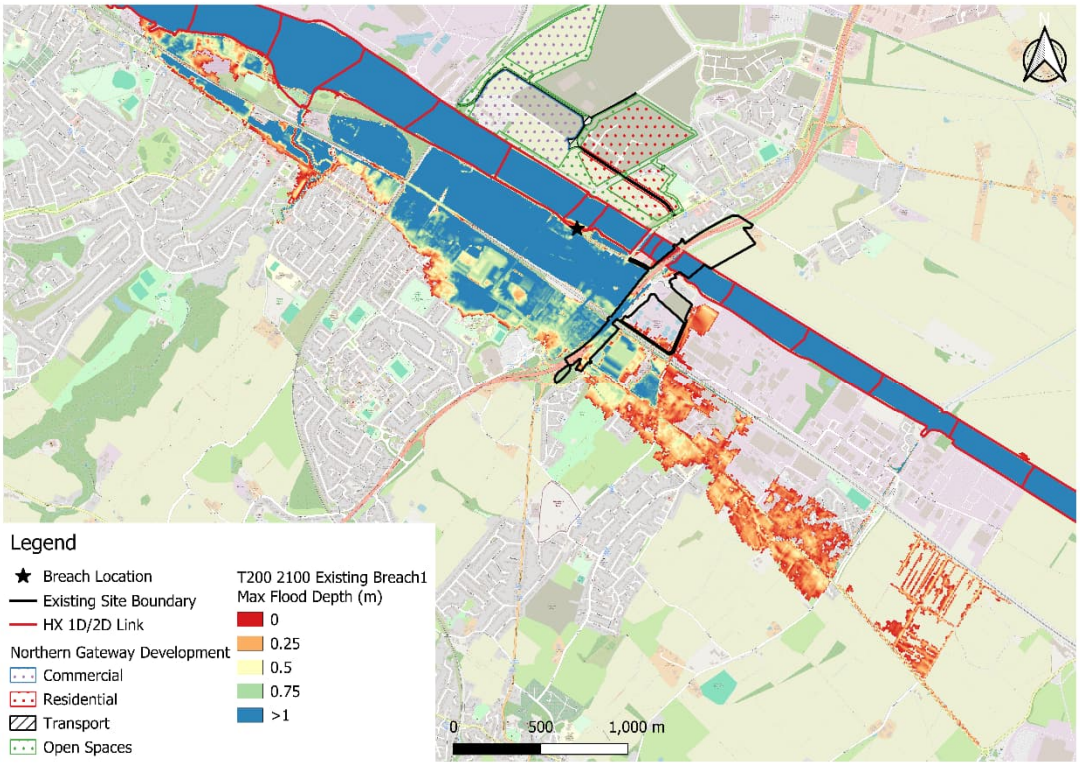
B.3 Tidal Breach

B.3.1 Tidal Breach One – 0.5% AEP 2100 Tidal

Tidal Breach One is located on the left bank tidal embankment downstream of the A494 River Dee crossing as shown in Figure B.17. Floodwater conveys overland through the breach and along the A494 railway underpass spreading eastward over Queensferry and Mancot towards Sandycroft. Under the latest model updates a watercourse running parallel to Shotton watercourse is defined in the 2D floodplain and accounts for the flooding located along Chester Road East to the south of Station Road. Areas directly next to the breach location as well as significant portions of residential areas in Shotton to the south of the North Wales Coast Line railway experience 1m or more in flood depth whilst areas to the south of the Scheme boundary experience under 1m of flooding.

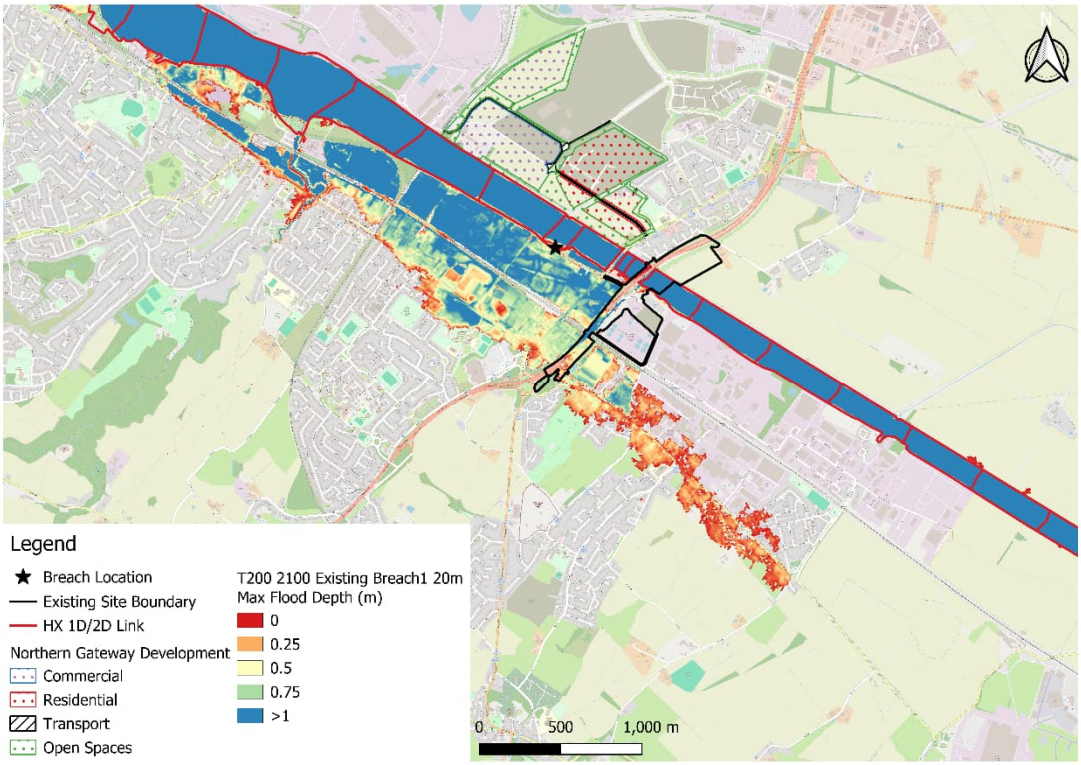
The results of the 20m sensitivity test are shown in Figure B.18. This scenario shows significantly reduced flooding extents and depths. Most notably flooding is significantly reduced in residential areas in Sandycroft and the watercourse to the south of this area does not overtop in this scenario. Only some areas nearby the breach location experience more than 1m of flooding and there is a significant reduction depth in areas across Shotton.

Figure B.17: 0.5% AEP 2100 Tidal Breach One Existing Scenario Flood Depth



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Figure B.18: 0.5% AEP 2100 Tidal Breach One 20m Existing Scenario Flood Depth



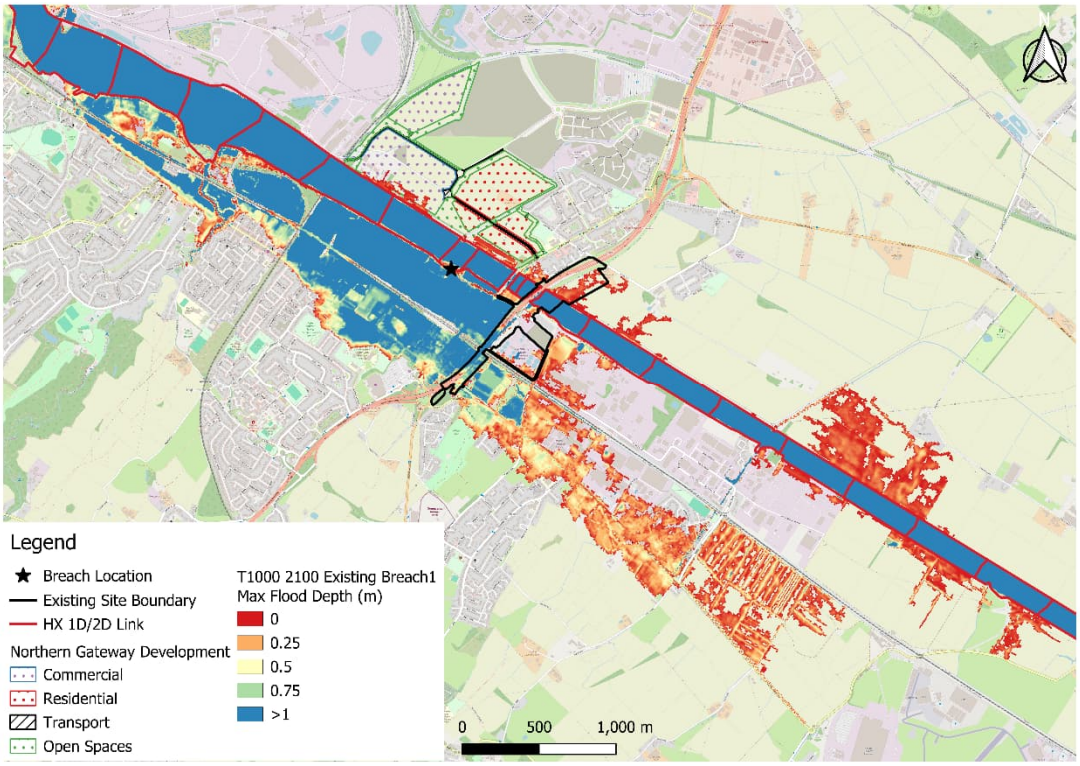
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B.3.2 Tidal Breach One – 0.1% AEP 2100 Tidal

The 0.1% AEP 2100 flood extent for Tidal Breach One spreads further eastwards across the open spaces south of Station Road compared to the 0.5% AEP 2100 event as shown in Figure B.19. Floodwater also extends onto the High Street in Shotton under this scenario.

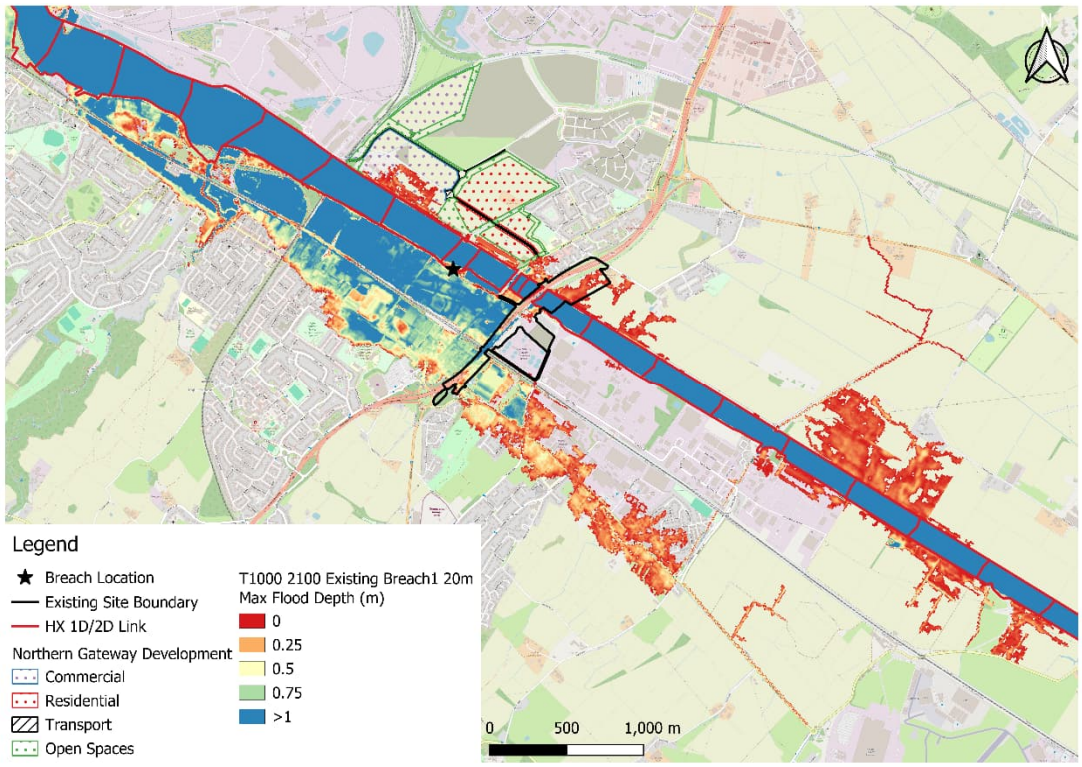
The results of the 20m sensitivity test are shown in Figure B.19. Similarly to the 0.5% AEP 2100 event even the 0.1% AEP 2100 event predicts a reduction in flood depths near the breach location and across areas of Shotton. There is also a reduction in flood depth and extend to the south of the Scheme boundary compared to the 50m breach with water not breaching into nearby open spaces south of Station Road. However, water does still cover some areas of Sandycroft to the south of the railway line.

Figure B.19: 0.1% AEP 2100 Tidal Breach One Existing Scenario Flood Depth



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Figure B.20: 0.1% AEP 2100 Tidal Breach One 20m Existing Scenario Flood Depth



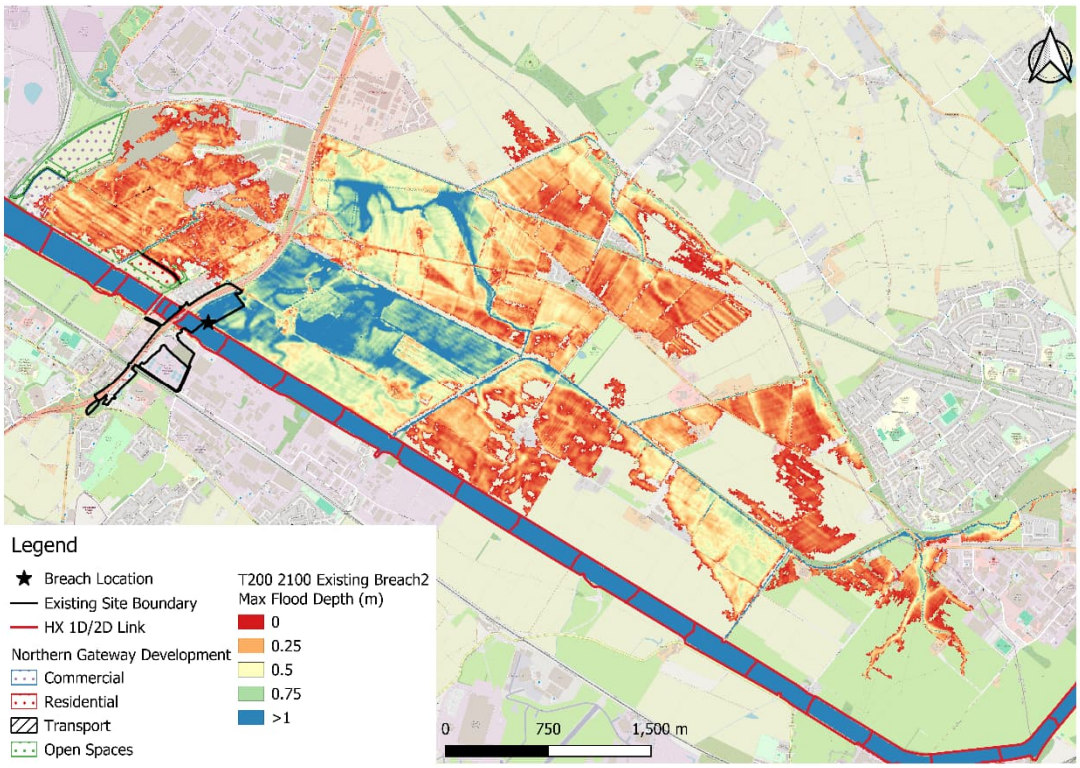
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B.3.3 Tidal Breach Two – 0.5% AEP 2100 Tidal

Tidal Breach Two is located on the right bank of the River Dee immediately upstream of the A494 river crossing as detailed in Figure B.21. This breach causes widespread flooding over the urban areas of Garden City and Sealand with flooding covering areas of The Airfields and extending north to the Cheshire West and Chester border. Flooding also covers significant areas of farmland on the right bank of the River Dee to both the north and south of Sealand Road (aka A548).

The results of the 20m sensitivity test are detailed in Figure B.22. There is a significant reduction in flooding depth close to the breach location with water depths under 1m in most locations in this area under this scenario. Additionally, there is a significant reduction in flood extents to the north of Sealand Road with flooding coming from the defined watercourses in the 2D domain rather than from the breach location.

Figure B.21: 0.5% AEP 2100 Tidal Breach Two Existing Scenario Flood Depth



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Figure B.22: 0.5% AEP 2100 Tidal Breach Two 20m Existing Scenario Flood Depth



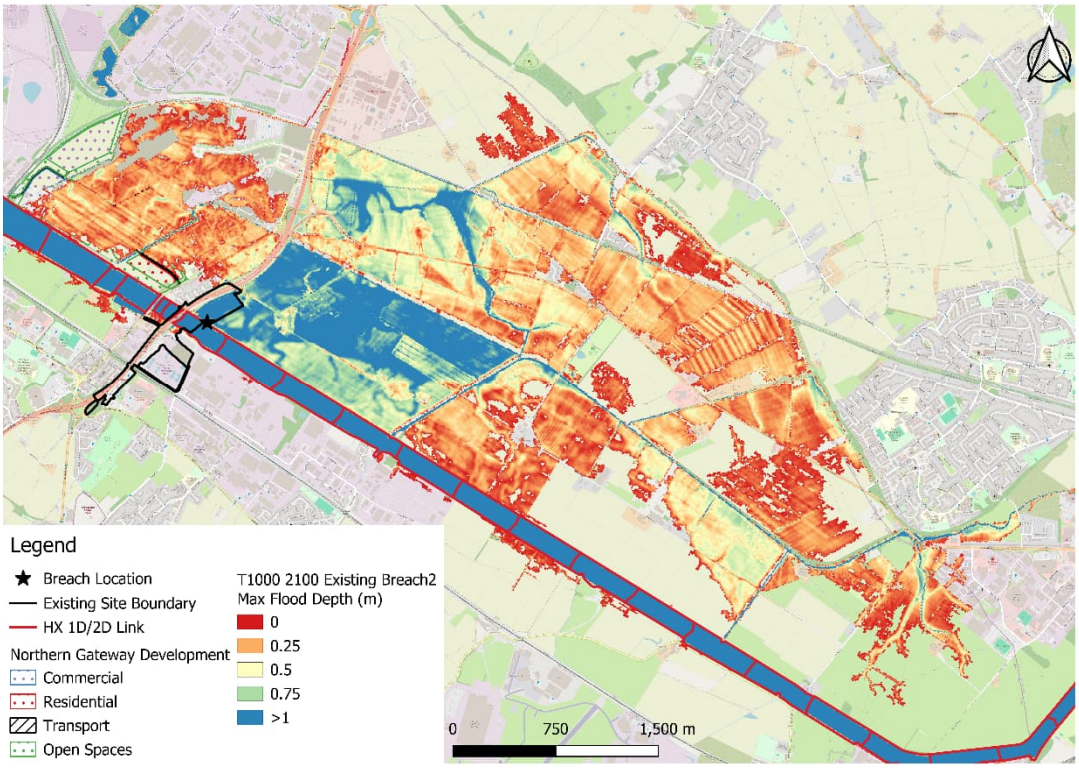
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B.3.4 Tidal Breach Two – 0.1% AEP 2100 Tidal

The 0.1% AEP 2100 flood extent for this tidal breach extents further west over farmland and rural areas than the 0.5% AEP 2100 event as shown in Figure B.23. Flood depths nearest the breach location and across Sealand are increased in this scenario with large areas predicted to be under more than 1m of flood water.

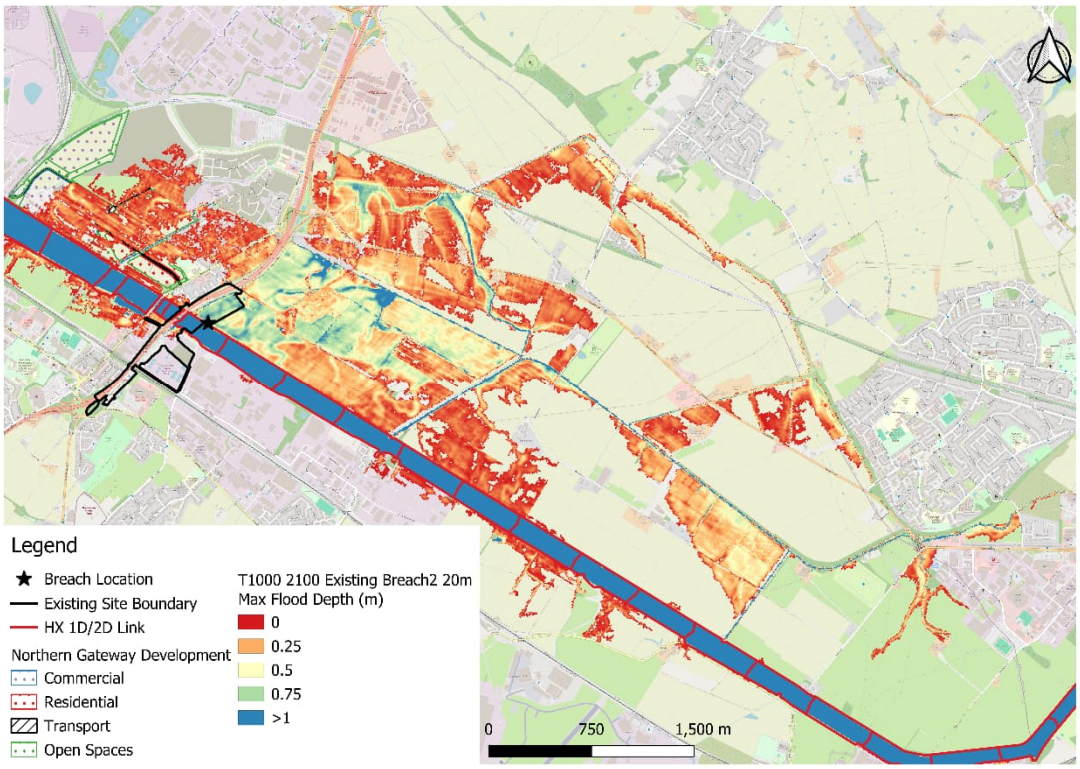
The results of the 20m sensitivity test are shown in Figure B.24. There are reductions in both flood extent and depth compared to the 20m scenario including reductions across The Airways to the east of the breach. There are also significant reductions in flooding to the northwest of the breach where flooding does not occur under the 20m scenario or is at a significantly lower depth.

Figure B.23: 0.1% AEP 2100 Tidal Breach Two Existing Scenario Flood Depth



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Figure B.24: 0.1% AEP 2100 Tidal Breach Two 20m Existing Scenario Flood Depth



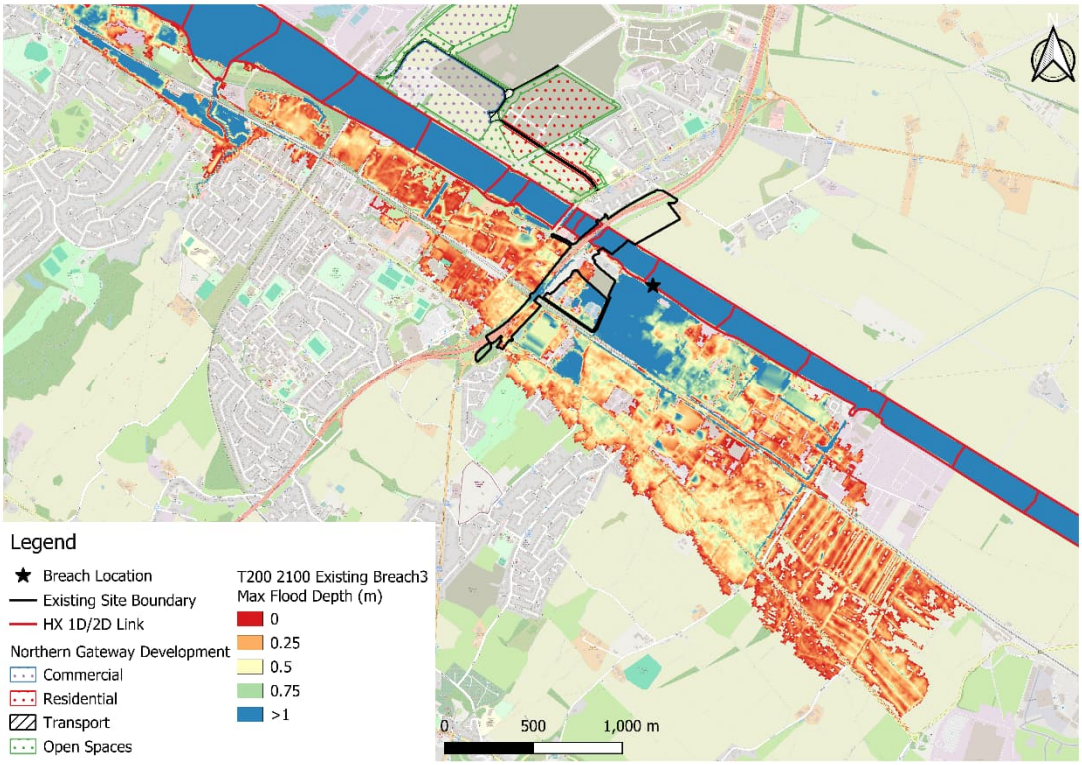
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

B.3.5 Tidal Breach Three – 0.5% AEP 2100 Tidal

Tidal Breach Three is located on the left bank of the River Dee just upstream of the A494 bridge crossing close to the Queensferry Seage Treatment Works. As shown in Figure B.25 this breach would cause significant flooding across the riverside travellers stie and the Queensferry Sewage Treatment Works. Additionally, there would be significant flooding across Sandycroft with significant flood depths of roughly 3m nearest the breach location. Flooding is also predicted across areas to the North of Shotton extending into some areas to the south of the railway line.

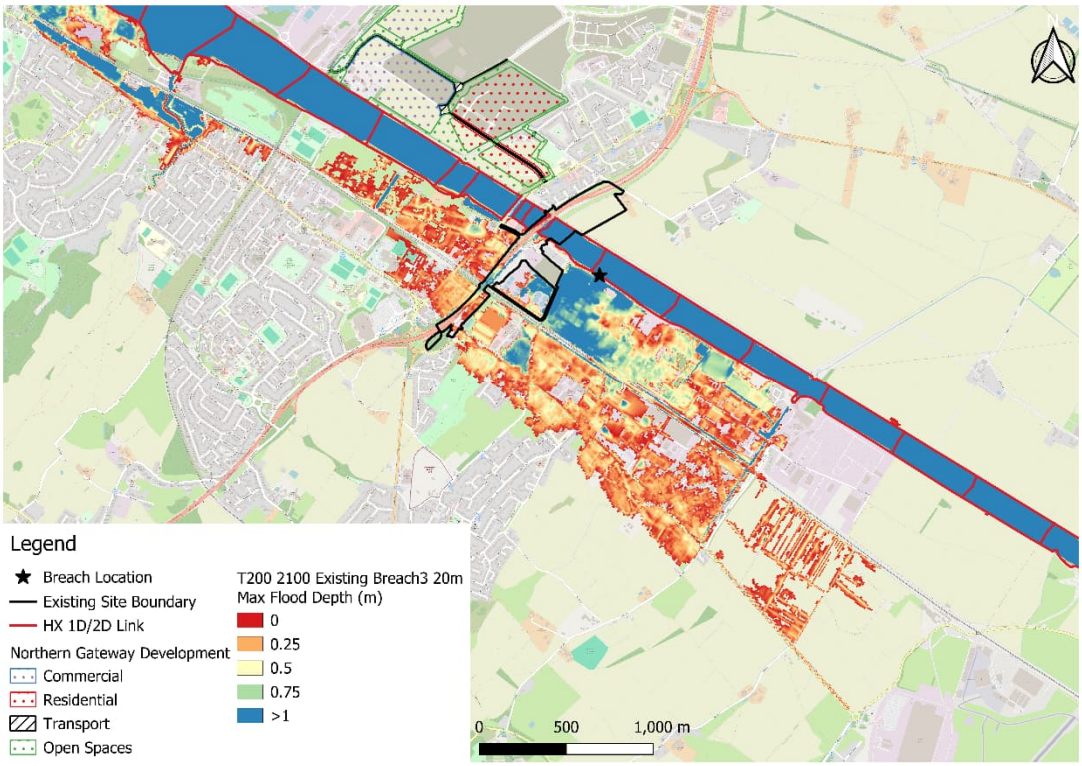
The results of the 20m sensitivity test are shown in Figure B.26. There is a reduction in flooding to the east of the breach north of Shotton. There is an unconnected flood extent coming from Wepre Brook which may have exacerbated the flood extent in the 50m breach scenario. Whilst there is a reduction in flooding depths to the south of Sandycroft, there is still upwards of 3m of flooding located immediately beside the breach under this test and flooding is still evident across all urbanised areas with only minor reductions in extent.

Figure B.25: 0.5% AEP 2100 Tidal Breach Three Existing Scenario Flood Depth



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Figure B.26: 0.5% AEP 2100 Tidal Breach Three 20m Existing Scenario Flood Depth



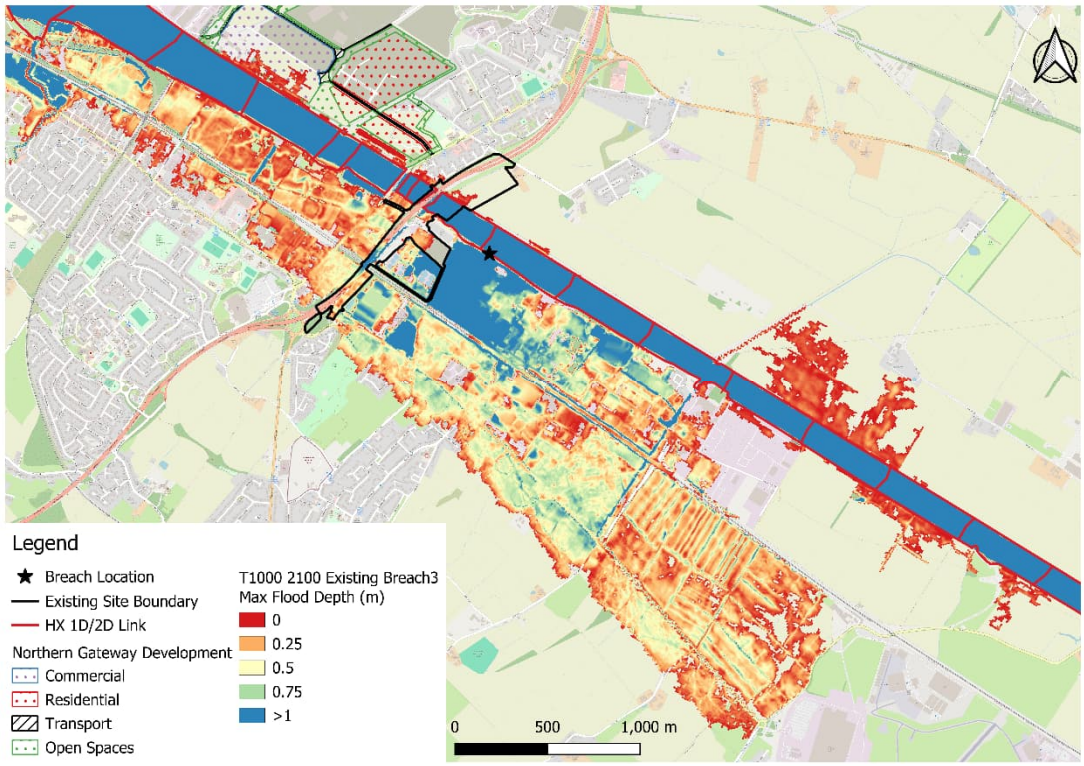
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

B.3.6 Tidal Breach Three – 0.1% AEP 2100 Tidal

Figure B.27 shows the 0.1% AEP 2100 flood extending further southwest past Sandycroft as well as extending northwest across Shotton with an increase in flood depth to these areas compared to the 0.5% AEP 2100 event.

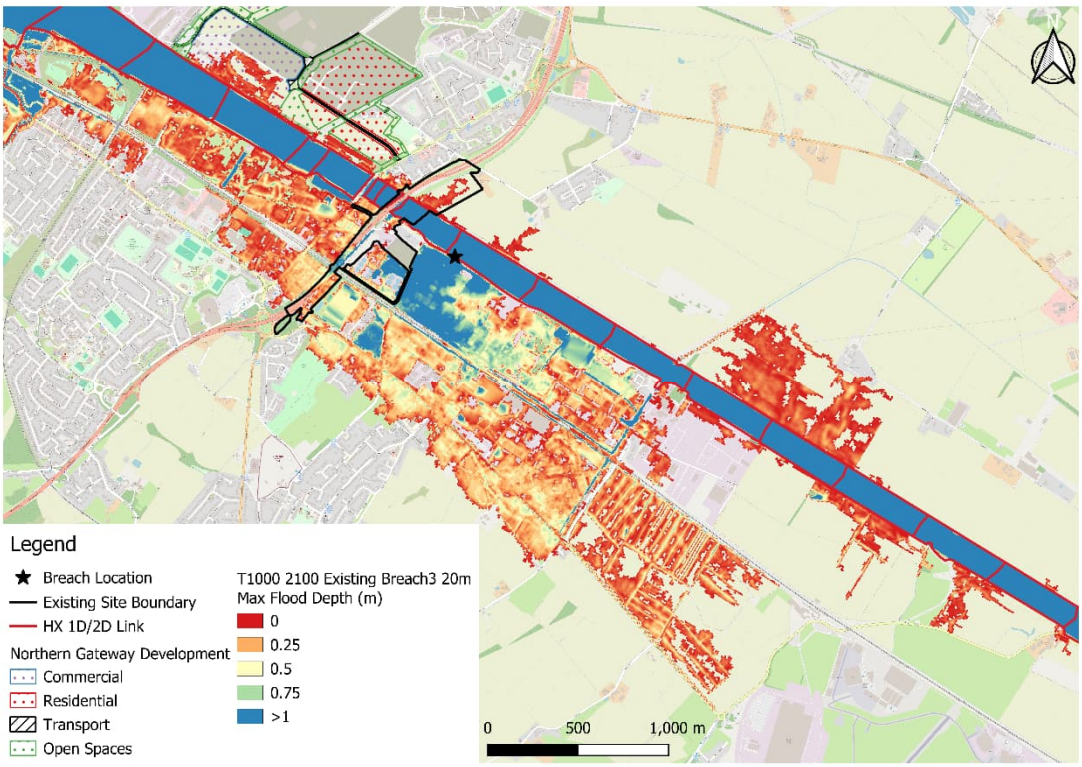
The 20m sensitivity test for Tidal Breach Three are shown in Figure B.28. There is a reduction in flood extent to the areas south of Sandycroft as well as reductions in flood depth across the urban areas in that region. Additionally, there is a reduction in flood extents across Shotton to the northwest compared to the 50m breach scenario.

Figure B.27: 0.1% AEP 2100 Tidal Breach Three Existing Scenario Flood Depth



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Figure B.28: 0.1% AEP 2100 Tidal Breach Three 20m Existing Scenario Flood Depth



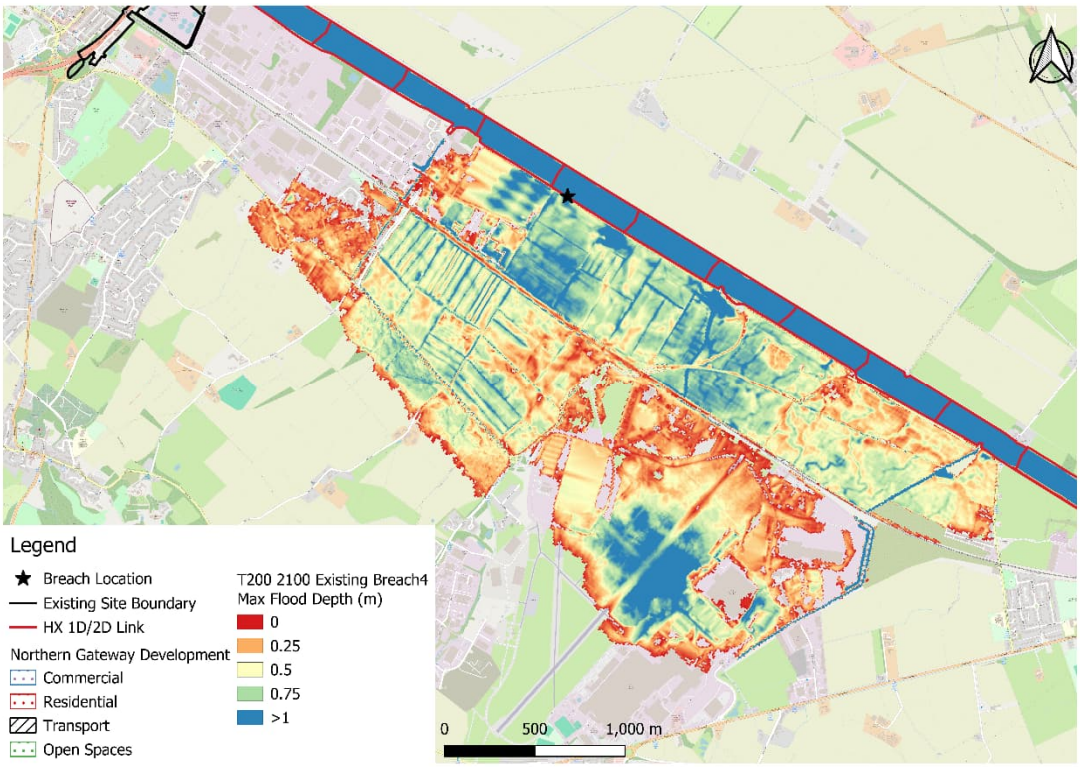
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

B.3.7 Tidal Breach Four – 0.5% AEP 2100 Tidal

Tidal Breach Four is located upstream of the Scheme at Sandycroft as shown in Figure B.29. Flooding from this tidal breach location does not extend to the Scheme with flooding stopping at Broughton Brook. However, Tidal Breach Four would cause a significant amount of flooding upstream across Sandycroft and the Hawarden Industrial Park with depths of up to 1m in areas closest the breach and near the Industrial Park itself. Flooding is also predicted to affect a section of Hawarden Airport runway in this breach scenario.

