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A494 River Dee Bridge Replacement Scheme
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Environmental Scoping Report

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December 2024

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Environmental Scoping Report

A494 River Dee Bridge Replacement

December 2024

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1 Introduction

1.1 Overview

1.1.1 This document is a draft Scoping Report for an Environmental Impact Assessment (EIA) of the proposed A494 River Dee Bridge Replacement Scheme (referred to in this document as 'the Scheme') prepared in accordance with the Environment (Wales) Act 2016 and The Environmental Impact Assessment (Miscellaneous Amendments relating to Harbours, Highways and Transport Regulations 2017) hereinafter referred to as the EIA Regulations. It is the intention that the Scheme will be taken forward as an application under the Highways Act 1980 (as amended) by the Welsh Ministers.

1.2 Purpose of this report

1.2.1 The purpose of the Scoping Report is to set out the extent of the proposed Scheme and scope of the EIA including the environmental factors or topics to be considered and a description of how each topic will be assessed in the EIA and reported in the Environmental Statement (ES). The Scoping Report is used to agree the scope of the EIA with statutory consultees and key stakeholders prior to commencing the EIA process.

1.2.2 This Scoping Report is undertaken in advance of undertaking an environmental assessment and specifically during:

- Initial scheme identification;
- Option identification/selection; and
- Preliminary Design of the best performing scheme option

1.2.3 This Scoping Report has been prepared in accordance with the Design Manual for Roads and Bridges (DMRB) LA 103 Scoping projects for environmental assessment. It supersedes a previous Scoping Report prepared for a scheme at the same location in 2018. Since that time the design of the Scheme has been reviewed in light of changes to Welsh Government policy and a new preferred Scheme selected to be progressed through the statutory process.

1.3 Location of the Scheme

1.3.1 The Scheme is located on the A494 at Queensferry in the county of Flintshire, North Wales and is for the replacement of an existing road bridge that crosses the tidal river Dee. The total length of the Scheme is approximately 1.2 kilometres and lies entirely within the principality of Wales. The Scheme runs from the Queensferry Interchange in the southwest, north-east along the A494 road corridor and across the river Dee, to rejoin the existing A494 at Garden City. Refer to Figure 1-11-1 Location Plan.

Figure 1-1 Location Plan

Due to size this Figure is included in Appendix A.1

1.4 Overview of the WelTAG process

1.4.1 The Scheme is following the latest Welsh Government Transport Appraisal Guidance, WelTAG, which was published in February 2024. The aim of WelTAG Stage 2 is to identify a best performing scheme option that not only demonstrates a strong strategic fit but delivers well-being benefits, and are affordable, deliverable and manageable. Stage 2 should encompass a more in-depth technical look at each option including environmental and geotechnical considerations. This should include the key design components, land and statutory requirements. In terms of benefits, the focus is on anticipating the impacts based on existing data and information.

1.5 EIA process and methodology

1.5.1 This is a Scoping Report that sets out the intended approach and methodologies to undertaking an EIA required for the River Dee Replacement Scheme that is classified under the EIA Regulations as being an Annex II project and a 'relevant project' in accordance with DMRB LA 102 Screening projects for Environmental Impact Assessment (formerly HD 47/08, IAN 126/15 and IAN 133/10). A Record of Determination has been prepared and approved and published by the Competent Authority in line with the Highways Act, 1980 (as amended) Chapter 66.

1.6 Structure and contents of this scoping report

1.6.1 The report is structured as follows:-

1. Section 2: Description of the Scheme
2. Section 3: Policy Context – national policy relating to transport and the environment
3. Section 4: Consultation – a resume of consultation undertaken to date and planned for the future
4. Sections 5-15: Scoping of environmental factors
5. Section 16: Cumulative Effects
6. Section 17: Next Steps

1.6.2 This report will include figures in the body of the text and also at the rear of the document.

1.7 The need for the Scheme

1.7.1 The Welsh Government is responsible, as the highway authority, for all Motorway and Trunk Road networks in Wales. The A55, A550 and A494 corridor forms a primary East-West link between Queensferry/Ellesmere Port /north-west of England and the rest of North Wales and is part of the Trans- European Road network. The River Dee crossing of the A494 Queensferry Bypass, constructed in 1960, forms a critical part of this link, carrying approximately 68,400 vehicles per day (2024 count data), far more traffic than it was designed for. The corridor is below modern standards. Some of the junctions have slip roads that are too short or too close to the road, and poor visibility is an ongoing problem. It is therefore critical that the existing bridge is replaced to ensure that the future of the A494 road corridor and crossing of the river Dee is safeguarded for future generations.

1.7.2 In recent years, there is evidence of concrete deck deterioration, which may have been occurring for many years. This deterioration has continued despite routine maintenance and repairs by North and Mid Wales Trunk Road Agent (NMWTRA) and NMWTRA estimate that they can maintain the bridge for, at most, a further 3 years before routine maintenance becomes unsustainable. Currently there is a prohibition for the restriction on the movement of abnormal loads over the structure. Major maintenance and/or refurbishment has become essential. A contingency plan for emergency repairs is now in place if the deck of the bridge deteriorates further and becomes hazardous to road traffic.

1.8 Scheme Objectives

1.8.1 The following Transport Planning Objectives (TPO's) have been adopted during the WelTAG Stage 2 process to provide clear aims for the project. Stakeholders are involved in the setting of these TPOs, which will be set out in their final form as part of the WelTAG Stage 2 report (currently in preparation).

- Fulfil the functions and importance of the A494 by addressing the life-expired River Dee bridge
- Improve the resilience of the A494 route by:
  - Making the journey times more reliable
  - Reducing the impact of incidents and accidents on the trunk road and local highway network
  - Improve safety through implementing positive design interventions and solutions
  - Enable easier maintenance of the A494 and more robust to climate change events
- Minimise scheme whole life carbon emissions through:
  - Applying carbon reduction measures to construction
  - Reducing the impact of the scheme on road user emissions
  - Other mitigation measures
- To maintain and enhance local environment by:
  - Maintaining air quality
  - Managing flood risk
  - Achieving net benefit for biodiversity
- To enable modal shift through better provision for alternative modes
- To minimise the impacts of construction by:
  - Keeping the link as open as much as possible for connectivity
  - Reducing adverse effects on other parts of the transport network
  - Reducing adverse effects on neighbouring residents and businesses

1.9 Environmental Objectives

1.9.1 A set of draft Environmental Objectives (EO's) have been developed by the project team to align with Welsh Government planning and environmental policies and to improve and enhance the environmental performance of the best performing scheme option (Option E). The nine EO's are set out below:

1. Protect and safeguard the designated site of the river Dee by avoiding and minimising adverse environmental impacts.
2. Enhance ecosystem resilience and secure long-term benefits for biodiversity.
3. Minimise environmental risks such as air and noise pollution and those posed by flood risk and coastal change.
4. Improve connectivity to adjacent ecosystems and deliver positive enhancement measures.
5. Protect and enhance the biodiversity and value of the soft estate and its resilience for future change.
6. Secure long-term mitigation and enhancement measures that are effective and resilient to climate change.
7. Deliver a network of green infrastructure and open green spaces and soft estate.
8. Minimise the use of carbon and reduce greenhouse gas emissions arising from construction and operational phases of the bridge replacement scheme

9. Ensure short-and long-term environmental mitigation and management measures are in place through the construction and operational stages of the scheme.

1.10 Other related documents

Habitat Regulations Assessment (HRA)

1.10.1 The Conservation of Habitats and Species Regulations 2017 (as amended) ensures the protection of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) in the UK which no longer form part of the EU's Natura 2000 ecological network. The amended Regulations have created a national site network on land and at sea, including both the inshore and offshore marine areas in the UK. The UK National Site Network includes existing SACs and SPAs, and new SACs and SPAs protected under these Regulations. The network also aligns with international commitments such as the Bern Convention and the Ramsar Convention, although Ramsar sites, which are wetlands of international importance, do not form part of the national site network.

1.10.2 Under Regulation 63, before deciding to undertake or give authorisation for a plan or project, the determining body and competent authority, must consider, under the requirements of Regulations, whether the scheme:

a. Is likely to have a significant effect on a protected site within the national sites network (either alone or in combination with other plans or projects), and
b. is not directly connected with or necessary to the management of the site.

1.10.3 In the light of the conclusions of the assessment, the competent authority may agree to the project or plan only after having ascertained that the propose will not, either alone or in-combination with other schemes, adversely affect the integrity of the protected site, in view of that site's conservation objectives. The only exceptions are where there are no alternatives and there are imperative reasons of overriding public interest (IROPI).

1.10.4 The HRA process is being conducted separately, in parallel with the Environmental Assessment process and in accordance with DMRB LA 115 Habitat Regulations Assessment. The HRA includes Habitats Regulations screening, informing the appropriate assessment and assessment of alternative solutions, IROPI and compensatory measures. The first step in the process is to conduct a screening assessment. The outcomes from the HRA screening process shall be reported in the form of an HRA report and accompanying screening matrices which would be submitted to the competent authority as part of the consenting process.

2 The A494 River Dee Replacement Scheme

2.1 Location and context of the Scheme

2.1.1 The Scheme is located along the A494 road corridor in Queensferry in the county of Flintshire, north Wales. This section of the A494 passes through the built-up urban area of Queensferry, including residential and commercial properties, crosses the corridor of the canalised River Dee and the parallel Wales Coast Path, and then passes between a further residential area and intensively farmed land to the north of the river. The landscape is flat and low-lying, being land originally reclaimed from the Dee Estuary.

2.1.2 In the corridor of the A494 the southern bank of the River Dee is almost entirely in urban uses (industrial sites, commercial properties and residential areas). North of the river lies the former RAF Sealand aerodrome which has been reclaimed for residential and mixed-use development, and Deeside Industrial Park which encompasses much of the former steelworks land as well as the current Tata operations.

2.1.3 The North Wales Main Line railway runs parallel with the River Dee, approximately 250m to the south-west. Its embankment forms a visual barrier and divide between the commercial – industrial riverside land and the residential – retail centre of Queensferry and the rising land further south.

2.1.4 The Airbus factory is located upstream of the existing river Dee Bridge where wings for the A380 “Superjumbo” used to be manufactured and loaded onto a barge that sailed down the river Dee to Mostyn Docks for onward shipment to France. The Airbus Load Out Facility (ALOF) was a jetty used on the west bank of the river to load the wings onto the barge and this section of the river was regularly dredged to maintain sufficient depth of water for the barge. Production of the A380 wings came to an end in 2020, but the ALOF remains and has been identified as a potential location for the construction of a jack up barge to be used in the construction of the replacement bridge.

2.2 Alternatives and selection of the preferred scheme

2.2.1 In accordance with Stage 2 of the WelTAG process, options for schemes to replace the existing bridge were identified and assessed against the Scheme Objectives set out above in section 1.6. The option identification, sifting and assessment are described in the WelTAG Stage 2 report. In parallel, the short list options were further investigated for technical feasibility and budget cost, taking account of the many existing constraints such as existing structures, as reported in the Options Report.

2.2.2 A particular factor in the consideration of options is the extent to which any option maintains traffic capacity during construction and meets the current and projected traffic flows once completed. The A494, in common with many other roads in the local network, is congested at peak times and so the displacement of traffic to other routes during construction or following completion is potentially significant for residents and other receptors along those routes.

2.2.3 The conclusion of these processes is that in the absence of alternative routes for the A494 traffic, it is essential to maintain a crossing at Queensferry with no less capacity than is currently provided.

Do nothing option

2.2.4 The ‘Do nothing’ option would result in a continuation of structural issues and the eventual deterioration of the River Dee Bridge. This would result in several negative impacts to the regional and national economy from disrupted strategic traffic flows, including freight, to and from north Wales.

2.2.5 The ‘Do nothing’ scenario would lead to weight restrictions, lane closures and potential full closure of the River Dee Bridge causing significant disruption, congestion and delay to the travelling public, businesses and freight.

2.2.6 Closing the A494 at the River Dee would create more traffic on other routes that would not be able to accommodate the extra traffic. This may have a negative impact on walking and cycling, have a bearing on road safety, air quality and noise pollution as well as disruption to public transport routes.

Do minimum option

2.2.7 The ‘Do minimum’ option would involve the renewal of the current bridge in-situ. This would involve the complete removal and reconstruction of the bridge deck, replacement works to the abutments and bridge approaches and repairs to the bridge beams and river piers.

2.2.8 To undertake the replacement work, the A494 would need to be closed completely to eastbound traffic for an extended period and westbound traffic limited to width and speed restrictions. There would then be a further extended period of traffic operating in single lane contraflow.

2.2.9 This is predicted to have a significant impact on traffic conditions during construction both locally and in the wider area resulting in traffic congestion, delays, and some traffic re-routing away from the A494 to alternative locations. In addition, there would be negative air quality and noise impacts during construction. This option would not deliver on the added benefits such as modal shift, road safety improvements and flood resilience offered by the ‘Do something’ options.

Do something option

2.2.10 An initial longlist of 44 intervention options was identified and then appraised on how they meet the Scheme objectives and design, engineering, wellbeing, and environmental considerations. In addition, they were tested on how they contribute towards the objectives of the Wales Transport Strategy. From the longlist of option appraisal, a shortlist of five options was identified as described and illustrated on the following panels. We are now consulting on these shortlisted options and would welcome your thoughts and comments

2.3 Description of the scheme

2.3.1 The proposed Scheme consists of constructing a replacement bridge over the River Dee to the south and upstream of the existing bridge that would be demolished following completion of the new bridge. The replacement bridge would be approximately 30 metres wide and have a span of approximately 130 metres to carry two lanes of eastbound and westbound traffic over the river Dee that is designated as a Special Area of Conservation (SAC) and Site of Scientific Interest (SSSI). The bridge will also include a shared use path for cyclists and pedestrians located on the southeast side of the new westbound carriageway. A General Arrangement drawing is included in Figure 2-1.

Figure 2-1: General Arrangement of the best scoring option

Due to size this Figure is included in Appendix A.2.

2.3.2 The new bridge will be located approximately 16m to the southeast of the existing A494 river bridge, with the intention that construction works can be undertaken ‘offline’ of the existing highway and allow the road to remain open during most of the construction period.

2.3.3 The key features of the proposed Scheme are:

1. A new bridge to carry two lanes of eastbound and westbound traffic over the River Dee supported by two sets of river piers. The bridge will also include a shared use path for cyclists and pedestrians located on the southeast side of the new westbound carriageway.

2. Improvements to the existing A494 to the east of where the road passes under the North Wales Coast Railway Line (CNH3), including introducing a new hard shoulder in each direction connecting to the existing hard shoulders to the east of the River Dee, alignment improvements and introduction of sustainable drainage systems.
3. A new left in/left out access from the westbound carriageway of the A494 to the Riverside Gypsy Travellers site, commercial properties and to a river pumping station.
4. A new shared use path for pedestrians and cyclists, running along the southeast side of the westbound carriageway, which will connect to the Wales Coast Path east of the river and improves to a number of other existing routes to improve the interconnectivity of active travel routes in the local area.
5. Diversion of the 'the Queensferry Drain' (a Natural Resources Wales main river), which is situated on the southeast side of the A494(T) and currently flows in a culvert beneath it, west of the North Wales Coast Railway Line (CNH3) and in open channel east of the railway line. New sections of open channel will be provided either side of the railway with a section of existing culvert beneath the railway line being retained.
6. A new drainage outfall to the River Dee will be created, and a new Queensferry Drain Pumping Station facility provided to the west of the River Dee.
7. Environmental mitigation and biodiversity enhancement works with earthworks and areas of soft estate including wildflower verges, swales, native woodland plantations and amenity grassland.
8. Subject to confirmation and review of alternative usages, the demolition of the existing A494 River Dee bridge.

2.3.4 The extent of the Scheme includes some areas that will be needed for the construction phase of the project. These include an area of agricultural land on the eastern bank of the river and south of the existing bridge, where a site compound will be required along with access off Foxes Lane. In addition to the main compound, the former Airbus Load Out Facility (ALOF) will be required to assemble a jack up barge required for the construction of the river piers. The ALOF is a ramped access to a jetty that was formerly used to load wings manufactured at the Airbus factory onto a barge that transported the wings down river to Mostyn Docks. When operational, regular dredging of the river was required to ensure sufficient depth of water to float the barge. The ALOF is likely to be required for the construction of the jack up barge in the early stages of the project and at the end for the dismantling of the barge. Localised dredging of the river may be required subject to further investigation of the riverbed and detailed operational requirements of the appointed Contractor.

2.4 Programme

2.4.1 The current programme for the Scheme is under development and subject to further consideration. However, it is anticipated that an indicative programme could assume the following timeline:-

Selection of Best Performing Scheme Option (WelTAG Stage 2):	Autumn 2024
Preparation of the Environmental Impact Assessment:	Winter 2025
Publication of Draft Orders:	Spring 2026
Public Local Enquiry:	Summer 2026
Construction:	Spring 2028

2.5 Construction and long-term management

2.5.1 This Scheme could generate adverse environmental effects during construction, arising from the works in proximity to residents and other receptors and from possible displacement of traffic to other routes during the works. The latter effect is considered particularly likely if a ‘Do Minimum’ option is adopted and so will be assessed.

2.5.2 The works would be constructed taking note of effects on nearby receptors. In particular, the contract would require the contractor to develop and operate a Construction Environmental Management Plan (CEMP) which would set out mitigation and controls on working methods so that effects were minimised. As part of the environmental assessment the topic specialists would identify good practice methods and/or mitigation which could be applied, making clear the extent to which such mitigation has been assumed in the assessment of effects. Only where there is clear evidence of the effectiveness of mitigation measures would the assessment be based on such measures being implemented. In all other cases the assessment would assume the ‘worst case’ but suggest mitigation that could or should be adopted.

2.5.3 With regards to the construction method of the potential bridge a piling rig mounted on a barge could be used to drive thin steel tubes into the riverbed. When the tubes reach the required depth, bored piles will be constructed by positioning an auger inside the steel tube. This way the disturbance of the silt at the riverbed will be kept to a minimum and restricted only to the steel tube driving operations. The toe of the bored pile could be located well below the steel tubes to suit the design requirement. Alternatively, the piling rig could reach the required location in the river via temporary platforms built in the river. Once the piles are complete, temporary platforms supported from the piles may be erected to construct the crossheads.

3 Policy Context

3.1 Backdrop

3.1.1 This section of the scoping report outlines the relevant legislative and policy framework with an overview of guidance and strategy documents. These documents will be considered in detail as part of the 'Legislative and Policy Context' chapter of the Environmental Statement.

3.1.2 Consideration of European and national legislation is a requirement of the EIA Regulations so that the scheme can be seen in the policy context and any problems caused, conflicts created and benefits to be derived can be identified and understood. DMRB LA104 Rev 0, Annex W/1 states that 'Environmental assessment, reporting and monitoring shall meet the requirements of the:

1. EIA Directive
2. Highways Act (as amended)
3. Planning Policy Wales, (Edition 12 – February 2024)

3.2 European and national legislation and policy

3.2.1 The EIA legislative framework in Wales originates from European Council Directive 85/337/EEC as amended by EC Directive 97/11/EC and the Public Participation Directive 2003/35/EC

3.2.2 The 2011 European Directive 2011/92/EU, and the most recent 2014 Directive (as amended) 2014/52/EU[1] are known, collectively, as the EIA Directive. Directive 2014/52/EU is transposed into the Environmental Impact Assessment (Miscellaneous Amendments Relating to Harbours, Highways and Transport) Regulations 2017 (EIA Regulations 2017) 5th December 2017. The equivalent under town and country planning act is the Town and Country Planning (Environmental Impact Assessment) (Wales) Regulations 2016.

Environment (Wales) Act 2016

3.2.3 The Environment (Wales) Act's primary purpose is as follows:

- To promote sustainable management of natural resources
- To require the Welsh Ministers to meet targets for reducing emissions of greenhouse gases from Wales
- To ensure Waste is processed separately and effectively.

Well-being of Future Generations Act (Wales) 2015

3.2.4 The Well-being of Future Generations Act requires public bodies in Wales to think about the long-term impact of their decisions, to work better with people, communities and each other, and to prevent persistent problems such as poverty, health inequalities and climate change.

Planning Act (Wales) 2015

3.2.5 The Planning (Wales) Act makes provision about sustainable development in the exercise of functions relating to development planning and applications for planning permission.

Active Travel Act 2013

3.2.6 The Active Travel (Wales) Act requires local authorities in Wales to map and plan suitable routes for active travel, and to build and improve their infrastructure for walking and cycling every year. It creates new duties for highways authorities to consider the needs of walkers and cyclists and make better provision for them. It also requires both the Welsh Government and local authorities to promote walking and cycling as a mode of transport so that local communities rely less on cars when making short journeys.

Planning Policy Wales

3.2.7 Planning Policy Wales (Edition 12 – February 2024) places Welsh Government's commitment to delivering and maximising the contribution planning makes to the achievement of the goals set out in the Well-being of Future Generations Act at the heart of the planning system.

Technical Advice Notes (TAN)

3.2.8 Welsh Government have prepared a number of Technical Advice Notes to provide guidance on specific technical considerations within the consenting process. These will be used where applicable under the relevant topics within the Environmental Statement and would include:

- Technical Advice Note 5 Nature Conservation and Planning, 2009
- Technical Advice Note 11 Noise, 1997
- Technical Advice Note 18 Transport, 2007
- Technical Advice Note 23 Economic Development, 2014

Llwybr Newydd: the Wales Transport Strategy 2021

3.2.9 Published by Welsh Assembly Government, the vision behind Llwybr Newydd is '*an accessible, sustainable and efficient transport system*. This would be achieved over 5 years by promoting sustainable transport and communication networks and encourage governments, local authorities, transport providers to ensure that transport contributes to the current and future well-being of Wales.

Llwybr Newydd i Natur: the Nature Recovery Action Plan for our Strategic Road Network

3.2.10 This publication by the Welsh Government is part of the Wales Transport Strategy and aims to protect and enhance biodiversity sets out how they will protect biodiversity and enhance nature and ecosystem resilience across the Strategic Road Network (SRN). It emphasises the need to integrate nature protection into every aspect of road network management to ensure that environmental considerations are a core principle in planning and operations.

National Transport Delivery Plan 2022 to 2027

3.2.11 First published by Welsh Government in February 2023, the National Transport Delivery Plan sets out how Welsh Government will deliver programmes, projects and new policies against priorities and ambitions set out in Llwybr Newydd and the Well-being of Future Generations Act and within the predicted Capital and Revenue spend. The plan also sets out the priorities for delivery, including reducing dependence on private cars, improving public transport, changing behaviour to tackle climate change and the nature emergency.

Moving North Wales Forward March 2017

3.2.12 The A494 River Dee Bridge is identified in the Welsh Government's 'Moving North Wales Forward' as a scheme for improvement to upgrade the existing bridge. It is set out in the TR111 plan dated September 2017.

Local Planning Policy

3.2.13 Flintshire Unitary Development Plan (FUDP) is the adopted development plan for the 15 year period 2015 – 2030 and was adopted in 2023. It forms part of the statutory development plan alongside Future Wales: The National Development Plan 2040 and the Strategic Development Plan (SDP) for North Wales, once prepared and adopted. The Flintshire Council will use the LDP and Future Wales as the primary basis for making decisions on planning applications and development proposals.

3.2.14 The aim of the FUDP is to provide a framework for making rational and consistent decisions on planning applications and to guide development to appropriate locations. This identifies sites where new housing, employment and other development can take place, as well as setting out policies to protect important countryside, habitats, resources and heritage.

Previous Studies

3.2.15 In 2006 a statutory EIA for the A494 Drome Corner to Ewloe Improvement Scheme was published. A Statement to Inform an Appropriate Assessment was submitted to the then Countryside Council for Wales. This scheme was not implemented.

3.2.16 Recognising the continued need to address deterioration in the river bridge structure, Welsh Government commissioned further study of options. This led to the A494 Queensferry Bypass River Bridge Options Report (AECOM, 2013).

3.2.17 In 2017 a 'WelTAG' Stage 2 report into the Key Stage 2 A55 A494 A548 Deeside Corridor Improvement was published. Among the many technical studies that supported that report were a number of environmental survey and appraisal reports. Draft Screening reports under the EIA Regulations and the Habitats Regulations were also prepared, covering both Options under consideration.

3.2.18 The present A494 River Dee Bridge Replacement Scheme is a separate project, but the reports noted above will be used as sources of information where relevant, taking note of the time elapsed since they were prepared.

4 Consultation

4.1 Previous consultations

4.1.1 This Scoping Report applies to a preferred scheme option developed in 2024 as a replacement scheme previously prepared in 2018. The previous scheme proposals have been the subject of several rounds of consultations with the statutory environmental bodies and other key stakeholders collectively known as the Environmental Liaison Group (ELG).

4.1.2 The purpose of the ELG is to be a forum for information sharing during the planning and pre-construction phases of the scheme proposals to ensure that all relevant environmental issues are addressed in the EIA process, including the screening and scoping of the EIA. ELG meetings were held at regular intervals during the preparation of the previous scheme proposals.

4.2 Consultations and stakeholder engagement

4.2.1 It is the intention of the Overseeing Organisation to re-convene the ELG during the preparation of this Scoping Report to agree the Environmental Objectives outlined in section 1.9 above and to hold regular meetings to address any environmental issues that need to be addressed as the scheme progresses through the statutory process.

5 Proposed content and structure of the EIA

5.1 Scope of the EIA

5.1.1 The scope of the EIA will be the subject to the responses received from the statutory environmental bodies (SEB's) and key stakeholders to this Scoping Report. A scoping exercise has previously been undertaken for an earlier scheme referred to as the A494 River Dee Improvement Scheme (2018). The location and parameters of this previous scheme are similar to that proposed for the best performing scheme option that is the subject of this Scoping Report. However, revisions to the DMRB guidance published in 2019/2020, means that the scope of the EIA topics will be structured slightly differently, and therefore this will be reflected in the scope and structure of the EIA that will be prepared following this scoping exercise.

5.1.2 In accordance with the EIA regulations, the environmental impact Assessment will go through the following process-

- The preparation of an environmental statement
- The carrying out of consultations about the likely significant effects of the project on the environment
- The consideration of the environmental statement and other information about the likely significant effects of the project on the environment, and
- The consideration of the reasoned conclusion when deciding whether to proceed with the project

Assessment of Significant Effects

5.1.3 The EIA process seeks to identify what the likely significant effects a proposed development or project will have on the existing environment. The significant effects can be both negative or positive or a combination of both. Typically, effects are considered over the construction and operational stages of a project. Significance is generally defined by the assessment methodologies and standards adopted for a particular environmental topic. It is measured by assessing the environmental value or sensitivity of the existing environment and by assessing the magnitude of change likely to be caused by the proposed development or scheme.

5.1.4 The assessment of significance of environmental effects typically covers the following factors:

- the receptors/resources (natural and human) which would be affected and the pathway for such effects;
- the geographic importance, sensitivity or value of receptors/resources;
- the duration (long or short term); permanence (permanent or temporary) and changes in significance (increase or decrease)
- reversibility - e.g. is the change reversible or irreversible, permanent or temporary
- environmental and health standards (e.g. local air quality standards) being threatened; and
- feasibility and mechanisms for delivering mitigating measures, e.g. Is there evidence of the ability to legally deliver the environmental assumptions which are the basis for the assessment?

5.1.5 A significance matrix is usually deployed to provide a category of significance as indicated in Table 5-1 below. Significance typically comprises effects that are within the moderate, large, or very large categories.

Table 5-1: Significance Matrix

Extracted from DMRB LA 104	Magnitude of Impact (degree of change)					
		No Change	**Negligible**	**Minor**	**Moderate**	**Major**
Environmental Value (Sensitivity)	**Very High**	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	High	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
	Medium	Neutral	Neutral or Slight	Slight	Moderate	Moderate or Large
	Low	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate
	Negligible	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight

5.2 Content of the Environmental Statement (ES)

5.2.1 The content of the Environmental Statement will be subject to the agreement of this Scoping Report but is likely to cover the environmental topics presented under the following specialist environmental chapters.

- Geology and Soils
- Road Drainage and the Water Environment
- Biodiversity
- Landscape and Visual Effects
- Archaeology and Cultural Heritage
- Air Quality
- Noise and Vibration
- Materials Assets and Waste
- Population and Human Health
- Climate
- Cumulative Effects

Heat and radiation

5.2.2 As stated in DMRB LA104, the effects of heat and radiation is considered unlikely to be relevant to the scope of most motorway and all-purpose trunk road projects and is therefore scoped out of the assessment process for this Scheme.

Major accidents and disasters

5.2.3 Major accidents and disasters referred to as major events can include both man-made and naturally occurring events. The potential for these to occur would be addressed as part of the EIA and presented as a risk assessment within the ES.

6 Geology and Soils

6.1 Introduction

6.1.1 This chapter considers an assessment of the potential likely significant effects of the proposed A494 River Dee Bridge Scheme (hereafter referred to as 'the Scheme') on geology and soils. The assessment also considers potential effects on the Scheme from any contaminated land that may be present and considers the potential for the Scheme to introduce new contaminant linkages that were otherwise not present.

6.1.2 This assessment has been undertaken in accordance with the Design Manual for Roads and Bridges (DMRB) LA 109 Geology and Soils[1]. Potential effects relating to contaminated land have been assessed in accordance with the Environment Agency's Land Contamination Risk Management (LCRM) guidance[2].

6.1.3 The effects on groundwater and surface water are considered in relation to contaminated land only. Hydrological effects are assessed in Chapter 7 Road Drainage and Water Environment.

6.1.4 The effects on mineral resources present and materials to be imported and exported in relation to earthworks construction will be assessed in Chapter 13 Material assets and waste.

6.1.5 The effects on soil as a biodiversity resource are considered within Chapter 8 (Biodiversity).

6.1.6 The effects of the proposed Scheme upon agricultural land will be assessed in Chapter 14 Population and Human Health (including agriculture and land use), and therefore are not considered in this chapter.

6.1.7 The Preliminary Sources Study Report (PSSR)[3] is the definitive publication for the initial geological assessment across the Scheme. A supplementary Contaminated Land Risk Assessment has been undertaken for the former Neston Tank Cleaners Site west of the River Dee. The findings of the report will update the contaminated land sections of the PSSR.

6.2 Policy context

6.2.1 The principal legislative and planning context for the assessment of the effects of the Scheme on geology and soils is presented below.

National Planning Policy

6.2.2 Planning Policy Wales (PPW) (Edition 12, February 2024)[4] sets out the land use planning policies of the Welsh Government. PPW provides a mechanism for managing contaminated sites through the planning process such that, once developed, the land cannot be determined as "contaminated land" under Part 2A of the Environmental Protection Act 1990[5] and is suitable for its intended use.

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[1] Design Manual for Roads and Bridges LA 109 Geology and Soils. Revision 0, 2019. Available at: LA 109 - Geology and soils (standardsforhighways.co.uk). Accessed September 2024

[2] Environment Agency. Land Contamination Risk Management (LCRM), 2023. Available at: https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm. Accessed September 2024

[3] Mott MacDonald. 2018. A494 River Dee Bridge Improvement – Preliminary Sources Study Report, ref. 395318-0044-B, dated 06/09/2018.

[4] Welsh Government (2024):Planning Policy Wales Edition 12 Available at: Planning Policy Wales - Edition 12 (gov.wales) Accessed September 2024

[5] Welsh Government (2012): Contaminated Land Statutory Guidance - 2012*, ref: WG19243*

Local Planning Policy

Flintshire County Council Local Development Plan 2015 to 2030

6.2.3 The Local Development Plan (the Plan) for Flintshire County Council (FCC) is currently in preparation; in advance of the final plan, topic papers were presented for relevant issues that the Plan will address, as well as possible approaches to be incorporated in the Plan.

Unstable and Contaminated Land

6.2.4 The planning system should guide development to lessen the risk from natural or human made hazards, including the risks from land instability and land contamination. The aim is to ensure that development is suitable on such land and that the physical constraints, including the impacts of climate change, are taken into account (recognising that responsibility rests with the developer).

6.2.5 For contaminated land, the Plan will need to take into account:

1. new development only being undertaken where there is an understanding of the risks;
2. not permitting or allocating development unless appropriate mitigation is in place; and
3. understanding the impacts of remediation on the natural and historic environment.

6.2.6 For unstable land, the Plan will require that:

1. new development is not undertaken without an understanding of the risks;
2. development does not take place without appropriate precautions;
3. development is not allowed if expensive engineering projects, which have implications for the public purse, will be required; and
4. unstable land is restored to safeguard investment and, where practicable, a return to productive use.

Waste Topic Paper No5 & No6 – Summary[6]

6.2.7 FCC has a large number of closed landfill sites. Development on such sites can bring with it associated risks due to the release of gas, leachate and issues relating to stability.

6.2.8 The Plan will ensure that risks posed by active or former landfill sites are minimised by directing sensitive development away from inappropriate sites.

6.2.9 Issues to be addressed by the Plan which may be relevant to the Scheme include:

1. balance the need to safeguard minerals of economic importance with the need for growth;
2. ensure legacies left by mining and issues of land instability are addressed where necessary;
3. protect areas of importance to the natural environment and built heritage from inappropriate mineral development;
4. encourage the sustainable use of minerals and the use of recycled materials; and
5. ensure risks posed by active or former landfill sites are minimised by directing sensitive development away from inappropriate sites.

[6] Flintshire Local Development Plan (February 2015) Waste Topic Paper No 5 – Summary - http://www.flintshire.gov.uk/en/PDFFiles/Planning/Topic-papers/Waste.pdf Accessed September 2024

6.3 Relevant guidance

Design Manual for Roads and Bridges (DMRB) LA 109 Geology and Soils (2019)

6.3.1 This assessment would be prepared in accordance with the DMRB LA 109 Geology and Soils and has also made reference to DMRB LA 113 Road drainage and the water environment[7] and Chapter 7 (Road Drainage and Water Environment). The environmental assessment covers geology, soil quality (including agricultural land as a national resource), as well as the effects from contamination on human health, surface water and groundwater as outlined in Section 1.4 of the DMRB LA 109.

Contaminated Land Guidance Documents

6.3.2 The framework for the assessment of potential land contamination is presented in LCRM. Specific guidance on related issues is provided in:

- Environmental Protection Act 1990: Part 2A, Contaminated Land Statutory Guidance;
- Environment Agency (2023). Land Contamination Risk Management (LCRM)[8]
- Updated technical background to the CLEA Model[9];
- BS 10175:2011+A2:2017, Investigation of Potentially Contaminated Sites. Code of Practice[10;]
- BS 8485:2015+A1:2019, Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings[11]; and
- Groundwater protection guides covering: requirements, permissions, risk assessments and controls (previously covered in GP3)[12].

6.4 Assessment methodology

6.4.1 This section describes the assessment of geology and soils (including groundwater and contaminated land) which may affect or be affected by the construction of the Scheme.

Assessment of sensitivity

6.4.2 The sensitivity (value) of receptors has been determined according to descriptions provided within Table 6-1.

Table 6-1: Criteria for evaluating the value (sensitivity) of receptors

Receptor value (sensitivity)	Criteria	Description
Very high	International scale: Very high importance and rarity and very	**Geology**: Very rare and of international importance with no potential for replacement (e.g. UNESCO World Heritage Sites,

[7] National Highways (2020). LA 113 – Road drainage and the water environment Revision 1 [online]. Available at: LA 113 - Road drainage and the water environment (standardsforhighways.co.uk) Accessed September 2024.

[8] Environment Agency (2023). Land Contamination Risk Management [online] available at: Land contamination risk management (LCRM) - GOV.UK (www.gov.uk). Accessed September 2024.

[9] Environment Agency (2009) Updated technical background to the CLEA Model, Report ref. SC050021/SR3.

[10] British Standard (2017) BS 10175:2011+A2:2017, Investigation of Potentially Contaminated Sites. Code of Practice.

[11] British Standard (2015) BS 8485:2015+A1:2019, Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.

[12] Environment Agency (2017) Groundwater protection guides covering: requirements, permissions, risk assessments and controls (previously covered in GP3).

Receptor value (sensitivity)	Criteria	Description
	limited potential for substitution	UNESCO Global Geoparks, (SSSIs) and Geological Conservation Review (GCR) sites where citations indicate features of international importance). Geology meeting international designation citation criteria which is not designated as such. **Soils**: 1) Soils directly supporting a site within the National Site Network (e.g. Special Area of Conservation (SAC), Special Protected Area (SPA)), or a Ramsar. 2) ALC grade 1 & 2. **Contamination**: 1) Human health: very high sensitivity land use such as residential or allotments. 2) Surface water: Watercourse having a Water Framework Directive (WFD) classification shown in a RBMP and Q_{95} ≥1.0m^3/s. Site protected/designated under legislation (SAC, SPA, SSSI, Ramsar site, salmonid water)/species protected by legislation. 3) Groundwater: Principal aquifer providing a regionally important resource and/or supporting a site protected under legislation. Groundwater locally supports Groundwater Dependent Terrestrial Ecosystems (GWDTE). Source Protection Zone 1 (SPZ1).
High	National scale: High importance and rarity, limited potential for substitution	**Geology**: Rare and of national importance with little potential for replacement (e.g. geological SSSI, Area of Special Scientific Interest (ASSI), National Nature Reserves(NNR)). Geology meeting national designation citation criteria which is not designated as such. **Soils**: 1) Soils directly supporting a UK designated site (e.g.SSSI). 2) ALC grade 3a. **Contamination**: 1) Human health: high sensitivity land use such as public open space. 2) Surface water: Watercourse having a WFD classification shown in a RBMP and Q_{95} <1.0m^3/s. Species protected under legislation 3) Groundwater: Principal aquifer providing locally important resource or supporting a river ecosystem. Groundwater supports a (GWDTE). Source Protection Zone 2 (SPZ2)
Medium	Regional scale: Medium quality and rarity	**Geology**: Of regional importance with limited potential for replacement (e.g. RIGS). Geology meeting regional designation citation criteria which is not designated as such.

Receptor value (sensitivity)	Criteria	Description
		Soils: 1) Soils supporting non-statutory designated sites (e.g. Local Nature Reserves (LNR), Local Geological Sites (LGSs), Sites of Nature Conservation Importance (SNCIs)). 2) ALC grade 3b. **Contamination**: 1) Human health: medium sensitivity land use such as commercial or industrial. 2) Surface water: Watercourses not having a WFD classification shown in a RBMP and Q_{95}>0.001m^3/s. 3) Groundwater: Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ3.
Low	District scale: Low quality and rarity	**Geology**: Of local importance/interest with potential for replacement (e.g. non designated geological exposures, former quarries/mining sites). **Soils**: 1) Soils supporting non-designated notable or priority habitats. 2) ALC grade 4 & 5. **Contamination**: 1) Human health: low sensitivity land use such as highways and rail. 2) Surface water: Watercourses not having a WFD classification shown in a RBMP and Q_{95} ⩽0.001m^3/s. 3) Groundwater: Unproductive strata.
Negligible	Local scale: Very low importance and rarity	**Geology**: No geological exposures, little or no local interest. **Soils**: Previously developed land formerly in 'hard uses' with little potential to return to agriculture. **Contamination**: 1) Human health: undeveloped surplus land or no sensitive land use proposed.

Source: LA109 and LA113

Magnitude of impact

6.4.3 The magnitude of impact includes consideration of its timing, scale, size, and duration. The qualitative magnitude of each impact (in the absence of quantitative data) has been determined according to the descriptions provided in Table 6-2.

Table 6-2: Magnitude of impact and typical descriptions

Magnitude of impact (change)	Typical description	
Major	**Geology**: Loss of geological feature, designation, quality or integrity, severe damage to key characteristics, features or elements. **Soils**: Physical removal or permanent sealing of >20 hectares of agricultural land. **Contamination:** Human health: Significant contamination identified. Contamination levels significantly exceed background levels and relevant screening criteria (e.g. category 4 screening levels) with potential for significant harm to human health. Contamination heavily restricts future use of land.	
	Major Adverse	**Major Beneficial**
	Surface Water: Failure of acute-soluble and chronic-sediment related pollutants in Highways England Water Risk Assessment Table (HEWRAT) and compliance failure with Ecological Quality Standards (EQS) value. Calculated risk of pollution from a spillage ≥2% annually (spillage assessment). Loss or extensive change to a fishery. Loss of regionally important public water supply. Loss or extensive change to a designated nature conservation site. Reduction in water body WFD classification. Groundwater: Loss of, or extensive change to, an aquifer. Loss of regionally important water supply. Potential high risk of pollution to groundwater from routine runoff – risk score >250 (Groundwater quality and runoff assessment). Calculated risk of pollution from spillages >2% annually (spillage assessment). Loss of, or extensive change to GWDTE or baseflow contribution to protected surface water bodies. Reduction in water body WFD classification. Loss of significant damage to major structures through subsidence or similar effects.	Surface Water: Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring to a watercourse. Improvement in water body WFD classification. Groundwater: Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring. Recharge of an aquifer. Improvement in water body WFD classification.

<table>
<tr><th>Magnitude of impact (change)</th><th colspan="2">Typical description</th></tr>
<tr><td rowspan="2">Moderate</td><td colspan="2">Geology:
Partial loss of geological feature or designation, potentially adversely affecting the integrity; partial loss of or damage to key characteristics, features or elements.
Soils:
Physical removal or permanent sealing of 1 – 20 hectares of agricultural land; or
Permanent loss or reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource).
Contamination:
Human heath: contaminant concentrations exceed background levels and are in line with limits of relevant screening criteria (e.g. category 4 screening levels). Significant contamination can be present. Control or remediation measures are required to reduce risks to human health and make land suitable for intended use.</td></tr>
<tr><td>Moderate Adverse
Surface water: Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT but compliance with EQS values. Calculated risk of pollution from spillages ≥1% annually and <2% annually. Partial loss in productivity of a fishery. Degradation of regionally important public water supply or loss of major commercial/industrial/agricultural supplies. Contribution to reduction in water body WFD classification.

Groundwater: Partial loss or change to an aquifer. Degradation of regionally important public water supply or loss of significant commercial/industrial/agricultural supplies. Potential medium risk of pollution of groundwater from routine runoff – risk score 150 – 250. Calculated risk of pollution from spillages ≥1% annually and <2% annually. Partial loss of the integrity of GWDTE. Contribution to reduction in water body WFD classification. Damage to major structures through subsidence or similar effects or loss of minor structures.</td><td>Moderate Beneficial
Surface water: HEWRAT assessment of both acute-soluble and chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. Calculated reduction in existing spillage by 50% or more (when existing spillage risk >1% annually). Contribution to improvement in water body WFD classification.

Groundwater: Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is >1% annually). Contribution to improvement in water body WFD classification. Improvement in water body catchment abstraction management Strategy (CAMS) (or equivalent) classification. Support to significant improvements in damaged GWDTE.</td></tr>
</table>

Magnitude of impact (change)	Typical description	
Minor	**Geology**: Minor measurable change in geological feature or designation attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. **Soils**: Temporary loss or reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource. Contamination: **Human health**: Contaminant concentrations are below relevant screening criteria (e.g. category 4 screening levels). Significant contamination is unlikely with a low risk to human health. Best practice measures required to minimise risks to human health.	
	Minor Adverse Surface water: Failure of either acute-soluble or chronic-sediment related pollutants in HEWRAT. Calculated risk of pollution from spillages ≥0.5% annually and <1% annually. Minor effects on water supplies. Groundwater: Potential low risk of pollution to groundwater from routine runoff – risk score <150. Calculated risk of pollution from spillages ⩾0.5% annually and <1% annually. Minor effects on aquifer, GWDTEs, abstraction, and structures.	**Minor Beneficial** Surface water: HEWRAT assessment of either acute-soluble or chronic-sediment related pollutants becomes pass from an existing site where the baseline was a fail condition. Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <1% annually). Groundwater: Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk <1% annually). Reduction of groundwater hazards to existing structures. Reductions in waterlogging and groundwater flooding.
Negligible	**Geology**: Very minor loss or detrimental alteration to one or more characteristics, features or elements of geological feature or designation. Overall integrity of resource not affected. **Soils**: No discernible loss or reduction (<1 hectare) of soil function(s) that restrict current or approved future use. **Contamination**: Human health: contaminant concentrations substantially below levels outlined in relevant screening criteria (e.g. Category 4 Screening Levels). No requirement for control measures to reduce risks to human health or to make land suitable for intended use. Surface water: No risk identified by HEWRAT (pass both acute-soluble and chronic-sediment related pollutants). Risk of pollution from spillages <0.5%. Groundwater: No measurable impact on aquifer and/or groundwater receptors and risk of pollution from spillages.	

Magnitude of impact (change)	Typical description
No change	**Geology**: No temporary or permanent loss/disturbance of characteristics features or elements. **Soils**: No loss/reduction of soil function(s) that restrict current or approved future use. **Contamination**: Human health: reported contaminant concentrations below background levels. Surface water: No loss or alteration of characteristics, features, or elements; no observable impact in either direction. Groundwater: No loss or alteration of characteristics, features, or elements; no observable impact in either direction.

Source: Adapted from Table 3.12 of LA109 Geology and Soils and Road drainage and water environment LA 113

Assessment of significance of effect

6.4.4 In accordance with DMRB LA 109 Geology and Soils Section 3.14, deriving the significance of effect from the receptor value and the magnitude of impact has been undertaken in accordance with DMRB LA 104 'Environmental Assessment and Monitoring'. Subsequent to identifying an appropriate receptor sensitivity and magnitude of impact using Table 6-1 and Table 6-26.2, the likely significance category and overall significance of effects is identified, as shown in Table 6-3. The approach to assigning significance of effect relies on reasoned argument, the professional judgement of competent experts and using effective consultation to ensure the advice and views of relevant stakeholders are taken into account. Effects of moderate significance and above (adverse and beneficial) are considered 'significant'.

Table 6-3: Criteria for assessing significance of effect

		Magnitude of impact (degree of change)				
		No change	Negligible	Minor	Moderate	Major
Environmental value (sensitivity)	Very High	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	High	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
	Medium	Neutral	Neutral or slight	Slight	Moderate	Moderate or Large
	Low	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or Moderate
	Negligible	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight

Source: Adapted from DMRB LA 104 - Section Environmental assessment and monitoring Revision 1: Table 3.8.1

6.5 Baseline conditions

6.5.1 Throughout this section, reference is made to geology and soils features located in the vicinity of the Scheme. Please see Figures 6-1 to 6-4 which visually display the location of the features discussed in this section in relation to the Scheme and current baseline mapping including the location of geological, hydrological and hydrogeological receptors.

