RSPB Conwy

Flood Consequence Assessment

August 2024

Prepared for:

Conwy County Borough Council.

www.jbaconsulting.com

Document Status

Issue date	29th August 2024
Issued to	Bryn Shiland
BIM reference	NGA-JBA-XX-00-TN-C-0002-S0-P01-RSPB_Conwy_FCA
Revision	Draft v1.0
Prepared by	Sam Brown B Eng Msc Assistant Flood Risk Analyst Chulani Herath BSc (Hons) MSc AMIESL Flood Risk Analyst
Reviewed by	Joseph Landells-Molloy MEng Engineer
Authorised by	Kevin Frodsham BSc BA MSc PhD Senior Analyst

Carbon Footprint

The format of this report is optimised for reading digitally in pdf format. Paper consumption produces substantial carbon emissions and other environmental impacts through the extraction, production and transportation of paper. Printing also generates emissions and impacts from the manufacture of printers and inks and from the energy used to power a printer. Please consider the environment before printing.

Contract

JBA Project Manager	Kevin Frodsham
Address	Phoenix House, Lakeside Drive, Centre Park, Warrington WA1 1RX
JBA Project Code	2028s0854

This report describes work commissioned by Conwy County Borough Council, by an instruction dated 03rd June 2024. The Client's representative for the contract was Bryn Shiland. Sam Brown and Chulani Herath of JBA Consulting carried out this work.

Purpose and Disclaimer

Jeremy Benn Associates Limited ("JBA") has prepared this Report for the sole use of Conwy Borough County Council and its appointed agents in accordance with the Agreement under which our services were performed.

JBA has no liability for any use that is made of this Report except to Conwy Borough County Council for the purposes for which it was originally commissioned and prepared.

No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by JBA. This Report cannot be relied upon by any other party without the prior and express written agreement of JBA.

The methodology adopted and the sources of information used by JBA in providing its services are outlined in this Report. The work described in this Report was undertaken between June and August 2024 and is based on the conditions encountered and the information available during the said period. The scope of this Report and the services are accordingly factually limited by these circumstances.

JBA disclaims any undertaking or obligation to advise any person of any change in any matter affecting the Report, which may come or be brought to JBA's attention after the date of the Report.

Copyright

Contents

List of Figures

List of Tables

Abbreviations

FCA - Flood Consequence Assessment

RSPB - Royal Society for the Protection of Birds

CCBC - County Conwy Borough Council

NRW - Natural Resource Wales

TAN - Technical Advice Note

LPA - Lead Planning Authority

DAM - Development Advice Map

AEP - Annual Exceedance Probability

CC - Climate Change

CCBC - County Conwy Borough Council

Definitions

Fluvial - Caused by a river.

Tidal - Caused by the sea.

Pluvial - Caused by direct rainfall.

1 Summary

This Flood Consequence Assessment (FCA) uses a combination of Natural Resources Wales's (NRW's) open data flood maps together with updated hydraulic modelling results to assess the flood risk for some proposed works at the Royal Society for the Protection of Birds (RSPB) Conwy site. The proposed works involve the creation of a new combined cycle and footpath that requires two new (single span) bridges: one across the Afon Ganol watercourse and the other a high level strcuture across the Conwy Valley Railway Line.

Under the updated TAN15, the cycle path would be categorised as 'less vulnerable development' and the bridges as "water compatible development.

NRW's flood maps suggest that the main risk to the site is likely to be tidal but there could also be a fluvial risk, given the proximity of the works to the Afon Ganol. Given that the current flood maps are based on hydraulic modelling that is several years old, some new hydraulic modelling was undertaken to provide an up-to-date picture of the fluvial and tidal flood risk to the site. This primarily involved calculating an up-to-date hydrology for the Afon Ganol deriving up-to-date tidal series for the Conwy Estuary and running these through an updated version of NRW's Afon Ganol (2012) fluvial and tidal hydraulic models.

Section 5 of this report provides a detailed summary of the resulting fluvial and tidal risk, which has the following outcomes for development.

- The modelled fluvial flood risk poses only minimal constraints to the proposed works. By placing the path and soffit level of the bridge over the Afon Ganol above the modelled 0.5% AEP with climate change level of 3.5m AOD plus an appropriate freeboard level (TBC), the development should be safe from fluvial flooding and will have no off-site impacts for the lifetime of the development. Dry access and egress would still be possible under these conditions. There would also be no increased risk due to blockage of the new bridge.
- The modelling shows that tidal flooding would pose a higher risk to the proposed works than fluvial flooding. Tidal overtopping is modelled to have the potential to lead to 0.5% AEP flood levels of 5.48m AOD over the lifetime of the development. There are also residual risks that 0.5% AEP levels could reach as high as 6.13m AOD in response to local defence failure or even 6.33m AOD due to uncertainties in the climate change allowance.
- It would not be practical to raise the new path above these extreme tidal levels. Therefore, the works would need to be designed to be resilient to these conditions and, because, safe access/egress would not be possible, a site access plan would be needed to forewarn users of the potential risks. Given that there should be sufficient lead time provided in advance of extreme tidal surges (e.g., by monitoring the coastal flood warnings for Conwy and/or Llandudno), site closure should be considered as an option to keep people safe from the consequences of any extreme tidal events.

2 Introduction

2.1 Overview

This Flood Consequence Assessment (FCA) at Royal Society for the Protection of Birds (RSPB) Conwy has been prepared following instruction from Bryn Shiland of Conwy County Council via a PO Order dated 03rd June 2024. The FCA is supported by a combination of NRW's open data flood maps and some updated hydraulic modelling. The proposed works are to create a new combined cycle and footpath along the northern and eastern boundaries of the RSPB Conwy reserve, which is located alongside the Conwy Estuary near Llansanffraid. Two new bridges are proposed to be part of the works where the route crosses the Afon Ganol and Conwy Valley Railway Line, respectively. There will also be a pedestrian ramp on the RSPB side of the railway footbridge. The goal of this Flood Consequence Assessment (FCA) is to provide an up-to-date summary of the flood risk to the site and identify any appropriate mitigation for the proposed works.

2.2 Scope

This FCA includes an assessment of the flood risk to the new combined cycle and footpath and bridges. This is based on the outcome of a set of up-to-date modelled scenarios using Natural Resources Wales's (NRW's) existing Afon Ganol hydraulic model, which supplements a review of the existing information.

3 Development Location and Description

3.1 Site Location and Description

Conwy County Borough Council (CCBC) are constructing a combined cycle and footpath plus two bridges in the RSPB Conwy nature reserve. The site's red line boundary is shown in Figure 3-1 and the nearest postcode for the site is LL31 9XZ. The site is located between Llandudno Junction (to the north) and Llansanffraid (to the south). It is bounded by the Conwy Estuary to the west and south, the North Wales expressway to the north and the Conwy Valley Railway Line to the east. Access to the site is proposed to be via a new bridge over the Conwy Valley Railway Line from the A570 (Conway Road) - labelled Bridge 2 on Figure 3-1.

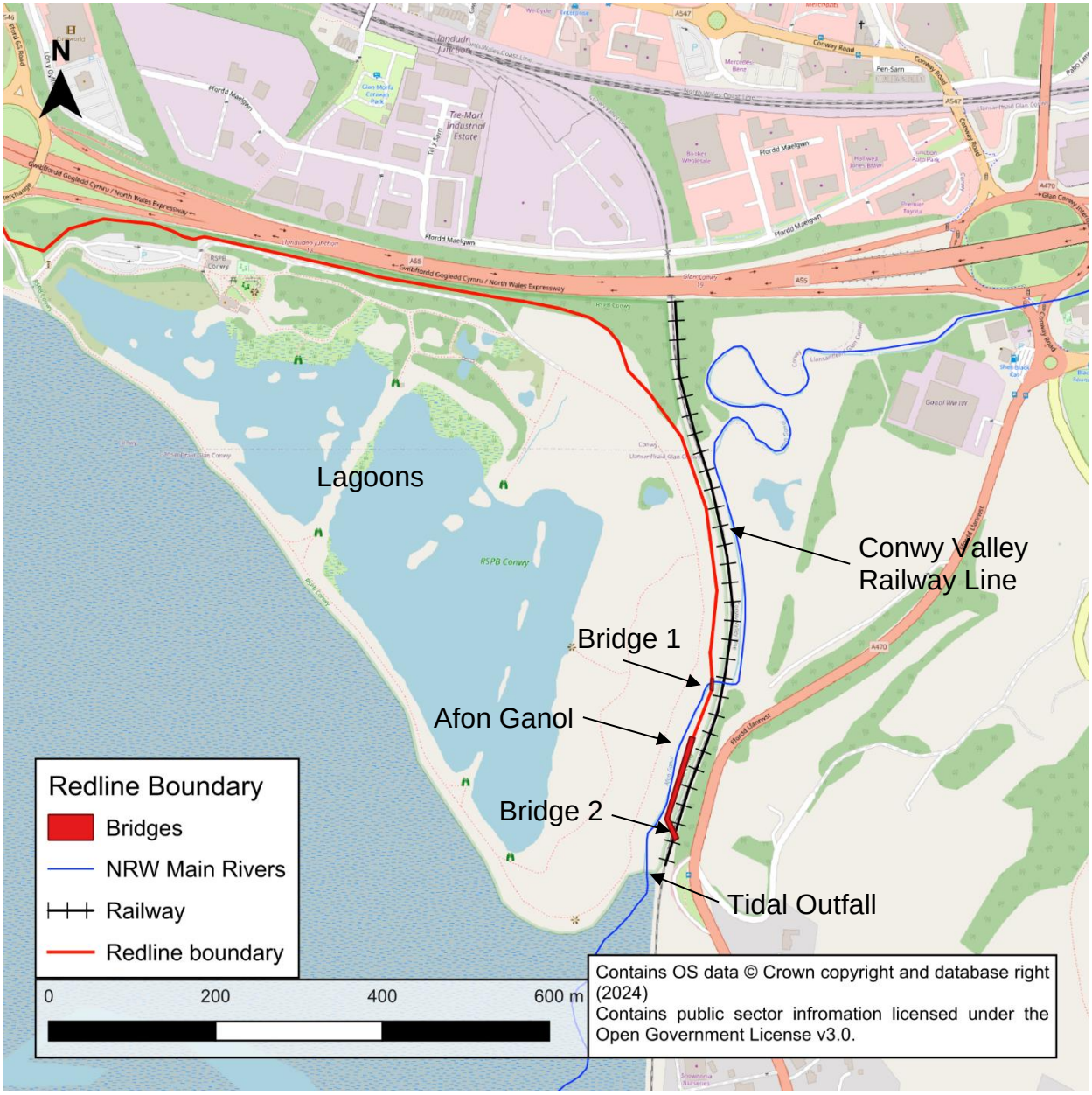


Figure 3-1 RSPB path and bridges red line boundary.

Much of the proposed new works is situated alongside a tidally influenced reach of the Afon Ganol, which is a designated main river on NRW's main river map. This means that the FCA must consider the fluvial risk from the Afon Ganol. The Afon Ganol discharges into the Conwy Estuary via a flapped tidal outfall just downstream of the proposed new footbridge over the railway line. There is also a small capacity flapped culvert beneath the railway embankment which is typically raised above the local floodplain at a minimum elevation of around 5m AOD. The tidal outfall forms a low point in a prominent tidal embankment that separates the lagoons on the RSPB site from the Conwy estuary.

3.2 Structure description

The design of the proposed bridge over the Afon Ganol (Bridge 1) is shown in Figure 3-2, with the western approach shown in Figure 3-3 and the eastern approach shown in Figure 3-4. The structure is for cyclists and pedestrian traffic and has been designed for a fluvial flood level of 3.031m AOD to allow the bridge to stay unsubmerged whilst crossing the Afon Ganol.

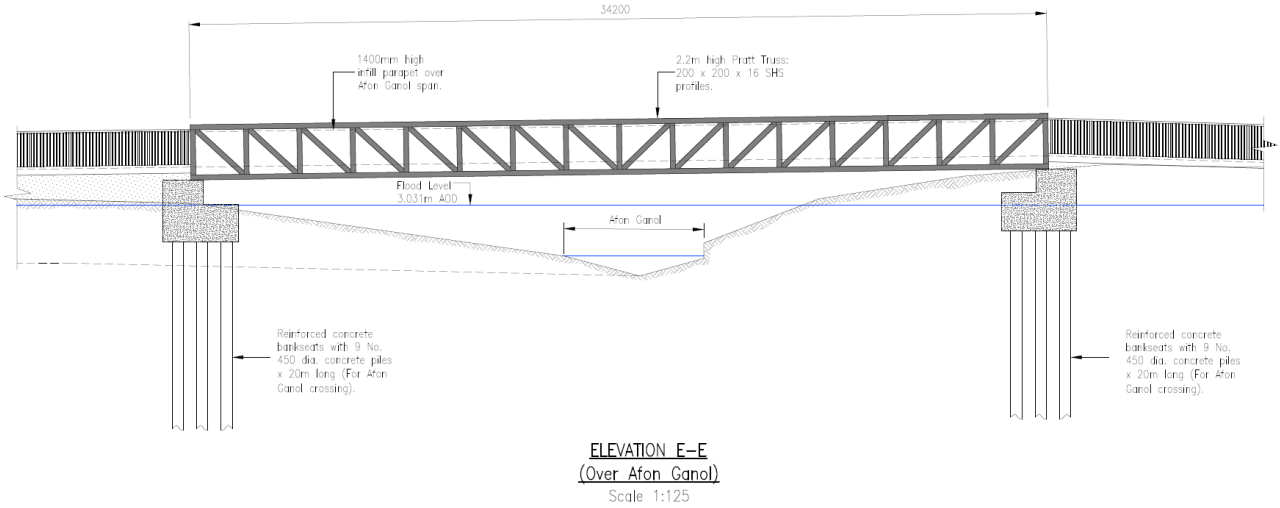


Figure 3-2 Footpath and cycleway bridge over the Afon Ganol (Bridge 1)