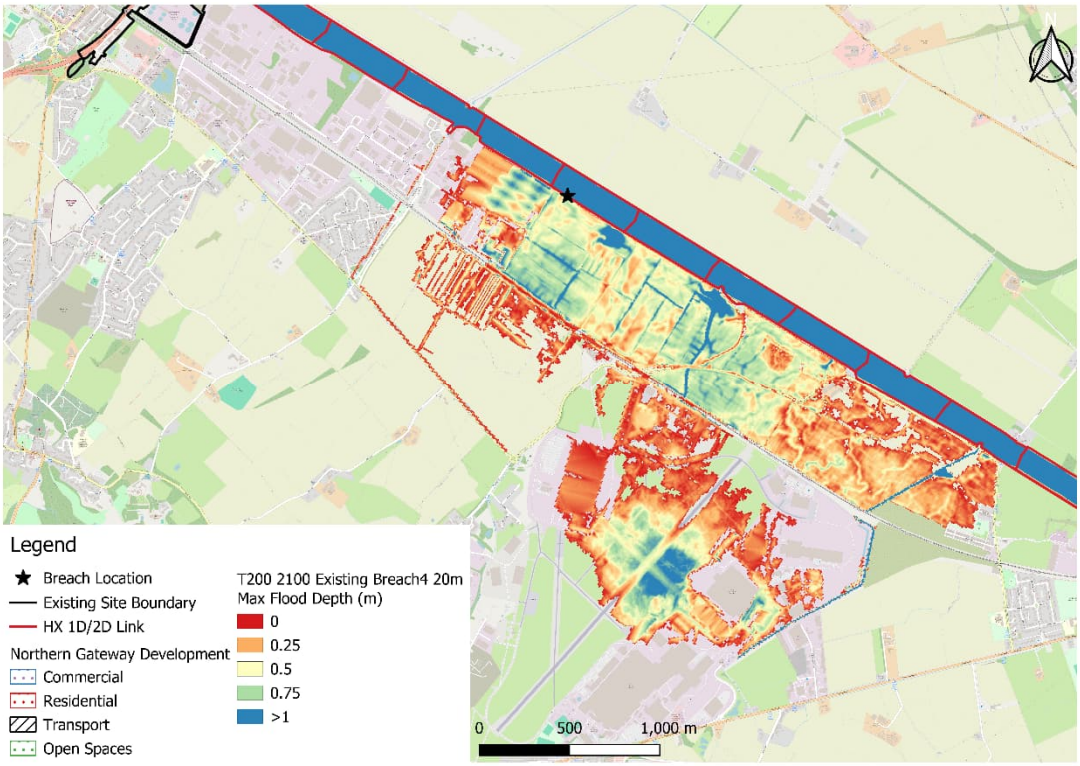
The results of the 20m sensitivity test are shown in Figure B.30. Flood extents are reduced compared to the 50m breach scenario with residential areas to the south of the railway line predicting significant reductions in flooding. There are also reductions in flood depths across the entire predicted extent for Tidal Breach Four including at the Industrial Park. Flooding still affects Hawarden airport runway under this scenario.

Figure B.29: 0.5% AEP 2100 Tidal Breach Four Existing Scenario Flood Depth



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Figure B.30: 0.5% AEP 2100 Tidal Breach Four 20m Existing Scenario Flood Depth



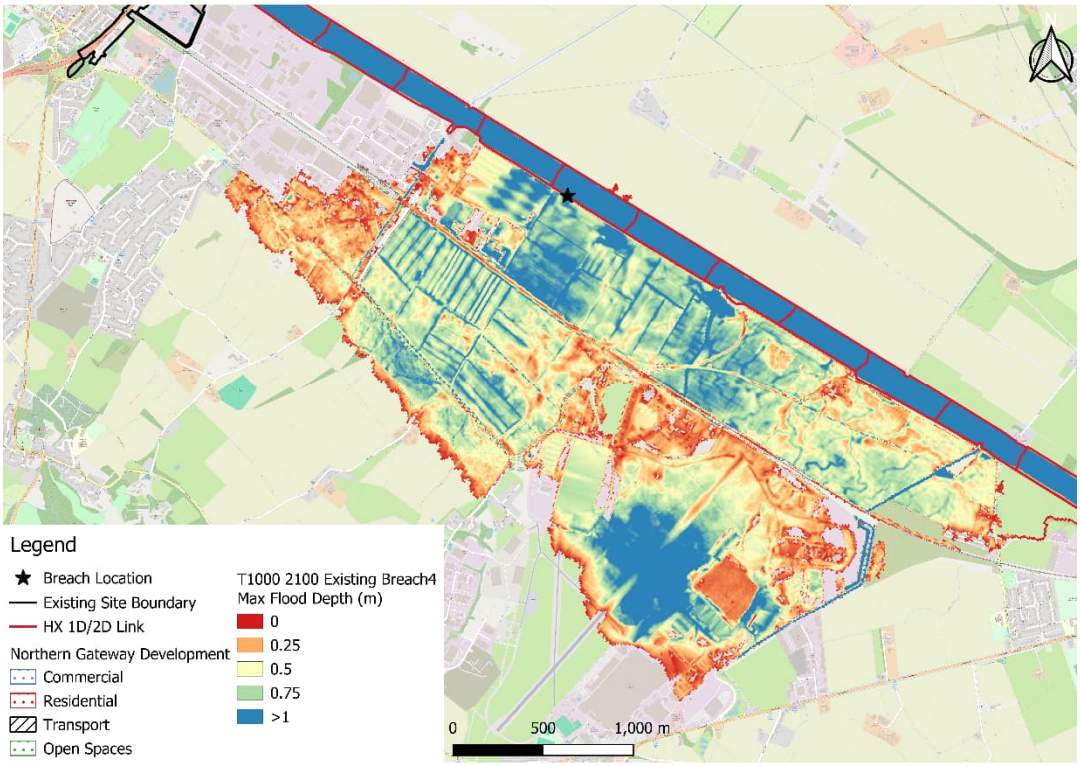
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B.3.8 Tidal Breach Four – 0.1% AEP 2100 Tidal

Figure B.31 shows the flood extent for Tidal Breach Four under the 0.1% AEP 2100 event. Flooding is largely similar to the 0.5% AEP 2100 event with an increase in depths present across the entire predicted flooding. However, there are only minimal increases to the extent of flooding mostly predicted to occur to the east of the breach across residential areas of Sandycroft. There is an increase in flood depth and extent across Hawarden Airport runway under the 0.1% AEP 2100 compared to the 0.5% AEP 2100 event.

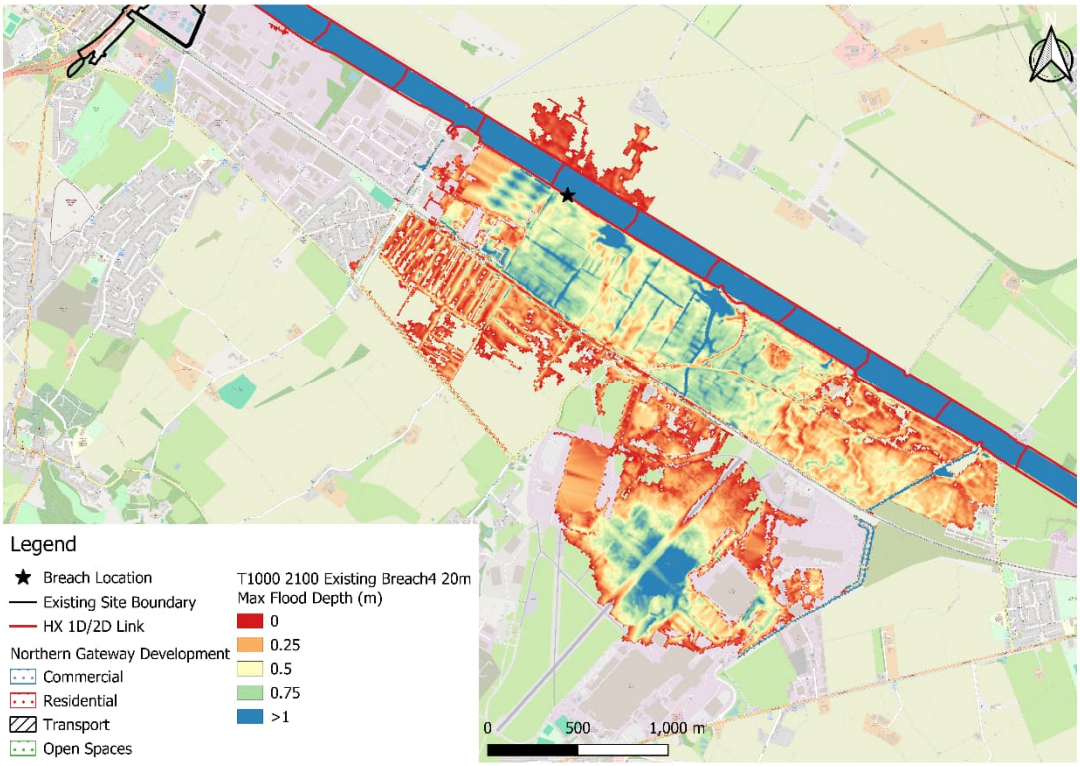
Figure B.32 shows the predicted flood extend for the 20m sensitivity test of Tidal Breach Four. Under this breach scenario flooding is not predicted to affect areas of Sandycroft to the east of Station Road.

Figure B.31: 0.1% AEP 2100 Tidal Breach Four Existing Scenario Flood Depth



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Figure B.32: 0.1% AEP 2100 Tidal Breach Four 20m Existing Scenario Flood Depth



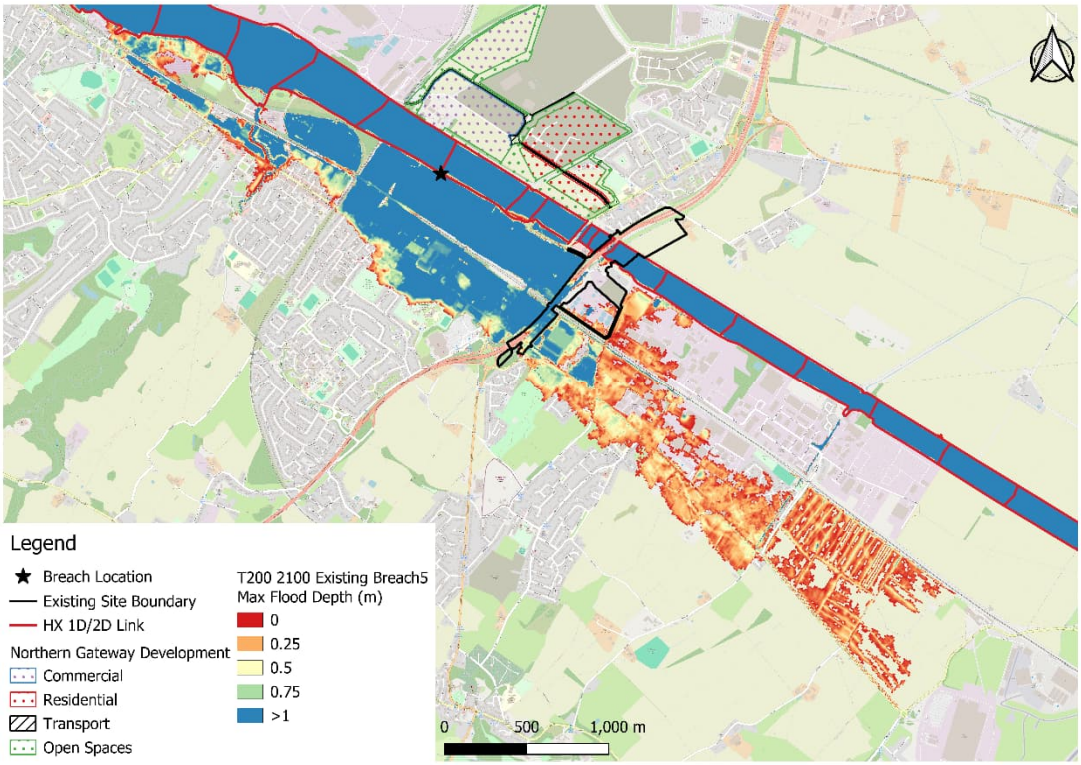
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B.3.9 Tidal Breach Five – 0.5% AEP 2100 Tidal

Tidal Breach Five is located downstream of the Scheme at Shotton as shown in Figure B.33. Flooding from this breach is predicted to result in significant flood depths with large areas around Shotton shown to be under >1m of flooding. Flooding is mostly restricted to the west of the Scheme there is some flow through the railway bridge opening which allows the transfer of water south across areas of Queensferry, Mancot, Pentre and Sandycroft.

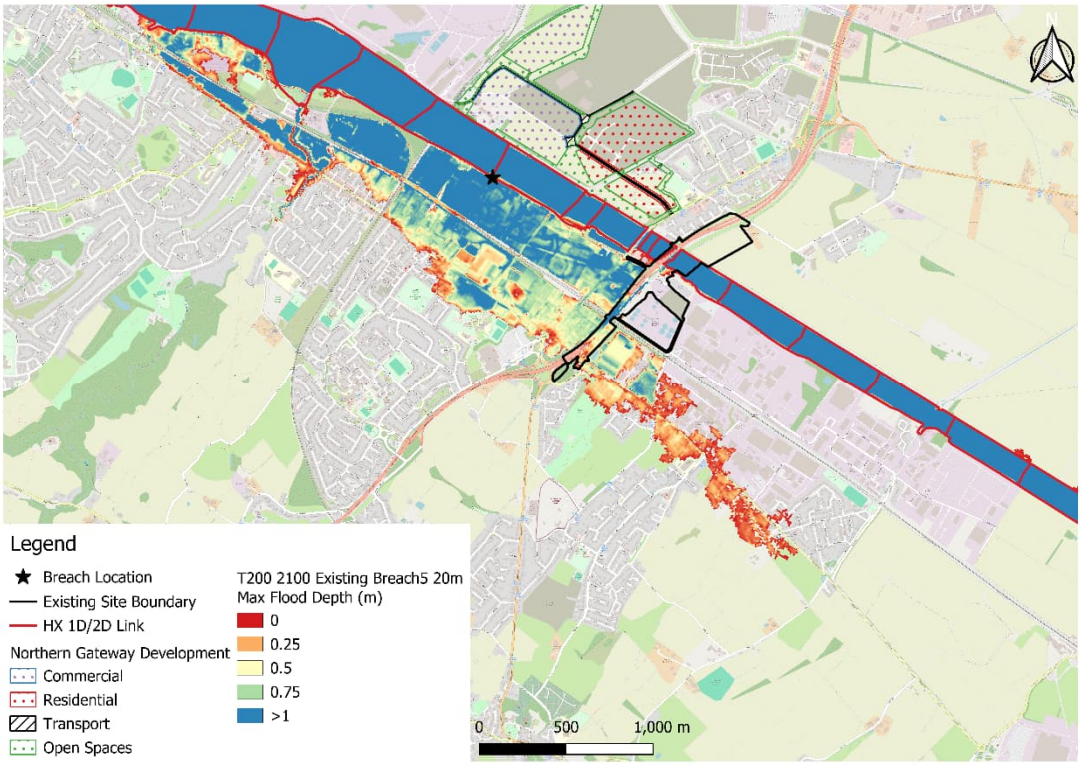
The results of the 20m sensitivity test are shown in Figure B.34. Areas north of the Scheme boundary experience a similar extent of flooding compared to the 50m scenario albeit it with reduced flood depths. The reduction in flood extent is most notable south of the Scheme where flood extents are significantly reduced across Sandycroft.

Figure B.33: 0.5% AEP 2100 Tidal Breach Five Existing Scenario Flood Depth



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure B.34: 0.5% AEP 2100 Tidal Breach Five 20m Existing Scenario Flood Depth



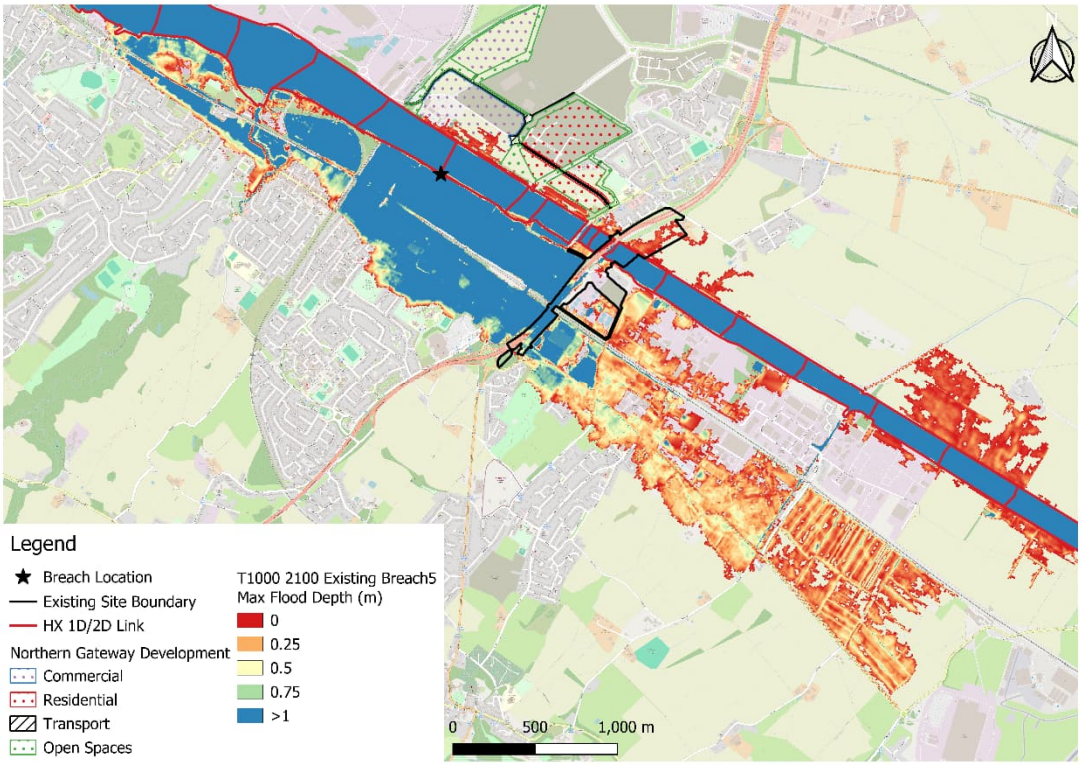
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B.3.10 Tidal Breach Five – 0.1% AEP 2100 Tidal

As shown in Figure B.35 the 0.1% AEP 2100 flood event covers a large area of Shotton, Queensferry and Sandycroft. There is a noticeable increase in flood depth across areas south of Station Road compared to the 0.5% AEP 2100 event. Flooding depth may also be exacerbated by flooding from Wepre Brook to the east of the breach location. Significant flooding is also predicted to the southwest of the Scheme and across Sandycroft.

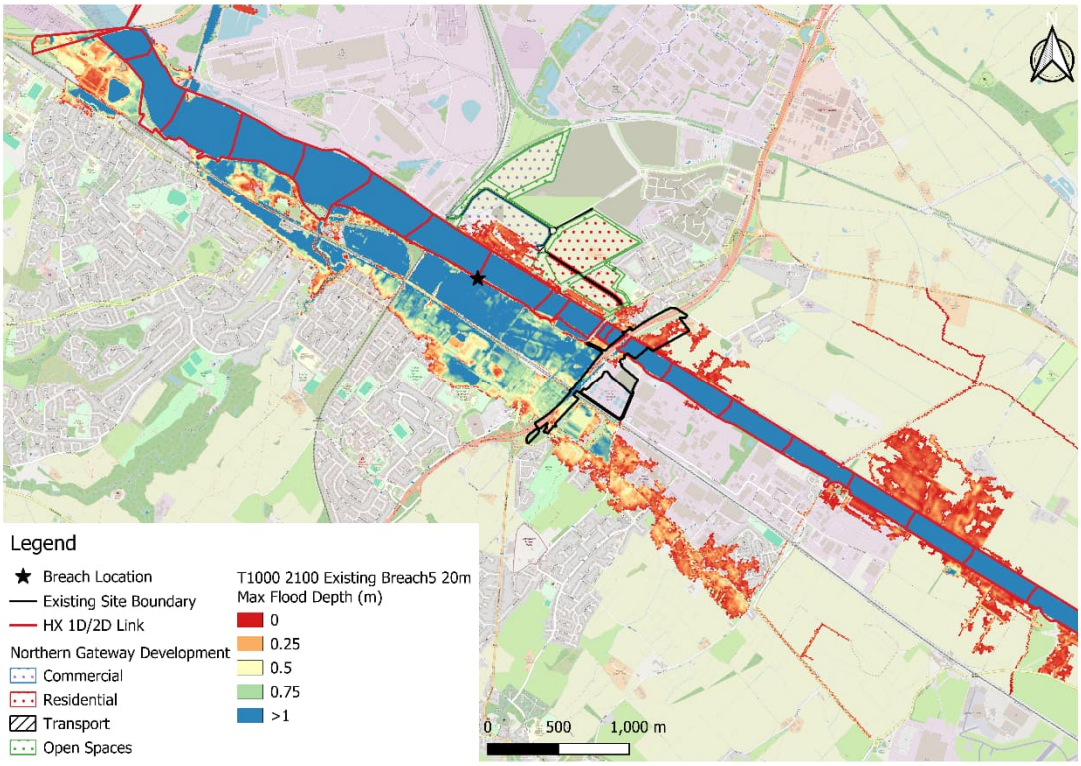
Figure B.36 shows the results of the 20m sensitivity test on Tidal Breach Five. Under the 20m scenario there are reductions in flood depth and extent around Sandycroft with flooding not predicted past Station Road. Additionally, there is a significant decrease in flood depth to Shotton especially in areas to the south of the railway line.

Figure B.35: 0.1% AEP 2100 Tidal Breach Five Existing Scenario Flood Depth



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Figure B.36: 0.1% AEP 2100 Tidal Breach Five 20m Existing Scenario Flood Depth



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

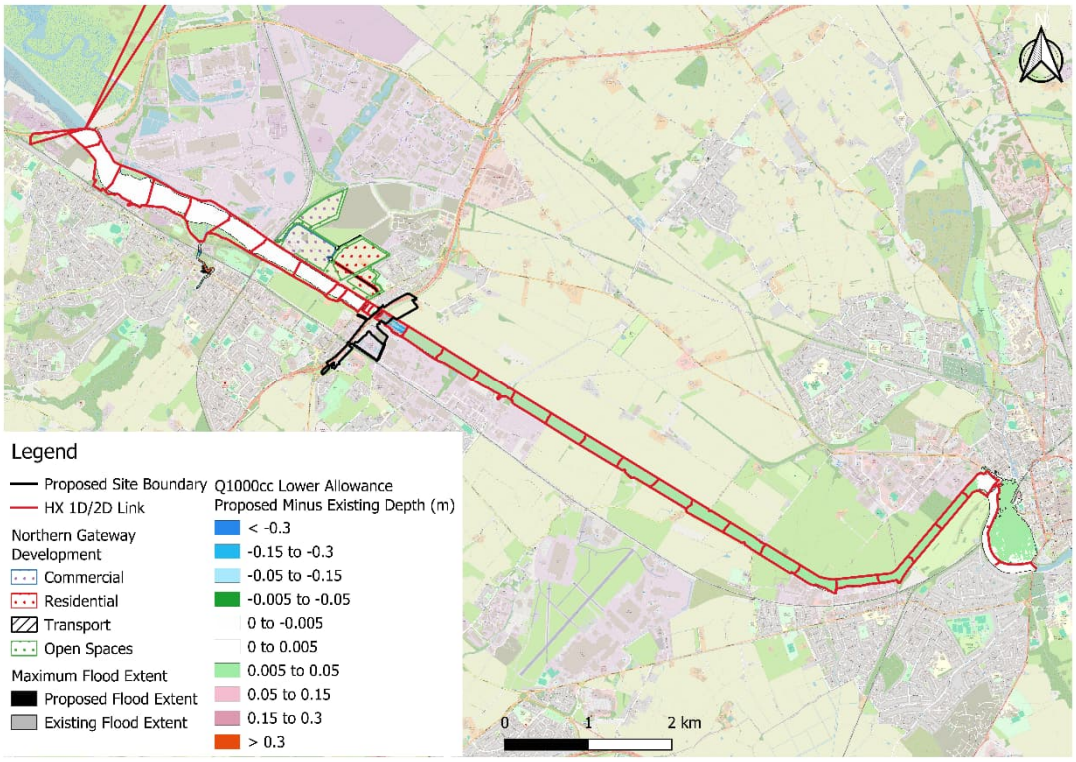
C. Proposed (Post-Development) Flood Risk Assessment

C.1 Fluvial Overtopping

There is no bank overtopping within the Scheme boundary under the Proposed Development, with the Scheme remaining flood free for the 0.1% AEP 2100 fluvial event under the Lower climate change allowance (5%). The only changes within the Scheme are predicted inside the channel where the current bridge is removed, and the proposed bridge is added. No out of bank flooding is expected in any location within the Scheme boundary under either the Proposed or Existing scenarios.

This change will have a localised impact on peak water level inside the channel upstream of the Scheme. The changes are a minor increase in in channel depths however these increases are within acceptable tolerances and do not lead to any out of bank flooding in any locations which do not occur in the Existing scenario (see Figure C.1).

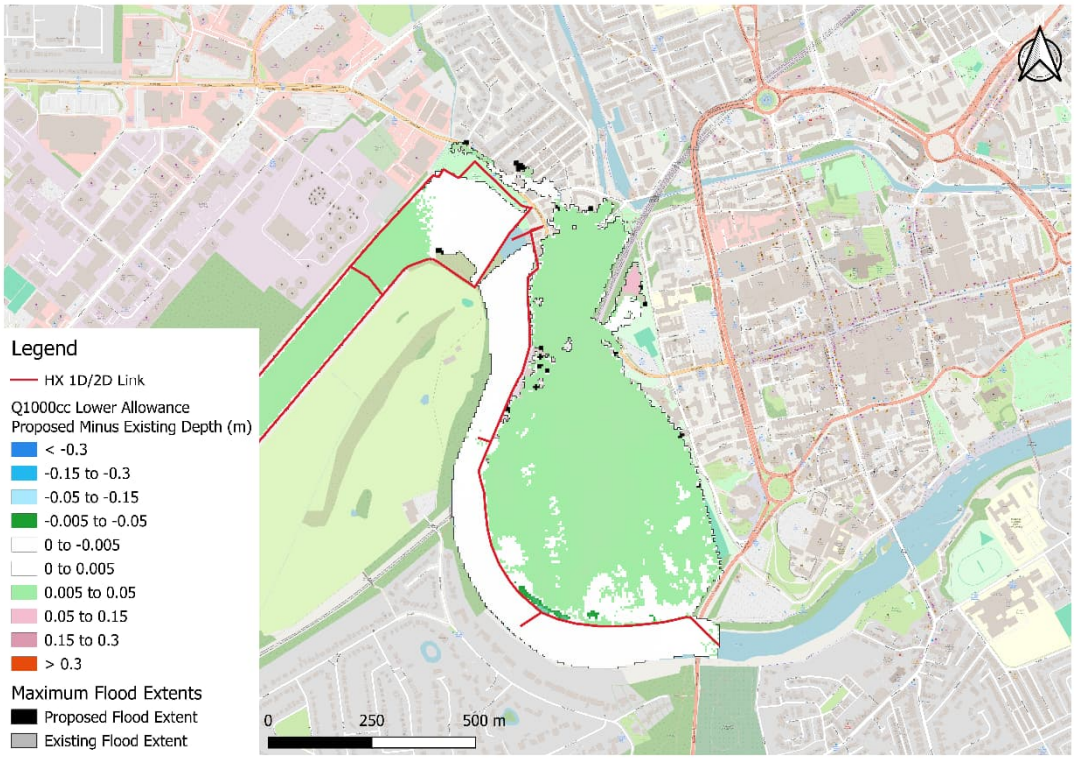
Figure C.1: 0.1% AEP 2100 Fluvial (Lower Climate Change Allowance) Existing vs Proposed Depth Difference



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Upstream at Chester there is a slight increase in the flood extent and depth. A small volume of additional water overtops the river embankments in the Proposed scenario and flows into the Chester racecourse and surrounding area. These increases in depth are predicted to propagate across residential areas (Saddlery Way, Towergate and Vernon Road). These differences are detailed in Figure C.2.

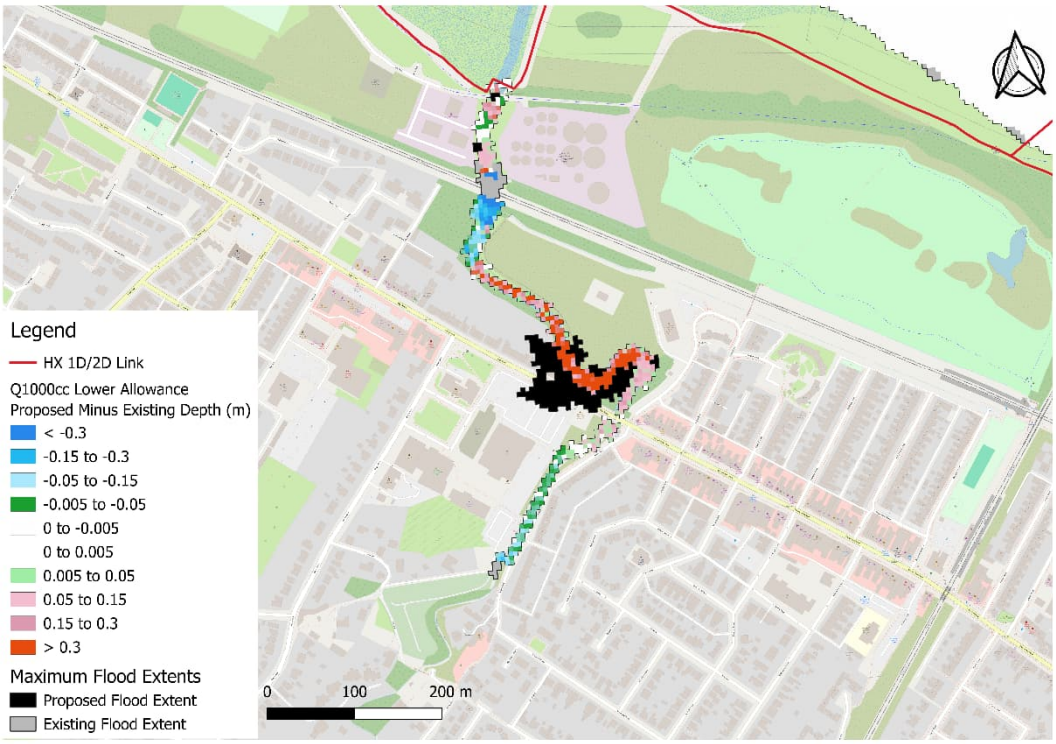
Figure C.2: 0.1% AEP 2100 Fluvial (Lower Climate Change Allowance) Existing vs Proposed Depth Difference at Chester



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Downstream by Wepre Gutter there is some additional out of bank flooding at detailed in Figure C.3. This additional flood extent appears to affect a small number of residential properties and flows over the high street affecting a supermarket car park.. These changes are caused by an increase in the in channel water levels along Wepre Gutter under the Proposed scenario.

Figure C.3: 0.1% AEP 2100 Fluvial (Lower Climate Change Allowance) Existing vs Proposed Depth Difference at Wepre Gutter



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C.2 Tidal Overtopping

The post-development scenario results in flood extents that are consistent with the pre-development flood predictions for the 0.5% and 0.1% AEP 2025 tidal overtopping scenarios (refer to Appendix B.1.4). However, under the 0.5% and 0.1% AEP 2100 events, out-of-bank flood extents are shown to decrease due to the influence of the Proposed Development.

In the sections which follow, please note that for all flood depth difference values the calculation used as been Proposed minus Existing, **hence a positive value indicated an increase in water levels.**

It is noted that the flood extents for the Existing and Proposed scenarios are different at the existing and proposed A494 bridge locations. This is because the 1d flood extents are not generated for the structure locations (bridges). Additionally, the Proposed scenario reduces the 1d channel extent at the confluence with the Queensferry Drain (left bank immediately upstream of the new bridge). These factors result in an artificial reduction in flood extent in the Proposed scenarios. Such areas are marked in the figures, with explanatory notes provided.

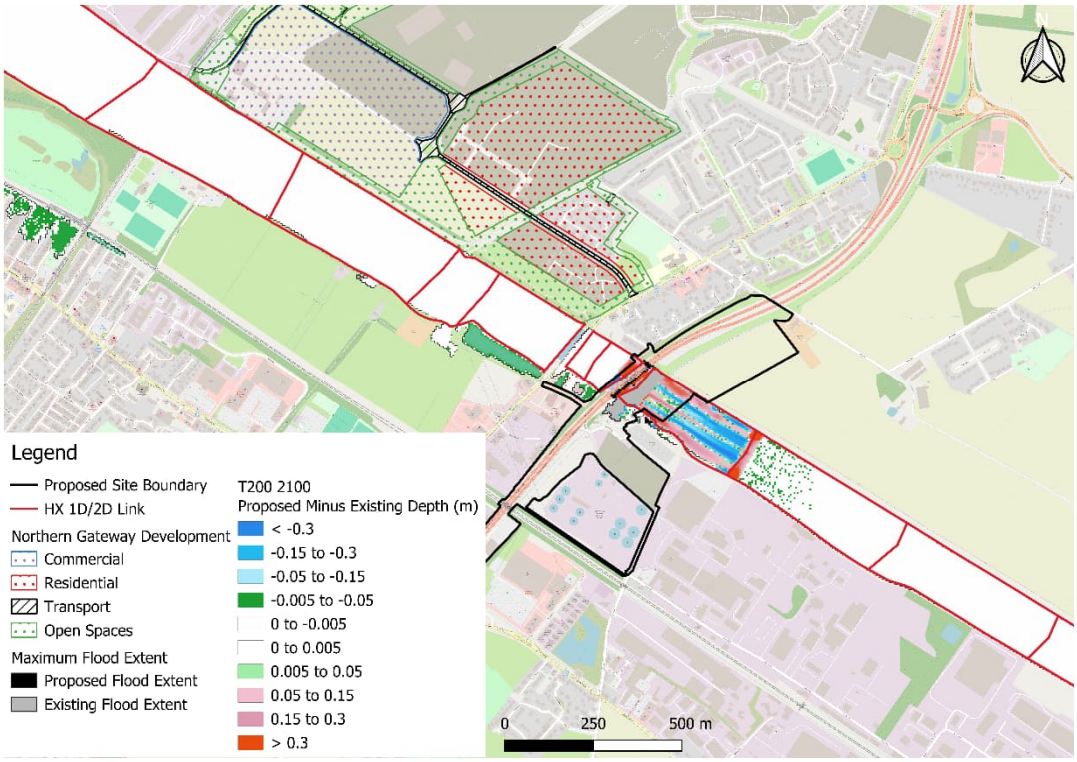
C.2.1 Future Scenario (2100)

For the 0.5% AEP 2100 event, flood risk remains largely unchanged from the Existing scenario. No overtopping flooding is predicted within the Scheme boundary, and only minimal out-of-bank flooding is observed downstream of the Scheme (see Figure C.4).