6.5.2 Where publicly available data has been utilised, the references are included as footnotes.

Study area

6.5.3 DMRB LA 109 states that the study area shall be defined on a project-by-project basis defined through professional judgement, based on the type and scale of the Scheme and the context of the surrounding area. The study area for the assessment of geology and soils encompasses the area over which the Scheme could be reasonably expected to have an effect. With respect to geology and soils, this generally only relates to the areas anticipated to be directly disturbed by the proposed physical works and ground disturbance.

6.5.4 The study area for contamination comprises the scheme boundary and an additional buffer of 500m. This area is considered appropriate for the consideration of historical and current potentially contaminative land uses and pollution incidents. It also considers potential contamination sources outside the scheme area which have the potential to migrate to the Scheme area (areas of landfill or historical potentially contaminative land use, for example) and any sensitive receptors which may feasibly be affected by the uncontrolled migration of contaminants outside the Scheme area.

Geological setting

6.5.5 A number of BGS published maps, geological memoirs and technical documents have been referenced within the PSSR to assess the geology of the Scheme.

6.5.6 An extract of the bedrock and superficial geological maps from the BGS of the area are shown in Figure 6-1 and Figure 6-2.

Figure 6-1: Superficial Geology

Due to size this Figure is included in Appendix A.3.

Figure 6-2: Bedrock Geology

Due to size this Figure is included in Appendix A.3.

Superficial deposits

6.5.7 The superficial deposits comprise:

1. Tidal Flat Deposits: Present across the entire Scheme, following the historical route of the River Dee. Described as organic-rich clay, silt, sand and gravel. Reported up to a maximum thickness of 16.3m, with deposits beneath the Scheme approximately 15m thick, thinning westward towards the railway bridge where deposits are approximately 9m thick.
2. Glacial Till: Present at the surface south-west of the Scheme, expected to underlie the Tidal Flat Deposits. Described as a variable lithology, usually a sandy, silty clay with pebbles. Proven to a depth of at least 27m, the base was not proven during the ground investigation.

6.5.8 The available information indicates that the Scheme is generally underlain by Tidal Flat Deposits at the surface, with Glacial Till only present at the surface in the south-west. Where Glacial Till is not present at the surface it is expected to be present beneath the Tidal Flat Deposits over the entire Scheme extents.

Solid geology

6.5.9 The bedrock geology consists of the Etruria Formation, Middle Coal Measures and Lower Coal Measures. The bedrock has been disrupted by faulting that is pervasive across the region.

6.5.10 In more detail, the bedrock geology comprises (in order of youngest to oldest):

1. Etruria Formation (formerly: Ruabon Marl Formation): Located to the east of the Scheme. A mottled mudstone with lenticular sandstones and conglomerates.
2. Pennine Coal Measures:
   a. Middle Coal Measures: Present to the north of the River Dee Bridge and east / south-east of the study area. Lies beneath the younger Etruria Formation. An interbedded grey mudstone, siltstone and sandstone with commonly occurring coal seams.
   b. Lower Coal Measures: Present across the entire Scheme area south of the River Dee Bridge, beneath the Middle Coal Measures. An interbedded grey mudstone, siltstone and sandstone, commonly with mudstones containing marine fossils in the lower part; more numerous and thicker coal seams in the upper part.

6.5.11 Ground conditions reported in the PSSR did not prove the base of the superficial deposits beneath the Scheme. Glacial Till was proven to at least 27m below ground level (bgl) in one borehole during a previous ground investigation[13].

Structural geology

6.5.12 The Etruria Formation lies unconformably over the Middle Coal Measures. To the east of the study area the Etruria Formation has been downthrown against the Middle Coal Measures. At the River Dee Bridge there is a fault that runs approximately south-east to north-west where the Middle Coal Measures to the north have been downthrown against the Lower Coal Measures.

Mining and quarrying

6.5.13 The PSSR identified that the Scheme lies in a primary opencast coal resource area due to the presence of shallow coal seams beneath the site. It is also shown that, coincident with the shallow coal, fireclay and brick clay are also present which may have been extracted. Several coal seams and mining locations are present along the A494 south of the Queensferry Interchange. A Coal Authority Report[14] included in the geotechnical report undertaken in 2008 indicates that no coal seams or mining locations are located within the study area. There are no records of any claims for subsidence or known shallow mine workings. The superficial deposits beneath the Scheme are proven to a thickness of at least 27m and so it is not anticipated that shallow mining will have taken place. A plan of the potential historical mining and stability issues within 500m of the Scheme are shown in Figure 6-7.

Figure 6-7: Stability and Mine Entries

Due to size this Figure is included in Appendix A.3.

[13] Faber Maunsell. AECOM, A494 Drome Corner to Ewloe Improvements Geotechnical Report, Report Number 36057M/0015, April 2008

[14] The Coal Authority. 2005. Coal Mining Report – Land at A494 Connah's Quay, dated 19th July 2005, ref. 00019583-05.

6.5.14 The Interactive Coal Authority Map[15] of the area confirmed the presence of a surface coal resource area covering the extent of the Scheme. The map also identified the location of high-risk development areas and former shallow workings south of Queensferry.

Topography

6.5.15 The banks of the River Dee sit at approximately 5m above ordnance datum (AOD). The river was realigned in 1737 to form a straight channel from Chester to the river mouth. The original course of the river ran to the north of its current position from Chester through Sealand and Burton. To the north-east of the river the land continues to lie flat at 5mAOD. To the southwest of the river, the elevation gradually rises to 10mAOD at Queensferry Interchange. Past this point the elevation increases more steeply towards the south-west.

Hydrology

6.5.16 The River Dee is a major watercourse running through the Scheme at its eastern end. The river is tidal in the vicinity of the Scheme. The bed of the river rises from the mouth of the estuary, in the north-west, to Chester in the south-east.

Hydrogeology

6.5.17 An extract of the aquifer designation maps of the area are shown in Figure 6-3 and Figure 6-4.

Figure 6-3: Aquifer Designations Superficial

Due to size this Figure is included in Appendix A.3.

Figure 6-4: Aquifer Designations Bedrock

Due to size this Figure is included in Appendix A.3.

6.5.18 The Pennine Coal Measures are described as a Secondary A Aquifer which suggests that there could be some movement of groundwater through the permeable sandstone layers, whilst the permeability will be reduced through the predominant mudstone layers. The extensive faulting in the area is likely to provide groundwater pathways.

6.5.19 The superficial Glacial Till is described as a Secondary (Undifferentiated) Aquifer, vertical movement of groundwater would likely be impeded by the impermeable clay layers that are interbedded with the granular material. There would likely be stronger horizontal flow paths through the granular layers.

6.5.20 Secondary aquifers are capable of supporting water supplies at a local rather than strategic scale and, in some cases, form an important source of base flow to rivers.

Soil quality (including agricultural land as a national resource)

6.5.21 An extract of the predictive agricultural land classification maps of the area are shown in Figure 6-5.

Figure 6-5: Agricultural Land Classification

Due to size this Figure is included in Appendix A.3.

[15] The Coal Authority. 2018. The Coal Authority – Interactive Map. Available at: The Coal Authority Map Viewer (arcgis.com)l Accessed September 2024

6.5.22 One post-1988 ALC survey[16] was undertaken east of the Scheme between the A494 and Manor Road (Ferry Bank Farm, Sealand (1995) 054-95). Within the extents of the surveyed area it was confirmed that the majority of the land is Grade 2 (best and most versatile land), with smaller pockets of Non-Agricultural in areas of drains. Predictive ALC maps for Wales indicate that much of the land within the Scheme area is Urban except for a parcel of land south-east of the A494 between Fox's Drive and the River Dee, adjacent to the surveyed parcel of land and is similarly designated as ALC Grade 2 on the predictive maps.

6.5.23 An Agricultural Land Classification survey for the area proposed for the construction Site Compound south-east of the A494 was undertaken in 2019. The report classified the satellite compound area as comprising exclusively Grade 1 ('Excellent') soil resources.

Geologically sensitive sites

6.5.24 Data Map Wales[17] provided by the Welsh Government does not identify any geological conservation sites within the vicinity of the Scheme study area. The superficial deposits are up to 27m thick; therefore no important geological exposures are anticipated to be present.

Potential contamination risks

6.5.25 The PSSR discussed the findings of the A494 Drome Corner to Ewloe Improvements Geotechnical Report which included an assessment of background information. Adjacent to the eastern bank of the River Dee is a section where contamination is likely to be present due to historic potentially contaminative activities including coal storage, ship building, chemical works and a tank cleaning operation. Extensive ground and groundwater contamination has been reported for the former Neston Tank Cleaning site, immediately south of the River Dee. The contaminated land risk assessment undertaken for the A494 Access Road[18] undertook a review of available data along the proposed access road immediately south of the Scheme within the footprint of the former Queensferry Chemical Works. The report highlights:

1. The intensive industrial heritage of the Neston site, including the Queensferry Chemical Works and subsequent industries, left a significant legacy of contamination across the Site.
2. Remediation was undertaken between 1994 and 1995 comprising bulk removal of contaminated material and placement of a 1050mm stone capping layer.
3. Despite the remediation completed, there is the potential that other, deeper, areas of contamination (contamination of the Marine Deposits down to 10m bgl was discussed in previous reporting) may still be present beneath the 1050mm thick capping layer.
4. Groundwater beneath the Site is reported to be contaminated.
5. The northern section of the NTCS is now in use as a gypsy traveller site with hardstanding and service buildings, the southern two-thirds comprises derelict land and is currently a disused car scrap yard.

6.5.26 The geotechnical report identified isolated shallow soil contamination in two areas along the Scheme area; St. David's Park Interchange and Garners Yard Area. The report concluded that the contamination does not pose a significant risk to human health and is not pervasive across the Scheme.

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[16] Welsh Government, Data Map Wales – Post 1988 Agricultural Land Classification (Wales) Surveys - Boundary, Available at New map | DataMapWales (gov.wales), Accessed September 2024

[17] Welsh Government, Data Map Wales, Available at New map | DataMapWales (gov.wales), Accessed September 2024

[18] Mott MacDonald. 2018. A494 River Dee Bridge Chemistry Lane Access Road – Phase 1 Contaminated Land Risk Assessment, ref.395318-0057-A.

6.5.27 The geotechnical report only identified groundwater contamination in the sand and gravels of the glacial deposits in the vicinity of the former Neston site and Garners Yard. The sediments within the River Dee were not found to contain elevated concentrations of contaminants of potential concern.

6.5.28 No landfills are located within 500m of the Scheme. Two pollution incidents were reported within 1km of the Scheme; these both relate to air pollution incidents with no impact on land or water.

6.5.29 A plan of the potentially contaminative land uses and environmental incidents within 500m of the Scheme is shown in Figure 6-6.

Figure 6-6: Potentially Contaminated Land

Due to size this Figure is included in Appendix A.3.

Unexploded ordnance

6.5.30 An unexploded bomb risk map was requested as part of the PSSR. This map shows that the whole of the Scheme area is at a low risk from unexploded bombs. Although this initial search indicated a low risk, given the proximity of the site to potential military and industrial targets a more thorough UXO assessment was carried out which confirmed that the Scheme is within a low-risk area.

6.6 Potential and likely significant effects

6.6.1 The Scheme includes a range of construction activities which have the potential to result in adverse or beneficial effects on geology and soils.

6.6.2 Principal construction activities of relevance to geology and soils are anticipated to include:

1. excavation works – resulting in the permanent removal of shallow deposits (soils, Made Ground and superficial deposits) and the potential to disturb contaminated materials
2. earthworks – resulting in waste generation and the disturbance of groundwaters, the generation of excavations which will require dewatering and ground gas risks
3. general construction works – the storage of hazardous chemicals leading to secondary effects on soils and groundwater; and
4. foundation works – piling or penetrative ground improvement as part of foundation construction may pose risks to controlled waters along with environmental risks relating to the use of concrete in construction.

Construction

Geology

6.6.3 The effects on geology during construction activities are considered to be negligible. No Regionally Important Geological / Geomorphological Sites or important outcrops are present within the vicinity of the Scheme.

Soils

6.6.4 Site construction may lead to the temporary and permanent removal of agricultural soils, topsoil or subsoil material. In addition, soil deterioration and consolidation may occur due to vehicle movements and loading, leading to adverse effects. ALC Grade 1 and predicted Grade 2 soils are present adjacent to the Scheme east of the River Dee in an area proposed for use as a satellite compound.

Contamination

6.6.5 Contaminant mobilisation during Scheme construction activities could potentially cause contamination of soils, groundwater and surface water. This will be particularly prevalent in the vicinity of any Made Ground and the former chemical works. The contamination of soils, groundwater and surface water could also occur through accidental spills and leaks relating to construction plant and fuels / oils.

6.6.6 There is the potential for the discharge of contaminated or sediment laden groundwater to watercourses following dewatering of excavations or foundation works. During foundation works (piling for example), given the presence of the underlying Secondary Aquifer within the superficial deposits, there is the potential for the creation of contamination pathways or driving down of contaminants presenting a risk to groundwater along with the potential for increased turbidity and quality deterioration within the aquifers which would result in adverse effects.

6.6.7 During foundation works within the River Dee there is the potential for significant disturbance of the river bed and silt agitation, which could distribute river sediments downstream.

6.6.8 The removal or remediation of any areas of contaminated soils identified would potentially have a beneficial effect.

Operation

6.6.9 The effects of the operation of the existing A494 will not significantly change following development of the Scheme. Consideration of the operational effects of the Scheme on geology and soils is therefore not required.

Cumulative effects

6.6.10 The cumulative effects of the Scheme, in conjunction with other proposed developments, will be assessed and presented in Chapter 16 Cumulative Effects. Major developments considered for the cumulative effects assessment are set out in Table 6-46-4.

Table 6-4: Development considered for cumulative effects

Project	Type of Development	Main Effects
Northern Gateway	Mixed Use Development	Traffic generation, drainage to the River Dee, pedestrian and cycle trips, loss of open grassland foraging for wildlife

Inter-relationships

6.6.11 Inter-relationships refer to the combined effect on individual (or groups of) receptors or resources from more than one source or type of environmental effect. There are no inter-relationships between the geology and soils receptors identified for the Scheme.

6.7 Mitigation and enhancements

6.7.1 The following general measures should be adopted during the construction stage to minimise effects upon geology and soils and to prevent significant impacts arising from contaminated land.

Construction Environmental Management Plan

6.7.2 An Outline Construction Environmental Management Plan (Outline-CEMP) would be produced to support the application and would be developed into a full Construction Environmental

Management Plan (CEMP) by the appointed Contractor. The CEMP will set out measures to be taken to prevent pollution of the surrounding area during potentially contaminative activities.

Protection of Soil Structure and Quality

6.7.3 The inclusion of a Soils Management Plan (SMP) within the CEMP will ensure works are undertaken in accordance with appropriate guidelines such as Defra's Code of Practice for the Sustainable Use of Soils on Construction Sites[19] and BS3882:2015[20], particularly in areas where the reinstatement of agricultural land would be required after construction.

6.7.4 Mitigation measures, in addition to topsoil and subsoil stripping and storage, include the use of a proprietary geotextile membrane to protect the existing ground condition where haul routes or site compounds and storage areas are located. A layer of inert crushed granular material placed on a geotextile membrane would form temporary running surfaces for construction plant and reinforcement of access tracks. Car parking and pedestrian areas could be bolstered with asphalt surfacing.

6.7.5 Where importation of topsoil is required for spreading on areas of newly constructed earthworks, this would be selected in accordance with BS3882:2015 to ensure that the topsoil provides suitable substrates for native plant species and to maximise biodiversity, in accordance with industry best practice.

Protection of Controlled Waters: General

6.7.6 Since the Scheme would be located across Secondary Aquifers in the superficial deposits and bedrock geology, there is a risk that the works would create pollution pathways to groundwater resources. To prevent contamination of the aquifer, the Contractor would take precautions, in line with all associated pollution prevention guidelines and best practice, to ensure that pollution of the aquifer cannot occur and new pathways for contaminant migration are not established when working in areas where Made Ground or contaminated materials are present.

6.7.7 Excavated materials would be managed in line with the requirements in the Outline-CEMP and eventual CEMP, including (but not limited to) the following measures:

- stockpiles would be located away from principal surface watercourses. The careful management of construction site drainage would be undertaken, including the use of cut-off ditches to collect site run-off, with run-off passed through settling lagoons or silt traps to allow removal of sediments prior to discharge. Where considered necessary, treatment plant would be made available on-site, including:
  - settlement tanks;
  - chemical dosing plant (addition of coagulants / flocculants to ensure slow settling solids can be removed);
  - concrete wash water treatment plant (designed to deal with high pH wash water from concrete construction works);
  - oil-water separators; and
  - materials separators (to separate and recover sand and gravel).
- management of excavated topsoil and subsoils would be in line with the guidance provided within the SMP. There would be clear segregation of materials with dust suppression measures

[19] Department for Environment, Food and Rural Affairs (2009) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites [online]. Available at: Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (publishing.service.gov.uk) Accessed September 2024

[20] Department for Environment, Food and Rural Affairs. 2015. BS3882:2015: Specification for topsoil and requirements for use. London.

and covers for stockpiles as necessary. Where stockpiles are long term, seeding would be considered to minimise soil being entrained in run-off water and being transported to drainage ditches;

- works would be monitored by a suitably qualified Site Environmental Clerk of Works, to be responsible for identifying and approving all methods of pollution control; and
- an auditing programme would be implemented to verify environmental performance.

Protection of Controlled Waters: Foundation Works

6.7.8 Since construction would be undertaken over Secondary Aquifers, there is a risk that excavation and foundation works could create vertical pollution pathways.

6.7.9 Where piling or penetrative ground improvement is required, the works would be carried out in accordance with EA guidance [21,22].

6.7.10 Where piling or penetrative ground improvement is required in areas of residual contamination, a foundation works risk assessment will be undertaken to determine the likely effects relating to the driving of piles through any contaminated Made Ground or landfilled materials and into the underlying Secondary Aquifers and to identify what mitigation measures are appropriate for the site. These would include:

- selection of pile design to minimise pathway creation at soil-pile interface and appropriate choice of piling method;
- selection of a suitable class of concrete; and
- use of temporary casing to protect groundwater from contact with grout and fines generated during boring.

6.7.11 The pouring of concrete or use of chemicals could result in the contamination of site soils and associated pollution entering the underlying Secondary Aquifers, surface water drains or the River Dee. Therefore, appropriate measures would be included within the Contractor’s method statement for the protection of the environment reflecting guidance in the CEMP, including the batching of concrete only in designated impermeable areas with a segregated drainage system, placement of temporary bunds down-slope to contain any spillages and the development of a spill response protocol.

6.7.12 The discharge of potentially contaminated groundwater would be appropriately managed by the Contractor through the use of appropriate treatment prior to discharge.

Management of Construction Plant and Materials

6.7.13 Working method statements would be in place during construction reflecting the guidance within the CEMP to ensure environmentally safe working practices on-site with respect to the underlying ground and groundwater. These would include (but not be limited to):

- the storage of oil, fuel and other potentially hazardous substances would be located within a secure site compound located on a hardstanding area. Storage of these substances would be within an appropriately bunded area (110% of total capacity volume);

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[21] Environment Agency (2002) *Piling into contaminated sites. National Groundwater and Contaminated Land Centre Report* [online] available at: http://webarchive.nationalarchives.gov.uk/20140329082414/http://cdn.environment-agency.gov.uk/scho0202bisw-e-e.pdf (last accessed November 2018).

[22] Environment Agency (2001) *Piling and penetrative ground improvement methods on land affected by contamination: guidance on pollution prevention*. National Groundwater and Contaminated Land Centre Report NC/99/72 [online] available at: http://www.merseygateway.co.uk/publicinquirydocs/Core-docs/CD-256.pdf (last accessed November 2018).

- there would be a designated refuelling and maintenance area and concrete batching area located on impermeable hardstanding with drainage treated appropriately;
- regular inspections of site plant would be carried out and the use of drip trays and training in the location and use of spill kits and emergency spillage procedures would be provided for site workers. Action Plans would be in place to effectively deal with any contamination issues during construction, for example spillages and leaks from construction plant; and
- wheel washing facilities with a wash water treatment system in place would be utilised to prevent the transfer of site soils to adjacent roads and best practice dust suppression methods would be employed on-site to prevent soil erosion.

6.7.14 Adjacent areas outside the development boundary would be protected by site fencing to prevent accidental encroachment and damage of topsoil.

Excavations and Dewatering

6.7.15 Excavations below ground level may require dewatering of run-off waters, perched waters or groundwaters from the underlying Secondary Aquifers. This water would be managed on-site through the use of appropriate treatment prior to discharge.

6.7.16 Discharge to surface waters may require an environmental permit and also a land drainage consent if the discharge requires the construction of a new culvert in an ordinary watercourse.

6.7.17 If contamination is present or suspected, on-site treatment or off-site disposal may be required and would be detailed within a Remediation Strategy.

Management of Contamination Risks

6.7.18 Central to planning guidance is the requirement that, following development, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the EPA. PPW also provides guidance on the implementation of contaminated land and pollution management requirements to address contamination risks associated with future site uses. The Land Contamination Risk Management (LCRM) guidance[9] details the steps that will need to be followed as the Scheme is progressed through the development and planning process. These steps include the production of a Preliminary Risk Assessment and completion of an appropriate ground investigation, tiered stages of risk assessments together with an assessment of unacceptable pollutant linkages. Where such linkages are found then a remediation options appraisal and strategy will be produced. Any remediation works required to manage contamination risk will be agreed with the LPA and Natural Resources Wales. Remediation will need to be completed and verified before completion of the project.

6.7.19 The ground investigations undertaken have confirmed the Neston site as containing residual concentrations of contaminants at depth. Construction of the new road on embankment across this area is not expected to present a significant impact; the contamination is present at depth and will not be disturbed.

6.7.20 Where excavations are required, arisings will be managed as waste. The Contractor will develop a method statement which would include specific instructions in relation to:

1. the control of excavation, separation, handling and storage activities to ensure that those soils identified as contaminated are not combined with uncontaminated soil;
2. the on-site treatment of contaminated material, if appropriate, to allow re-use as appropriate thereby minimising the amount for off-site disposal; and
3. the issue of appropriate health and safety procedures when working with contaminated materials.

6.7.21 Risks to construction and maintenance workers would be mitigated through risk assessments undertaken by the Contractor, specific to the works, in order to identify risks and appropriate mitigation measures in line with all relevant health and safety legislation and guidance.

6.7.22 In addition, it is the responsibility of the producer to implement the following measures to mitigate risks associated with potentially contaminated materials:

- ensure that all material created on-site undergoes basic characterisation prior to reuse / disposal. To ensure on-site waste management is in line with best practice and the waste hierarchy, the following would be implemented:
  - full characterisation of soil and macadam samples in accordance with Guidance on the Classification and Assessment of Waste[23] and determine whether re-use of the soils within the Scheme earthworks could be safely achieved; and
  - once waste characterisation has been undertaken, the completion of Waste Acceptance Criteria (WAC) testing, where necessary, to establish the acceptability of hazardous, hazardous non-reactive and inert wastes for landfill disposal. Every effort would be made to minimise waste to be landfilled with treatment at an appropriate facility or on-site treatment hub considered in the first instance.

6.7.23 Hazardous substances such as excavated contaminated land, fuels, chemicals, waste and construction materials would be stored, handled, transported and disposed of in accordance with the CEMP and SWMP.

6.7.24 Similar methodologies would also be employed during the selection of any fill for import. Greater detail in respect of proposed screening and testing of imported materials is provided in Chapter 14 Materials.

Works in Areas of Historic Landfills, Infilled Quarries or Made Ground

6.7.25 It is anticipated that works would be undertaken crossing areas of Made Ground, commercial and agricultural land and in the proximity of off-site industrial / commercial land uses. A road construction project would not be considered sensitive to residual contamination present within any areas of made ground.

Enhancement measures

6.7.26 The removal / remediation of any areas of contaminated soils would result in a beneficial effect from the Scheme.

6.7.27 There are limited opportunities for additional enhancement in relation to geology and soils for the Scheme.

Monitoring

6.7.28 Any monitoring requirements in relation to contaminated land would be included within any Remediation Strategy.

6.7.29 Any monitoring requirements in relation to geological stability and geotechnical issues would be included in the future geotechnical assessment.

[23] Environment Agency (2015) WM3 *Waste Classification – Guidance on the classification and assessment of waste* (1st Edition v1.1): Technical Guidance [online] available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/427077/LIT_10121.pdf (last accessed November 2018).

6.7.30 Monitoring and aftercare requirements for soil reinstatement will be included within a soil management plan.

Description of likely significant effects

6.7.31 Table 6-5 summarises the assessment of effects, showing the potential effect identified and appropriate mitigation measures for the specified receptor. The receptor sensitivity and magnitude of impact have been estimated, followed by the identification of the significance of effects after mitigation.

Table 6-5: Assessment of likely significant construction effects

Receptor	Sensitivity / Value	Summary of Effects	Magnitude	Mitigation (Section 6.7 paragraph references including compliance mechanisms)	Significance of Effect (with Mitigation)
Geology	Negligible	No Regionally Important Geological / Geomorphological Sites or rock exposures are present within the vicinity of the Scheme.	No Change	N/A	Neutral
Soils (ALC grade 1 and grade 2 land)	Very High	Site construction may lead to the temporary and permanent removal of agricultural soils, topsoil or subsoil material. Soil deterioration and consolidation may occur due to vehicle movements and loading, leading to adverse effects. Grade 1 and Grade 2 ALC soils are present south of the A494 between the River Dee and Sealand Road.	Minor Adverse (Temporary loss or reduction of one or more soil functions)	Environmental Management Plan Protection of Soil Structure and Quality Soil Management Plan (SMP)	Slight Adverse
Contamination: Human health	Low – Medium	Contaminant mobilisation during construction could cause contamination of soils, groundwater and surface water, particularly in the vicinity of any Made Ground, tank washing facilities, former chemical works and other potential contamination sources. The contamination of soils, groundwater and surface water could also occur through accidental spills and leaks relating to construction plant and fuels / oils.	Minor Adverse (Significant contamination is unlikely with a low risk to human health).	Environmental Management Plan Dust Suppression Protection of Controlled Waters: *General* Management of Construction Plant and Materials Excavations and Dewatering	Neutral/ Slight – Slight Adverse

Receptor	Sensitivity / Value	Summary of Effects	Magnitude	Mitigation (Section 6.7 paragraph references including compliance mechanisms)	Significance of Effect (with Mitigation)
				Management of Contamination Risks Works in Areas of Historic Landfills, Infilled Quarries or Made Ground	
		The removal or remediation of any areas of contaminated soils identified would potentially have a beneficial effect.	Minor beneficial		Neutral/ Slight – Slight beneficial
Contamination: Surface Water (River Dee)	Very High	Potential for: Discharge of contaminated or sediment laden groundwater to watercourses following dewatering of excavations or foundation works.	Minor adverse	Environmental Management Plan Protection of Controlled Waters: General Management of Construction Plant and Materials Excavations and Dewatering	Slight Adverse
Contamination Groundwater (Secondary A Aquifer and Undifferentiated Aquifer)	Medium	Potential for: Creation of contamination pathways or driving down of contaminants during foundation / piling works; and	Minor adverse	Environmental Management Plan Protection of Controlled Waters: General Protection of Controlled Waters: Foundation Works	Slight Adverse

Receptor	Sensitivity / Value	Summary of Effects	Magnitude	Mitigation (Section 6.7 paragraph references including compliance mechanisms)	Significance of Effect (with Mitigation)
		increased turbidity and quality deterioration within the aquifers, which would result in adverse effects.		Management of Construction Plant and Materials Excavations and Dewatering	

6.8 Assumptions and limitations

6.8.1 This chapter is based on the current Scheme boundary, known ground conditions and knowledge of any potential contamination. The findings may be subject to change during Scheme development, should any previously unidentified contamination or unforeseen ground conditions become evident.

6.9 Conclusions of scoping

6.9.1 This chapter has provided an assessment of the potential effects of the proposed Scheme on geology and soils. The site baseline has been summarised and an assessment of potential effects completed with subsequent mitigation measures identified.

6.9.2 It is considered that the Scheme has the potential to result in construction stage adverse effects upon geology, soils and the associated environment, such as the potential for:

- soil deterioration and consolidation due to poor storage and handling;
- loss of ALC Grade 1 soils on agricultural land east of the River Dee;
- discharge of contaminated or sediment laden groundwater to watercourses following dewatering of excavations or foundation works;
- the creation of contamination pathways or driving down of contaminants presenting a risk to groundwater along with the potential for increased turbidity and quality deterioration within the aquifers;
- encountering contaminated materials within Made Ground, the mobilisation of contaminants, and the generation of contaminant transport pathways from site activities;
- contamination of soils, groundwater and surface water from accidental spills and leaks relating to construction plant and fuels / oils; and
- removal / remediation of any areas of contaminated soils identified (beneficial effect).

6.9.3 A number of measures have been highlighted as being suitable for mitigating the effects identified above, which include measures designed to:

- protect soil structure and quality;
- protect controlled waters from both general site works and foundation works; and
- Management of contamination risks.

6.9.4 Together the CEMP and LCRM process comprise embedded mitigation measures that deal with temporary and permanent contamination effects respectively. Therefore, once these have been applied there will be no significant adverse effects as a result of the proposed development. The proposed scope of the Environmental Statement (ES) is contained in Table 6-6

Table 6-6: Proposed scope of the Geology and Soils Chapter of the ES

Stage	Scoped in	Scoped out	Justification for scoping out
Construction	Soils (inclusive of Agricultural Land Classification)	Geology and Contaminated Land	The assessment and possibly the remediation of land contamination will be a requirement of the planning process to ensure that the site is suitable for its proposed use. No Regionally Important Geological / Geomorphological Sites or important outcrops are present within the vicinity of the Scheme.

Stage	Scoped in	Scoped out	Justification for scoping out
Operation	N/A	Geology, Contaminated Land and Soils (inclusive of Agricultural Land Classification)	No operational impacts are anticipated, and no further assessment is required.

6.10 Consultations and key stakeholders

6.10.1 Consultation with Natural Resources Wales and Flintshire County Council environmental protection teams is ongoing via the Environmental Liaison Group (ELG) to identify any concerns regarding contamination or ground stability issues. Consultations undertaken to date have identified the following actions relevant to this Chapter;

a. ELG Meeting 11 June 2018
   i. The composition of the railway embankment is unknown;
   ii. A supplementary ground investigation is proposed; and
   iii. A contaminated land assessment needs to be done due to previous uses of some areas of the site, e.g. former Neston Tank Cleaners site remediated in the 1980s.
b. ELG Meeting 10 October 2018
   i. There is a limited amount of undisturbed soils left within the proposed footprint;
   ii. Soils will be reused on soft estate areas of the scheme; and
   iii. The ground investigation should ensure that all information on contaminated sites is captured.
c. ELG Meeting 3 April 2019
   i. Risk assessment to be conducted for contaminated land from the former Neston Tank Cleaners site. Where possible, works will be conducted above the capping layer;
   ii. Ground Investigation to be carried out to greater depth at the site of the new pumping station; and
   iii. Pollution Protection Plan will be required for the Scheme.

7 Road Drainage and water environment

7.1 Introduction

7.1.1 This chapter of the Scoping Report describes the scope of the road drainage and water environment assessment for the Scheme. A summary of relevant legislation and policies, along with the methodology which will be used to assess the likely environmental effects of the Scheme is provided within this chapter. The road drainage and water environment baseline conditions within the study area are set out followed by a summary of the potential impacts and the design and mitigation measures.

7.1.2 Section 2.4 contains a detailed description of the Scheme. The assessment methodology follows the guidance set out in the Design Manual for Roads and Bridges (DMRB) LA 113 Road Drainage and the Water Environment (March 2020)[24].

7.2 Legislation and policy context

7.2.1 The following national legislation, national planning policy and relevant guidance for the assessment of the effects of the Scheme on road drainage and the water environment are detailed below.

National Legislation

- Environmental Protection Act 1990[25]
- Water Industry Act 1991[26]
- Land Drainage Act 1991[27] (as amended)
- Water Resources Act (England and Wales) 1991[28] (Amended 2009)
- Pollution Prevention and Control (England and Wales) Regulations 2000[29]
- Water Act 2003[30]
- Water Resources (Abstraction and Impounding) Regulations (2006) SI 2006/641[31]
- Flood Risk Regulations 2009[32]
- Environmental Damage (Prevention and Remediation) (Wales) Regulations 2009[33]

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[24] Highways England 2020. Design Manual for Roads and Bridges. Available at: d6388f5f-2694-4986-ac46-b17b62c21727 (standardsforhighways.co.uk). Accessed 11/10/2024.

[25] Environmental Protection Act 1990. Available at: https://www.legislation.gov.uk/ukpga/1990/43/data.pdf. Accessed 11/10/2024.

[26] Water Industry Act 1991. Available at: https://www.legislation.gov.uk/ukpga/1991/56/data.pdf. Accessed 11/10/2024.

[27] Land Drainage Act 1991. Available at: https://www.legislation.gov.uk/ukpga/1991/59/data.pdf. Accessed 11/10/2024.

[28] Water Resources Act (England and Wales) 1991 (https://www.legislation.gov.uk/ukpga/1991/57/data.pdf) Accessed 11/10/2024

[29] The Pollution Prevention and Control (England and Wales) Regulations 2000. Available at: https://www.legislation.gov.uk/uksi/2000/1973/made/data.pdf. Accessed 11/10/2024.

[30] Water Act 2003 (https://www.legislation.gov.uk/ukpga/2003/37/data.pdf) Accessed 11/10/2024.

[31] Water Resources (Abstraction and Impounding) Regulations SI 2006/641. Available at: https://www.legislation.gov.uk/uksi/2006/641/made/data.pdf. Accessed 11/10/2024.

[32] Flood Risk Regulations 2009. Available at: http://www.legislation.gov.uk/uksi/2009/3042/pdfs/uksi_20093042_en.pdf. Accessed 11/10/2024.

[33] Environmental Damage (Prevention and Remediation) (Wales) Regulations 2009. Available at: https://www.legislation.gov.uk/wsi/2009/995/data.pdf. Accessed 11/10/2024.

- The Water Supply (Water Quality) Regulations 2010[34]
- Flood and Water Management Act 2010[35]
- The Water Resources (Control of Pollution) (Silage, Slurry and Agriculture Fuel Oil) (Wales) Regulations 2010[36]
- Environment (Wales) Act 2016[37]
- The Environmental Permitting Regulations 2016[38]
- The Groundwater (Water Framework Directive) (Wales) Direction 2016[23]
- Water Environment (Water Framework Directive) (England and Wales) Regulations 2017[39]
- Environment Act 2021[40]

National Planning Policy

- Future Wales: The National Plan 2040[41]
- Planning Policy Wales Edition 12 (February 2024)[42] (PPW)
- Technical Advice Note (TAN) 5: Nature Conservation and Planning (2009)[43]
- Technical Advice Note (TAN) 15: Development and Flood Risk (2021) [44]
- Flintshire Local Flood Risk Management Strategy 2013[45]

River Basin Management Plan (RBMP)

7.2.2 Dee RBMP 2021-2027[46]: RBMPs are drawn up for the 11 River Basin Districts in England and Wales as a requirement of the WFD. The plan for the Dee River Basin District is managed by Natural Resources Wales (NRW) and sets out the programme of measures needed to achieve the objective of the WFD over the next six-year period (2021-2027).

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[34] The Water Supply (Water Quality) Regulations 2010. Available at: https://www.legislation.gov.uk/wsi/2010/994/made/data.pdf. Accessed 11/10/2024.

[35] Flood and Water Management Act 2010. Available at: https://www.legislation.gov.uk/ukpga/2010/29/data.pdf Accessed 11/10/2024.

[36] The Water Resources (Control of Pollution) (Silage, Slurry and Agriculture Fuel Oil) (Wales) 2010. Available at: https://www.legislation.gov.uk/wsi/2010/1493/made/data.pdf. Accessed 11/10/2024.

[37] The Environment (Wales) Act 2016. Available at: https://www.legislation.gov.uk/anaw/2016/3/enacted/data.pdf. Accessed 11/10/2024.

[38] The Environmental Permitting Regulations 2016. Available at: https://www.legislation.gov.uk/uksi/2016/1154/made/data.pdf. Accessed 11/10/2024.

[39] Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. Available at: https://www.legislation.gov.uk/uksi/2017/407/made/data.pdf. Accessed 11/10/2024.

[40] Environment Act 2021. Available at: https://www.legislation.gov.uk/ukpga/2021/30/enacted/data.pdf. Accessed 11/10/2024.

[41] Welsh Government, 2021. Future Wales: The National Plan 2040. Available at: Update to Future Wales - The National Plan 2040 (gov.wales). Accessed 14/10/2024.

[42] Planning Policy Wales Edition 12 – February 2024. Available at: https://www.gov.wales/sites/default/files/publications/2024-07/planning-policy-wales-edition-12.pdf. Accessed 11/10/2024.

[43] Technical Advice Note 5 Nature Conservation and Planning, 2009. Available at: https://www.gov.wales/sites/default/files/publications/2018-09/tan5-nature-conservation.pdf. Accessed 11/10/2024.

[44] Technical Advice Note (TAN) 15, 2021. Available at: https://www.gov.wales/sites/default/files/publications/2022-03/technical-advice-note-15-development-flooding-and-coastal-erosion.pdf. Accessed 11/10/2024.

[45] Flintshire Local Flood Risk Management Strategy 2013. Available at: https://www.flintshire.gov.uk/en/PDFFiles/Flooding-and-Drainage/Flintshire-Local-Flood-Risk-Management-Strategy.pdf. Accessed 11/10/2024.

[46] Dee River Basin Management Plan (RBMP) 2021-2027. Available at: https://cdn.cyfoethnaturiol.cymru/media/695219/dee-rbmp-2021_2027-summary.pdf. Accessed 11/10/2024.

Local Planning Policy

7.2.3 FCC adopted its Local Development Plan (FLDP)[47] 2015-2030 which forms part of the statutory development plan in alignment with Future Wales: The National Plan 2040. The FLDP reference strategic policies relevant to Road Drainage and the Water Environment including:

- STR4: Principles of Sustainable Development and Design;
- STR5: Transport and Accessibility;
- STR6: Services, Facilities and Infrastructure;
- STR13: Natural and Built Environment, Green Networks and Infrastructure;
- STR14: Climate Change and Environmental Protection

7.3 Relevant guidance

7.3.1 The Guidance for Pollution Prevention (GPP) documents provide environmental good practice guidance on a UK-wide level, and regulatory guidance to Northern Ireland, Scotland and Wales only. The documents cover an array of individual topics related to pollution prevention, with those most applicable to this Scheme being:

- GPP 1 Understanding your environmental responsibilities – good environmental practices[48]
- GPP 5 Works and maintenance in or near water[49]
- GPP 6 Working on construction and demolition sites[50]
- GPP 13 Vehicle washing and cleaning[51]

7.3.2 The withdrawn Pollution Prevention Guidance (PPG) continue to provide useful guidance on pollution prevention across the UK where an updated GPP has not been provided, for example:

- PPG 7 Safe storage - The safe operation of refuelling facilities[52]

7.3.3 Construction Industry Research and Information Association (CIRIA) guidelines are best practice publications, many of which have been adopted as the standard for excellence in their respective areas.

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[47] Flintshire Local Development Plan (FLDP) 2015-2030. Available at: https://www.flintshire.gov.uk/en/PDFFiles/Planning/Examination-Library-Documents/FINAL-LDP-Written-Statement-English.pdf. Accessed 11/10/2024.

[48] GPP 1 Understanding your environmental responsibilities – good environmental practices, Version 1.2, 2021. Available at: https://www.netregs.org.uk/environmental-topics/guidance-for-pollution-prevention-gpp-documents/gpp-1-understanding-your-environmental-responsibilities-good-environmental-practices. Accessed 11/10/2024.

[49] GPP 5 Works and maintenance in or near water. Version 1.2, 2018. Available at: https://www.netregs.org.uk/media/1418/gpp-5-works-and-maintenance-in-or-near-water.pdf. Accessed 11/10/2024.

[50] GPP 6 Working on construction and demolition sites. Version 1, 2023. Available at: https://www.netregs.org.uk/media/tsybv2y3/gpp6-working-on-construction-and-demolition-sites.pdf. Accessed 11/10/2024.

[51] GPP 13 Vehicle washing and cleaning Version 1.2, 2010. Available at: https://www.netregs.org.uk/media/1882/guidance-for-pollution-prevention-13-2022-update-v2.pdf. Accessed 11/10/2024.

[52] PPG 7 'Safe storage – The safe operation of refuelling facilities' (https://assets.publishing.service.gov.uk/media/5a74c73c40f0b619c865a5d6/pmho0711btzl-e-e.pdf) Accessed 11/10/2024

7.4 Assessment Methodology

7.4.1 The assessment of effects methodology will take into account DMRB LA 113 – Road drainage and the water environment to assess the likely significance of effects of the Scheme on the road drainage and water environment.

7.4.2 The environmental impact assessment chapter will be prepared which will include the following elements:

- assessment methodology
- baseline conditions
- assessment of potential impacts during construction and operational phases
- mitigation measures
- residual effects
- cumulative effects assessment
- summary of effects

7.4.3 The assessment to estimate the importance of receptors will be carried out using the criteria from DMRB LA 113[24] Table 3.70. Table 3.71 from DMRB LA 113 sets out the criteria that will be used in the assessment to estimate the magnitude of impact on an attribute. Following on from identifying an appropriate receptor sensitivity and magnitude of impact using Table 3.70 and 3.71 the likely significance category and overall significance of effects would be assessed by using the matrix provided in Table 3.8.1 of DMRB LA 104[53]. Professional judgement will be used to consider site-specific factors that may be of relevance whilst calculating the likely significance of the effects attributed to the Scheme.

7.5 Baseline conditions

Study area

7.5.1 The study area for this assessment includes the geographical extent of the full scope of the Scheme location, all surface and groundwater bodies within a 1km radius and any water bodies outside of this which are hydrologically connected to the Scheme. Water bodies outside the 1km buffer were identified during the assessment, based on professional judgement of their sensitivity and connectivity to the Scheme area. This approach ensures that any potential effects of the Scheme are proportionately identified.

7.5.2 The Airbus Load Out Facility (ALOF) which is considered enabling works for the Scheme construction is located approximately 4km upstream of the Scheme. The reach of the River Dee between the Scheme and 1km upstream of the ALOF will also be considered in the assessment.

7.5.3 The study area and key surface water receptors are shown in Figure 7-1.

Figure 7-1: Water Environment Scheme Study Area

Due to size this Figure is included in Appendix A.4.

Land use and topography

7.5.4 The land use of the area is predominantly urban, with industrial and commercial uses located on the southern bank of the River Dee and residential and agricultural fields located on the northern

[53] Design Manual for Roads and Bridges LA 104, Revision 1. 2020. Available at: https://www.standardsforhighways.co.uk/tses/attachments/0f6e0b6a-d08e-4673-8691-cab564d4a60a?inline=true. Accessed 11/10/2024.

bank of the River Dee. The Scheme is located in a low-lying coastal area, with elevations varying from 0m AOD to 20m AOD.

Surface water

7.5.5 The Scheme crosses the River Dee at National Grid Reference (NGR) SJ323685, the river is tidal at this location. The River Dee has a total catchment area of approximately 2,251km^2. There is also a number of other smaller surface water receptors classified by NRW as main rivers within the 1km study area including:

- Daisy Bank Farm Drain
- Pentre Drain North
- Pentre Drain South West
- Queensferry Drain
- Manor Drain
- Garden City Drain West
- Rowleys Gutter.

7.5.6 Three additional main rivers were identified on the reach between the Scheme and 1km upstream of the ALOF.

- Beeches Drain Dee
- Sandycroft Drain North
- Sealand Main Drain.

Road Drainage

7.5.7 The existing A494 drainage in this location consists of kerbs and gullies connected to carrier drains. There are also filter drains collecting cutting and embankment runoff, which are connected to the carrier drains. The discharges are to the St David's Park lagoon, to the Daisy Bank Drain culvert and to the Queensferry Drain culvert. All discharges are untreated with no attenuation. The River Dee is the final receiving watercourse for all drainage derived from the existing A494 bridge.

Ponds

7.5.8 There are three ponds located within the study area which are not hydraulically connected to the Scheme.

Licensed Abstractions and Consented Discharges

7.5.9 No licensed abstractions were identified within the 1km study area[54]. The nearest consented abstraction is located approximately 1.6km upstream of the study area on Finchetts Gutter for spray irrigation.

7.5.10 Eight consented discharges were identified within the 1km study area[54].

Hydrogeology

7.5.11 Detailed information relating to geology and soils assessment is included in Chapter 6. In summary, the site superficial geology is dominated by Marine Deposits over Glacial Till. Beneath this the bedrock consists of the Etruria Formation (mudstone, sandstone and conglomerate),

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[54] Welsh Government 2024. DataMapWales – Licenced Water Abstractions. Available at: https://datamap.gov.wales/layers/geonode:nrw_water_resource_permits. Accessed 11/10/2024.

Pennine Middle Coal Measures Formation (mudstone, siltstone and sandstone) and Pennine Lower Coal Measures Formation (mudstone, siltstone and sandstone).

7.5.12 The Marine Deposits and Glacial Till are classified as a Secondary (Undifferentiated) aquifer, while the bedrock is classified as Secondary A aquifers. This suggests that the aquifers are capable of supporting water supplies at a local rather than strategic scale and, in some cases, form an important source of base flow to rivers.

7.5.13 Due to the presence of Coal Measures beneath the site, there is potential for coal seams to be present near or at the site which could act as primary groundwater pathways.

Water Framework Directive

7.5.14 A number of designated Water Framework Directive (WFD)[39] water bodies are located within 1km of the scheme. The Scheme is located on the reach of the River Dee which is within the 'Dee (N. Wales) WFD transitional water body (ID: GB531106708200). The Scheme is underlain by the Dee Carboniferous Coal Measures (ID: GB41102G204800) groundwater body. These WFD water bodies are managed by NRW.

7.5.15 Garden City Drain (GB111067056960) is a surface water tributary of the Dee Estuary located approximately 0.6km downstream of the scheme (managed by the Environment Agency). Sandycroft Drain (GB111067052160) river water body managed by NRW is located on the reach between the Scheme and the ALOF facility.

Protected areas

7.5.16 A number of designated sites are located within 1km of the Scheme as detailed in Table 7-1 and shown in Figure 8-1 and 8-2, included in Appendix A.4.