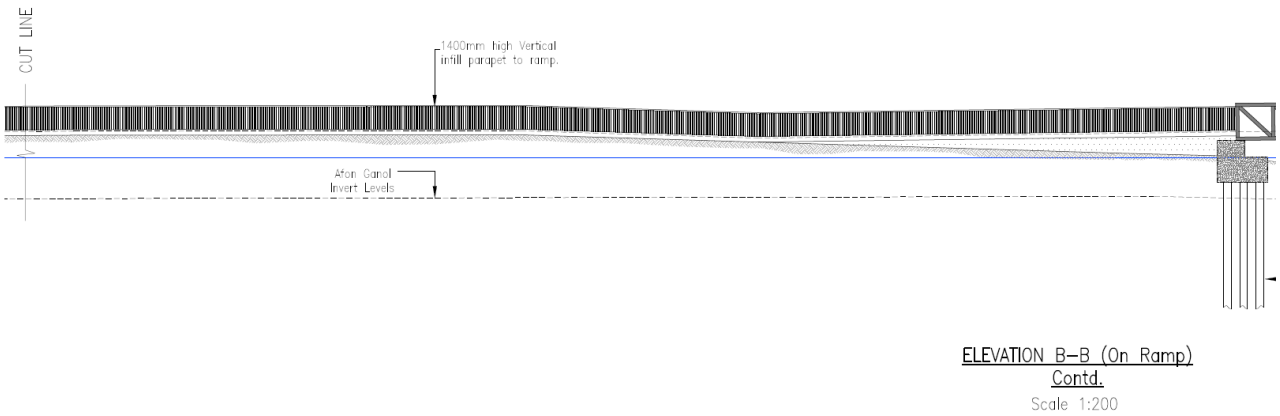


Figure 3-3 Western approach to bridge over the Afon Ganol (Bridge 1)

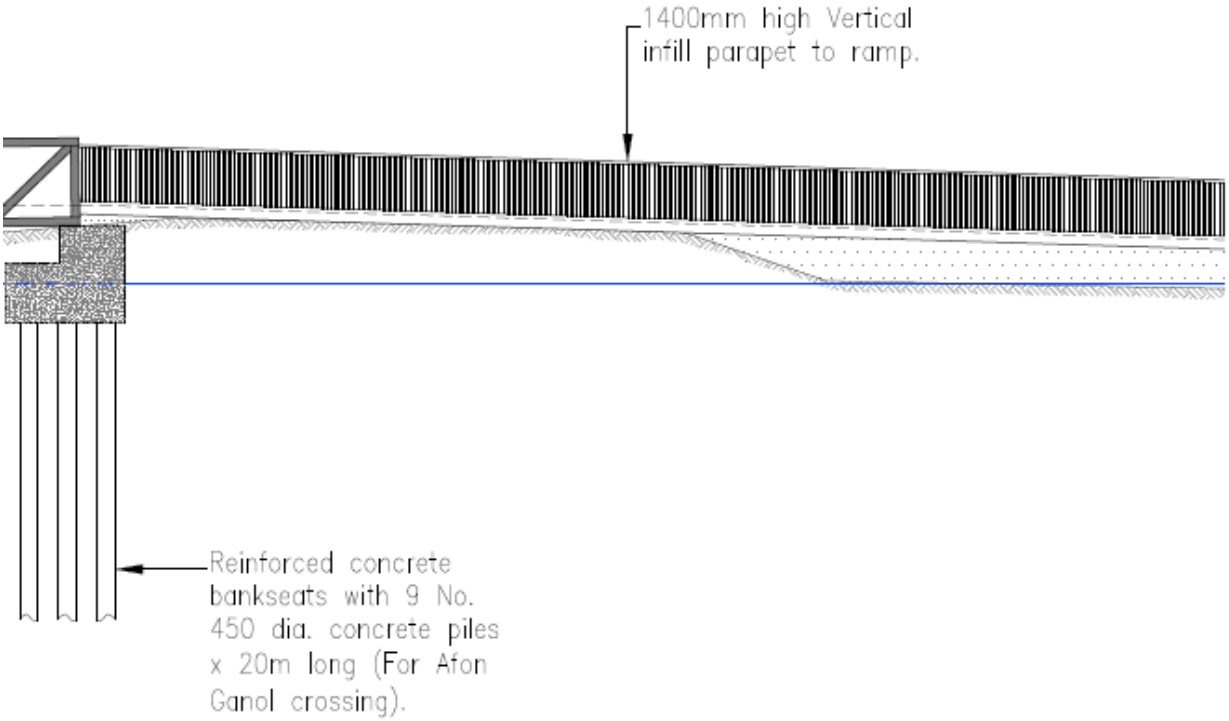


Figure 3-4 Eastern approach to bridge over the Afon Ganol (Bridge 1)

The proposed bridge over the railway line (Bridge 2) is shown in Figure 3-5, with its western approach ramp in Figure 3-6 and Figure 3-7. The structure is for cyclists and pedestrian traffic to cross the Conwy Valley Railway Line and access the new RSPB path. Note that the proposed soffit level of this structure is significantly above both fluvial (3.5m AOD) and tidal (5.5m AOD) design levels presented in this report so the bridge will remain unsubmerged under all flood events and there will be no major flood risk constraints to this bridge.

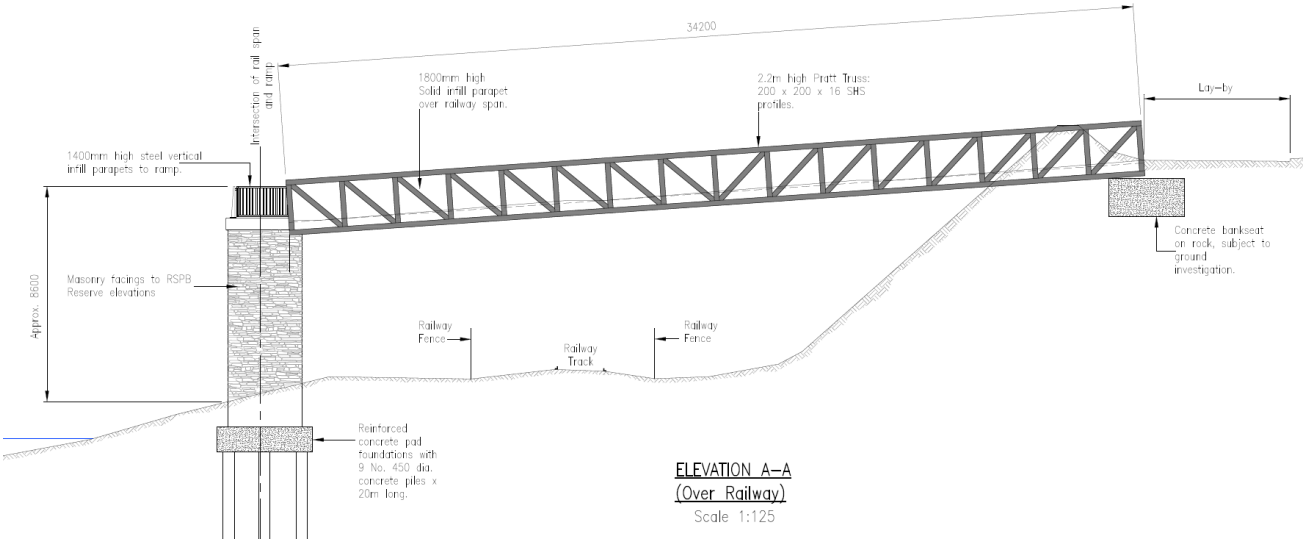


Figure 3-5 Footpath and cycleway over the railway line (Bridge 2)

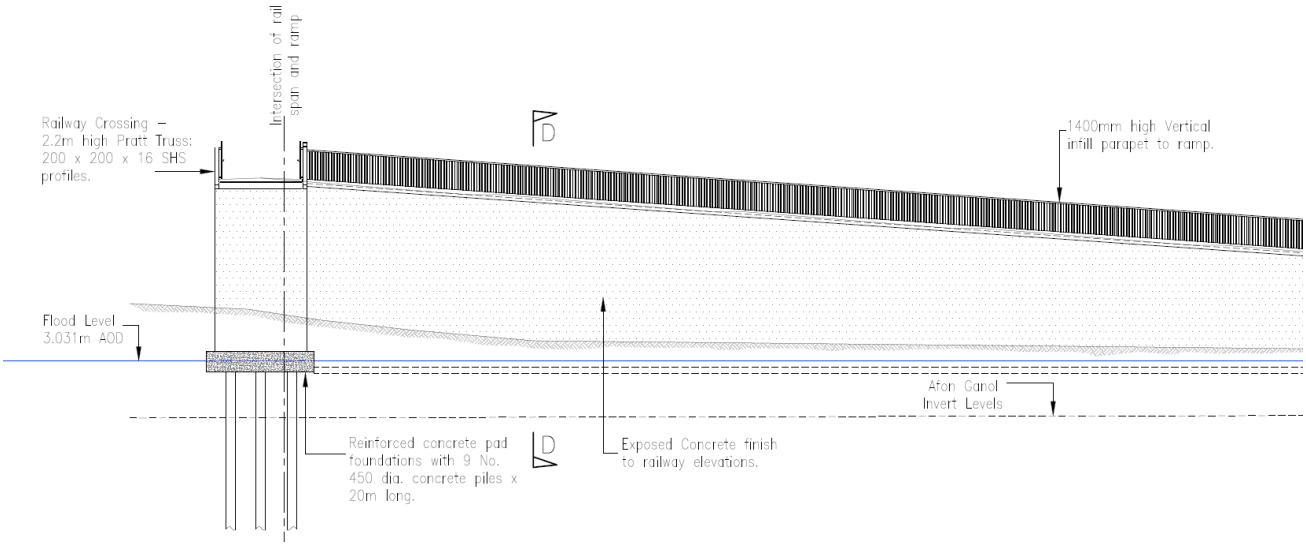


Figure 3-6 Proposed western approach to bridge over the railway line (Bridge 2) - south

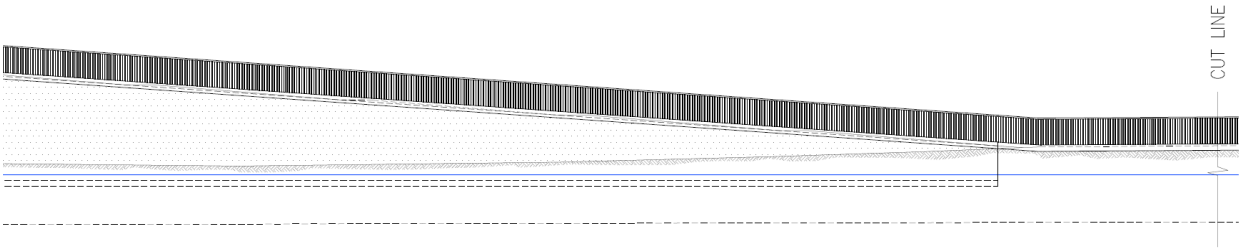


Figure 3-7 Proposed western approach to bridge over the railway line (Bridge 2) - north

3.3 Existing topography

The existing topography of the site and its vicinity based on 2m LIDAR DTM downloaded in July 2024 (and flown on 19th March 2022) is shown in Figure 3-8. The RSPB site is generally low lying and slopes down from the north-west to the south-east. Two large lagoons, which are permanently inundated with water, and have a narrow embankment between them cover the majority of the nature reserve. The LIDAR also illustrates that the site is enclosed by embankments on all sides (tidal embankments to the south and west, the Conwy Valley Railway Line to the east and the North Wales Expressway to the north). There is also a relatively large area of low-lying ground to the east of the railway embankment that could store fluvial floodwater.

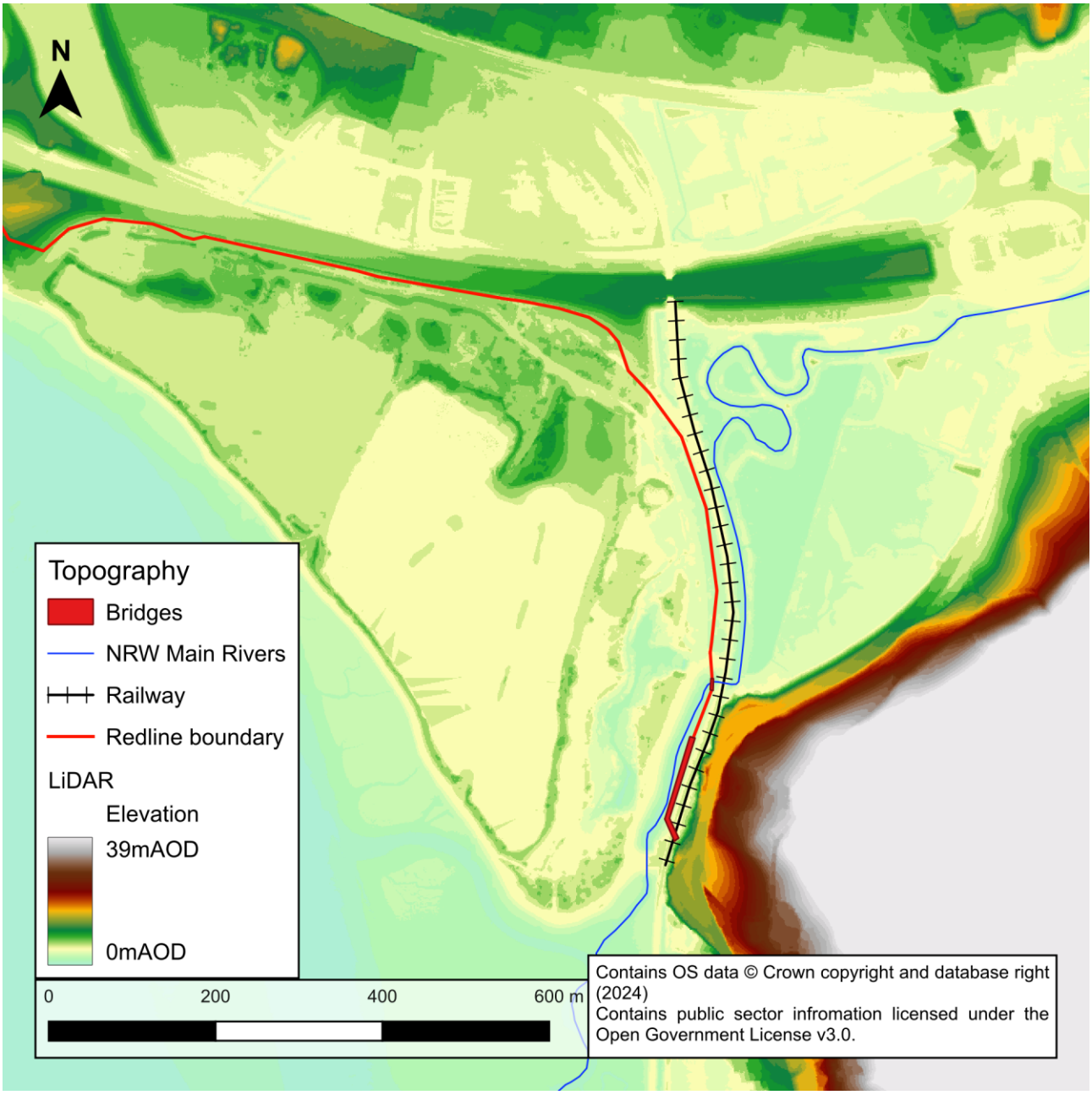


Figure 3-8 Site LIDAR Topography.