In contrast, the 0.1% AEP 2100 event shows overtopping and flooding at the Scheme under both the Existing and Proposed scenarios, as shown in Figure C.5. Flooding occurs on both banks of the River Dee, with more significant impact on the right bank, affecting nearby commercial and residential areas. The Proposed scenario generally reduces the extent of flooding compared to that of the Existing scenario. However, some areas experience increased flood extent and depth:

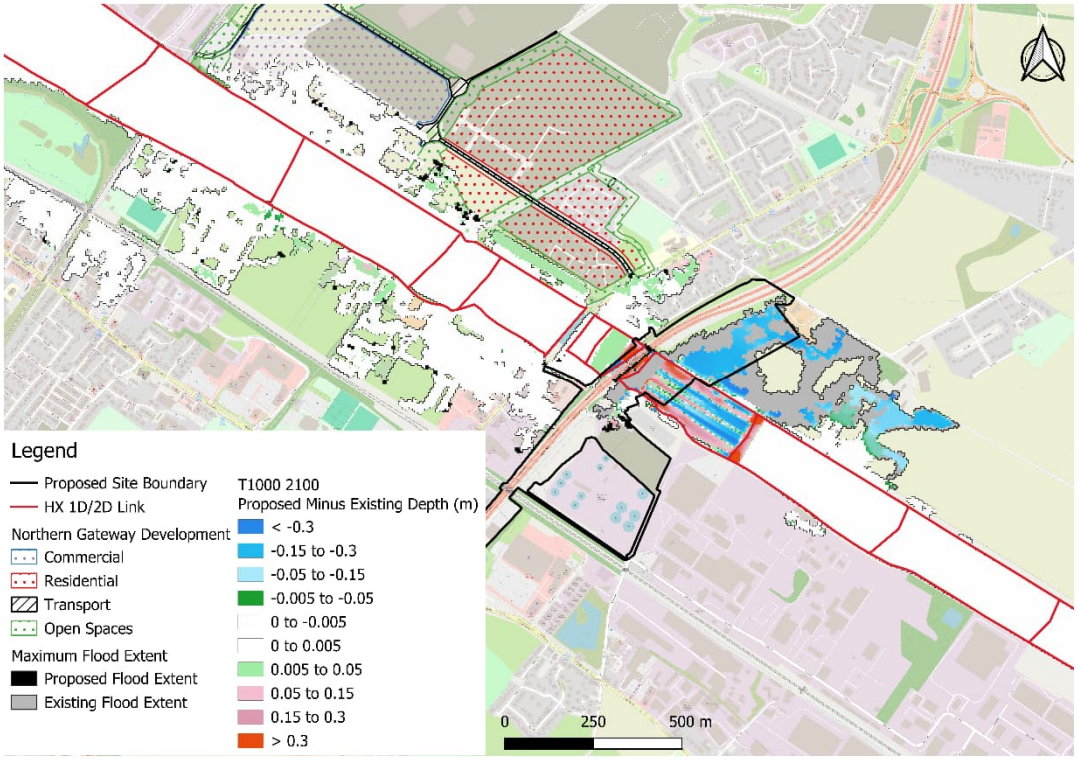
- A small area of Garden City close to the River Dee sees a small increase in the number of residential areas affected.
- On the left bank, flood extent increases are most notable in the commercial area within the Expressway Business Park.

Figure C.4: 0.5% AEP 2100 Tidal Existing vs Proposed Depth Difference



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Figure C.5: 0.1% AEP 2100 Tidal Existing vs Proposed Depth Difference



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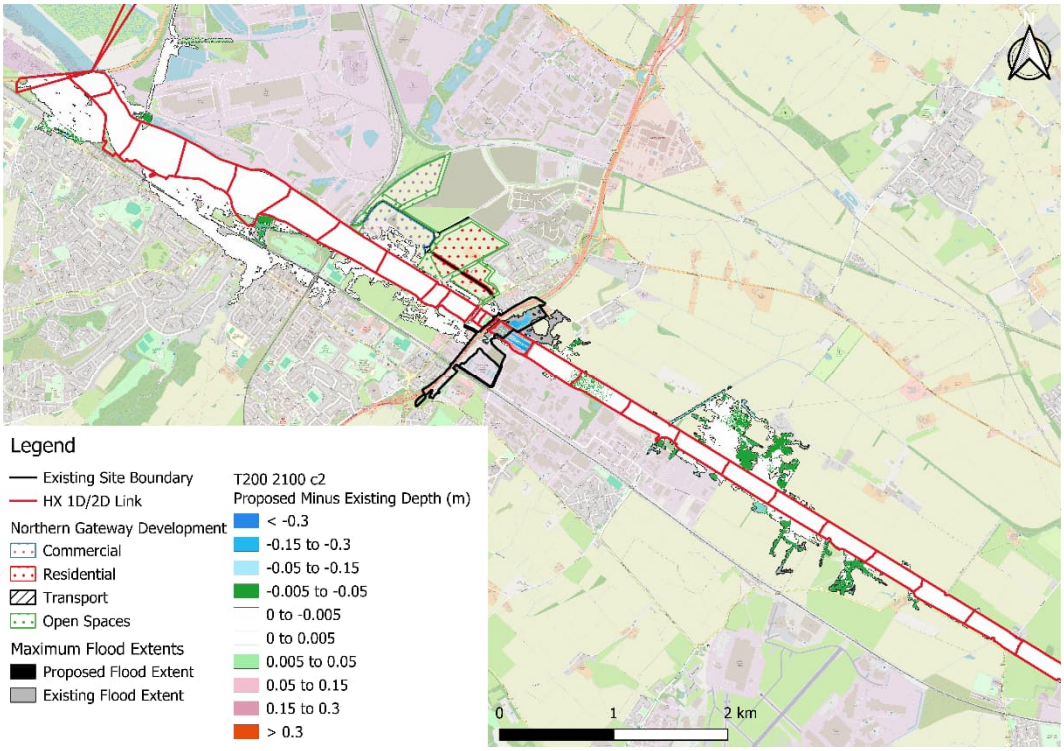
C.2.2 Future Scenario Under Upper Confidence Limit (2100)

A sensitivity run was also performed for the 2100 tidal flood events using the c2 confidence interval. The resulting flood extents are shown in Figure C.6 and Figure C.7.

Under the Existing 0.5% AEP 2100 event with the c2 conditions, the model predicts out-of-bank flow around the Scheme and in the floodplain to the south of Foxes Lane. In the post-development scenario for the same return period, this flooding is notably reduced. Flood depths are also reduced, particularly on the right bank upstream of the Scheme, where flooding persists in the pre-development scenario. Downstream of the development there are some minor increases in flood extent however these are shallow and represent only minimal differences in flood depth between the two scenarios.

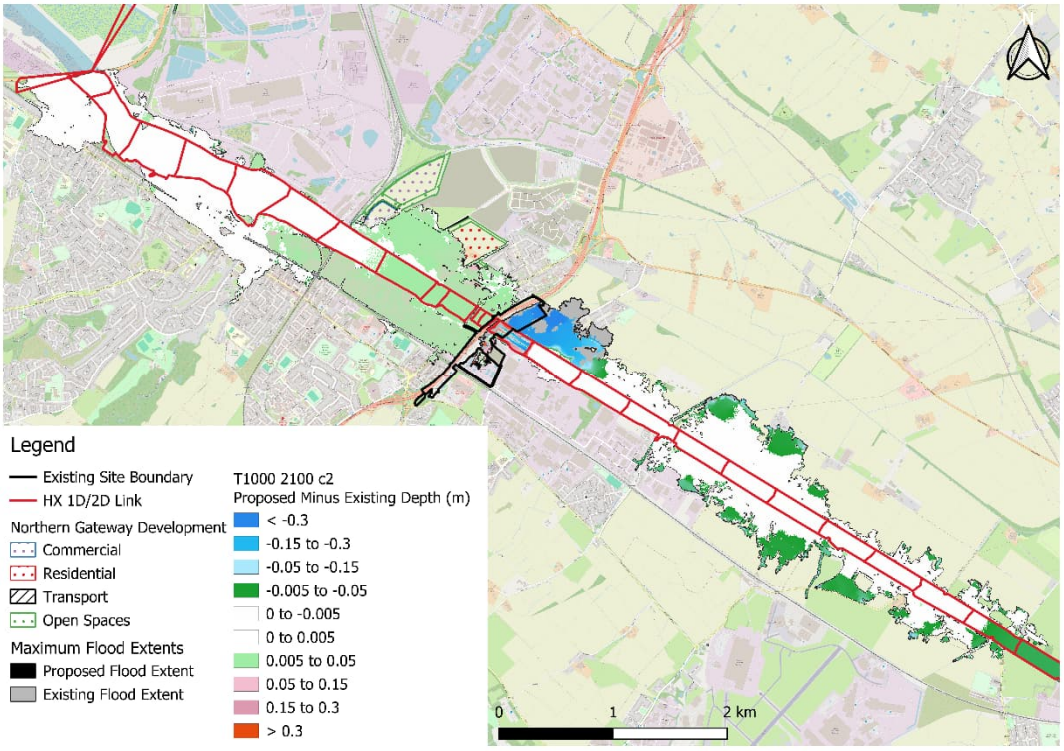
The 0.1% AEP 2100 under c2 conditions the post-development model predicts a significant reduction in flood extent across the Scheme and upstream along the right bank compared to the pre-development scenario. Flood depths are also reduced in these areas. Downstream of the development, flood extents fluctuate slightly between the two scenarios, with some areas showing reductions and other showing increases. Flood depths downstream are increased in large areas of the models 2D floodplain including areas in Garden City and some urban areas in Shotton. Flood depths are minorly reduced at the fringes of the flooding extent under the post-development scenario.

Figure C.6: 0.5% AEP 2100 Tidal Under c2 Conditions Existing vs Proposed Depth Difference



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Figure C.7: 0.1% AEP 2100 Tidal Under c2 Conditions Existing vs Proposed Depth Difference



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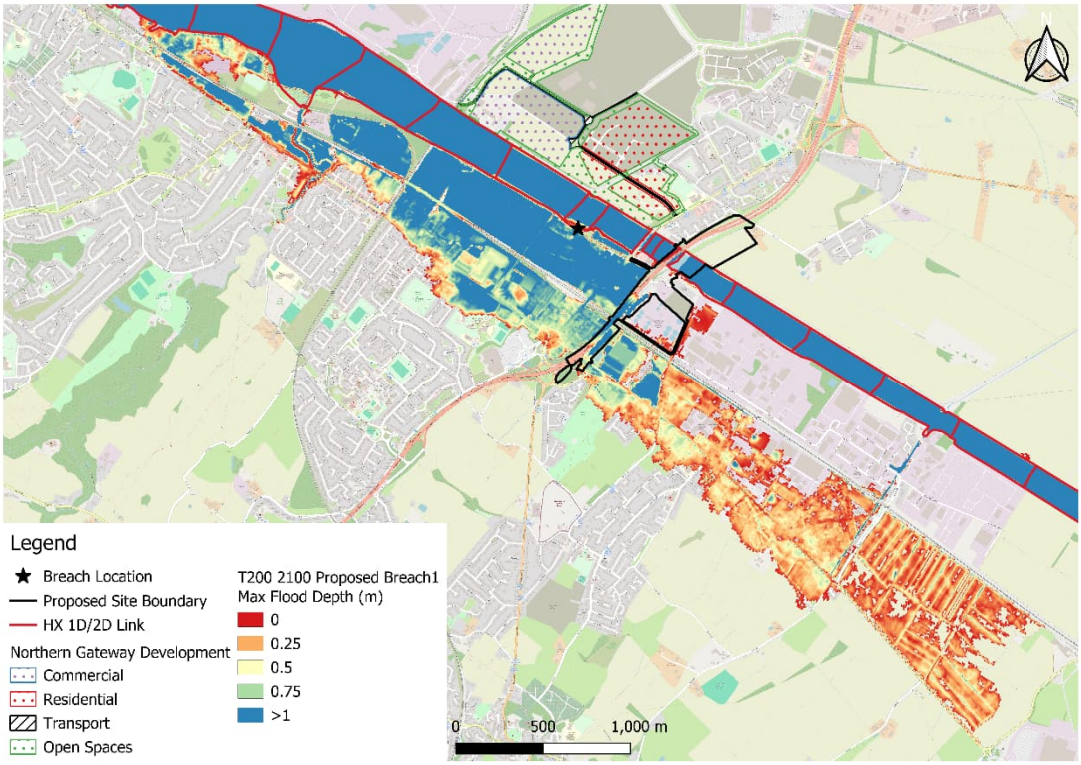
C.3 Tidal Breach (No Mitigations)

In the sections which follow, please note that for all flood depth difference values the calculation used as been Proposed minus Existing, **hence a positive value indicated an increase in water levels.**

C.3.1 Tidal Breach One

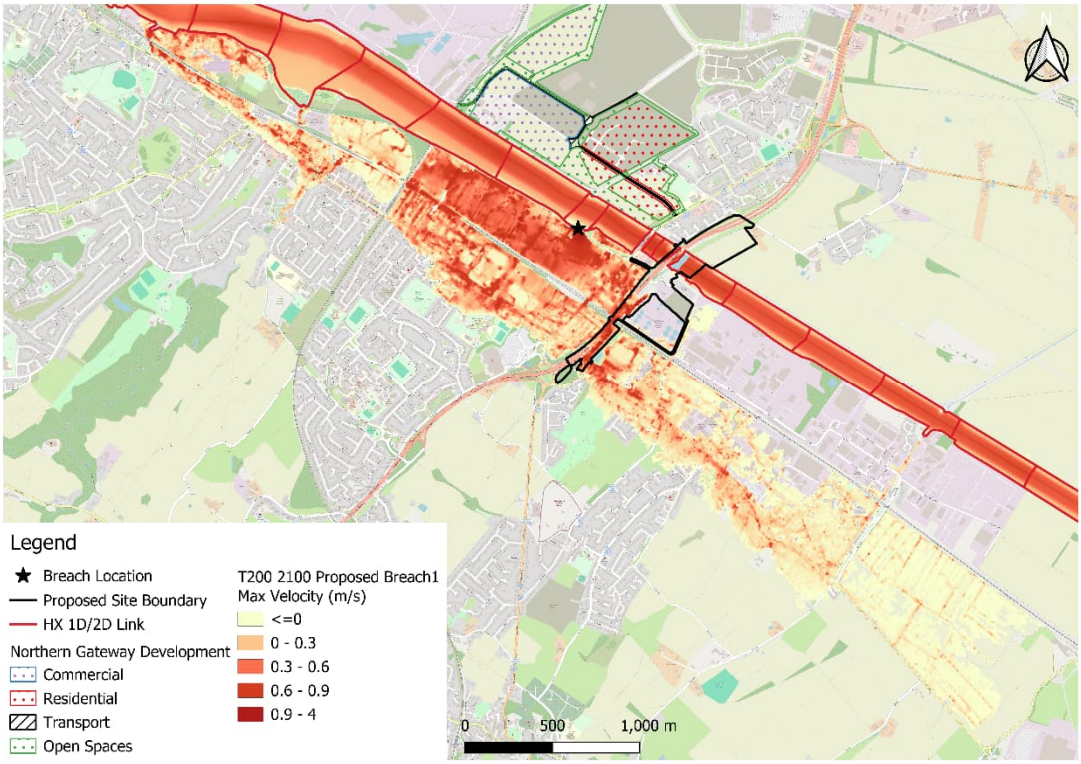
Figure C.8 to Figure C.13 show the predicted flood extent, depth and velocities caused by Tidal Breach One under the post-development scenario as well as the flood extent and depth of the 20m sensitivity breach scenario. Tidal Breach One poses a significant flood risk to the Shotton, Queensferry, Pentre and Sandycroft areas, as well as to the Scheme. Flood depths close to the breach location are predicted to be in excess of 1m for much of the area around Shotton. Flooding from this breach also intersects with existing flooding from Wepre Brook to the north of Shotton.

Figure C.8: 0.5% AEP 2100 Tidal Breach One Flood Depth



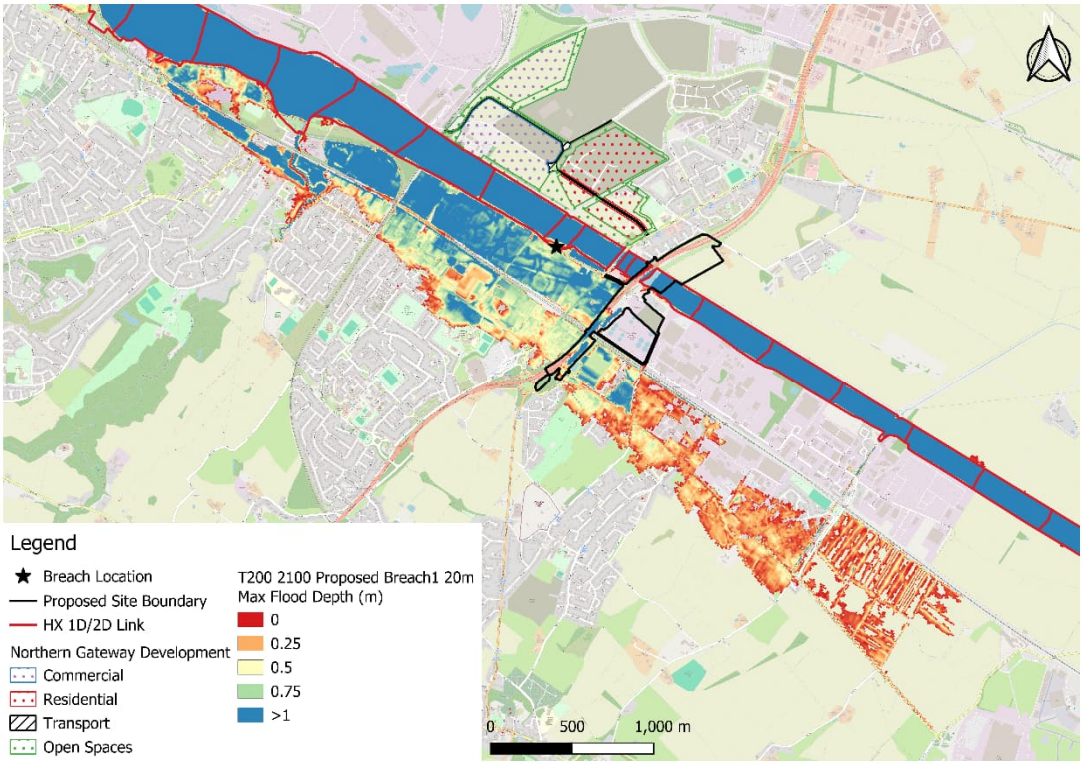
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Figure C.9: 0.5% AEP 2100 Tidal Breach One Flood Velocity



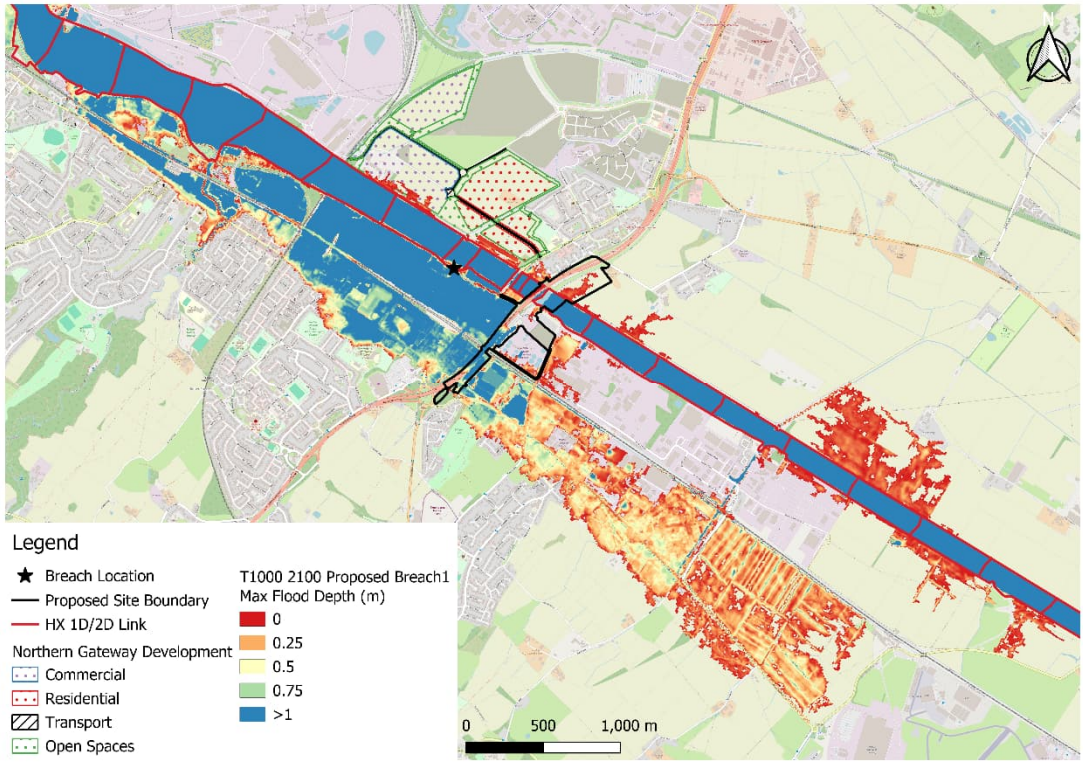
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Figure C.10: 0.5% AEP 2100 Tidal Breach One 20m Flood Depth



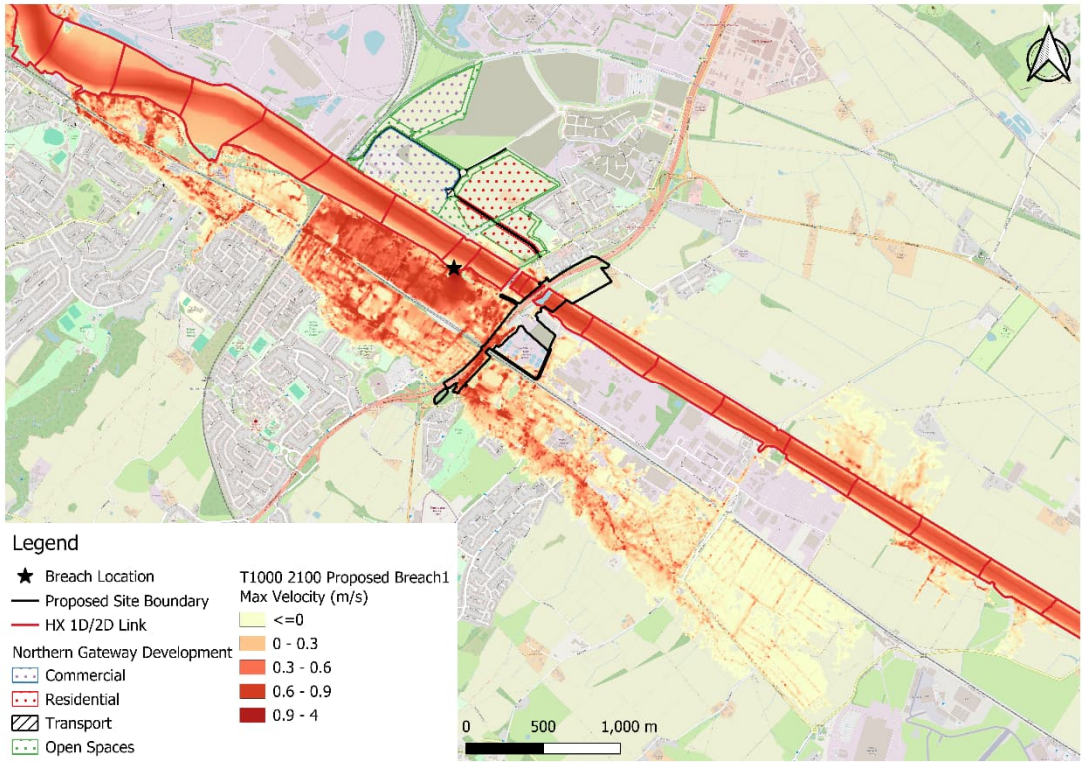
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Figure C.11: 0.1% AEP 2100 Tidal Breach One Flood Depth



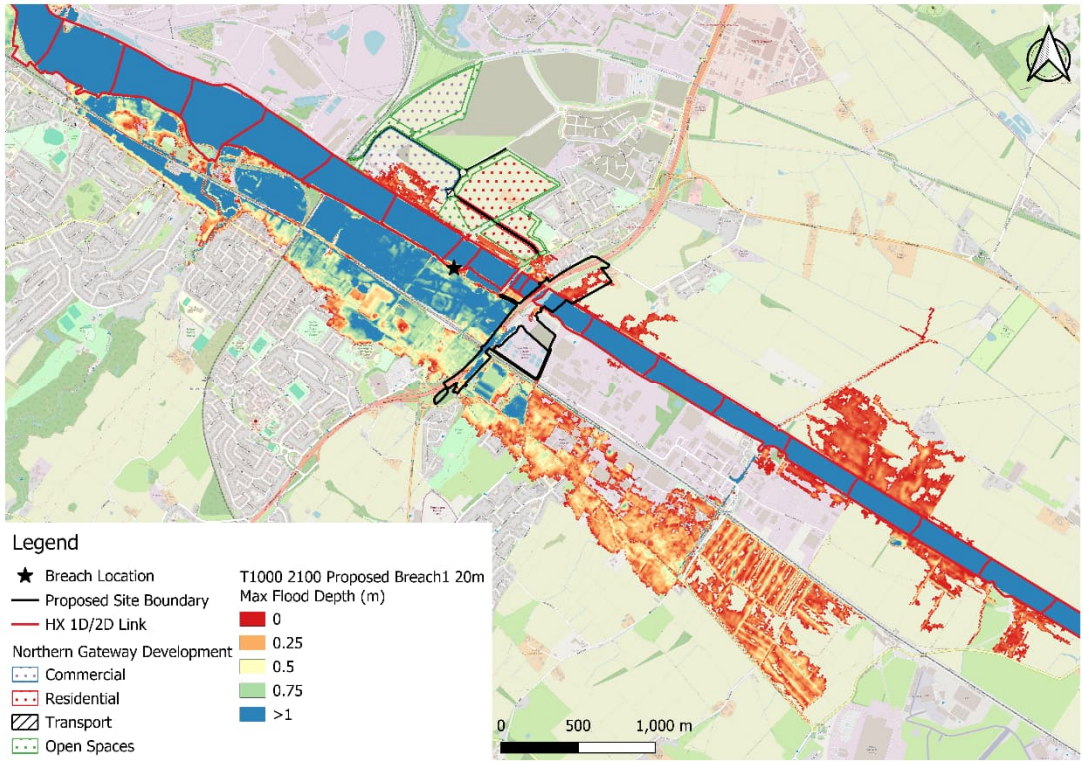
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Figure C.12: 0.1% AEP 2100 Tidal Breach One Flood Velocity



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Figure C.13: 0.1% AEP 2100 Tidal Breach One 20m Flood Depth



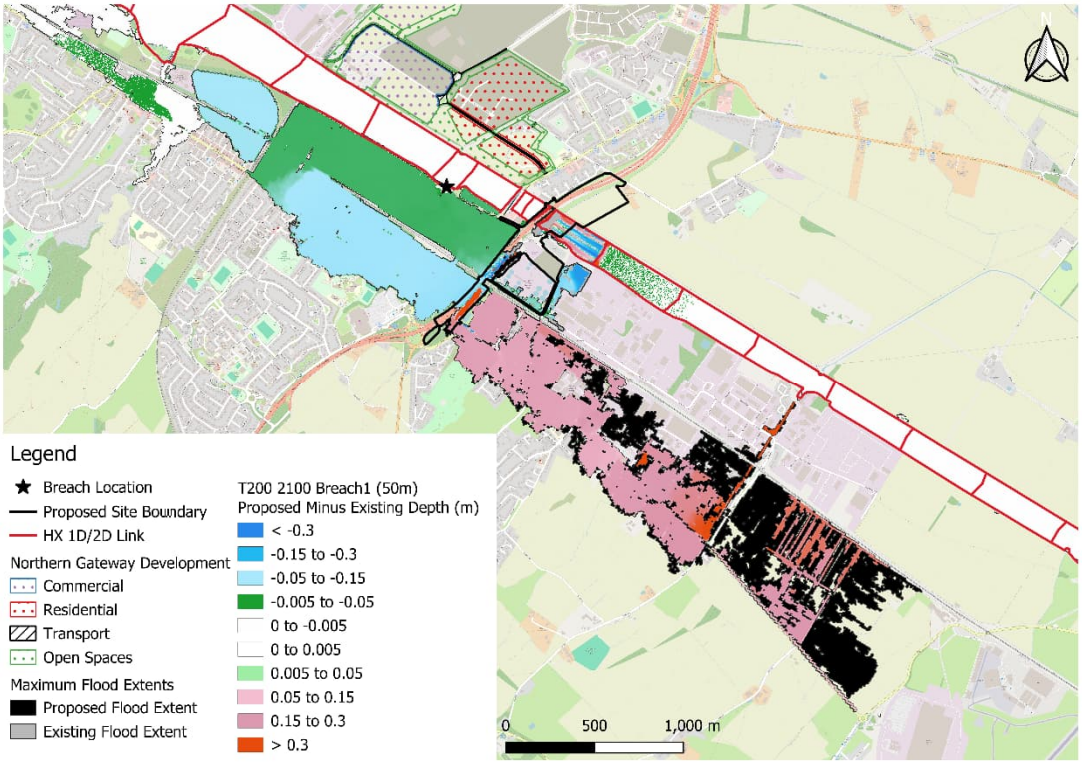
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

C.3.1.1 Comparison Against Existing Scenario

Depth differences from Tidal Breach One for the Proposed (post-development) scenario and the Existing (pre-development) scenario are detailed in Figure C.14 and Figure C.15. Both the 0.5% and 0.1% AEP 2100 events show a reduction in flood depth to the northwest of the Scheme but there is an increase in water levels to the southeast. Additionally, both events predict an increase in flood extents compared to the Existing scenario. This increase is most noticeable in areas across Sandycroft.

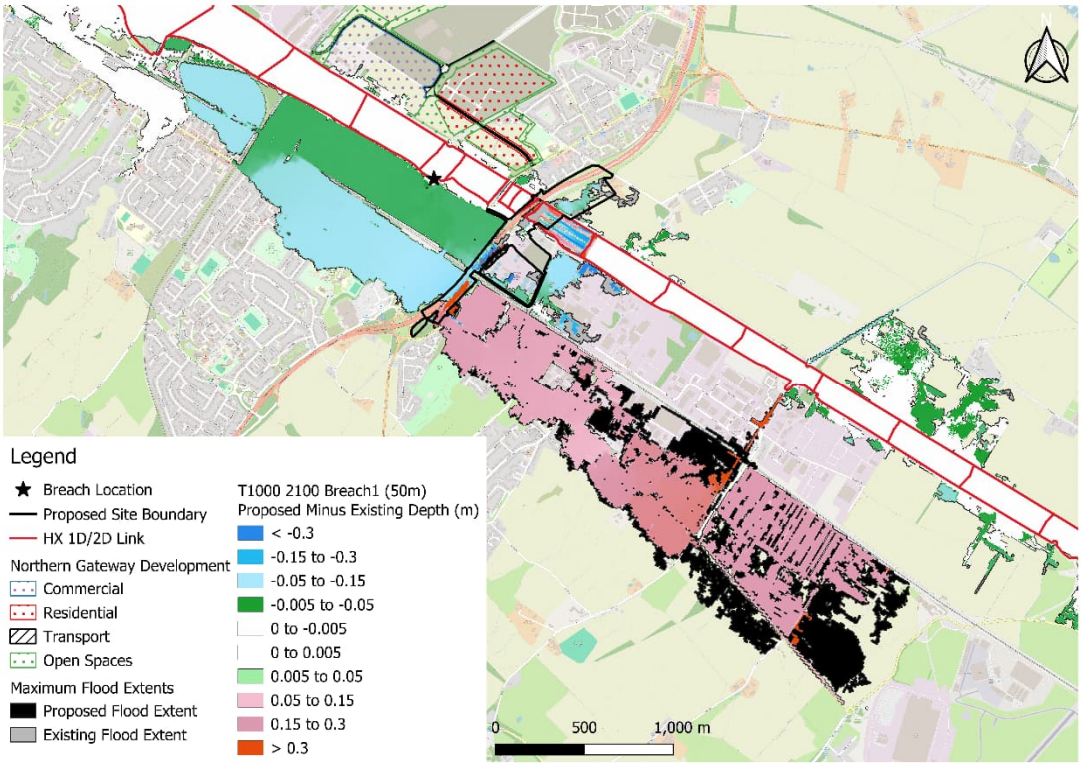
Figure C.16 and Figure C.17 detail the results of the Tidal Breach One 20m sensitivity runs. There are similar patterns of flood risk compared to the 50m breach scenarios with areas to the south of Shotton predicted to have reduced flood levels whilst area to the southeast of the development indicates an increase in water levels. Areas close to the breach appear to have similar flood levels to the Existing scenario.

Figure C.14: 0.5% AEP 2100 Tidal Breach One Flood Depth Difference



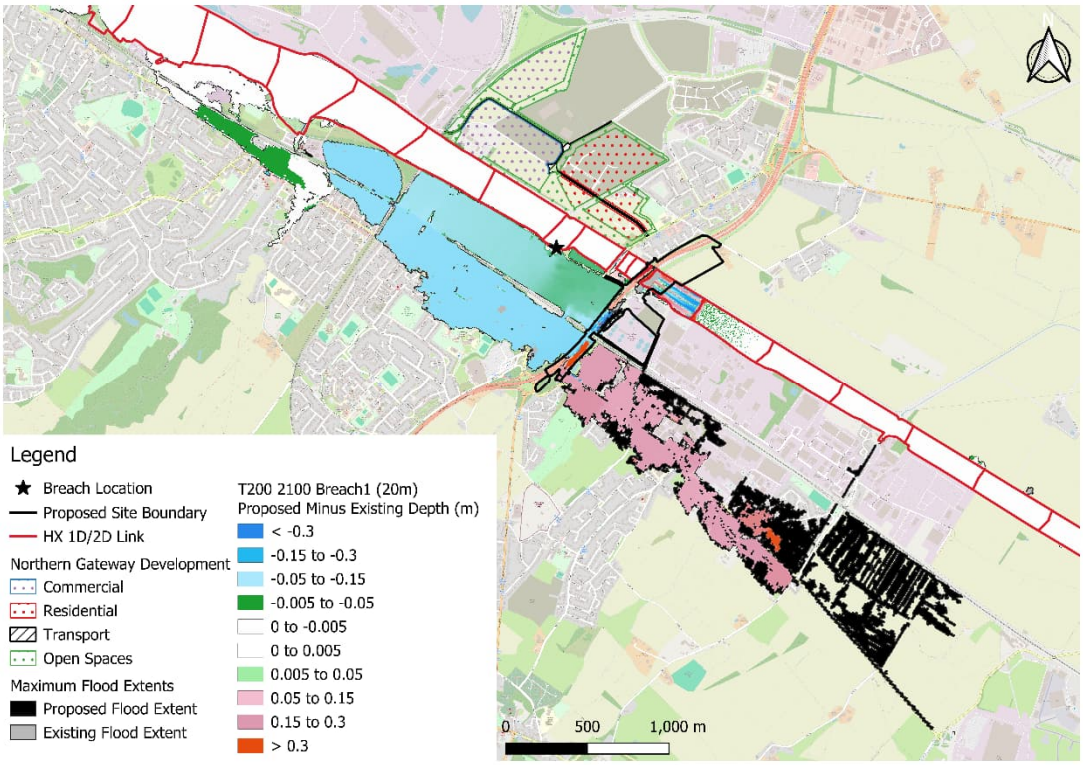
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.15: 0.1% AEP 2100 Tidal Breach One Flood Depth Difference



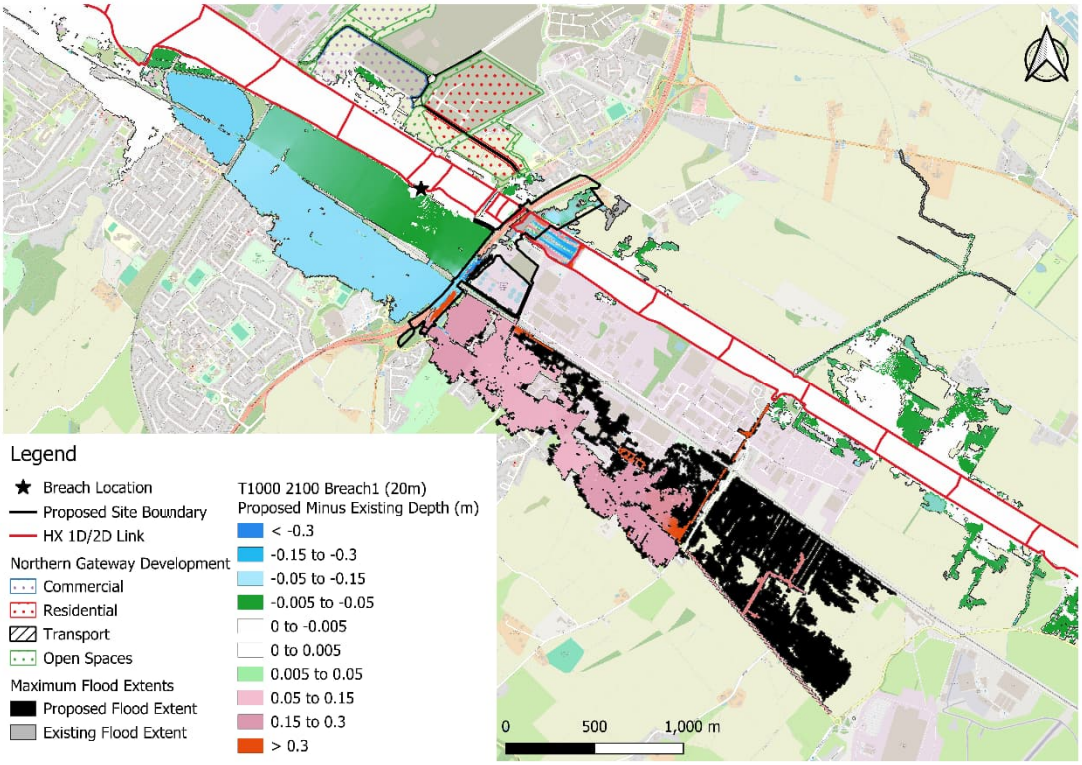
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.16: 0.5% AEP 2100 Tidal Breach One 20m Flood Depth Difference



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.17: 0.1% AEP 2100 Tidal Breach One 20m Flood Depth Difference