Table 7-1: Statutory designated sites within the study area

Site	Designation	Reasons for designation	Distance from Scheme
Dee Estuary	Ramsar Site	Designated for its bird species, wetland habitat saltmarsh, intertidal mudflats and sandflats	1.0 km due northwest (Tidal link)
	SPA - UK	Designated for its wintering, breeding and migratory bird assemblages.	
	SAC -UK -	Designated for its mudflats, coastal habitats and fish species.	
	SSSI	Designated for its wintering bird populations and coastal habitat.	
River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid	SAC - UK	Designated for its coastal habitats and fish species.	Intersect by Scheme
Dee Estuary / Aber Afon Dyfrdwy	GWDTEs	Dee Estuary is classified as a groundwater dependent terrestrial ecosystem.	Intersect by Scheme

Site	Designation	Reasons for designation	Distance from Scheme
River Dee / Afon Dyfrdwy	SSSI	Designated for its fluvial geomorphology, carboniferous geology, range of river habitat types and fish species.	Intersect by Scheme
Shotwick Brook NVZ	Nitrate Vulnerable Zone	Area at risk from agricultural nitrate pollution	Within the Scheme footprint
Dee Carboniferous Coal Measures	Groundwater Drinking Water Protected Areas	Groundwater DWPA's include areas where water is/ can be abstracted for public or private drinking water supplies.	Underlying the Scheme

Flood Risk

Rivers/Tidal

7.5.17 NRW's Flood Risk Map[55] shows that where the Scheme crosses the River Dee there is a high risk of flooding (chance of flooding of greater than 1 in 30 each year) from rivers and sea. This high-risk area is confined by flood defences. There is also a high-risk area along the route just northeast of the railway and approximately 100m northeast of the railway bridge.

Surface water

7.5.18 There is also shown to be low, medium and high surface water flood risk running from approximately 100m southwest of the River Dee to the southwest end of the study area. The risk is highest just northeast of the railway bridge, with the risk decreasing away from this area.

7.6 Potential and likely significant effects

Potential construction impacts

7.6.1 During construction, the Scheme has the potential to directly affect road drainage and the water environment for a temporary duration. It is assumed that decommissioning impacts will be the same as those for the construction phase, and as such these are not considered separately. The potential impacts during construction include:

- Disturbance of silt/soil generating surface runoff with high sediment concentrations (mobilised suspended solids). Potential for natural silts within the floodplain to contain metals (including lead) that could be washed downstream.
- Accidental spillage of fuels, oils, chemicals and materials (e.g. concrete, plant fuels / oils, lubricants, hydraulic fluids and floating solids such as litter) resulting in pollution of watercourses and potential impacts on fish and downstream ecological designated features.
- Discharge of water with high suspended solid concentrations and / or contaminants (particularly from concrete pouring) due to a flood event overwhelming the site.

[55] Natural Resources Wales 2024. National Flood Hazard and Risk Maps. Available at: https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/Flood_Risk/viewers/Flood_Risk/virtualdirectory/Resources/Config/Default&layerTheme=0. Accessed 11/10/2024.

- Dewatering of excavations and discharge of high suspended solid content to receiving watercourses.
- Obstructions within the channel/floodplain or plant trafficking on riverbanks causing an increased risk of erosion or scouring.
- Alteration of geomorphological features through plant trafficking, excavation, and alteration of the Queensferry Drain.
- Risk that piling works will introduce pollution pathways and allow infiltration of contaminated water/runoff to an aquifer.
- Disturbance of the ground from piling could lead to increased turbidity in groundwater.
- Localised reduction in groundwater level associated with potential dewatering in excavations.
- Localised dredging may be required at the former ALOF to ensure there is sufficient depth of water to float the jack up barge.

Potential operational impacts

7.6.2 Aspects of the operational phase of the Scheme that may have the potential to affect road drainage and the water environment are:

- Removal of vegetation during bank works may result in a higher risk of bank erosion or bank failure over the medium term, although this would reduce as the landscape design matures.
- Piling and permanent dewatering may cause a change in the groundwater flow regime which may result in interruption of flow, leading either to reduction or loss of water supply to the watercourses, and potential loss of habitat (which may be permanent).
- Discharges from new drainage outfalls could result in degradation of water quality.
- Discharge of routine run-off may cause a long-term degradation of water quality and changes to flow and velocity in the receiving watercourses.
- Direct loss of salt marsh habitat on river banks.
- Changes to hydromorphology/habitat from realignment of Queensferry drain.
- Changes to flow, velocity or sediment dynamics within the River Dee as a result of additional piers.
- New drainage systems may reduce recharge to the underlying aquifer, thereby interrupting flow, leading to a reduction or loss of water supply to abstractions, springs, streams, and wetland, and potential loss of aquatic habitat (which may be permanent).
- The installation of a new pumping station which will discharge into the River Dee, has the potential to impact the water quality within the river.
- Changes in surface water flood flow pathways may result in increased flood risk.
- Installation of a new bridge crossing could lead to localised changes in bank stability and potential for disturbance of in-channel morphological features, as well as localised permanent riparian vegetation. Creation of new bridge crossings could result in a disconnect in the floodplain resulting in loss of floodplain habitat.

7.7 Mitigation and enhancements

Construction

7.7.1 During construction, standard mitigation measures for pollution prevention would be implemented and a CEMP would be put in place to manage the implications of the Scheme on the water environment and to ensure the Scheme will comply with current policies and regulations that aim to protect the water environment. The process and procedure for responding to and reporting environmental incidents would be agreed with NRW and included within the CEMP.

7.7.2 Works for the river bridge, dredging, realignment, and any activity within 8m of a non-tidal main river or within 16m of a tidal main river, would be carried out in accordance with the conditions of a relevant Flood Risk Activity Permit.

7.7.3 Any piling works required for the Scheme would be subject to appropriate risk assessments. Method statements detailing piling operations would cover the potential to cause pollution to the underlying secondary aquifers and potential mobilisation of contaminated soil.

7.7.4 Use of a jack-up barge and/or temporary platforms to auger and fill piles will be carried out in line with best practice to minimise disturbance to the river bed.

All pumped drainage from the construction works, including areas used for temporary storage of construction materials or excavated soils, would be passed through pollution prevention treatment prior to discharge to surface watercourses or drains.

Operation

7.7.5 Alterations to the road network will provide adequate drainage to accommodate potential changes in surface run-off, including an allowance for climate change in accordance with DMRB CG 501 - Design of highway drainage systems[56], and through consultation with the NRW and the Lead Local Flood Authority.

7.7.6 The Scheme design will be assessed by a Flood Consequences Assessment to confirm no increased flood risk from overtopping of the current tidal embankment, thereby meeting TAN 15[44] Table A1.14 requirements, up to the 0.1% Annual Exceedance Probability (AEP) 2095 tidal event.

7.7.7 A Flood Management Plan would be developed to set out the procedures, roles, responsibilities, and triggers for evacuating the site. This would include a Variable Message Sign system to warn motorists of flooding to the A494 carriageway.

7.7.8 Residual risk of flooding will be reduced by improving the existing drainage system. It should also be ensured that regular maintenance is undertaken throughout the scheme's operational phase.

7.7.9 During operation, there is a potential for surface water run-off to be contaminated by accidental spills/collisions/vehicle fuel spills and/or mobilisation of de-icing salt. However, appropriate treatment and containment measures would be incorporated into the drainage design to mitigate for this.

7.7.10 To mitigate for the permanent loss of saltmarsh habitat as a result of the Scheme, enhancement and monitoring of existing salt marsh habitat would be developed.

Enhancements – Operational

7.7.11 Environmental mitigation and biodiversity enhancement works with earthworks and areas of soft estate including wildflower verges, swales, native woodland plantations and amenity grassland.

7.7.12 A section of the existing Queensferry Drain culvert would be replaced by an open channel. This will help provide enhancement to the WFD catchment.

7.7.13 Provision of suitable replacement saltmarsh habitat, in agreement with NRW and FCC.

[56] National Highways, 2022. CG 501- Design of highway drainage systems. Version 2.1.0. Available at: CG 501 - Design of highway drainage systems (standardsforhighways.co.uk). Accessed 14/10/2024.

7.8 Assumptions and limitations

7.8.1 This Scoping report has been prepared using publicly available information as well as photographs taken during a site walkover. It has been assumed that the available information on surface water, groundwater and flood risk is representative of the general conditions.

7.9 Conclusions of scoping

7.9.1 The assessment of likely significant effects considers effects on surface water and groundwater features within the study area. This assessment only considers receptors that may be hydrologically connected or linked to the Scheme. A comprehensive assessment of the ecological protected areas can be found in Chapter 8 Biodiversity.

7.9.2 Table 7-2 Table 7 provides a summary of key receptors scoped in at this stage for further assessment and the justification for this.

Table 7-2: Summary of key receptors scoped in for the further assessment

Stage	Receptor	Justification
Construction / Operational	Main rivers (River Dee, Garden City Drain, Queensferry Drain, Sandycroft Drain)	Hydrologically connected to the Scheme. Additional assessments such as Hydrodynamic and Sediment Transport modelling and HEWRAT will be carried out to support the assessment.
Construction / Operational	Groundwater (Superficial Secondary (Undifferentiated) aquifer and bedrock Secondary A aquifer)	Hydrogeologically connected to the Scheme.
Construction / Operational	WFD water bodies (Dee (N. Wales) WFD transitional water body, Dee Carboniferous Coal Measures groundwater body and Garden City Drain and Sandycroft Drain surface water body.	Within the study area and hydrologically and hydrogeologically connected to the Scheme. Additional WFD assessment will be carried out to support the assessment.
Operational	Flood Risk: Scheme is classified as essential infrastructure	Scheme within high flood risk zone (tidal and river flooding). Additional assessment such as a Flood Consequences Assessment will be carried out to confirm no increased flood risk from overtopping of the current tidal embankment.
Construction / Operational	Designated sites (River Dee SSSI & GWDTE, River Dee & Bala Lake SAC, Dee Estuary – Ramsar, SPA, SAC and SSSI)	Hydrologically and hydrogeologically connected to the Scheme. Additional water quality assessment such as HEWRAT and WFD will be carried out to support the assessment.

7.9.3 The following receptors are deemed to not be impacted by the Scheme and are scoped out of the assessment at this stage:

- Ponds – not hydrologically connected.
- Water bodies upstream of the Scheme: The Pentre Drain North, Pentre Drain South West and Daisy Bank Farm Drain.

- Consented abstractions- not within the study area and unlikely to be impacted beyond this distance.
- Consented discharges – the existing discharges will unlikely to be impacted by the scheme.

7.10 Consultations and key stakeholders

7.10.1 This Scheme is a continuation from the A494 River Dee Bridge Improvement Scheme and will be taken forward independently of any other highways project. It does draw on information and consultations undertaken as part of the previous WelTAG Stage 3 study of the A494 River Dee Bridge Improvement Scheme.

7.10.2 Consultation will be ongoing with key stakeholders as the Scheme progresses through the Environmental Liaison Group. The draft Scoping Report will be issued to statutory consultees for comment, and any comments received will be recorded in the final report to Welsh Government.

8 Biodiversity

8.1 Introduction

8.1.1 This chapter of the scoping report describes the scope of the assessment of the nature conservation interest within the study area. The relevant national and local planning policies to be considered within the assessment are included alongside the assessment methodology, key guidance and baseline ecology including protected sites in the vicinity of the Scheme.

8.1.2 This chapter has been prepared in accordance with the Design Manual for Roads and Bridges (DMRB) LA 108 Biodiversity[57] and LD 118 Biodiversity Design[58]. The requirement for further assessment in accordance with the DMRB LA 115 Habitat Regulations Assessment[59] is also identified within this chapter.

8.1.3 The baseline has been established through a combination of desk study, including a review of previous ecological survey work and field work carried out in 2018 and 2019 which was subsequently updated in 2020, 2022, 2023 and 2024.

8.2 Legislation and policy context

National legislation

8.2.1 The following national legislation and national planning policy have been considered in the production of this assessment:

- The Conservation of Habitats and Species Regulations 2017 (*as amended*)[60]
- Wildlife and Countryside Act 1981 (*as amended*)[61]
- The Environment (Wales) Act 2016[62]
- Salmon and Freshwater Fisheries Act 1975[63]
- The Protection of Badgers Act 1992[64]
- Well-being of Future Generations (Wales) Act 2015[65]

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[57] DMRB LA 108 Biodiversity. Available at https://www.standardsforhighways.co.uk/search/af0517ba-14d2-4a52-aa6d-1b21ba05b465 [Accessed:10/09/24)

[58] DMRB LA 118 Biodiversity Design. Available at https://www.standardsforhighways.co.uk/search/9317652b-4cb8-4aaf-be57-b96d324c8965 [Accessed:10/09/24)

[59] DMRB LA 115 Habitat Regulations Assessment. Available at https://www.standardsforhighways.co.uk/search/e2fdab58-d293-4af7-b737-b55e08e045ae. [Accessed:10/09/24)

[60] The Conservation of Habitats and Species Regulations 2017 (as amended). Available at https://www.legislation.gov.uk/uksi/2017/1012/contents/made [Accessed:10/09/24)

[61] Wildlife and Countryside Act 1981 (as amended). Available at (http://www.legislation.gov.uk/ukpga/1981/69) [Accessed:10/09/24)

[62] Environment (Wales) Act 2016. Available at (http://www.legislation.gov.uk/anaw/2016/3/contents) [Accessed:10/09/24)

[63] Salmon and Freshwater Fisheries Act 1975. Available at (https://www.legislation.gov.uk/ukpga/1975/51) [Accessed:10/09/24)

[64] Protection of Badgers Act 1992. Available at (http://www.legislation.gov.uk/ukpga/1992/51/contents) [Accessed:10/09/24)

[65] Well-being of Future Generations (Wales) Act 2015. Available at https://www.gov.wales/well-being-of-future-generations-wales [Accessed:10/09/24)

- The Invasive Alien Species (Enforcement and Permitting) Order 2019[66]
- Flood and Water Management Act 2010[67]

8.2.2 The Conservation of Habitats and Species Regulations 2017 (*as amended*) ensures the protection of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) in the UK which no longer form part of the EU's Natura 2000 ecological network. The amended Regulations have created a national site network on land and at sea, including both the inshore and offshore marine areas in the UK. The national site network includes existing SACs and SPAs, new SACs and SPAs designated under these Regulations. Any references to Natura 2000 in the 2017 Regulations and in guidance now refers to the new national site network.

8.2.3 A network of nationally designated sites has been established through the designation of Sites of Special Scientific Interest (SSSIs) under the Wildlife and Countryside Act 1981 (*as amended*). The protection afforded under the Act means it is an offence to carry out or permit to be carried out any operation listed within the notification without the consent of the Statutory Nature Conservation Organisation (Natural Resources Wales). The protection afforded to SSSIs is used to underpin the designation of areas within the national site network.

8.2.4 The Welsh Government has particular responsibilities with respect to SSSIs under Section 28G of the Wildlife and Countryside Act 1981. An authority to which this section applies has the duty of exercising its functions to take reasonable steps, consistent with the proper exercise of those functions, to further the conservation and enhancement of the flora, fauna or geological or physiographical features by reason of which the site is notified as being of special scientific interest.

8.2.5 All wild birds, their nests and eggs are protected under Part 1, Section 1 of the Wildlife and Countryside Act. Birds listed in Schedule 1 of the Act are subject to special protection. Wild animals listed in Schedule 5 are protected under Section 9. Plants listed in Schedule 8 are protected under Section 13 of the Act.

8.2.6 The Act also includes provisions for the control of invasive non-native species (INNS). Under these provisions it is an offence to:

1. Release, or allow to escape into the wild, any animal which is not ordinarily resident in, or a regular visitor to, Great Britain or is included in Schedule 9 of the Act.
2. Plant, or otherwise cause to grow in the wild, any plant which is included in Schedule 9 of the Act.

8.2.7 The Environment (Wales) Act 2016 introduces a new, enhanced Biodiversity and Resilience of Ecosystem Duty on public bodies to ensure that biodiversity is an integral part of decision making. Public authorities will be required to report on the actions they are taking to improve biodiversity and promote ecosystem resilience.

8.2.8 Section 6 of the Act places a duty on public authorities to seek to maintain and enhance biological diversity (referred to as biodiversity). All public bodies, statutory undertakers, Ministers of the Crown and other public office holders are required to apply the duty when they are carrying on any functions in Wales, or in relation to Wales.

[66] Available at The Invasive Alien Species (Enforcement and Permitting) Order 2019 (legislation.gov.uk) [Accessed:10/09/24)

[67] Flood and Water Management Act 2010. Available at (https://www.legislation.gov.uk/ukpga/2010/29/schedule/3) [Accessed:10/09/24)

8.2.9 Section 7 of the Act places a duty on the Welsh Ministers to publish, review and revise lists of living organisms and types of habitat in Wales, which they consider are of key significance to sustain and improve biodiversity in relation to Wales.

8.2.10 The Well-being of Future Generations (Wales) Act 2015 includes a number of well-being goals (Part 2 Section 4), the second of which is 'A resilient Wales' described as:

'*A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change).*'

8.2.11 Schedule 3 of the Flood and Water Management Act 2010 makes SuDS a mandatory requirement for all new developments. The legislation ensures resilient drainage systems for new developments in both urban and rural areas. Within the regulations is a specific requirement for biodiversity (Standard S5) which states:

'The design of the surface water management system should maximise biodiversity benefits'.

8.2.12 Standard S5 addresses the design of SuDS development and enriches biodiversity value by linking networks of habitats and ecosystems together.

8.2.13 The Invasive Alien Species (Enforcement and Permitting) Order 2019 came into force on 1st October 2019. This Order allows for the enforcement of Regulation (EU) No. 1143/2014 on the prevention and management of the introduction and spread of invasive alien species in England and Wales including the relevant licences, permits and rules for keeping invasive alien species.

National Planning Policy

8.2.14 Planning Policy Wales 12 (PPW12)[68] Section 6.4.3 sets out the responsibilities of the Local Planning Authority when assessing development proposals and their impacts on biodiversity. This document states:

'*The planning system has a key role to play in helping to reverse the decline in biodiversity and increasing the resilience of ecosystems, at various scales, by ensuring appropriate mechanisms are in place to both protect against loss and to secure enhancement'*.

8.2.15 PPW 12 sets out the requirement for planning authorities to demonstrate that they have sought to fulfil the duties and requirements of Section 6 of the Environment Act 2016 by taking all reasonable steps to maintain and enhance biodiversity in the exercise of their functions.

8.2.16 Policies relevant to nature conservation included into Planning Policy Wales can be summarised as follows:

1. **Green Infrastructure**: to include the submission of proportionate green infrastructure statements with planning applications and signposting Building with Nature standards.
2. **Net Benefit for Biodiversity** and the Step-wise Approach: The step-wise approach is the means of demonstrating the steps which have been taken towards securing a net benefit for biodiversity. In doing so, planning authorities must also take account of and promote the resilience of ecosystems, in particular the following attributes, known as the DECCA Framework[69]
3. **Protection for Sites of Special Scientific Interest (SSSI's)**: strengthened approach to the protection of SSSIs.

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[68] Available at https://www.gov.wales/sites/default/files/publications/2024-02/planning-policy-wales-edition-12_1.pdf [Accessed:10/09/24]

[69] Available at Ecosystem Resilience in a Nutshell 1: what is ecosystem resilience? (cyfoethnaturiol.cymru) [Accessed 11/09/240

4. **Trees and Woodlands:** closer alignment with the stepwise approach, along with promoting new planting as part of development based on securing the right tree in the right place. Planning authorities must protect trees, hedgerows, groups of trees and areas of woodland where they have ecological value, contribute to the character or amenity of a particular locality, or perform a beneficial green infrastructure function.

8.2.17 Future Wales: The National Plan 2040[70]. provides a framework that sets the direction for development in Wales to 2040. The plan is concerned with infrastructure and development in Wales and aims to ensure that the planning system is consistent at all levels. The National Plan introduced specific policies that safeguard areas for the purposes of improving the resilience of ecological networks and ecosystems services, to identify areas for the provision of green infrastructure, and to secure biodiversity enhancement, the plan introduced a requirement for development to deliver a net benefit for biodiversity (NBB).

8.2.18 Policy 9 – (Resilient Ecological Networks and Green Infrastructure) of The National Plan states:

'*the Welsh Government will work with key partners to ensure the enhancement of biodiversity, the resilience of ecosystems and the provision of green infrastructure'*.

Local Planning Policy

8.2.19 The Scheme lies within the administrative area of Flintshire Council. For the purposes of the ecology and nature conservation assessment, relevant policies from this local planning authority have been considered. FCC adopted their Local Development Plan (LDP) on the 24th January 2023 and it covers the period 2015 – 2030[71]. It forms part of the statutory development plan alongside The National Plan.

8.2.20 Policies STR13 (Natural and Built Environment, Green Network and Infrastructure), EN2 (Green Infrastructure) and EN6 (Sites of Biodiversity Importance) of the LDP are considered relevant to the scheme.

Neighbouring authorities

8.2.21 The Scheme is not likely to have any effect on nature conservation matters within the scope of neighbouring authorities. The Dee Estuary SAC/SPA/Ramsar is located within the Flintshire, Wirral, Cheshire West and Cheshire Authorities. A management plan covering these sites has been produced by Natural England and the Countryside Council for Wales (now NRW) which will be considered in the scope of assessment and also the Habitat Regulations Assessment.

8.3 Relevant guidance

8.3.1 The following relevant guidance, plans and initiatives have been considered in the production of this assessment:

1. DMRB LA 108 Biodiversity
2. DMRB LD 118 Biodiversity Design
3. DMRB LA 115 Habitat Regulations Assessment
4. Guidelines for Ecological Impact Assessment in the UK and Ireland Terrestrial, Freshwater, Coastal and Marine September 2018 Version 1.2 Updated April 2022 (Chartered Institute of Ecology and Environmental Management CIEEM)[72]

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[70] Available at Future Wales: The National Plan 2040. [Accessed:10/09/24)

[71] Available at https://www.flintshire.gov.uk/en/Resident/Planning/Local-Development-Plan.aspx [Accessed:10/09/24]

[72] Available at ECIA-Guidelines-2018-Terrestrial-Freshwater-Coastal-and-Marine-V1.2-April-22-Compressed.pdf (cieem.net) [Accessed 11/09/24]

5. FCC Section 6 Biodiversity Duty Delivery Plan[73]
6. Nature Recovery Action Plan (NRAP)[74]
7. Flintshire Biodiversity and Ecosystem Resilience Duty Delivery plan[75]
8. Llwybr Newydd I Natur: The Welsh Strategic Road Network Nature Recovery Action Plan for our Strategic Road Network – October 2023[76]
9. Llwybr Newydd: the Wales transport strategy (March 2021)[77]

Biodiversity Policy and Net Benefits for Biodiversity

8.3.2 Wales Biodiversity Partnership (WDP)[78] have produced biodiversity checklists for local authority and public authority staff in Wales. The checklists will assist public and local authorities to take account of biodiversity in their operational activities and will help organisations to remain legal under the Environment (Wales) Act (2016) Biodiversity Duty, Habitats Regulations and other biodiversity related legislation. In addition, the implementation of the checklists and guidance will help build towards the biodiversity outcomes contained in the Environment Strategy for Wales. The Welsh Government work with the Partnership to improve and support our ecosystems.

8.3.3 The net-benefits for biodiversity approach by The Welsh Government has the intention to deliver an overall improvement in biodiversity by putting an emphasis on proactive consideration of biodiversity and wider ecosystem benefits within a placemaking context to be considered early in the design process[79]. The current adopted approach does not utilise a metric, or calculation of biodiversity 'units' the approach which has been generally adopted in England. The Welsh Government is working with NRW and other stakeholders to develop a common approach to measure whether a net benefit will be achieved on site, with further guidance forthcoming.[80]

8.4 Assessment methodology

8.4.1 The assessment of effects will follow a methodology primarily taking account of the following guidance:

a. DMRB LA 108 Biodiversity
b. DMRB LD 118 Biodiversity Design
c. DMRB LA 115 Habitat Regulations Assessment[81]
d. CIEEM Guidelines for Ecological Impact Assessment in the UK and Ireland

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[73] Available at https://www.flintshire.gov.uk/en/PDFFiles/Countryside--Coast/Biodiversity/Flintshire-County-Council-Environment-Act-Section-6-Biodiversity-Duty-Delivery-Plan-update-2020.pdf. [Accessed 11/09/24]

[74] Available at https://www.bionetwales.co.uk/nature-recovery-plan/ . [Accessed 11/09/24]

[75] Available at https://cyfarfodyddpwyllgor.siryfflint.gov.uk/documents/ [Accessed 11/09/24]

[76] Available at https://www.gov.wales/sites/default/files/publications/2023-10/llwybr-newydd-i-natur-nature-recovery-action-plan-our-strategic-road-network.pdf [Accessed 11/09/24]

[77] Available at https://www.gov.wales/llwybr-newydd-wales-transport-strategy-2021 [Accessed 11/09/24]

[78] Available at https://www.gov.wales/wales-biodiversity-partnership [Accessed 11/09/24]

[79] CIEEM (September 2022) Welsh Government's Approach to Net Benefits for Biodiversity and the DECCA Framework in the Terrestrial Planning System CIEEM Briefing Paper. Available at https://cieem.net/wp-content/uploads/2022/08/Net-Benefits-briefing.pdf [Accessed 11/09/240

[80] Available at Targeted policy changes to Planning Policy Wales on Net benefit for Biodiversity and Ecosystems Resilience (incorporating changes to strengthen policy on Sites of Special Scientific Interest, Trees and Woodlands and Green Infrastructure) [HTML] | GOV.WALES [Accessed 11/09/24]

[81] Please note that a separate HRA would be produced

8.4.2 LA 108 provides a framework for assessing, mitigating and reporting the impact on biodiversity resources. This document has been influenced by CIEEM's Guidelines for Ecological Impact Assessment in the UK and Ireland.

8.4.3 LD 118 provides principles for the biodiversity design and ecological survey for the construction, improvement and maintenance of motorways and all-purpose trunk roads.

8.4.4 LA 115 sets out the requirements for assessment and reporting of the implications, from construction, operation and maintenance, of highways and/or roads projects on European sites (i.e. sites within the national site network on land and at sea). A separate Habitat Regulations Assessment would be produced which would set out the assessment methodology in full.

8.4.5 The assessment will use baseline data from field surveys conducted between the period of 2018 - 2024, published information and from consultation conducted with recognised nature conservation bodies. The current baseline will be described, considering the likely effects of the Scheme on the nature conservation interest to determine those feature to be scoped in to the ES.

8.4.6 The valuation of habitats and species will be based on professional judgement, applying published guidance from the Chartered Institute of Ecology and Environmental Management and DMRB LA108. The value of ecological features would be interpreted within the context of the surrounding area (Zone of Influence), and the potential effects of the proposed Scheme. Strategies to minimise, mitigate and/or compensate them would be described in the relevant chapter of the ES, should they be scoped in.

Significance criteria and biodiversity resource importance

8.4.7 Baseline studies have established the relative importance of the biodiversity resources using the guidance in Table 3.9.of LA 108, as shown in Table 8-1.

Table 8-1: Biodiversity resource importance

Value (sensitivity)	Typical descriptors
International or European importance	SPA, pSPA, SAC, cSAC, pSAC, Ramsar site. A viable area of a habitat type listed in Annex I of the Habitats Directive[82], or smaller areas of such habitat which are essential to maintain the viability of a larger whole. Any regularly occurring population of an internationally important species, which is threatened or rare in the UK. i.e., it is a UK Red Data Book species, on the red list of birds of conservation concern or listed as occurring in 15 or fewer 10.0km squares in the UK. Resident or regularly occurring, populations of species which can be considered at an international level where the loss of these populations would adversely affect the conservation status or distribution at an international or European scale.
UK or National	A nationally designated site (SSSI, ASSI, NNR, Marine Conservation Zones and Marine Protected Areas).

[82] Terminology retained as classified by the Joint Nature Conservation Committee

Value (sensitivity)	Typical descriptors
	A viable area of a priority habitat identified in Section 7 of the Environment (Wales) Act 2016, or of smaller areas of such habitat which are essential to maintain the viability of a larger whole. Any regularly occurring population of a nationally important species which is threatened or rare in the region or county. A regularly occurring significant population / number of any nationally important species, including Schedule 8 plant species on the amber list of birds of conservation concern.
Regional	Viable areas of key habitat identified in Section 7 of the Environment (Wales) Act 2016 or other plans or smaller areas of such habitat which are essential to maintain the viability of a larger whole. Areas of habitats identified (including for restoration) in regional plans or strategies. Designated sites, (non statutory) including heritage coasts. Any regularly occurring, locally significant population of a species listed as being nationally scarce which occurs in 16-100 10.0km squares in the UK or occurs on Section 7 or is relevant account of its regional rarity or localisation. A regularly occurring, locally significant number of a regionally important species.
County	Semi-natural ancient woodland greater than 0.25 ha. County / District sites and other sites which the designating authority has determined meet the published ecological selection criteria for designation, including Local Nature Reserves. Any regularly occurring, locally significant population of a species which is listed in a County “red data book” or similar on account of its regional rarity or localisation. A regularly occurring, locally significant number of a County important species on the green list of birds of conservation concern.
Local	Semi-natural ancient woodland smaller than 0.25 ha. Local sites that the designating authority has determined meet the published ecological selection criteria for designation, including Local Wildlife Sites. Sites / features that are scarce within the locality or which appreciably enrich the habitat resource. Areas of habitats identified in county or equivalent authority plans or strategies (where applicable).

Value (sensitivity)	Typical descriptors
	Areas of habitat considered to appreciably enrich the habitat resource within the local context including features of importance for migration, dispersal, or genetic exchange. Populations / communities of species considered to appreciably enrich the habitat resource within the local context including features of importance for migration, dispersal or genetic exchange.
None	Scoped out from further assessment due to limited in extent or not affected.

(adapted from Table 3.9 LA 108)

8.4.8 The level of impacts on biodiversity resources would be reported within the ES in accordance with the criteria provided in Table 3.11 of LA108 as shown in Table 8-2, taking in consideration the Guidelines for Ecological Impact Assessment for the UK and Ireland (CIEEM).

8.4.9 Level of impact shall be determined by the assessment of the following characteristics:

1. positive or negative (e.g. adverse/beneficial)
2. duration (e.g. permanent/temporary)
3. reversibility (e.g. irreversible/reversible)
4. extent/magnitude, and
5. frequency and timing.

Table 8-2: Level of impact and descriptors

Level of impact	Typical descriptors
Major	Permanent addition of, improvement to, or restoration of a biodiversity resource. The extent, magnitude, frequency and/or timing of an impact positively affects the integrity of key characteristics of the resource and the change is likely to restore an ecological receptor to favourable conservation status, or to create a feature of recognisable value within an international or national context – **major beneficial effect.** The change is likely to cause a permanent (irreversible) effect on the integrity of an ecological receptor and/or biodiversity resource. The extent, magnitude, frequency and/or timing of an impact positively affects the integrity of key characteristics of the resource – **major adverse effect.**
Moderate	Temporary addition of, improvement to, or restoration of a biodiversity resource. The extent, magnitude, frequency and/or timing of an impact positively affects the integrity of key characteristics of the resource and the change is likely to restore an ecological receptor to favourable conservation status, or to create a feature of recognisable value within a regional or county context – **moderate beneficial effects.** Temporary/reversible damage to a biodiversity resource. The change adversely affects the valued ecological receptor, but there will probably be no permanent effect on its integrity with

Level of impact	Typical descriptors
	appropriate mitigation and is reversible – **moderate adverse effect.**
Minor	Permanent addition of, improvement to or restoration of a biodiversity resource. The extent, magnitude, frequency and/or timing of an impact positively affects the integrity of key characteristics of the resource and the change is likely to restore an ecological receptor to favourable conservation status, or to create a feature of recognisable value within a local context **minor beneficial effect.** The extent, magnitude, frequency and/or timing of an impact does not affect the integrity or key characteristics of the resource. The change adversely affects the valued ecological receptor in the short term but there will be no permanent effect (reversible) – **minor adverse effect.**
Negligible	The change is likely to restore or retain the status of an ecological receptor – **negligible or slight beneficial effect**. The change affects the valued ecological receptor in the short term but there will be no permanent effect (reversible) – **negligible or slight adverse effect**.
No change	No observable impact, either positive or negative

(adapted from Table 3.11 LA 108)

8.4.10 The importance of the resource/receptor and level of impact would be used to determine the significance of effect based on Table 3.13 of LA108, Significance matrix as detailed in Table 8-38-3.

Table 8-3: Significance matrix

		Level of impact				
		No change	**Negligible**	**Minor**	**Moderate**	**Major**
Resource importance	**International or European**	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	UK or national	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
	Regional	Neutral	Neutral or slight	Slight	Moderate	Moderate or Large
	County	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or Moderate
	Local	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight

(Source DMRB LA108)

8.4.11 Determining the sensitivity of ecological features includes consideration of factors such as their size (area), conservation status and quality. Importance is measured against published selection criteria where available, and with reference to published lists. According to CIEEM (2022) ecologists may identify ecological features that are not included in lists of important sites or features but are considered important based on expert judgement, perhaps because of their local rarity or because they enable effective conservation of other important features.

8.4.12 If protected species or sites could be adversely affected, regardless of the level of importance, they would be subject to detailed assessment within the ES and the application of development licenses would be made, where required. Non-native, invasive species listed under Schedule 9 of the Wildlife and Countryside Act would also be considered in the assessment.

8.4.13 The 'source-pathway-receptor' approach will be followed to identify potential significant effects on ecological features. All three (source-pathway-receptor) must be in place for a significant effect to occur.

8.4.14 Any significant impacts remaining after mitigation (the residual impacts), together with an assessment of the likelihood of success of the mitigation, are the factors which would to be considered against legislation, policy and development management in determining the scheme.

Study area 'Zone of Influence'

8.4.15 The 'zone of influence' has been established based on the features of interest and how they may be affected by biophysical changes as a result of the proposed scheme and associated activities during construction, operation and restoration and would include the scheme boundary including any off-site ancillary works or areas, construction footprint, including potential construction compounds, haul routes, borrow pits and temporary land take.

8.4.16 The 'zone of influence' to inform the desk study for the scheme would extend to:

30km for Special Areas of Conservation designated for bats

10km for other designated sites which form the national site network (SPA's, and SAC non bats)

5km for nationally-designated sites, such as SSSIs and Local Nature Reserves (LNRs)

2km for locally-designated Wildlife Sites.

8.4.17 For protected and otherwise notable species the desk study area extends to 2km and includes records within the last 10 years.

8.4.18 The proposed study area for ecological field surveys included all land affected by the project and immediately adjacent areas where accessible. For the assessment of ponds, aerial photography and OS base mapping up to a buffer of 500m would be used.

Assessment of Net Benefits for Biodiversity

8.4.19 The assessment of Net Benefits for Biodiversity (NBB) differs to the approach to assess Biodiversity Net Gain (BNG) in England where there is a statutory requirement for a 10% gain in biodiversity for new developments and for habitats to be secured for a minimum of 30 years through planning conditions or conservation covenants. In England, it is a requirement that the 10% net gain is measured by the use of a metric developed by Natural England[83].

8.4.20 BNG is not a statutory requirement in Wales and measurement of BNG does not currently utilise a metric. Nor is there a requirement to secure habitats for a minimum of 30 years. However, the approach by the Welsh Government has the same intent to provide net-benefits for biodiversity and to deliver an overall improvement. The adopted Welsh Government approach does not utilise a metric, or calculation of biodiversity 'units' the approach which has been generally adopted in England which utilises the Biodiversity Metric 4. It is unknown as to whether this approach will officially be adopted in Wales.

8.4.21 A net benefit for biodiversity, whilst similar in concept to Net Gain, includes a distinct reference to ecosystem resilience and how the site relates to surrounding ecosystems and biodiversity. As

[83] The Biodiversity Metric 4, Natural England available at https://publications.naturalengland.org.uk/publication/6049804846366720

such it encourages proposals to pro-actively maintain and enhance biodiversity and ecosystems with a focus on avoidance, minimisation and mitigation of impacts within the context of the site with offsite mitigation seen as a last resort in considering the resilience of ecosystems, their diversity, extent, condition, connectivity and adaptability.

8.4.22 The current Welsh Government approach is to aim is to design developments that positively impact ecosystem resilience[84]. NRW have developed a framework for evaluating ecosystem resilience based on five attributes and properties specified in the Environment (Wales) Act 2016, as detailed above. This is referred to as DECCA: Diversity, Extent, Condition, Connectivity and Aspects of ecosystem resilience (refer to Table .8-48-41).

Table 8-4: The DECCA framework

D	**Diversity**: to ensure mechanisms are in place to minimise further loss and where circumstances allow for species' populations to expand and recolonise their natural range (former range) or adapt to future change. More diverse ecosystems are more resilient to external influences (this includes biological, geological and physical diversity on a site). This means development should not cause any significant loss of habitats or populations of species, locally or nationally and must provide a net benefit for biodiversity.
E	**Extent**: to ensure mechanisms allow for the identification of potential habitat, the maintenance of existing assets and networks and promote the restoration of damaged, modified or potential habitat and the creation of new habitat. This means that planning decisions should incorporate measures which seek the creation, restoration and appropriate management of green networks and linkages between habitats and maintaining and enhancing other green infrastructure features and networks.
C	**Condition**: Ecosystems need to be in a healthy condition to function effectively, to deliver a range of important ecosystem services. Planning decisions should not compromise the condition of ecosystems. By taking an integrated approach to development, for example, which considers both direct and wider impacts and benefits it should be possible to make a positive contribution. Planning for the long-term management of retained habitats is key to maintaining condition through for example, the use of planning obligations.
C	**Connectivity**: to take opportunities to develop functional habitat and ecological networks within and between ecosystems and across landscapes, building on existing connectivity and quality and encouraging habitat creation, restoration and appropriate management. The opportunities could include enlarging habitat areas, developing buffers around designated sites or other biodiversity assets or corridors, including transport and river corridors, and the creation of 'stepping stones' which will strengthen the ability of habitats and ecological networks to adapt to change, including climate change
A	**Adaptability to change**: primarily in the form of climate change, for both species (diversity) and ecosystems requires action to protect the extent, condition and connectivity of habitats, features and ecological networks. Development plans, planning proposals and applications which build on protecting designated sites and securing and enhancing green infrastructure will be key ways of addressing the attributes of ecosystems resilience identified in the Environment (Wales) Act as well as facilitating social and economic resilience aspirations of the Well-being of Future Generations Act

8.4.23 In the absence of the utilisation of a metric system, the assessment of NBB will review the proposed Schemes performance against the principles of DECCA.

8.4.24 The baseline ecological conditions would be used as the reference scenario to demonstrate net gains (or losses) in biodiversity from before the Scheme commences to its completion. An overview of the habitats current on site (based on updated site surveys conducted in 2024) would be provided, along with habitats, mitigation and enhancements for species, proposed as part of the Scheme[85]

[84] CIEEM Briefing Paper (September 2022). Welsh Government's Approach to Net Benefits for Biodiversity and the DECCA Framework in the Terrestrial Planning System.

[85] A full assessment upon valuable ecological receptors, would be undertaken as part of the submitted Environmental Statement.

Assessment of Ecosystem Services – Biodiversity

8.4.25 Ecosystem Services are the direct and indirect contributions made by natural capital (ecosystems) to provide for human wellbeing and quality of life. This includes, for example, pollination, provision of clean water, clean air and oxygen supplies, materials, carbon sequestration, moderation of extreme temperature, growth of food, decomposition of waste, and cultural and mental health benefits of contact with the natural world.

8.4.26 In Wales, NRW produced The State of Natural Resources Report (SoNaRR)[86], a requirement under the Environment (Wales) Act 2016. SoNaRR2020 builds on several Welsh, UK and global assessments of the status and trends of natural resources. It looks at the risks those trends pose to our ecosystems and to the long-term social, cultural and economic well-being of Wales, in terms defined by the Well-Being of Future Generations (Wales) Act 2015.

8.4.27 Taken in isolation, biodiversity is generally not considered an ecosystem service itself, but rather a fundamental prerequisite for the provision of ecosystem services. Biodiversity forms the ecological foundation upon which ecosystem services depend. The variety of living organisms and their interactions create the conditions necessary for ecosystems to function and provide services, higher biodiversity often leads to greater ecosystem functioning and stability.

8.4.28 NRW have produced a report[87] which sets out opportunities to be considered for biodiversity enhancement which will be considered in the assessment of effects and enhancement measures in writing the ES. There are also a number of supporting documents in relation to specific habitats and species and ecosystem resilience outlining measure for long term resilience.

8.5 Baseline conditions

8.5.1 The baseline has been established through a combination of desk study, including a review of previous ecological survey work and field work carried out in 2018 and 2019 which was subsequently updated in 2020, 2022, 2023 and 2024.

8.5.2 In accordance with the relevant guidance, an ecology desk study was undertaken in June 2018, which was subsequently updated in 2020, 2022 and 2023. Data would be requested to inform the ES going forward.

8.5.3 Records were obtained from Cofnod (the biological records centre for North Wales) to identify designated sites and protected habitats or species within the 'zones of influence' identified in Section 8.4.16. Cofnod records include wildlife casualties found on roads, where this data is provided to the record centre.

8.5.4 Surveys were conducted following best practice guidance. Table .8-58-521 summarises the surveys that have been undertaken to date in order to identify the baseline conditions along with key findings.

8.5.5 The normal validity period for ecology surveys is 1 - 2 years dependent upon species or habitat being surveyed[88]. Surveys completed during this Scoping study may require further updating or re-validation during subsequent scheme stages.

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[86] Available at https://naturalresources.wales/evidence-and-data/research-and-reports/state-of-natural-resources-report-sonarr-for-wales-2020/sonarr2020-introduction/?lang=en [Accessed 12/09/24]

[87] Natural Resources Wales. 2021. State of Natural Resources Report (SoNaRR): Assessment of the achievement of Biodiversity. Natural Resources Wales.

[88] CIEEM (April 2019) Advice Note on the Lifespan of Ecological Reports and Surveys. Available at https://cieem.net/wp-content/uploads/2019/04/Advice-Note.pdf

Table 8-5: Summary of surveys 2018 - 2024

Survey type	Date survey completed	Survey details	Summary of findings
Desk Study Data	June 2018, June 2020, Sept 2022	COFNOD data retrieval	Protected species records and designated sites.
Phase 1 Habitat Survey	June and October 2018, June 2020, 2022 and 2024	Phase 1 habitat surveys, target noting plant species of importance and INNS.	Noted habitats recorded onto Phase 1 habitat plans. 2024 surveys included the former Airbus Load Out Facility (ALOF) required to assemble a jack up barge required for the construction of the river piers.
Great Crested Newt Habitat Appraisal/ Surveys	July 2018. 5th June 2020 and 24th June 2021, 27th June 2022, 21st June 2024	Habitat Suitability Assessment	Seven ponds assessed over the survey period, ranging between poor to good.
Great Crested Newt Habitat eDNA surveys	22nd June 2020 (RMLP1 only) 24th June 2021 and 27th June 2022 (all suitable ponds), 21st June 2024 (to accessible ponds)	eDNA surveys	Results of the edna surveys highlighted one pond as positive for GCN. This status is unlikely to change. Pond deteriorated in 2022 and no access in 2024. SPEN ecologists conducted edna on ponds in 2023 in relation to works to an overhead powerline within the scheme footprint. EDNA data was negative for the ponds they surveyed. No presence/absence surveys have been conducted, this was approved in principle by NRW.
Badger surveys	July 2018 and as part of extended Phase 1 in 2020 and 2022. Updated walkover and deployment of camera traps in 2023 and 2024	Confirming badger movements around the proposed development site and locating any setts and any additional areas where access not permitted. Bait marking surveys are not deemed as necessary in order to inform Scheme options.	Sett in close proximity (just within 30m) of construction site boundary. Badger activity within the scheme area including for passage.
Otters and water voles	July and Sept 2018 and June 2020 (otter) July and October 2020 Water vole, July and October 2022 (otter and water vole), July and September 2024 (otter and water vole).	Walkover of suitable habitats including the River Dee and Queensferry drain. Presence absence surveys for water voles within Queensferry drain and edna.	No evidence of water voles noted during the surveys conducted in 2018 and 2020 but previous surveys have indicated presence and prints noted under the bridge in 2022 but no other field signs. Evidence of otters along the River Dee, field signs.
NVC Saltmarsh	2021 and July 2022 updated 27th June	Surveys to inform potential mitigation areas Wepre and Greenfield	The Wepre site shows signs of succession along the seaward bund with an increase in scrub,

Survey type	Date survey completed	Survey details	Summary of findings
	2024 for proposed mitigation areas only.		tall ruderal and grass species not specific to saltmarsh communities. The Greenfield site presents as a miniature salt-marsh tidal creek ecosystem.
Overwintering bird surveys	Nov 2018 and Feb 2019 (inclusive). Nov 2020 – Feb 2021 November 2022 to January 2023 Nov 2023 – Feb 2024	Low-tide counts and wintering bird surveys conducted once a month between November 2018 and February 2019 and over 2020 and 21 and Nov 2022 – Jan 2023. Surveys scheduled for winter 2024 / 2025 to include additional areas	Notable bird species recorded including Schedule 1, birds of Principle Importance in Wales and Red List Birds of Conservation Concern. The Dee Estuary Ramsar/SPA sites supports internationally important populations of a number of species. Surveys conducted to date have identified wintering SPA species utilising the fields and the riverbanks within the site extent.
Breeding Bird Surveys	1 April to 31 July 2021 April – July 2023 April – July 2024	The survey methodology applied for the breeding bird surveys broadly followed that used for the Breeding Bird Survey (BBS). Six survey visits of three days each.	Notable bird species recorded including Schedule 1, birds of Principle Importance in Wales and Red List Birds of Conservation Concern.
Reptile presence/ absence surveys	Presence/Absence surveys – Sept – Oct 2018 July – August 2020 July – Sept 2022 July – Sept 2023	Refugia was deployed within suitable land . Seven presence/absence surveys were conducted, in suitable weather conditions.	No evidence during surveys conducted to date
Assessment of PRF of trees and structures	June and October 2018. Updated 9th of June 2020 22nd June 2020 30th June 2022 and during updated walkovers in 2023 and 2024	Potential Roost Features assessment of trees and structures affected by the scheme proposal.	Trees identified which had moderate potential for bats have become subject to damage from storms etc, so valuation has decreased. All trees categorised as having low potential Structures have been identified as supporting bat roosts identified as bat roost and would be subject to a licence from NRW.
Bat surveys on trees – emergence / return to roost	June and Sept 2020	Emergent and return to roost surveys conducted to trees with moderate potential, conducted in 2020. No evidence noted.	During the updated PRA conducted in 2022. It was noted that storm damage had resulted in tree loss which removed the roosting potential of these and

Survey type	Date survey completed	Survey details	Summary of findings
			other trees, as such no further activity surveys were necessary. During PRA's conducted in 2023 and 2024 no further trees were considered to have moderate potential for bats negating the need for further emergence surveys.
Activity Survey Emergence /return to roost Bat surveys structures	July – Sept 2018 June – September 2020 July - October 2022 May – September 2024	Survey of buildings/structures to be demolished. Bat roosts discovered in two structures.	Structures identified as bat roost would be subject to licence from NRW.
Bat Activity Surveys transects	July – Sept 2018 June, August and Sept 2020 July – October 2022 and May 2023. May – September 2024	Activity transects within the scheme footprint and the deployment of static bat detectors.	The bat transect surveys and deployment of statics conducted to date have identified eight species of bat within the scheme area, including the common and soprano pipistrelle, whiskered / Brandt's, noctule, natterers, Daubenton's, lesser horseshoe bat and brown long-eared bat.
Fisheries	NRW asked to provide recent records from the River Dee Chester Weir fish trap upstream of the bridge.	No surveys undertaken.	The results indicate that there is a peak migration time for sea lamprey between May and June, and for the river lamprey in February. Salmon and sea trout generally have their peak migration periods from June to August. There is movement outside of this period (including an Autumn run of smolts) but these were limited in numbers. Taking these peak migration times for salmonids and lampreys together, the most sensitive period for these species within this part of the Dee is from March – August inclusive.