3.4 Site development history

The nature reserve was initially constructed between 1986 and 1991 as a compensatory wildlife habitat when the A55 road tunnel was created. The site was constructed by material that was removed from the tunnel and later landscaped into various habitats. The site was then opened to the public in 1995 and has existed as a nature reserve ever since.

4 Planning Policy

4.1 Policy Changes

The guidance provided in Technical Advice Note (TAN) 15, dated December 2021, is used in the determination of planning applications by Local Planning Authorities (LPAs) in Wales with respect to flood risks. This represents an update to the TAN15 July 2004 guidance.

4.2 TAN15 2004 (Overview)

The NRW Development Advice Maps (DAM) are used as the basis against which to assess the flood risk to development sites under TAN15 2004. The DAM is split into three zones (A, B, C1 and C2), for which specified planning tests are required.

New development should be directed away from Zone C and towards suitable land in Zone A, otherwise to Zone B, where river or coastal flooding will be less of an issue.

In Zone C, the tests outlined in sections 6 and 7 (of TAN15) will be applied, recognising, however, that highly vulnerable development and Emergency Services in Zone C2 should not be permitted.

The proposed development for a new cycle/footpath and two bridges, would be classed as less vulnerable and an exception respectively.

4.3 TAN15 2021 (Overview)

The Flood Map for Planning, which presents Flood Zones for different sources of flooding, should be used as the basis against which to assess the flood risk to development sites under the published, but since rescinded, TAN15 2021 (dated December 2021). It is highlighted that the Flood Map for Planning is a better source of flood risk information than the DAM since the latter is no longer updated.

The proposed footpath and cycleway would be classed as ‘Less Vulnerable’ whereas the bridges would be classed as 'Water Compatible', under TAN15 2021.

The current revision of TAN15 2021 (as of June 2024) includes the key guidance with respect to site development and flood risk.

5 Flood Risk

5.1 Current Guidance

The TAN 15 current advice outlines the constraint of developing in Flood Zone 3 for the footpath and cycleway.

For Zone 3 (Rivers and Sea), less vulnerable development will only be justified if:

1. There are exceptional circumstances that require its location in Flood Zone 3, such as the interests of national security, energy security, public health or to mitigate the impacts of climate change; AND
2. Its location meets the definition of previously developed land; AND
3. The potential consequences of a flooding event for the particular type of development have been considered and found to be acceptable in accordance with the criteria contained in section 11.

Section 11 then goes on to outline that the structure needs to be free of flooding in the 1 in 100 year flood event with an allowance for climate change.

For a water compatible structure such as a bridge, "water compatible development is acceptable, from a flooding perspective, in all flood zones."

5.2 Flood Risk from Publicly Available Information

5.2.1 Fluvial and Tidal Risk

Development Advice Map (DAM) - Superseded

The DAM flood map (Figure 5-1) does not provide a distinction between sources of flooding so represents the area at risk from either (or both) fluvial and tidal/coastal flooding. The RSPB Conwy site is shown to be largely within DAM Zone B with a portion of the site in DAM Zone C1. The key receptors can be identified as the existing pathways running throughout the site, the RSPB café, the RSPB reception building and viewing area.

The site is shown to be at risk of flooding; it is shown to be within DAM Zone B and C1, this usually indicates that the site is not suitable for construction unless:

- i) Its location in zone C is necessary to assist, or be part of, a local authority regeneration initiative or a local authority strategy required to sustain an existing settlement; or,
- ii) Its location in zone C is necessary to contribute to key employment objectives supported by the local authority, and other key partners, to sustain an existing settlement or region;

and,

- iii) It concurs with the aims of PPW and meets the definition of previously developed land (PPW fig 2.1); and,

- iv) The potential consequences of a flooding event for the particular type of development have been considered, and in terms of the criteria contained in sections 5 and 7 and appendix 1 found to be acceptable.

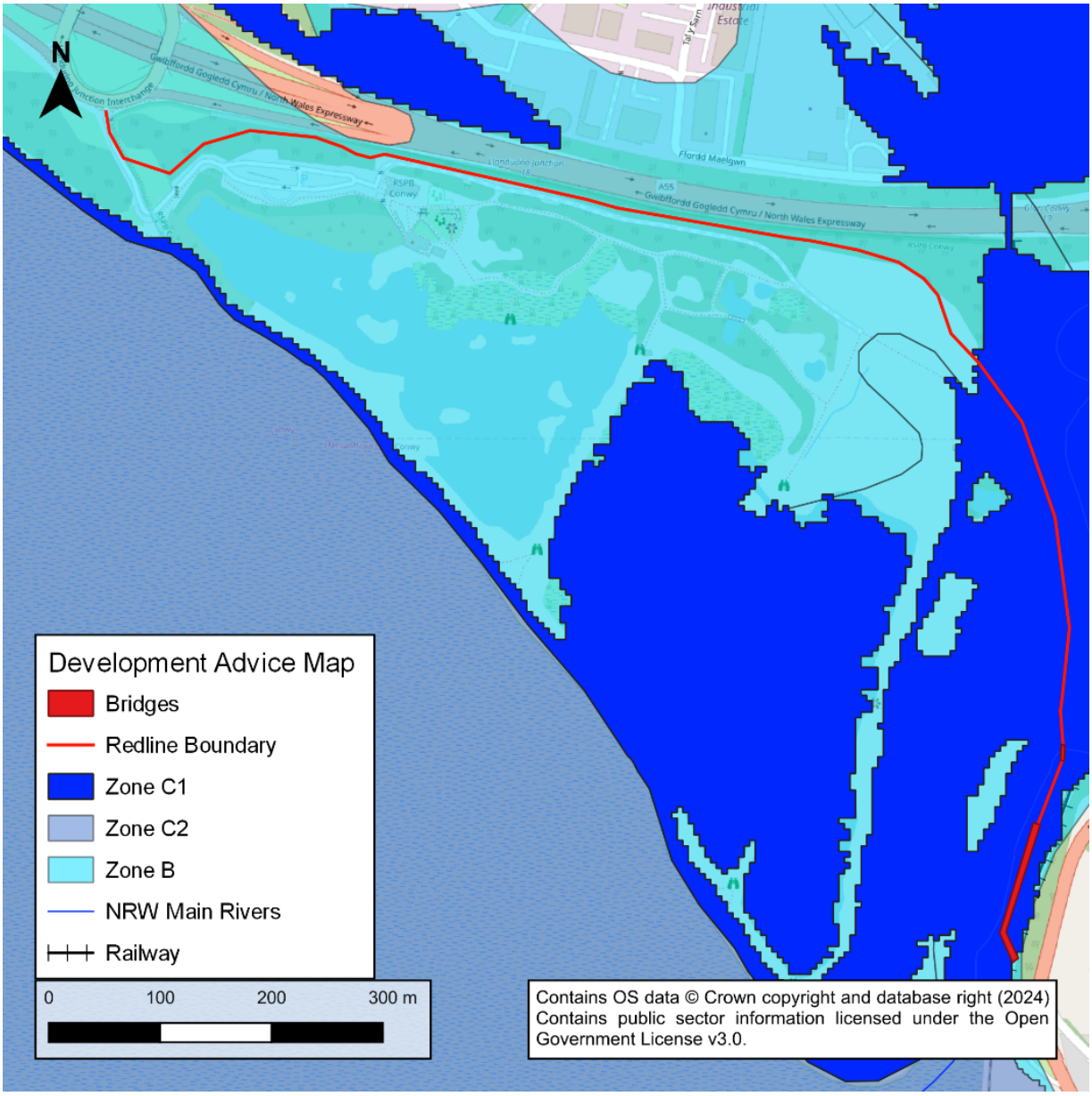


Figure 5-1 RSPB Conwy DAM flood map.

An application of the original TAN guidance classifies the proposed paths as a less vulnerable development and the bridges as an exception development, both the path and the bridges exist within Flood Zone C1. The bridges being an exception, development does not have to be justified, although the bridge over the Afon Ganol has been designed with the fluvial flood levels in mind. However, the path needs to follow the acceptability criteria within section 7 and appendix one of the 2004 TAN 15 document, which is outlined in Table 5-1.

The acceptability criteria of the path will be met by the nature of how the path is designed and modelled to gain an understanding of the risk involved and mitigate it.

Table 5-1 Flood Zone classification table

C1	Emergency services Highly vulnerable development Less vulnerable development	• Application of justification test (section 6) , including acceptability of consequences (section 7 and appendix 1) • Refer to surface water requirements	• Acceptable consequences for nature of use • Flood defences adequate • Agreement for construction and maintenance costs secured • Occupiers aware of flood risk • Escape/evacuation routes present • Effective flood warning provided • Flood emergency plans and procedures • Flood resistant design • No increase in flooding elsewhere	Plan allocations and applications for all development can only proceed subject to justification in accordance with section 6 and acceptability of consequences in accordance with section 7 and Appendix 1.
	Other	• Application of acceptability of consequences (section 7 and appendix 1) • Refer to surface water requirements	• Acceptable consequences for nature of use • Occupiers aware of flood risk • Desirable if effective flood warning and evacuation routes/procedure provided depending on nature of proposal • No increase in flooding elsewhere	Plan allocations and applications for development should only be made if considered acceptable in accordance with section 7 and Appendix 1.

Flood map for planning current guidelines (current guidelines)

The Flood Map for Planning guidelines, as outlined in the 2021 TAN 15 Guidelines document[1], should now be used to inform an FCA. The Flood Map for Planning showing the areas at potential fluvial and tidal risk adjacent to the RSPB Conwy site is shown in Figure 5-2. The definitions of the Flood Map for Planning Zones are provided in Table 5-2, with the vulnerability categories contained in Table 5-3; noting that the Flood Zones do not include for the impact of informal raised flood defences such as the embankments around the RSPB site.

Structures developed within the Flood Zones will need to demonstrate that they will be safe and have no adverse off-site impacts for the planned lifetime of the development. For this study, a 100-year lifetime has been assumed for the development. This aspect of the FCA has been assessed against the fluvial and tidal flood risk that has been modelled for this study rather than the publicly available information. This is because the publicly available information on the risk to the Afon Ganol catchment is based on modelling that was undertaken in 2012 so is now potentially out of date.

[1] https://www.gov.wales/technical-advice-note-tan-15-development-flooding-and-coastal-erosion

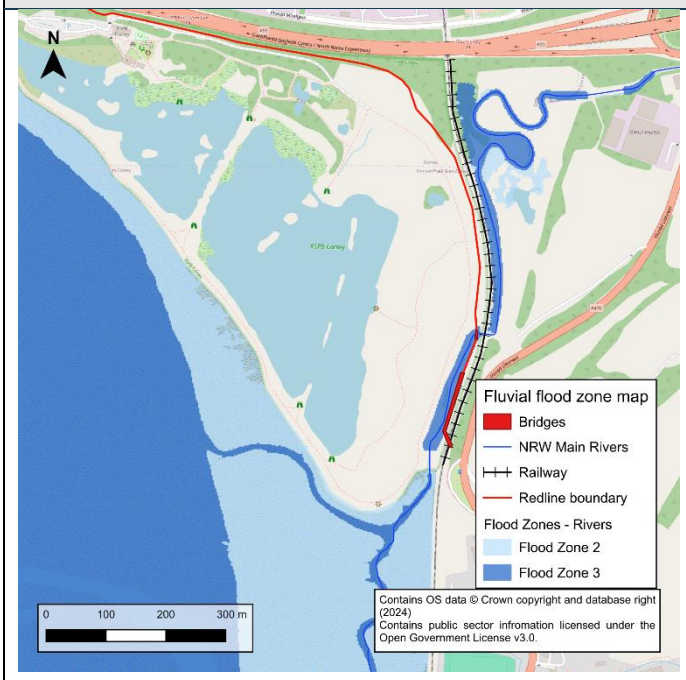
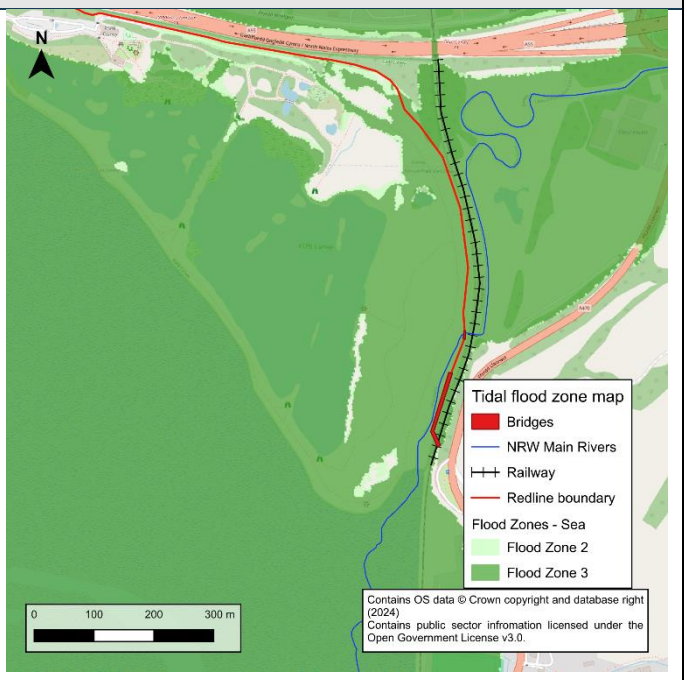
Flood Risk from Rivers	Flood Risk from the Sea
	

Figure 5-2 NRW's Flood Map for Planning for River and Sea.