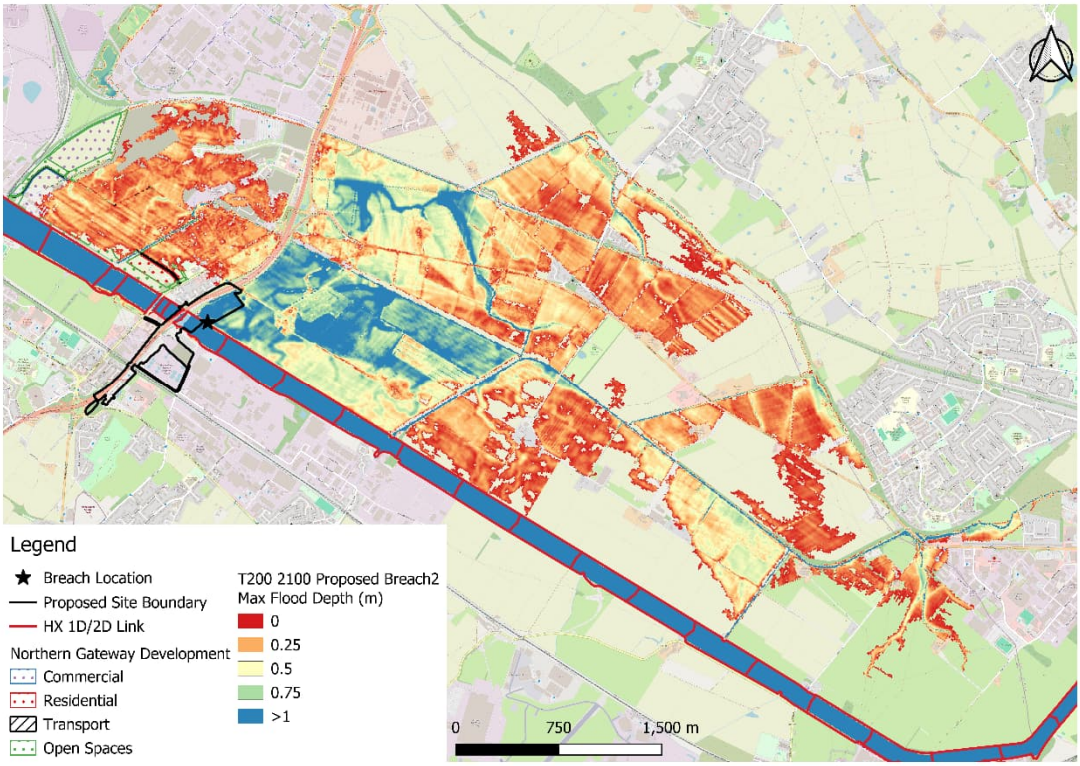


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C.3.2 Tidal Breach Two

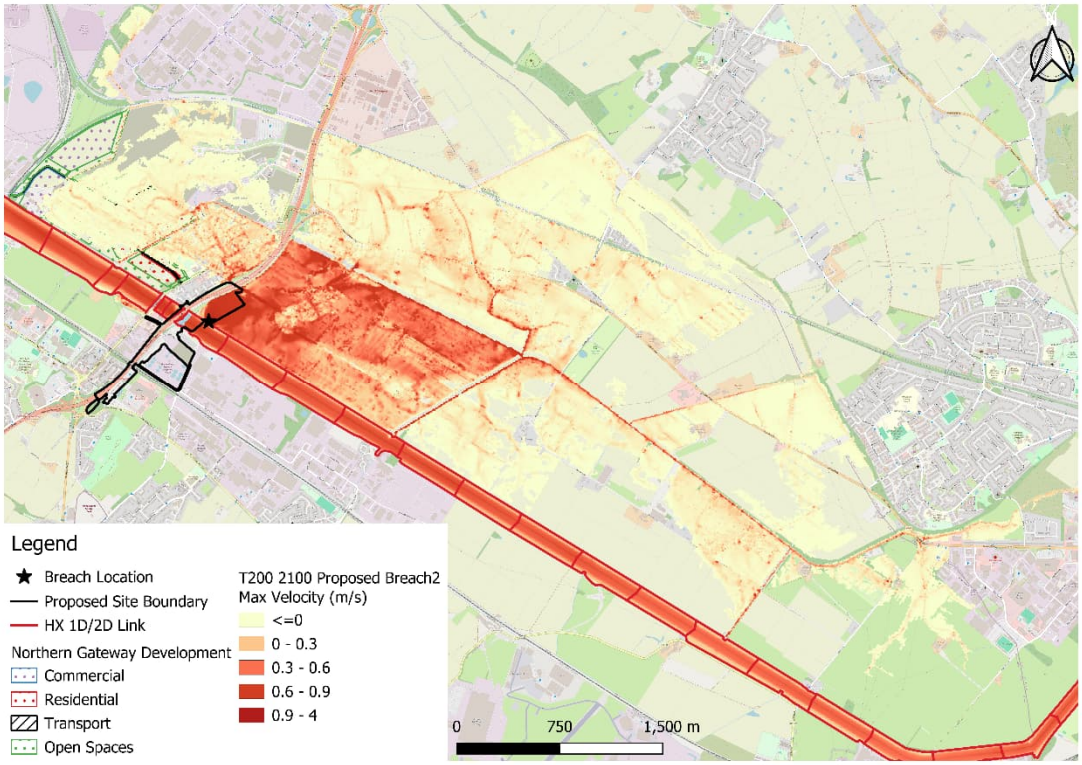
Figure C.18 to Figure C.23 show the predicted flood extent, depth and velocities caused by Tidal Breach Two under the post-development scenario as well as the flood extent and depth of the 20m sensitivity breach scenario. Flooding extents across residential areas of Garden City and Sealand as well as extending across the commercial areas of the Deeside Industrial Park. Much of the flooding to the east of the breach location occurs on rural land with the exception of Sealand road and a few urban areas on Deeside Lane.

Figure C.18: 0.5% AEP 2100 Tidal Breach Two Flood Depth



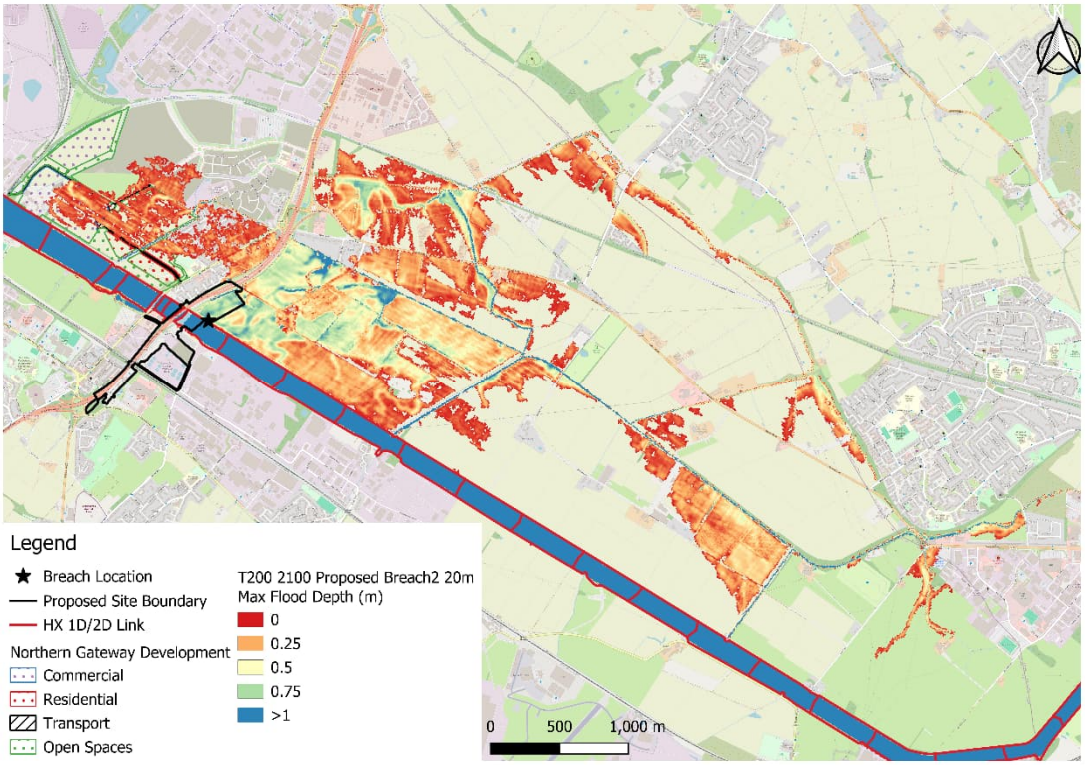
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.19: 0.5% AEP 2100 Tidal Breach Two Flood Velocity



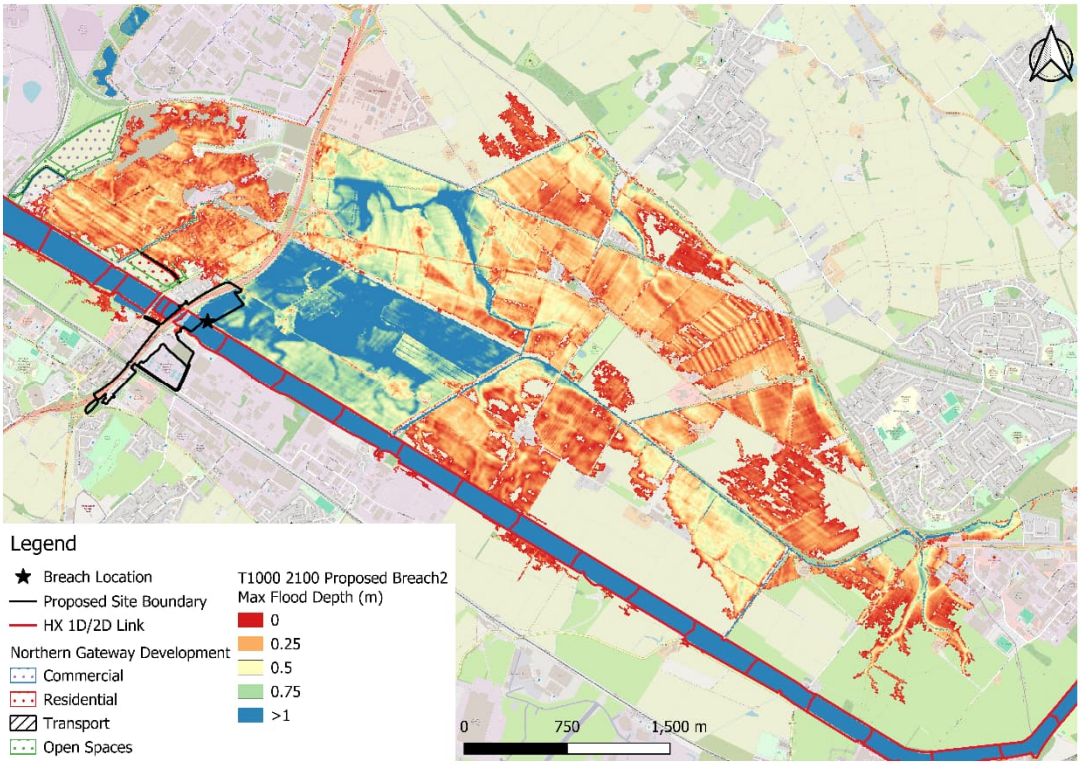
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.20: 0.5% AEP 2100 Tidal Breach Two 20m Flood Depth



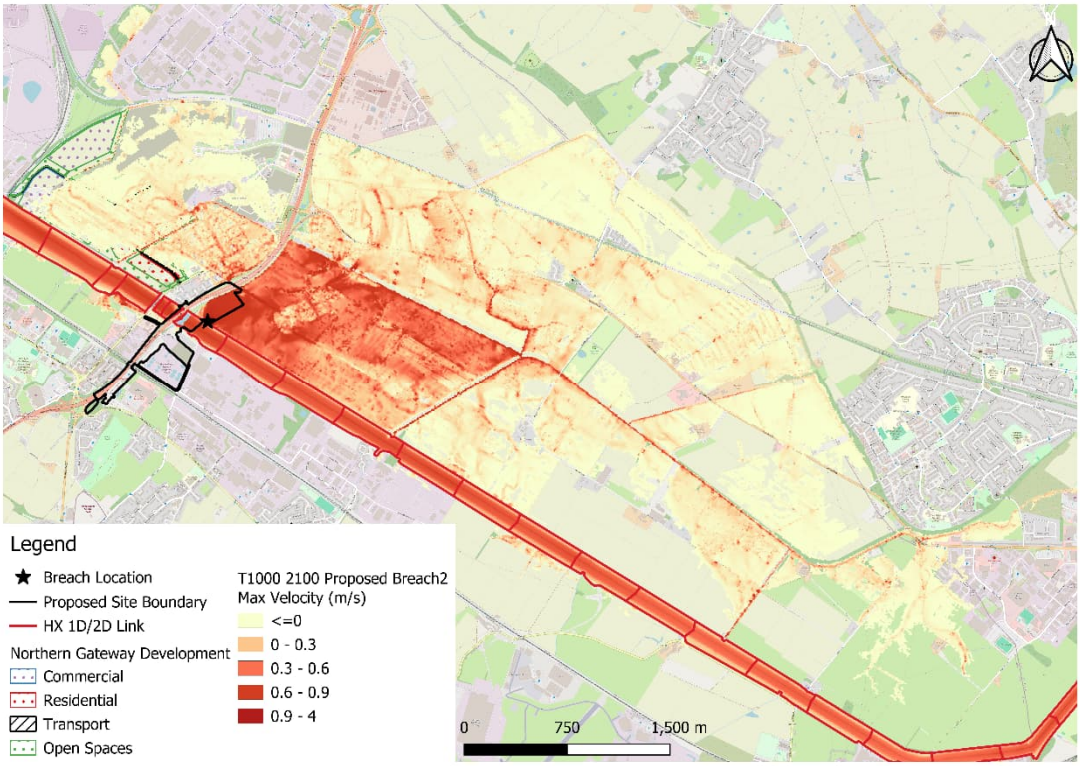
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.21: 0.1% AEP 2100 Tidal Breach Two Flood Depth



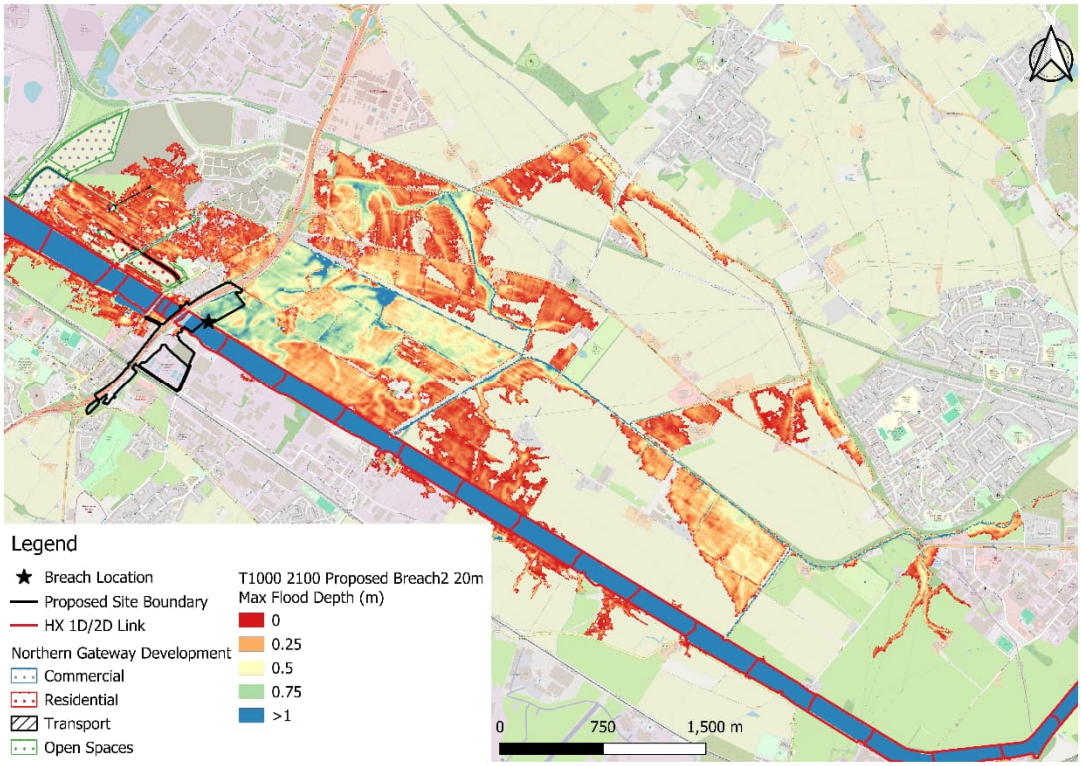
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Figure C.22: 0.1% AEP 2100 Tidal Breach Two Flood Velocity



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.23: 0.1% AEP 2100 Tidal Breach Two 20m Flood Depth



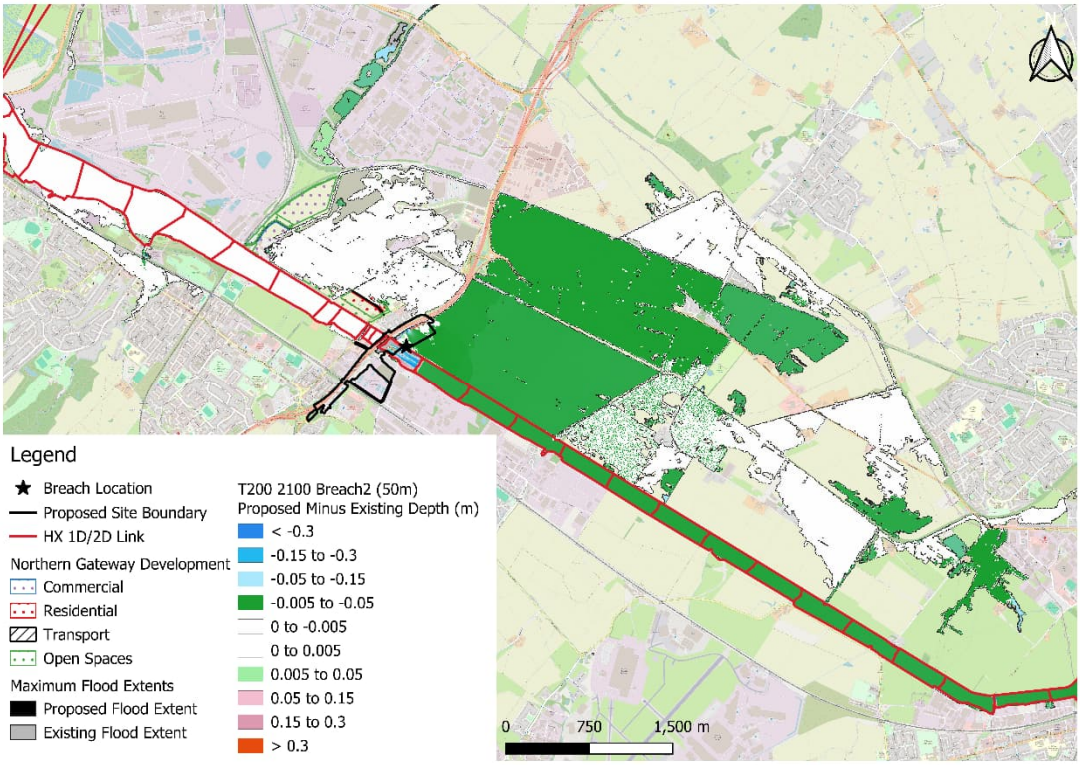
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

C.3.2.1 Comparison Against Existing Scenario

Depth differences from Tidal Breach Two for the Proposed scenario and the Existing scenario are detailed in Figure C.24 and Figure C.25. For both the 0.5% and 0.1% AEP 2100 events there are some minor changes in flood extent for the Tidal Breach Two scenario. Flood extents and depths are similar between the Proposed and the Existing scenarios, with reductions in flood depth in the rural areas of the River Dee floodplain for the post-development scenario model. An average reduction of 0.009m.

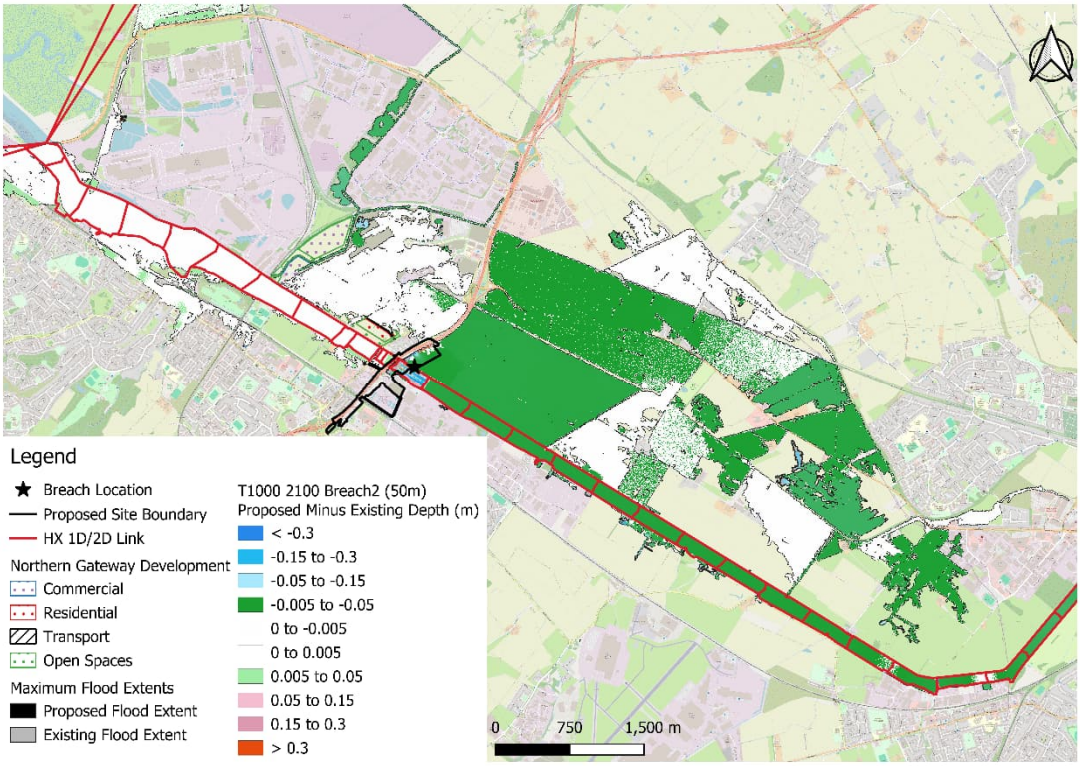
Figure C.26 and Figure C.27 detail the results of the Tidal Breach Two 20m sensitivity runs. For the 20m sensitivity assess the same patterns as the 50m breach can be with areas showing minimal reductions in or no changes to flood depth compared to the Existing scenario for this breach.

Figure C.24: 0.5% AEP 2100 Tidal Breach Two Flood Depth Difference



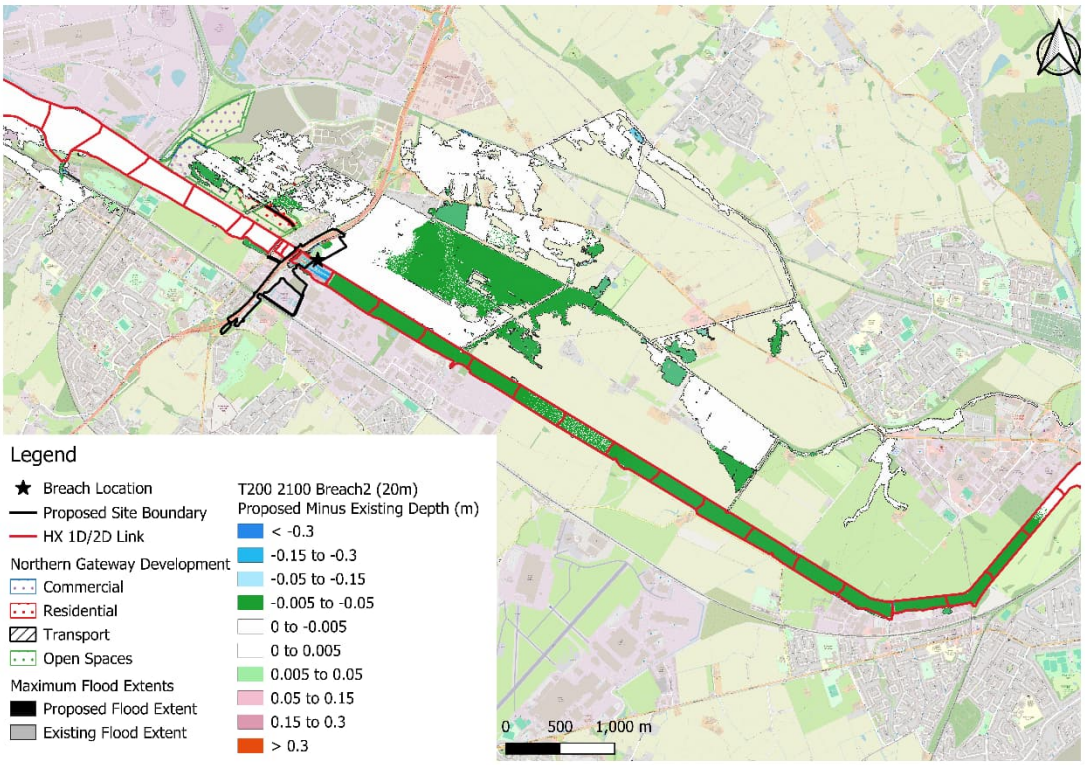
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.25: 0.1% AEP 2100 Tidal Breach Two Flood Depth Difference



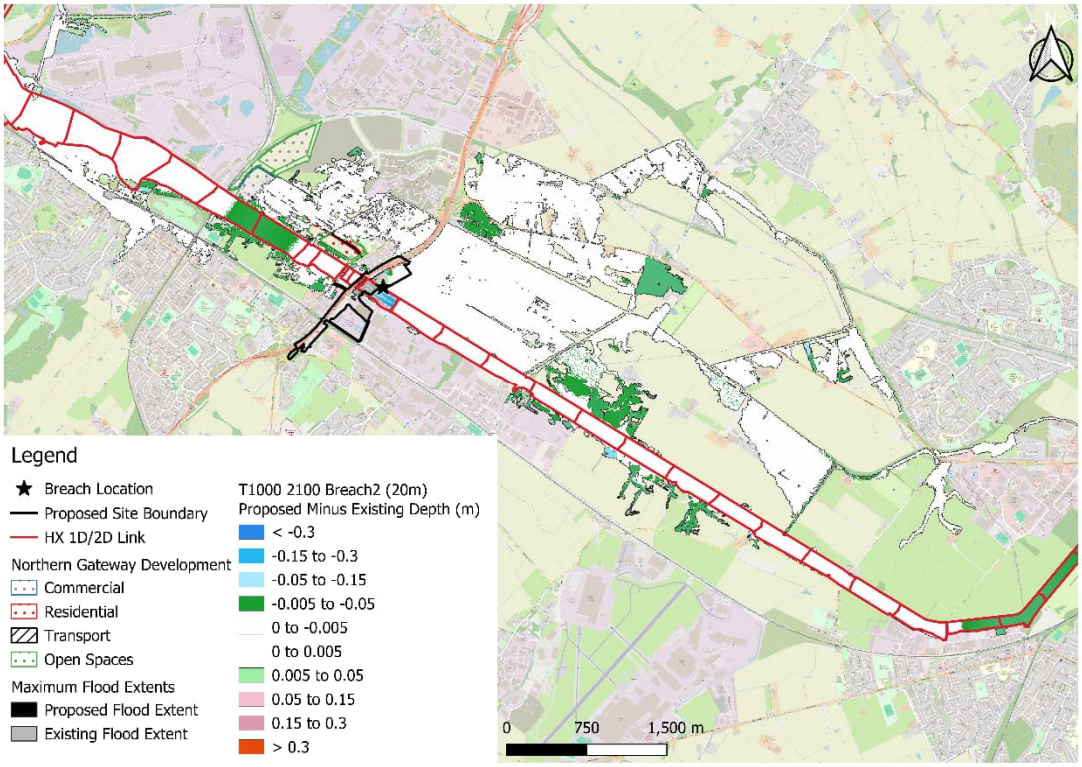
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Figure C.26: 0.5% AEP 2100 Tidal Breach Two 20m Flood Depth Difference



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.27: 0.1% AEP 2100 Tidal Breach Two 20m Flood Depth Difference

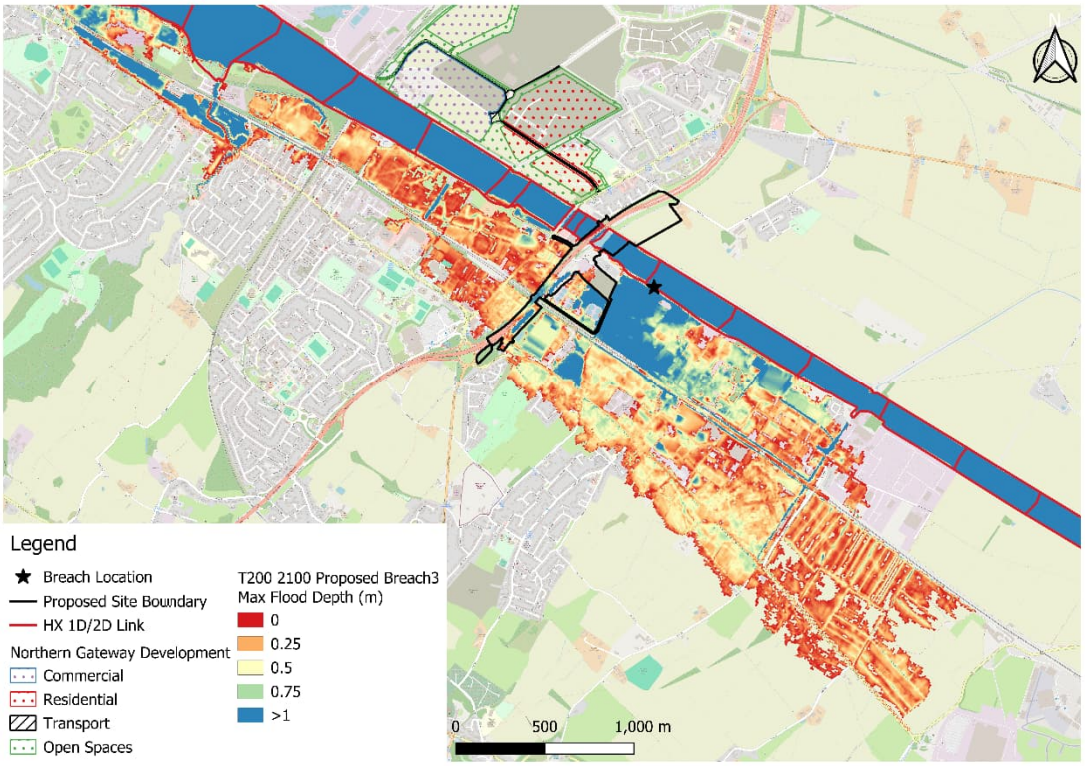


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C.3.3 Tidal Breach Three

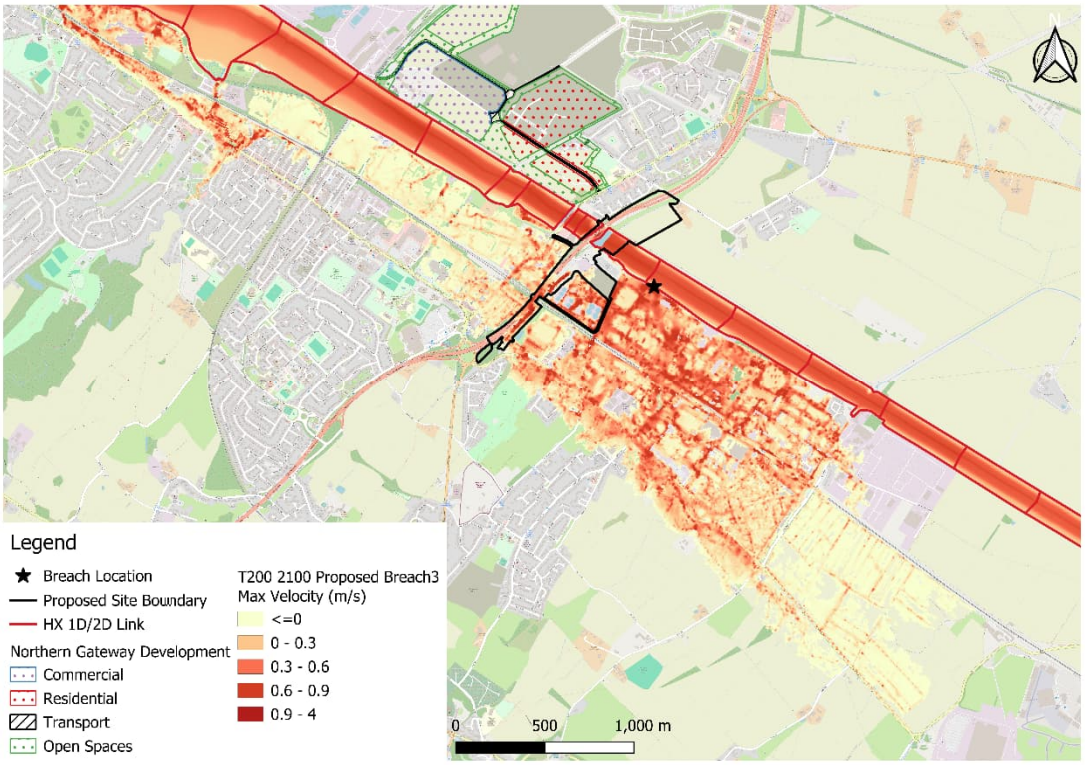
Figure C.28 to Figure C.33 show the predicted flood extent, depth and velocities caused by Tidal Breach Three under the post-development scenario as well as the flood extent and depth of the 20m sensitivity breach scenario. There is significant flooding under the Tidal Breach Three scenario with Shotton, Queensferry, Pentre and Sandycroft areas affected by flooding mostly up to 1m. Queensferry Sewage Treatment Works and the Riverside Travellers Site are most heavily affected areas with over 1m of flooding in 0.5% and 0.1% AEP 2100 tidal flood event.