Designated sites

8.5.6 Information on statutory designated sites within distances of 30km for SAC designated for bats, 10km for other designated sites such as SPA, Ramsar, 5km for nationally designated sites such as SSSIs and LNRs was obtained through desk study.

8.5.7 Designated sites which form the national site network are shown on Figure 8-1 Other designated sites and Wildlife Sites are shown on Figure 8-2.

Figure 8-1: Internationally Designated Nature Conservation Sites

Due to size this Figure is included in Appendix A.5.

Figure 8-2: Nationally Designation Nature Conservation and Wildlife Sites

Due to size this Figure is included in Appendix A.5.

8.5.8 Table 8.8-68-6 details the statutorily-designated sites within the vicinity of the proposed scheme.

8.5.9 No SACs designated for bats occur within 30km of the Scheme.

Table 8-6: Statutory designated sites within the scheme area

Site	Designation	Reason for notification	Proximity to scheme[89]
Dee Estuary	Ramsar Site (UK11082)	Location of mud and sand flats, supports breeding Natterjack Toad, supports waterfowl.	Within 1 km northwest. Tidal link
	Special Protected Area (SPA) Classified 17/07/1985	Importance for waterfowl by supporting populations of importance of wintering, breeding and migratory bird assemblages.	Within 1km northwest. Tidal link
	Special Area of Conservation (SAC)	Annex 1 habitats Primary reason – Mudflats and sandflats, Salicornia spp. And Atlantic salt meadows. Noted for river and sea lamprey and Petalwort	Within 1km northwest. Tidal link
	Site of Special Scientific Interest (SSSI) 0839	Populations of internationally important wintering waterfowl; its populations of individual waterfowl and tern species; its intertidal mud and sandflats, saltmarsh and transitional habitats; the hard rocky sandstone cliffs of Hilbre Island and Middle Eye with their cliff vegetation and maritime heathland and grassland; its assemblage of nationally scarce plants; and its populations of sandhill rustic moth *Luperina nickerlii gueneei*, a Red Data Book species	Within 1km northwest Tidal link

[89] As taken from the centre of the existing bridge

Site	Designation	Reason for notification	Proximity to scheme[89]
River Dee and Bala Lake Site	Special Area of Conservation (SAC)	Aquatic habitats and migratory fish, otters.	Crossed by project. ALOF area within boundary of designated site.
River Dee	Site of Special Scientific Interest (SSSI) 2554	Fluvial geomorphology, carboniferous geology, range of river habitats types, saltmarsh transition habitats floating water plantain, slender hare's ear, sea barley, hard grass, otter, salmon, bullhead, brook lamprey, river lamprey, sea lamprey, club tailed dragonfly and other aquatic invertebrates.	Crossed by project. ALOF area within boundary of designated site.
Connah's Quay and Woodlands	Site of Special Scientific Interest (SSSI) 2498	Population of great crested newt, assemblage of widespread amphibian species and its semi-natural broadleaved woodland.	2km southwest
Deeside and Buckley Newt sites	Special Area of Conservation (SAC)	Annex 1 species - Old sessile oak woods. Annex 2 species - Great Crested Newt.	2km west
Buckley Claypits and Commons	Site of Special Scientific Interest (SSSI) 2592	Population of Great crested newt, assemblage of widespread amphibian species and for its mosaic of semi-natural grassland.	2km southwest
Gathering grounds and grounds woods & Llwyni pond.	Local Nature Reserve (LNR) (2641)	This 5-hectare reserve is nearly completely surrounded by housing development but the pond is still a haven for great crested newts while the oak and ash trees provide cover for bluebells, wood anemones and ramsons and the cuckoo flower and yellow rattle can be seen in the open grasslands.	2.7km west
Shotton Lagoons and Reedbed	Site of Special Scientific Interest (SSSI) 1639	This SSSI supports a large and increasing population of breeding common terns and reedbeds important for locally uncommon breeding species such as reed warblers. Wildfowl from the nearby estuary use the site in winter and the site contributes therefore to the overall wintering waterfowl assemblage of the Dee Estuary	3.4 km west
Inner Marsh Farm	Site of Special Scientific Interest (SSSI) - 1438	The site is notified for the ornithological interest it supports, particularly its wintering and summering bird populations.	4.8km northwest
Maes y Grug	Site of Special Scientific Interest (SSSI) 1423	Population of great crested newt.	>5km west

8.5.10 A separate HRA Screening report would be produced which would detail those sites within the national site network screened in for further assessment as required under the Habitat Regulations.

8.5.11 Information on non-statutory designated Wildlife Sites within 2 km was obtained through desk study (Cofnod). Five sites were identified and are shown on Figure 8-2 and detailed in Table .8-78-7.

Table 8-7: Non-statutory designated sites within the scheme area

Site	Designation	Reason for notification	Proximity to scheme[90]
The River Dee	Wildlife Site (36NW01)	Coastal and floodplain grazing marsh, Coastal saltmarsh, Mudflats, Ornithological interest.	420 northwest
Aston Wetland	Wildlife Site (36NW02)	Level triangular site of willow scrub with marshy grassland mosaic with patches of tall herb fern and birch trees along the railway. Floristically species rich.	1.48 km southwest
Sea View Wetland	Wildlife Site (26NE11)	Wetland with stands of common reed, great willowherb, bare ground (where disturbance has occurred) and a marshy grassland. Floristically species rich.	1.60 km west
Engineer Park	Wildlife Site (36NW05)	Pasture / meadow and scrub	1.80 km east
Wepre Wood	Wildlife Site (26NE12)	Broad-leaved woodland and scrub	1.89 km east

Habitats

8.5.12 A summary list of the habitats recorded within the scheme boundary and adjacent areas is provided below along with their Phase 1 Category Codes).

1. Woodland broadleaved plantation A1.1.2
2. Scrub dense and continuous A2.1 and scattered A2.2
3. Parkland / scattered trees – broadleaved A3.1;
4. Neutral grassland – semi-improved B2.2
5. Improved grassland B4
6. Tall herb and fern – tall ruderal C3.1
7. Marginal and inundation – inundation vegetation F2.2
8. Running water G2
9. Intertidal mud / sand H1.1
10. Saltmarsh dense / continuous H2.6
11. Cultivated disturbed land – arable J1.1
12. Cultivated disturbed land – introduced shrub J1.4
13. Boundaries – hedge intact species poor J2.1.2
14. Built up areas – building J3.6 and caravan site J3.4
15. Bare ground J4, and

[90] As taken from the centre of the existing bridge

16. Standing water G1.

8.5.13 Figures 8-3A – 8-3F identifies the broad habitats occurring within the scheme boundary.

Figures 8-3A-8-3F: Broad habitats within the scheme boundary

Due to the size, Figures 8-3A-8.3F are included in Appendix A.5.

Protected and notable species

8.5.14 Table .8-58-521 provides a summary of key findings from surveys of protected and notable species conducted to date. Surveys have been conducted between 2018 and 2024, and will be updated as the scheme progresses. Initial survey data was reported in the ES produced to inform the scheme proposals current at that time. Supplementary survey data has been reported in a separate report[91] as well as Ghost Licenses which have been produced and submitted to NRW for approval in principle. A brief summary is provided below, supplementary survey data can be provided upon request.

Notable flora

8.5.15 The desk study identified twenty-nine notable or protected plant species within a 2.0km search radius within the last ten years. During the site surveys conducted to date, the following species, which are included in the categories detailed above, were noted: Wild Onion, found on the cycle track east of the A494 and northern bank of the River Dee (GR SJ 3248 6861); Babington's orache, found along both the northern and southern banks of saltmarsh along the River Dee; lombardy poplar, bordering the eastern and southern side of the DCWW Queensferry Water Treatment Works and western side of the A494 just south of the River Dee Bridge (GR SJ 3226 6852).

Great crested newts and other amphibians

8.5.16 Seven ponds were assessed over the survey period, in terms of their suitability to support great crested newts, results ranged from between poor to good in terms of habitat suitability. Results of the eDNA surveys highlighted one pond as positive for GCN which is located within 500m of the scheme footprint. This status is unlikely to change. The pond deteriorated in 2022 and there was no access to survey in 2024.

8.5.17 During updated reptile surveys conducted between July and August 2020, one great crested newt was discovered under artificial refugia (roofing felt) placed within an undisturbed area located at the back of the wastewater treatment works. Seven visits were made over the survey period in 2020, 2022 and 2023, but GCN was only observed on only the one occasion. The location where the GCN was discovered is within the scheme footprint. This area has since been subject to clearance works in respect of improvement works to the water treatment facility, not part of this scheme, and subject to surveys and site supervision from other ecological consultants.

8.5.18 Other amphibian species may be present within the scheme as there is suitable habitat within the Queensferry Drain, the water treatment works (a single frog was observed) and along the railway embankments.

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[91] Hall D (2023) a494 River Dee Bridge Improvement Scheme Key Stage 3 – 4 Appendix 08.I Supplementary Ecological Survey Information for Welsh Government. MML Document Ref: 395318-0105-(01)

Otter

8.5.19 Otters are a feature of interest of the River Dee and Bala Lake SAC which is crossed by the scheme and evidence of otters has previously been found along the River Dee during surveys including feeding remains, spraint and footprints. However, suitable secure breeding sites are absent from the scheme footprint although there are suitable rest-up areas within trees and scrub.

Water vole

8.5.20 Surveys conducted in 2018 identified Queensferry Drain as having suitable habitat for water voles; no field signs were recorded during surveys conducted in 2018, 2020 or 2022, although numerous field signs for the brown rat were recorded. A dropping sample was collected on 04/09/2018 for further confirmation, the results received confirmed that the dropping sample was from a brown rat, 99% sequence similarity.

8.5.21 Surveys conducted in 2022 highlighted water vole prints within the mud on the south bank of the River Dee underneath the A494 bridge. At this location there are no areas suitable for burrows, and no other evidence, such as burrows or latrines have been found. The habitat at the bridge is not suitable for water voles owing to a lack of cover, burrowing habitat and the tidal influences of the Dee.

Badger

8.5.22 A total of four setts have been recorded during surveys conducted between 2018 – 2024 as well as foraging and movement activity, no latrines have been recorded. These are considered to be single outliers, with partially used or disused holes.

8.5.23 There was evidence that badgers are commuting under the fence which bounds the footpath between the railway and the water treatment works and are entering the land within the water treatment works and also Queensferry drain. All land within the water treatment works and adjacent to the water treatment works, including the Queensferry drain, is considered to be part of the resident badger clan’s territory and foraging / commuting habitat. Badgers would also utilise the habitat long the railway network to disperse into the wider habitat.

Reptiles

8.5.24 Presence / absence surveys were conducted in 2018, 2020, 2022 and 2023. Surveys focused on suitable land within the wastewater treatment works, the Queensferry Drain, a former scrap yard located to the north of the water treatment works and adjacent to the Riverside gypsy travellers site and along the footpath leading north from Chemistry Lane. No reptiles were recorded.

Breeding birds

8.5.25 Breeding bird surveys were conducted in 2021, 2023 and updated in 2024. The results of the surveys highlight that the scheme area is considered to support a good number of ‘notable’ and ‘priority’ species. However, most species were recorded in relatively low or moderate numbers which may be attributable to ongoing anthropogenic disturbance in the vicinity. Nevertheless, the desk and field data together highlight the importance of various habitats for birds in the scheme area.

8.5.26 Separate reports have been produced and can be provided on request.

Overwintering birds

8.5.27 Surveys for overwintering bird have been conducted between November to February, including Nov 2018 and Feb 2019 (inclusive), Nov 2020 – Feb 2021, November 2022 to January 2023 and Nov 2023 – Feb 2024. Surveys are due to be repeated this winter season Oct/Nov 24 – February 2025

8.5.28 The survey have identified Schedule 1 species as well as species of Principal Importance (Wales) and species of conservation concern.

8.5.29 Small numbers of six wintering SPA species were recorded, utilising the fields and the riverbanks within the site extent.

8.5.30 There were distinct areas in which species did concentrate and appeared to be of more value than others. These notable areas include the following (including the distance from the Scheme footprint):

1. Running watercourse (River Dee) (0m)
2. Rocky embankments exposed during low tide (220m)
3. Riverbanks (0m), and
4. Arable land, north-west of the A494 bridge (50m).

8.5.31 Separate reports have been produced and can be provided on request.

Invertebrates

8.5.32 No detailed invertebrate surveys have been conducted to inform the scheme. The desk study identified thirty-four notable or protected invertebrates within a 2.0km search radius within the last ten years, the majority of which are moths.

Fisheries

8.5.33 The desk study identified four records within a 2.0km search radius within the last ten years. These are the brown / sea trout (*Salmo trutta)*, bullhead (*Cottus gobio)* and European eel (*Anguilla anguilla),* all within Wepre Book located 1741m from the Scheme location and Allis Shad (*Alosa alosa)* recorded in the River Dee.

8.5.34 Fish species that migrate through the River Dee and under the location of the bridge include those which are features of interest of the designated sites. These are Atlantic salmon (*Salmo salar*), Sea lamprey (*Petromyzon marinus*) and River lamprey (*Lampetra fluviatilis*).

8.5.35 The canalised section of the River Dee is a uniform habitat with few species at fairly low densities. There is little habitat for resident fish populations and any fish present, which would also include any Eel, would only be transient. All these protected species are migratory and none feed on the journey up the estuary.

8.5.36 The results of fish catches at Chester weir for sea and river lamprey were provided by NRW. The results current ate time of writing indicate that there is a peak migration time for sea lamprey between May and June, and for the river lamprey in February.

8.5.37 The results of fish catches for salmon and sea trout were provided from NRW. Both generally have their peak migration periods from June to August. However, there is movement outside of this period (including an Autumn run of smolts).

8.5.38 Taking these peak migration times for salmonids and lampreys together, the most sensitive period for these species within this part of the Dee is from March – August inclusive.

Invasive non-native species

8.5.39 Information on the locations of INNS was collected through a desk study and site surveys conducted in 2018, 2020, 2022 and 2024.

8.5.40 Large stands of Japanese knotweed were recorded during the Phase 1 habitat surveys. These stands occur adjacent to the Chester to Holyhead railway line, close to the eastbound carriageway as shown on Figure 8.3A, Target Note 9 and Target Note 11.

8.5.41 A stand of giant hogweed *Heracleum mantegazzianum* did occur within plantation woodland adjacent to the footpath which heads under the A494 bridge crossing. This plant is a hazardous skin irritant and appears to have been treated with herbicide. No evidence of this species was noted during surveys conducted in 2024.

8.5.42 Chinese mitten crab (*Eriocheir sinensis)* was recorded within 1735m from the Scheme in Wepre Brook. The first record of the Chinese mitten crab in North Wales was made in the River Dee in 2006[92]. In their report, NRW state that a substantial population is thought to be present on the River Dee, however this is based on anecdotal evidence. However, the Chester Weir fish trap has captured a total of 234 mitten crabs since 2007, 94% of which were caught in the months of September and October. The NRW report suggests that the canalised section of the River Dee between Connah's Quay and Saltney (which includes the areas subject to this assessment) does not appear to be favourable habitat due to a lack of vegetation below the high tide water mark. However, evidence suggests that the River Dee population size and geographical range is increasing.

8.6 Potential and likely significant effects

8.6.1 The assessment of the significant effects of the Scheme would focus on those ecological features identified through desk study and field surveys as being important. The value of an ecological feature would be determined based on professional judgement and the role of the ecological feature within the landscape, as well as considering its importance within a defined geographical context and overall resilience.

8.6.2 LA108 states that a scoping assessment shall identify potential significant effects by answering the following questions to gain an understanding of the need to undertake further assessment:

1. is the project likely to impact designated sites (statutory or non- statutory)
2. is the project likely to impact protected or priority habitats
3. is the project likely to impact protected or priority species
4. is the project likely to impact the function or quality of habitats
5. is the project likely to impact the conservation status of habitats and species.

8.6.3 Where the response to one or more of the scoping assessment questions is 'yes', further assessment shall be undertaken.

8.6.4 Various characteristics contribute to the importance of ecological features including whether it is internationally (former Natura 2000 sites which are now noted as those which are within the national site network), nationally, regionally, of county or local importance, the size of habitat or species population, habitat connectivity, rarity and robustness (resilience). This includes, for protected species, consideration of both the current conservation status (CCS) and favourable conservation status (FCS) where this information is available. In cases of reasonable doubt,

[92] Falkingham, A., Yeardley, J. and Hughes, R., 2016. Monitoring of Chinese Mitten Crabs (*Eriocheir sinensis)* on the River Dee. NRW Evidence Report No: 154, 90 pp, Natural Resources Wales, Bangor.

where it is not possible to justify a conclusion of no significant effect robustly, a significant effect would be assumed and, where uncertainty exists, this would be acknowledged.

8.6.5 The Scheme includes works within the River Dee which is a dynamic and changeable environment which may influence the potential nature, scale and extent of environmental change as well as the way in which the species which utilise the River Dee are affected. These factors would be considered within the assessment of the river environment.

8.6.6 The former Airbus Load Out Facility (ALOF) will be required to assemble a jack up barge required for the construction of the river piers. The ALOF is a ramped access to a jetty that was formerly used to load wings manufactured at the Airbus factory onto a barge that transported the wings down river to Mostyn Docks. When operational, regular dredging of the river was required to ensure sufficient depth of water to float the barge. The ALOF is likely to be required for the construction of the jack up barge in the early stages of the project and at the end for the dismantling of the barge. Localised dredging of the river may be required subject to further investigation of the riverbed and detailed operational requirements of the appointed Contractor.

Potential effect pathways

8.6.7 There are a number of areas of potential effect pathways that are relevant and which would be considered within the ES. These include, but are not limited to, the following:

1. Pre-construction activities – ground investigations, vegetation clearance, site preparation
2. Construction phase – demolition, noise and vibration, habitat loss from land take, pollution incidents, dredging.
3. Operational phase – wildlife casualties, land use change, change in hydrology, lighting, maintenance, road run-off, alteration to hydrodynamics.

In-combination effects and inter-relationships

8.6.8 In-combination effects refer to the combined or synergistic impacts on a single receptor or resource resulting from multiple environmental effects of a proposed Scheme. When considering in-combination effects in the assessment, the potential effects of the measure on the feature is the key consideration. The scheme could have an effect on water quality which, in isolation, would not be a significant effect but, in combination with other effects, could be significant.

8.6.9 In identifying and assessing the likely significant effects of the proposed Scheme on ecology and nature conservation, the inter-relationships with the environmental impacts identified in other ES chapters would be considered.

8.6.10 In-combination effects on sites within the national sites network would also be addressed in the HRA.

Cumulative effects

8.6.11 Cumulative effects can result from individually insignificant but collectively significant actions taking place over a period of time or concentrated in a location. Different types of actions can cause cumulative impacts and effects including multiple projects added together to give rise to a significant effect due to their proximity in time and space.

8.6.12 The assessment of cumulative effects of the Scheme with other projects in the vicinity are set out in Chapter 16 of this scoping report.

8.6.13 Cumulative effects on sites within the national sites network would also be addressed in the HRA.

8.7 Mitigation and enhancements

8.7.1 The design and mitigation hierarchy outlined in LA 104 shall be applied to avoid, reduce and remediate adverse effects on biodiversity resources.

8.7.2 Where a residual effect continues to be significant, the design and mitigation hierarchy outlined within LA 104 would be re-applied to reduce effects further.

8.7.3 Mitigation would be described to ensure the compliance of the Scheme with nature conservation legislation and biodiversity policy and any enhancements are proposed. The Scheme would also be assessed for residual impacts and their significance.

8.7.4 Environmental mitigation and biodiversity enhancement works would occur within areas of the soft estate and would include wildflower verges, swales, native woodland plantations and amenity grassland.

8.7.5 A number of Environmental Objectives have been produced which include the protection and safeguarding of designated sites, mitigation to enhance ecosystem resilience and secure long-term benefits for biodiversity and improve habitat connectivity.

8.7.6 Mitigation and enhancement as set out within any required development licenses would also be adhered to.

8.8 Assumptions and limitations

8.8.1 This chapter is based on the current Scheme boundary, and of surveys conducted to date. The findings may be subject to change as a result of further surveys and consultations and again during Scheme development.

8.8.2 Surveys to date have been conducted following best practice guidance, within the appropriate survey season and where access was permissible and possible. However it should be noted that conducting surveys for mobile species presents several important assumptions and limitations owing to the mobility of species. Mobile species can move in and out of survey areas, and results are dependent upon a number of factors including behaviour, habitat use, or environmental conditions.

8.9 Conclusions of scoping

8.9.1 Taking into consideration the questions as set out in Section 8.6.2 and LA108 further assessment is required and Biodiversity is scoped into the ES. The assessment of the baseline from surveys conducted to date has established the relative importance of biodiversity resources/receptors using the guidance within Table 3.9 of LA108.

8.9.2 It is impractical for an assessment of the ecological effects of the Scheme to consider every species and habitat that would be affected; instead, it should focus on 'Valued Ecological Receptors' (VERs) based on their legal protection, designation, rarity etc and whether they are significantly affected by the Scheme. Species and habitats which are considered to be widespread, not threatened and resilient to the Scheme effects, and which will remain viable and sustainable, have been scoped out of the assessment. However, where a species or habitat has been 'scoped out' consideration will still be given to safeguarding biodiversity in general in order to comply with relevant plans, policies and initiatives.

8.9.3 **Table 8-8** provides a summary of key receptors scoped in at this stage and the justification for this. In respect of protected sites, these would be subject to further assessment as part of the HRA.

Table 8-8: Biodiversity interest scoped in for further assessment

Valuable Ecological receptor (VER)	Resource value	Justification for scoping in for further assessment
Statutory designated sites		
Dee Estuary Ramsar	**International / European**	Due to its assemblages of waterfowl and wetland birds and habitats.
Dee Estuary SPA	**International /European**	As above.
Dee Estuary SAC/SSSI	**International / European**	Due to the presence of Atlantic salt meadows which includes the sub feature saltmarsh, estuaries, mud flats and sandflats not covered by seawater at low tide which includes the sub feature intertidal communities. The presence of migratory fish species Atlantic salmon and sea and river lamprey.
River Dee and Bala Lake / SAC	**International / European**	SAC is considered to be of international / very high value due to the presence of migratory fish species Atlantic salmon and sea and river lamprey, and otter.
Priority Habitats		
Running water	**International – European**	The River Dee is a priority habitat as well as being designated an SAC/SSSI.
Intertidal mud / sand	**UK / National**	A feature of the River Dee SSSI as well as being a priority habitat.
Saltmarsh	**UK / National**	Although limited in its extent at the location of the Scheme, saltmarsh is a feature of the River Dee SSSI as well as being a priority habitat.
Standing water	**Local**	Only one pond is considered to be classified as a Priority Habitat[93], this is owing to the positive record of GCN, a protected species. In general, the habitat quality of the pond is below average. No ponds would be lost or directly effected as a result of the scheme, however, GCN have been recorded within the scheme footprint and conditions can change.
Species (Fauna)		
Great Crested Newt	**Regional**	A GCN was discovered within the Scheme footprint during the reptile presence/absence survey, and one pond was positive for GCN eDNA.
Other amphibians	**Local**	Suitable habitat within the Queensferry Drain and the water treatment works and along railway embankments.
Bats	**Regional**	All bats are afforded protection under current legislation and the surveys to date have identified seven species of bats and two pipistrelle roosts. A Regional value is proportionate to the species and numbers encountered on site, habitat to be affected and roost status.
Otter	**UK / National**	Otters are a feature of interest of the River Dee and Bala Lake SAC which is crossed by the Scheme and evidence of otters has been found along the River Dee, however the suitability for natal dens is poor due to disturbance although there are suitable rest up areas within areas of trees and scrub. Otter populations and trends show a general upward trend in the Dee catchment and so a value of National importance has been assigned.
Badger	**Local**	Active setts recorded just within the Scheme footprint and badgers utilise land within the water treatment works, railway line and the Queensferry Drain for foraging as well as habitat occurring along the Dee embankments.
Wintering birds	**Local**	Considering the range and number of species recorded during the surveys to date the site generally supports local populations of birds and is considered to be of Local Importance as coined by Fuller (1980). In general, the utilisation of this area by wintering birds is considered to be typical in respect to the habitat types found within the site extent.

[93] Ponds (UK BAP Priority Habitat description) (jncc.gov.uk)

Valuable Ecological receptor (VER)	Resource value	Justification for scoping in for further assessment
Breeding birds	**Local**	Notable species recorded during previous surveys Loss of, and disturbance to, habitat used for nesting and foraging.
Fisheries	**International / European**	The Atlantic salmon, sea and river lamprey are features of interest of the SACs and regularly occur within the Dee at the location of the proposed Scheme.
Water voles	Local	Limited evidence along the River Dee.

8.10 Consultations and key stakeholders

8.10.1 This scheme is a continuation from the A494 River Dee Bridge Improvement Scheme and will be taken forward independently of any other highways project. It does draw on information and consultations undertaken as part of the WelTAG Stage 3 study for the A494 River Dee Bridge Improvement Scheme.

8.10.2 An Environmental Liaison Group for the A494 River Dee Bridge Improvement Scheme was constituted and held its first meeting in June 2018; further meetings continued during the preparation of the Statement for the A494 River Dee Bridge Improvement Scheme until a decision was made in 2023 to revisit the Scheme proposals as a result of the Roads Review.

8.10.3 Representatives of NRW, FCC, NMWTRA, the Welsh Government, CADW and the project team have been involved in previous consultations and responses have been received on reports produced in respect of nature conservation interests, current at that time. The last ELG in respect of the previous Scheme was on the 26th May 2022.

8.10.4 Consultation will be ongoing with key stakeholders as the Scheme progresses. The draft Scoping Report will be issued to statutory consultees for comment, and any comments received will be recorded in the final report to Welsh Government.

9 Landscape and Visual Effects

9.1 Introduction

9.1.1 This chapter describes the scope of the landscape as a resource, and visual amenity potentially affected by the replacement of the A494 River Dee Bridge. The applicable national and local planning policies that should be considered in the assessment are presented alongside the assessment methodology, and relevant guidelines.

9.1.2 This chapter has been prepared in accordance with the Design Manual for Roads and Bridges (DMRB) LA103 Scoping projects for Environmental Assessment[94], LA104 Environmental assessment and monitoring[95], and LA107 Landscape and visual effects[96].

9.1.3 The baseline would be formed using a combination of desk study and field survey work, which includes examining assessments of previous iterations of proposals to improve the A494 at Queensferry.

9.2 Legislation and policy context

9.2.1 The following legislation, including subsequent amendments, is relevant to the Scheme landscape design and assessment:

1. National Parks and Access to the Countryside Act 1949.
2. Wildlife and Countryside Act 1981.
3. Hedgerows Regulations 1997.
4. The Countryside and Rights of Way (CRoW) Act 2000.
5. The Natural Environment and Rural Communities (NERC) Act 2006.
6. Well Being if Future Generations Act 2015.
7. Environment (Wales) Act 2016.
8. The Green Corridors on the Welsh Government Trunk Road and Motorway Network Initiative 2018.

9.2.2 The current national land use planning policies for the Welsh Government are set out in Planning Policy Wales Edition 12 (February 2024). Of relevance to landscape and visual impact assessment (LVIA), is Chapter 6 'Distinctive and Natural Places.

9.2.3 Planning Policy Wales (PPW) is supplemented by a series of topic based Technical Advice Notes (TANs). TANs relevant to the Scheme landscape design include:

1. TAN10 *tree preservation orders*[97] provides guidance on where local planning authorities are to make adequate provision for the preservation and planting of trees when granting planning permission, through the process of making Tree Preservation Orders (TPOs).

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[94] https://www.standardsforhighways.co.uk/tses/attachments/fb43a062-65ad-48d3-8c06-374cfd3b8c23?inline=true

[95] https://www.standardsforhighways.co.uk/tses/attachments/0f6e0b6a-d08e-4673-8691-cab564d4a60a?inline=true

[96] https://www.standardsforhighways.co.uk/tses/attachments/bc8a371f-2443-4761-af5d-f37d632c5734?inline=true

[97] https://www.gov.wales/technical-advice-note-tan-10-tree-preservation-orders

2. TAN12 *design*[98] *provides guidance on how good design should be achieved through the planning process.*

9.2.4 Procedural guidance relevant to LVIA is provided in Welsh Government planning circulars, including Circular 64/78 *Trees and Forestry*[99] (Department of the Environment, Welsh Office 1978).

9.2.5 PPW promotes the use of Natural Resources Wales' LANDMAP data system as an important information resource to establish the landscape baseline.

9.2.6 FCC adopted their Local Development Plan (FLDP) 2015-2030[100] in January 2023 and this plan will be considered in the assessment. Strategic policy ST13 *Natural and Built Environment, Green Networks and Infrastructure* states:

Environmental networks can, and do, have a variety of roles in protecting and enhancing biodiversity, defining the landscape setting of places, defining the transition from urban to countryside, and facilitating well-being through amenity, recreation and active leisure. The key is to balance these sometimes conflicting roles, achieving a sustainable balance.

Development should identify, respect, protect, enhance and connect Flintshire's environmental assets, to create a multifunctional network of natural and historic resources.

9.2.7 Parts of the Scheme may be visible from the neighbouring authority of Cheshire West and Chester (CWC). There would be no direct impact, but reference is made to the adopted Local Plan (*Cheshire West and Chester Local Plan* adopted in 2019), when assigning a sensitivity to landscape and visual receptors.

9.3 Relevant guidance

9.3.1 The LVIA would be carried out in accordance with methodology set out within DMRB LA107.

9.3.2 Other relevant guidance documents referred to include:

1. *National Landscape Character Areas*[101] (NLCA) (Natural Resources Wales 2014).
2. LANDMAP[102], maintained by Natural Resources Wales, including guidance notes GN46 Using LANDMAP in landscape and visual impact assessment, GN4 LANDMAP and the Cultural Landscape, and GN5 LANDMAP and the Geological Landscape.
3. Guidelines for Landscape and Visual Impact Assessment, Third Edition (GLVIA3) Landscape Institute and Institute of Environmental Management and Assessment (2013)
4. Technical Guidance Note LITGN-2024-01 Notes and Clarifications on Aspects of GLVIA3 (2024).
5. Technical Guidance Note 06/19 Visual Representation of Development Proposals[103] (2019) (under review as of January 2024).
6. Technical Information Note 04/2018 Environmental Colour Assessment[104] (2018).

[98] https://www.gov.wales/technical-advice-note-tan-12-design
[99] https://www.gov.wales/trees-and-forestry-circular-6478
[100] https://www.flintshire.gov.uk/en/Resident/Planning/Local-Development-Plan.aspx
[101] https://naturalresources.wales/evidence-and-data/maps/nlca/?lang=en
[102] https://naturalresources.wales/guidance-and-advice/business-sectors/planning-and-development/evidence-to-inform-development-planning/landmap-the-welsh-landscape-baseline/?lang=en
[103] https://www.landscapeinstitute.org/visualisation/
[104] https://www.landscapeinstitute.org/technical-resource/environmental-colour-assessment/

9.4 Assessment methodology

9.4.1 The Welsh Government have been investigating solutions to improve road safety and traffic flow for the A494 corridor at Deeside for many years. The review of previous work includes:

1. A494 Drome Corner to Ewloe Improvement (2006).
2. A55 / A494 / A548 Deeside Corridor Improvement (2017).
3. A494 River Dee Bridge Improvement Scheme (2020).

9.4.2 In accordance with LA107, the study area includes the project land take boundary, the wider landscape setting that could be influenced, and the extent of the area from which the Scheme including structures and traffic would theoretically be visible.

9.4.3 The extent of visibility is determined by analysing terrain data with specialist GIS software to produce a Zone of Theoretical Visibility. Field work is then carried out to refine the study area and identify where potentially significant effects are likely to occur. Built elements in the urban landscape significantly limit the extent of visibility.

9.4.4 Viewpoints selected to represent a range of directions and distances from the Scheme, and land uses will be used as an aid to the assessment of landscape and visual effects. The representative viewpoints would be accessible from public roads, open areas with public access and rights of way.

9.4.5 As part of the desk study a review of the landscape resource within the study area is carried out to establish the baseline scenario, with reference to the following relevant published sources:

1. National Landscape Character Areas (NRW).
2. LANDMAP (NRW).
3. National Character Areas (Natural England).
4. A Landscape Strategy for Cheshire West and Chester Borough 2016 (CWC).
5. Marine Character Areas (NRW in Wales, Marine Management Organisation in England).
6. National and Local Planning Policy (as outlined in 9.2).
7. Topographic maps including Ordnance Survey (OS) Landranger maps (1:50,000 scale), OS Explorer maps (1:25,000 scale), OS VectorMap Local (1:10,000 to 1:5,000 scale), and OS MasterMap (1:2,500 to 1:1,250 scale).
8. Aerial imagery (both ortho-rectified and oblique).
9. Terrain data including OS Terrain 5 digital terrain model (DTM) for initial ZTV and LiDAR digital surface model (DSM) for refinements in built-up areas.

9.4.6 Landscape character is a combination of geology, soils, landform, vegetation, field patterns, land use and settlement. Wales is divided into 48 broad national-scale character areas. The Scheme is located within NLCA 13 *Deeside and Wrexham*. Key characteristics include an area of lowland plain traversed by a large single river, generally foothills and wooded tributary valleys to the west and broad flat plain to the east. Settlement consists of relatively large urban, almost linked communities with industrial character and rural communities associated with landed estates.

9.4.7 LANDMAP further divides the NLCA into geographical areas identified by their own landscape characteristics and qualities. There are 5 datasets (or aspects). These are *Geological Landscape* (GL), *Landscape Habitats* (LH), *Historic Landscape* (HL), *Cultural Landscape Services* (CLS) and *Visual and Sensory* (VS). Each aspect area has been evaluated in a nationally consistent way.

9.4.8 CWC have produced a landscape strategy incorporating the regional landscape character types (such as *Rolling farmland* and *Mudflats and Saltmarsh*), within the local authority area. Main urban areas are not included. Each landscape character type is further divided into local character areas (e.g. *Mudflats and Saltmarsh* includes *Dee Estuary* and *Stanlow and Ince banks*), and guidance is provided for the conservation, enhancement and restoration of the landscape. There is no evaluation, but an overall landscape management strategy is given.

9.4.9 Information contained within LANDMAP, the CWC Landscape Strategy and field work define the Landscape Character Area (LCA) boundaries that are taken forward for assessment. The LCAs within the study area are determined by:

1. Organising the landscape into areas of distinct, consistent and recognisable character.
2. Describing the key characteristics such as landcover and pattern, scale and appearance, human interaction and tranquillity, sense of place and scenic value, seasonal interest and night-time influences.
3. Assessing their condition and quality.
4. Judging importance or value, which considers any landscape, ecological or cultural heritage designation, and any assets of local significance without designation that may be valued by local communities.
5. Considering their ability to accommodate change of the type proposed without unjustifiable change to the baseline condition and/or the achievement of landscape strategies and policies.

9.4.10 The assessment of significance of effect on the landscape character areas is a combination of a judgement of sensitivity of landscape receptor and a judgement of the magnitude of landscape effect. Figure 3.17N in LA107 presents the steps in assessing landscape effects. Landscape sensitivity is a combination of judgements of the susceptibility of the receptor to change and the value related to that receptor. The magnitude of effect is a combination of judgements about size and scale of effect, extent of area it occurs over, whether reversible or irreversible and whether short term or long term in duration.

9.4.11 The scheme operational stage would be long term and irreversible. The scheme construction stage would be short-term and partially reversible. Areas used for construction compounds and not required for operation of the scheme could be restored to their original condition. The size and scale of landscape effect is usually greatest during construction, but when combined with short term duration and reversibility, the magnitude of landscape effect during construction may not necessarily be greatest.

9.4.12 The significance of landscape sensitivity will be reported in the assessment in accordance with LA107 Table 3.22 *Landscape sensitivity (susceptibility and value) and typical descriptions*. The magnitude of visual effect will be reported in the assessment in accordance with the criteria provided in LA107 Table 3.24 *Magnitude and nature of effect on the landscape and typical descriptions*.

9.4.13 Table 3.8.1 in LA104 presents a significance matrix. This will be used to derive the significance of landscape effect.

9.4.14 The visual baseline assessment describes the people that may have specific or general views within the study area that may be changed by the Scheme.

9.4.15 To establish a visual baseline, a review of the visual resource and topography within the study area will be carried out as part of the desk study, with reference to the following relevant published sources:

1. OS Landranger and OS Explorer small scale maps.
2. OS VectorMap Local and OS MasterMap medium and large scale maps.
3. Aerial imagery both ortho-rectified and oblique.

4. Arboriculture surveys, NRW Urban Trees and National Forest Inventory datasets.

9.4.16 Potential screening features including buildings, structures and substantial vegetation will be identified during this process together with visual receptors such as residential and business properties, recreational areas, public rights of way and transport routes.

9.4.17 Field work will be carried out during winter and summer months to identify the number and type of properties from which people would experience a change in view, the nature of the view, and the activity and sensitivity of the viewer.

9.4.18 The location of representative viewpoints in Table 9-1 are used as a starting point for the visual baseline within landscape character areas. The selection is based on those used for the previous study (A494 River Dee Bridge Improvement Scheme (2020)), and represent a variety of distances, ordinal directions and viewer occupancy.

Table 9-1 Representative viewpoints

View-point	Description	Location (OSGB)	Distance to Scheme (km)	Direction to River Dee crossing
A	Public footpath in field south of Aston Hall	SJ 3095 6684	1.48	North-east
B	Rowley's Drive	SJ 3110 6900	1.12	East-south-east
C	Dee View	SJ 3120 6976	0.51	East-north-east
D	Chevron's Road footbridge	SJ 3128 6785	0.43	East-north-east
E	Clay Hill Farm	SJ 3149 6765	0.31	North-east
F	Queensferry town centre	SJ 3162 6815	0.20	East-north-east
G	Old Hall Farm	SJ 3170 6884	0.51	East-south-east
H	Pembroke Close	SJ 3178 6785	0.02	North-east
I	Greenacres Farm	SJ 3185 6727	0.59	North-east
J	Queen Street	SJ 3188 6814	0.04	North-east
K	Dundas Street	SJ 3195 6819	0.01	North-east
L	Station Road Business Park	SJ 3204 6843	0.11	East-north-east
M	Pentre Trade Park	SJ 3207 6787	0.20	North-north-east
N	Pentre	SJ 3219 6777	0.30	North-north-east
O	Bascule Bridge	SJ 3221 6866	0.10	East-south-east

P	Farm Road	SJ 3228 6838	0.47	South-south-east
Q	Welsh Road	SJ 3230 6875	0.13	South-south-east
R	Chemistry Lane/Factory Road	SJ 3249 6845	0.00	North
S	Aston Quay landing stage near to Riverside Joinery	SJ 3249 6845	0.02	North-north-west
T	Wales Coast Path	SJ 3250 6859	0.00	West-south-west
U	Foxes Lane/Claremont Avenue	SJ 3269 6887	0.04	South-west
V	Willans and Robinson landing stage	SJ 3286 6818	0.17	North-west
W	Rector's Lane footbridge	SJ 3286 6767	0.58	North-north-west
X	Foxes Lane/Manor Road	SJ 3311 6862	0.03	West
Y	Sealand Embankment	SJ 3322 6919	0.49	South-west
Z	West Green/Manor Road	SJ 3333 6872	0.26	West

9.4.19 The assessment of significance of effect on the visual receptors is a combination of a judgement of sensitivity of viewer and a judgement of the magnitude of visual effect. Figure 3.38N in LA107 presents the steps in assessing visual effects. Sensitivity of the visual receptor is a combination of judgements of the susceptibility of the receptor to change and the value attached to the view. The magnitude of effect is a combination of judgements about scale, nature and duration of change, distance and direction of change (including focus of the view), screening features such as buildings and vegetation, the activity of the viewer and a judgement of the effect during year 1 (opening year) and year 15 (design year) when proposed mitigation planting would had sufficient time to achieve its environmental function).

9.4.20 The significance of visual sensitivity will be reported in the assessment in accordance with LA107 Table 3.41 *Visual sensitivity (susceptibility and value) and typical descriptions*. The magnitude of visual effect will be reported in the assessment in accordance with the criteria provided in LA107 Table 3.43 *Magnitude (change) of visual effect and typical descriptions*.

9.4.21 Table 3.8.1 in LA104 presents a significance matrix. This will be used to derive the significance of landscape effect.

9.5 Baseline conditions

9.5.1 The River Dee and Dee Estuary are recognised for their important ecological value and are statutorily designated as a Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar Wetland. The baseline nature conservation condition is detailed in Chapter 8.

9.5.2 Queensferry and Sealand are recognised for their important industrial heritage and innovation and feature listed buildings and structures. The baseline cultural heritage condition is detailed in Chapter 10.

9.5.3 Sites with statutory landscape designations include Registered parks and Gardens at Burton Manor, Shotton Steelworks and Hawarden Castle. Conservation Areas are designated in Hawarden, Puddington and Shotwick. Much of the agricultural land surrounding Queensferry and Garden City in Sealand is designated as a Green Wedge.

9.5.4 Sensitive visual receptors include people in residential areas with direct and uninterrupted views of the Scheme and pedestrians and passive recreational users of paths and open spaces near to the Scheme.

9.6 Potential and likely significant effects

9.6.1 The potential significant effects are considered to arise from the removal of plantations and buildings, the movement of materials required to build earthwork embankments, the construction of the new bridge and retaining structures and eventually the removal of the existing bridge.

9.6.2 The receptors most likely to experience a significant effect are those landscape receptors directly affected by the Scheme and those visual receptors indirectly affected. Light industry, businesses, transport and energy infrastructure elements are not considered to be sensitive to the type of change proposed but residential, amenity and natural spaces would be.

9.6.3 The Scheme is not likely to directly affect statutorily designated landscapes, but is likely to directly affect locally designated landscapes. There may be an indirect effect on views from Registered Parks and Gardens and Conservation Areas.

9.6.4 The Scheme corridor crosses a landscape characterised by transport networks, industry and business sites, power and water services infrastructure, agricultural land and residential areas. The Scheme is likely to increase the area of land characterised as transport network at the expense of mainly industrial and some agricultural areas.

9.6.5 Residents and users of recreational paths near to the Scheme would experience a change in their views. The magnitude of change experienced would likely be greatest during the construction period.

9.7 Mitigation and enhancements

9.7.1 The designers will follow an iterative design process to meet the Scheme objectives. At all stages the design will be developed and refined to future-proof the Scheme against predictable circumstances and to support Welsh Government objectives, including the need to encourage active travel and support the sustainability objectives of the Well-being of Future Generations (Wales) Act 2015.

9.7.2 The design team's approach to mitigation will be based on a hierarchy that places avoidance of significant impacts as the most preferable and compensation off-site the least preferable. The mitigation and enhancement measures will be designed to implement key objectives found in UK and Welsh legislation, policy and best practice guidance documents on landscape assessment, design and mitigation. Close liaison with other disciplines to reduce habitat fragmentation and prioritise habitat connectivity and assisting species dispersal will be reflected in the mitigation design.

9.7.3 Transport Planning Objectives relevant to landscape and environmental design are:

1. To maintain and enhance local environment by achieving net benefit for biodiversity

2. To minimise the impacts of construction by reducing adverse effects on neighbouring residents and businesses

9.7.4 Scheme environmental objectives are developed in parallel to the Transport Planning Objectives and agreed with statutory environmental consultees. The objectives to guide the landscape and environmental design, which include mitigation and enhancements are:

1. Enhance ecosystem resilience and secure long-term benefits for biodiversity.
2. Improve connectivity to adjacent ecosystems and deliver positive enhancement measures.
3. Protect and enhance the biodiversity and value of the soft estate and its resilience for future change.
4. Deliver a network of green infrastructure and open green spaces and soft estate.
5. Ensure short and long-term environmental mitigation and management measures are in place through the construction and operational stages of the scheme.

9.7.5 Proposed biodiversity mitigation will be integral to the landscape design. Land take that is ancillary to the proposed bridge and approaches, such as embankment slopes, open drainage swales and channels, or severed land parcels can be used to contribute towards biodiversity objectives.

9.7.6 The Scheme provides an opportunity to improve connectivity with existing footpaths. Some paths that lead to the Trunk Road have been truncated with no through fare available and are since disused. The following points will be considered in the landscape mitigation design:

1. Native planting and seeding to provide species-rich areas should, where appropriate, be carried out using species and material of local provenance.
2. Hedgerows and plantations located to screen night-time light-spill to provide dark corridor routes for commuting and foraging bats.
3. Bat roosting boxes and building to mitigate loss of known roosts within existing buildings.
4. Mammal barriers to deter badger access to highway.
5. Maintain existing public rights of way crossing beneath Scheme at Queensferry and the River Dee and connect these paths to the wider network to encourage non-motorised use.
6. Should saltmarsh be lost, compensation would be provided on-site or if necessary, at a location off-site.