Table 5-2 Flood Map for Planning Zone Definitions 2021

Zone	Flooding from rivers	Flooding from the sea	Flooding from surface water and small watercourses
1	Less than 1 in 1000 (0.1%) (plus climate change) chance of flooding in a given year.		
2	Less than 1 in 100 (1%) but greater than 1 in 1000 (0.1%) chance of flooding in a given year, including climate change.	Less than 1 in 200 (0.5%) but greater than 1 in 1000 (0.1%) chance of flooding in a given year, including climate change.	Less than 1 in 100 (1%) but greater than 1 in 1000 (0.1%) chance of flooding in a given year, including climate change.
3	A greater than 1 in 100 (1%) chance of flooding in a given year, including climate change.	A greater than 1 in 200 (0.5%) chance of flooding in a given year, including climate change.	A greater than 1 in 100 (1%) chance of flooding in a given year, including climate change.
TAN 15 Defended Zones	Areas where flood risk management infrastructure provides a minimum standard of protection against flooding from rivers of 1:100 (plus climate change and freeboard[6]).	Areas where flood risk management infrastructure provides a minimum standard of protection against flooding from the sea of 1:200 (plus climate change and freeboard).	Not applicable.

Table 5-3 Flood Map for Planning Vulnerability Definitions 2021

Development category	Types
Highly vulnerable development	All residential premises (including hotels, Gypsy and Traveller sites and caravan parks and camping sites). Schools and childcare establishments, colleges and universities. Hospitals and GP surgeries. Especially vulnerable industrial development (e.g. power generating and distribution elements of power stations, transformers, chemical plants, incinerators), and waste disposal sites. Emergency services, including: ambulance stations, fire stations, police stations, command centres, emergency depots. Buildings used to provide emergency shelter in time of flood.
Less vulnerable development	General industrial, employment, commercial and retail development. Transport and utilities infrastructure. Car parks. Mineral extraction sites and associated processing facilities (excluding waste disposal sites). Public buildings including libraries, community centres and leisure centres (excluding those identified as emergency shelters). Places of worship. Cemeteries. Equipped play areas. Renewable energy generation facilities (excluding hydro generation).
Water compatible development	Boatyards, marinas and essential works required at mooring basins. Development associated with canals. Flood defences and management infrastructure. Open spaces (excluding equipped play areas). Hydro renewable energy generation.

5.2.2 Groundwater flooding

There is no available information for groundwater flooding within Wales at this moment in time.

5.2.3 Surface water flooding

The site is at a relatively low risk of surface water flooding based on NRW's Flood Zone 2 and 3 surface water and small watercourses map (Figure 5-3). Although some surface water flooding is evident in Figure 5-3, these are small isolated wet islands within the existing wetland.

5.2.4 Flooding from sewers

There is no available information for flooding from sewers within Wales at this moment in time. However, it is difficult to see how sewer flooding will be an issue for the proposed works.

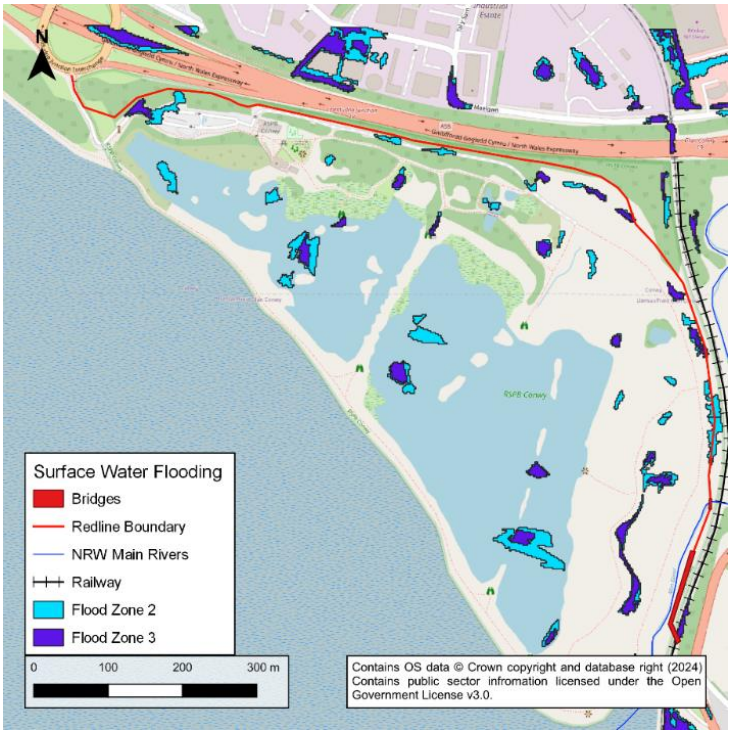


Figure 5-3 Flood Map for planning Surface Water Map

5.2.5 Reservoir Inundation

NRW provide a reservoir inundation flood map for use in planning. This is reproduced in Figure 5-4 for the RSPB Conwy site and shows that reservoir inundation is unlikely to be an issue on the RSPB site.

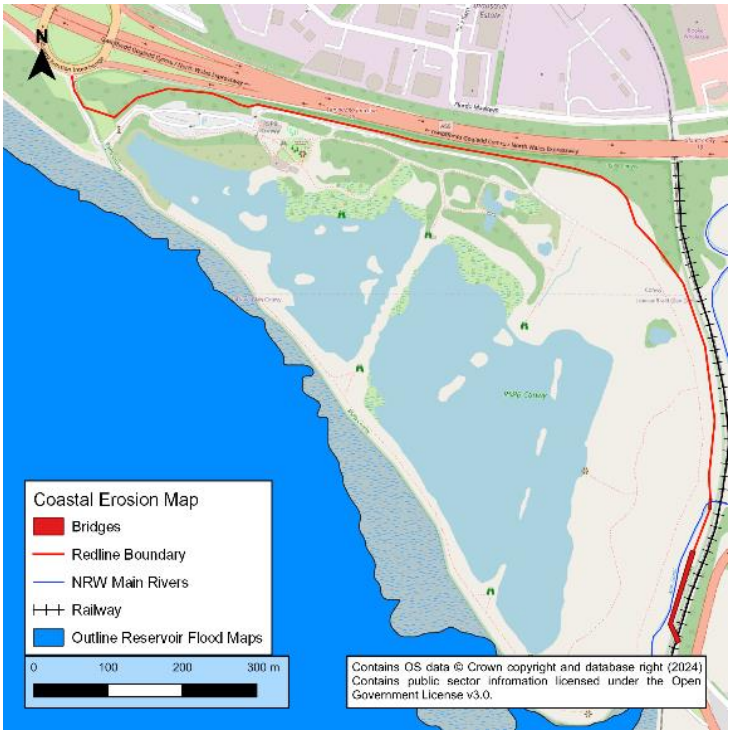


Figure 5-4 Reservoir Inundation Flood Map

5.2.6 Coastal erosion

The NRW coastal erosion map, Figure 5-5, shows that the development is not at risk from coastal erosion.

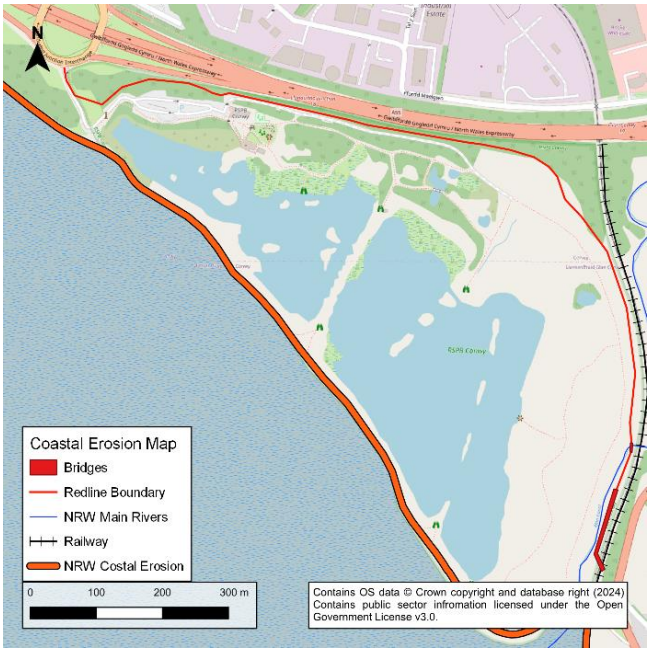


Figure 5-5 Coastal Erosion Map

5.2.7 Historic Flooding

NRW maintains a Recorded Flood Extents map. Figure 5-6 shows areas known to have flooded in the past from rivers, the sea, or surface water. The NRW Historic flooding map highlights an area of coastal flooding in Llansanffraid from 1990 but shows no history of flooding on the RSPB Conwy site to the north.

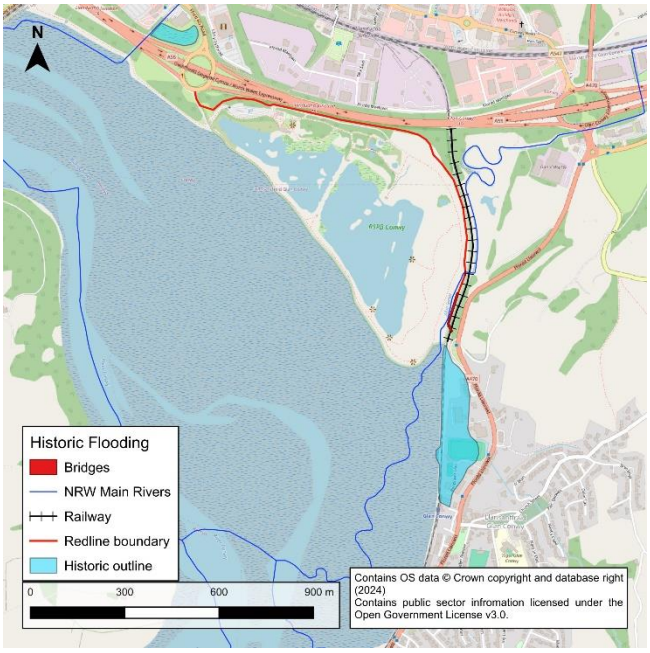


Figure 5-6 Historic Flood Map

5.3 Updated fluvial and tidal risk from additional modelling

5.3.1 Modelling Approach and Rationale

NRW's existing flood maps in the vicinity of the RSPB site are based on the results of previous modelling. The fluvial Flood Zones are based on an NRW Afon Ganol flood mapping study from 2012, and the tidal Flood Zones would appear to be based on a large-scale coastal model (of uncertain date to the consultants). Therefore, to obtain an up-to-date picture of the fluvial and tidal flood risk and design levels, some additional modelling was undertaken. The modelling approach is discussed in more detail in the accompanying modelling technical summary (Appendix B) but the following bullet points outline the main approach and rationale behind the updated modelling.

- NRW's Afon Ganol (2012) and Conwy Estuary (2023) models were sourced under licence from NRW. The Ganol model download contained separate fluvial and tidal models.
- The floodplain topographies of both the fluvial and tidal models were updated to use the latest available LIDAR DTM (flown in 2022).
- A new FEH calculation record was undertaken to ensure that the fluvial inflows to the fluvial model were suitably up to date. This is supplied as Appendix A to this FCA and summarised in Appendix B (the technical modelling note). This led to increases in both peak flows and storm duration relative to the 2012 study, so the fluvial risk was expected to increase relative to this previous work.
- New tidal boundaries were developed that were consistent with the currently published coastal flood boundaries extreme sea level dataset[2] and climate change uplifts (Table 5-4). These were run through the Conwy Estuary model to obtain suitable downstream boundaries for the Ganol (west) tidal model.

Table 5-4 Offshore peak tidal levels (m AOD) applied to Conwy Estuary (Tidal Prism) model

2024			2125		
MHWS	0.5% AEP	0.1% AEP	MHWS	0.5% AEP	0.1% AEP
3.90	5.28	5.48	4.94	6.23	6.43

The following model scenarios were created and run for the FCA.

- Fluvial existing risk (pre-development) scenario. Run with present day 1% AEP and 0.1% AEP events plus a future 1% AEP event with a 30% uplift for climate change[3,4].

[2] This analysis was carried out for chainage 1098 of the UK Mainland https://www.data.gov.uk/dataset/73834283-7dc4-488a-9583-a920072d9a9d/coastal-design-sea-levels-coastal-flood-boundary-extreme-sea-levels-2018

[3] Adapting to Climate Change. Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales. August 2022.

[4] Note that it was not possible to obtain stable results for the fluvial 0.1% AEP plus climate change event, but this was not ultimately believed to be critical for this development.

- Fluvial post-development scenario (with the path and the bridges modelled according to the proposed design drawings). Run with present day 1% AEP and 0.1% AEP events plus a future 1% AEP event with a 30% uplift for climate change.
- Fluvial post-development with (a 50%) blockage of the proposed new bridge over the Afon Ganol. Run with a future 1% AEP event with a 30% uplift for climate change.
- Tidal existing risk (pre-development) scenario. Run with both present day (2024) and future (2125) 0.5% AEP and 0.1% AEP events.
- Tidal 'undefended' (pre-development) scenario. Run with both present day (2024) and future (2125) 0.5% AEP and 0.1% AEP events.