Figure C.28: 0.5% AEP 2100 Tidal Breach Three Flood Depth



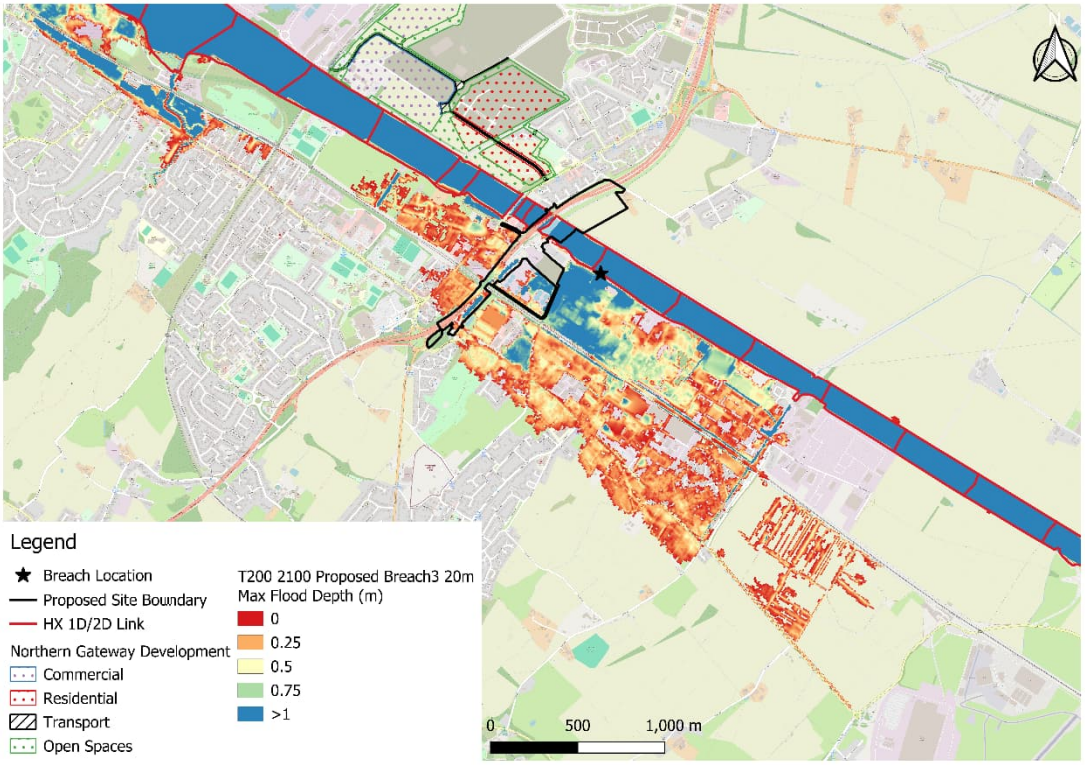
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.29: 0.5% AEP 2100 Tidal Breach Three Flood Velocity



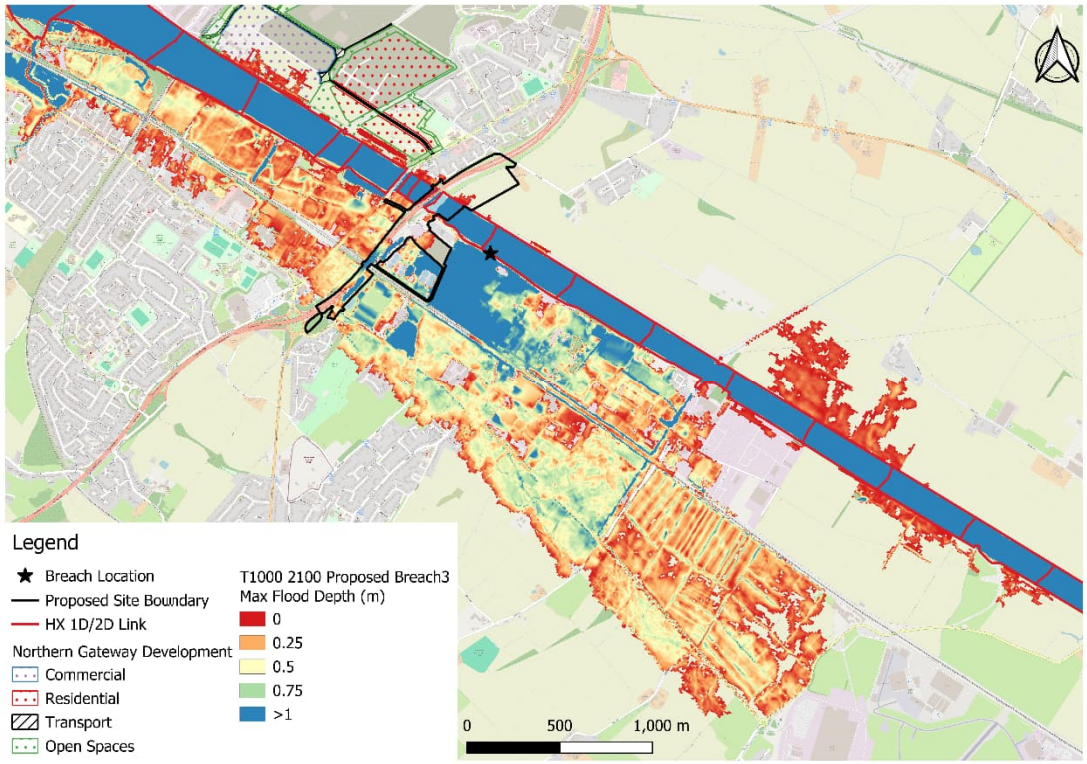
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.30: 0.5% AEP 2100 Tidal Breach Three 20m Flood Depth



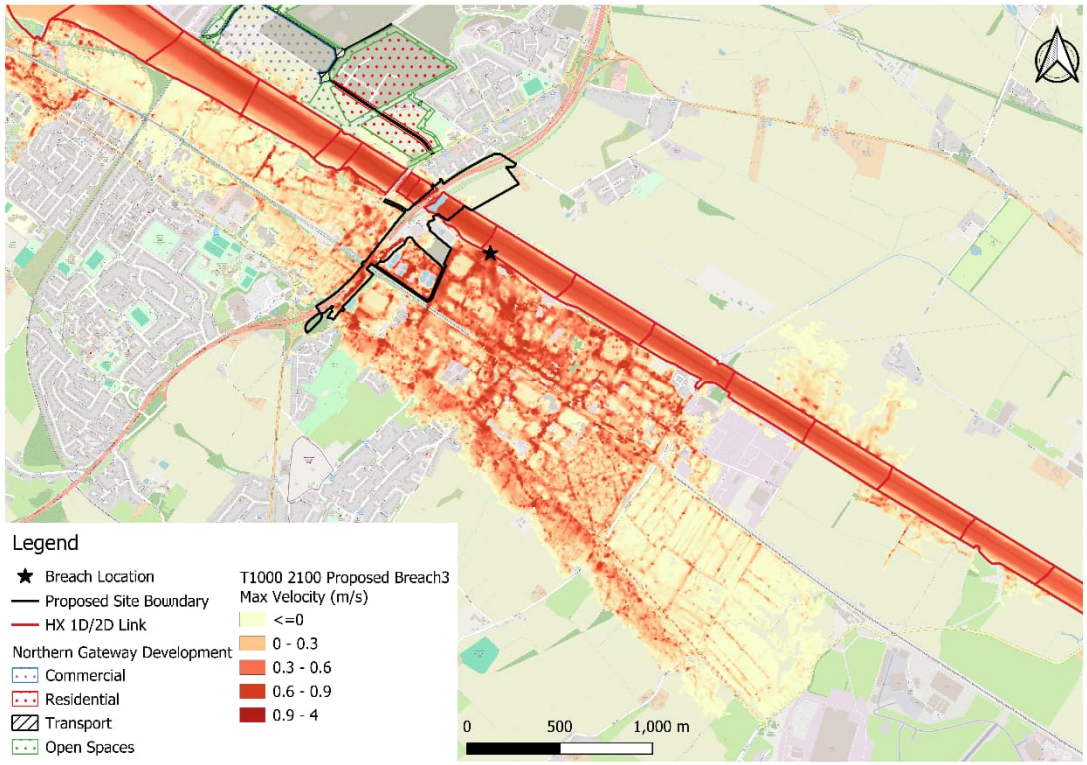
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.31: 0.1% AEP 2100 Tidal Breach Three Flood Depth



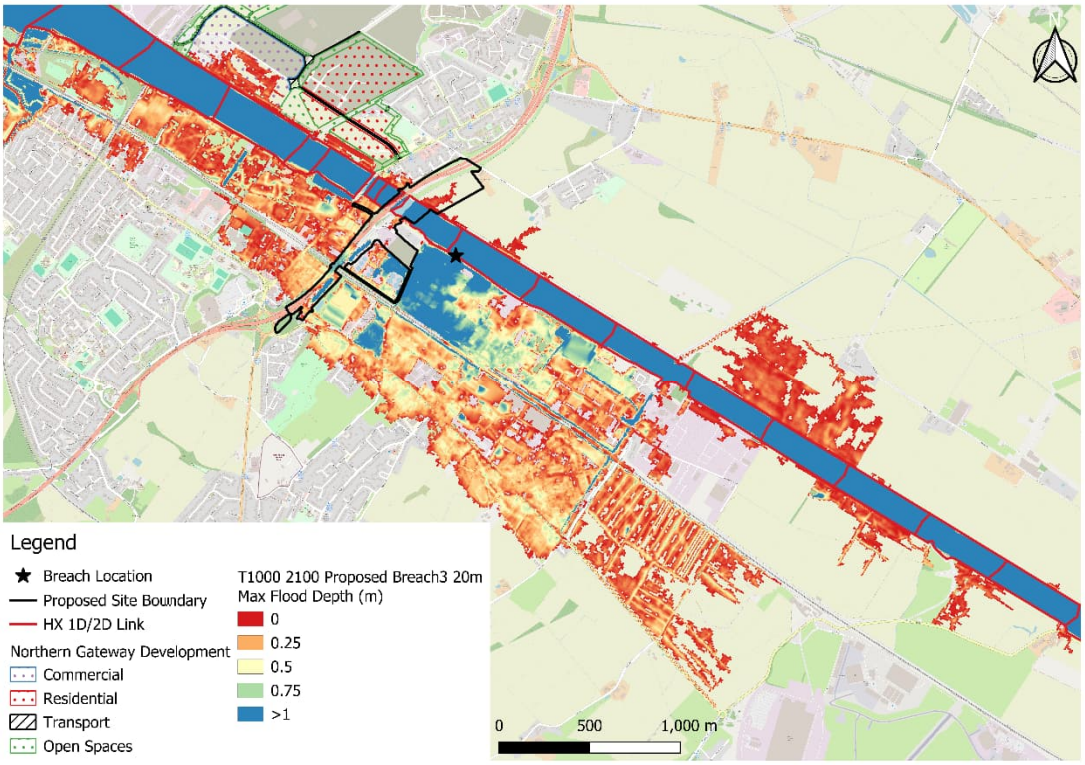
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.32: 0.1% AEP 2100 Tidal Breach Three Flood Velocity



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.33: 0.1% AEP 2100 Tidal Breach Three 20m Flood Depth



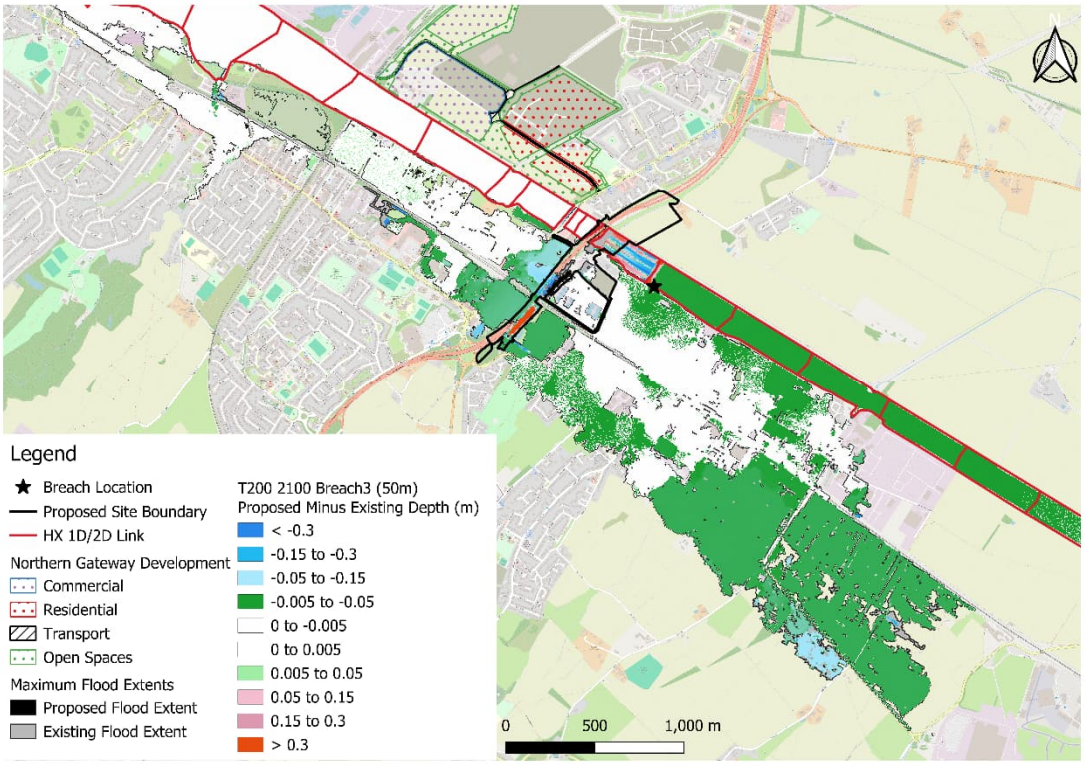
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

C.3.3.1 Comparison Against Existing Scenario

Depth differences from Tidal Breach Three for the Proposed and the Existing scenario are detailed in Figure C.34 and Figure C.35. Flood extents caused by Tidal Breach Three are nearly identical with very little differences in flooding between the Existing and Proposed scenario results. Flood depths do vary across the extent with depths staying similar to the Existing scenario close to the breach location and then decreasing in areas to the east of the breach under both the 0.5% and 0.1% AEP 2100 events. Flood water levels increase to the northwest of the A494 although much of this area is rural in nature. Under the 0.1% AEP 2100 event there are more pronounced increases in water levels in this area exacerbated by flooding from Wepre Brook.

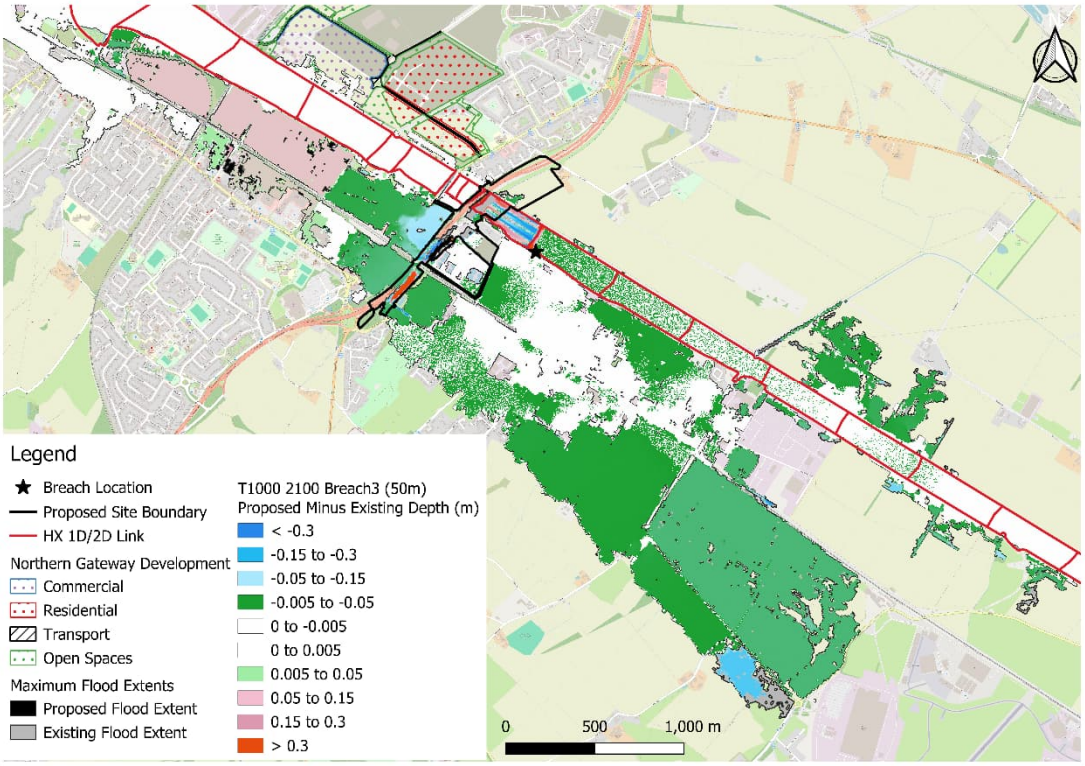
Figure C.36 and Figure C.37 detail the results of the Tidal Breach Three 20m sensitivity runs. A similar pattern is seen for the 20m breach scenario apart from flood water extending further northwest above the railway line for the post-development scenario compared to the pre-development scenario. Under the 0.5% scenario flood depths are close to the Existing scenario for large portions of the overall flood extent.

Figure C.34: 0.5% AEP 2100 Tidal Breach Three Flood Depth Difference



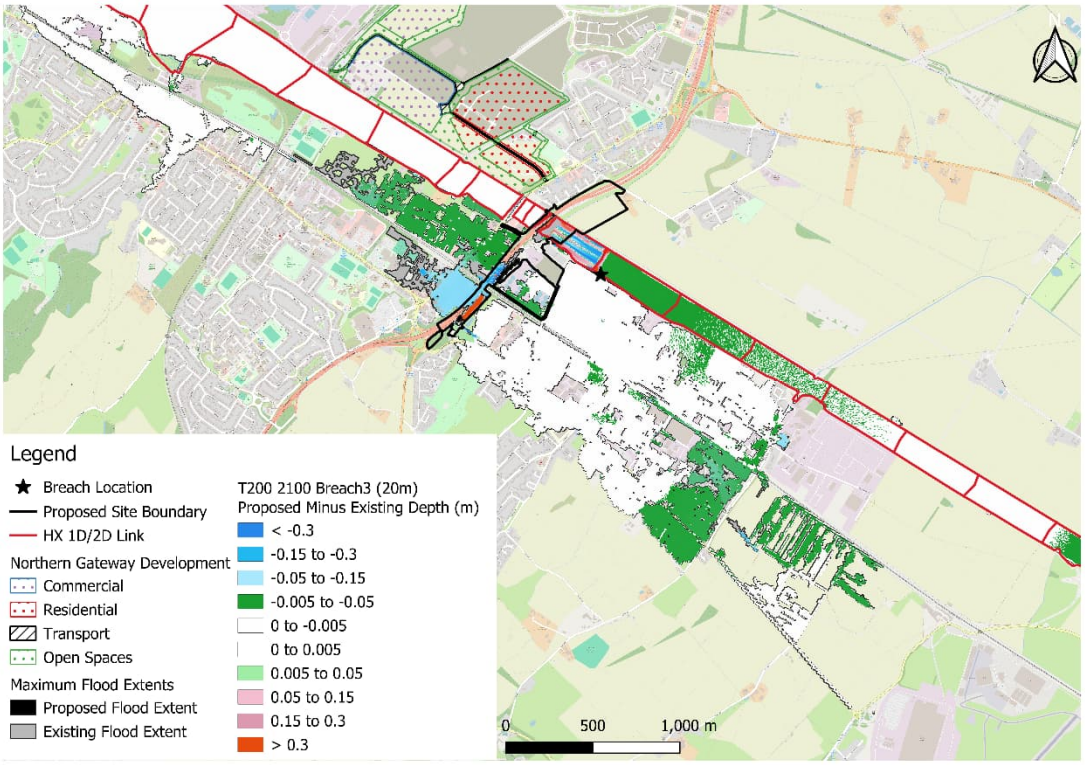
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.35: 0.1% AEP 2100 Tidal Breach Three Flood Depth Difference



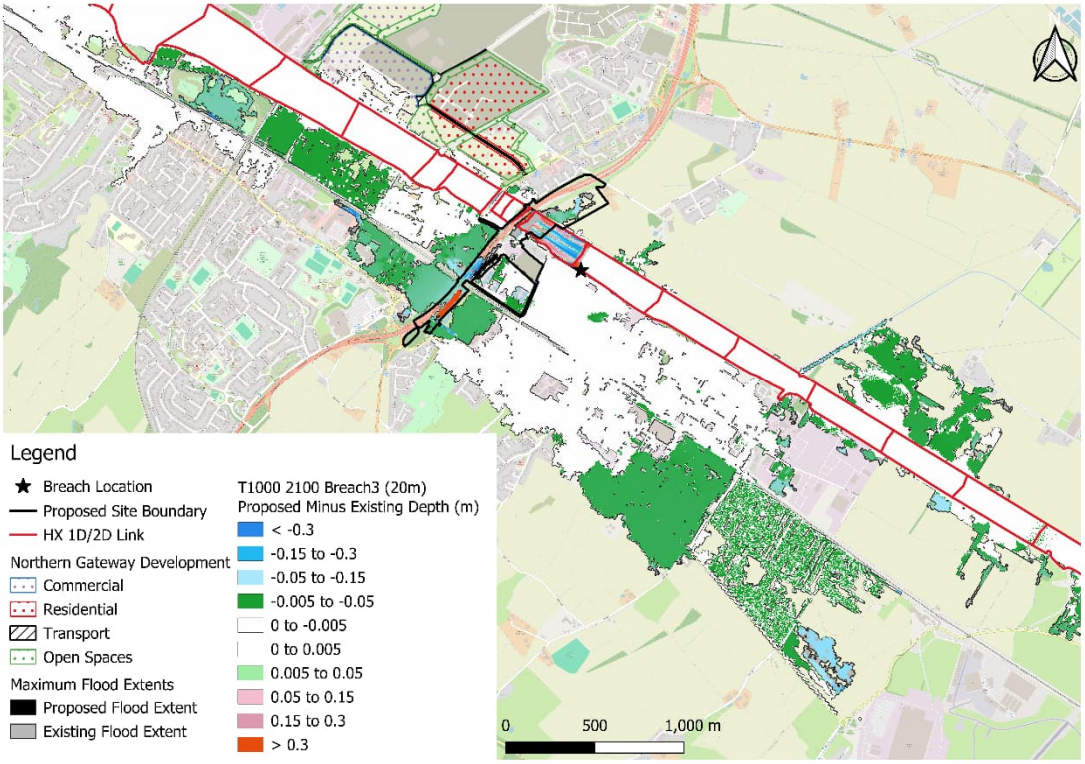
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Figure C.36: 0.5% AEP 2100 Tidal Breach Three 20m Flood Depth Difference



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.37: 0.1% AEP 2100 Tidal Breach Three 20m Flood Depth Difference

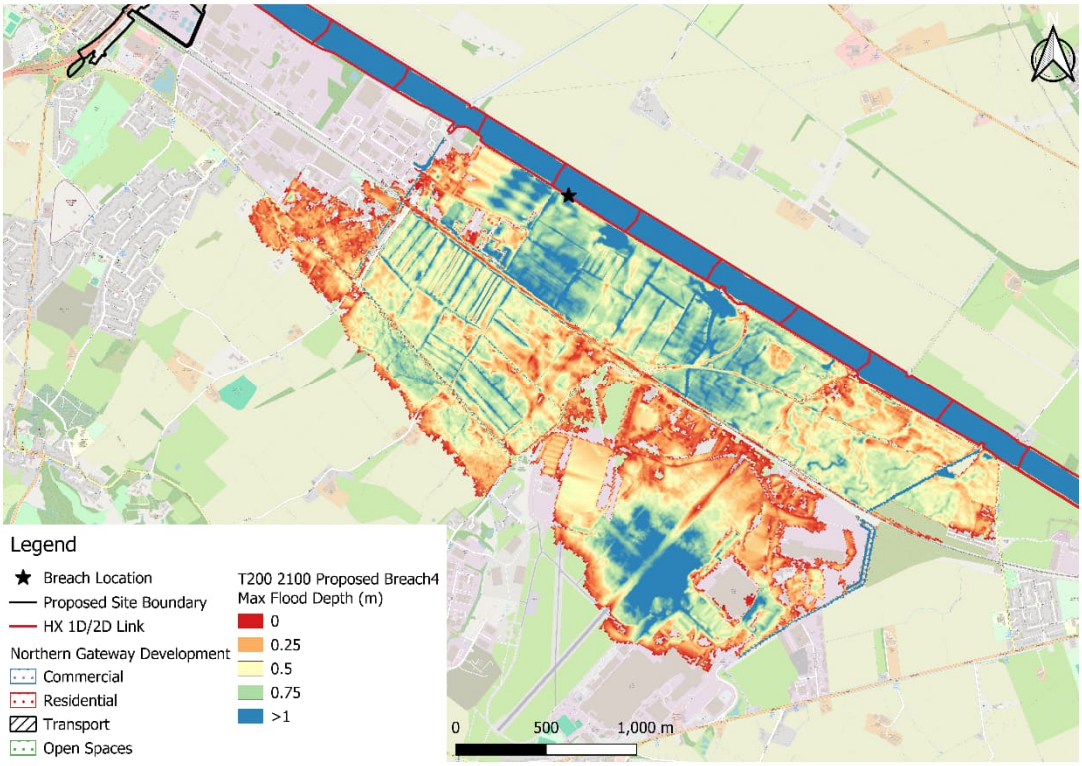


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C.3.4 Tidal Breach Four

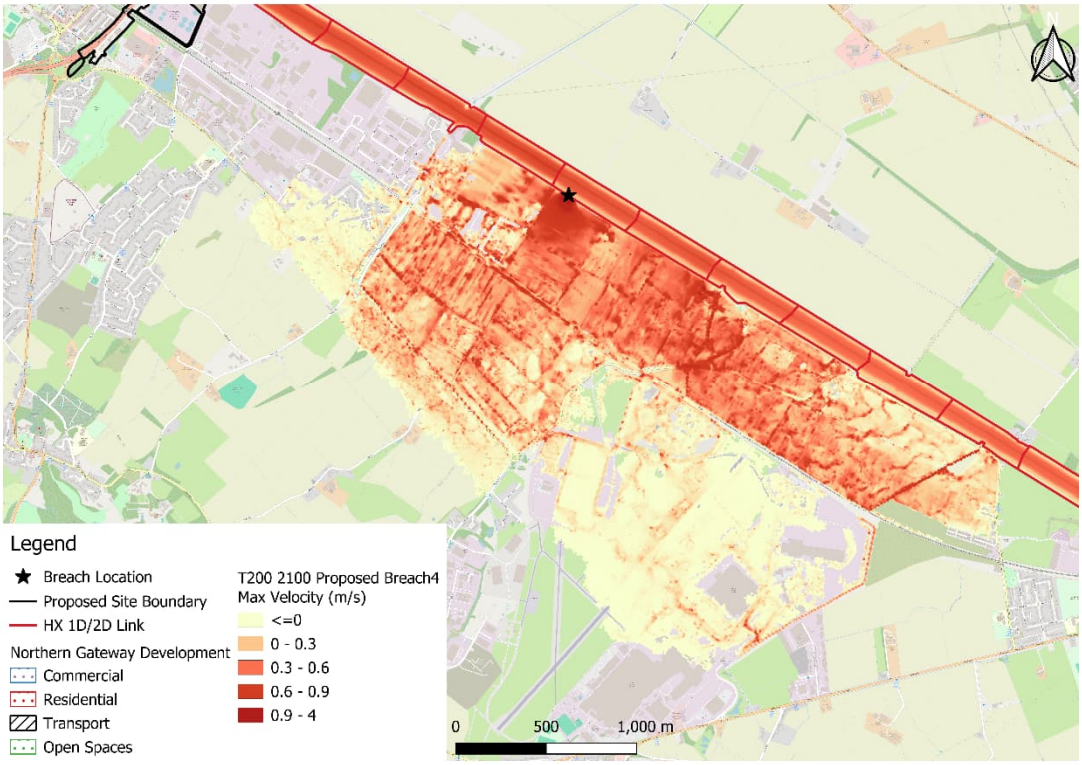
Figure C.38 to Figure C.43 show the predicted flood extent, depth and velocities caused by Tidal Breach Four under the post-development scenario as well as the flood extent and depth of the 20m sensitivity breach scenario. Under both scenarios there is some flooding across residential areas of Sandycroft, the extent of which is increased under the 0.1% AEP 2100 event. Additionally flooding extends across the runway of Hawarden Airport and flooding can pool to depths of over 1m in these areas.

Figure C.38: 0.5% AEP 2100 Tidal Breach Four Flood Depth



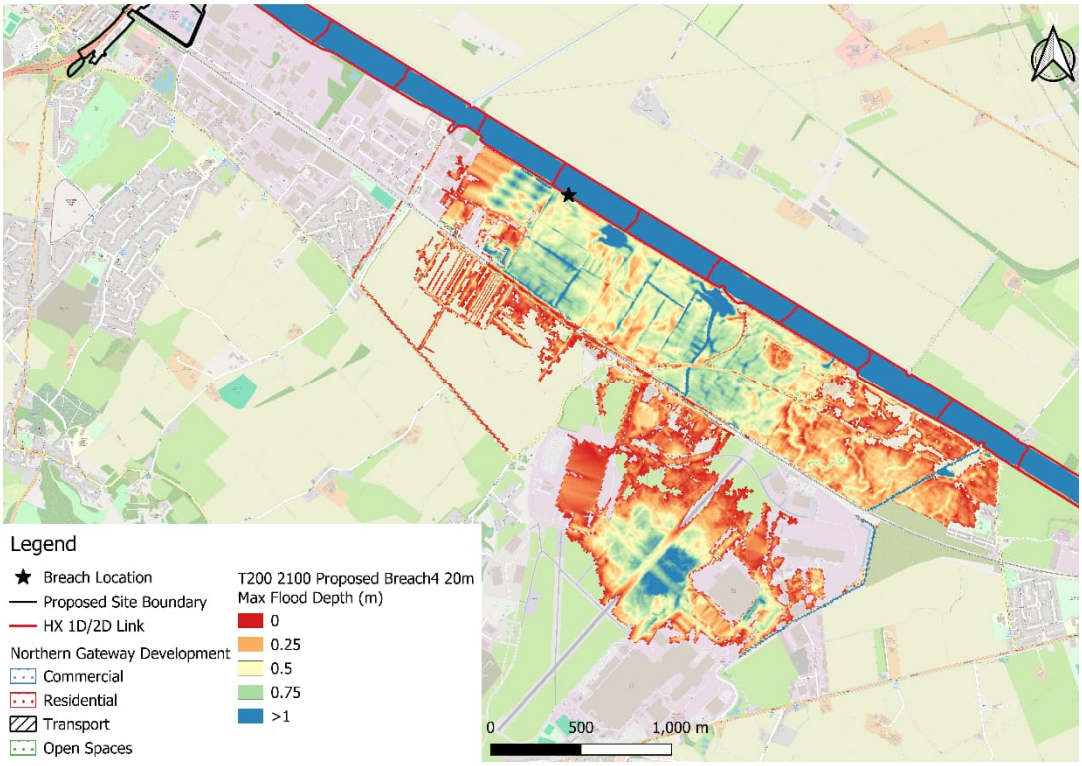
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.39: 0.5% AEP 2100 Tidal Breach Four Flood Velocity



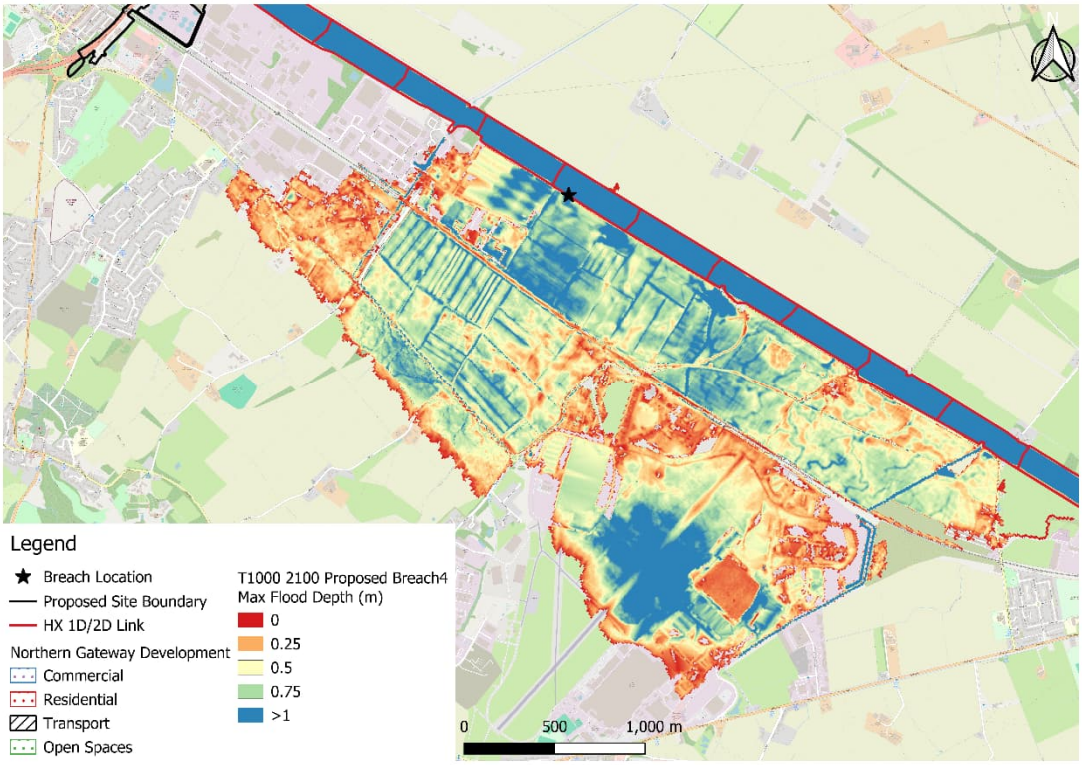
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Figure C.40: 0.5% AEP 2100 Tidal Breach Four 20m Flood Depth



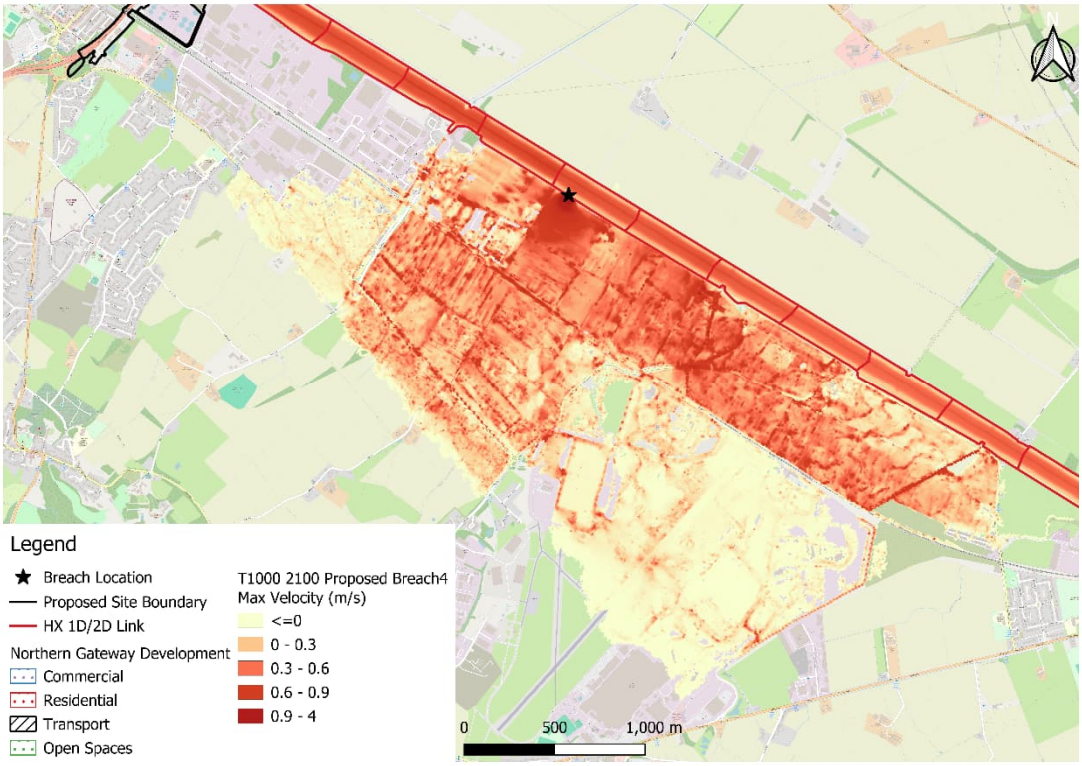
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Figure C.41: 0.1% AEP 2100 Tidal Breach Four Flood Depth



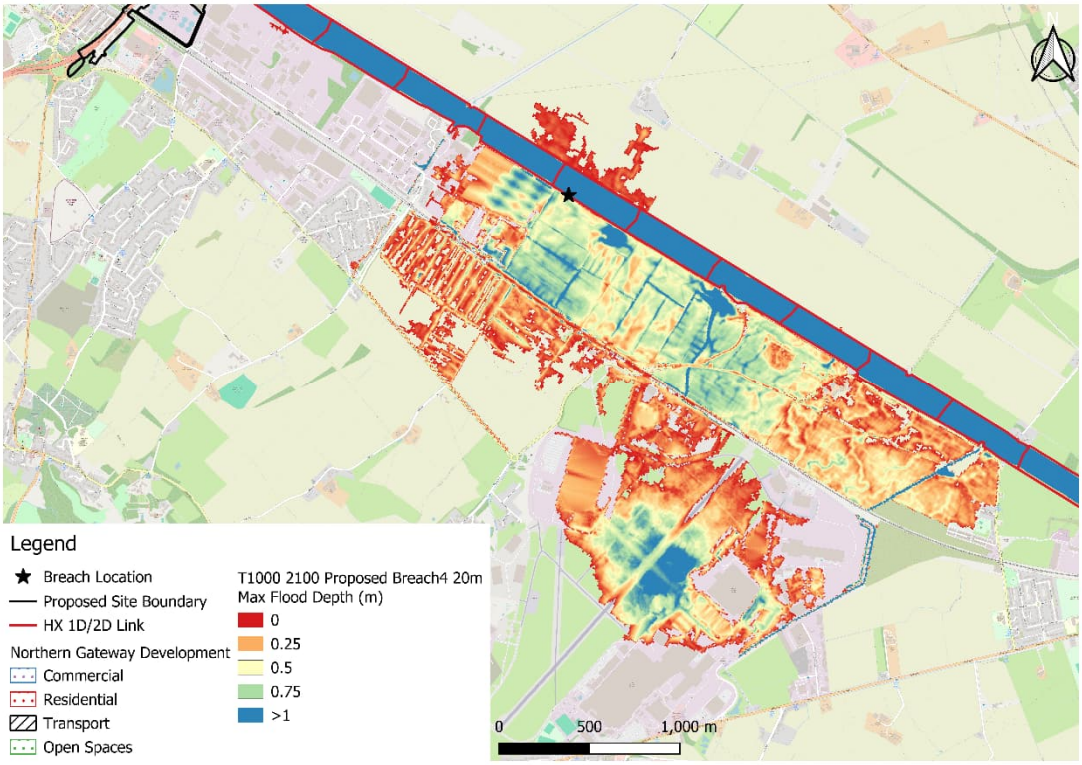
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.42: 0.1% AEP 2100 Tidal Breach Four Flood Velocity



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Figure C.43: 0.1% AEP 2100 Tidal Breach Four 20m Flood Depth



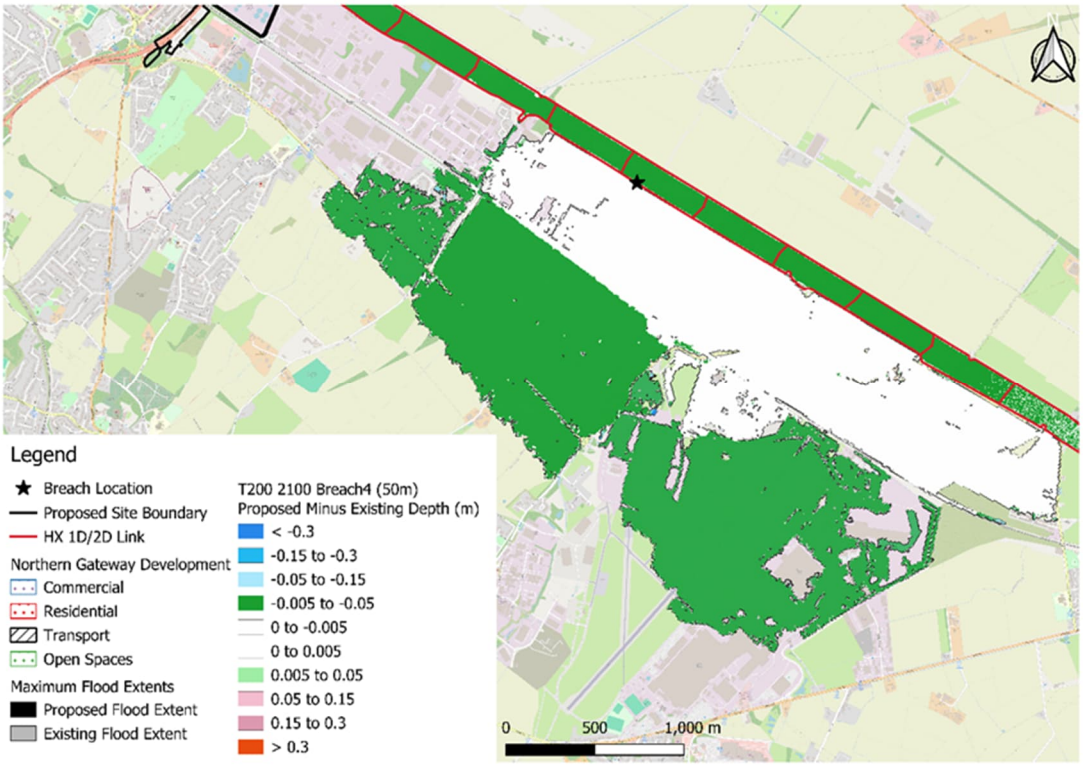
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

C.3.4.1 Comparison Against Existing Scenario

Depth differences from Tidal Breach Four for the Proposed and the Existing scenario are detailed in Figure C.44 and Figure C.45. Tidal Breach Four is located upstream of the Scheme and sees a reduction in flooding in areas of both the 0.5% and 0.1% AEP 2100 events. Under the 0.1% AEP 2100 event these reductions occur all affected areas of Hawarden Airport and Hawarden Industrial Estate, whilst rural areas adjacent to the breach see no significant change in flood depth.