9.7.7 Planting areas would be designed to address the required Environmental Function as set out in LD117 Landscape design. The core functions are required to state the purpose of the various features and what they are intended to achieve in environmental terms

9.8 Assumptions and limitations

9.8.1 The LVIA field work will be undertaken from publicly accessible locations without direct access to private land, residential premises or business properties. Queensferry and Sealand are built-up areas where there is uninhibited access to streets, retail parking areas, riverside paths and bridges.

9.8.2 An aftercare period for landscape areas would be implemented to aid the establishment and growth of new tree and shrub planting, seeding and other landscape elements to ensure that these achieve the environmental functions (as set out in LD117 Table 4.2a *Environmental function codes*.

9.8.3 The establishment and growth would be monitored to identify and carry out any management interventions as are required to ensure that landscape areas satisfy the intended function and performance requirements that are set out in LD117. Monitoring of planting areas would include frequent aftercare visits to determine whether sufficient growth is being achieved.

9.8.4 At the end of the aftercare period the Scheme would be handed over to the North and Mid Wales Trunk Road Agent (NMWTRA), who would be the maintaining authority for the Scheme thereafter. For the landscape elements, this maintenance would include formal reporting of the progress of the Scheme against stated design and performance aims and on landscape interventions where progress or species establishment has not been as anticipated.

9.8.5 The cumulative landscape and visual effects of the Scheme, in combination with known planning applications and allocated development sites will be considered. Scoping opinion of intra-relationships is contained within Chapter 16 Assessment of Cumulative Effects and Inter-relationships.

9.8.6 The Landscape and Visual Impact Assessment process and the preparation of the Environmental Masterplans will be an iterative and collaborative process across the other environmental disciplines and the design team. This chapter should be read in conjunction with the other ES chapters, in particular those relating to Cultural Heritage (Chapter 10), Biodiversity (Chapter 8), and Population and Human Health (Chapter 14).

9.9 Conclusions of scoping

9.9.1 Comparison of the existing situation with the proposed Scheme is likely to see the increase of land characterised as transport infrastructure albeit not necessarily a significant increase in road surface elements. The removal of existing buildings and plantations could cause a significant change in views. The detailed assessment of landscape character and visual effects is scoped in.

9.10 Consultations and key stakeholders

9.10.1 Consultation with stakeholders will take place through the Environmental Liaison Group and will include agreement of LVIA methodology, extent of LVIA study area, identification of visual receptors, location of representative viewpoints, and requirements for mitigation.

10 Cultural Heritage Assessment

10.1 Introduction

10.1.1 Archaeology and cultural heritage is the evidence relating to earlier and existing cultures that may be found within the perimeter of a project. DMRB defined three subject areas as follows:

1. **Archaeological Remains** materials created or modified by past human activities that contribute to the study and understanding of past human societies and behaviour
2. **Historic Buildings** architectural or designed, and other structures with a significant historical value
3. **Historic Landscapes** defined by perceptions that emphasise the evidence of the past and its significance in shaping the present landscape.

10.1.2 Cultural heritage encompasses all these and other linguistic and cultural practises valued by contemporary society.

10.2 Legislation and policy context

10.2.1 DMRB LA106 Cultural Heritage Assessment, Revision 1, January 2020 (formerly HA 208/07)' (Highways Agency, 2019a) and DMRB LA104 Environmental Assessment, Revision 1, August 2020 (Highways Agency 2019b) sets out the structure for the identification of cultural heritage impacts. This implies that the Design Organisation will report to and confirm with Transport Wales and Cadw on the scope of assessment proposed. The Design Organisation will be responsible for agreeing the Scheme Design, assessment reports, archaeological designs and mitigation measures with Transport Wales and Cadw. The Design Organisation will also consult with the regional archaeological trust and obtain up to date information from its site and monuments record. In this case the organisation which maintains the Heritage Environment Record (HER) is the Clwyd Powys Archaeological Trust.

National Planning Policy

10.2.2 National planning policy applicable to this topic includes:

- Planning Policy Wales Edition 12 (February 2024)
- Heritage Impact Assessment in Wales (Cadw – May 2019)
- Conservation Principles for the Sustainable Management of the Historic Environment in Wales (Cadw, 2011)
- Setting of Historic Assets in Wales (Cadw, 2017)
- Welsh Office Circular 1/98: Planning and the historic environment directions by the Secretary of State for Wales (Ref 10.5);
- Welsh Office Circular 60/96: Planning and historic environment – archaeology (Ref 10.6);
- Welsh Office Circular 61/96: Planning and historic environment: historic buildings and conservation areas (Ref 10.7);

Local Planning Policy

10.2.3 Flintshire County Council (FCC) adopted their Local Development Plan (LDP) in January 2024. This covers the period 2015 to 2030. The strategy includes a number of policies relevant to Archaeology and cultural heritage and will be considered within the environmental assessment.

Neighbouring authorities

10.2.4 The project is not likely to affect archaeology and cultural heritage within the scope of neighbouring authorities.

10.3 Relevant guidance

10.3.1 National legislation and guidance that is relevant to the cultural heritage for this area comprises:

- The Historic Environment (Wales) Act 2016, soon to be supplemented by the Historic Environment (Wales) Act 2023, which will come into effect in November 2024.
- Ancient Monuments and Archaeological Areas Act 1979 (as amended by the Historic Environment (Wales) Act 2016);
- Planning (Listed Buildings and Conservation Areas) Act 1990 (as amended by the Historic Environment (Wales) Act 2016);
- Chartered Institute for Archaeologists 'Standards and guidance for historic environment desk-based assessment' (2017) (Ref 10.8)

10.4 Assessment methodology

10.4.1 The assessment will be presented as a chapter for inclusion in the environmental statement. All work will be prepared in accordance with Chartered Institute for Field Archaeologists Standard and Guidance for Historic Environment Desk-Based Assessment, October 2020 and DMRB LA106 Cultural Heritage Assessment Revision 1.

10.4.2 Tasks to be undertaken will include the following

- Acquire Historic Environment Records information for a 500m study area and designated sites within 5km radius
- Undertake reviews of recorded assets;
- Examine published local history and other sources;
- Examine published documentary, cartographic (Tithe Map and historic Ordnance Survey maps) and air photographic (Google Earth and National Monument Records air photographs) data;
- Examine available Lidar surveys of the area;
- Prepare summary archaeology and landscape development description, incorporating data from a combination of the various surveys using GIS;
- Undertake predictive analysis on archaeological data;
- Identify direct and indirect impacts;
- Produce a mitigation strategy in line with DRMB LA106 Cultural Heritage Assessment Revision 1 (Highways Agency, 2019).

10.4.3 The subject matter will be broken down into four main areas. These will be identified and considered separately insofar as they are directly overlapping, but may require different mitigation techniques:

- Archaeological remains
- Historic buildings
- Historic landscapes
- Cultural heritage

10.5 Baseline conditions

10.5.1 All information on sites on the route is the result of previous general data collection and site visits. A desk-based assessment was prepared as part of the earlier work and will be revised and updated to meet standard requirements.

10.5.2 A field visit was conducted in August 2018, which examined a corridor 500 beyond the boundary of the land take for the bridge replacement scheme proposed at that time. He study area was then extended in order to provide sufficient additional context for the understanding of features that extended beyond the boundary. This corridor was considered sufficient context. Further field visits were carried out in February 2019 and September 2024.

10.5.3 Information on designated sites will be displayed on a landscape plan at the appropriate scale indicating each grid-referenced designated site

10.6 Potential and likely significant effects

10.6.1 The proposed project corridor contains sites which are mainly in the form of buildings which would not be directly affected, or are identified as features of low significance (in relation to cultural heritage).

10.6.2 An assessment of impacts on cultural heritage assets was undertaken for the 'A55 A494 A548 WelTAG Stage 2 study' (2017), through the analysis of data obtained from the Royal Commission on the Ancient and Historic Monuments of Wales and the online database; Coflein. Lists of Scheduled Ancient Monuments and Listed Buildings were accessed from Cadw databases. Lists of sites contained in the Welsh archaeological trusts' online database Archwilio and previous work undertaken in this area were added to the database.

10.6.3 It is considered unlikely that the proposed scheme would cause any significant adverse or positive effects on site of known heritage value. However, as a precautionary approach and for a scheme of such magnitude and complexity, the undertaking of an assessment of cultural heritage is recommended.

10.7 Consultations and key stakeholders

10.7.1 Interested parties including Cadw and Heneb (Clwyd Powys Archaeological Trust Planning Service) will be consulted with, along with other groups. Information from previous contact with these groups in included in reports of earlier studies undertaken

11 Air Quality

11.1 Introduction

11.1.1 This chapter of the scoping report describes the scope of the air quality assessment. The relevant national and local planning policies to be considered within the assessment are included alongside the assessment methodology, key guidance and baseline air quality in the vicinity of the proposed Scheme.

11.1.2 This chapter has been prepared in accordance with the Design Manual for Roads and Bridges (DMRB) LA 105 Air Quality[105]. The potential requirement for further assessment in accordance with the DMRB LA 105 is identified within this chapter. Where necessary, further assessment will be presented within the Environmental Statement.

11.2 Legislation and policy context

National legislation

11.2.1 The Air Quality Standards (Wales) Regulations 2010[106] (amended by The Air Quality Standards (amendment) Regulations 2016, The Air Quality Standards (Wales) (Amendment) (EU Exit) Regulations 2019[107] and the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[108]) implement Directive 2008/50/EC on ambient air quality[109].

11.2.2 These pieces of legislation define limit values, and times by which they are to be achieved, for the purpose of protecting human health and the environment by avoiding, reducing, or preventing harmful concentrations of air pollutants.

11.2.3 The limit values apply everywhere, with the exception of:

- Any locations situated within areas where members of the public do not have access and there is no fixed habitation.
- On factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply.
- On the carriageway of roads.
- On the central reservations of roads except where there is normally pedestrian access to the central reservation.

11.2.4 The Department for Environment Food and Rural Affairs (Defra) assesses and reports on the compliance with the limit values for each of the 43 zones and agglomerations across the UK. Zones and / or agglomerations achieve compliance when everywhere within the zone and/or agglomeration (except locations provided in the Directive) does not exceed the relevant limit value. The proposed Scheme is located within the North Wales Zone.

[105] National Highways (Jun 2024) DMRB LA 105 – Air Quality. Available at: https://www.standardsforhighways.co.uk/search/af7f4cda-08f7-4f16-a89f-e30da703f3f4

[106] Statutory Instrument (2010) The Air Quality Standards (Wales) Regulations

[107] Statutory Instrument (2019) The Air Quality Standards (Wales) (Amendment) (EU Exit) Regulations

[108] Statutory Instrument (2020) Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020, No. 1313.

[109] European Union (2008) Directive on Ambient Air Quality and Cleaner Air for Europe, Directive 2008/50/EC Official Journal, vol. 152, pp. 0001-0044. Available at: Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe (legislation.gov.uk)

11.2.5 Part IV of the Environment Act 1995[110] (as amended in Schedule 11 of the Environment Act 2021[111]) requires that every local authority shall periodically carry out a review of air quality within its area, including predictions of likely future air quality. The air quality objectives specifically for use by local authorities in carrying out their air quality management duties are set out in The Air Quality (Wales) Regulations 2000[112] and The Air Quality (Wales) (Amendment) Regulations 2002[113]. In most cases, the air quality objectives are set at the same pollutant concentrations as the limit values transposed in UK law, although compliance dates differ.

11.2.6 As part of the review of air quality, the local authority must assess whether air quality objectives are being achieved, or likely to be achieved within the relevant periods and identify the key sources of emissions responsible for the failure to achieve the objectives. Any parts of a local authority's area where the objectives are not being achieved or are not likely to be achieved within the relevant period must be identified and declared as an Air Quality Management Area (AQMA). Once such a declaration has been made, local authorities are under a duty to prepare an Action Plan which sets out measures to pursue the achievement of the air quality objectives within the AQMA.

11.2.7 The Environment Act requires the UK Government to produce a national Air Quality Strategy (AQS). The AQS establishes the UK framework for air quality improvements. The previous AQS[114] and its subsequent iterations, have now been superseded as of the 14th January 2019 with the Clean Air Strategy 2019 (CAS).[115]

11.2.8 The CAS does not set legally binding objectives, the CAS instead has targets for reducing total UK emissions of nitrogen oxides (NOx) and fine particulate matter ($PM_{2.5}$) from sectors such as road transport, domestic sources and construction plant (non-road mobile machinery (NRMM)).

11.2.9 The UK Government produced a revised draft AQS in 2023. This revision replaces the 2007 strategy and compliments the CAS. The 2023 revision sets out the actions the government expects local authorities in England to take in support of achieving the Government's long-term air quality goals, including their two new long-term $PM_{2.5}$ targets. The AQS does not mention local authorities in Wales and as such the long-term $PM_{2.5}$ targets currently only apply to England. Therefore, the revised draft AQS and new targets are not applicable to this project.

11.2.10 The Environment (Air Quality and Soundscapes) (Wales) Act 2024[116] became law in Wales on 14th February 2024 to make provision for improving air quality. The Act requires Welsh Ministers to set a $PM_{2.5}$ air quality target within three years of this date. However, it is not currently known what this target may be and as such it will not be considered in the assessment. In November 2023, the Welsh Government published a development timeline for the $PM_{2.5}$ target[117]. It is proposed that evidenced targets will be developed by Spring 2025, public consultation will be undertaken between October 2025 and January 2026 and Senedd Elections in May 2026. The final drafting and laying of target legislation are expected to take place between September and December 2026.

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[110] Department for Environment Food and Rural Affairs. (2003) Part IV of the Environment Act 1995 Local Air Quality Management

[111] Statutory Instrument. (2021) Chapter 30, Schedule 11 Local Air Quality Management Framework of Environment Act 2021

[112] Statutory Instrument (2000) The Air Quality (Wales) Regulations, No. 1940 (W.138).

[113] Statutory Instrument (2002) The Air Quality (Amendment) (Wales) Regulations, No. 3182 (W.298).

[114] Department for Environment Food and Rural Affairs. (July 2007), 'The Air Quality Strategy for England, Scotland, Wales and Northern Ireland', Cm 7169, Department for Environment Food and Rural Affairs.

[115] Department for Environment Food and Rural Affairs. (January 2019), 'The Clean Air Strategy'

[116] Acts of Welsh Parliament (2024) Environment (Air Quality and Soundscapes) (Wales) Act 2024

[117] Welsh Government (2023) Welsh Government Update. Available at: 01_Welsh_Government_update_for_WAQF_Annual_Seminar_November_2023.pdf

11.2.11 The Welsh Government published the 'Clean Air Plan' for Wales[118] in 2019 to provide a framework and actions for air quality improvements within Wales.

11.2.12 Air quality objectives and limit values relevant to the proposed Scheme are summarised in Table 11-111-111-1.

Table 11-1- Relevant air quality objectives and limit values

Pollutant	Averaging period	Concentration	Allowance	Attainment date	
				Air quality objectives	Limit values
Nitrogen dioxide (NO_2)	Annual	40 µg/m^3	-	31 December 2005[(a)]	1 January 2010[(c)]
	1 Hour	200 µg/m^3	18	31 December 2005[(a)]	1 January 2010[(c)]
Particulates less than 10 microns in diameter (PM_{10})	Annual	40 µg/m^3	-	31 December 2004[(a)]	1 January 2005[(c)]
	24 Hour	50 µg/m^3	35	31 December 2004[(a)]	1 January 2005[(c)]
Fine particulates less than 2.5 microns in diameter ($PM_{2.5}$)[(e)]	Annual	20 µg/m^3	-	-	1 January 2020[(f)]
		25 µg/m^3	-	2020[(b)]	-
Oxides of nitrogen (NO_x)[(d)]	Annual	30 µg/m^3	-	31 December 2000[(a)]	19 July 2001[(c)]

Notes: [(a)] The Air Quality (Wales) Regulations 2000 as amended

[(b)] Air Quality Strategy 2007

[(c)] The Air Quality Standards (Wales) Regulations 2010 (as amended)

[(d)] Designated for the protection of vegetation and ecosystems and also referred to as the 'critical level' for NOx. The policy of the UK statutory nature conservation agencies is to apply the annual mean NOx criterion in internationally designated conservation sites and Site of Special Scientific Interest (SSSI) on a precautionary basis, as the limit value applies only to locations more than 20km from towns with more than 250,000 inhabitants or more than 5km from other built-up areas, industrial installations or motorways.

[(e)] As the Air Quality Strategy 2007 and the Air Quality Standards Regulations 2010 (as amended) have a different numerical standard for $PM_{2.5}$, the more stringent standard of 20µg/m^3 has been adopted for this assessment.

[(f)] The Air Quality Standards Regulations 2010 (as amended)

11.2.13 Table 11-211-211-2 provides details of where the respective objectives should and should not apply and therefore the types of receptors that are relevant to the assessment of air quality.

[118] Welsh Government (2019) Clean Air Plan for Wales: Healthy Air, Healthy Wales

Table 11-2- Locations where the air quality objectives apply

Averaging period	Objectives should apply at:	Objectives should not apply at:
Annual	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes, etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
24-Hour	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
1-Hour	All locations where the annual mean and 24-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations, etc., which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

Source: Defra Local Air Quality Management Technical Guidance (LAQM TG22)[119].

11.2.14 Section 79(1)(d) of the Environmental Protection Act 1990[120] defines one type of 'statutory nuisance' as "any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being prejudicial to health or a nuisance". Where a local authority is satisfied that a statutory nuisance exists, or is likely to occur or recur, it must serve an abatement notice. Failure to comply with an abatement notice is an offence. Best practicable means is a widely-used defence by operators, if employed to prevent or to counteract the effects of the nuisance.

National Planning Policy

11.2.15 The current air quality planning policies for the Welsh Government are set out in Planning Policy Wales Edition 12 (July 2024)[121]. Of relevance to air quality assessment, are:

- Chapter 3 'Strategic and Spatial Choices', which highlights the importance of promoting healthier places through the planning system. This includes enabling opportunities for outdoor activities, good design in planning to minimise exposure to poor air quality, reduction of health inequalities and making positive contributions to environmental protection and improvement, including air quality.
- Chapter 4 'Active and Social Places', which states that the Welsh Government is committed to supporting modal shift from private cars to walking, cycling and public transport and that

[119] Department for Environment, Food and Rural Affairs and Devolved Administrations (2022) Local Air Quality Management – Technical Guidance LAQM.TG22

[120] Parliament of the United Kingdom (1990) Environmental Protection Act 1990

[121] Welsh Government (2024) Planning Policy Wales. Edition 12. Available at: https://www.gov.wales/sites/default/files/publications/2024-07/planning-policy-wales-edition-12.pdf

local authorities must adopt an integrated approach to traffic management, also considering wider planning objectives such as improvement in air quality.

- Chapter 6 'Distinctive and Natural Places' states that development plan strategies, policies and development proposals should look to the long-term protection and enhancement of the built and natural environment in order to achieve Wales's wellbeing goals. This includes considering effects of development proposals on air quality with the aim to reduce population exposure to air pollution in Wales.

11.2.16 Planning Policy Wales (PPW) is supplemented by a series of topic-based Technical Advice Notes (TANs). TAN 18 Transport[122] details the importance of good air quality, and states: "*well designed and implemented traffic management can help secure planning objectives*…[by]… *reducing*…*local air pollution*…".

11.2.17 In June 2017, the Welsh Government set out further provisions in Policy guidance PG(W)(17)[123], which adopts five ways of working set out in the Well-being of Future Generations (Wales) Act 2015[124] with the intention to improve the economic, social, environmental and cultural well-being of Wales in accordance with the sustainable development principles. The five ways of working are:

- "looking to the long term so we do not compromise the ability of future generations to meet their own needs;
- *taking an integrated approach;*
- *involving a diversity of the population in the decisions affecting them;*
- *working with others in a collaborative way to find shared sustainable solutions; and*
- *acting to prevent problems from occurring or getting worse."*

11.2.18 Welsh Local Authorities are expected to follow these ways of working when carrying out their Local Air Quality Management (LAQM) duties.

11.2.19 The Welsh Government published The Wales Transport Strategy 2021[125] in 2021, which sets out the Government's main transport development aims and how these will be achieved. The strategy contains long-term environmental outcomes for transport in Wales. In relation to air quality, the strategy aims to "*improve air quality by pursuing modal shift, encouraging more active travel, greater use of public transport and low emissions vehicles, and by creating closer links between land-use planning and transport in line with our commitments in the Clean Air Plan for Wales: Healthy Air, Healthy Wales".*

Local Planning Policy

11.2.20 FCC adopted their Local Development Plan 2015-2030[126] in 2023 and this plan will be considered within the environmental assessment. Air quality policies within the Local Development Plan include strategic policy STR14, PC2 and EN18:

[122] Welsh Government (2007) Planning Policy Wales Technical Advice Note 10: Transport. Available at: https://www.gov.wales/sites/default/files/publications/2018-09/tan18-transport.pdf

[123] Welsh Government (2017) Local air quality management in Wales. Part of the Environment Act 1995. Policy guidance PG(W)(17)

[124] Welsh Government (2015) Well-being of Future Generations (Wales) Act 2015.

[125] Welsh Assembly Government (2021) The Wales Transport Strategy. Available at: https://www.gov.wales/sites/default/files/publications/2021-03/llwybr-newydd-wales-transport-strategy-2021-full-strategy_0.pdf (Accessed September 2024)

[126] Flintshire County Council (2023) Flintshire Local Development Plan 2015-2030. Available at: https://www.flintshire.gov.uk/en/PDFFiles/Planning/Examination-Library-Documents/FINAL-LDP-Written-Statement-English.pdf

11.2.21 Policy STR14: Climate Change and Environmental Protection states that:

"The Council will seek to mitigate the effects of climate change and ensure appropriate environmental protection in the County through:…

vi: Ensuring that new development has regard to the protection of the environment in terms of air, noise and light pollution, unstable and contaminated land and former landfill sites"

11.2.22 Policy PC2: General Requirements for Development states that:

"All development should: …

b. not have a significant adverse impact on the safety and living conditions of nearby residents, other users of nearby land/property, or the community in general, through increased activity, disturbance, noise, dust, vibration, hazard, or the adverse effects of pollution…

f. not result in or be susceptible to problems related to foul and surface water drainage, land stability, contamination, flooding, or pollution of light, air and water, either on or off site"

11.2.23 Policy EN18: Pollution and Nuisance states that:

"New development which is sensitive to the effects of existing noise, vibration, odour, dust, light or other pollution or nuisance, will be permitted only if it can be demonstrated that appropriate measures can be taken to mitigate any potential adverse effects.

New development which would create an increased risk of noise, vibration, odour, dust, light or other pollution or hazard will only be permitted if:

a. it would not unacceptably harm general amenity or living conditions; and

b. it would not impose significant restrictions on the use or development of surrounding land."

Neighbouring authorities

11.2.24 The Cheshire West and Chester Local Plan (Part Two)[127], which contains the relevant policies for air quality, was adopted 18th July 2019. The local authority area of Cheshire West and Chester is located 2.5km northeast of the proposed Scheme. Policy DM 31 – Air Quality states *"development must not give rise to significant adverse impacts on health and quality of life, from air pollution."*

11.3 Relevant guidance

11.3.1 This chapter and any subsequent assessment will be carried out with reference to the following guidance documents:

- DMRB LA 105 – Air Quality (2019)[105]
- Defra's LAQM Technical Guidance (LAQM TG22)[119]

11.4 Assessment methodology

Study Area

11.4.1 The proposed Scheme has the potential to affect air quality due to:

[127] Chester West and Chester Council Local Plan (Part Two) Land Allocations and Detailed Policies. Available at: Cheshire West and Chester Local Plan (Part Two) Land Allocations and Detailed Policies - Details - Keystone

- Potential for dust-generating activities during construction, such as earthmoving and construction works during the construction phase
- Changes in emissions associated with changes in traffic flows (including composition and speed) on the local road network during the construction and operation phase;
- Changes in road layout which may bring road traffic emission sources closer to, or further away from, sensitive receptors during the construction and operation phase.

11.4.2 For the construction phase the study area for assessing dust risk will be limited to 200 metres from the scheme footprint in accordance with DMRB LA 105.

11.4.3 The study area to assess vehicle emissions during the construction and operational phase covers human health receptors and ecologically designated sites within 200m of roads that are affected by the proposed Scheme, in line with DMRB LA 105[105].

11.4.4 Affected roads included in the assessment will be those which meet the DMRB LA 105 traffic scoping criteria, which is used to determine whether air quality effects of a proposed Scheme can be scoped out or require an assessment. The criteria are based on the changes between the “with proposed Scheme” and “without proposed Scheme” traffic scenarios. The changes would need to be triggered for a two-year period for them to lead to likely significant effects.

11.4.5 The criteria are:

- A change in annual average daily traffic (AADT) by >=1,000; or
- A change in heavy duty vehicle (HDV)[128] AADT by >= 200; or
- A change in speed band[129]; or
- A change in carriageway alignment by >=5m

Construction Phase

11.4.6 Key stages of the construction phase and the locations and types of sensitive receptors will be identified in accordance with DMRB LA 105. Construction dust will be assessed by identifying the construction dust risk potential of the proposed Scheme and the distance of receptors from construction activities using distance buffers of 50 metres, 100 metres and 200 metres. The construction dust risk will be calculated in line with paragraph 2.58 of DMRB LA 105.

11.4.7 Appropriate construction dust mitigation measures will be identified in accordance with Best Practicable Means (BPM) and will be incorporated into the Construction Environmental Management Plan (CEMP).

11.4.8 Information on changes in traffic during the construction phase is not available at this stage however the construction period is programmed for up to two years. DMRB LA 105 requires the impact of construction activities on vehicles movements shall be assessed where construction activities are programmed to last for more than two years. The additional traffic generated by construction is also unlikely to trigger the assessment criteria set out in DMRB LA 105 and there are no areas within the study area at risk of exceeding air quality thresholds, based on a review of the baseline air quality conditions undertaken in Section 11.5. On this basis, traffic management measures and the effect of additional construction vehicles on human health receptors and ecologically designated sites will be assessed qualitatively.

[128] HDVs include goods vehicles with a gross weight greater than 3.5 tonnes and buses and coaches

[129] Unadjusted traffic model speeds will be used to define the speed bands for individual links within the traffic model for the purpose of defining study area

Operation Phase

11.4.9 The assessment of operational phase local air quality effects on human health receptors and ecologically designated sites will include:

- An assessment of air quality effects using the advanced dispersion modelling software (ADMS Roads) incorporating the latest available version of
  - National Highway's speed banded emission factors
  - Defra's NOx to NO_2 conversion tool
  - Defra's background pollutant maps
  - National Highways 'Long Term Gap Analysis Calculator v1.1'
  - National Highways 'Ammonia N Deposition Tool'
- Verification of model outputs with local monitoring data and proposed Scheme specific data
- Prediction of NO_2 concentrations in the base year, do-minimum and do-something scenarios at sensitive human health receptors and ecological designated sites
- As per DMRB LA 105, base year concentrations of PM_{10} will be assessed to confirm there is no risk of PM_{10} concentrations exceeding relevant thresholds. These results will be used to justify why no further modelling of $PM_{2.5}$ is required as part of the Environmental Statement.
- Prediction of NOx and nitrogen deposition (including the contribution from road ammonia) at designated sites located within 200m of the ARN. As per DMRB LA 105 designated sites considered in the assessment will include Ramsar sites, special protection areas, special areas of conservation sites of special scientific interest, local nature reserves, local wildlife sites, nature improvement areas, ancient woodlands and veteran trees that are sensitive to nitrogen deposition.
- Projects known or reasonably likely to be implemented by the time of the opening year and the future year will be included in the forecasted traffic flows.

11.4.10 The assessment will be desk based; it will be based upon traffic data generated specifically for the proposed Scheme as part of the Environmental Statement and use baseline data from local authorities and collected specifically for the proposed Scheme (see Section 11.5).

11.4.11 The assessment will determine significance of impacts based upon:

- The assessment of the effects on human health through the determination of changes in pollutant concentrations at sensitive receptors where the air quality objectives apply,
- The assessment of compliance risk by determining if the proposed Scheme could affect the UK's reported ability to comply with relevant limit values, and
- The assessment of the impacts on ecological designated sites.

Human health

11.4.12 DMRB LA 105 provides advice for evaluating significant local air quality effects at receptors. Receptors that have a reasonable risk of exceeding an air quality threshold will be assessed in both a do minimum and do something scenario.

11.4.13 In accordance with DMRB LA 105, a conclusion of no likely significant air quality effect for human health shall be recorded where the:

- outcomes of the air quality modelling for human health indicate that all concentrations are less than the air quality thresholds; and/or
- difference in concentrations is imperceptible i.e. less than 1% of the air quality threshold (e.g. 0.4 $\mu g/m^3$ or less for annual mean NO_2)

11.4.14 Where changes in concentrations are greater than 1% of the air quality threshold at qualifying receptors and there is a predicted exceedance of the air quality threshold, each receptor shall be assigned to one of the six boxes in Table 2.91 of DMRB LA 105, presented below in Table 11-311-311-3.

Table 11-3 Guideline to number of properties constituting a significant effect

Magnitude of change in concentration	Number of receptors with:	
	Worsening of air quality objective already above objective or creation of a new exceedance	Improvement of an air quality objective already above objective or the removal of an existing exceedance
Large (>4)	1 to 10	1 to 10
Medium (>2 to 4)	10 to 30	10 to 30
Small (>0.4 to 2)	30 to 60	30 to 60

11.4.15 Table 11-311-311-3 presents guideline bands, setting an upper level of likely non-significance and the lower level of likely significance, for the number of receptors affected by the proposed Scheme. Between these two levels are the ranges where likely significance is more uncertain, therefore professional judgement would be required.

11.4.16 Where the total number of receptors are less than the lower guideline band for all of the magnitude of change categories, the proposed Scheme is unlikely to trigger a significant air quality effect for human health. Where the total number of receptors is greater than the upper guideline band in any of the magnitude categories the proposed Scheme shall trigger a significant air quality effect.

11.4.17 If a proposed Scheme results in effects where the number of properties falls between the lower and upper guideline bands for any of the magnitude of change criteria, the information in Table 11-311-311-3 will then be used along with the following key criteria to determine the overall evaluation of local air quality significance:

- the absolute concentration at each receptor i.e. is the modelled concentration 40 $\mu g/m^3$
- how many receptors are there in each of the magnitude of change criteria i.e. does the project create more worsening than improvements;
- the magnitude of change in concentration at each receptor e.g. 0.6 $\mu g/m^3$ vs 1.8$\mu g/m^3$

Limit Value Compliance risk

11.4.18 DMRB LA 105 sets out the approach to assessment of compliance risk in Figure 2.79 which will be followed.

11.4.19 The assessment shall conclude there is no risk to the UK's reported ability to comply with the limit values in the shortest timescale possible where:

- there are no modelled exceedances of the air quality thresholds for any PCM link; or
- there are modelled exceedances of the air quality thresholds for any PCM link, but the change in annual mean NO_2 concentrations between the do minimum and do something is less than or equal to +/-0.4 $\mu g/m^3$
- the project does not materially impact on measures within local air quality or national plans for the achievement of compliance.

Ecologically designated sites

11.4.20 For ecologically designated sites, the determination of significant effects will be undertaken in line with the flow chart at para 2.98 of DMRB LA 105. If the change in nitrogen deposition is greater than 0.4kg N/ha/yr at a designated sites as a result of the proposed Scheme, the competent expert for biodiversity will determine overall significance and this will be reported within the biodiversity chapter.

11.5 Baseline conditions

11.5.1 Information on air quality in the UK can be obtained from a variety of sources including local authorities, national network monitoring sites and other published sources. For this assessment, data has been obtained from FCC[132] and Defra.

11.5.2 The effects associated with the coronavirus (Covid-19) pandemic during 2020 and 2021 when Wales was subject to full lockdowns for periods may have an influence on the monitoring data during these periods and therefore the data may not be representative of normal conditions at the monitoring sites and should be appraised with caution.

Local Authority Review and Assessment

11.5.3 There are no AQMAs currently declared by FCC and there are no AQMAs elsewhere that are likely to be affected by the proposed Scheme. The nearest AQMA is the Chester City Centre AQMA located approximately 7.2km east of the proposed Scheme and declared for exceedances of the annual mean NO_2 objective.

Local Authority Monitoring

11.5.4 No automatic monitoring is undertaken by FCC.

11.5.5 FCC currently undertakes non-automatic (diffusion tube) monitoring at 59 sites to assess compliance with the annual mean NO_2 air quality objective. Of these sites, 13 are within approximately 1km of the proposed Scheme, as shown in Figure 11-111-1. The monitoring results for these sites are presented in Table 11-411-411-4. Over the past five years of monitoring, annual and hourly NO_2 concentrations at all sites have been well below the annual mean objectives.

Table 11-4: Annual passive monitoring data for NO_2

Site ID	British National Grid Coordinates		Site Type	Data Capture 2022 [b]	Annual Mean NO_2 Concentration (µg/m^3)			
	X	Y			2019	2020	2021	2022
ADDC-008 a	330792	367434	Kerbside	90.4	24.3	14.4	14.9	26.6
ADDC-023	331663	368028	Urban background	90.4	27.8	18.6	20.1	19.3
ADDC-034	333040	369051	Roadside	82.4	14.4	14.1	14.7	14.3
ADDC-037	332221	367723	Kerbside	75	16.6	14.3	15.9	18.3
ADDC-052	333731	369079	Kerbside	74.7	16.7	7.2	7.0	10.3
ADDC-070	331806	368271	Kerbside	90.4	17.6	18.7	16.3	17.3

[132] North Wales Authorities (2023) North Wales Authorities Collaborative Project 2023 Air Quality Progress Report

Site ID	British National Grid Coordinates		Site Type	Data Capture 2022 [b]	Annual Mean NO_2 Concentration (µg/m^3)			
	X	Y			2019	2020	2021	2022
ADDC-083 a	330792	367434	Kerbside	90.4	24.3	14.4	14.9	26.0
ADDC-085	330718	367350	Kerbside	90.4	25.2	19.1	20.4	20.7
ADDC-099	330727	367354	Kerbside	73.1	13.9	17.7	19.0	18.5
ADDC-101 a	330792	367434	Kerbside	90.4	24.3	14.4	14.9	24.3
ADDC-104	332558	368750	Kerbside	90.4	-	-	12.5	16.5
ADDC-116	332535	368907	Kerbside	82.7	22.1	14.6	14.7	15.5
ADDC-117	332500	367357	Kerbside	90.4	32.5	10.0	11.1	10.3

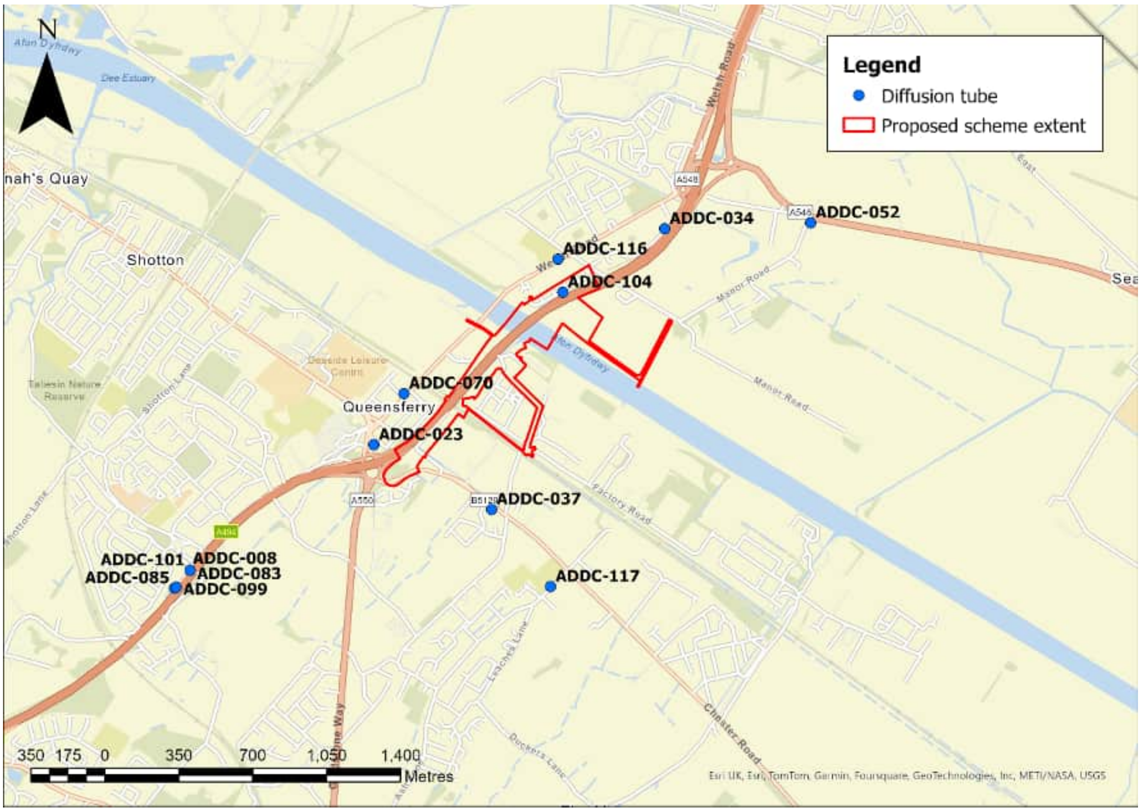
Source: 2019-2022 data has been obtained from the North Wales Authorities Collaborative Project 2023 Air Quality Progress Report. 2023 data has been obtained directly from FCC.

Note: [a] Sites ADDC-008, ADDC-083 and ADDC-101 are co-located with an automatic monitor operated locally by an external organisation. Data from this automatic monitoring site for 2022 was inaccessible by FCC and therefore FCC were unable to calculate a local bias adjustment factor using this co-location study. As such, the national bias adjustment factor has been applied to FCC monitoring results, which was 0.76 in 2022.

[b] Monitoring data with data capture <75% has been annualised.

'-' indicates no monitoring data available for corresponding year.

Figure 11-1: Local authority monitoring locations in 2022



Source: Produced by Mott MacDonald using data from North Wales Authorities Collaborative Project 2023 Air Quality Progress Report. 2023

Mott MacDonald proposed Scheme-specific survey

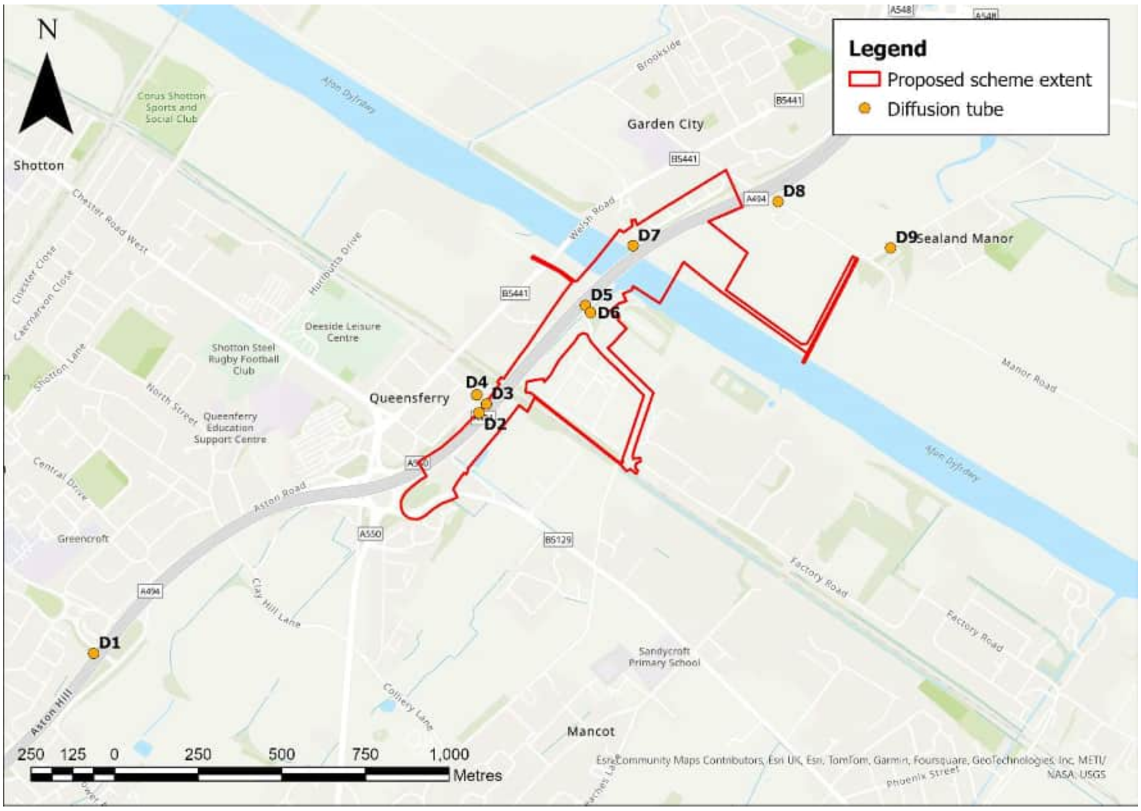
11.5.6 A six-month proposed Scheme specific NO_2 diffusion tube monitoring survey is currently being undertaken. Monitoring commenced in June 2024 and will be completed in December 2024.

Monitoring will improve the robustness of the air quality baseline around receptors very close to the A494 where monitoring was not undertaken by the local authority in 2022. It will also improve the reliability of the proposed Scheme dispersion modelling, if required, by enabling calibration of the model at sensitive receptors locations most likely to have the highest pollutant concentrations and most likely to be impacted by the proposed Scheme.

11.5.7 This section of the A494 has been a focus of the Welsh Government in recent years due to risk of non-compliance with the limit values as set out in Directive 2008/50/EC as transposed into UK law. Monitoring will support the conclusions of the compliance risk assessment by demonstrating that existing concentrations do not exceed the limit value and the predictions made by the dispersion model used to assess the proposed Scheme is robust (verified and calibrated) in this elevated risk area.

11.5.8 The locations for the monitoring are shown in Figure 11-2Figure 11-2. Monitoring data from the survey will be annualised and bias adjusted following Defra LAQM TG22 guidance. The results of the survey will be reported in the Environmental Statement.

Figure 11-2: Proposed Scheme specific monitoring locations



Note: Site D1 is in the same location as the FCC sites ADDC-008, ADDC-083 and ADDC-101.

Defra Projected Background Concentrations

11.5.9 Defra provides mapped future year projections of background pollution concentrations for NO_X, NO_2, PM_{10} and $PM_{2.5}$ for each 1km grid square across the UK for all years between 2018 to

2030[133]. The maps include a breakdown of background concentrations by emission source, including road and industrial sources, which have been calibrated against 2018 (the baseline year) UK monitoring data. The maximum concentrations across the grid square containing the proposed Scheme area are presented below in Table 11-511-511-5. There are no exceedances of air quality objectives.

Table 11-5: Defra projected background concentrations across the proposed Scheme area

Year	Pollutant			
	NOx	NO_2	PM_{10}	$PM_{2.5}$
2024	14.0	10.6	11.9	8.0

Source: Defra (2018)
Note: The background concentrations provided for NOx, NO_2 and $PM_{2.5}$ are for the 1km square centred on X 332500 Y 367500. The background concentration provided for PM_{10} is for the 1km square centred on X 332500 Y 368500

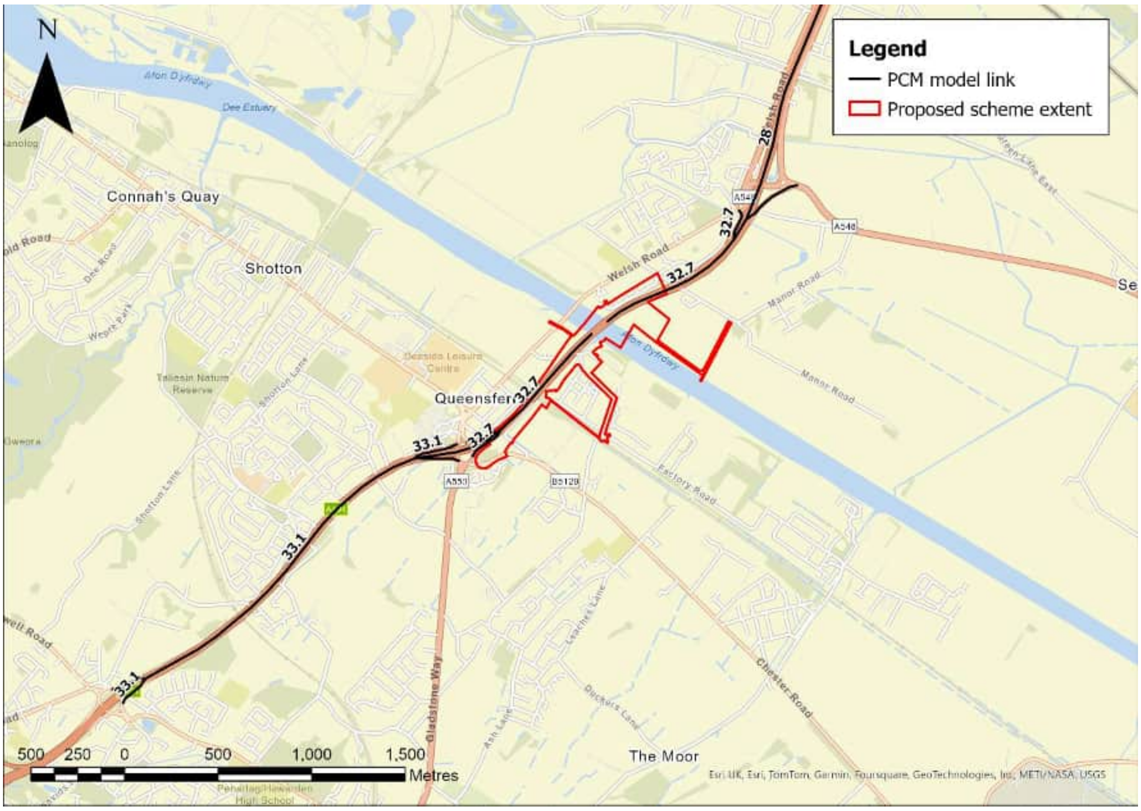
Limit Value Compliance

11.5.10 Defra uses the Pollution Climate Mapping (PCM) model to report compliance with limit values as transposed into UK Law from Directive 2008/50/EC[109]. PCM projections are available for all years from 2018 to 2030 from the base year of 2018. The most recent PCM model was published in 2020.