Note that the tidal 'undefended' scenario utilised the same defence removal scenario as had been used for the 2012 Afon Ganol study. This simply removed the tidal outfall and reduced the tidal embankment immediately above the outfall to appropriate ground levels so represents more of a tidal breach than a fully undefended scenarios as the embankments around the lagoon were not altered. However, this local breach scenario is more appropriate to this FCA than a scenario with all embankments removed.

The Afon Ganol 2D fluvial models were in conjunction with a Mean High Water Springs (MHWS) downstream boundary to provide a suitably conservative assessment of tide locking for the FCA.

5.3.2 Climate Change

The potential impacts of climate change on the site were assessed for an assumed 100-year[5] lifespan of the path and bridges. Following the latest (August 2022) Welsh Government guidance on climate change, the development proposals were evaluated as follows.

- Fluvial risk scenarios - flows were increased by 30% in accordance with the Central climate change scenario for West Wales in the 2080's. The MHWS downstream boundary was also adjusted for 100 years of sea level rise (using the same approach listed below for the tidal risk scenarios).
- Tidal risk scenarios - the offshore tidal series were increased to reflect the Higher Central allowance (70th percentile) of the revised climate change projections arising from the UKCP18 study. This led to a 0.95 metre rise in the offshore tidal series, which were then run through the Conwy Estuary (Tidal Prism) model to obtain appropriate downstream boundaries for the Ganol Tidal model.

[5] Note that the future (with climate change) tidal boundaries were modelled for the Year 2125.

5.3.3 Updated Fluvial Flood Risk Flooding

The outcome of the updated fluvial modelling is now presented in terms of the flood outlines and peak flood levels at the location of the proposed new bridge.

5.3.3.1 Pre-Development fluvial outlines and levels

The flood outlines from the pre-development fluvial simulations are shown in Figure 5-7. This shows that water alongside the proposed works between the railway embankment and tidal outfall remains in the vicinity of the channel and does not overtop into the RSPB lagoons. Flooding is restricted to the upstream side of the railway embankment due to a small head loss across the railway embankment and a lower upstream channel capacity.

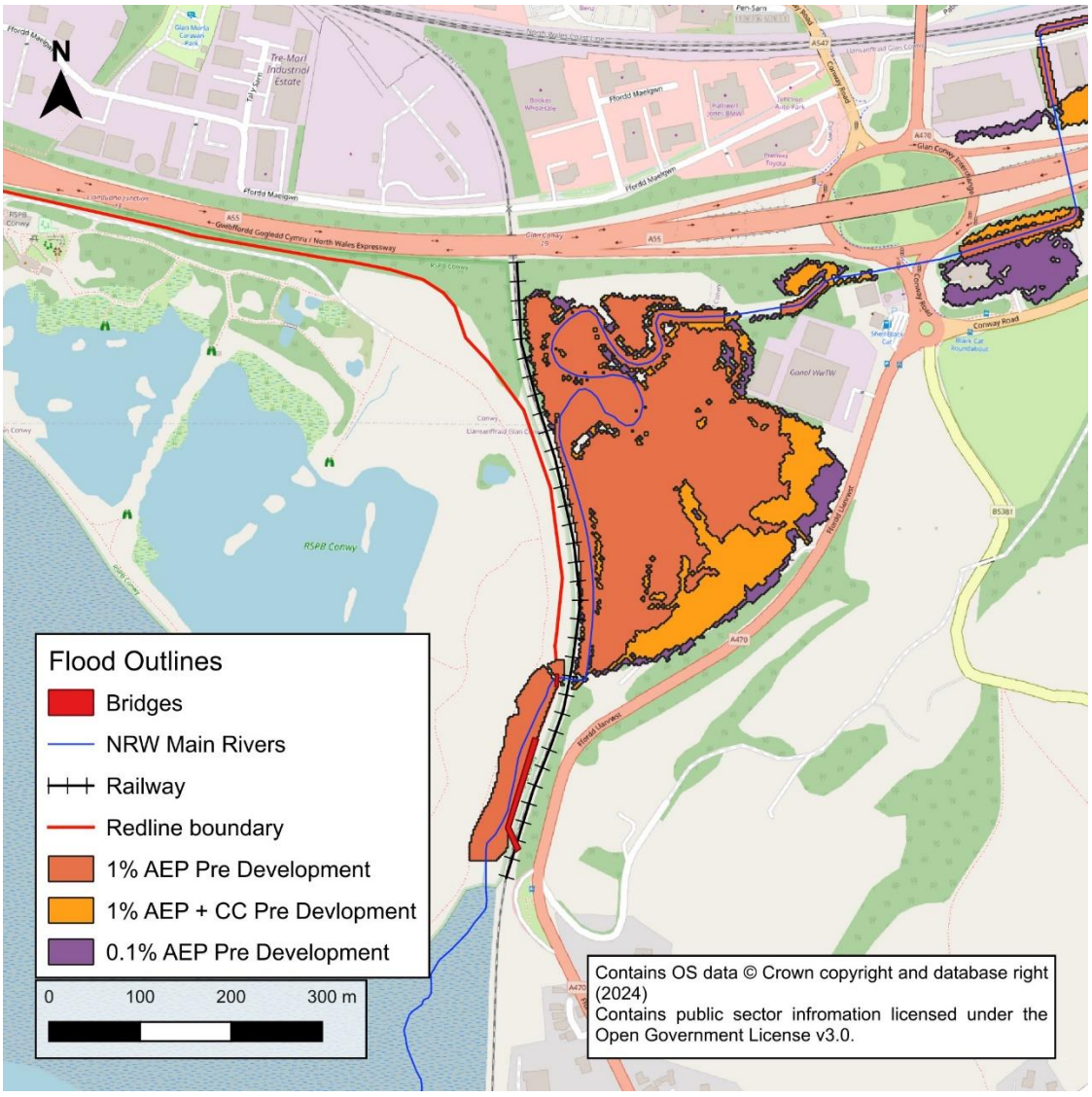


Figure 5-7 Pre-Development Fluvial Flood outlines

The modelled peak river level for each event was constant along the reach between the railway embankment and tidal outfall. These levels are provided in Table 5-5, from which it is evident that the 1% AEP with climate change and 0.1% AEP events peak close to 3.5m AOD, whereas a level in excess of 5.0m AOD would be needed to overtop into the lagoons.

Table 5-5 Modelled Pre-Development Fluvial Flood Levels alongside the RSPB site.

Event	1% AEP	1% AEP+ CC	0.1% AEP
Height m AOD	3.40	3.49	3.47

The model results show that the peak fluvial level occurs in response to tide-locking, which was modelled to last for a period of up to six hours alongside the site. Therefore, peak levels would generally coincide with low flood velocities along the reach of interest. During a 1% AEP with climate change event, peak flows (of 3.5m^3/s) and velocities (of 1.1m/s) along this reach were modelled to occur in response to the release of tide locked conditions when the tide recedes.

5.3.3.2 Post Development fluvial outlines and levels

The flood outlines from the post-development fluvial simulations are shown in Figure 5-8 and the peak river levels are shown in Table 5-6.

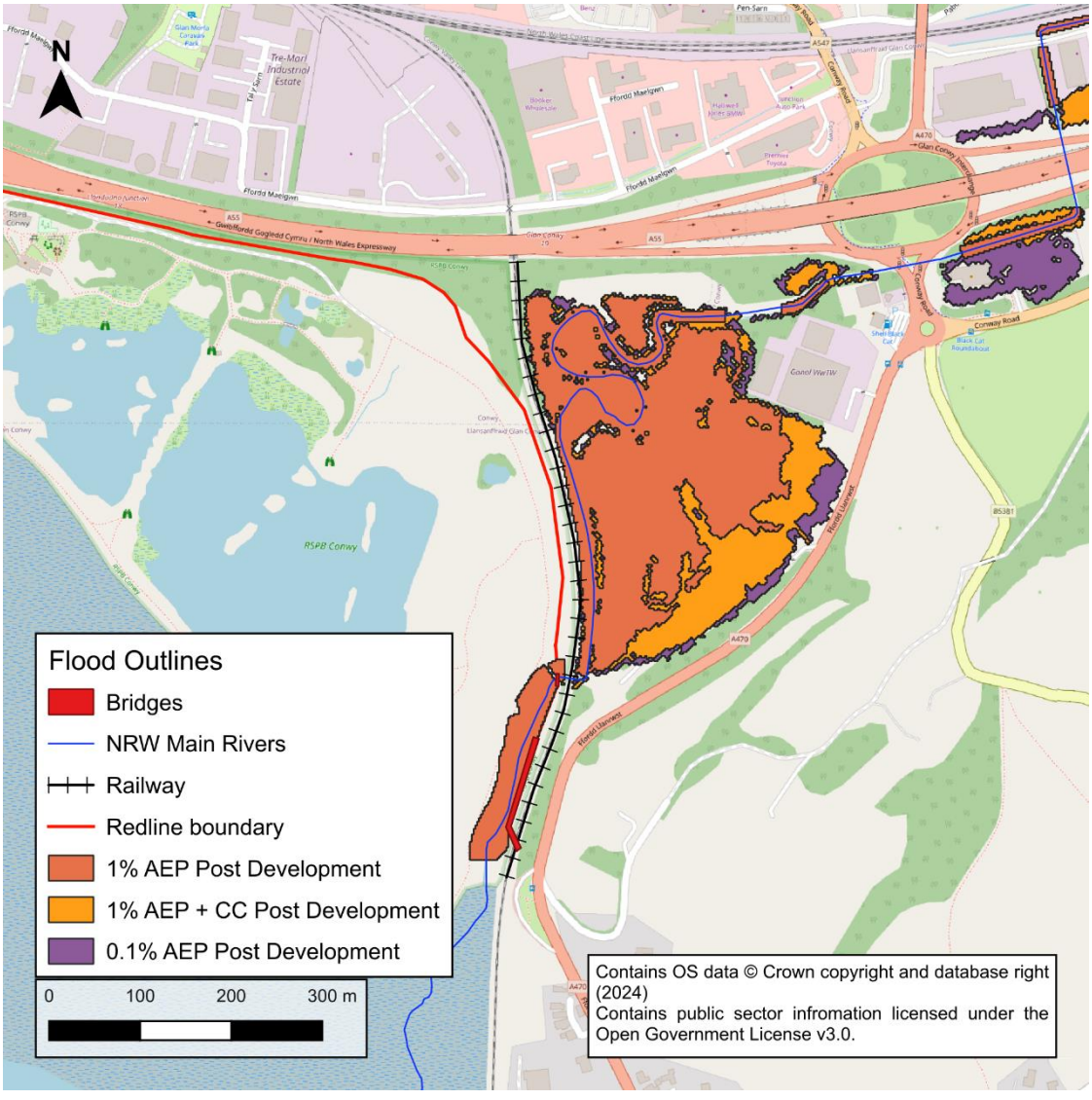


Figure 5-8 Post development Fluvial flood outlines

Table 5-6 Post Development Fluvial Levels at Bridge 1 over Afon Ganol.

Event	1% AEP	1% AEP+ CC	0.1% AEP
Peak Flood Level (m AOD)	3.40	3.49	3.47

The peak river levels from the post development situation are unchanged from the pre-development situation and there are no obvious differences in the flood outlines as can be seen in Figure 5-9, Figure 5-10 and Figure 5-11 for 1%, 1% with climate change and 0.1% AEP events, respectively. The lack of impact is confirmed by the production of depth difference maps between the pre and post development scenarios (Figure 5-12), which show that any impacts across the study area are within a tolerance of ±0.005 metres. Therefore, the fluvial modelling implies that the proposed works are not predicted to have any noticeable impact on the fluvial flood risk.