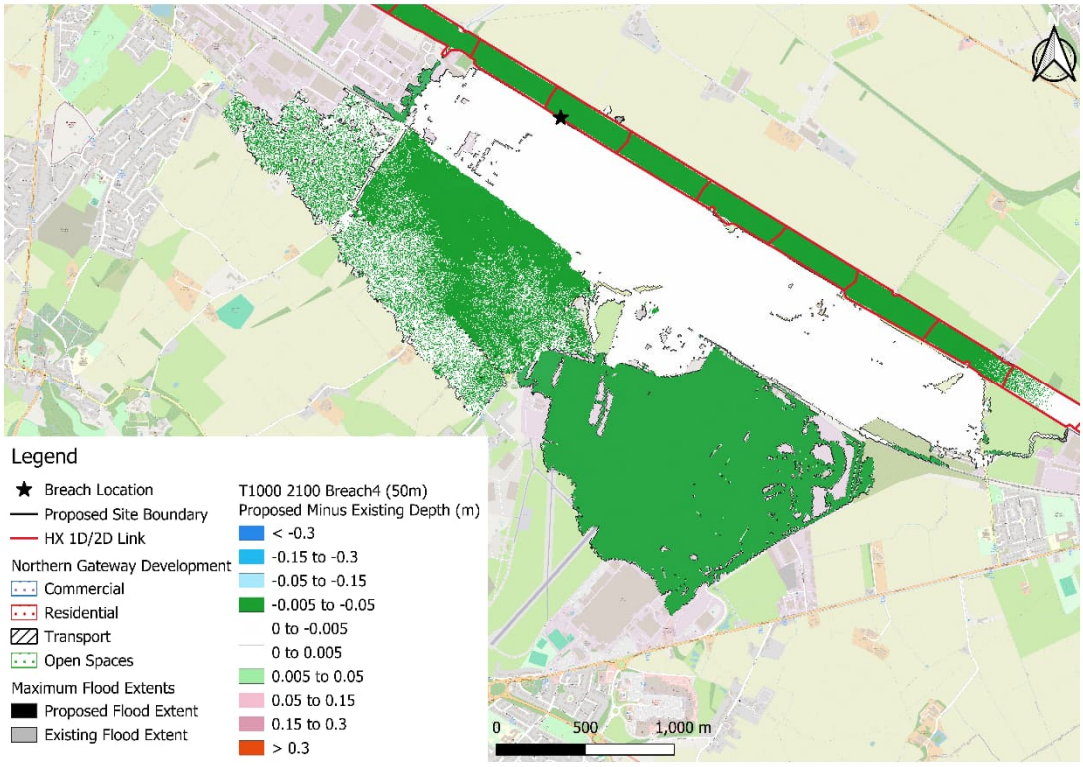
Figure C.46 and Figure C.47 detail the results of the Tidal Breach Four 20m sensitivity runs. Both the Proposed and the Existing scenario are equally as susceptible to the 20m sensitivity test at this Tidal Breach location. This is due to the location of the Tidal Breach being unaffected by changes to the Scheme.

Figure C.44: 0.5% AEP 2100 Tidal Breach Four Flood Depth Difference



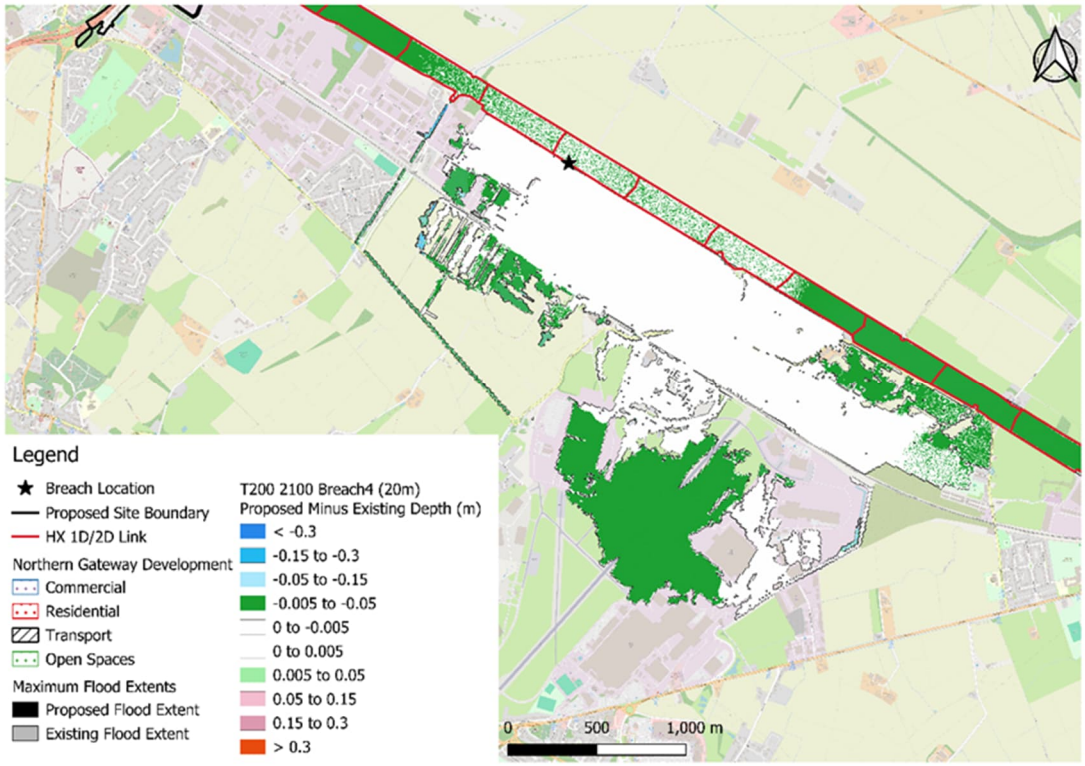
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Figure C.45: 0.1% AEP 2100 Tidal Breach Four Flood Depth Difference



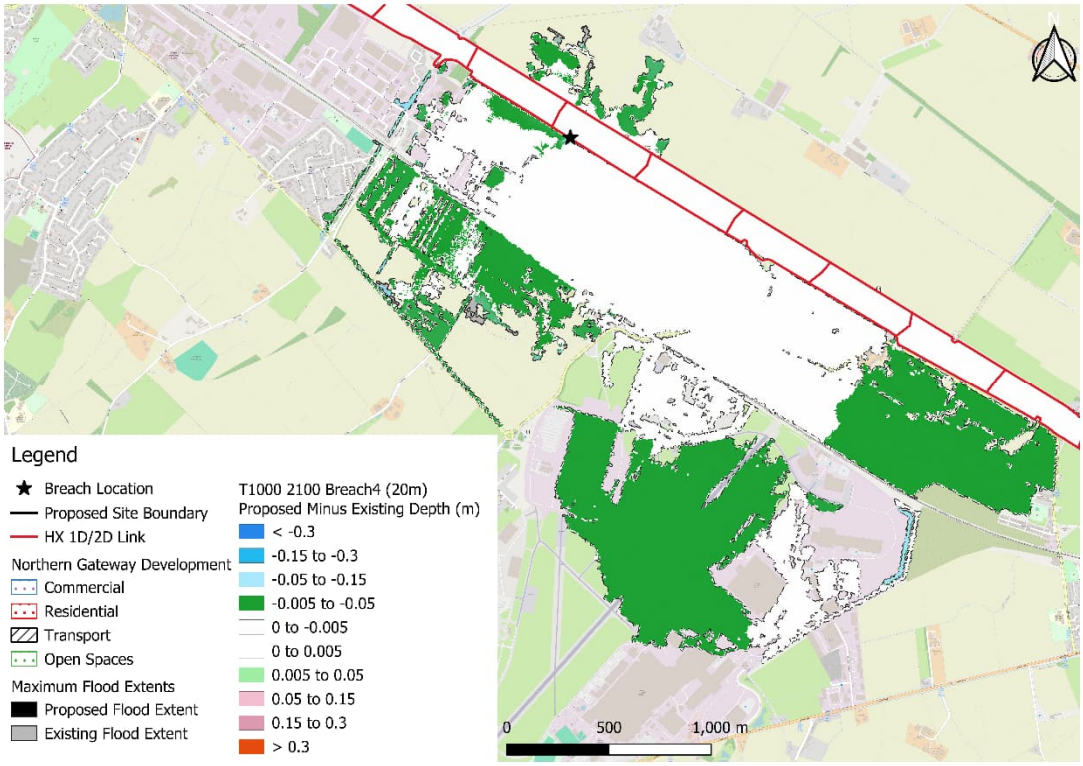
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Figure C.46: 0.5% AEP 2100 Tidal Breach Four 20m Flood Depth Difference



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.47: 0.1% AEP 2100 Tidal Breach Four 20m Flood Depth Difference

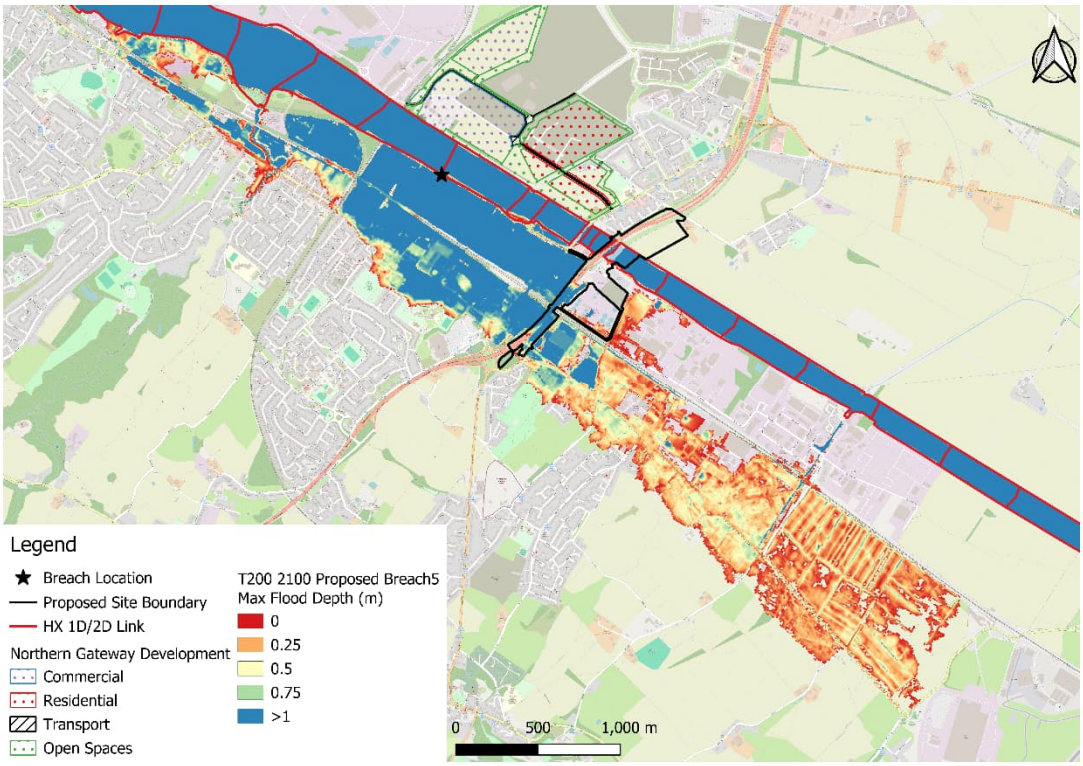


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C.3.5 Tidal Breach Five

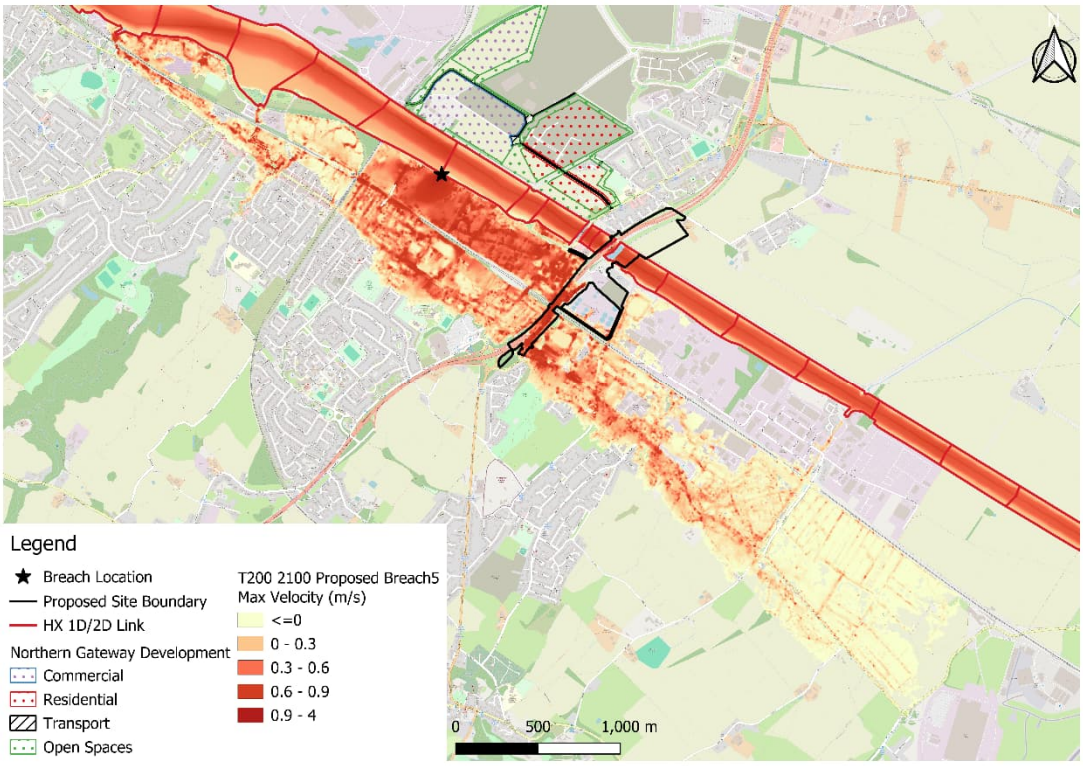
Figure C.48 to Figure C.53 show the predicted flood extent, depth and velocities caused by Tidal Breach Five under the post-development scenario as well as the flood extent and depth of the 20m sensitivity breach scenario. Tidal Breach Five causes significant flooding to the Shotton, Queensferry, Pentre and Sandycroft areas with a significant area around the Tidal Breach location being inundated flood water over 1m in depth. In the 0.1% AEP 2100 event this over 1m of inundation extends across nearly all areas to the west of the A494.

Figure C.48: 0.5% AEP 2100 Tidal Breach Five Flood Depth



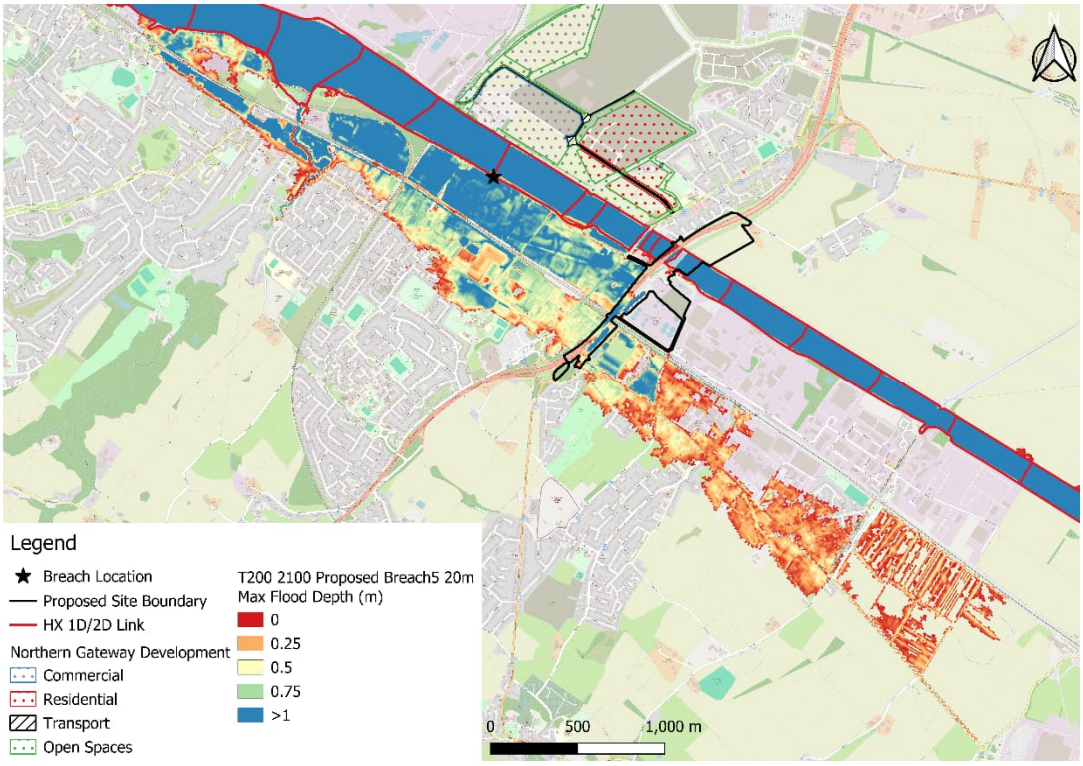
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Figure C.49: 0.5% AEP 2100 Tidal Breach Five Flood Velocity



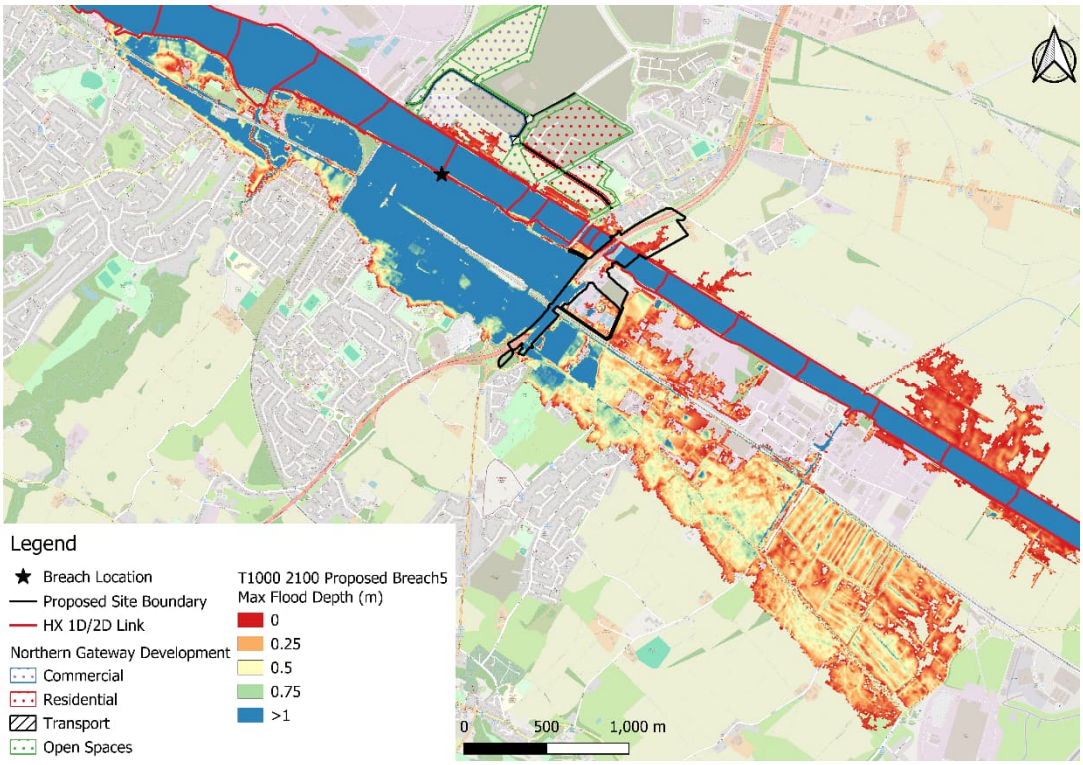
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.50: 0.5% AEP 2100 Tidal Breach Five 20m Flood Depth



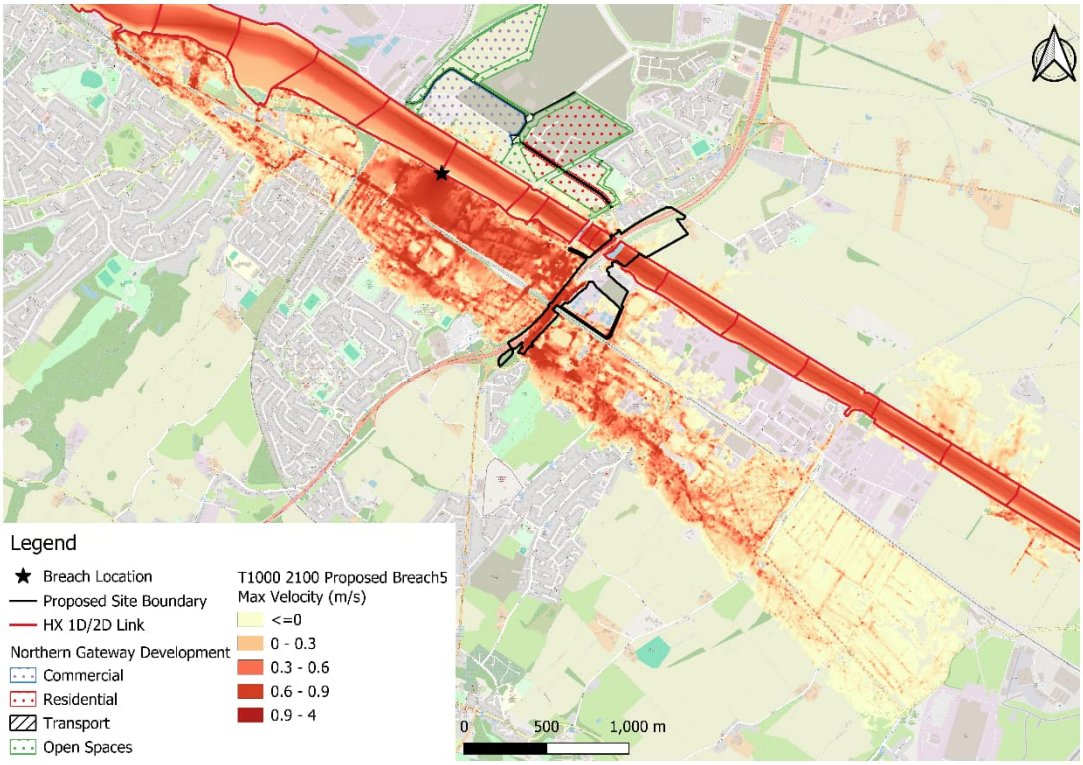
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.51: 0.1% AEP 2100 Tidal Breach Five Flood Depth



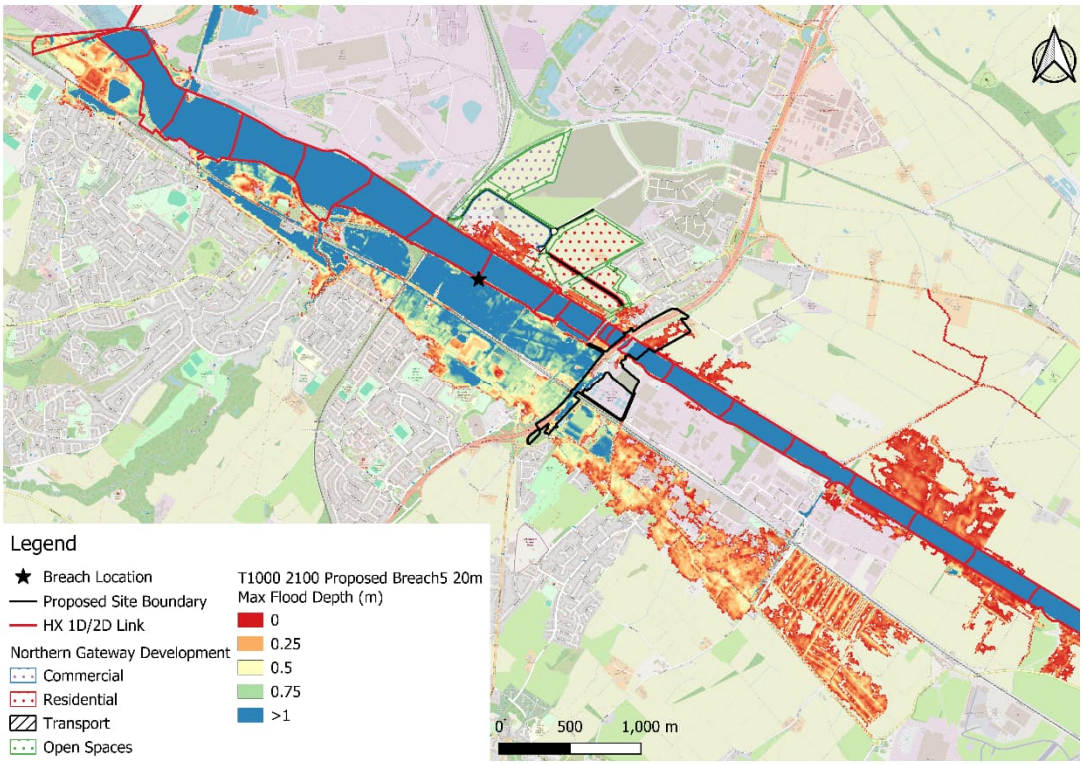
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.52: 0.1% AEP 2100 Tidal Breach Five Flood Velocity



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.53: 0.1% AEP 2100 Tidal Breach Five 20m Flood Depth



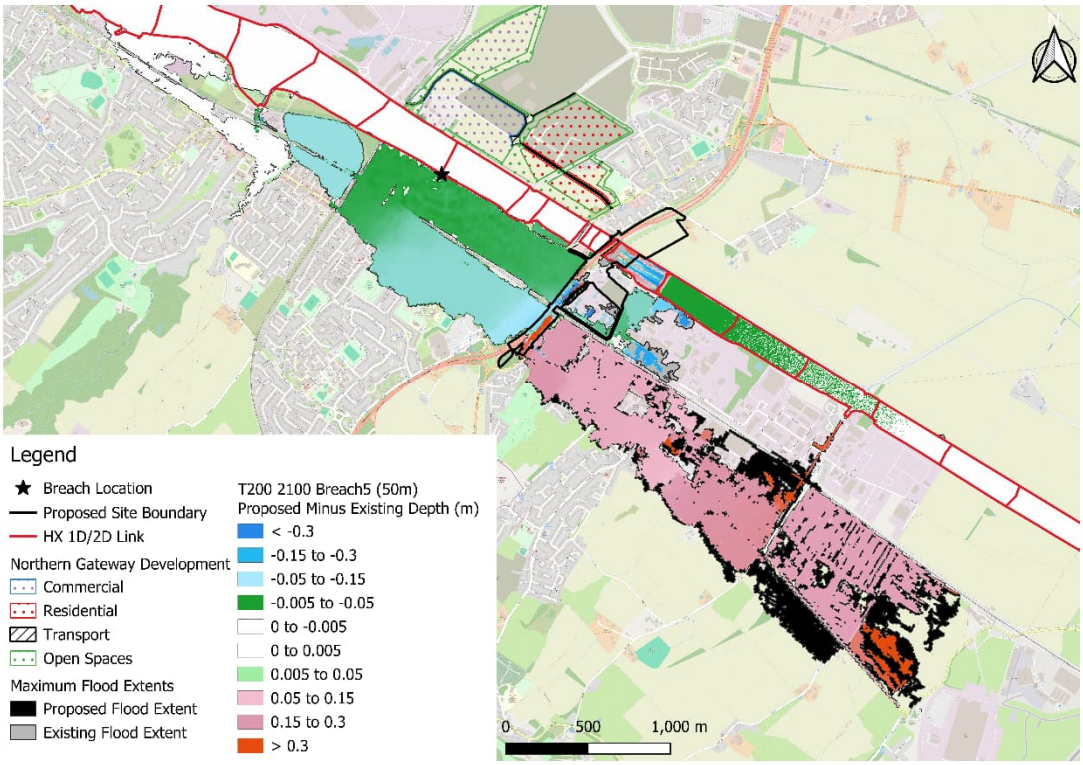
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

C.3.5.1 Comparison Against Existing Scenario

Depth differences from Tidal Breach Five for the Proposed and the Existing scenarios are detailed in Figure C.54 and Figure C.55. For Tidal Breach Five there is a slight decrease in depth between the Proposed and the Existing scenario in the areas around Shotton in most places under the 0.5% AEP 2100 event and under the 0.1% AEP 2100 event. In areas to the south of the Scheme there is an increase in flood depth with many areas in both the 0.5% and 0.1% AEP 2100 events experiencing up to 0.3m of increase. This rise is seen around Sandycroft, as well as up to 0.15m of depth increase for all areas south of the Scheme.

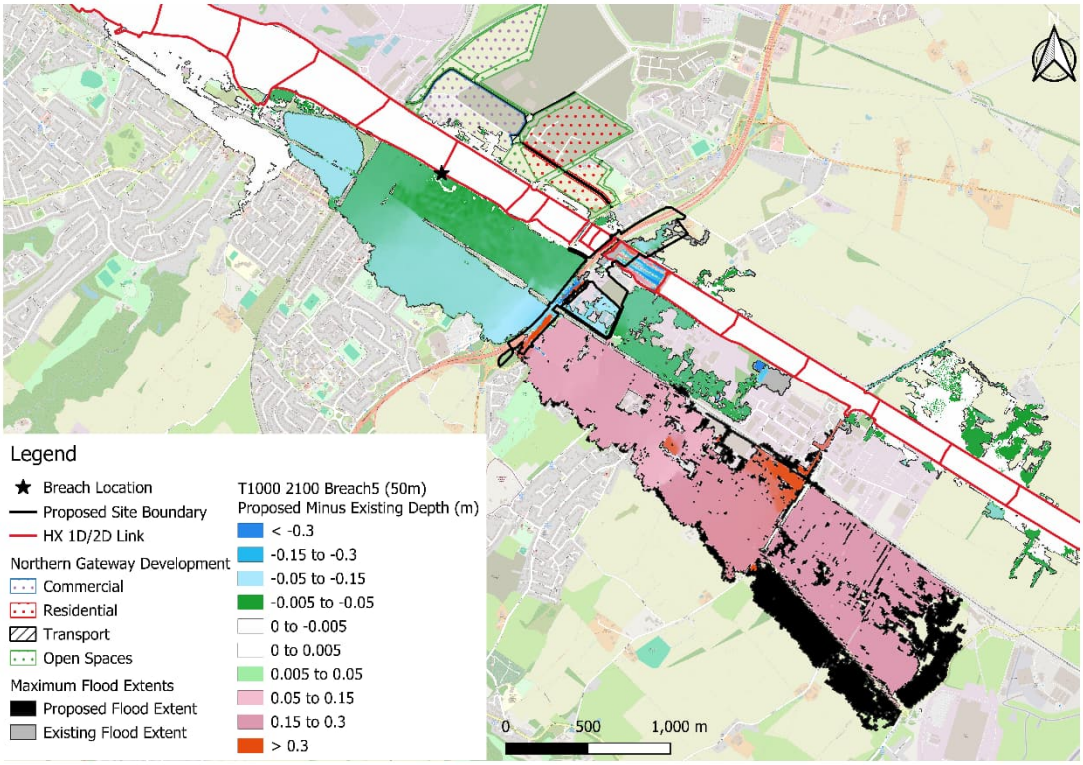
Figure C.56 and Figure C.57 detail the results of the Tidal Breach Five 20m sensitivity runs. The 0.5% AEP 2100 event has depth reduction in areas around Shotton with residential areas seeing a reduction of up to 0.08m. However, this is offset by increased flooding to the south of the project Scheme which sees an increase in flooding of the same extent across Sandycroft and beyond comparative to the Existing scenario. A similar depth difference pattern can be seen for the 0.1% AEP 2100 event with areas around Shotton displaying further decreases in flood depth compared to the Existing scenario. Whilst there is a significant increase in flood depth across Sandycroft with increases in flood depth of over 0.45m in some areas as well as having a significant increase in flood depth compared to the Existing scenario extents.