11.5.11 Based on projected roadside NO_2 concentrations in the current version of the PCM model, there are no PCM links in the vicinity of the proposed Scheme that exceed the annual mean limit value of 40µg/m^3 for the current year of 2024. The closest link with an exceedance is located in Birmingham over 100km away from the proposed Scheme. The PCM link closest to the proposed Scheme is the A494, as shown in Figure 11-3. This link has a reported annual mean NO_2 concentration in 2024 of 32.7µg/m^3, which is below the limit value of 40µg/m^3.

[133] Defra Background maps (2018) Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps

Figure 11-3: PCM model links and 2024 predicted annual mean NO_2 concentrations ($\mu g/m^3$)



Source: Produced by Mott MacDonald with data from Data AIR

11.6 Potential and likely significant effects

Construction

11.6.1 The main risks to sensitive receptors during the construction phase include on site dust emissions arising from construction activities and vehicle movements which can lead to loss of amenity and/or nuisance at nearby receptors. Dust can be mechanically transported, either by wind or re-suspension via vehicles. It can also arise from wind erosion on material stockpiles and earth moving activities. Significant adverse construction phase effects are unlikely to occur with mitigation measures implemented through the CEMP. However, details of the construction methodology are yet to be developed and will be included within the Environmental Statement once they have been established.

11.6.2 Construction can require the use of different equipment such as excavators, cranes and on-site generators. All construction plant has an energy demand; with some plant resulting in direct emissions to air from exhausts. Guidance from the Institute of Air Quality Management (IAQM)[134] notes that effects from on-site plant exhausts would likely not be significant. Given the nature of the site plant, effects of plant emissions on local air quality are considered of negligible significance relative to the surrounding road traffic contributions on the local road network. Construction plant emissions have therefore been scoped out as the impacts would be de minimus and not significant. However, mitigation measures to reduce the effect of the temporary site on local air quality will be considered in the Environmental Statement.

[134] https://iaqm.co.uk/wp-content/uploads/2013/02/Construction-Dust-Guidance-Jan-2024.pdf

11.6.3 In addition, the construction phase will introduce additional construction vehicle movements to the road network and traffic management which have the potential to affect traffic flows and speeds. This has the potential to directly affect ambient concentrations of NO_2 and PM_{10} (for human health receptors) and NO_x (for ecological receptors). As detailed in Section 11.4.8,

- the construction period is expected to last for approximately two years;
- additional traffic generated by the construction of the proposed Scheme is unlikely to trigger the assessment criteria set out in DMRB LA 105; and
- there are no areas within the study area at risk of exceeding air quality thresholds based on a review of the baseline air quality conditions undertaken in Section 11.5.

11.6.4 On this basis, it is unlikely that changes in ambient concentrations caused by the construction phase of the proposed Scheme would be significant. This will be confirmed in the Environmental Statement in accordance with the requirements of the DMRB LA 105.

Operation

11.6.5 The operational phase of the proposed Scheme has the potential to directly affect ambient concentrations of NO_2 and PM_{10} (for human health receptors) and NO_x (for ecological receptors) due to a changes in road alignment which may bring road traffic emission sources closer to, or further away from, sensitive receptors. There are not expected to be any change in traffic composition (number of vehicles or speed) as the proposed Scheme is a like for like replacement of the existing A494 River Dee Bridge.

11.6.6 Considering the existing baseline and the location of new alignment relative to sensitive receptors it is unlikely that changes in ambient concentrations because of the proposed Scheme would be significant. This will be confirmed in the Environmental Statement in accordance with the requirements of the DMRB LA 105.

11.6.7 The key pollutants for consideration within the assessment of operational phase local air quality effects (if the assessment criteria are met) are:

- NO_2 and PM_{10} for human health receptors
- Atmospheric NOx, nitrogen deposition for ecological receptors

11.6.8 There will be no consideration of emissions of any pollutants other than those identified above, as no substantial emission sources of these pollutants will be introduced or impacted by the proposed Scheme, or because concentrations are expected to be below the air quality objectives within the study area.

11.7 Mitigation and enhancements

Construction

11.7.1 Appropriate mitigation measures to control dust generation will be included within the CEMP for the proposed Scheme, proportionate to the level of construction dust risk identified within the assessment. Mitigation measures could include measures such as: development of a dust management plan, daily on-site and off-site inspections, minimising the use of dust-generating activities, storing materials on site for the shortest time possible and the use of water as a dust suppressant.

Operation

11.7.2 Air quality operational mitigation measures would be dependent on identified traffic impacts, which are yet to be determined. Based on the baseline conditions on site, it is considered unlikely that operational mitigation measures will be required.

11.8 Assumptions and limitations

11.8.1 Air quality modelling predictions will be based on the most reasonable, robust and representative methodologies in accordance with best practice guidance. However, there is an inherent level of uncertainty associated with the model predictions, including:

- Uncertainties with model input parameters such as surface roughness length (defined by land use) and minimum Monin-Obukhov length (used to calculate stability in the atmosphere)
- Uncertainties with traffic forecasts
- Uncertainties with vehicle emission predictions
- Uncertainties with background air quality data
- Uncertainties with recorded meteorological data; and
- Simplifications made within screening tool calculations or post processing of the data that represent atmospheric dispersion or chemical reactions

11.8.2 In order to best manage these uncertainties, the air quality assessment undertaken for the Environmental Statement will be verified using the air quality measurements from the proposed Scheme-specific monitoring survey which is due to be completed in December 2024, as well as any local authority data that is within the ARN study area, has suitable data capture and is representative of modelled sensitive receptors. The verification process will be undertaken in line Defra LAQM TG22 best practice guidance.

11.9 Conclusions of scoping

11.9.1 The following impacts on air quality will be scoped in and considered in the ES:

- Impacts associated with construction dust.
- A qualitative review of construction vehicle movements and traffic management
- Changes in air quality resulting from changes in traffic flow composition (although none expected) and road alignment during the operational phase.

11.9.2 As a result of the information collected in the preparation of this EIA scoping report, it is proposed that the following impacts will be scoped out of further consideration in the Environmental Statement because there will be no likely significant environmental effects to assess:

- Changes in air quality associated with construction plant.

11.10 Consultations and key stakeholders

11.10.1 Consultation will be undertaken with Flintshire Council’s Pollution Control Officer to discuss air quality matters in relation to the assessment approach and the study area once traffic data for the Environmental Statement is finalised. Consultation will also be undertaken to obtain the most recent local authority air quality monitoring data available.

12 Noise and Vibration

12.1 Introduction

12.1.1 This chapter sets out the proposed scope for the assessment of noise and vibration impacts and associated effects resulting from construction and operation of the Scheme.

12.1.2 The Design Manual for Roads and Bridges (DMRB) LA 111 Revision 2 (2020)[135] provides the methodology for assessment of temporary and permanent noise and vibration impacts and associated effects of road projects within the UK. This methodology will be followed for the assessment of the Scheme.

12.1.3 In accordance with the Note to paragraph 1.4 of DMRB LA111 operational vibration will be scoped out of the assessment. This is because, "*a maintained road surface will be free of irregularities as part of project design and under general maintenance, so operational vibration will not have the potential to lead to significant adverse effects.*"

Relocation of Queensferry surface water pumping station.

12.1.4 Relocation of the Queensferry surface water pumping station is necessary due to displacement of the current facility by the proposed new westbound carriageway. The pumping station will be designed and constructed to achieve noise limits agreed with Flintshire County Council. The pumping station will not therefore generate noise impacts resulting in a significant adverse effect. For this reason, it is proposed that assessment of noise from the operation of the water pumping station is scoped out of the EIA.

Noise and vibration impacts on natural environmental receptors

12.1.5 Noise and vibration impacts and associated effects on natural environmental receptors will not be considered within the noise and vibration chapter but will be captured within Chapter 8 Biodiversity.

12.2 Legislation and policy context

12.2.1 The legislation, policy and guidance listed below will inform the assessment of potential noise and vibration impacts and associated effects generated by the construction and operation of the Scheme.

Legislation

12.2.2 The following legislation is relevant to the assessment of noise and vibration:

- The Control of Pollution Act 1974[136];
- The Noise Insulation Regulations 1975[137] (amended 1988[138]);

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[135] Highways England (2020) LA111 - Noise and Vibration (Revision 2) [online] available at: [LA 111 - Noise and vibration (standardsforhighways.co.uk)](https://www.standardsforhighways.co.uk) (last accessed June 2023)

[136] CROWN, 1974. Control of Pollution Act 1974

[137] CROWN, 1975. Building and Buildings The Noise Insulation Regulations 1975

[138] CROWN, 1988. The Noise Insulation (Amendment) Regulations 1988

- The Environmental Noise (Wales) Regulations 2006[139] as amended by the Environmental Noise (Wales) (Amendment) Regulations 2009[140] collectively referred to as the Environmental Noise Regulations; and
- The Well-being of Future Generations (Wales) Act 2015[141].

National Planning Policy

12.2.3 The following national policy will inform the assessment of noise and vibration:

- Planning Policy Wales Edition 12 – February 2024[142];
- Technical Advice Note (TAN) 11: Noise[143]; and
- The Noise and Soundscape Action Plan 2018-2023[144].

Local Planning Policy

- Flintshire Local Development Plan 2015-2030[145], specifically policies:
  - STR14: Climate Change and Environmental Protection;
  - PC2: General Requirements for Development;
  - PC3: Design; and
  - EN 18: Pollution and Nuisance

Neighbouring Authorities

12.2.4 The proposed scheme is approximately 2km away from the boundary with England, and Cheshire West and Chester Council (CWaC). This is beyond the study area as defined in Section 12.4. English national and local planning policy is not therefore considered in this chapter.

12.3 Relevant guidance

12.3.1 The following guidance will be used in the assessment of noise and vibration as a matter of best practice:

- Design Manual for Roads and Bridges (DMRB) LA 111 Noise and vibration Revision 2, 2020;
- Department of Transport and Welsh Office Calculation of Road Traffic Noise (CRTN) 1988;
- Transport Research Laboratory TRL Research Report 53, Ground vibration caused by civil engineering works;
- Transport Research Laboratory TRL PR/SE/451/02 Converting the UK traffic noise index $L_{A10,18hour}$ to EU noise indices for noise mapping;
- British Standard (BS) 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise;
- BS5228-2:2009+A1:2014 Code of construction practice for noise and vibration control on construction and open sites - Part 2: Vibration;
- BS4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound;

[139] WELSH GOVERNMENT, 2006. The Environmental Noise (Wales) Regulations 2006
[140] WELSH GOVERNMENT, 2009. The Environmental Noise (Wales) (Amendment) Regulations 2009
[141] WELSH GOVERNMENT, 2015. Well-being of Future Generations (Wales) Act 2015
[142] WELSH GOVERNMENT, 2024. Planning policy Wales (Edition 12, February 2024)
[143] WELSH GOVERNMENT, 1997. Technical Advice Note (TAN) 11: Noise
[144] WELSH GOVERNMENT, 2018. Noise and soundscape action plan 2018-2023
[145] FLINTSHIRE COUNTY COUNCIL, 2023. Flintshire Local Development Plan 2015-2030

- BS 7385-2:1993 Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from groundborne vibration;
- BS8233:2014 Guidance on sound insulation and noise reduction for buildings; and
- DIN 4150-3 Vibrations in Buildings Part 3: Effects on Structures

12.3.2 The above list is not exhaustive and further guidance will be referred to where necessary.

12.4 Assessment methodology

12.4.1 The assessment of construction noise and vibration and operational noise impacts will be undertaken using the DMRB LA 111 methodology to identify potential significant effects.

12.4.2 Note that DMRB LA 111 introduced the concepts of Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL) to the assessment of significance of effect for the construction and operation of road schemes.

12.4.3 Table 12-1 summarises LOAEL and SOAEL values for noise and vibration at NSRs as defined in Table 3.12, 3.31 and 3.49.1 of DMRB LA 111.

Table 12-1: Summary of LOAEL and SOAEL values used to identify significant effects due to noise and vibration

Period	LOAEL	SOAEL
Construction Noise		
Day (07:00-19:00) weekday and Saturday morning (07:00-13:00)	Baseline noise levels $L_{Aeq,T}$	Threshold level determined as per BS 5228-1 Section E3.2 and Table E.1 BS 5228-1.
Night (23:00-07:00)	Baseline noise levels $L_{Aeq,T}$	Threshold level determined as per BS 5228-1 Section E3.2 and Table E.1 BS 5228-1.
Evening and weekends (periods not covered above)	Baseline noise levels $L_{Aeq,T}$	Threshold level determined as per BS 5228-1 Section E3.2 and Table E.1 BS 5228-1.
Construction Vibration		
Anytime	0.3mm/s	1.0mm/s
Operational Noise		
Daytime	55 dB $L_{A10,18hr}$ (facade)	68 dB $L_{A10,18hr}$ (facade)
Night-time	40 dB $L_{night, outside}$ (free-field)	55 dB $L_{night, outside}$ (free-field)

Source: DMRB LA 111

Study Area

12.4.4 For construction noise, DMRB LA 111 states that the study area is defined to include all noise sensitive receptors (NSR):

"*1) that are potentially affected by construction noise;*

2) in areas where there is a reasonable stakeholder expectation that a construction noise assessment will be undertaken."

12.4.5 A construction noise study area of 300m from the closest construction activity is considered sufficient to account for all relevant NSR for the purposes of this assessment. However, the construction noise study area may be extended to assess the effects from construction traffic on the existing road network and from potential diversion routes.

12.4.6 For operational noise, DMRB LA 111 states that the study area should include the following:

"*1) noise sensitive receptors that are potentially affected by operational noise changes generated by the project, either on the route of the project or other roads not physically changed by the project;*

2) noise sensitive receptors in areas where there is a reasonable stakeholder expectation that noise assessment is undertaken."

12.4.7 The DMRB LA 111 methodology advises that assessment is undertaken for receptors within 600m of new road links or road links physically changed or bypassed by the project, and within 50m of roads which are likely to experience a short-term change of more than 1dB $L_{A10,18hr}$ as a result of the proposed scheme. Consequently, the spatial extents of the assessment extend beyond the physical works associated with the proposed scheme. This approach to define the study area will be adopted for the assessment of operational noise effects.

Construction noise

12.4.8 The methodology set out in Annex F of BS 5228-1:2009+A1:2014 will be used to predict construction noise levels incident upon NSR. Predictions will be undertaken for the main construction activities anticipated and will utilise reference noise emission levels for construction plant from Annexes C and D of BS 5228-1:2009+A1:2014.

12.4.9 The methodology within DMRB LA 111 will be adopted for the assessment of construction noise effects at NSRs resulting from predicted construction noise levels. DMRB LA 111 utilises '*Example Method 1 – The ABC Method'* calculation methodology from Annex E of BS 5228–1:2009+A1:2014. DMRB LA 111 provides a methodology for the determination of the magnitude of impact and significance of effects due to construction noise including noise from construction traffic and diversion routes. The magnitude of impact is determined to be negligible, minor, moderate or major by comparison with LOAEL and SOAEL values for all relevant NSRs as shown in Table 3.16 of DMRB LA 111 and reproduced in Table 12-2.

Table 12-2: Magnitude of impact and construction noise descriptions

Magnitude of impact	Construction noise level
Major	Above or equal to SOAEL +5 dB
Moderate	Above or equal to SOAEL and below SOAEL +5 dB
Minor	Above or equal to LOAEL and below SOAEL
Negligible	Below LOAEL

Source: DMRB LA 111 Table 3.16

12.4.10 The magnitude of impact from noise due to construction traffic and diversion routes is determined by changes in Basic Noise Level (BNL) to be negligible, minor, moderate or major in accordance with Table 3.17 of DMRB LA 111 reproduced in Table 12-3.

Table 12-3: Magnitude of impact at receptors for construction traffic and diversion routes

Magnitude of impact	Increase in BNL of closest public road used for construction traffic (dB)
Major	Greater than or equal to 5.0
Moderate	Greater than or equal to 3.0 and less than 5.0
Minor	Greater than or equal to 1.0 and less than 3.0
Negligible	Less than 1.0

Source: DMRB LA 111 Table 3.17

12.4.11 For diversion routes used at night, DMRB LA 111 Section 3.18 states that a major magnitude of impact shall be determined at NSR within the diversion route study area.

12.4.12 Construction noise and construction traffic noise is determined to result in a significant effect where a moderate or major magnitude of impact is predicted to occur for a duration exceeding: 10 or more days or nights in any 15 consecutive days or nights; or a total number of days exceeding 40 in any six consecutive months as set out in DMRB LA 111 Section 3.19.

Construction vibration

Construction vibration impacts on human receptors

12.4.13 Data on the propagation of ground borne vibration with distance derived from the annexes of BS 5228-2:2009+A1:2014 and from the TRL Research Report 53 will be used to predict levels of ground borne vibration from the main construction activities at nearby sensitive receptors.

12.4.14 The methodology within DMRB LA 111 will be adopted for the assessment of construction vibration effects at sensitive receptors resultant from the predicted levels of vibration. This methodology refers to BS 5228-2:2009+A1:2014.

12.4.15 A potential significant effect due to construction vibration is identified where a moderate or major magnitude of impact is predicted to occur for a duration exceeding: 10 or more days or nights in any 15 consecutive days or nights; or a total number of days exceeding 40 in any six consecutive months as shown in Table 3.33 and Section 3.34 of DMRB LA 111 (reproduced in Table 12-412-412.4). The LOAEL and SOAEL for construction vibration are defined in Table 12-1Table 12-112.1.

Table 12-4: Construction vibration level – magnitude of impact

Magnitude of impact	Vibration level
Major	Above or equal to 10 mm/s PPV
Moderate	Above or equal to SOAEL and below 10 mm/s PPV
Minor	Above equal to LOAEL and below SOAEL
Negligible	Below LOAEL

Source: DMRB LA 111 Table 3.33

12.4.16 Damage to buildings due to construction vibration is not anticipated occur. Predicted vibration levels from construction plant will however be compared to values associated with cosmetic damage to residential or light commercial buildings provided in Table B.2 of BS 5228-2:2009+A1:2014. These are reproduced in Table 12-5.

Table 12-5: Criteria for construction vibration (building damage)

Type of building	PPV in frequency range of predominant pulse	
	4 Hz – 15 Hz	15 Hz and above
Unreinforced or light framed structures Residential or light commercial buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Source: BS 5228-2:2009+A1:2014

Building damage to heritage structures

12.4.17 Heritage structures have been identified within the construction noise and vibration study area Consequently, an assessment will be undertaken to determine whether the construction of the Scheme will generate vibration levels that approach the thresholds for potential damage to the listed structures. For more detail on designated heritage assets, refer to Cultural Heritage Assessment, Chapter 10.

12.4.18 BS 7385-2 notes that: "*A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.*" However, it is evident that none of the limits given in Table 12-512-512.5 specifically relate to heritage or particularly sensitive structures. If a heritage structure is deemed to be particularly sensitive by a structural engineer, some guidance on this is provided by German Standard DIN 4150-3. It provides ranges for vibration limits for building types similar to those given in Table 12-512-512.5 above but also provides limits for *"Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g., listed buildings under preservation order)".* These are shown in Table 12-612-612.6. The threshold of significance for damage to heritage structures used in the assessment will be 3 mm/s.

Table 12-6: Criteria for construction vibration (building damage heritage)

Type of building	PPV in the range of the dominant frequency		
	3 Hz – 10 Hz	10Hz to 50 Hz	50Hz to 100Hz
Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)"	3 mm/s	3-8 mm/s	8-10 mm/s

Source: DIN 4150-3

Operational noise

12.4.19 The methodology within DMRB LA 111 will be adopted for the quantitative assessment of operational noise effects at sensitive receptors.

12.4.20 The level of road traffic noise from the road network will be predicted using the CRTN methodology and using forecast traffic data provided in terms of 18-hour Annual Average Weekday Traffic (AAWT) flow between the hours of 06:00 to 00:00, along with speed-pivoted vehicle speed and percentage of heavy goods vehicles. Calculations will determine road traffic noise levels using noise descriptors $L_{A10,18hr}$ and L_{night}. L_{night} values will be derived using TRL PR/SE/451/02 Method 3 in accordance with DMRB LA 111.

12.4.21 Calculations of the road traffic noise level will be carried out for four scenarios:

- Do-minimum option in the opening year;
- Do-minimum option in the future assessment year;
- Do-something option in the opening year; and
- Do-something option in the future assessment year.

12.4.22 In the above scenarios, 'do-minimum' means traffic growth with committed development only. 'Do-something' means committed growth with the proposed scheme. The future assessment year is opening year +15 years. In accordance with the DMRB LA 111 the assessment of road traffic noise effects requires the following comparisons:

- Do-minimum scenario in the opening year against do-something in the opening year (short-term change with the proposed scheme);
- Do-minimum scenario in the opening year against do-something in the future assessment year (long-term change with the proposed scheme); and
- Do-minimum scenario in the opening year against do-minimum in the future assessment year (long-term change without the proposed scheme).

12.4.23 DMRB LA 111 classifies the magnitude of noise level change as negligible, minor, moderate or major and applies different criteria in the short-term and long-term. These changes may be beneficial (noise decrease) or adverse (noise increase). These classifications will be applied as per DMRB LA 111 Tables 3.54a and 3.54b (reproduced in Table 12-712-712.7).

Table 12-7: Construction noise short-term and long-term magnitude of change

Magnitude of impact	Short term noise change (dB $L_{A10,18hr}$ or L_{night})	Long term noise change (dB $L_{A10,18hr}$ or L_{night})
Major	Greater than or equal to 5.0	Greater than or equal to 10.0
Moderate	3.0 to 4.9	5.0 to 9.9
Minor	1.0 to 2.9	3.0 to 4.9
Negligible	Less than 1.0	Less than 3.0

Source: DMRB LA 111 Table 3.54a and Table 3.54b

12.4.24 Initial assessment of operational noise significance will be determined based on the short-term magnitude of change as per Table 3.58 of DMRB LA 111 (reproduced in Table 12-8). Initial assessment considers negligible and minor short-term change to be not significant and moderate and major short-term change to be significant.

Table 12-8: Initial assessment of operational noise significance

Significance	Short term magnitude of change
Significant	Major
Significant	Moderate
Not significant	Minor
Not significant	Negligible

Source: DMRB LA 111 Table 3.33

12.4.25 In all cases where the magnitude of noise level change in the short-term is found to be minor, moderate or major, additional factors described in Table 3.60 of DMRB LA 111 are considered to determine the final significance. The factors that influence the final significance judgement include the magnitude of change with respect to minor and moderate boundaries, the magnitude of impact in the long term and short term, consideration of absolute noise levels with respect to the LOAEL and SOAEL, location of noise sensitive parts of the receptor, acoustic context and perception of change.

12.5 Baseline conditions

Noise and Vibration Sensitive Receptors

12.5.1 The Study Area for the Scheme comprises a mix of suburban, rural and commercial / industrial areas. The A494 is the primary source of noise for receptors close to the Scheme. For noise and vibration-sensitive receptors more remote from the Scheme alignment, traffic noise from other main roads predominates, with contributions from the local minor road network and trains using the Chester to Holyhead railway line. Significant roads within the study area include the A548 Sealand Road, B5441 Welsh Road, B5129 Chester Road East and A550 Gladstone Way.

12.5.2 Noise and vibration-sensitive receptors close to the alignment of the Scheme, and to affected routes, are generally residential dwellings including a gypsy traveller site although there is a school, Sealand Primary School, and the Queensferry Campus in relative proximity.

Noise priority areas

12.5.3 A noise priority area in Wales is defined in the Noise and Soundscape Action Plan 2018-2023 as an area “where people’s homes are exposed to a day-evening-night noise level exceeding 73 dB according to the 2017 noise maps, or where people live alongside concrete trunk roads”.

12.5.4 There are a number of priority areas within or near to the Scheme extents; these are listed in Table 12-9.

Table 12-9: Noise priority areas

Priority Area ID	Location	Responsible Authority
423	A494(T) North of Garden City	Welsh Government
404	A494(T) Garden City	Welsh Government
402	A494(T) adjacent Dundas Street, Queensferry	Welsh Government

Source: A noise action plan for Wales 2013 – 2018

Baseline noise survey

12.5.5 A baseline noise survey was undertaken between 16 October 2018 and 24 October 2018. Given the time elapsed since these surveys were undertaken, repeat surveys will be undertaken to provide a more up to date reference for assessment of noise impacts.

Vibration Baseline

12.5.6 It is considered unlikely that any vibration sensitive receptors are currently subject to adverse levels of vibration so no survey to establish baseline levels of vibration will be carried out.

12.6 Potential and likely significant effects

Construction phase

12.6.1 During construction, temporary noise and vibration impacts associated with the proposed scheme have the potential to result in adverse effects at NSR.

12.6.2 Factors which have the potential to influence construction phase noise and vibration impacts include:

- construction plant inventory and utilisation;
- programme and the duration of activities with noise and vibration impacts exceeding relevant thresholds;
- hours of work;
- proximity of the works to NSRs;
- frequency and routing of the movement of construction vehicles, including construction staff journeys;
- the location of construction compounds; and
- The routing of road traffic during temporary diversions, the volumes of road traffic using them and duration they are applied.

12.6.3 The affected NSR are expected to be those in the vicinity of the extents of the proposed scheme as identified in Section 12.4, although could extend along the existing road network, subject to diversions and construction-related traffic. At the time of writing, the construction methodology is at an early stage of development. Therefore, the extent of the affected road network is not known at this time.

Operational phase

12.6.4 The proposed scheme has the potential to result in adverse operational noise impacts and associated effects at NSRs close to the alignment of the proposed scheme and in proximity to highway routes where traffic flows may change due to the implementation of the proposed scheme. Factors which have the potential to affect road traffic noise include:

- Overall traffic volume;
- Proportion of heavy vehicles;
- Traffic speed (i.e. changes in free-flow conditions and waiting times at junctions);
- Road alignment (vertical and horizontal alignment);
- The type of carriageway surfacing material; and
- Changes in the noise character of the existing area or non-acoustic factors (e.g. vegetation removal)

12.7 Mitigation and enhancements

Construction phase mitigation

12.7.1 Mitigation measures to reduce and manage noise and vibration during construction will be based upon implementation of Best Practicable Means (BPM) as defined in Section 72 of The Control of Pollution Act 1974, applying the methods for the control of noise and vibration arising from construction activity described within BS 5228 Parts 1 and 2.

12.7.2 Typical means by which noise and vibration would be minimised include the following:

- Selecting quiet equipment;
- Ensuring equipment is maintained in good working order and is used in accordance with the manufacturer’s instructions;
- Members of the construction team trained and advised during tool box briefings on quiet working methods;
- Equipment not to be left running unnecessarily;
- Equipment fitted with silencers or mufflers;
- Plant enclosures used whenever feasible;
- Careful orientation of plant with directional features;

- Materials lowered instead of dropped from height;
- Informing nearby sensitive receptors in advance of construction activities and keeping them up to date with progress and changes;
- Giving nearby sensitive receptors access to a Public Liaison Officer, responsible for liaising with residents and maintaining good communications;
- Managing deliveries to prevent queuing of site traffic at access points;
- Using adjustable, directional audible vehicle-reversing alarms or alternative warning systems (for example white noise alarms); and
- Monitoring of noise during the construction phase.

12.7.3 Specific vibration mitigation measures may include the following:

- Utilising low vibration working methods;
- Replacement of plant that is causing significant levels of vibration with other plant;
- Consideration of alternative methods;
- Providing residents with advance notice of piling with a complaint process similar to the noise procedure set out above; and
- Monitoring of vibration during the construction phase.

12.7.4 Construction phase noise and vibration mitigation will be set out within the Construction Environment Management Plan (CEMP) for the Scheme.

Operational phase mitigation

Operational noise mitigation measures will be included in the design of the proposed scheme where required and may include a combination of:

- Acoustic barriers or bunds; and
- Low noise road surfacing (noting that noise modelling corrections for low noise surfacing are implemented only for speeds of 75 km/h and above).

12.8 Assumptions and limitations

12.8.1 The following assumptions and limitations have been identified. The uncertainty associated with each limitation will be reduced as far as practicable.

- Predictions of sound levels have an associated degree of uncertainty. Modelling, calculations, and measurement processes are undertaken in such a way to reduce such uncertainty. However, it is unavoidable that this limitation remains;
- Baseline noise surveys are necessarily a snapshot of the noise climate at the time of the survey and, for practical reasons are carried out at a limited number of locations. Surveys will not be fully representative of the noise conditions experienced at all receptors at all times;
- Operational noise modelling calculations are undertaken based upon modelled traffic flows and are subject to the uncertainties associated with the traffic modelling; and
- Construction noise and vibration predictions are based upon the information available at a project stage when construction methodology is under development. Predictions presented in the Environmental Statement may not be fully reflect final construction methodology and plant selections.

12.9 Conclusions of scoping

12.9.1 The following aspects of noise and vibration will be scoped into the assessment:

- Temporary noise impacts on human receptors resulting directly from construction of the Scheme;
- Temporary noise impacts on human receptors resulting from construction traffic;
- Temporary noise impacts on human receptors resulting from traffic diversions required for construction of the Scheme;
- Vibration impacts on human receptors and structures resulting from construction of the Scheme; and
- Permanent impacts on human receptors resulting from changes in traffic noise.

12.9.2 The following aspects of noise and vibration will be scoped out of the assessment:

- Operational vibration; and
- Operational noise from relocated Queensferry surface water pumping station.

12.10 Consultations and key stakeholders

12.10.1 Consultation will be undertaken with Flintshire County Council environmental protection team to confirm the assessment approach.

13 Material assets and waste

13.1 Introduction

13.1.1 This chapter presents the baseline materials and waste assessment in the vicinity of the Scheme and describes the proposed approach for the assessment for material assets and waste within the Scoping Report.

13.2 Legislation and policy context

13.2.1 The legislation, policy, standards and guidelines considered to be relevant to the assessment of materials assets and waste are detailed below.

Assimilated law

13.2.2 The overarching European Directives that are applicable to the assessment of use of material and waste generation are set out below. Whilst it is acknowledged that the UK has left the European Union (EU)[146] it should be noted that existing legislation which transpose these Directives remains in force as Assimilated law.

13.2.3 Waste Framework Directive (2008/98/EC)[147]: has been transposed into UK legislation as Assimilated law (The Waste and Environmental Permitting etc. (Legislative Functions and Amendment etc.) (EU Exit) Regulations 2020). This Directive sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling and recovery.

13.2.4 Landfill Directive (1999/31/EC)[148]: The Landfill Directive has been transposed in the Environmental Permitting (England and Wales) Regulation 2016 as amended and aims to prevent, or reduce as far as possible, negative effects on the environment from the landfilling of waste. This assessment has considered disposal to landfill as the last option for waste management, prioritising the higher up options of the waste hierarchy.

National legislation

13.2.5 The Environment Act 2021[149]: Makes provision about plans and policies for improving the natural environment. The scoping assessment has adhered to the plans and requirements of the Environment Act 2021, including separation of recyclable waste from residual waste, and appropriate management of hazardous waste (if any arises).

13.2.6 Waste (Circular Economy) (Amendment) Regulation 2020[150]: These Regulations transpose the EU's 2020 Circular Economy Package, which aims to promote a more sustainable and circular approach to waste management. The Scheme will handle materials and waste in accordance with circular economy principles favouring reuse and recycling rather than being discarded.

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[146] His Majesty's Government (2018) European Union (Withdrawal) Act 2018 [online]. Available at: European Union (Withdrawal) Act 2018 (legislation.gov.uk). Accessed September 2024.

[147] European Union Directive. (2008) Waste Framework Directive (2008/98/EC) [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098. Accessed September 2024.

[148] European Union Council Directive (1999). Landfill Directive (1999/31/EC) [online]. Available at: EUR-Lex - 31999L0031 - EN - EUR-Lex (europa.eu) . Accessed September 2024.

[149] His Majesty's Government (2021) The Environment Act 2021 [online]. Available at: Environment Act 2021 (legislation.gov.uk). Accessed September 2024.

[150] His Majesty's Government (2020) The Waste (Circular Economy) (Amendment) Regulations 2020 [online]. Available at: Legislation.gov.uk Accessed September 2024.

13.2.7 The Environmental Protection Act 1990 (as amended)[151]: These regulations define the fundamental structure and authority for waste management and control of emissions into the environment. The assessment in this chapter has considered the EPA 1990 definition of waste and the Act's requirements relating to the duty of care for the waste arisings from the construction, operation and decommissioning of the Scheme.

13.2.8 The Waste and Environmental Permitting etc. (Legislative Functions and Amendment etc.) (EU Exit) Regulations 2020[152]: These regulations pertain to environmental protection and waste management functions in the context of the UK's withdrawal from the European Union.

13.2.9 The Waste (England and Wales) Regulations (2011) as amended[153] transpose the Waste Framework Directive in England and Wales. The Regulations are a set of rules aimed at managing waste more efficiently and sustainably.

13.2.10 The Hazardous Waste (England and Wales) Regulations (2005) as amended[154]: These regulations provide for the control of hazardous wastes and their movements and have been considered in this assessment in the event that hazardous waste arises from the Scheme's constructional, operational activities.

13.2.11 The Environmental Permitting (England and Wales) Regulations (2016), as amended[155]: These regulations introduce a streamlined system of environmental permitting in England and Wales for certain installations, waste operations and mobile plants. Waste will be managed in appropriate and permitted facilities, and the Scheme's activities will adhere to these Regulations, if required, for waste storage, use or disposal.

13.2.12 Controlled Waste (England and Wales) Regulations 2012 (SI 2012/811)[156]: These regulations are applicable to the Scheme to ensure waste arising from construction, operational and decommissioning phase will be managed by permitted facilities and will be collected / transferred by permitted waste carriers.

13.2.13 The Waste Electrical and Electronic Equipment (WEEE) Regulations 2013[157] apply to all electrical and electronic equipment placed on the market in the UK covered by the scope of the regulations. There are 10 broad categories of WEEE currently outlined within the regulations, and relevant categories for the Scheme could include lighting equipment, electrical tools and monitoring equipment used during construction.

[151] His Majesty's Government (1990) Environmental Protection Act 1990 [online]. Available at: Environmental Protection Act 1990 (legislation.gov.uk). Accessed September 2024.

[152] His Majesty's Government (2020) The Waste and Environmental Permitting etc. (Legislative Functions and Amendment etc.) (EU Exit) Regulations 2020 [online]. Available at The Waste and Environmental Permitting etc. (Legislative Functions and Amendment etc.) (EU Exit) Regulations 2020 (legislation.gov.uk). Accessed September 2024.

[153] His Majesty's Government (2011) The Waste (England and Wales) Regulations 2011, No.988 [online]. Available at: https://www.legislation.gov.uk/uksi/2011/988/contents. Accessed September 2024.

[154] His Majesty's Government (2005) The Hazardous Waste (England and Wales) Regulations 2005, No. 894 [online]. Available at: https://www.legislation.gov.uk/uksi/2005/894/contents/made. Accessed September 2024.

[155] His Majesty's Government (2016) The Environmental Permitting (England and Wales) Regulations 2016 No. 1154 [online]. Available at: https://www.legislation.gov.uk/uksi/2016/1154/contents/made. Accessed September 2024.

[156] His Majesty's Government (2012) Controlled Waste (England and Wales) Regulations 2012 [online]. Available at: www.legislation.gov.uk/uksi/2012/811/contents/made. Accessed September 2024.

[157] Her Majesty's Government (2013) Waste Electrical and Electronic Equipment (WEEE) (England and Wales) Regulations, 2013 [online]. Available at: https://www.legislation.gov.uk/uksi/2013/3113/made Accessed September 2024.

National policy

13.2.14 Net Zero Strategy: Build Back Greener 2021 (UK)[158]: The UK-wide strategy highlights the reduction of waste sent to landfill for disposal, particularly biodegradable waste, as well as the importance of resource efficiency in the construction sector. The assessment considers that disposal of waste to landfill is the least preferred option for waste management.

13.2.15 The Clean Growth Strategy 2017[159]: The Clean Growth Strategy 2017 highlights the ambition to achieve zero avoidable waste by 2050. The Scheme takes into account measures for an efficient use of materials aiming to minimise waste arisings from its activities.

13.2.16 National Planning Policy for Waste (2014)[160]: This sets out detailed waste planning policies and maintains the core principles of the 'plan led' approach with a continued focus of moving waste up the waste hierarchy, and facilitating a more sustainable and efficient approach to resource use and management.

13.2.17 Towards Zero Waste (Wales)[161]: This is the overarching waste strategy for Wales, a long-term framework for resource efficiency and waste management to 2050. It sets out recycling and waste reduction targets for all sectors including construction and demolition which will be implemented in this Scheme.

13.2.18 Beyond Recycling (Wales) [162] : This is Wales' strategy for a circular economy. It proposes a Circular Economy Fund to help Wales reach the milestones of 70% recycling and zero waste to landfill by 2025 and 100% recycling by 2050'.

13.2.19 Separated waste collections for workplaces (Wales)[163]: The new law came into force in Wales in April 2024, mandating all non-domestic premises to collect recyclables separately, including food waste, paper and card, glass, metals and plastics. The scope of non-domestic premises includes construction sites. It is therefore expected that this Scheme will adhere to this during construction operational and decommissioning stages.

13.2.20 Planning Policy Wales (2024)[164]: Sets out the land use planning policies of the Welsh Government. This includes principles around making best use of material resources, promoting the circular economy, design choices to prevent waste, and sustainable waste management facilities.

13.2.21 Minerals Planning Policy (Wales)[165]: sets out the land use planning policy guidance of the National Assembly for Wales in relation to mineral extraction and related development in Wales, which includes all minerals and substances in, on or under land extracted either by underground

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[158] Department for Energy Security and Net Zero and Department for Business, Energy & Industrial Strategy (2021) Net Zero Strategy: Build Back Greener [online]. Available at Net Zero Strategy: Build Back Greener - GOV.UK (www.gov.uk). Accessed September 2024.

[159] Department for Energy Security and Net Zero and Department for Business, Energy & Industrial Strategy (2018). Clean Growth Strategy [online]. Available at: Clean Growth Strategy (publishing.service.gov.uk) Accessed September 2024.

[160] Department for Communities and Local Government (2014) National planning policy for waste [online]. Available at: National planning policy for waste - GOV.UK (www.gov.uk). Accessed September 2024.

[161] Towards Zero Waste: One Wales: One Planet [online]. Available at: towards-zero-waste-our-waste-strategy.pdf (gov.wales). Accessed September 2024.

[162] Welsh Government (2021) Beyond Recycling: A Strategy to make the circular economy in Wales a reality [online]. Available at beyond-recycling-strategy-document.pdf (gov.wales) Accessed September 2024.

[163] Welsh Government (2024) Separated waste collections for workplaces [online] Available at Separated waste collections for workplaces | GOV.WALES Accessed September 2024.

[164] Welsh Government (2024) Planning Policy Wales [online]. Available at: gov.wales/sites/default/files/publications/2024-07/planning-policy-wales-edition-12.pdf (gov.wales) Accessed September 2024.

[165] National Assembly for Wales (2000) Minerals Planning Policy (Wales) [online] Available at: wd25.pdf (bridgend.gov.uk) Accessed September 2024.

or surface working. An accompanying technical advice note[166] covers policy relating to aggregates.

Local policy

13.2.22 Flintshire County Council Local Development Plan (2023)[167]: This includes strategic policies on waste management, such as sufficient waste treatment facilities in the area, and the importance waste reduction and increasing recycling for new developments as well as construction and demolition, which will be implemented for this Scheme. The Plan also includes policies on mineral safeguarding and policies to maximise use of secondary/recycled aggregate.

13.3 Relevant guidance

13.3.1 Separate Collection of Waste Materials for Recycling: A Code of Practice for Wales[168]: A code of practice guidance document for workplaces to comply with the Separate Waste Collection Regulations from 2024. This defines the obligations of workplaces, including construction sites, any exemptions, and the materials that must be collected for recycling.

13.3.2 Site Waste Management Plans (SWMPs) – Guidance for Construction Contractors and Clients Voluntary Code of Practice[169]: Site Waste Management Plans (SWMPs) are no longer mandatory for projects commencing after 01 December 2013. However, the principles behind the regulations remain best practice and will be used for managing construction waste.

13.3.3 Construction Code of Practice for Sustainable Use of Soils on Construction Sites[170]: The document provides relevant advice to protect soil resources and provides information for mitigation measures for excavated material.

13.3.4 Contaminated Land: Applications in Real Environments (CL:AIRE) Definition of Waste: Development Industry Code of Practice (DoWCoP)[171]: provides a clear, consistent and efficient process which enables the reuse of excavated materials on=site or their movement between sites. Use of the DoWCoP supports the sustainable and cost-effective development of land. It can provide an alternative to Environmental Permits or Waste Exemptions and has been used for as part of the assumed mitigation process.

13.3.5 Design Manual for Roads and Bridges LA110 Material Assets and Waste[173]: Produced by Standards for Highways, the requirements in the LA110 document shall be applied to the assessment, reporting and management of environmental effects associated with the consumption/use of material assets, and the disposal and recovery of waste from the delivery of

[166] Welsh Assembly Government (2004) Minerals Technical Advice Note (Wales) 1: Aggregates. [online] Available at: 31585_NAFW_Cover (gov.wales) Accessed September 2024.

[167] Flintshire County Council (2023) [online]. Available at: FINAL LDP Written Statement English (flintshire.gov.uk) Accessed September 2024.

[168] Welsh Government (2024) Separate Collection of Waste Materials for Recycling [online]. Available at: Separate Collection of Waste Materials for Recycling: A Code of Practice for Wales (gov.wales) Accessed September 2024.

[169] Department of Trade and Industry (2004). Site Waste Management Plans - Guidance for Construction Contractors and Clients [online]. Available at: https://www.bathnes.gov.uk/sites/default/files/sitewastemanagement.pdf. Accessed September 2024.

[170] Code of practice for the sustainable use of soils on construction sites. [online]. Available at: Code of practice for the sustainable use of soils on construction sites - GOV.UK (www.gov.uk). Accessed September 2024.

[171] Definition of Waste: Code of Practice [online]. Available at: DoW:CoP (claire.co.uk). Accessed September 2024.

[173] Standards for Highways (2019) Design Manual for Roads and Bridges – LA110 Material assets and waste [online]. Available at: https://www.standardsforhighways.co.uk/tses/attachments/6a19a7d4-2596-490d-b17b-4c9e570339e9?inline=true Accessed September 2024.

motorway and all-purpose trunk road projects. For Wales, there are no specific supplementary or alternative requirements in addition to those set out in LA110.

13.4 Assessment methodology

13.4.1 The assessment methodology is in accordance with DMRB LA110 Material Assets and Waste[173]. LA110 sets out the requirements for initial considerations when assessing the environmental impacts and effects of material assets and waste generation for the construction and maintenance of motorways and roads. It promotes the reduction in overall impacts of material asset use and the efficient use of resources. It also promotes the prevention and/or reduction of impacts due to waste generation and management by adhering to the waste hierarchy principles.

13.4.2 In addition, DMRB LA110 sets out the requirements for screening, scoping, the assessments, and the subsequent reporting and monitoring of material assets use and waste management.

Study Area

13.4.3 The Design Manual for Roads and Bridges (DMRB) LA 110 – Material assets and waste provides definitions for two geographically different study areas to examine and assess the use of material assets and waste generation.

13.4.4 The first study area is the area within the construction footprint of the Scheme, as this constitutes the area within which construction material assets will be consumed (used, reused and recycled) and waste will be generated. The first study area is defined by the red line boundary, of the Scheme.

13.4.5 To identify potential key sources of contaminated waste, a review of authorised and historic landfill sites that lie within 500m of the Scheme was undertaken and stated in 0.

13.4.6 The second study area focuses on an area sufficient to identify the feasible sources and availability of construction materials typically required for the works, suitable waste infrastructure that could accept arisings or waste generated by the Scheme, and, the proximity principle and value for money.

13.4.7 For material assets, the second study area is within Flintshire/North Wales. For waste management, the second study area has been assessed based on an initial search area of 10km from the Scheme. Where sufficient capacity is not available the search area will be extended accordingly, based on professional judgement, but kept within the boundaries of Wales.

13.4.8 For the purposes of the scoping report, the following will be included:

- The consumption of material assets and products (from primary, recycled or secondary, and renewable sources), the use of material assets offering sustainability benefits, and the use of excavated and other arisings that fall within the scope of waste exemption criteria;
- Sterilisation of Mineral Safeguarding Areas (MSAs) and peat resources; and,
- The production and disposal of waste.

13.4.9 For the assessment of material assets use, an assessment against the regional demand will be undertaken. The assessment for waste will be based on the availability of suitable waste management infrastructure and capacity in Flintshire and Wales. The assessment will consider the following:

- Types and quantities of material assets required for the Scheme, where known;

- Details of the source or origin of material assets, site-won material assets to replace virgin material assets, material assets from secondary or recycled sources, or virgin or non-renewable sources, if known;
- Cut and fill balance (import of fill material is envisaged);
- Forecast of non-hazardous, hazardous, and inert waste arisings;
- Surplus material assets and waste falling under regulatory controls;
- Waste that requires storage onsite prior to reuse, recycling and disposal;
- Waste to be pre-treated onsite for reuse;
- Waste requiring treatment or disposal offsite;
- Legislation, policy and guidance that will be adhered to;
- The impacts that will arise from the issues identified in relation to material assets and waste, including the potential sterilisation of MSAs;
- Identification of mitigation measures based on identified impacts; and,
- Conclusion based on nature and magnitude of impacts.

13.4.10 The assessment of effects on material assets and waste generation will encompass effects arising during excavation and demolition activities and the construction of the Scheme up until the point when it becomes operational.

13.4.11 It should be noted that no surveys specific to material assets use and waste generation have been undertaken or are required at this stage.

Significance criteria

13.4.12 DMRB Volume 11 LA110, Section 3, Part 13 will be used to identify significance criteria, to support professional judgement. This standard is primarily intended for motorway and all-purpose trunk road projects and provides more focused guidance for assessing the significance of potential effects resulting from material resource use and waste generation.

13.4.13 The effect categories and typical descriptors for material assets and waste generation are provided in Table 13-113-113-1 and the level of significance are provided in Table 13-213-213-2. For both of these tables, “Region” comprises the second study area, in this case Flintshire and Wales. “Primary material assets” describes material assets that are from a non-renewable source.