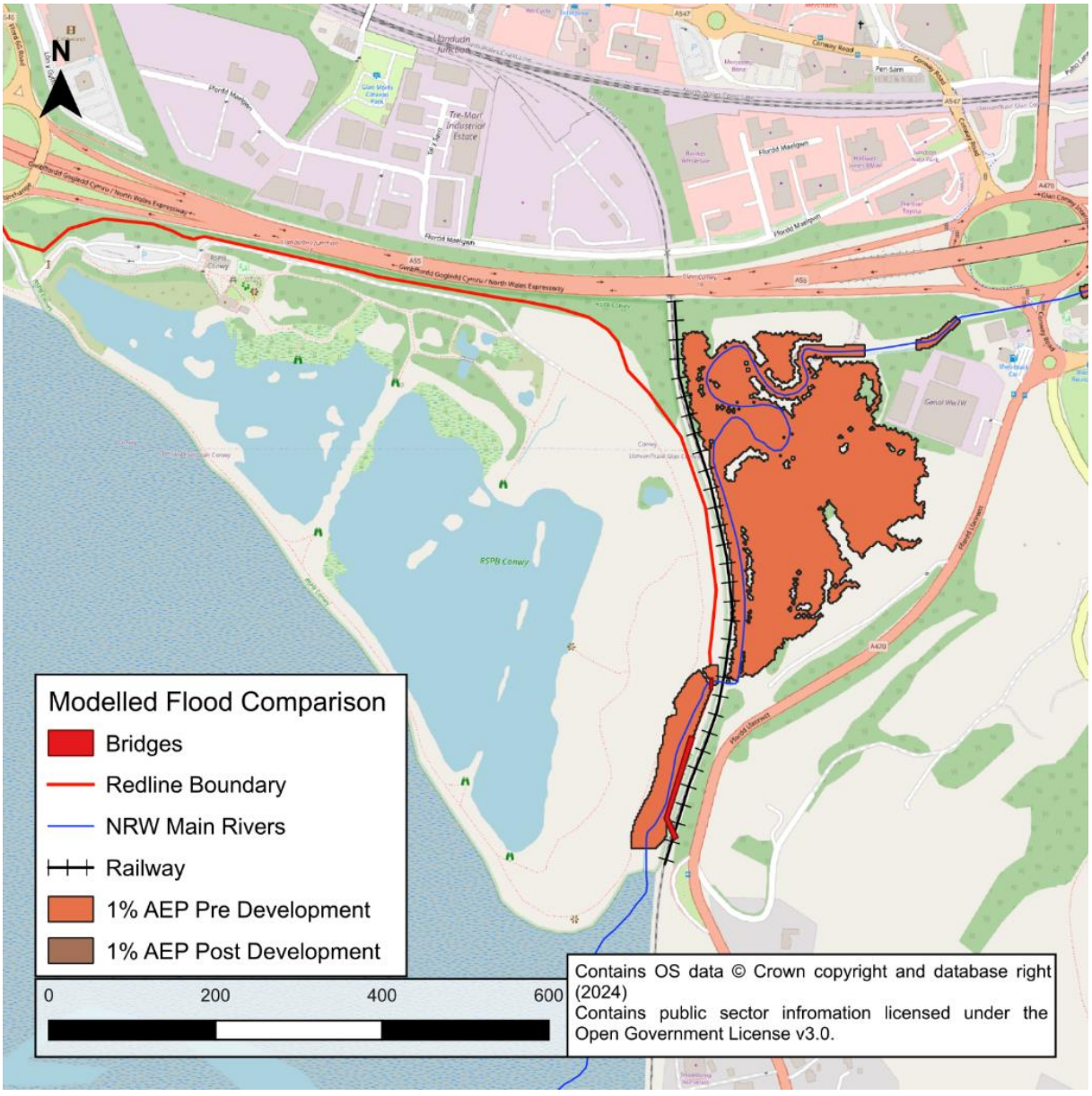


Figure 5-9 Comparison of 1% AEP Pre- and Post-Development Flood Outlines

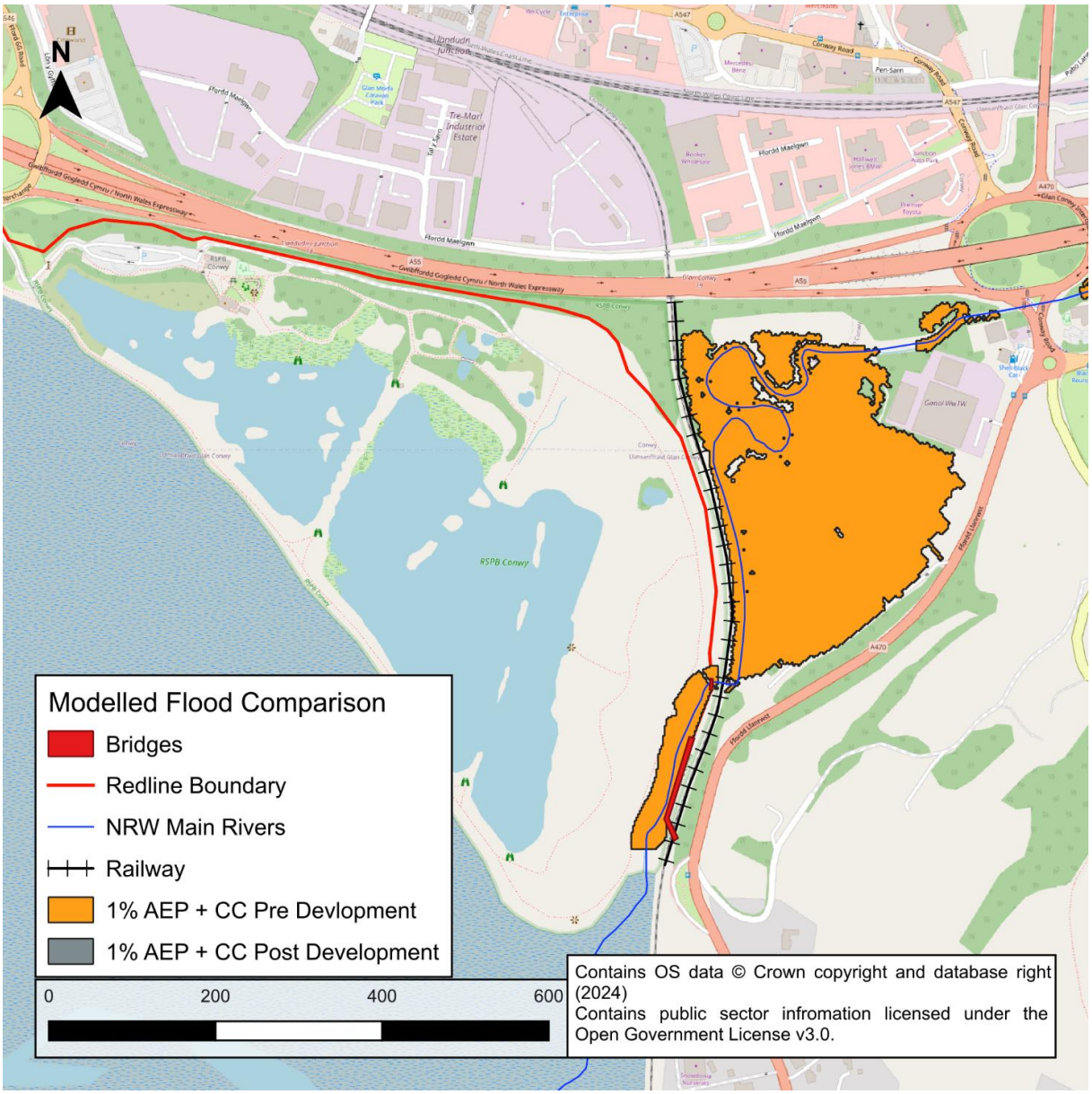


Figure 5-10 Comparison of 1% AEP with climate change Pre- and Post-Development Flood Outlines

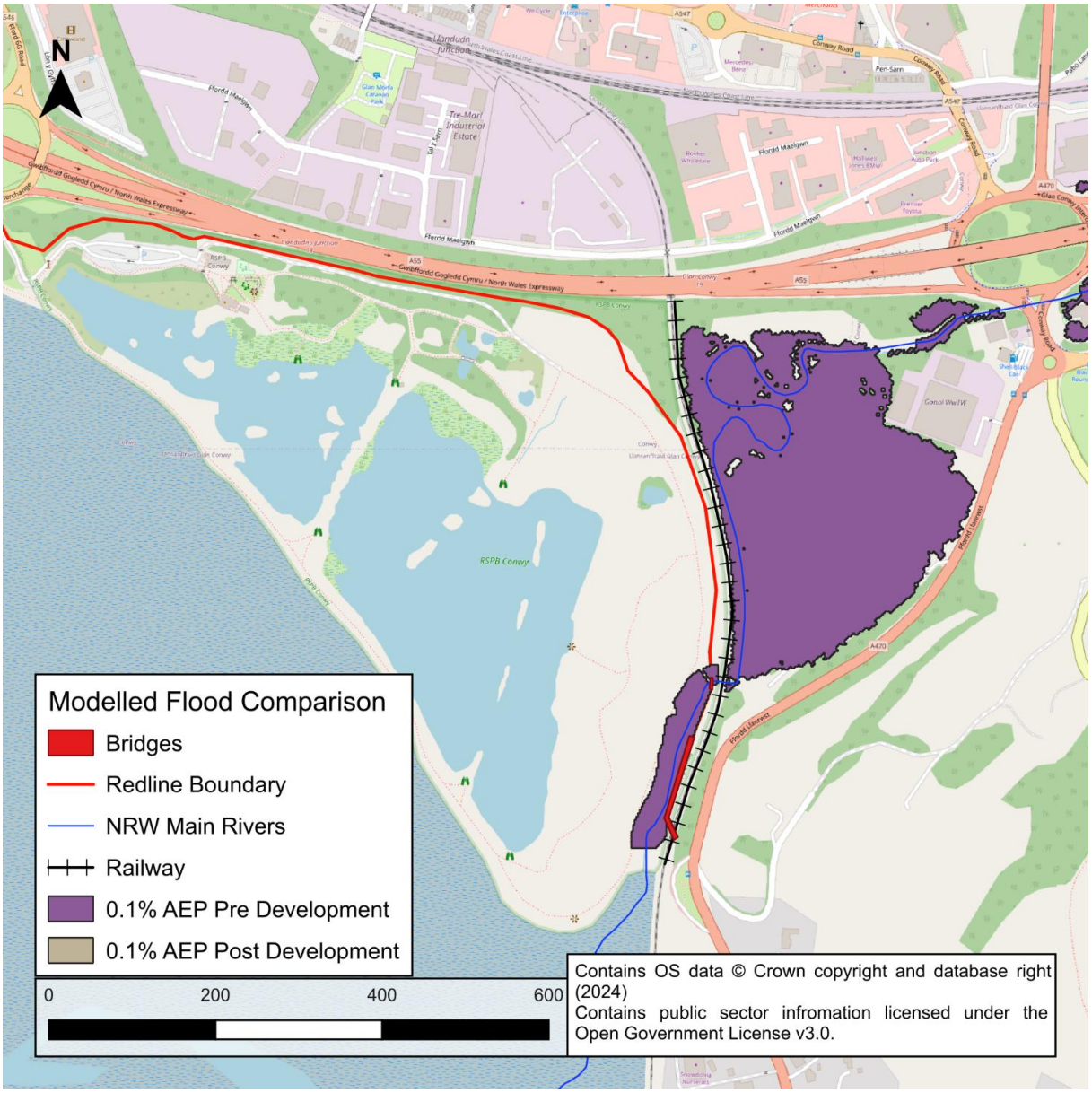


Figure 5-11 Comparison of 0.1% AEP Pre- and Post-Development Flood Outlines

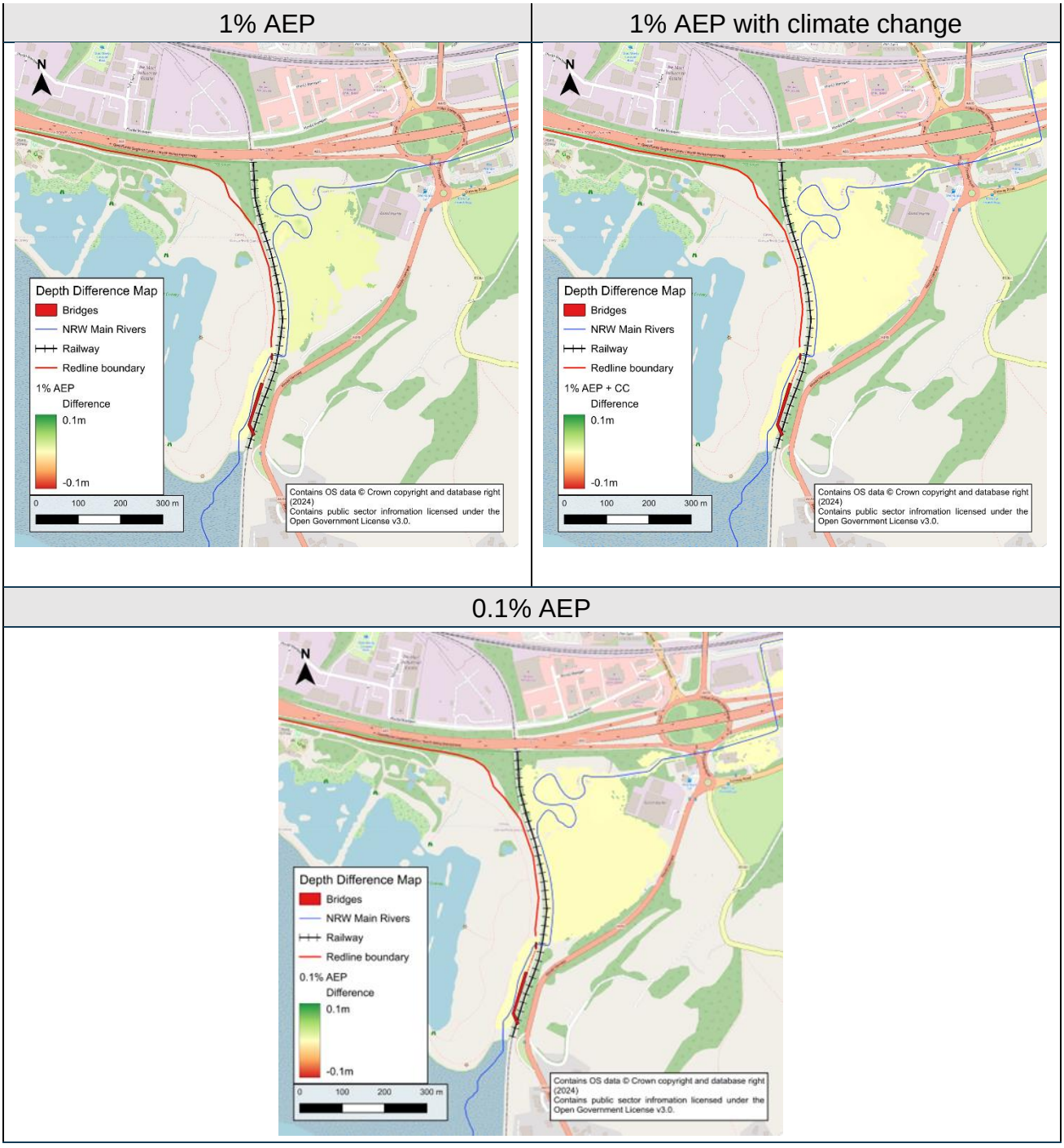


Figure 5-12 Fluvial depth difference maps

5.3.4 Residual fluvial risk from blockage

The proposed footbridge is single span with a soffit above the modelled fluvial flood levels. It will also be located a short distance downstream of a much more restrictive railway culvert. Therefore, it is unlikely that this structure would be subject to a significant blockage. However, because a new bridge over the Afon Ganol is the focus of the FCA, a blockage run was undertaken to demonstrate that a blockage would be unlikely to lead to a significantly increased fluvial flood risk. Given the unlikelihood of a significant blockage occurring, a 50% blockage proportion was considered appropriate for this FCA and the impact was tested with a 1% AEP with climate change event.