Figure C.54: 0.5% AEP 2100 Tidal Breach Five Flood Depth Difference



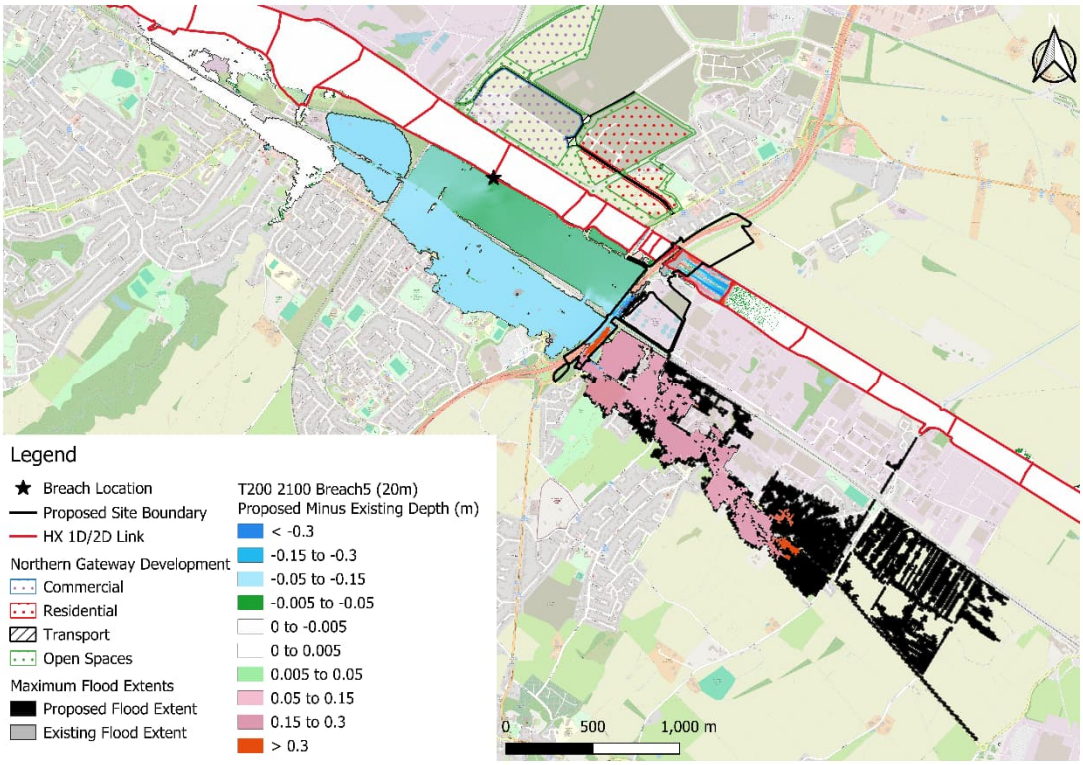
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.55: 0.1% AEP 2100 Tidal Breach Five Flood Depth Difference



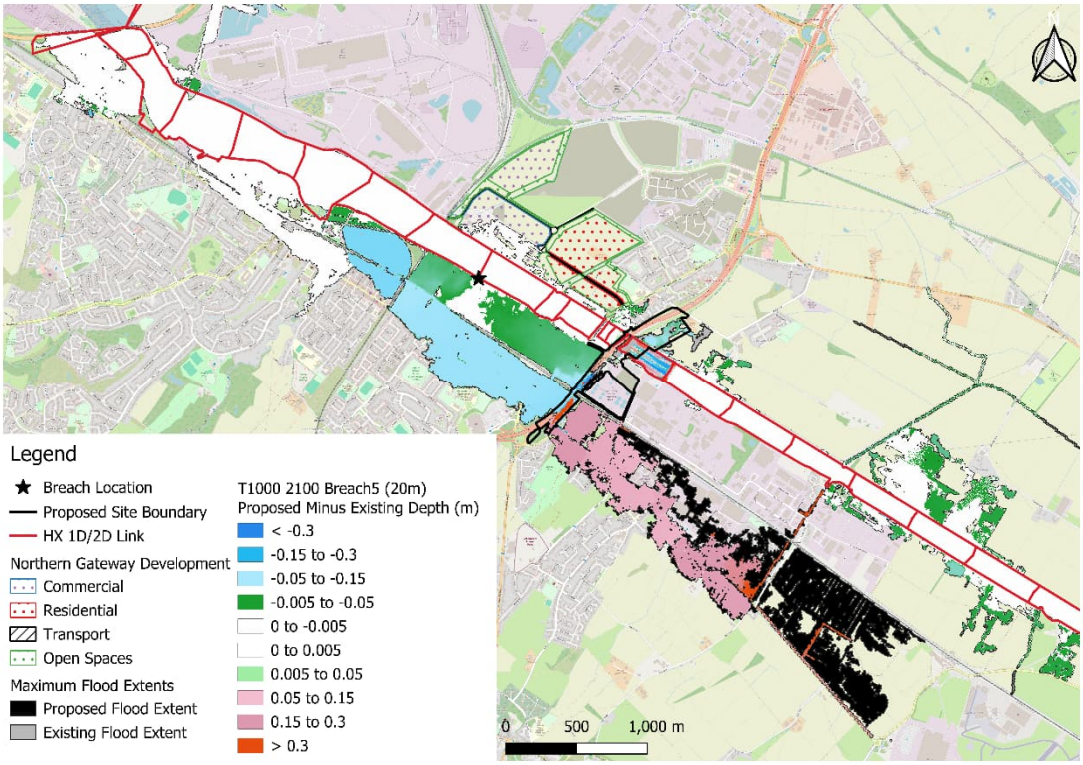
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Figure C.56: 0.5% AEP 2100 Tidal Breach Five 20m Flood Depth Difference



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Figure C.57: 0.1% AEP 2100 Tidal Breach Five 20m Flood Depth Difference



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C.4 Tidal Breach (With Mitigation)

The results of a sensitivity test on Tidal Breaches One, Three and Five are detailed in this section, these results detail the depths of flooding seen with the mitigation measure in place and the depth difference between the Proposed scenario with the mitigation measures in place and the Existing scenario. As before please note that for all flood depth difference values the calculation used as been Proposed minus Existing, **hence a positive value indicated an increase in water levels.**

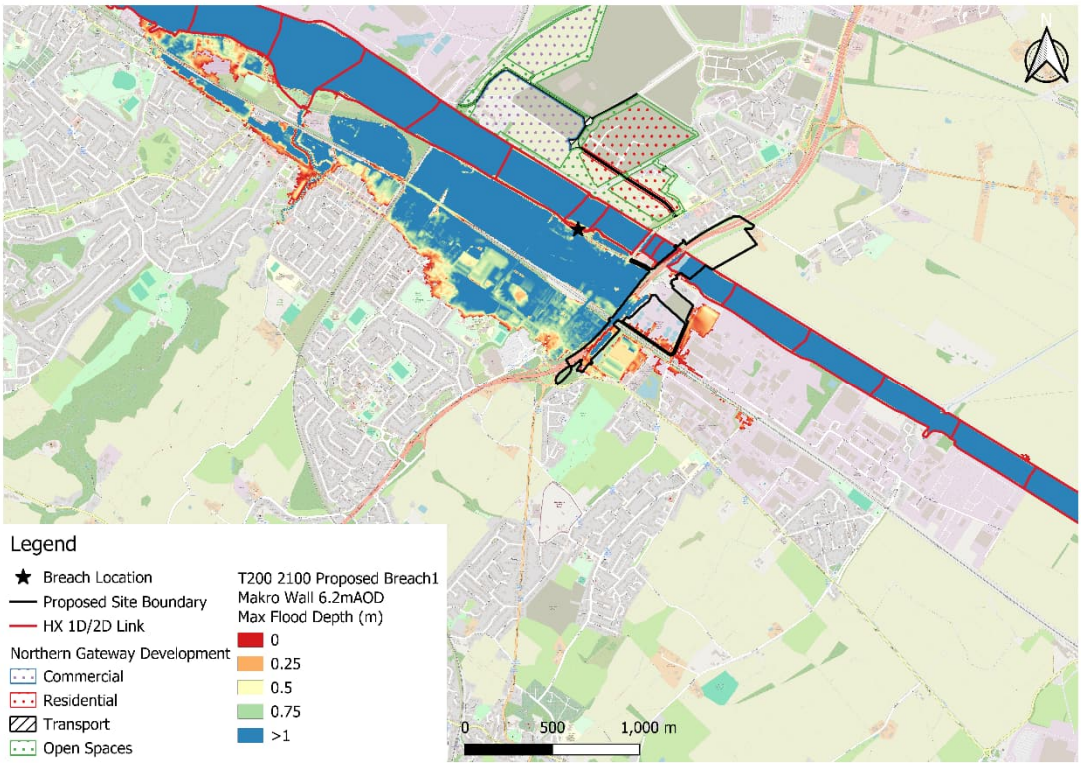
C.4.1 Makro Wall Flood Mitigation

C.4.1.1 Tidal Breach One

Figure C.58 details the flood depth for Tidal Breach One including the Makro Wall flood mitigation measure for the 0.5% AEP 2100 event. This flood scenario poses a significant threat to areas around Shotton. Flood depths close to the breach location and to the north of Shotton are predicted to be under an excess of 1m of flooding. Flooding from this event intersects with flooding from Wepre Brook to the north, whilst flooding does not persist over Pentre or Sandycroft.

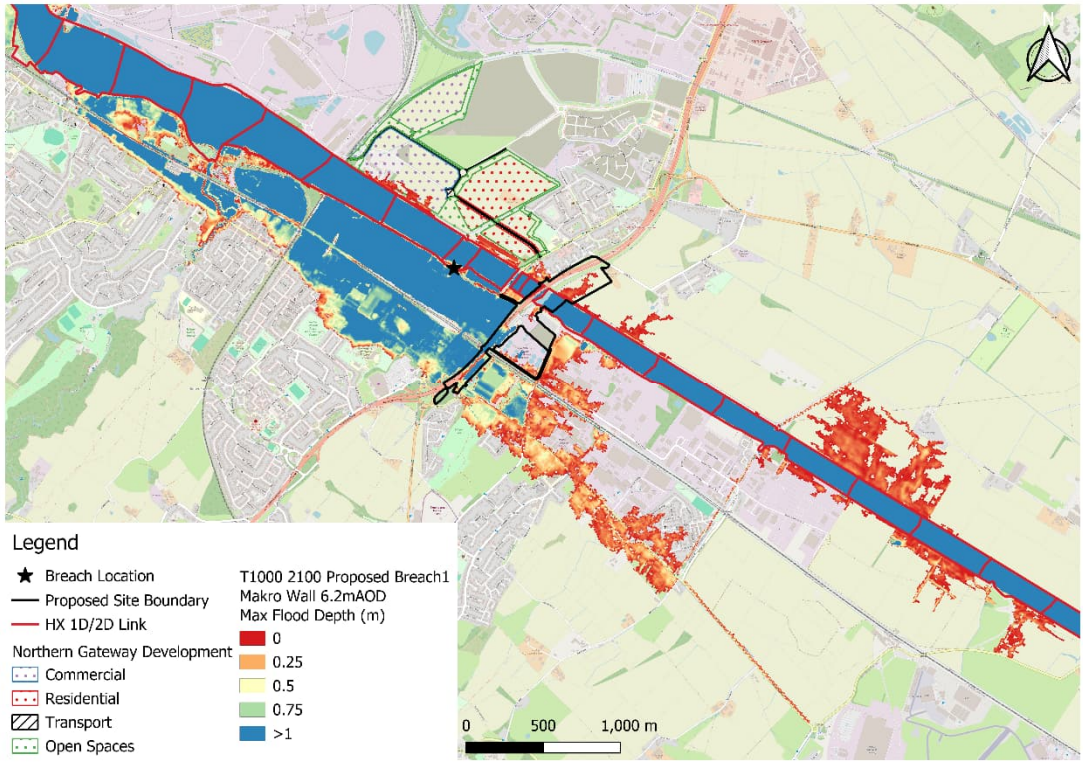
Figure C.59 details the flood depth for Tidal Breach One including the Makro Wall flood mitigation measure for the 0.1% AEP 2100 event. Under this scenario Tidal Breach One poses a significant flood risk to the Shotton and Queensferry as well as to the Scheme. Flood depths close to the breach location are predicted to be in excess of 1m for much of the area around Shotton. Flooding from this breach also intersects with existing flooding from Wepre Brook to the north of Shotton. Some flooding occurs near Pentre however Sandycroft remains flood free under this scenario.

Figure C.58: 0.5% AEP 2100 Tidal Breach One Makro Wall Flood Depth



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.59: 0.1% AEP 2100 Tidal Breach One Makro Wall Flood Depth

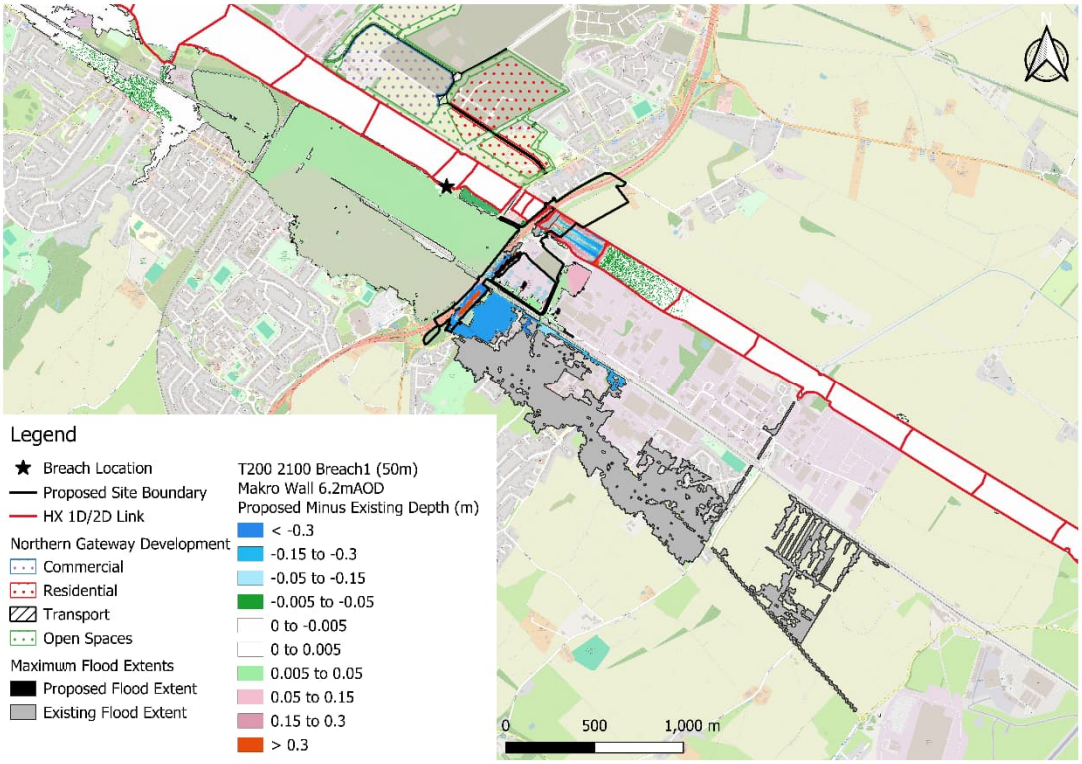


Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.60 details the impact of the Makro Wall on the 0.5% AEP 2100 event for Tidal Breach One. As detailed, there is a significant reduction in flood extent compared to the Existing scenario where flooding extended across the floodplain to Sandycroft. However, this reduction in flood extent is counterbalanced by water levels being raised around 0.013m on average across the open spaces to the north of Shotton and 0.029m across the urbanised areas.

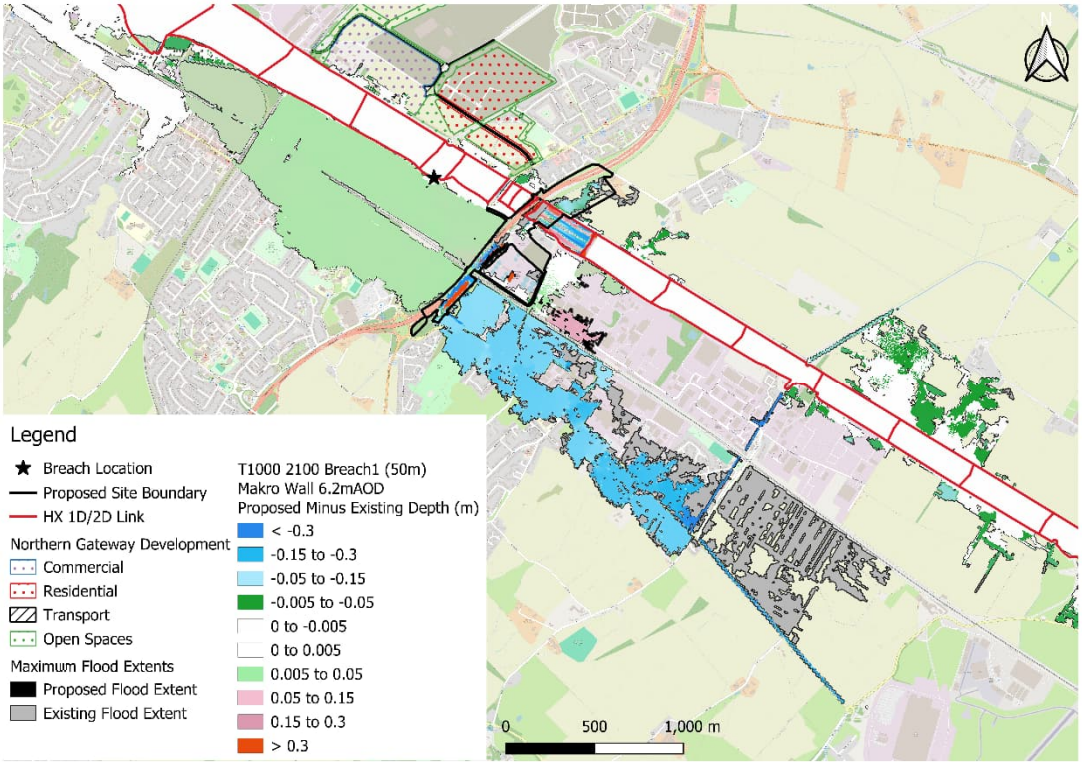
Figure C.61 details the flood depth difference between the Proposed scenario including mitigation measures and the Existing scenario for Tidal Breach One. As detailed, there is an increase in flood depths across Shotton, this is an average increase on average of 0.014m over the urbanised areas of Shotton and an average increase of 0.013m across the open spaces to the north of the railway line. However, flood extent is significantly decreased with flood depths being reduced across Queensferry to the south of the Scheme and flood extent no longer transferring across the floodplain to Sandycroft. There are some changes in flood extents around Factory Road due to the change in flow paths.

Figure C.60: 0.5% AEP 2100 Tidal Breach One Makro Wall Flood Depth Difference



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.61: 0.1% AEP 2100 Tidal Breach One Makro Wall Flood Depth Difference



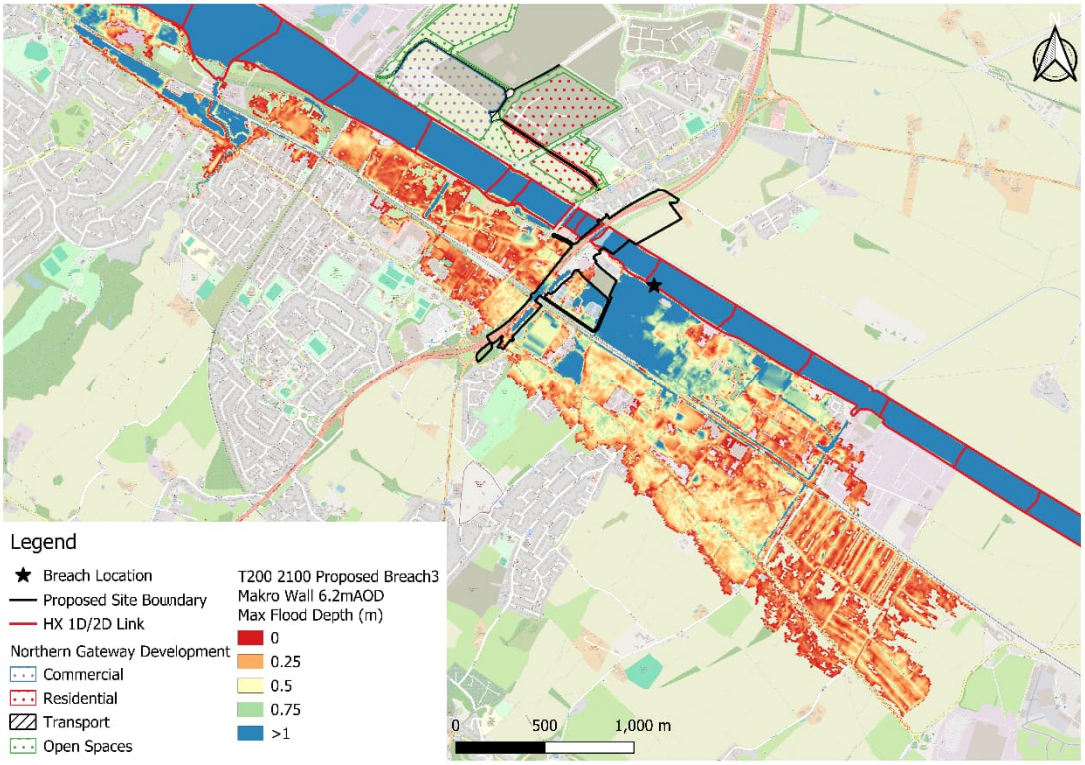
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C.4.1.2 Tidal Breach Three

Figure C.62 details the flood depths from Tidal Breach Three including the Makro Wall flood mitigation measure in place under the 0.1% AEP 2100 event. There is significant flooding from the breach with areas close to the breach location predicted to be under up more than 1m and areas around Queensferry, Pentre, and Sandycroft under up to 1m of water. Flooding is less severe around Shotton with most of the flooding occurring in the open spaces to the north of the railway line.

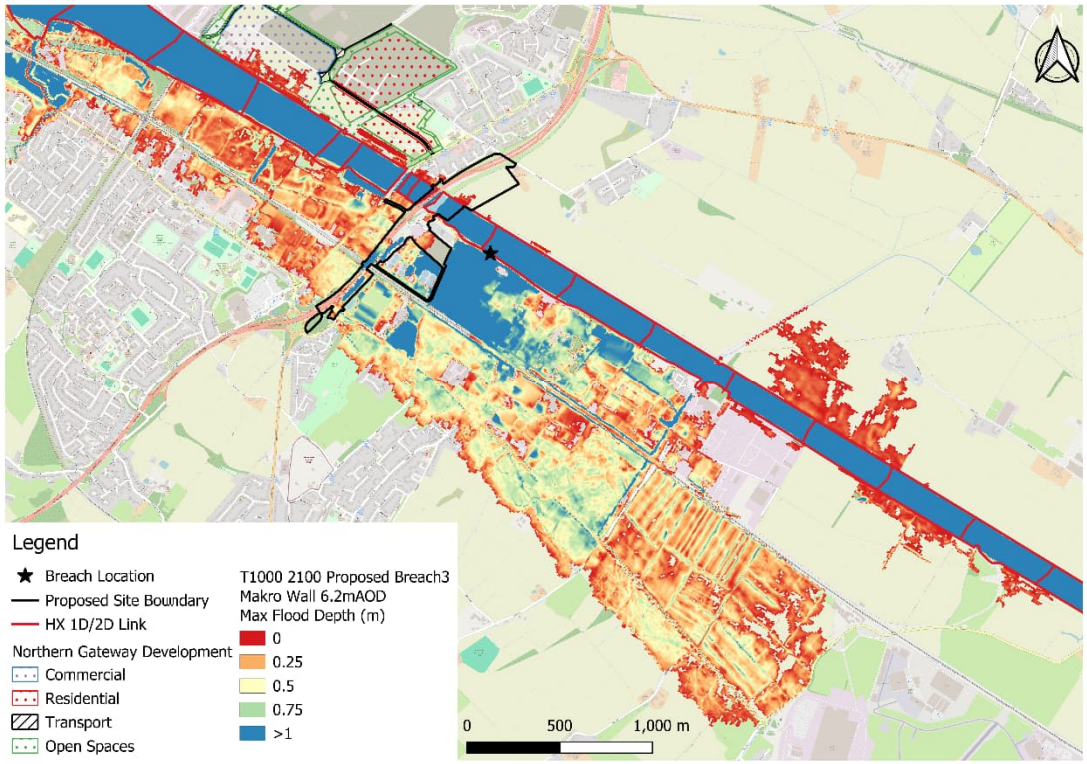
Figure C.63 details the flood depths from Tidal Breach Three including the Makro Wall flood mitigation measure in place under the 0.1% AEP 2100 event. There is significant flooding under the Tidal Breach Three including mitigation scenario with Queensferry, Pentre and Sandycroft areas affected by flooding mostly up to 1m. Flooding also extends across Shotton although flood depths are less severe here than other areas. Queensferry Sewage Treatment Works and the Riverside Travellers Site are most heavily affected areas with over 1m of flooding under this sensitivity test.

Figure C.62: 0.5% AEP 2100 Tidal Breach Three Makro Wall Flood Depth



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Figure C.63: 0.1% AEP 2100 Tidal Breach Three Makro Wall Flood Depth

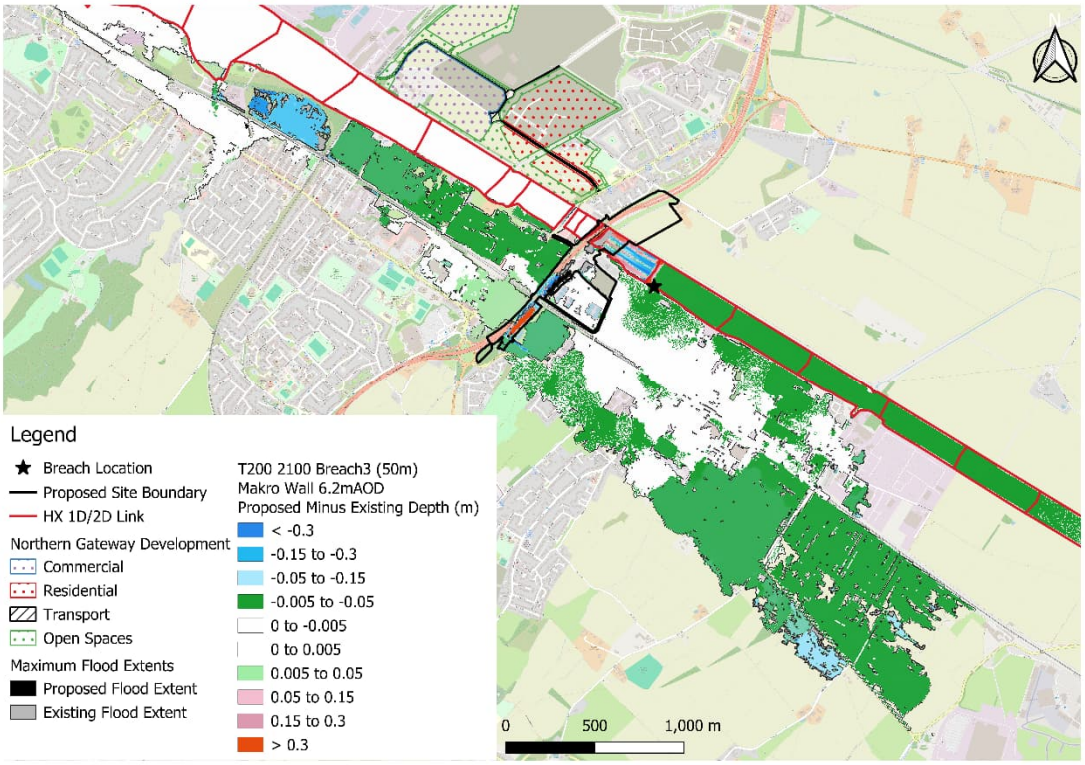


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Figure C.64 details the impact of the Makro Wall on the 0.5% AEP 2100 event for Tidal Breach Three. Flood depth near to the breach location does not change within a noticeable range. Whilst areas to the south of the breach and north of the Scheme see a reduction in flood depth compared to the Existing scenario with flood depths reducing the further from the breach location the water flows.

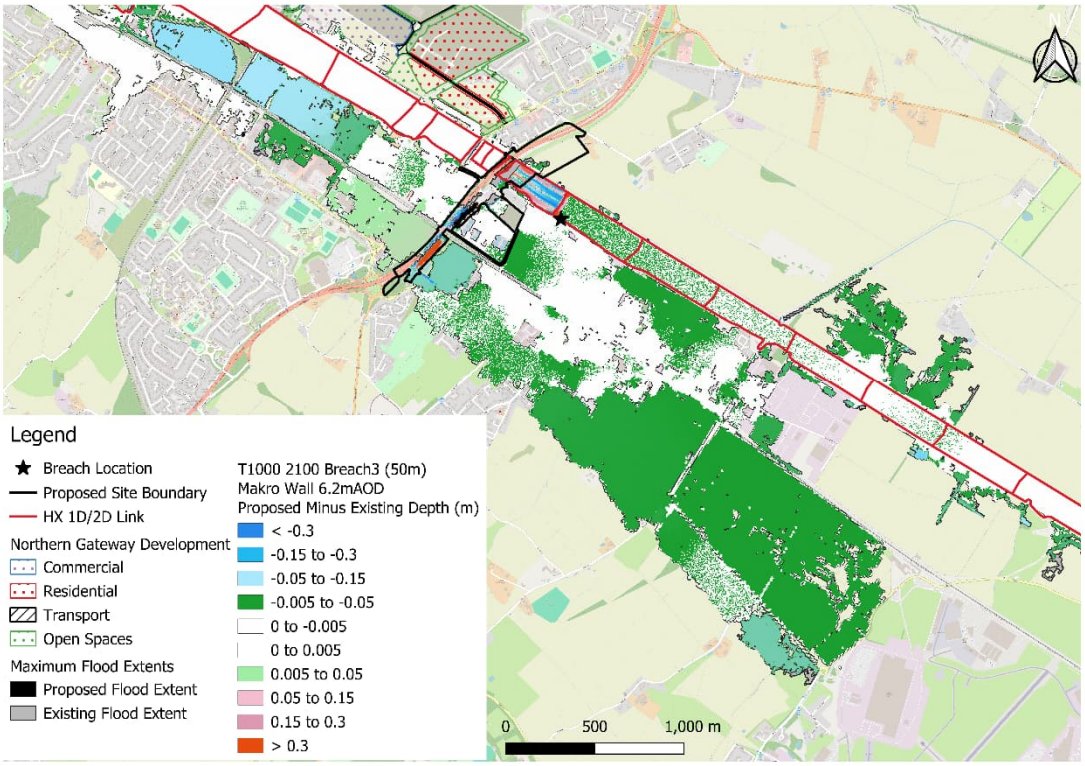
Figure C.65 details the flood depth difference between the Proposed scenario including mitigation measures and the Existing scenario for the 0.1% AEP 2100 event for Tidal Breach Three. Flood depths near the breach location remain largely similar between the Existing scenario and the Proposed scenario including mitigation, there is a slight decrease in flood depths around the area of Sandycroft. Flood depths increase slightly near the Deeside Leisure Centre and in areas of Shotton to the south of the railway line, up to around 0.030m in locations closest to the railway crossing. To the north of the railway line flood depths can be seen reducing by up to 0.060m.

Figure C.64: 0.5% AEP 2100 Tidal Breach Three Makro Wall Flood Depth Difference



Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2026)

Figure C.65: 0.1% AEP 2100 Tidal Breach Three Makro Wall Flood Depth Difference



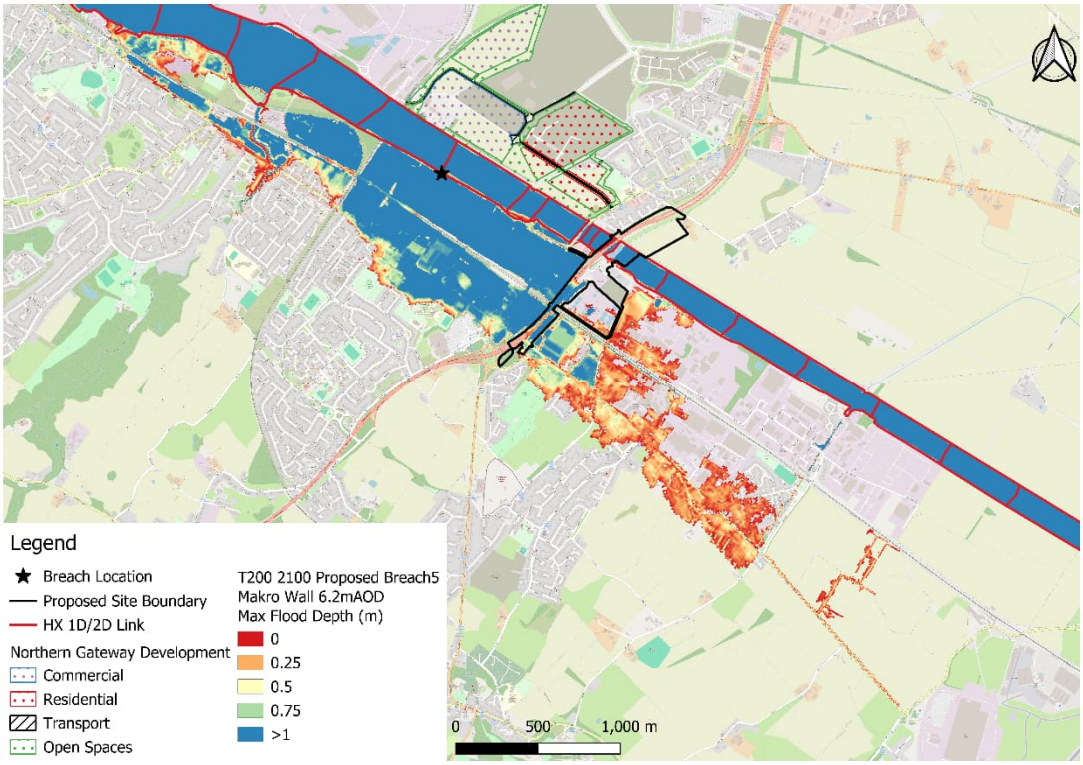
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C.4.1.3 Tidal Breach Five

Figure C.66 details the flood depths from Tidal Breach Five including the Makro Wall flood mitigation measure in place under the 0.5% AEP 2100 event. Under this scenario Shotton is predicted to be under significant levels of flooding with both the rural and urbanised areas of Shotton being under more than 1m of flood water. Flood depths are much lower in areas of Queensferry where flood water makes it past the Makro Wall mitigation.

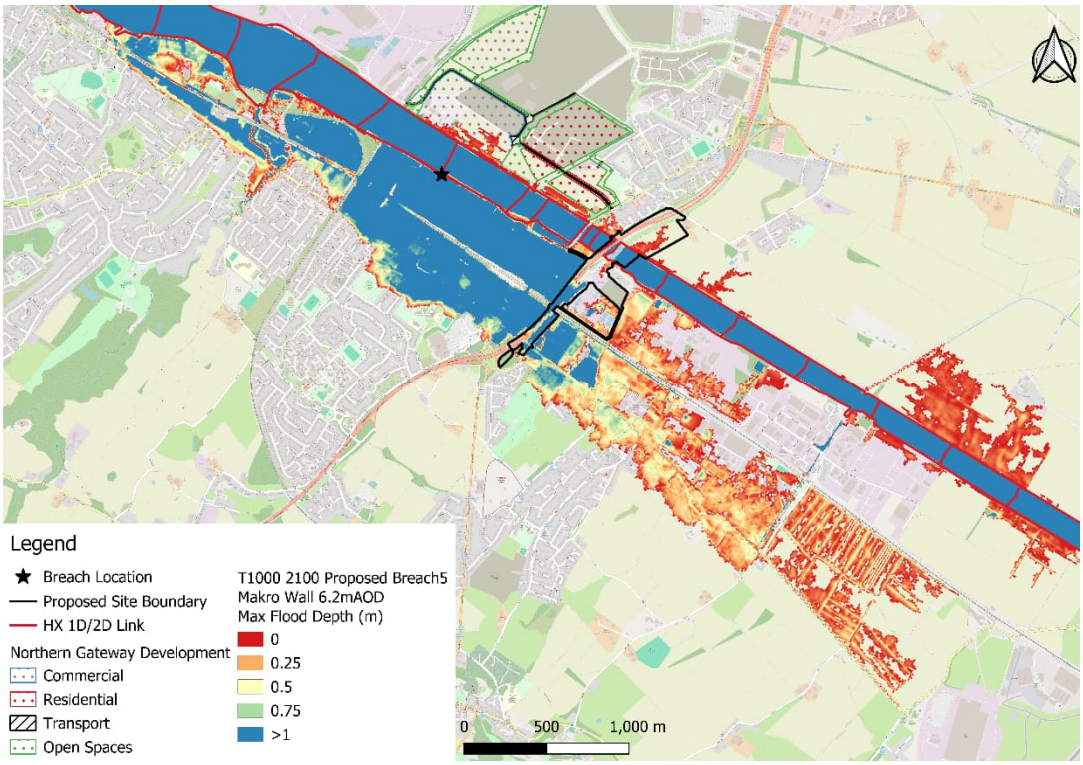
Figure C.67 details the flood depths from Tidal Breach Five including the Makro Wall flood mitigation measure in place under the 0.1% AEP 2100 event. Under this scenario Tidal Breach Five causes significant flooding to the Shotton, Queensferry, and Pentre areas with a significant area around the Tidal Breach location being inundated flood water over 1m in depth. Flooding does pass the Makro Wall and extend further across the floodplain to Sandycroft along Chester Road East.

Figure C.66: 0.5% AEP 2100 Tidal Breach Five Makro Wall Flood Depth



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Figure C.67: 0.1% AEP 2100 Tidal Breach Five Makro Wall Flood Depth

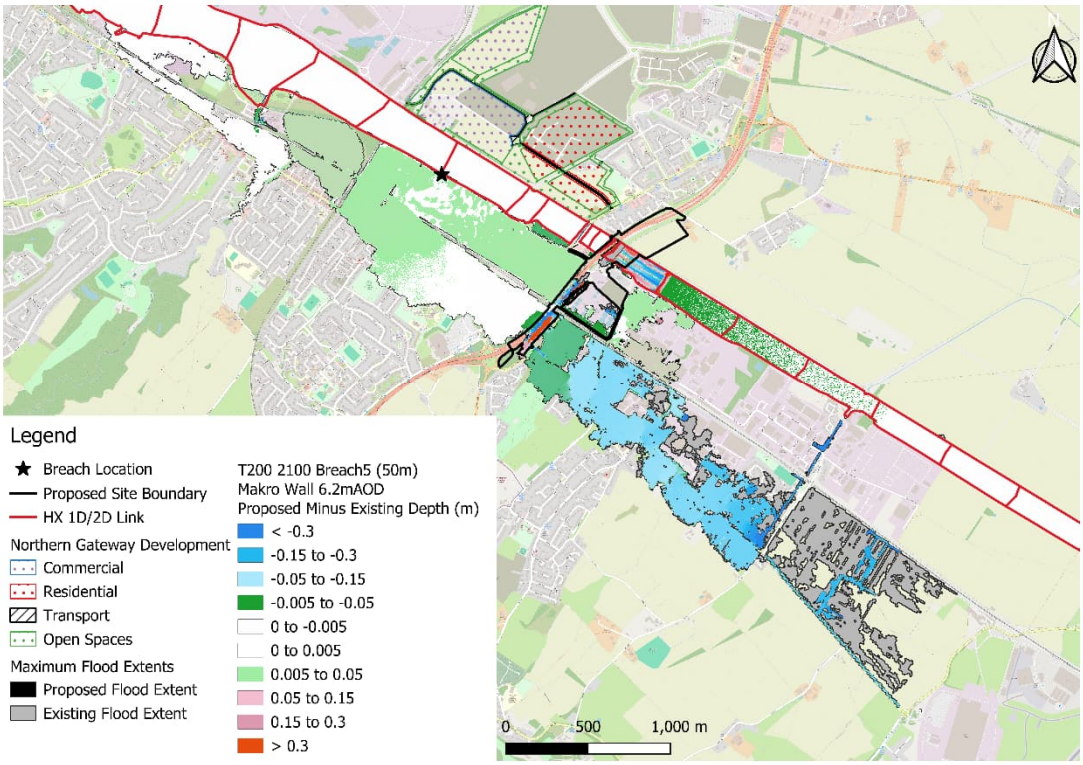


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Figure C.68 details a significant reduction in flood extent for the 0.5% AEP 2100 event compared to the Existing scenario. Areas across Sandycroft and much of the floodplain to the southeast of the Scheme is predicted to remain flood free with the inclusion of the Makro Wall. In areas to the north of the railway line north of Shotton the water levels are predicted to increase with an average rise of 0.011m to the east of the Borderlands railway line and 0.021m to the west. Water levels are expected to improve by an average of 0.100m in the areas of flooding around Queensferry. A maximum reduction in flood depths of around 0.325m is predicted for areas in Sandycroft.