13.4.14 Significant environmental effects are more likely to arise from those material assets which:

- Are associated with the largest quantities;
- Are primary or virgin material assets; and,
- Have hazardous properties.

13.4.15 Significant environmental effects are more likely to arise from those waste which:

- Are associated with the largest quantities; and,
- Have hazardous properties.

Table 13-1 Effect categories and typical descriptors for material assets and waste generation

Effect	Description
Neutral	**Material assets:** Project achieves >99% overall material recovery or recycling (by weight) of non-hazardous Construction and Demolition (C&D) waste to substitute use of primary material assets; and Aggregates required to be imported to site comprise >99% reused or recycled content. **Waste generation:** No reduction or alteration in the capacity of waste infrastructure within the region.
Slight	**Material assets:** Project achieves 70-99% overall material recovery or recycling (by weight) of non-hazardous C&D waste to substitute use of primary material assets; and Aggregates required to be imported to site comprise reused or recycled content in line with the relevant regional percentage target. **Waste generation:** ⩽1% reduction or alteration in the regional capacity of landfill; and Waste infrastructure has sufficient capacity to accommodate waste from a project, without compromising integrity of the receiving infrastructure (design life or capacity) within the region.
Moderate	**Material assets:** Project achieves <70% overall material recovery or recycling (by weight) of non-hazardous C&D waste to substitute use of primary material assets; and Aggregates required to be imported to site comprise reused or recycled content below the relevant regional percentage target. **Waste generation:** >1% reduction or alteration in the regional capacity of landfill as a result of accommodating waste from a project; and 1-50% of project waste requires disposal outside of the region.
Large	**Material assets:** Project achieves <70% overall material recovery or recycling (by weight) of non-hazardous C&D waste to substitute use of primary material assets; and Aggregates required to be imported to site comprise <1% reused or recycled content; and Project sterilises ⩾1 mineral safeguarding site and/or peat resource. **Waste generation:** >1% reduction in the regional capacity of landfill as a result of accommodating waste from a project; and >50% of project waste for disposal outside of the region.
Very Large	**Material assets:** No criteria: use criteria for large category above. **Waste generation:**

Effect	Description
	>1% reduction or alteration in the national capacity of landfill, as a result of accommodating waste from a project; or Construction of new (permanent) waste infrastructure is required to accommodate waste from the project.

Source: National Highways (2019), DMRB LA110, Table 3.13[173]

Table 13-2 Significance criteria for material assets and waste generation

Significance	Description
Not Significant	**Material assets:** Category description met for Neutral or Slight effect. **Waste generation:** Category met for Neutral or Slight effect.
Significant (one or more criteria met)	**Material assets:** Category description met for Moderate or Large effect. **Waste generation:** Category met for Moderate, Large or Very Large effect.

Source: National Highways (2019), DMRB LA110, Table 3.13[173]

13.5 Baseline conditions

13.5.1 The baseline conditions are centred on the demand for key construction material assets and the national and local generation of waste, within Flintshire and Wales. The baseline also outlines the key construction material assets required and the capacity/availability of waste management infrastructure within the vicinity of the Scheme. It has been established to ensure the most up-to-date information is reported. The assessment describes the current and likely future state of the types and quantities of material assets use and waste associated with the construction of the Scheme. This information is determined through a desk-based study, using a range of readily available resources.

Baseline sources

13.5.2 Baseline information and data were gathered from the following sources:

- British Geological Survey: United Kingdom Minerals Yearbook 2022[181]
- Mineral Products Association: Profile of the UK Mineral - Products Industry[182]
- World Steel Association: 2021 World Steel in Figures[183]
- Regional Technical Statement (Second Review, 2019) of the North and South Wales Regional Aggregates Working Party[174]
- Regional Technical Statement Appendix A (North Wales, Second Review, 2020) of the North Wales Regional Aggregates Working Party[175]

[174] North and South Wales Regional Aggregates Working Party (2019) Regional Technical Statements [online]. Available at: 1 (nwrawp-wales.org.uk). Accessed September 2024.

[175] North Wales Regional Aggregates Working Party (2020) Regional Technical Statements Appendix A [online]. Available at: 1 (swrawp-wales.org.uk) Accessed September 2024.

- British Geological Survey: Collation of the results of the 2019 Aggregate Minerals Survey for England and Wales[176]
- Natural Resources Wales – Data Interrogator for Waste[177]
- DataMapWales: Peatlands of Wales[178]
- DataMapWales: Historic Landfill Sites[179]
- British Geological Survey: North East Wales Aggregate Safeguarding Areas Map[180]

Use of material assets

13.5.3 Information on the demand for key construction material assets within the UK and within Wales has been used to provide the baseline for material assets. This information has been determined through a desk-based study using a number of readily available resources, in particular from the British Geological Survey (BGS), World Steel Association, Flintshire Council and the local Regional Aggregates Working Party.

Great Britain's (GB) sale of minerals and mineral products is shown in Table 13 and the production of minerals within UK and Wales in 2021 and available mineral workings is shown in

13.5.4 Table 13-4.

Table 13-3: GB demand for minerals and mineral products

Mineral/ mineral product	GB Demand (2021, unless otherwise stated)
Aggregates, of which:	279.8 million tonnes
Crushed rock	148.2 million tonnes
Sand and gravel	62 million tonnes
Recycled and secondary aggregates	69.6 million tonnes
Finished cement	11.2 million tonnes
Ready-mixed concrete	52.7 million tonnes
Concrete products	24.8 million tonnes
Asphalt	28.3 million tonnes
Apparent steel use	10.8 million tonnes, of which 7.2 million tonnes were produced in the UK

Source: British Geological Society (2022)[181], Mineral Products Association (2023)[182] and World Steel Association (2023)[183]

[176] British Geological Survey (2021) Collation of the results of the 2019 Aggregate Minerals Survey for England and Wales [online]. Available at: Aggregate Minerals Survey for England and Wales, 2019 (publishing.service.gov.uk). Accessed September 2024.

[177] Natural Resources Wales (2023) Waste Data Interrogators [online]. Natural Resources Wales - Citrix FileShare (sharefile.eu) Accessed September 2024.

[178] DataMapWales (2022) Peatlands of Wales [online]. Peatlands of Wales Maps | DataMapWales (gov.wales). Accessed September 2024.

[179] DataMapWales (2024) Historic Landfill Sites [online]. Available at: New map | DataMapWales (gov.wales) Accessed September 2024.

[180] British Geological Survey (2012) North East Wales Aggregate Safeguarding Map [online]. Available at: NE_Wales_FINAL.pdf (nerc.ac.uk). Accessed September 2024.

[181] British Geological Survey (2023). United Kingdom Minerals Yearbook 2022. [online] available at: https://nora.nerc.ac.uk/id/eprint/534312/1/OR23001.pdf . Accessed September 2024.

[182] Mineral Products Association (2023). Profile of the UK Mineral - Products Industry. [online] available at: Profile_of_the_UK_Mineral_Products_Industry_2023.pdf (mineralproducts.org) Accessed September 2024.

[183]

Table 13-4: Production of minerals in 2021

Mineral	UK production in tonnes in 2021	Wales production in tonnes in 2021	Number of mineral workings in Wales
Igneous rock	125.9 million*	-	17
Limestone and dolomite		-	36
Dolomite		14.1 million	-
Sandstone			19
Sand and gravel	64.6 million	1.9 million	15

Source: British Geological Society (2023)[176181,] North and South Wales Regional Aggregates Working Party (2019)[174174]
Note: *Includes marine-dredged landings at foreign ports.

13.5.5 The North and South Wales Regional Aggregates Working Party assesses the demand for and supply of aggregates in the study areas of the Scheme. The latest second review of the Regional Technical Statement of the North and South Wales Regional Aggregates Working Party[185] provides data for each of the 22 mineral planning authorities of Wales, divided into two sub-regional clusters North Wales and South Wales. The Scheme is within North Wales which includes Conwy, Denbighshire, Flintshire, Gwynedd, the Isle of Anglesey, and Wrexham.

Table 13-5: Total consumption of primary aggregate in Wales, 2019

Aggregate	Total sales, Wales (thousand tonnes)	Total sales, North Wales (thousand tonnes)	Imports into Wales (thousand tonnes)	Exports out of Wales (thousand tonnes)	Imports into North Wales (thousand tonnes)	Exports out of North Wales (thousand tonnes)	Total consumptio n, Wales (thousand tonnes)
Sand and Gravel	1,810	1,021	55	515	40	473	1,350
Crushed Rock	12,832	4,522	808	3,863	69	1,839	2,752

Table 13-6: The 10-year and 3-year total land-won primary aggregate sales average (to 2016) for Flintshire / North Wales

Aggregate	10-year average aggregate sales (Mtpa)	3-year average aggregate sales (Mtpa)	Annual sales, 2016, North Wales* (Mt)	Existing permitted reserves at end of 2016 (Mt)	Landbank at end of 2016 (years)
Land-won sand and gravel	-	-	5.023	1.369	6.1

[185] North Wales and South Wales Regional Aggregate Working Parties (2019) Regional Technical Statements, Second Review [online]. Available at: 1 (nwrawp-wales.org.uk) Accessed September 2024.

Aggregate	10-year average aggregate sales (Mtpa)	3-year average aggregate sales (Mtpa)	Annual sales, 2016, North Wales* (Mt)	Existing permitted reserves at end of 2016 (Mt)	Landbank at end of 2016 (years)
Crushed rock	-	-	8.41	48.04	14.3
Primary aggregates	2.663	3.204	-	-	-

Source: Regional Technical Statement (Second Review, 2019) of the North and South Wales Regional Aggregates Working Party
Note: *data not recorded for Flintshire only

13.5.6 The required landbank in Flintshire at the end of 2016 stood at 6.1 years for sand and gravel, and 14.3 years for crushed rock. Therefore, within Flintshire, there is only an adequate supply of crushed rock above the seven years required by the NPPF[186] whereas the amount of sand and gravel within Flintshire is less than this, at 6.1 years. A list of both active and inactive quarries for sand and gravel in 2016 is provided in Table 13-7.

13.5.7 According to the BGS map of North East Wales[180], the Scheme is not located in or near (500m) a MSA. The Scheme is also not located in or near a peatland as shown in the peatland map by DataMapWales[178].

Table 13-7: Active, inactive and dormant aggregate quarries in Flintshire (2018)

Site name	Activity status	Facility type	Operator name
Aberdo	Active	Limestone	CCP Building Products Ltd
Fron Haul	Active	Sand and gravel	Breedon Southern
Halkyn	Active	Limestone	Cemex UK
Hendre	Active	Limestone	Tarmac
Maes Mynan	Active	Sand and gravel	Breedon Southern
Pant	Active	Limestone	Tarmac
Ddol Uchaf	Inactive	Sand and gravel	Breedon Southern
Pen-yr-Henblas	Inactive	Limestone	Grosvenor Estate
Grange	Dormant	Limestone	Mr D Priestley or Tarmac

Source: Appendix A (North Wales) Regional Technical Statement (Second Review, 2020) of the North Wales Regional Aggregates Working Party[170]

Generation and management of waste

13.5.8 The most recent information available, relating to current waste generation and operational waste management infrastructure in Wales, has been gathered to provide the baseline information. Information on the current waste arisings, and the waste management infrastructure have been determined through a desktop study, using a number of readily available resources, in particular data from Natural Resources Wales.

Waste generation in Wales

13.5.9 The latest data from the Natural Resources Wales indicated that Wales produced over 13 million tonnes of waste in 2023. As of 2021, there are a total of 729 permitted waste facilities

[186] Ministry of Housing, Communities and Local Government (2021) National Planning Policy Framework [online]. Available at: National Planning Policy Framework (publishing.service.gov.uk). Accessed September 2024.

according to Natural Resources Wales[187]. The permitted waste facilities in North Wales region received over 3.2 million tonnes of waste in 2021, and those in Flintshire received approximately 1.26 million tonnes, as shown in Table 13-813-813.8.

Table 13-8: Waste breakdown by site type in tonnes (2023)

Site type	Flintshire (tonnes)	North Wales (tonnes)	Wales (tonnes)
Landfill	82.88	251,985.47	1,042,650.22
Transfer	365,923.93	987,397.24	2,673,054.59
Treatment (excluding metal recycling)	255,539.07	805,452.92	6,003,215.38
Metal recovery	39,926.74	126,481.78	1,434,221.35
Incineration	430,762.37	435,943.47	1,100,708.42
Land disposal	139,694.08	154,825.71	160,100.71
Total	**1,264,046.85**	**3,254,684.44**	**13,032,507.00**

Source: Natural Resources Wales[177]
Note: Mining, mobile plant, processing, and storage of waste are included in the total waste breakdown

Construction and demolition waste

13.5.10 Natural Resources Wales' Waste Permit Returns Data Interrogator (WPRDI) recorded that 3,557,180.71 tonnes of inert construction and demolition (C&D) waste were received in permitted waste facilities in the Wales region in 2023, of which 1,008,484.18 was in North Wales and 447,264.17 tonnes were received in Flintshire. The WPRDI states that 5,557,794.609 tonnes of inert C&D waste were removed from permitted waste facilities in from Wales with 1,343,662.13 tonnes removed from North Wales and 522,666.56 removed from Flintshire.

13.5.11 According to Defra[188], the recovery rate of non-hazardous C&D waste in 2020 across England and Wales was 92.6%. According to Natural Resources Wales[189], the recovery rate of non-hazardous C&D waste in Wales in 2019 was 93%, above the 90% target.

Hazardous waste

Regarding hazardous waste, Table 13-9 summarises the quantities received in 2021 in Wales, North Wales region and Flintshire. 35,263.39 tonnes of hazardous waste were received in Flintshire. NRW does not separately declare the proportion of hazardous waste that is C&D waste.

Table 13-9: Treatment of hazardous waste in tonnes in 2023

Site Type	Flintshire (tonnes)	North Wales (tonnes)	Wales (tonnes)
Landfill	0	54.84	27,152.05
Transfer	10,135.48	20,908	87,731.38
Treatment (excluding metal recycling)	0	4,210.19	175,454.67

[187] Natural Resources Wales (2021) Annual Regulation Report [online]. Available at: Natural Resources Wales / Annual regulation report 2021 Accessed September 2024.

[188] DEFRA (2022) UK Statistics on Waste [online]. Available at: UK statistics on waste - GOV.UK (www.gov.uk). Accessed September 2024.

[189] Natural Resources Wales (2022) Wales Construction & Demolition Waste Arisings Survey [online]. Available at: 2019 Wales construction and demolition waste arising survey (naturalresources.wales) Accessed September 2024.

Site Type	Flintshire (tonnes)	North Wales (tonnes)	Wales (tonnes)
Metal recovery	1,606.40	9,115.80	45,219.16
Incineration	23,521.51	28,104.18	50,045.34
Total	**35,263.39**	**55,577.39**	**387,537.42**

Source: Natural Resources Wales[177]
Note: Mining, mobile plant, processing, and storage of waste are included in the total waste breakdown

Table 13-10 Hazardous waste received and removed in 2023

Hazardous waste	Flintshire (tonnes)	North Wales (tonnes)	Wales (tonnes)
Received	35,263.39	55,577.39	387,537.42
Removed	522,666.56	1,343,662.13	5,557,794.61

Source: Natural Resources Wales[177]

Potentially hazardous waste arisings

13.5.12 To identify potential sources of contamination, an initial review of authorised and historic landfill sites that are in close proximity to the Scheme was undertaken using DataMapWales web map[190] for historic landfills, and Natural Resources Wales permitted waste sites map for current landfills[191].

13.5.13 There are no former or current landfills within 500m of the Scheme. Potential sources of contamination that are greater than 500m away from the Scheme have not been considered, as these are considered unlikely to affect the Scheme.

Waste Management Facilities

13.5.14 NRW reported that in 2021, there are a total of 729 permitted waste facilities according to Natural Resources Wales[192]. As of 2019 there are only 19 active landfills remaining in Wales, one of which is in Flintshire[193]. The remaining landfill capacity within Wales in 2018 has been stated in Table 13-1113-1113.11 and is the latest available information.

Table 13-11: Estimated landfill void in Wales (2018)

Landfill type	North Wales (m^3)	Wales (m^3)
Hazardous	0	13,868
Non-Hazardous	2,434,154	8,287,452
Inert	1,014,676	1,840,552
Total	3,448,830	10,141,872

Source: Natural Resources Wales[194]

[190] DataMapWales (2024) Historic Landfill Sites [online] Available at: New map | DataMapWales (gov.wales) Accessed September 2024.

[191] Natural Resources Wales (2024) Find details of permitted sites in Wales [online] Available at: Natural Resources Wales / Find details of permitted waste sites. Accessed September 2024.

[192] Natural Resources Wales (2021) Annual Regulation Report [online] Available at: Natural Resources Wales / Annual regulation report 2021 Accessed September 2024.

[193] Natural Resources Wales (2020) Estimated Landfill Void [online] Available at: Natural Resources Wales - Citrix FileShare (sharefile.eu) Accessed September 2024.

[194] Natural Resources Wales (2020) Estimated Landfill Void [online] Available at: Natural Resources Wales - Citrix FileShare (sharefile.eu) Accessed September 2024.

13.5.15 A search on the Natural Resources Wales public register was undertaken for all permitted waste facilities within 10km of the Scheme, measured from a central point within the Scheme's red line boundary. Permitted sites for recycling and recovery within 5km of the Scheme (using postcode CH5 2TE) are listed in **Table** 13-12. There are 19 permitted waste sites within a 5km radius of the Scheme.

13.5.16 Not all treatment facilities may be suitable for the waste generated by the Scheme during construction, but it demonstrates that sufficient treatment facilities are available for the waste that will be generated by the Scheme.

Table 13-12: Permitted sites within 5km of the Scheme for waste recycling and recovery

Site name	Treatment facility type	Distance from Scheme (km)
Queensferry Recycling Park	Fixed collection infrastructure	0.62
Queensferry Depot	Fixed collection infrastructure	0.73
Chadwicks Metal Processing Facility	Physical treatment infrastructure	0.87
Trident Commercial Holdings Ltd	Physical treatment infrastructure	0.95
Paperback Collection & Recycling Ltd	Fixed collection infrastructure, Specialist Treatment Infrastructure	1.71
J Chadwicks Scrapyard	Physical treatment infrastructure	1.91
Parry and Evans Ltd	Physical treatment infrastructure	2.06
Sandycroft Recycling Park	Fixed collection infrastructure	2.14
Materials Recycling and Recovery Facility, Orchid Shotton Ltd	Fixed collection infrastructure	2.20
Dock Road Recycling Park	Fixed collection infrastructure	2.22
Copart UK – Prince William Avenue	Physical treatment infrastructure	2.38
The Old Transport Yard	Physical treatment infrastructure	2.45
Sea View Farm 1	Disposal infrastructure	2.45
Sea View Farm 2	Disposal infrastructure	2.47
Glasfryn Yard	Physical treatment infrastructure	2.50
Deeside Motorcycles	Physical treatment infrastructure	2.79
Standard Road Transfer Station	Fixed collection infrastructure	4.72
Spencer Ind Est Scrapyard	Physical treatment infrastructure	4.82
Globe Way Recycling Park	Fixed collection infrastructure	4.83

Source: Natural Resources Wales[196]

13.5.17 Reuse, recycling and recovery of wastes will be prioritised. However, if these options are not available or feasible, the alternative is to adopt the proximity principle which implies that waste

[196] Natural Resources Wales (2024) Find details of permitted waste sites [online]. Available at: Natural Resources Wales / Find details of permitted waste sites. Accessed September 2024.

should generally be managed as near as possible to its place of origin, mainly because transporting waste could result in significant environmental effects. There are no landfill sites within 10km of the Scheme. The NRW map search does not offer longer distance radius searches. However, a full list of active landfills in North Wales is provided in Table 13-1313-1313.13. The volumes of waste generated by the Scheme will be assessed against the capacities of the relevant waste infrastructure to identify if there is sufficient capacity available.

Table 13-13: Permitted landfill sites with remaining capacity within North Wales

Facility name	Facility type	Operator name	Local authority	Remaining capacity at the end of 2018 (m^3)
FCC Environment (Llanddullas)	Non-hazardous	FCC Recycling (UK) Ltd	Conwy	167,922
Hafod Landfill	Non-hazardous	Enovert North Ltd	Wrexham	2,218,538
Landfill Site No.1 Shotton Works	Non-hazardous	Tata Steel UK Ltd	Flintshire	47,694
Griffiths Griffith Wyn, Edward Lloyd and Gwenfrai Rees (Ty Mawr Farm)	Inert	Wyn Griffiths & Sons	Conwy	397,791
Rhuddlan Bach Quarry	Inert	Hurt Plant Hire Ltd	Anglesey	337,500
Nant Newydd Quarry	Inert	Hurt Plant Hire Ltd	Anglesey	262,500
Nant Y Garth Landfill	Inert	Treborth Leisure Ltd	Gwynedd	16,885

Source: Natural Resources Wales[193]

13.5.18 It is expected that the region will have sufficient capacity for waste arisings generated by the Scheme. North Wales has sufficient capacity to treat inert, non-hazardous C&D waste arisings associated with the Scheme.

13.5.19 However, there are no landfills in North Wales that accept hazardous waste. The only permitted site that accepts hazardous waste in Wales is the Tata Steel (Port Talbot) landfill in South West Wales. It is likely that, if excavated material is found to be contaminated and therefore unsuitable for reuse, and may potentially be identified as hazardous and requires landfilling, then it will required to be disposed outside the region. .

13.5.20 Future baseline data are not produced by Natural Resources Wales or the local authorities and is therefore not available at present.

13.6 Potential and likely significant effects

Construction

13.6.1 This section provides an overview of potential impacts relating to use of material assets and waste generation as a result of the Scheme during construction. The construction phase considers site preparation, demolition and construction.

Use of material assets

13.6.2 Material assets required for the construction phase of the Scheme include raw material assets such as aggregate and minerals from primary, secondary and recycled sources, and manufactured construction products. Manufactured construction products include material assets required for the construction of road surface, pre-cast elements for the construction of structures such as bridges, gantries and signage, barriers, lighting, and fencing.

13.6.3 Road and bridge schemes generally require large quantities of both primary raw material assets and manufactured construction products. Many material assets may originate offsite, purchased as construction products. However, some material assets may arise onsite, for example excavated soils and sub-strata.

13.6.4 The consideration of the impacts associated with raw material extraction, processing, and manufacturing of construction material is outside the scope of this assessment due to the range of unknown variables associated with the processes involved and are not considered to form part of the Scheme.

13.6.5 The receptors likely to be subject to impacts as a result of the requirement for material assets during the construction of the Scheme include quarries and other sources of minerals, and other finite raw material assets. The potential impacts associated with the use of material assets on these receptors include:

- Materials will need to be imported to the site as it is assumed the Scheme will be unlikely to entirely recover or reuse site-won material;
- The majority of materials used on the Scheme will comprise primary materials as the Scheme is unlikely to be able to source all required materials from recycled or secondary materials.

13.6.6 Exact quantities of materials likely to be required by the construction and demolition involved in the Scheme have not been quantified at this stage. The potential significant impacts of material assets usage are listed below for each likely stage of construction/demolition:

- Site remediation/preparation/earthworks: Potential direct impacts associated with the import and use of primary aggregates and/or fill material, which may result in the depletion of non-renewable resources
- Demolition: significant demolition work is expected as the existing bridge shall be demolished, however it would be unlikely to require a significant input of any building materials.
- Construction: Construction of the proposed scheme, along with signage, lighting, safety barriers, drainage, communications infrastructure, pavement, and landscaping works, would require moderate amounts of materials. Although quantities of materials are not known at present, the type of materials that are likely to be required may include (and are not limited to) steel, aggregates, cement, concrete, bitumen, wood, plastic and other metals.

13.6.7 The Scheme is not anticipated to sterilise (substantially constrain/prevent existing and potential future use of) peat resources or MSA. This is due to the Scheme being anticipated to be located greater than 500m away from the nearest peat resource or MSA.

Generation and management of waste

13.6.8 The construction phase of the Scheme has the potential to generate waste which may result in adverse environmental effects, including the temporary occupation of waste management facility space (from treatment of waste) and the permanent reduction to landfill capacity (from disposal of waste).

13.6.9 In considering the generation and management of waste, it is important to define when, under current legislation and understanding, a material is considered to be a waste. The EU Waste Framework Directive 2008/98/EC defines waste as “any substance or object which the holder discards or intends or is required to discard”.

13.6.10 The receptors likely to be subject to impacts as a result of waste generation and its management are the surrounding environment and habitats, landfills and other waste management infrastructure. The potential impacts relating to the generation and management of waste on these receptors include:

- Temporary occupation of waste management infrastructure capacity (from treatment of waste) and temporary occupation of land for the storage of waste awaiting transfer off-site; and
- Permanent reduction in landfill capacity (from disposal of waste).

13.6.11 Exact quantities of waste likely to be generated by the construction of the Scheme have not been quantified at this stage. The potential significant impacts from waste generation are listed below for each likely stage of construction/demolition:

- Site remediation/preparation/earthworks: The production of waste from site clearance, e.g. green waste, contaminated soils, inert waste, exceeding the cut and fill balance, therefore, generating excess cut material as waste.
- Demolition: As the existing bridge is to be demolished there will be direct impacts associated with the generation of waste, in particular concrete, rubble, steel and other inert C&D waste. This may cause indirect impacts if disposal in landfill is required, which will result in a permanent reduction in landfill void capacity.
- Construction: The construction phase of the Scheme may result in waste arisings through:
  - Materials brought to site that are not used for their intended purpose, e.g. damaged items, offcuts, and surplus materials.
  - Excavated materials such as soil which may be contaminated, unsuitable or surplus to requirements.

Operational Phase

Use of material assets

13.6.12 Small quantities of materials are going to be required for maintenance of the Scheme, during the operational lifetime. This includes localised repairs, which may require concrete, and other materials consistent with construction materials listed in Section 13.6.2.

13.6.13 Maintenance activities would occur infrequently and would require relatively negligible quantities of both primary raw materials and manufactured construction products compared to the construction phase. The same is true for general operation of the Scheme.

The receptors likely to be subject to impacts as a result of the requirement for material assets during the operation of the proposed scheme include quarries and other sources of minerals, and other finite raw material assets. The potential impacts associated with the use of material assets on these receptors include:

- Materials would need to be imported to the site as it is assumed the proposed scheme would be unlikely to entirely recover or reuse site-won material; and
- The majority of materials used on the Scheme comprise primary materials as the proposed scheme are unlikely to be able to source all required materials from recycled or secondary materials.

13.6.14 For the operational phase, significant quantities of material assets requirement is not anticipated for the maintenance works and general operation when compared to the construction of the Scheme and thus can be scoped out.

Generation and management of waste

13.6.15 Maintenance works may generate waste from vegetation clearance, clearing of drainage networks, and from materials brought to site that are not used for their intended purposes, as well as surplus materials such as concrete, asphalt for road and junction repairs, paints and oils (some of which may be hazardous or require additional requirements for safe and compliant handling).

The receptors likely to be subject to impacts as a result of waste generation and its management are the surrounding environment and habitats, landfills and other waste management infrastructure. The potential impacts relating to the generation and management of waste on these receptors include:

- Temporary minor occupation of waste management infrastructure capacity (from treatment of waste) and temporary occupation of land for the storage of waste awaiting transfer off-site
- Permanent minor reduction in landfill capacity (from disposal of waste)

13.6.16 Therefore, in the operational phase, no significant effects relating to the operation of the Scheme are anticipated on waste generation as significant maintenance, repairs and replacements will be infrequent and unlikely to generate large volumes of waste and unlikely to generate large volumes of waste requiring disposal or treatment. So, generation and management of waste for operational phase can be scoped out.

13.7 Mitigation and enhancements

13.7.1 Good practice measures will be implemented to reduce the effects of material assets use and waste generation by the Scheme during the construction phase. There is substantial overlap in the mitigation for both aspects (material asset use and waste generation), due to the synergy between the reuse of material assets and the avoidance of waste generation.

13.7.2 Mitigation measures that will be implemented on site to ensure efficient use of material assets and reduction of waste arisings, and to reduce the potential impacts identified, are as follows (but not limited to) the following:

- All suitable excavated material will be reused in the construction of the Scheme and in landscaping features along the Scheme, wherever feasible. This could include material arising from:
  - The demolition of the bridge, such as concrete, rubble and steel
  - Digging up of existing road and earthworks
  - Potential dredging of the river
- This aims to reduce the requirement to import material assets for construction and to reduce the need to remove surplus material assets from site.
- Options for reuse of excavated material that is surplus to requirement, will be explored within neighbouring schemes to avoid disposal in landfill wherever possible.
- Where site-won material is not available or suitable for reuse, secondary or recycled material assets will be procured where available.
- Temporary stockpiling of fill material assets prior to incorporation in the Scheme will be avoided where possible, to ensure double handling and damage is minimised and, therefore, avoiding waste. However, where required, material assets will be stockpiled in accordance

with best practice and managed appropriately to limit the likelihood of damage or contamination.
- Locally sourced material assets and suppliers, ideally within 10km, will be identified and used, where feasible.
- Pre-cast elements will be used, for example, during construction of the new bridge, where practicable, to ensure efficient use of material assets and avoid generation of waste arisings from cut offs.

13.7.3 An Environmental Management Plan (EMP) may be produced and will incorporate the mitigation measures proposed.

13.7.4 A Materials Management Plan (MMP) will be compiled by the contractor as part of the EMP, if required. It will identify ways to reuse site-won or excavated materials within the construction of the preferred scheme, provided they meet the requirements of the CL:AIRE DoW CoP

13.7.5 It is also recommended that a Site Waste Management Plan (SWMP) is developed by the contractor as part of the EMP. The aim of the SWMP is to ensure that waste is managed in accordance with the waste hierarchy and other relevant legislative requirements, and it details information on the waste carriers and waste management facilities that could be used. It can also be used to measure and monitor the types and quantities of waste removed offsite. The SWMP is a key part of the EMP and will be a live document based on construction operations as they occur.

13.7.6 Measures which should be considered within the SWMP include:

- Reusing excavated (from land) or dredged soils (from the river) onsite in the landscaping features of the Scheme.
- Chipping green waste onsite for use in the landscaping for the Scheme, or composting.
- Recycling of inert material by crushing, blending and subsequent reuse, as an aggregate.
- Reusing waste on other nearby schemes.
- Reusing waste for uses with clear benefits to the environment, for example in the remodelling of agricultural land or in the restoration of nearby quarries or other excavation sites.
- Facilities will be provided onsite to separate out waste to enable the recovery of material through recycling.

13.7.7 Waste audits should be undertaken by the contractor throughout the construction phase. The contractor will report on the types and quantities of waste taken offsite and performance against reuse and recycling targets throughout the construction phase, and indicate where continual improvements to waste management and minimisation can be made. Information relating to these audits will be used to inform the revisions of the SWMP.

13.7.8 The MMP, SWMP and EMP will capture how efficient use of material assets and reduction of waste arisings will be achieved, and how the potential effects identified in Chapter 13.6 will be reduced or mitigated.

13.7.9 Where waste must be taken to a recycling or disposal site, the contractor has a legal duty to ensure that the sites have the appropriate permits. The appointed contractor will identify the closest relevant treatment and disposal sites, to minimise the impacts of transportation, such as carbon emissions.

13.8 Assumptions and limitations

13.8.1 The assessment was based on desktop information and information available for the Scheme at the time of writing. Field surveys were not required for the assessment of material assets and waste management. Baseline information and potential impacts identified are based on publicly available information.

13.8.2 The assessment did not consider the environmental effects associated with the offsite extraction of raw material assets used for the offsite manufacture of products. These stages of the products' or material assets' lifecycles are outside of the scope of the assessment due to the range of unknown variables associated with the processes involved and are not considered to form part of the Scheme.

13.8.3 Information on permitted capacity of waste management facilities has been used in the assessment, based on current publicly available data at the time of writing. However, it should be noted that the capacity information obtained from Natural Resources Wales for the sites and regions identified does not necessarily mean that the capacity detailed will be available for use by the Scheme.

13.8.4 It is noted that any future changes to the permitted capacity and throughput are uncertain. It is also difficult to assess the available capacity due to the commercial sensitivity of existing contracts and the timescales over which waste will be produced. It is likely that additional capacity will become available. However, it is not currently possible to predict the timeframes for when these new waste management facilities will become available and, therefore, how many of these sites will be available to accommodate waste arisings from the Scheme. Similarly, it is also possible that some of the existing waste management facilities might be closed or be unavailable.

13.8.5 The use of material assets and the generation of waste will also have the potential to generate adverse environmental effects through the transportation of material assets (for use onsite) and waste (to appropriate waste facilities offsite). These include detrimental impacts to air quality and increases in local noise levels. The effects of these activities are more appropriately covered in Chapter 11 (Air Quality), Chapter 15 (Climate), and Chapter 12 (Noise and Vibration).

13.8.6 The assessment has not considered waste and material types and quantities for the decommissioning or amendments of the Scheme at the end of its lifetime, as decommissioning is not envisaged. This assessment has not considered the effects of land contamination (such as impacts on groundwater and human health) (see Chapter 6 Geology and Soils, and Chapter 7, Road Drainage and Water environment). Where the potential from contaminated land is identified, this chapter addresses the management of this waste only.

13.8.7 The procurement strategy for the material assets required for the construction of the proposed scheme is unknown at this stage. For the purposes of the assessment, it will be assumed that not all material assets will be available to be sourced regionally (within Wales), and that the majority will be sourced nationally (within the UK). This will represent the (environmentally) worst case scenario. It is also assumed that all aggregate material sourced either regionally or nationally will meet the regional target for the recycled and secondary aggregate where technically appropriate and economically feasible.

13.8.8 Given the early stages of design, estimates relating to the quantity of material assets required are not available nor are there estimates available relating to the quantity of waste arisings anticipated. As such, a qualitative exercise has been carried out at this stage, limited to identifying activities that are likely to require significant quantities of material assets, or are likely to produce significant quantities of waste.

13.8.9 It is assumed that the Scheme will aim to minimise the generation of waste and that, in the worst-case scenario, all waste identified for disposal will be sent to landfill. It is assumed that all acceptable excavated topsoil will be reused in landscaping activities, e.g. within or near the Scheme.

13.8.10 Based on professional judgment, it is assumed that, as a worst-case scenario, 5% of material assets required for the construction of the proposed scheme that is brought to the site, may become waste due to damages, off-cuts or surplus to requirements.

13.8.11 When distances from the proposed scheme were required, these have been measured from postcode CH5 2TE.

13.9 Conclusions of scoping

Use of material assets

13.9.1 Due to the size and scale of the Scheme, there is the potential for moderate to large volumes of material assets to be required for the construction phase. It is likely that any significant effects due to the quantity of materials resources required could be appropriately mitigated through the implementation of mitigation measures outlined in Section 13.7.

13.9.2 However, without accurate material quantification at this stage, this assumption cannot be confirmed. Therefore, further assessment is required, with accurate material quantification, a cut/fill balance calculation and further design information, to confirm the likelihood of significant effects.

13.9.3 It is proposed to **scope in** further assessment of material assets use relating to construction of the proposed scheme.

13.9.4 Sterilisation of MSA and peat resources has been **scoped out** as the Scheme is not within 500m of any MSA or peat resources.

13.9.5 Due to the negligible significant effect of use of material assets during the operational phase of the Scheme, this has been **scoped out** of further assessment.

Generation and management of waste

13.9.6 The Scheme is likely to generate significant waste during demolition and construction which could result in the temporary occupation of waste management facility space (from treatment of waste) and the permanent reduction in landfill capacity (from disposal of waste). Potential impacts are summarised in Section 13.6.

13.9.7 Due to current uncertainty regarding the quantities of waste anticipated and limited design information on which to base an assessment, further assessment is required to confirm the likely significant effects.

13.9.8 It is therefore proposed to **scope in** further assessment of waste generation and management relating to the construction of the Scheme.

13.9.9 Due to the negligible generation of waste during the operational phase of the Scheme, this has been **scoped out** of further assessment.

13.10 Consultations and key stakeholders

13.10.1 It is expected that consultation with key stakeholders will take place as the Scheme is underway and as it progresses. This will be expected to include the appointed construction and demolition contractor, associated waste contractors, Flintshire Council, and Natural Resources Wales, where appropriate.

14 Population and Human Health

14.1 Introduction

14.1.1 This chapter of the Scoping Report sets out the scope of the assessment proposed for population and human health to be undertaken in accordance with Design Manual for Roads and Bridges (DMRB)[198] – LA 112 Population and Human Health Revision 1 (DMRB LA 112) for the construction and operational phases of the proposed Scheme.

14.1.2 It provides an overview of the population and human health baseline within the study area and details the likely significant community and health effects that may result from the proposed scheme. It also sets out the proposed approach for assessing the impact of the scheme on population and human health.

14.1.3 This assessment will consider land use, accessibility and human health, and should be read as part of the wider Environmental Impact Assessment (EIA), when completed, with particular reference to:

- Chapter 11: Air quality;
- Chapter 9: Landscape and Visual Effects;
- Chapter 6: Geology and soils; and
- Chapter 12: Noise and vibration.

14.2 Policy Context

National policy

Countryside and Rights of Way Act, 2000

14.2.1 The Countryside and Rights of Way Act 2000[199] represents the main legal framework governing the public footpaths, bridleways, traffic and restricted byways. The first two parts of the Act are relevant to this assessment:

- Part 1 Access recognises the right of access to mountain, moor, health, down and registered common land. It also recognises the needs of landowners and managers.
- Part 2 Rights of Way of the Act requires local authorities to review and publish plans for improving rights of way in their areas, considering the needs of the public including disabled people. The section of the Act also outlines the mechanism to divert PRoW temporarily and permanently.

Equality Act 2010

14.2.2 The Equality Act 2010[200] requires decision making to have due regard to the need to remove discrimination and support equality of opportunity for a range of ‘protected characteristic’ groups. This is further considered within the Equality Impact Assessment (EqIA) for the scheme.

[198] National Highways (2020) DMRB LA 112 – Population and Human Health, Revision 1 [online] available at: https://www.standardsforhighways.co.uk/dmrb/search/1e13d6ac-755e-4d60-9735-f976bf64580a (Last accessed May 2022)

[199] The Countryside and Rights of Way Act 2000 [online] available at: https://www.legislation.gov.uk/ukpga/2000/37/contents.

[200] GOV UK (2010): ‘The Equality Act 2010’ Available at: Equality Act 2010 (legislation.gov.uk)

Planning Policy Wales, 2024

14.2.3 The Planning Policy Wales (PPW)[201] outlines various planning policies set out by the Welsh Government, with the primary objective of ensuring that the planning system for a major development contributes towards the delivery of sustainable development and improves the social, economic, environmental and cultural well-being of Wales. The PPW contains the following polices relevant to the scheme:

- Policy 4.1: Transport: The policy states that the planning system in Wales should enable people to access jobs and services through shorter, more efficient and sustainable journeys, by walking, cycling and public transport.
- Policy 5.3: Transport Infrastructure: The policy states that development plans should specify the primary road network, including trunk roads, and separately identify the core network. These routes should be identified on the constraints map as corridors for movement adjacent to which development that would compromise this strategic transport role, or adversely affect the environment or people's health, amenity or wellbeing, will be resisted.
- Policy 6.2: Green Infrastructure: Integrating Green Infrastructure and Development: The quality of the built environment should be enhanced by integrating green infrastructure into development through appropriate site selection and use of creative design.
- Policy 6.3: Landscape: The policy states that developments should ensure that landscapes provide opportunities for tourism, outdoor recreation, local employment, renewable energy and the physical and mental health and well-being of local population.
- Policy 6.7: Air Quality and Soundscape: When proposing new strategies for development, the policy states that it is important to avoid instances where incremental development of infrastructure, housing, commercial and industrial development creates or exacerbate health and amenity inequalities by introducing more sensitive receptors into an area or by making existing occupiers more vulnerable to poor air quality or noise.

Future Wales: The National Plan 2024

14.2.4 Future Wales: The National Plan 2040[202] provides a framework that sets the direction for development in Wales from 2024 to 2040. The plan is concerned with infrastructure and development in Wales and aims to ensure that the planning system is consistent at all levels.

14.2.5 Within the plan, policies relevant to the scheme are:

- Policy 11: National Connectivity: The Welsh Government state that it will support and invest in improving national connectivity. Their priorities are to encourage longer distance trips to be made by public transport, while also making longer journeys possible by electric vehicles. To achieve the aims of the policy the Welsh Government will work with Transport for Wales, local authorities, operators and partners to support the delivery of the following measures to improve national connectivity:
  - Rail Network: The policy aims to transform the rail network and improve the quality of rail services for passengers.
  - Bus Network: The policy aims to invest in the development of the national bus network, achieve full integration with regional and local bus networks, and to increase modal share of bus travel in Wales.

[201] Welsh Government (2024): Planning Policy Wales. Available at: Planning Policy Wales - Edition 12 (gov.wales)

[202] Welsh Government (2021): Future Wales: The National Plan 2040. Available at: Update to Future Wales - The National Plan 2040 (gov.wales)

  - Strategic Road Network: The policy states that the Welsh Government will increase investment in road improvements, with the aims of reducing journey times, delivering a safer and more resilient road network, and improving air and noise quality.
  - National Cycle Network: The policy aims to revitalise the National Cycle Network to create a network of traffic free paths connecting cities, towns and countryside across Wales.
- Policy 12: Regional Connectivity: The policy states that the Welsh Government will aim to support and invest in improving regional connectivity. In urban areas, the policies priorities are on improving and integrating active travel and public transport. In rural areas the policies priorities are supporting the uptake of ultralow emission vehicles and diversifying and sustaining local bus services. Policy aims which are relevant to the scheme are:
- Active Travel: The policy aims to support the implementation of the Active Travel Act to create comprehensive networks of local walking and cycling routes that connect places that people need to get to for everyday purposes.
- Bus: The policy aims to improve the legislative framework for how local bus services are planned and delivered. It states that the Welsh Government will invest in the development of integrated regional and local bus networks to increase modal share of bus travel and improve access by bus to a wider range of trip destinations.
- UltraLow Emission Vehicles: The policy aims to support the rollout of suitable fuelling infrastructure to facilitate the adoption of ultralow emission vehicles, particularly in rural areas.

Well-being of Future Generations (Wales) Act 2015:

14.2.6 The Well-being of Future Generations (Wales) Act [203] aims to improve the social, economic, environmental and cultural well-being of Wales. The Act includes seven legally binding well-being goals for national government, local government, local health boards and other specified public bodies. It details the ways in which specified public bodies must work to improve the well-being of Wales. The seven well-being goals are set out below:

- A prosperous Wales
- A resilient Wales
- A healthier Wales
- A more equal Wales
- A Wales of cohesive communities
- A Wales of vibrant culture and thriving Welsh language
- A globally responsible Wales

14.2.7 The Act places a well-being duty on which public bodies are expected to carry out when undertaking development. This well-being duty includes the following steps:

- setting and publishing objectives ("well-being objectives") that are designed to maximise its contribution to achieving each of the well-being goals, and
- taking all reasonable steps (in exercising its functions) to meet those objectives.

[203] Welsh government (2015) 'Well-being of Future Generations (Wales) Act 2015' Available at: https://www.legislation.gov.uk/anaw/2015/2/contents/enacted

Regional Policy

North Wales Economic Ambition Board Growth Vision & Development Bid, 2016

14.2.8 Ambition North Wales, an organisation which comprises of six local authorities in the North Wales region, has produced a growth and development plan to ensure that the region develops sustainably, with opportunities for people to gain new skills for the future and develop rewarding careers. The plan has four key pillars to make promote sustainable development in North Wales:

- Connected: To improve road and transport infrastructure to enhance connectivity for the region's businesses and residents.
- Smart: To develop and promote development projects in the regions keys sectors and infrastructure.
- Resilient: To create employment opportunities and focus on retaining young people in North Wales.
- Sustainable: To ensure that all developments are designed to be carbon neutral and have a positive impact on biodiversity.

Local Policy

Flintshire Local Development Plan, 2023

14.2.9 The Flintshire Local Development Plan[204] identifies the need to promote safe communities, address local housing needs, encourage economic prosperity and implement mitigations for environmental issues. The plan sets out four key themes as part of its strategic priorities, these are:

- Creating sustainable places and communities
- Supporting a prosperous economy;
- Meeting housing needs; and
- Valuing the environment.

14.2.10 Under these themes, policies relevant to the scheme are:

- Policy STR13: Natural and Built Environment, Green Networks and Infrastructure – encouraging the creation and protection of green space, open space and play environments that encourage and support good health, well-being and equality in access;
- Policy PC6: Active Travel – ensuring that people have access to employment, education, healthcare and other essential services through the provision of public walking and cycle routes; and
- Policy PC12: Community Facilities – encouraging the development of new education, health and community facilities on suitable sites.

14.3 Relevant Guidance

14.3.1 DMRB LA 112 provides national guidance for the provision of population and human health assessments on the effects which are most likely to occur as a result to changes to the road network. The guidance states that environmental assessments of population and human health on road schemes must report on the following elements:

- Land-use and accessibility.

[204] Flintshire County Council (2023) 'Flintshire Local Development Plan' Available at: Flintshire Local Development Plan

- Human Health.

14.3.2 The guidance sets out criteria to determine magnitude and sensitivity of land-use and accessibility and human health receptors, as well as on significance of effect to determine the overall impact of an effect. DMRB LA 112 has been used as the assessment methodology for this chapter and is explored in greater detail below in Section 14.4.

14.4 Assessment methodology

14.4.1 The following methodology outlines the approach that was used in the scoping phase of the assessment, which will also be followed to complete the assessment and reporting for the EIA.

14.4.2 The full EIA assessment will focus on those impacts that are likely to have significant effects on population and human health conditions and will be completed in accordance with DMRB LA 112 (as set out above, in Section 14.3). For the purpose of this scoping chapter, this assessment will assess the potential impacts of the scheme on the land-use and accessibility and human health receptors set out in DMRB LA 112 and determine if a full assessment is required.

14.4.3 Significance of effects is determined by considering the sensitivity of the receptor, and the magnitude of the impact on those receptors.

14.4.4 Combinations of significant residual (post mitigation) effects from other assessment topics such as the effects of noise, vibration, poor air quality, and landscape and visual intrusions will be assessed in a chapter on cumulative effects (Chapter 16).