The outcome of the blockage modelling was that the peak 1% AEP with climate change river levels were unchanged along the River Ganol and that there was no observable difference in the modelled flood outline relative to the post-development scenario.

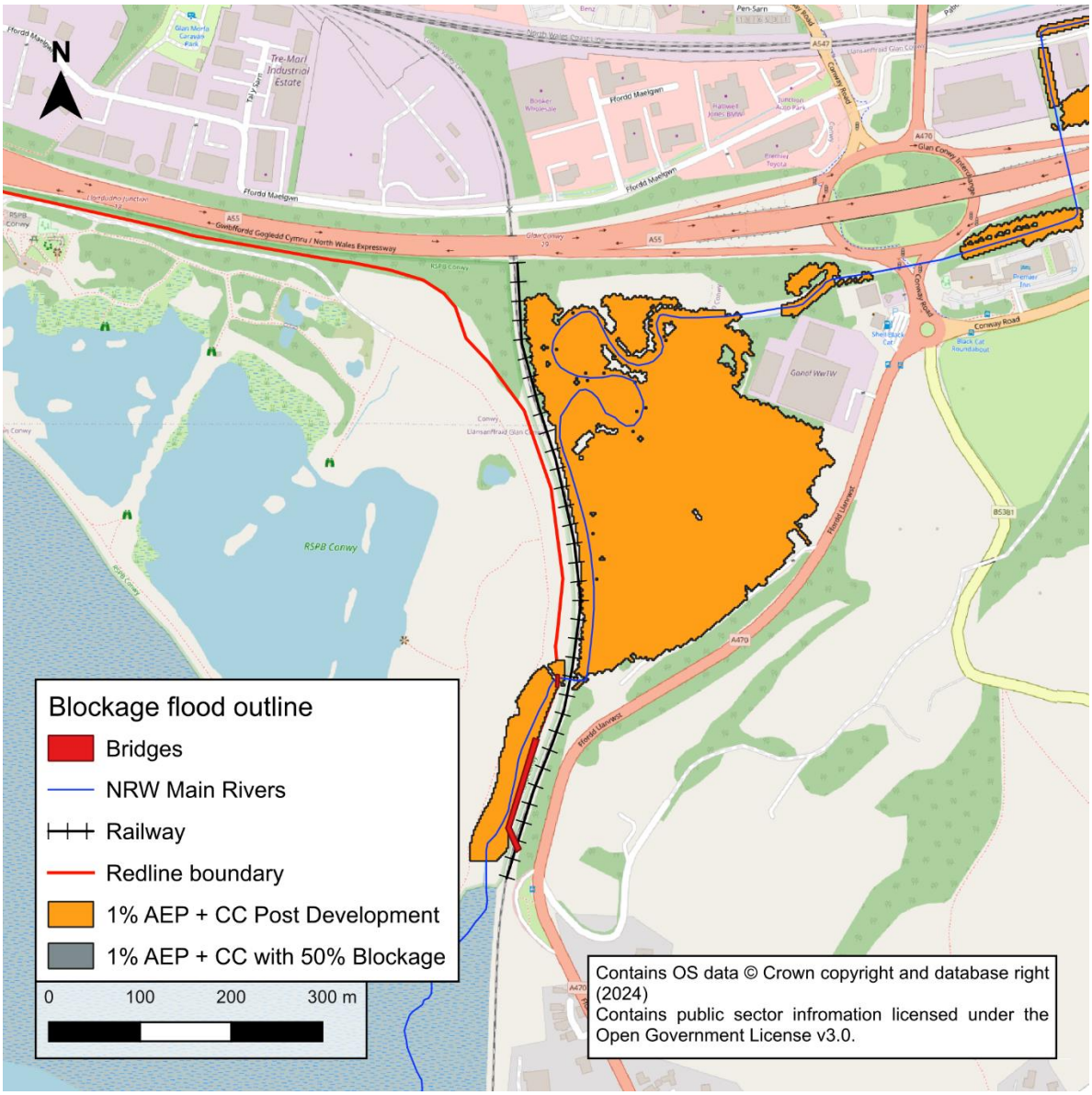


Figure 5-13 Comparison of 1% AEP with climate change Blockage and Post-Development Flood Outlines

5.3.5 Updated Tidal Modelling

5.3.5.1 Pre-Development tidal outline and levels.

The present day (2024) 0.5% and 0.1% AEP tidal boundary series were both modelled to peak below the lowest point of the embankments along the western side of the RSPB reserve. Therefore, no tidal overtopping was modelled in response to the present day, existing risk tidal scenarios. However, the future peak tide levels are higher than the low point of the estuary embankments, which is located above the Ganol (West) outfall at around 5.5m AOD, so tidal overtopping is simulated in response to both 0.5% and 0.1% AEP with climate change events. This overtopping is modelled to lead to the flood outlines shown in Figure 5-14, which cover much of the area to the east of the lagoons.

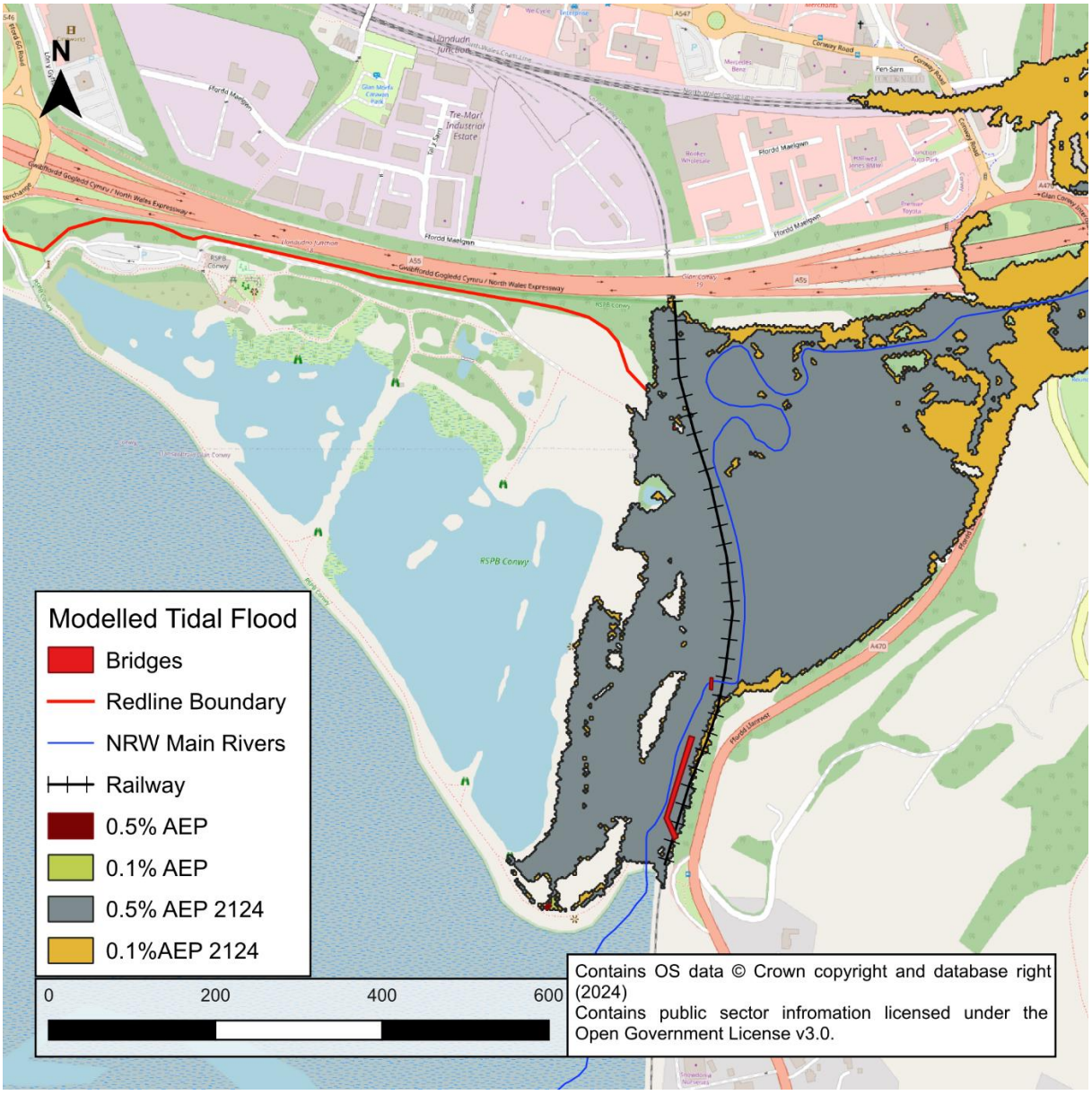


Figure 5-14 Pre-Development Tidal Flood outlines.

The modelled peak tidal flood levels between the railway embankment and tidal outfall are shown in Table 5-7. These show that the area alongside the proposed works is potentially at risk from future extreme tidal events to a level in the order of 5.5m AOD. This is noticeably higher than the predicted peak fluvial flood level (of in the order of 3.5m AOD) and is also sufficient to lead to widespread overtopping of the railway embankment, the crest of which is around 5.2m AOD.

Table 5-7 Modelled existing risk tidal flood levels at Bridge 1 over the Afon Ganol

Event	0.5% AEP	0.5% AEP 2124	0.1% AEP	0.1% AEP 2124
Height m AOD	0	5.48	0	5.61

As Figure 5-14 shows that the proposed works would be at future tidal risk, the potential flood conditions in a 0.5% AEP event over the lifetime of the development is of relevance to the FCA. Therefore, Figure 5-15 shows the modelled flood hazard information from the tidal 0.5% AEP in 2124 existing risk simulation. This shows that flood depths along the route of the cycle path under existing conditions (i.e., before any raising) would typically peak at in the order of 0.5 metres. Velocities would peak in excess of 1m/s across parts of the proposed route and the resulting flood hazard along parts of the route would represent a 'Danger To All'.

The volume of tidal overtopping is such that the proposed new bridges and walkway will have a negligible impact on the flood risk, so the post-development tidal situation was not modelled. However, the works will need to be designed to accommodate the tidal risk.

5.3.6 Residual Risk from Local Embankment Failure

As explained in Section 5.3.1, tidal events were also run in conjunction with the existing 'undefended' Ganol tidal model scenario, which involved failure of the Ganol West outfall and an overlying segment of the estuary embankment. As the lowest point of the lengthy embankment that runs between the RSPB reserve and Conwy estuary occurs at the tidal outfall, this potentially marks the most likely location of any defence failure and represents a potential worst-case location for defence failure for the FCA site.

The flood outlines resulting from the local defence failure are shown in Figure 5-16. This shows that a defence failure would allow inundation of the proposed site during present day (2024) 0.5% and 0.1% AEP events and that inundation would also be more extensive than under existing conditions in the future (with climate change) scenarios. Table 5-8 provides the modelled peak flood levels adjacent to the proposed new bridge over the Afon Ganol for each of the modelled tidal defence failure events. Flood hazard information was also recorded from these runs and is available if required but the flood levels provided in Table 5-8 should act as a guide to the kind of flood conditions that could be encountered locally in response to defence failure.

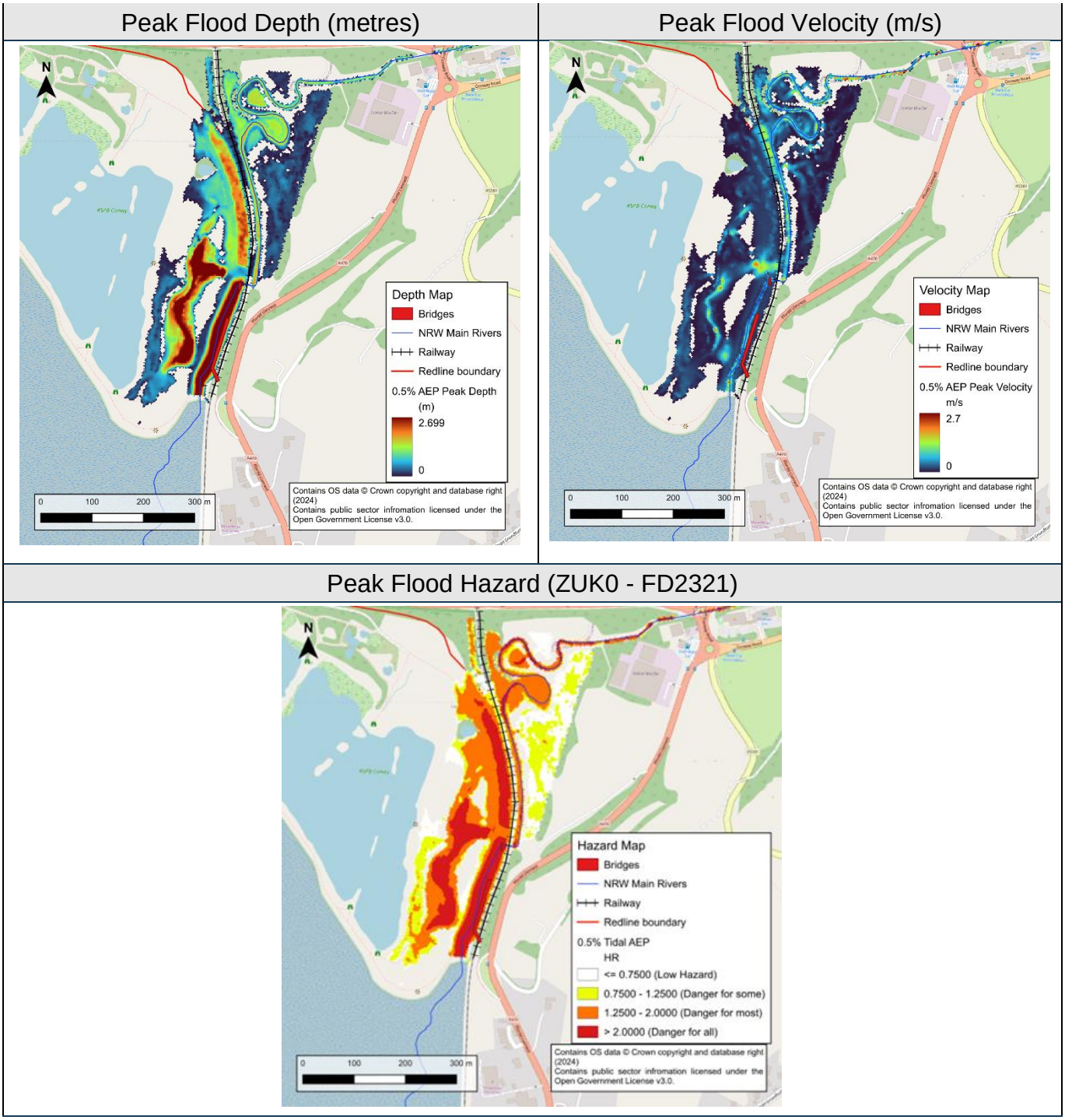


Figure 5-15 Modelled peak flood hazard conditions at the site during a 0.5% AEP in 2124 event