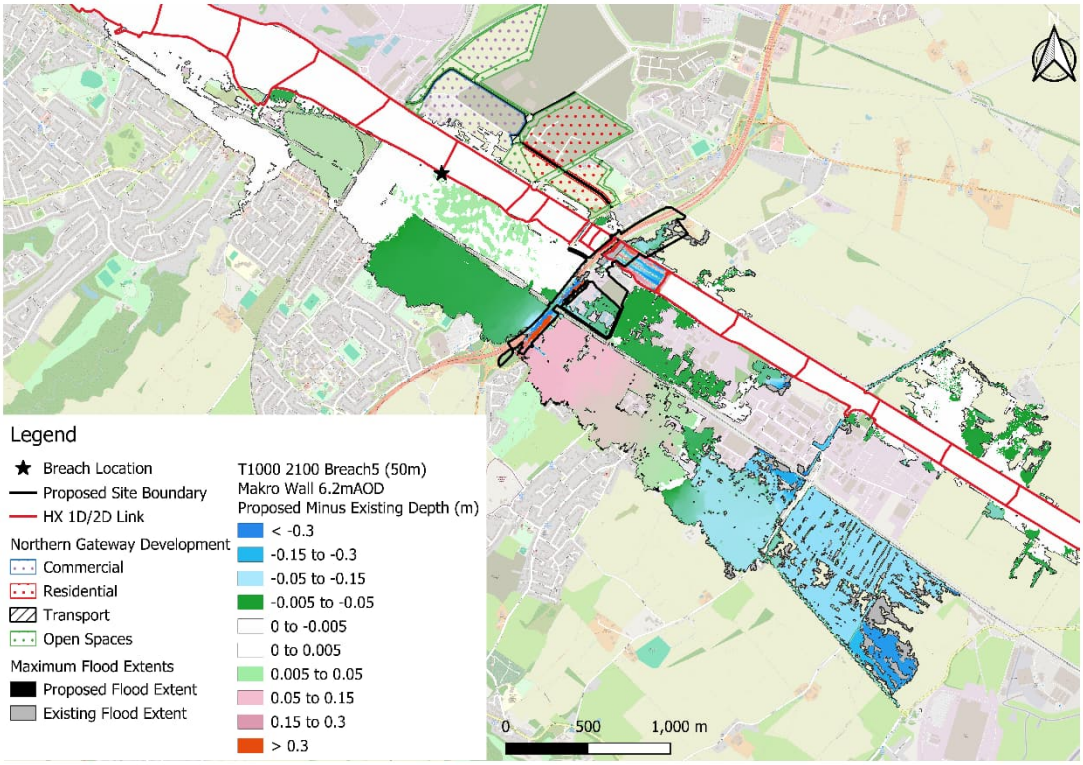
Figure C.69 details the flood depth difference between the Proposed scenario including mitigation measures and the Existing scenario for the 0.1% AEP 2100 event for Tidal Breach Five. Flooding can be seen to increase across areas to the east of the Borderlands railway line with an average increase of 0.019m. Flood depths near the breach stay largely similar to the Existing scenario with some increases above .0005m whilst the urbanised areas of Shotton see a decrease in depths of an average of .0010m. To the south of the proposed development area in Queensferry flood depths are increased compared to the Existing scenario with flood depths increasing by up to 0.065m. Flood depths decrease further towards Sandycroft with flood depths decreasing by an average of 0.050m and with some rural area seeing significant improvements of up to 0.250m.

Figure C.68: 0.5% AEP 2100 Tidal Breach Five Makro Wall Flood Depth Difference



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Figure C.69: 0.1% AEP 2100 Tidal Breach Five Makro Wall Flood Depth Difference



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C.5 Tidal Flooding Additional Sensitivity Tests

The results of these sensitivity tests on the 0.1% AEP 2100 event are detailed in this section, these results detail the depths of flooding seen with the different sensitivity measures in place and the depth difference between the Proposed with the measures in place and the Existing scenario. As before please note that for all flood depth difference values the calculation used as been Proposed minus Existing, **hence a positive value indicated an increase in water levels.**

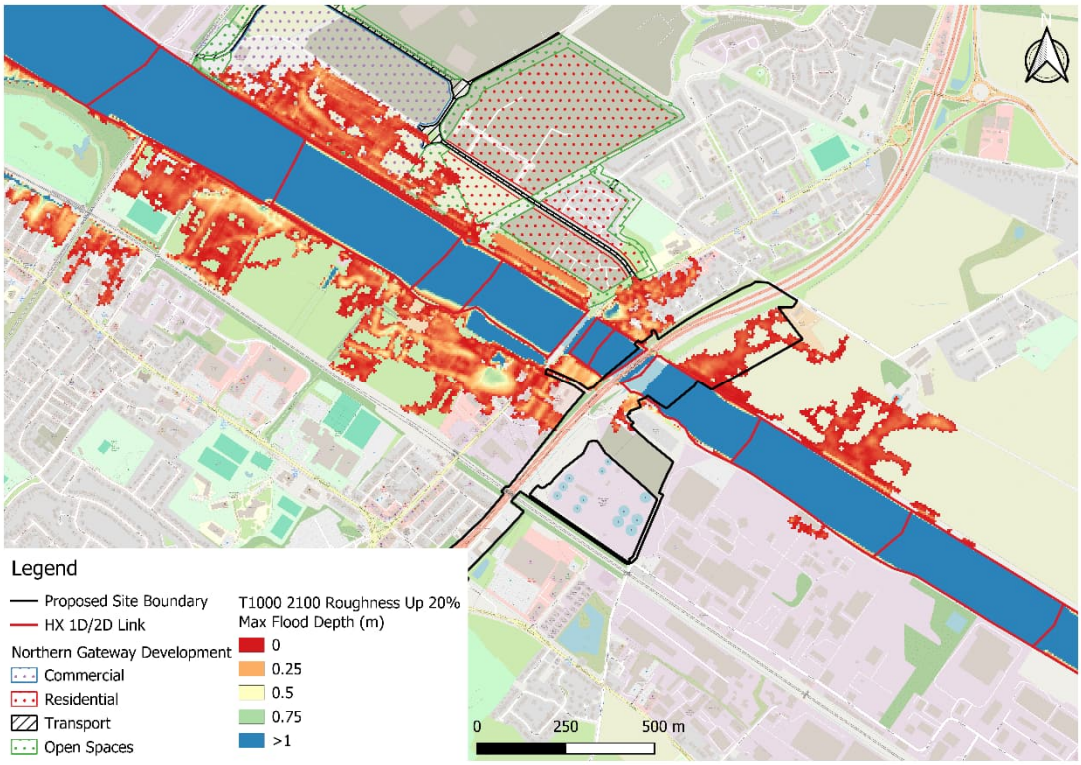
C.5.1 Roughness Sensitivity

The roughness file of the River Dee post-development scenario model was increased and decreased by 20% to assess the model's sensitivity to this parameter.

C.5.1.1 Roughness up 20%

Figure C.70 details the flood depths from the 0.1% AEP 2100 tidal event with the material roughness file increased by 20%. Under this scenario flooding extends out of bank between the proposed bridge and the Jubilee bridge on both the left and right banks of the River Dee. This flooding is shallow in nature with depths exceeding 1m on the left bank in the low open space downstream of Jubilee bridge and in a small, localised area on the right bank immediately adjacent to the Welsh Road.

Figure C.70: 0.1% AEP 2100 Tidal Roughness Up 20% Flood Depth

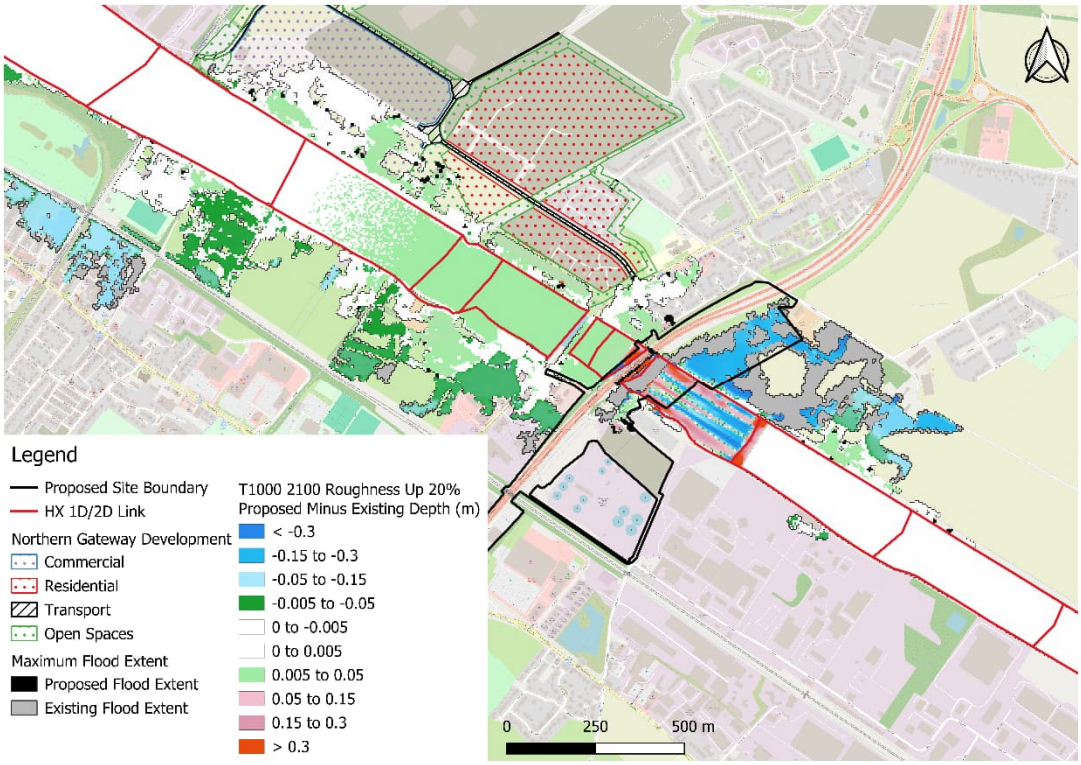


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Figure C.71 details the flood depth difference between the increased roughness post-development scenario model results and the pre-development flood depths for the 0.1% AEP 2100 event. There are some small increases in flood depth in the channel and on the right bank downstream of the proposed bridge under this scenario, as well as some additional flood extent compared to the Existing scenario in some small, localised areas. Flooding on the left bank mostly

decreases in depth most noticeably in commercial areas around the Expressway Business Park. Flooding is reduced both in depth and extent significantly upstream of the Scheme along the right bank under this scenario.

Figure C.71: 0.1% AEP 2100 Tidal Roughness Up 20% Flood Depth Difference

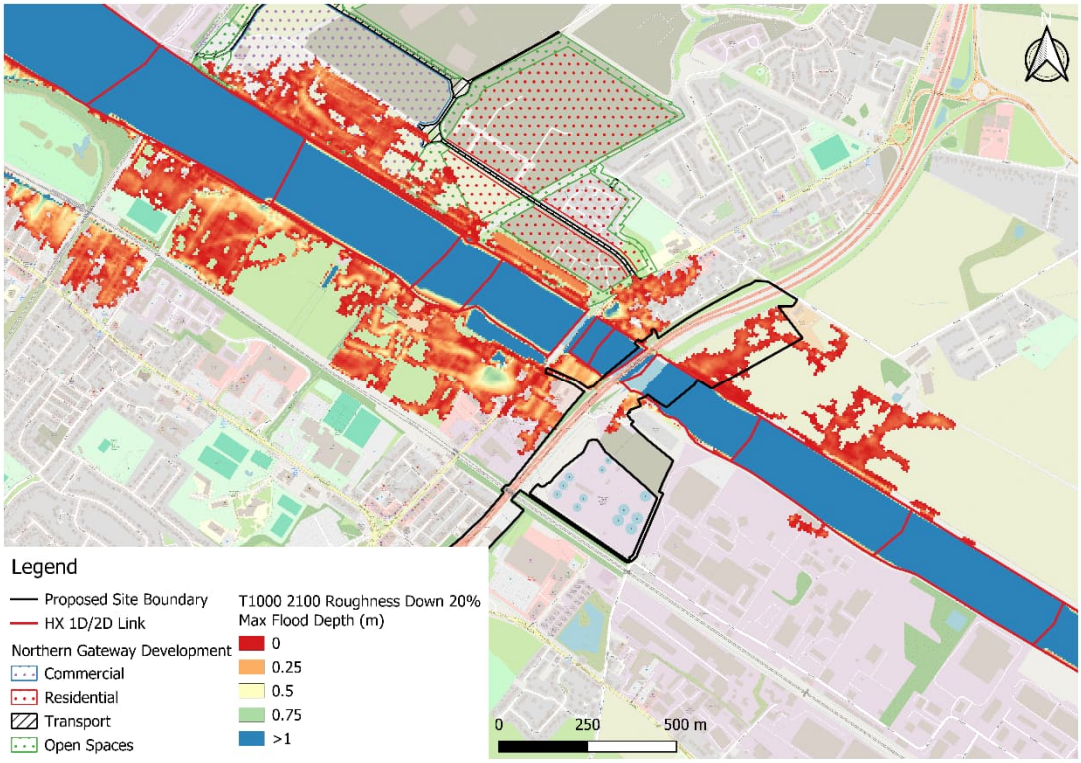


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C.5.1.2 Roughness down 20%

Figure C.72 details the flood depths from the 0.1% AEP 2100 tidal event with the material roughness file decreased by 20%. Under this scenario flooding extends out of bank between the proposed bridge and the Jubilee bridge on both the left and right banks of the River Dee. This flooding is shallow in nature with depths exceeding 1m on the left bank in the low open space downstream of Jubilee bridge and in a small, localised area on the right bank immediately adjacent to the Welsh Road. Flooding on the left bank also extends across commercial areas in Queensferry. Whilst on the right bank flooding extends onto areas of the Welsh roads and affects several residential areas.

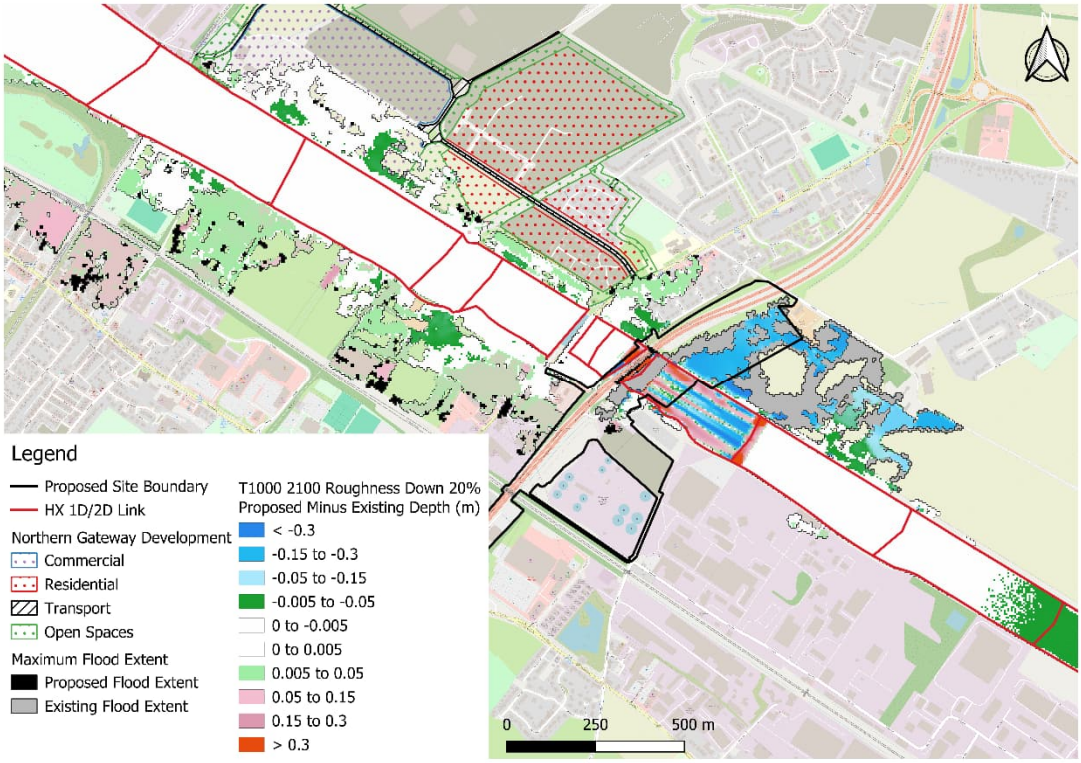
Figure C.72: 0.1% AEP 2100 Tidal Roughness Down 20% Flood Depth



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Figure C.73 details the flood depth difference between the decreased roughness Proposed scenario results and the Existing scenario flood depths for the 0.1% AEP 2100 event. There are some small increases in flood depth in the channel immediately downstream of the existing bridge piers. On the right bank downstream of the proposed bridge flood depths seem some minor fluctuations in depth compared to the Existing scenario. Flood extent is also slightly increased in some small, localised areas. Flooding on the left bank sees a noticeable increase in flood depth with an average increase of approximately 0.05m across commercial areas to the west of Station Road. Flooding is reduced both in depth and extent significantly upstream of the Scheme along the right bank under this scenario.

Figure C.73: 0.1% AEP 2100 Tidal Roughness Down 20% Flood Depth Difference

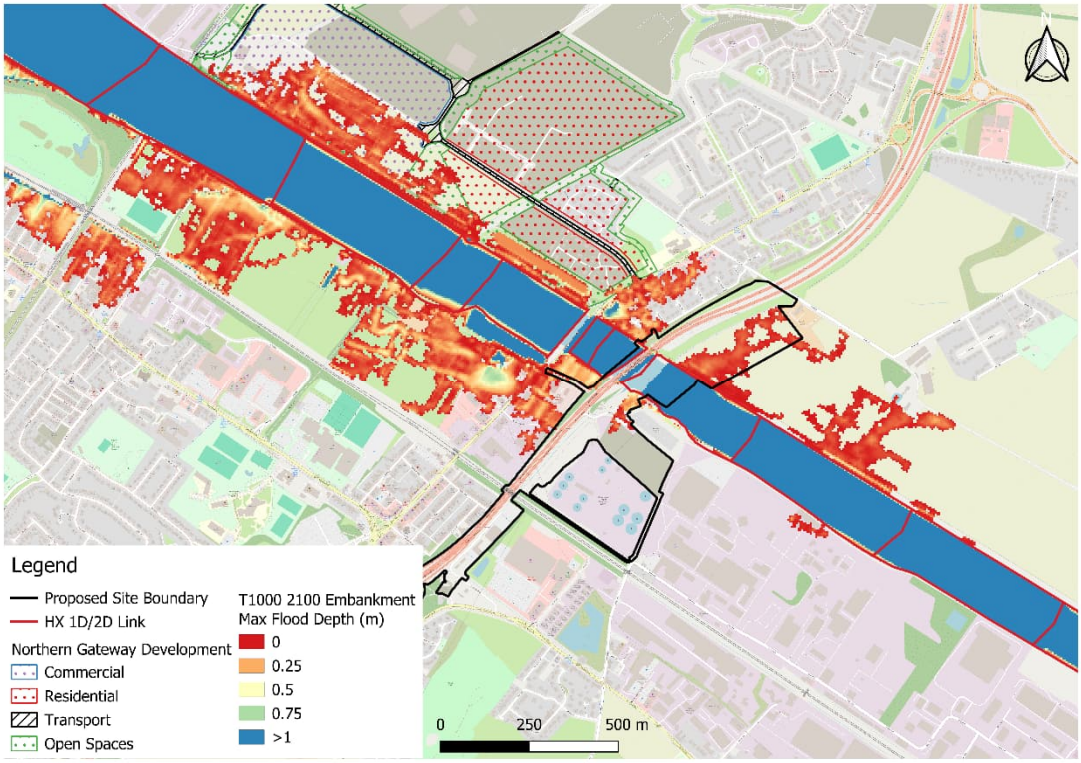


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C.5.2 Embankment Mitigation

Figure C.74 details the flood depths for the results of the 0.1% AEP 2100 event including a 10mm embankment raise on both banks downstream of the proposed bridge location extending to the Jubilee bridge. Flooding under this scenario is mostly low level with a few small areas of noticeably greater depths. On the right bank there is an area of flooding immediately adjacent to the bank downstream of the proposed bridge which exceeds 1m. On the left bank there are some areas of flood depth that exceed 1m, these areas are located on either open spaces or commercial areas.

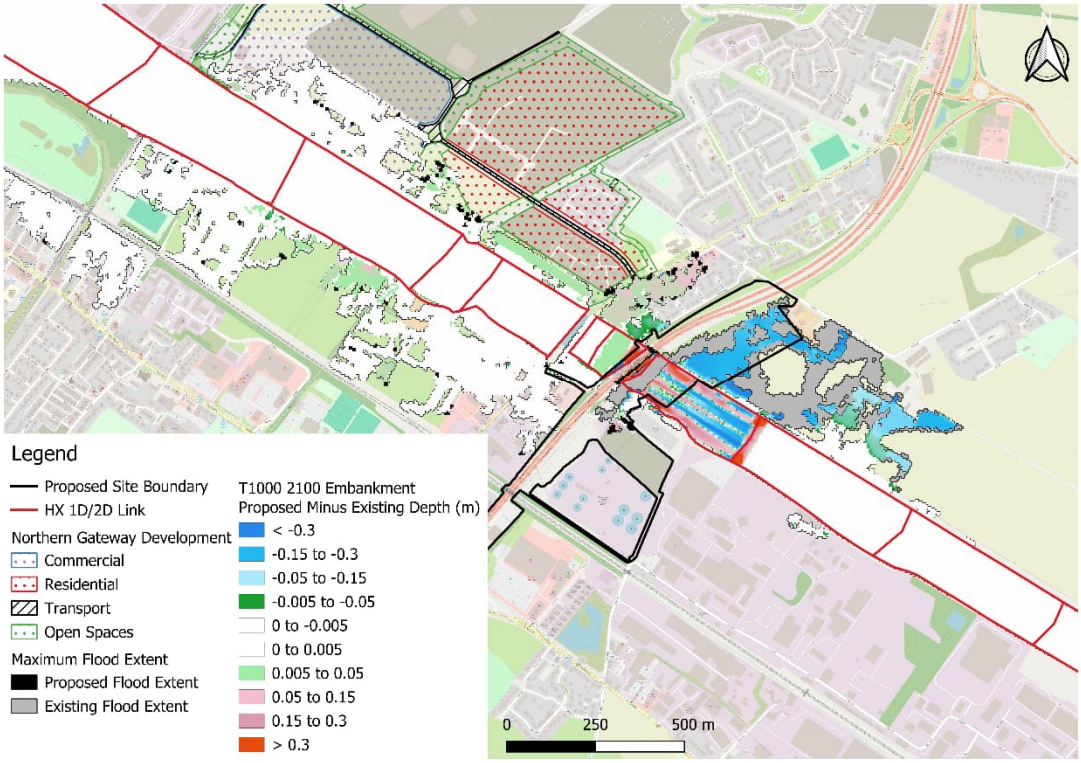
Figure C.74: 0.1% AEP 2100 Tidal Embankment Mitigation Flood Depth



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Figure C.75 details the difference in flood depth between the proposed bridge results including a 10mm embankment raise and the Existing scenario flood depths for the 0.1% AEP 2100 event. There is no significant difference in flood extent and depth between this scenario and the proposed scenario with no adjustment to the embankment.

Figure C.75: 0.1% AEP 2100 Tidal Embankment Mitigation Flood Depth Difference



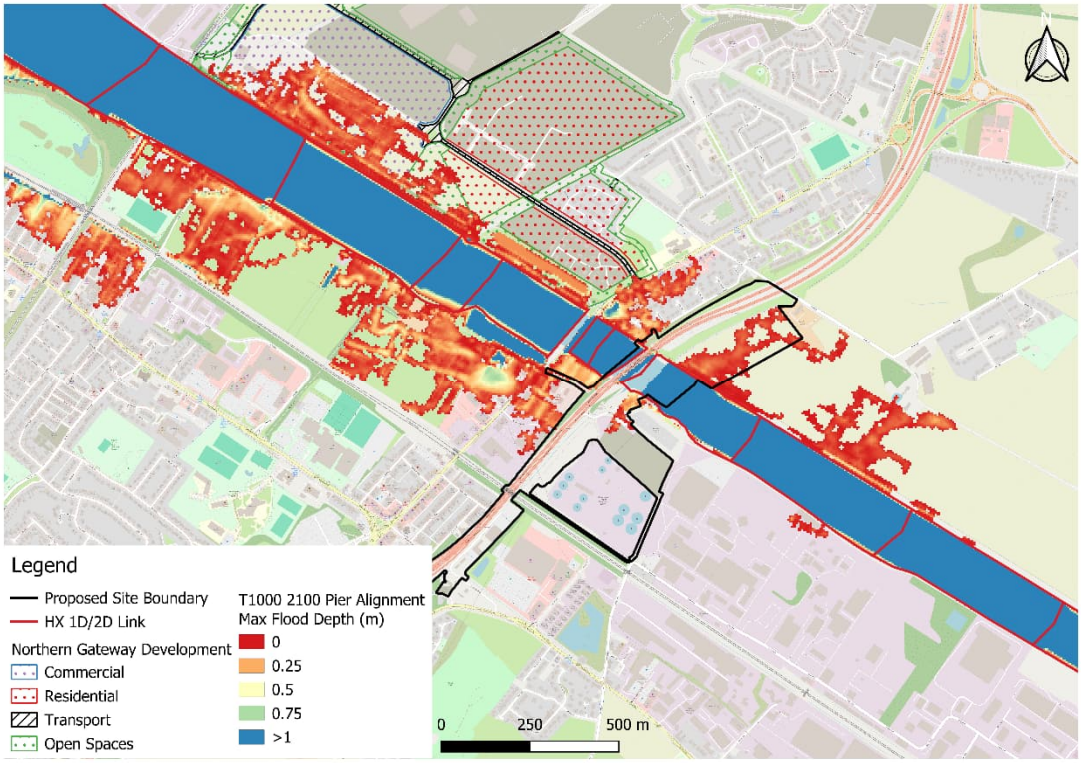
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C.5.3 Pier Adjustments

C.5.3.1 Pier Alignment

Figure C.76 details the flood depths for the results of the 0.1% AEP 2100 event including a reduction in skew angle of the proposed bridge from 20 degrees to 0 degrees. Under this scenario, flooding is mostly shallow with some areas of significant depth located in a low spot in the open space immediately downstream of the Jubilee Bridge. There is no difference in flood extent compared to the post-development model with pier skew set to 20 degrees.

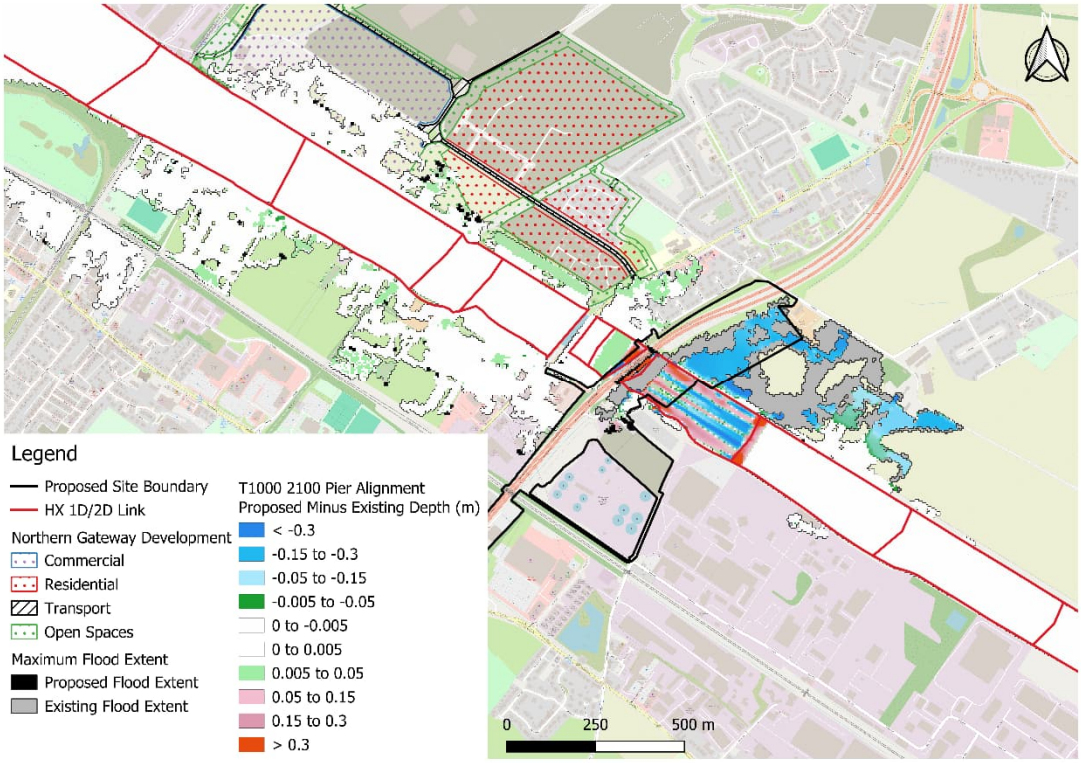
Figure C.76: 0.1% AEP 2100 Tidal Pier Alignment Flood Depth



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Figure C.77 details the flood depth difference between the post-development scenario model with pier skew angle for the Proposed scenario results and the Existing scenario flood depths for the 0.1% AEP 2100 event. There is a raise in flood depth along the right bank of the river as well as an increase in flood extent along Welsh Road and across a small residential area. Along the left bank there is a small increase in flood depth across commercial areas to the west of Station Road with an average depth increase of 0.008m compared to the Existing scenario. Flooding is reduced both in depth and extent significantly upstream of the Scheme along the right bank under this scenario.

Figure C.77: 0.1% AEP 2100 Tidal Pier Alignment Flood Depth Difference

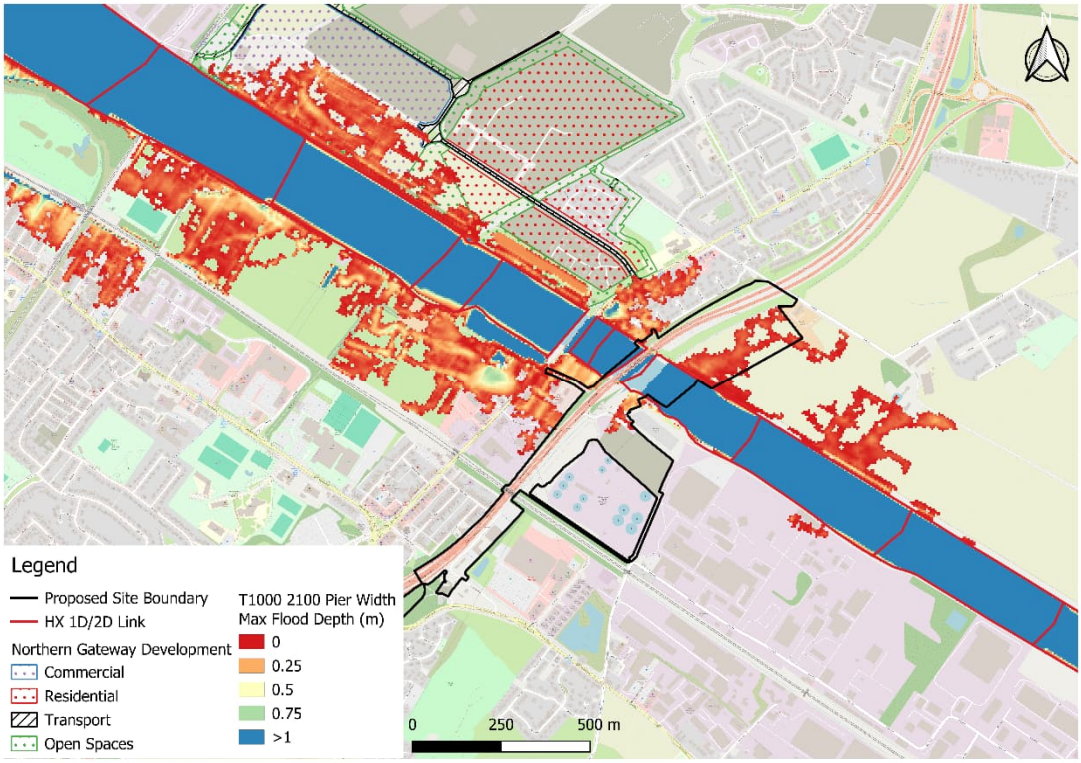


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C.5.3.2 Pier Widths

Figure C.78 details the flood depths for the results of the 0.1% AEP 2100 event including a reduction in pier width from 4m to 3.04m. Under this scenario, flooding is mostly shallow with some areas of significant depth located in a low spot in the open space immediately downstream of the Jubilee Bridge.

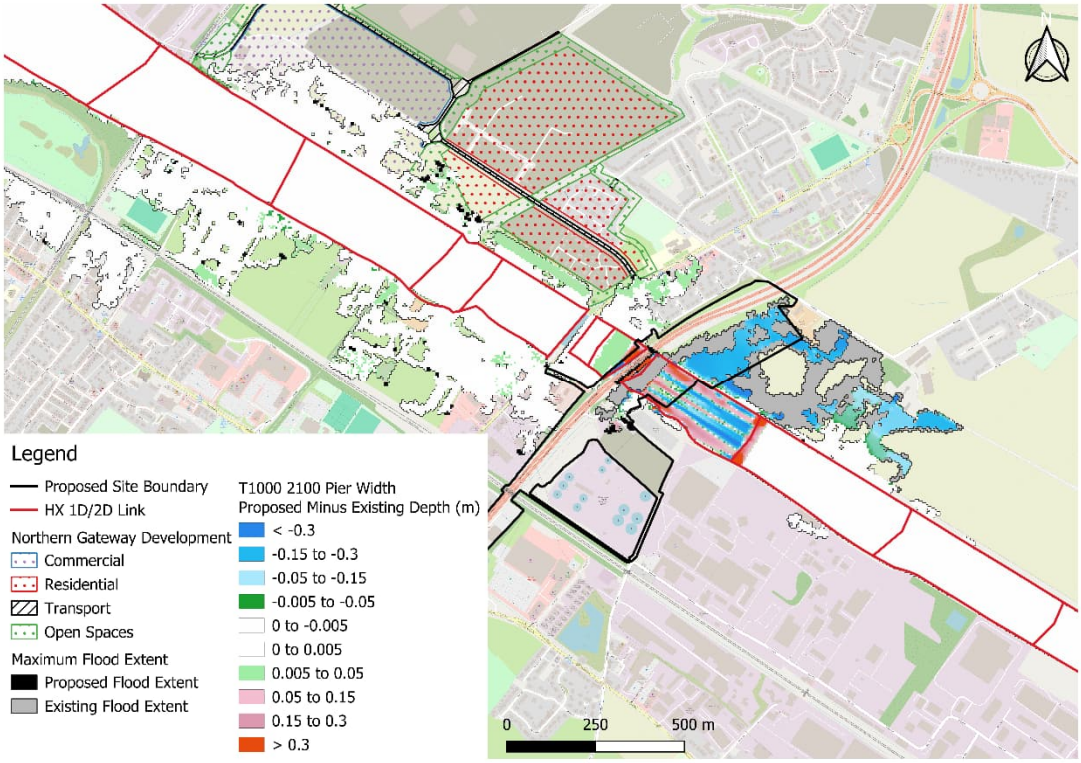
Figure C.78: 0.1% AEP 2100 Tidal Pier Width Flood Depth



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Figure C.79 details the flood depth difference between the Proposed (post-development) scenario model with pier width decreased from 4m to 3.04m for the new bridge results and the Existing (pre-development) scenario flood depths for the 0.1% AEP 2100 event. There is a raise in flood depth along the right bank of the river as well as an increase in flood extent along Welsh Road and across a small residential area. Along the left bank there is a small increase in flood depth across commercial areas to the west of Station Road with an average depth increase of 0.008m compared to the Existing scenario. There is a minimal increase in flood extent compared to the model with pier width along the right bank affecting a small residential area. Flooding is reduced both in depth and extent significantly upstream of the Scheme along the right bank under this scenario.

Figure C.79: 0.1% AEP 2100 Tidal Pier Width Flood Depth Difference



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