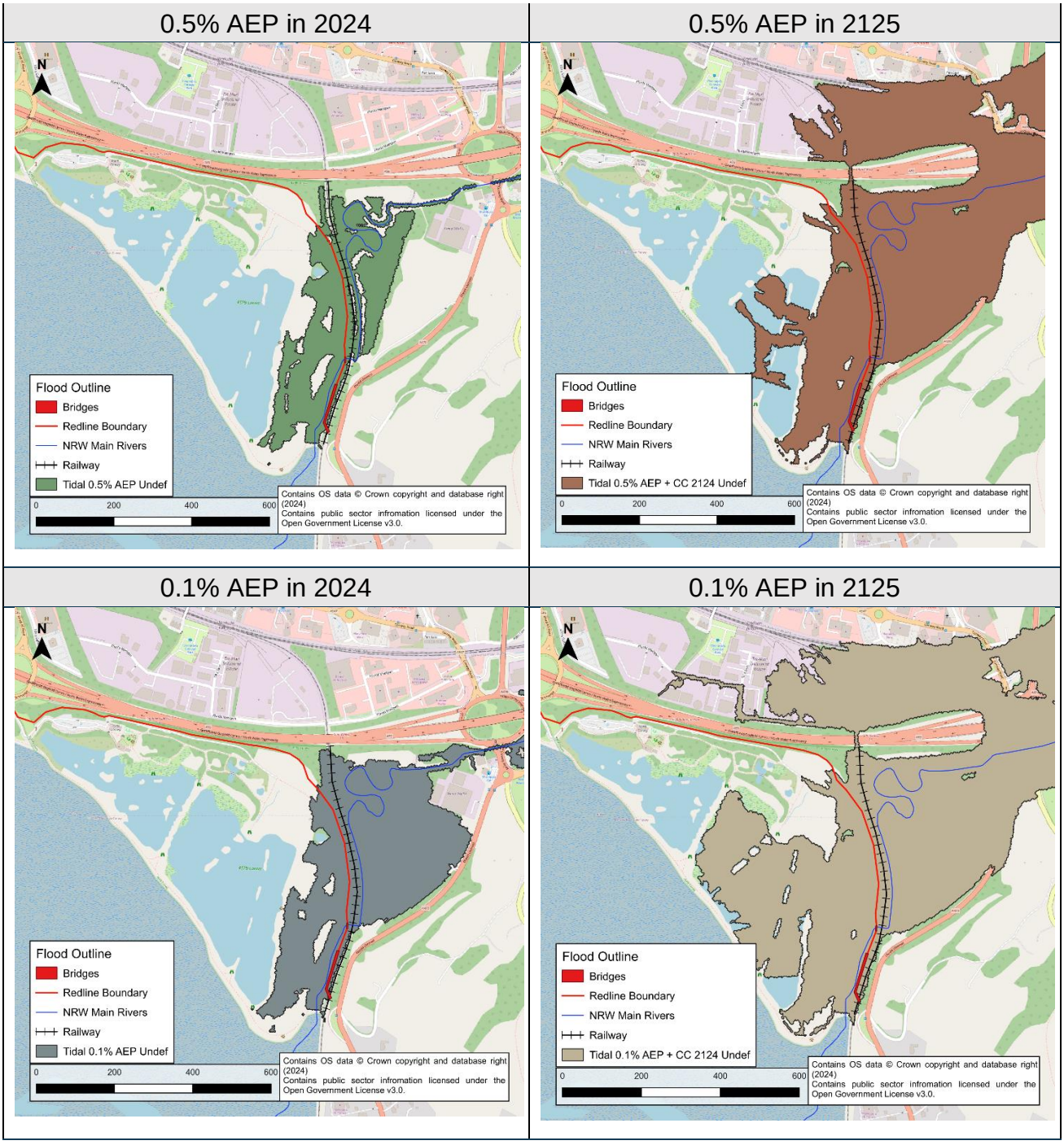


Figure 5-16 Modelled tidal flood outlines arising from local defence failure at the outfall

Table 5-8 Modelled tidal flood levels adjacent to proposed bridge over the Afon Ganol in response to local defence failure

Event	0.5% AEP	0.5% AEP 2124	0.1% AEP	0.1% AEP 2124
Height m AOD	5.24	6.13	5.46	6.30

5.3.7 Climate Change Uncertainty

One further model run was undertaken to provide a potential worst-case sea level rise due to climate change. This involved simulating the impact of the 95th percentile of the UKCP18 climate change allowance for a 0.5% AEP tidal event in the year 2125. The offshore peak extreme sea level for this event was calculated to be 6.61m AOD and the resulting flood outline is shown in Figure 5-17. The modelled peak flood level adjacent to the proposed new bridge over the Rive Ganol was 6.33m AOD.

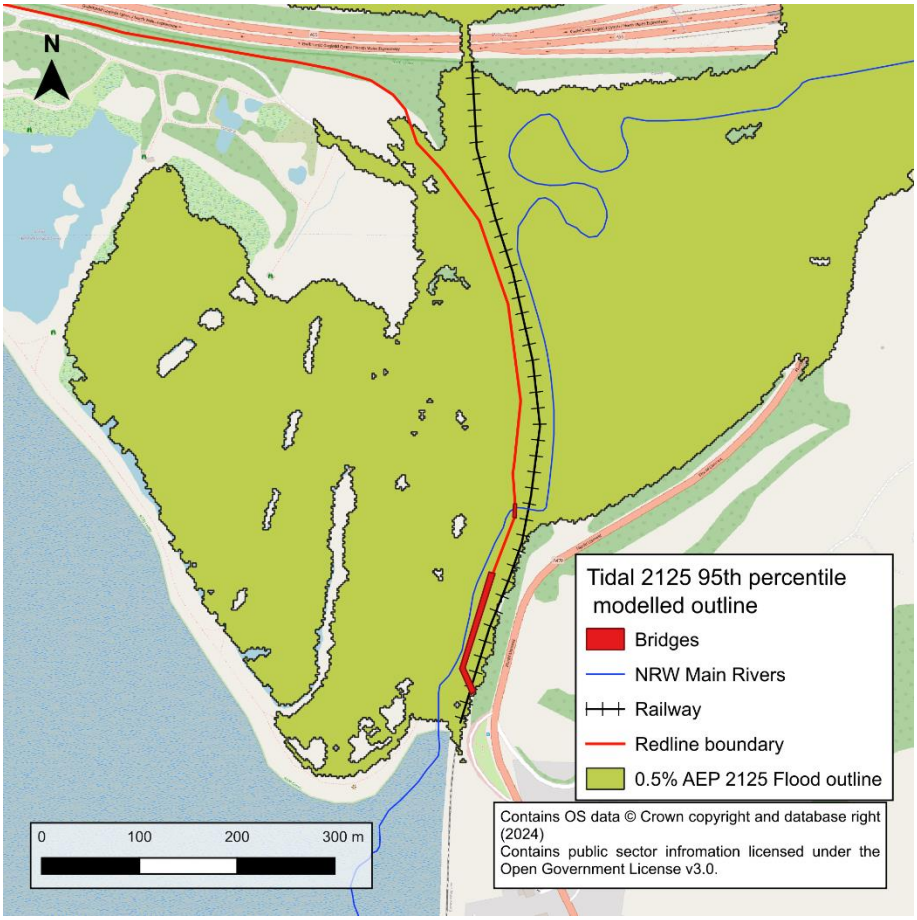


Figure 5-17 Modelled tidal flood outline arising from modelling the 95th percentile of the UKCP18 climate change allowance for a 0.5% AEP event in 2125

6 Flood Risk Constraints on Development

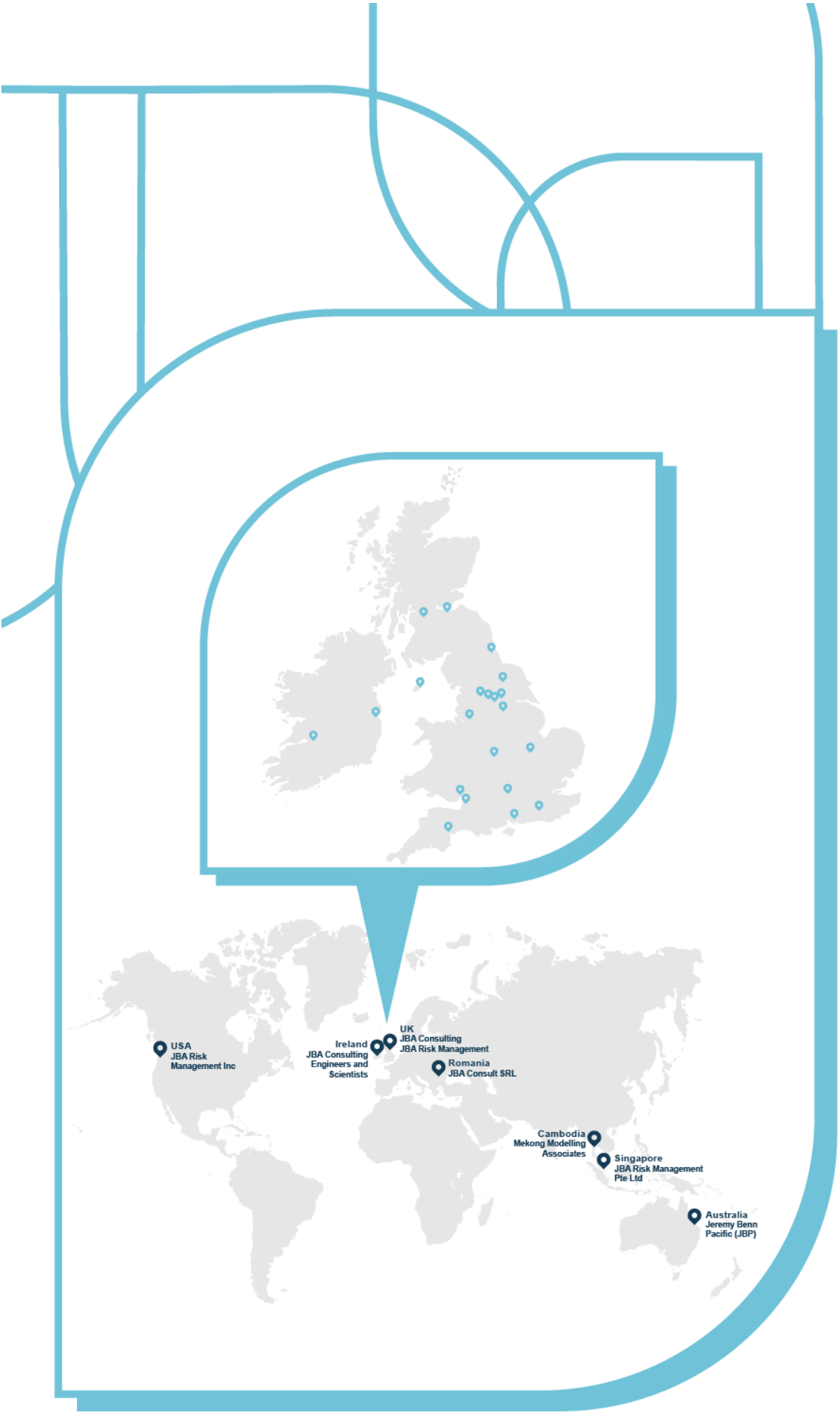
6.1 Fluvial

The modelled fluvial flood risk poses only minimal constraints for the proposed works. By placing the path and soffit level of the bridge over the Afon Ganol above the modelled 0.5% AEP with climate change level of 3.5m AOD plus an appropriate freeboard level (TBC), the development should be safe from fluvial flooding and will have no off-site impacts for the lifetime of the development. Dry access and egress would still be possible under these conditions. There would also be no increased risk due to blockage of the new bridge.

6.2 Tidal

The modelling shows that tidal flooding would pose a higher risk to the proposed works than fluvial flooding. Tidal overtopping is modelled to have the potential to lead to 0.5% AEP flood levels of 5.48m AOD over the lifetime of the development. There are also residual risks that 0.5% AEP levels could reach as high as 6.13m AOD in response to local defence failure or even 6.33m AOD due to uncertainties in the climate change allowance.

It would not be practical to raise the new path above these extreme tidal levels. Therefore, the works would need to be designed to be resilient to these conditions and, because, safe access/egress would not be possible, a site access plan would be needed to forewarn users of the potential risks. Given that there should be sufficient lead time provided in advance of extreme tidal surges (e.g., by monitoring the coastal flood warnings for Conwy and/or Llandudno), site closure should be considered as an option to keep people safe from the consequences of any extreme tidal events.



JBA consulting

Offices at

Bristol
Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Leeds
Limerick
Newcastle upon Tyne
Newport
Peterborough
Portsmouth
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

Registered Office
1 Broughton Park
Old Lane North
Broughton
SKIPTON
North Yorkshire
BD23 3FD
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
Follow us:

Jeremy Benn Associates Limited
Registered in England 3246693

JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
ISO 27001:2013
ISO 45001:2018