Land use and accessibility

14.4.5 The assessment will focus on impacts that are likely to affect ‘land use and accessibility’ receptors and resources and will be completed in accordance with the standard on population and human health impact assessment included in DMRB LA 112.

14.4.6 Significance of effects is determined by considering the sensitivity of the receptor as well as the magnitude of impact on those receptors. The following receptors are included in the assessment, as defined in DMRB LA 112:

- Private Property and Housing
- Community Land and Assets
- Development Land and Businesses
- Agricultural Land Holdings
- Walkers, Cyclists and Horse riders (WCH)

Sensitivity of receptors

14.4.7 Table 14-1 sets out criteria that will be used to describe and assess the sensitivity of population and human health receptors relevant to the land-use and accessibility assessment, as outlined in the DMRB LA 112.

Table 14-1: Sensitivity of receptors

Sensitivity	Sensitivity criteria
Very high	**Private property and housing:** • Existing private property or land allocated for housing located in a Local Authority area where the number of households are expected to increase by >25% by 2041 (ONS data).

Sensitivity	Sensitivity criteria
	• Existing housing and land allocated for housing (e.g. strategic housing sites) covering >5ha and/or >150 houses. **Community land and assets where there is a combination of the following:** • Complete severance between communities and their land/assets, with little/no accessibility provision • Alternatives are only available outside the local planning authority area. • The level of use is very frequent (daily). • The land and assets are used by the majority (>=50%) of the community. **Development land and businesses:** • Existing employment sites (excluding agriculture) and land allocated for employment (e.g. strategic employment sites) covering >5ha. **Agricultural land holdings:** • Areas of land in which the enterprise is wholly reliant on the spatial relationship of land to key agricultural infrastructure. • Access between land and key agricultural infrastructure is required on a frequent basis (daily). **WCH:** • National trails and routes likely to be used for both commuting and recreation that record frequent (daily) use. Such routes connect communities with employment land uses and other services with a direct and convenient WCH route. Little / no potential for substitution. • Routes regularly used by vulnerable travellers such as the elderly, school children and people with disabilities, who could be disproportionately affected by small changes in the baseline due to potentially different needs. • Rights of way for WCH crossing roads at-grade with >16,000 vehicles per day.
High	**Private property and housing:** • Private property or land allocated for housing located in a local planning authority area where the number of households are expected to increase by 16-25% by 2041 (ONS data). • Existing housing and land allocated for housing (e.g. strategic housing sites) covering >1-5ha and / or >30-150 houses. **Community land and assets where there is a combination of the following:** • There is substantial severance between community and assets, with limited accessibility provision. • Alternative facilities are only available in the wider local planning authority area. • The level of use is frequent (weekly). • The land and assets are used by the majority (>=50%) of the community. • Development land and businesses: • Existing employment sites (excluding agriculture) and land allocated for employment (e.g. strategic employment sites) covering >1 - 5ha. **Agricultural land holdings:** • Areas of land in which the enterprise is dependent on the spatial relationship of land to key agricultural infrastructure. • Access between land and key agricultural infrastructure is required on a frequent basis (weekly).

Sensitivity	Sensitivity criteria
	WCH: • Regional trails and routes (e.g. promoted circular walks) likely to be used for recreation and to a lesser extent commuting, that record frequent (daily) use. Limited potential for substitution. • Rights of way for WCH crossing roads at-grade with >8,000 - 16,000 vehicles per day.
Medium	**Private property and housing:** • Houses or land allocated for housing located in a Local Authority area where the number of households are expected to increase by >6-15% by 2041 (ONS data). • Existing housing and land allocated for housing (e.g. strategic housing sites) covering <1ha and / or <30 houses. **Community land and assets where there is a combination of the following:** • There is severance between communities and their land/assets but with existing accessibility provision. • Limited alternative facilities are available at a local level within adjacent communities. • The level of use is reasonably frequent (monthly). • The land and assets are used by the majority (>=50%) of the community. **Development land and businesses:** • Existing employment sites (excluding agriculture) and land allocated for employment (e.g. strategic employment sites) covering <1ha. **Agricultural land holdings:** • Areas of land in which the enterprise is partially dependent on the spatial relationship of land to key agricultural infrastructure. • Access between land and key agricultural infrastructure is required on a reasonably frequent basis (monthly). **WCH:** • Public Rights of Way and other routes close to communities which are used for recreational purposes (e.g. dog walking), but for which alternative routes can be taken. These routes are likely to link to a wider network of routes to provide options for longer, recreational journeys. • Rights of way for WCH crossing roads at-grade with >4,000 – 8,000 vehicles per day.
Low	**Private property and housing:** • Proposed development on unallocated sites providing housing with planning permission/in the planning process. **Community land and assets where there is a combination of the following:** • Limited existing severance between community and assets, with existing Equality Act 2010 compliant accessibility provision. • Alternative facilities are available at a local level within the wider community • The level of use is infrequent (monthly or less frequent). • The land and assets are used by the minority (>=50%) of the community. **Development land and businesses:** • Proposed development on unallocated sites providing employment with planning permission / in the planning process.

Sensitivity	Sensitivity criteria
	Agricultural land holdings: • Areas of land which the enterprise is not dependent on the spatial relationship of land to key agricultural infrastructure. • Access between land and key agricultural infrastructure is required on an infrequent basis (monthly or less frequent). **WCH:** • Routes which have fallen into disuse through past severance or which are scarcely used because they do not currently offer a meaningful route for either utility or recreational purposes. • Rights of way for WCH crossing roads at-grade with <4,000 vehicles per day.
Negligible	**Private property and housing:** • N/A **Community land and assets where there is a combination of the following:** • No or limited severance or accessibility issues • Alternative facilities are available within the same community. • The level of use is very infrequent (a few occasions yearly). • The land and assets are used by the minority (>=50%) of the community. **Development land and businesses:** • N/A **Agricultural land holdings:** • Areas of land which are infrequently used on a non-commercial basis **WCH:** • N/A

Source: DMRB LA 112

Magnitude of impacts

14.4.8 Table 14-2 sets out criteria that will be used to describe and assess the magnitude of impact on land use and accessibility receptors, as outlined in DMRB LA 112.

Table 14-2: Magnitude of receptors

Magnitude	Criteria
Major	**Private property and housing, community land and assets, development land and businesses and agricultural land holdings:** • Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements. e.g. direct acquisition and demolition of buildings and direct development of land to accommodate highway assets. • Introduction (adverse) or removal (beneficial) of complete severance with no/full accessibility provision. **WCH:** • >500m increase (adverse) / decrease (beneficial) in WCH journey length.
Moderate	**Private property and housing, community land and assets, development land and businesses and agricultural land holdings:** • Partial loss of / damage to key characteristics, features or elements, e.g. partial removal or substantial amendment to access or acquisition of land compromising viability of property, businesses, community assets or agricultural holdings.

Magnitude	Criteria
	• Introduction (adverse) or removal (beneficial) of severe severance with limited / moderate accessibility provision. **WCH:** • >250m - 500m increase (adverse) or decrease (beneficial) in WCH journey length.
Minor	**Private property and housing, community land and assets, development land and businesses and agricultural land holdings:** • A discernible change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristic, features or elements, e.g. amendment to access or acquisition of land resulting in changes to operating conditions that do not compromise overall viability of property, businesses, community assets or agricultural holdings. • Introduction (adverse) or removal (beneficial) of severance with adequate accessibility provision. **WCH** • >50m - 250m increase (adverse) or decrease (beneficial) in WCH journey length.
Negligible	**Private property and housing, community land and assets, development land and businesses and agricultural land holdings:** • Very minor loss or detrimental alteration to one or more characteristics, features or elements. e.g. acquisition of non-operational land or buildings not directly affecting the viability of property, businesses, community assets or agricultural holdings. • Very minor introduction (adverse) or removal (beneficial) of severance with ample accessibility provision. **WCH** • <50m increase (adverse) or decrease (beneficial) in WCH journey length.
No change	• No loss or alteration of characteristics, features, elements or accessibility; no observable impact in either direction.

Source: DMRB LA 112

Significance of effect

14.4.9 Once the appropriate sensitivity of the receptor and magnitude of impact have been identified using the sensitivity and magnitude criteria above, along with professional judgement to consider site specific factors that may be of relevance, the likely significance category and overall significance of effects are assessed by using the matrix provided within the Table 5-1 in Chapter 5.

14.4.10 Effects can be adverse or beneficial, and temporary or permanent. Only effects that are moderate, large, or very large are considered significant.

Human Health

14.4.11 A qualitative assessment of human health will be undertaken in accordance with LA 112, with evidence provided to support conclusions. The impacts considered within the qualitative assessment are dependent upon the nature and characteristics of the project and the sensitivity of receptors.

14.4.12 Health determinants, as set out in DMRB LA 112, include the range of personal, social, economic, and environmental factors that influence health status.[205] The DMRB specifies that

[205] UK Government (2017) Chapter 6: social determinants of health. Available at: https://www.gov.uk/government/publications/health-profile-for-england/chapter-6-social-determinants-of-health

the scoping assessment shall identify health determinants likely to be affected by a project, specifically reporting on:

- The location and type of community, recreational and education facilities and severance / separation of communities from such facilities.
- The location of green and open space and severance / separation from such facilities.
- The location of healthcare facilities and severance / separation from such facilities.
- Outline spatial characteristics of the transport network and usage in the area.[206]
- Air quality management areas and ambient air quality.
- Noise sensitive areas.
- Sources and pathways of potential pollution.
- Landscape amenity.
- Safety information associated with the existing road.[207]
- Information from stakeholder consultation

14.4.13 Once the health profile of communities has been established, the sensitivity of a community / population to change has been identified (supported with evidence).

14.4.14 The sensitivity of a community / population from health point of view shall be reported as:

4. Low
5. Medium
6. High

14.4.15 The likely health outcome(s) will be identified in line with the categories in Table 14-3 below.

Table 14-3: Human health outcomes

Health outcome category	Health outcome description
Positive	A beneficial health impact is identified
Neutral	No discernible health impact is identified
Negative	An adverse health impact is identified
Uncertain	Where uncertainty exists as to the overall health impact

Source: DMRB LA 112

14.4.16 While the assessment of human health effects will describe the likely qualitative health outcomes, it is not possible to quantify the severity or extent of the effects which give rise to these outcomes. The potential health outcomes during construction and operation are based on broad categories for the qualitative impacts identified in accordance with Table 14-3 above.

14.5 Baseline

14.5.1 To support the scoping exercise for population and human health, a baseline of known population and human health receptors has been collated to include all assets which may be impacted by land use, accessibility or human health effects as a result of the proposed Scheme.

[206] Usage details are not available at this early stage, therefore this aspect is not discussed in detail in this scoping report.

[207] Safety information is not available at this early stage, therefore this aspect is not discussed in detail in this scoping report.

This baseline is not exhaustive but is considered sufficient to guide the scoping exercise for population and human health.

Study area

14.5.2 The scheme is located in Queensferry, Flintshire. The A494 Dee Bridge provides east/west connection between Queensferry and Garden City, over the River Dee. The A494 passes through both Queensferry and Garden City, providing access to the North Wales Expressway to the west, and the English border and M56 in the East.

14.5.3 The population and human health conditions are considered according to the following spatial areas, in accordance with DMRB LA 112.

- Local Impact Area (LIA): defined as a 500m buffer around the Site and the Indicative Area for all of the scheme options. This impact area will be used for the analysis of potential impacts on land use and accessibility.
- Wider Impact Area (WIA): defined as Flintshire County Council. This Impact area will be used for the analysis of potential impacts on human health. As the scheme is located close to the border of Cheshire West and Chester Council, access to health facilities in Cheshire located close to the scheme location will be considered in the assessment.
- National: Wales

Land use and accessibility

Private property and housing

14.5.4 The LIA is located in an urban area, and the density of private property and housing is high.

14.5.5 Key urban areas include Queensferry, to the south of the Scheme, and areas of Garden City, Shotton and Sealand, to the north of the Scheme. The majority of residential properties are located in these locations. In addition, there are a small number of individual residential properties located throughout the LIA, the majority of which are located on the A548/Sealand Road.

14.5.6 There is a traveller site located to the south east of the scheme, on the south bank of the River Dee, located approximately 300m from the scheme location.

14.5.7 The closest residential properties to the scheme are located in Clermont Avenue in Garden City, located approximately 50m north of the scheme, and Dundas Street in Queensferry, located approximately 30m to the northwest of the scheme.

Community land and assets

14.5.8 There are approximately 14 community resources located within the LIA. The community resources can be categorised as follows:

- Schools
  - Sealand Primary School is located approximately 190m to the northeast of the scheme.
  - Queensbury Primary School is located approximately 500m to the northwest of the scheme.
- Activity/Leisure/Sports Centre
  - Deeside Rhythmic Gymnastics Club is located approximately 500m to the northwest of the scheme.
  - Dee Rink, the national ice sports centre of Wales, is located approximately 400m to the northwest of the scheme.

  - Deeside Leisure Centre is located approximately 490m to the northwest of the scheme.
  - Deeside Family Martial arts Taekwondo Flintshire, a Taekwondo school, is located approximately 480m to the north of the scheme.
- Community Centres:
  - Queensbury War Memorial Institute: located approximately 200m to the north of the scheme.
  - Sealand Youth Centre, located approximately 440m to the north east of the scheme
- Places of worship:
  - St Andrews Church, an Anglican church located approximately 500m northeast of the scheme.
  - Church of the Blessed Trinity, a catholic church located approximately 190m to the north of the scheme.
- Playgrounds, recreation facilities and green and open spaces:
  - Queensbury Primary School Playing fields, located approximately 450m to the northwest of the scheme.
  - Playground located on Bridge View in Garden City, located approximately 430m to the north of the scheme.
  - Garden City Skatepark, located approximately 480m to the northeast of the scheme.
  - Playing fields located on Welsh road, located approximately 420m to the northeast of the scheme.

Development land and businesses

Development Land

14.5.9 Based on the Flintshire Local Development Plan,[208] there is one development site located in the LIA. The Northern Gateway Site, which is located to the north of the B5441 in Garden City. The site is currently under construction and once operational, will be an employment led mixed use development and associated infrastructure comprising construction of accesses, roads, footpaths, cycle paths, earthworks, and flood mitigation.

Businesses

14.5.10 There are approximately 81 businesses located in the LIA. These businesses are predominantly located in the following areas:

- Station Road/B5441: local high street with various eateries and shops.
- Express Business Park: business park with various shops and services.
- Welsh Road/B5441: residential area which includes a variety of shops and services.

14.5.11 The businesses located in the LIA are set out below:

- 8 Beauty Salons and barbershops: Headmasters Barbershop, Blade Barbers Shop, Sam Barber, Oasis Hair & Beauty, Janto Hair Beauty Piercings Brow Microblading, Ocean Tanning Ltd, Hair by La Coco and Pro Tan Studios.
- 16 Restaurants, cafes and catering businesses The Old Café, Dominos Pizza, Smash'd it, Silver River: Chinese Takeaway, Ambia Indian Takeaway, Pizza Magic 7: Takeaway, Café de Cazza, Honour House, Indian Saffron, Shakes N Cakes (Deeside), The Master Fryer: Fish and Chip shop, Sylhet Spice: Indian Takeaway, Two Dragons: Chinese Takeaway,

[208] Flintshire County Council (2023): 'Flintshire Local Plan' Available at: https://www.flintshire.gov.uk/en/Resident/Planning/Local-Development-Plan.aspx

Garden City Kebab Pizza House, Chef Zhong at Fortune Cookies: Chinese Takeaway, and KFC Queensferry station.

- 3 Businesses Centres: KTSi (UK) Design Centre Limited, Expressway Business Park and Interlinq Trade Park
- 5 Grocery stores: Tatry Delicatessen, Mixed European store, SPAR Garden City, Makro Queensferry: Supermarket, ASDA Queensferry: Supermarket
- 6 Gyms and sporting stores: Queensferry sports: Sporting goods store, CJ's Gym Ltd, The Cycle Hub, Fortitude Fortis: gym, Number One Health Strength Performance CIC: gym, and Wizz Kidz: Indoor playground
- 17 shops: Butlers Kitchen Centre: kitchen appliance store, Flowers at number 30: florist, Gemini Blinds & Sun awnings: blinds shop, Buying Wild: greetings card shop, Starpicks: video game shop, Loki's Tattoo Studio Limited: Tattoo and piercing shop, Get Cash Quick Pawnbrokers & Gold Shop: Pawn shop, Office Furniture Place Chester: furniture shop, Pups and Pets: Pet shop, Stopping Power: paint shop, RDS: Car Stereo shop, Macy Olivia Boutique: Clothing Shop, Screwfix Deeside: hardware shop, Deeside Bathrooms & Wet rooms: a bathroom supply shop, Lloyd Sign Solutions: sign shop, HiQ Tyres & Autocare Queensferry: tyre shop and Screwfix Deeside: hardware shop
- 14 services and suppliers: Bear Trading House Clearances/Rubbish removals: waste collection service, Huws Gray Queensferry: building materials supplier, Enbarr Enterprises Limited: recruiter, Hexagon Recruitment Services Ltd: Job centre, Deeside Cars: taxi service, Welsh Water (Queensferry), Kinetic Plc: recruiter, Vinlyl's Laminate's Commercial & Domestic Flooring: floor refinishing service, Mara Electrical: electrician services, Portakabin: modular building and portable unit service, RES Fencing & Security: fencing service, Wilsons Auctions: auction house, LA Davies: contractor and TaxAssist Accountants: accountancy
- 12 automative dealerships, mechanics and repair shops: Saxon scooters: motor scooter dealer, Kustro Ltd: trucking company, TK Motor Repairs: vehicle repair shop, Lindop Toyota Queensferry: Toyota car dealership, Bell Automotive: vehicle repair shop, Sammys Car Sales: used car dealership, Checkpoint Service Centre: vehicle repair, Spinney Flintshire: caravan dealer, Nick Auto Dealing: car dealership, J&M Garner Haulage: trucking company, S Express Car Sales: car dealership and Spraycraft Deeside Ltd: car body shop

Agricultural Land Holdings

14.5.12 At this stage of assessment, individual details of agricultural land holdings are not known, and analysis of agricultural holdings will be undertaken in the next stage of assessment.

14.5.13 There are likely to be several agricultural land holdings within the LIA, to the northeast and southeast of the scheme location, comprised of predominantly large fields separated by hedgerows and local roads. The majority of the land within the LIA appears to be used for arable production. There are areas of agricultural land within the footprints of all options. Access to these areas of land appear to be by a combination of local roads. The field nearest the A494 is approximately 42ha in extent and is currently cultivated for arable and vegetable cropping.

Walkers, cyclists and horse-riders

14.5.14 According to the Flintshire County Council's Public Rights of Way (PRoW) data,[209] there are several PRoW within the LIA. These are:

- Footpath 309/12/10: Stems from the A550 in a southeast direction towards Seahill farm;

[209] Flintshire County Council. (No date): 'Public Rights of Way Map' [Online] Available from: https://rightsofway.flintshire.gov.uk/standardmap.aspx [last accessed August 2024]

- Footpath 309/4/10: Stems from Footpath 309/12/10 in a west direction towards Bridleway 309/7/20;
- Bridleway 309/7/20: Stems from the A550 in a southeast direction towards Sealand;
- Footpath 309/4/20: Stems from footpath 309/4/10 in a west direction towards the A494.
- Footpath 309/16/20: Stems from the A494 in a south direction towards Sealand Manor;
- Footpath 309/16/10: Stems from Footpath 309/16/20 in a northeast direction towards the A548
- Footpath 309/10/30: a north/south footpath located to the south of footpath 309/16/20;
- Footpath 309/1/20: passes in a northwest/southeast direction along the north bank of the river Dee. Located to the north of the A494;
- Footpath 309/2/50: passes in a northwest/southeast direction along the north bank of the river Dee. Located to the south of the A494;
- Footpath 308/16/10: passes in a northwest/southeast direction along the south bank of the river Dee. Located to the north of the A494;
- Footpath 308/3/40: passes in a northwest/southeast direction along the south bank of the river Dee. Located to the south of the A494;
- Footpath 308/16/10: Stems from the B5442 in a north direction passing through eastern Queensferry;
- Footpath 308/7/30: Connects Footpath 308/7/30 to the A494, travels in a north/south direction;
- Footpath 308/7/10: Connects the A494 to Footpath 308/3/40, travels in a north/south direction;
- Footpath 308/6/20: Connects the A494 to Footpath 308/3/20, travels in a north/south direction;
- Footpath 308/3/20: Travels in a southwest/northeast direction from the rail line towards the River Dee.
- Footpath 308/15/10: Connects Footpath 308/3/20 to the A494. Travels in a north/south direction;
- Footpath 303/14/10: Stems from Dee View in a northwest direction towards Queensbury Primary School;
- Footpath 3030/146/10: Stems from Dee View in a northwest direction towards Aston Road.

14.5.15 At this stage information on the level and frequency of use as well as the type of user (e.g., whether vulnerable travellers use any routes in the study area) of different WCH routes is not known. Please see section 14.8, Assumptions and Limitations.

Human Health

Population and age structure

14.5.16 The table below shows the population and age structure of Flintshire and Wales. At this stage of the assessment, data for the LIA is unavailable.

Table 14-4: Population and age structure

Area	Total population	Children (under 16)	Young people (16-24)	Working age population (16-64)	Older people (65+)
LIA	n/a	n/a	n/a	n/a	n/a
Flintshire	155,000	17.4%	8.9%	60.9%	21.9%

Area	Total population	Children (under 16)	Young people (16-24)	Working age population (16-64)	Older people (65+)
Wales	3,105,600	17.3%	10.6%	61.0%	21.6%

Source: Population estimates, ONS (2023)

Employment and Economic activity

14.5.17 The table below shows the economic activity rate, employment rate and unemployment rate for the working age population (16-64) in Flintshire and Wales. At this stage of the assessment, data for the LIA is unavailable.

Table 14-5: Employment and economic activity

Area	Working age population (16-64)	Working age population (16-64) (% of population)	Economic activity rate (% of working age population)	Employment rate (% of working age population)	Unemployment rate (% working age population)
LIA	n/a	n/a	n/a	n/a	n/a
Flintshire	94,400	60.9%	81.3%	78.7%	3.2%
Wales	1,893,000	61.0%	76.2%	73.5%	3.6%

Source: Census 2021, ONS (2022) & Annual Population survey, ONS (2024)

Employment by industry

14.5.18 The table below shows employment figures by industry in Flintshire and Wales. At this stage of the assessment, data for the LIA is unavailable.

Table 14-6: Employment by industry

Industry	Flintshire	Wales
Agriculture, forestry & fishing (A)	0.6%	1.2%
Mining, quarrying & utilities (B,D and E)	1.4%	1.7%
Manufacturing (C)	26.4%	10.7%
Construction (F)	4.9%	4.8%
Motor trades (Part G)	1.7%	1.9%
Wholesale (Part G)	3.1%	2.3%
Retail (Part G)	6.9%	8.9%
Transport & storage (inc postal) (H)	5.6%	4.2%
Accommodation & food services (I)	6.2%	8.7%
Information & communication (J)	1.4%	2.3%
Financial & insurance (K)	0.8%	3.0%
Property (L)	0.7%	1.5%
Professional, scientific & technical (M)	6.9%	5.1%
Business administration & support services (N)	9.7%	6.7%
Public administration & defence (O)	5.6%	8.1%
Education (P)	6.2%	9.0%
Health (Q)	6.9%	15.2%
Arts, entertainment, recreation & other services (R,S,T and U)	3.1%	4.7%

Source: Business Register and Employment Survey, ONS (2019)

14.5.19 The largest industries of employment in the WIA of Flintshire are: manufacturing (26.4%), business administration & support services (6.9%), retail (6.9%), health (6.9%) and professional, scientific & technical (6.9%). The proportion of the working population employed in the manufacturing sector in Flintshire (26.4%) is considerably higher than the proportion in Wales (10.7%).

Deprivation

14.5.20 The table below outlines the households by The Multiple Indices of Deprivation (IMD) use a collection of indicators to outline deprivation levels (poverty) within Wales. Table 14-7 shows the proportion of the population across Flintshire and Wales living in each of the deprivation quintiles. At this stage of the assessment, data for the LIA is unavailable.

Table 14-7: Deprivation

Area	Household is not deprived in any dimension	Household is deprived in one dimension	Household is deprived in two dimensions	Household is deprived in three dimensions	Household is deprived in four dimensions
LIA	n/a	n/a	n/a	n/a	n/a
Flintshire	48.9%	33.5%	14.2%	3.2%	0.1%
Wales	45.9%	33.4%	16.0%	4.5%	0.2%

The English Indices of Multiple Deprivation (2019)

14.5.21 A summary of population and age structure is set out below:

- 0.1% of households within Flintshire are deprived in four dimensions. This is broadly in line with the proportion in Wales (0.2%).
- The vast majority (48.9%) of households in Flintshire are not deprived in any dimension, which is higher than the proportion of Wales (45.9%).

Health indicators

14.5.22 The table below presents key health indicators within Flintshire and Wales. Although data for the LIA is unavailable, using health indicators for comparator regions provides an overview of the health profile of the population of the LIA in the context of regional and national averages.

Table 14-8: Health indicators

Area	Long-term health problem or disability (2011)	Life expectancy at birth (male) (years)	Life expectancy at birth (female) (years)
LIA	n/a	n/a	n/a
Flintshire	19%	79.3	82.6
Wales	22%	78.3	82.3

Source: Life expectancy at birth and at age 65 years by local areas, ONS (2019) & Census 2021, ONS (2012)

14.5.23 The above table is summarised below:

- The proportion of Flintshire who have a long-term health problem of disability (19%) is slightly lower than that of Wales (22%).

- Life expectancy for males in Flintshire (79.3) is in line with the life expectancy of Wales (78.3).
- Life expectancy for females in Flintshire (82.6) is in line with the life expectancy of Wales (82.3).

Community, recreational and educational facilities, green and open space

14.5.24 The community, recreational, and green and open space resources located in the LIA are listed in section 14.5.8.

14.5.25 There is one educational facility in the LIA, Sealand Primary school. However, there are several more within the WIA. Those closest to the scheme include:

- Queensferry CP School: Primary school located approximately 650m to the northwest of the scheme.
- Sandycroft Primary School: Primary school located approximately 950m to the southeast of the scheme.
- St Ethelwolds Church Primary School: Primary school located approximately 1.30km to the southeast of the scheme.
- Venerable Edward Morgan Catholic Primary School: Primary school located approximately 1.50km to the northeast of the scheme.

Healthcare facilities

14.5.26 There are a small number of healthcare facilities in the WIA. These are listed below:

- Rowlands Pharmacy Queensferry – 30m west of the scheme
- Queensferry Medical Practice – 320m west of the scheme
- Griffiths Pharmacy & Travel Clinic & Weight Management Clinic - 370m northeast of the scheme
- St John Ambulance Cymru – 300m northwest of the scheme

Transport Network

14.5.27 Apart from the A464 (see section 14.5.2), there are two major roads in the LIA:

- The B5441 provides connectivity between Queensferry to Garden City, located to the west of the LIA, via a bridge over the River Dee parallel to A494.
- The B5129 provides connectivity between Pentre and Shotton, located to the southeast and northwest of the LIA respectively. Shotton train station is located further north from the LIA on the B5129 road.

14.5.28 There are five bus routes located in the LIA, both which service the bus stops located along the B5441 from Queensferry to Garden City approximately 160m parallel to the Scheme. These routes are:

- 10/10A Bus Route, which services a route from Chester to Connah's Quay or Flint
- 811 Bus Route, which services a route from Moreton or Leasowe to Broughton
- 5 Bus route, which services a route from Mold to Ellesmere Port
- 8 Bus route, which services a route from Sealand Manor to Mold (via Connah's Quay)
- F1 Bus route, which services a route from Deeside Industrial Estate to Flint (via Queensferry)

14.5.29 The LIA includes several PRoWs, which are set out in section 14.5.1.14 above.

Air Quality

14.5.30 Chapter 12: Air Quality states that there are no Air Quality Management Areas (AQMAs) located in the WIA, or which are likely to be impacted by the Scheme.

Noise

14.5.31 Chapter 12: Noise and Vibration states that there are several noise and vibration-sensitive receptors close to the alignment of the Scheme, and to affected route. These are generally residential dwellings including a gypsy traveller site although there is a school, Sealand Primary School, and the Queensferry Campus in relative proximity.

Source of pathways of potential pollution

14.5.32 Chapter 6: Soils and Geology states that there are no geological conservation sites located within the vicinity of the WIA.

Landscape amenity

14.5.33 Chapter 9: Landscape and Visual states that sensitive visual receptors include people in residential areas with direct and uninterrupted views of the Scheme and pedestrians and passive recreational users of paths and open spaces near to the Scheme.

14.6 Potential and likely significant effects

Potential Impacts

Table 14-9 below summarises potential impacts identified during construction and operation of the scheme.

Table 14-9: Potential impacts

Potential construction impacts	Potential operational impacts
Land use and accessibility • The construction of the scheme is expected to require temporary use of agricultural land in the LIA, especially located to the south east of the scheme location, potentially impacting on the functioning and viability of impacted agricultural holdings. • Temporary increases in traffic from construction activities could impact access to number of residential properties, community receptors, businesses and agricultural land holdings within the LIA. • Temporary changes in access to residential properties, community receptors, businesses and agricultural land holdings in the LIA due to changes to the local road network during Scheme construction. • Temporary diversions or closures of WCH routes (including PRoW, footways, road crossings and long distance routes) are likely to be needed within the LIA. This could result in changes to accessibility and increases to journey lengths for WCHs potentially introducing severance for communities.	**Land use and accessibility** • The works are likely to result in a reduction in congestion on the A494 in Queensferry and Garden City. This will permanently improve access to residential properties, community receptors, businesses and agricultural land holdings within the LIA. • The scheme has the potential to permanently reduce severance for WCH wishing to use PRoWs within the LIA to access land use and accessibility receptors. • There is the potential for permanent closures or diversions to be needed for WCH routes within the LIA and for associated WCH provisions to be designed as part of the scheme. These could potentially increase journey lengths for WCH.
Human Health • Temporary changes to the local environment (adverse impacts on noise, air quality, etc.) may affect the amenity, health, and wellbeing of the communities in the WIA. • Temporary increases in traffic from construction activities could impact access to number of health facilities, transport services, community, recreational and educational facilities and green and open spaces within the WIA. • Temporary changes in access to a number of healthcare facilities, transport services, community, recreational and educational facilities, and green and open spaces to in the WIA due to changes to the local road network during the scheme construction. • Temporary creation of jobs necessary to deliver the scheme may have direct and indirect impacts on employment within the WIA.	**Human Health** • The scheme has the potential to improve the provision of infrastructure that encourages active travel modes, supports a potential reduction in pollutants and access to employment with the potential for positive health impacts. • The works are likely to result in a reduction in congestion on the A494 in Queensferry and Garden City. This will permanently improve access to healthcare facilities and public transport routes within the WIA. • The operation of the scheme is anticipated to reduce congestion and reduce journey time, improving the access to employment for people living within the LIA and supporting the future economic growth of the region.

14.7

14.7 Description of likely significant effects

Construction

Land-use and accessibility

14.7.1 The likely significant effects on land use and accessibility in the scheme construction are set out below.

14.7.2 The construction of the scheme will require temporary land take from agricultural land holdings located to the immediate south east of the scheme, with a likely significant effect on the viability of agricultural land holdings where land take is occurring.

14.7.3 The construction of the Scheme will be ‘offline’ of the existing highway, which will allow the A494 to remain open during the majority of the scheme construction. However, there will be periods of the scheme construction where the Dee Bridge, and therefore the A494, will have to close. It is anticipated that this will result in a likely significant effect on access to private property and housing; community assets; businesses; agricultural land holdings and PRoWs within the LIA. These impacts will be temporary, and mitigation in the form of diversions will be provided. Receptors expected to principally affected are those which are accessed via the Aston Road roundabout in Queensferry, Farm Road in Garden City, and Foxes Lane in Sealand.

14.7.4 Once the scheme construction begins, temporary increases in construction activity may impact the access to private property and housing; community assets; businesses; agricultural land holdings and PRoWs within the LIA. These impacts will be temporary but are anticipated to result in likely significant effects on land-use and accessibility receptors within the LIA, as a result of temporary reduction in access. Receptors expected to be principally affected are those which are accessed via the Aston Road roundabout in Queensferry, Farm Road in Garden City and Foxes Lane in Sealand.

14.7.5 The construction of the scheme may result in temporary and permanent diversions to existing PRoWs. This may result in journey length and time increases, resulting in severance which will have a likely significant effect on routes used by local people for accessing community facilities and travelling between communities.

14.7.6 In addition, the land take of agricultural land during the scheme construction will result in a reduction of access to PRoWs located in the area where land take is occurring. This is expected to result in likely significant effects as the impacted PRoWs are likely to be used by local WCHs to access private property and housing, community assets and businesses located in the vicinity of Sealand Road.

Human Health

14.7.7 The likely significant effects on human health during the scheme construction are set out below.

14.7.8 There is likely to be temporary changes to the local environment (including changes to visual amenity, such as cranes, plant and machinery introduced into the local landscape, increase of dust and noise, and severance). This will have a likely significant effect on the health of communities.

14.7.9 As stated in 14.6.3 above, the construction of the scheme will be ‘offline’ of the existing highway. However, during the periods of the scheme construction where the Dee Bridge will have to close, there is anticipated to be likely significant effects on human health receptors within the WIA, as a result of temporary reduction in access. Receptors which are expected to be affected include health facilities located in the WIA, which are accessed via the A494 Dee Bridge, and public transport services which use the A494 Dee Bridge as part of their route. Green and open spaces in the WIA are accessed through the local road network, and it is therefore expected that access to these receptors will be maintained during the scheme construction. For this reason, likely significant effects on these receptors are not anticipated.

14.7.10 There are anticipated to be likely positive effects on the local economy and the supply chain during construction of the scheme. Temporary creation of jobs necessary to deliver the scheme may have direct and indirect significant beneficial effect on employment in the WIA.

Operation

Land-use and accessibility

14.7.11 The likely significant effects on land use and accessibility during the scheme operation are listed below.

14.7.12 The scheme has the potential to decrease congestion on the local road network, which will have a likely significant effect on improving access to private property and housing, community receptors, businesses, PRoWs and agricultural land holdings in the LIA during the scheme operation.

14.7.13 The scheme works will include the permanent realignment of, and the addition of a cycle track to, a PRoW route located to the south of the scheme location. The PRoW stems from Riverside Way and travels south west towards the bridge over North Wales Coast Line at Chemistry Lane. This is expected to result in a likely significant effect, as it will permanently improve access for WCH to the business receptors located in the vicinity of Riverside Way and Factory Road, including the Welsh Water Treatment Works site.

14.7.14 There is also the potential for permanent closures or diversions to be needed for WCH routes within the LIA and for associated WCH provisions to be designed as part of the scheme. These could potentially have a likely significant impact on increased journey lengths for WCH including for vulnerable WCH travellers and result in potentially significant adverse effects.

Human health

14.7.15 The likely significant effects on human health during the scheme operation are set out below.

14.7.16 The scheme has the potential to decrease congestion on the local road network, which will have a likely significant effect in improving access to healthcare facilities and public transport services located in the WIA.

14.7.17 The scheme has the potential to decrease congestion on the local road network, which has the potential to support future economic growth in the region. This is likely to positively impact health and wellbeing outcomes for communities within the WIA.

14.8 Mitigations and enhancements

Construction

14.8.1 Potential design, mitigation and enhancement measures during construction include:

- Maintaining access to all residential properties, businesses and community resources.
- Liaison with stakeholders prior to the commencement of construction works such as hospitals, emergency services, local businesses and residents.
- Working with local businesses along the Proposed Development to mitigate potential adverse construction effects through engaging them to understand their operational requirements and ensure updates are communicated in a timely manner.

- Providing appropriate signage for temporary WCH diversions, if required as part of the Proposed Development (dependant on the PRoWs and construction activities)
- Appropriate mitigation measures will be documented in the Construction Environmental Management Plan (CEMP). This document will set out a series of best practice measures to reduce construction impacts, to be implemented during the Proposed Development construction.

Operation

14.8.2 Potential design, mitigation and enhancement measures in operation include:

- Embedding landscaping and biodiversity enhancement measures into the Proposed Development design to prevent amenity effects related to the Proposed Development operation.
- Consideration will be given throughout the design to any potential for enhancement opportunities in relation to population and human health that can be incorporated into the Proposed Development design.

14.9 Assumptions and limitations

14.9.1 Several limitations and assumptions are considered within the Population and Human Health chapter. These are detailed as follows:

- The assessment of the potential for significant effects has been carried out against a benchmark of current baseline conditions within the LIA and WIA. As with any dataset, these may be subject to change over time, which may influence the findings of the assessment and could lead to the assessment being subject to statistical time lag.
- No topic-specific formal consultation or primary research has been undertaken in the production of this chapter.
- It is assumed that the construction process would not render local properties unusable and there would be no displacement of local residents.
- Information on road and PRoW closures and diversions is not available at this early stage.
- Operational WCH design is not currently available.
- It is understood that there will be no temporary or permanent land take required as part of this scheme.
- At this moment it is not certain if there will be agricultural land take as part of the scheme and impacts due to loss of agricultural land. However, potential impacts on access to agricultural land, businesses, and private properties should be explored at the next stage once detailed information on route closures and diversions are known.
- WCH surveys have not been undertaken at this early stage of design. If WCH amenities (e.g. PRoWs) are to be affected, then surveys will need completing at next PCF Stage to inform WCH provision for the scheme.
- Traffic data is not available at this early stage of design and therefore information on traffic flows at any WCH crossings in the study area is not known.

14.10 Conclusions of scoping

14.10.1 The scoping exercise proposes that the assessment on population and human health should be scoped into the EIA for both construction and operation.

14.10.2 During the scheme construction, the proximity of private property and holdings, community receptors, businesses, agricultural land holdings and PRoWs to the scheme means that there is potential for significant effects on access to these assets, and the people who use them. In addition, temporary land take from agricultural land holdings may impact the viability of effected agricultural land. For these reasons, land-use and accessibility is scoped in for the scheme construction.

14.10.3 During the scheme operation, decreased congestion is anticipated to improve access to private property and holdings, community receptors, businesses, agricultural land holdings and PRoWs. Additionally, the realignment of, and addition of a cycleway to, a PRoW route is anticipated to result in likely significant effects for WCH. As such, land-use and accessibility is scoped in for scheme operation.

14.10.4 During the scheme construction, the proximity of healthcare facilities and public transport services to the scheme means that there is potential for significant effects on access to these assets, and the people who use them. Temporary changes to the environment during the scheme construction may also result in significant amenity effects on human health. It is also anticipated that the scheme construction will increase employment opportunities for the local population. For these reasons, human health is scoped in for the scheme construction.

14.10.5 During the scheme operation, decreased congestion is anticipated to improve access to healthcare facilities and public transport services. The anticipated reduction in congestion will also result in a likely significant effect on the future economic growth of the WIA. For this reason, human health is scoped in for the scheme operation.

14.10.6 Table 14-10 below summarises whether land-use and accessibility and human health have been scoped in or out for further assessment during the scheme construction and operation.

Table 14-10: Summary of potential impacts and requirement for further assessment

	Scoped in	Scoped out	Justification for scoping out where applicable
Construction	• Land use and accessibility • Human Health	n/a	n/a
Operation	• Land use and accessibility • Human Health	n/a	n/a

14.11 Consultations and key stakeholders

14.11.1 At this stage of the assessment, consultation with stakeholder has not taken place. A public consultation period of 12 weeks is scheduled to commence in December 2024.

14.11.2 The full EIA will be informed by consultation and engagement with stakeholders, including local planning authorities, and non-statutory stakeholders as required to ensure that specialist local views and expertise can be considered as part of the EIA.

15 Climate

15.1 Introduction

15.1.1 This chapter of the environmental scoping report has been prepared on behalf of the Welsh Government by Mott MacDonald Ltd in accordance with the Highways Act 1980 (as amended) and The Environmental Impact Assessment Regulations 2017 (EIA Regulations 2017). The project is the A494 River Dee Bridge Improvement Scheme (hereafter referred to as "the Scheme").

15.1.2 The 2017 amendments to the EIA Directive place an emphasis on climate change within the EIA process. The two main elements of this topic relevant to the Scheme are the effects on climate (i.e. the generation of greenhouse gases (GHG)[210]) and the vulnerability of the Scheme to climate change. The vulnerability of the Scheme to climate change with regards to extreme rainfall events and sea levels over the lifetime of a Scheme will also be considered in the processes for flood modelling and assessment, reported in Chapter 7 (Road Drainage and Water Environment).

15.1.3 Potential impacts of GHGs will be discussed considering relevant policy and legislation and in the context of current GHG emissions budgets. Additionally, both the UK and Welsh Governments declared climate emergencies in 2019 placing a greater focus on GHGs being produced.

15.1.4 The effects on climate aspects of this chapter will be prepared in accordance with the Design Manual for Roads and Bridges (DMRB) LA 114 Climate[211] and WelTAG[212][213]. The assessment of the effects on climate will be undertaken in line with the principles of Publicly Available Standard (PAS) 2080:2023 Carbon Management in Buildings and Infrastructure[214]. For the purposes of this assessment, GHG emissions will be expressed as carbon dioxide equivalent (CO_2e)[215].

15.1.5 Assessing the vulnerability of the Scheme to climate change is fundamentally different to the remainder of the scoping report's assessment and topic chapters, as it assesses the impact of climate change on the Scheme receptors, as opposed to the impact of the Scheme on the environment. The assessment of the vulnerability of the Scheme to climate change will be prepared in accordance with the DMRB LA 114 Climate and the Institute of Environmental Management and Assessment (IEMA) Guide to Climate Resilience and Adaptation (2020)[216],

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[210] A greenhouse gas is a gas that absorbs and emits radiant energy within the thermal infrared range. Greenhouse gases cause the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide and ozone.

[211] Standards for Highways (2021). *Design Manual for Roads and Bridges – Sustainability and Environment LA 114 (Climate)* [online] available at: https://www.standardsforhighways.co.uk/dmrb/search/d1ec82f3-834b-4d5f-89c6-d7d7d299dce0 (last accessed September 2024).

[212] As the Scheme is located in Wales, WelTAG guidance was consulted. This guidance references the use of the WebTAG methodology which is used for this assessment.

[213] Department for Transport (2015): *TAG UNIT A3: Environmental Impact Appraisal* [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/638648/TAG_unit_a3_envir_imp_app_dec_15.pdf (last accessed September 2024).

[214] BSI (2023) *PAS 2080: Carbon management in infrastructure* [online] available at: PAS 2080:2023 Carbon Management in Infrastructure | BSI (bsigroup.com) (last accessed September 2024).

[215] Carbon dioxide equivalent is a standard unit of measurement in which other greenhouse gases are converted to equivalent amounts of carbon dioxide, in other words to amounts of carbon dioxide that would give the same radiative forcing.

[216] IEMA (2020) IEMA EIA Guide to: Climate Change Resilience and Adaptation (2020). Available from: IEMA - IEMA EIA Guide to: Climate Change Resilience and Adaptation (2020). (last accessed: August 2024).

with a bespoke assessment approach adapted based on these guidance documents and professional judgement.

15.2 Legislation and policy context

15.2.1 The principal policy and legislative context of the Scheme in relation to the assessment of Climate are listed below.

National legislation

The Climate Change Act 2008

15.2.2 The Climate Change Act 2008[217] forms part of the UK Government's plan to reduce GHG emissions, committing the Government to a reduction of at least 80% of 1990 levels by 2050. In 2019 the UK Government amended the Act to commit to net zero[218] GHG emissions by 2050, supporting the Paris Agreement which provides a framework to keep global warming well below 2 °C, pursuing efforts to limit the temperature increase to 1.5 °C.The Climate Change Act creates a new approach to managing and responding to climate change in the UK, by:

- Setting ambitious, legally binding emission reduction targets.
- Taking powers to help meet those targets.
- Strengthening the institutional framework.
- Enhancing the UK's ability to adapt to the impact of climate change.
- Establishing clear and regular accountability to the UK Parliament and to the devolved legislatures[219].

15.2.4 Key provisions of the Act in respect of climate change mitigation include the requirement for the Government to set legally binding carbon budgets capping the amount of GHG emissions emitted in the UK over a 5-year period, as set out in Table 15-1:

Table 15-1: UK carbon budgets

Carbon Budget	Carbon Budget Level	Reduction Below 1990 Levels
4th carbon budget (2023- 2027)	1,950MtCO_2e	51% by 2025
5th carbon budget (2028- 2032)	1,725MtCO_2e	57% by 2030
6th carbon budget (2033-2037)	965MtCO_2e	78% by 2035

Source: Department for Business, Energy & Industrial Strategy

15.2.5 The Act also establishes a framework to deliver on the requirements of adapting to climate change. As set out in the Act, the UK Government are required to assess the risks and opportunities from climate change for the UK and to adapt to them. It also established the Committee on Climate Change who advise Government on climate change risk and assesses adaptation progress towards tackling them. The UK Government is also required to produce a UK Climate Change Risk Assessment (CCRA) every five years which assesses current and future risks to the UK from climate change, including national summaries for the devolved administrations.

[217] Gov.uk (2008) Climate Change Act 2008 (legislation.gov.uk) (last accessed September 2024).

[218] Net zero refers to a state in which the greenhouse gases going into the atmosphere are balanced by removal out of the atmosphere.

[219] DECC (2012) Climate Change Act 2008

15.2.6 Following publication of the CCRA, the Act requires the UK Government to produce a National Adaptation Programme. Climate adaptation policy is a devolved matter therefore Wales has established its own adaptation programme in the form of the Welsh Government's 'Prosperity for all: A Climate conscious Wales', published in 2019 (see further details on this below).

The Well-being of Future Generations (Wales) Act 2015

15.2.7 The Well-being of Future Generations (Wales) Act 2015[221] sets the goal for 'A prosperous Wales'. This goal is stated: "*An innovative, productive and low carbon society which recognises the limits of the global environment and therefore uses resources efficiently and proportionately (including acting on climate change)*".

15.2.8 The Act also includes as a goal for 'A resilient Wales' which is stated as: *"A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change)"*. The Act requires that within the 12 months after an Assembly election, Ministers must publish a 'Future Trends Report' which should take into account the impact of climate change on Wales. The most recent report was published in 2021 which details big trends and drivers to help shape Wales' policy direction.

The Environment (Wales) Act 2016 Part 2 Climate Change

15.2.9 The Environment (Wales) Act 2016 Part 2 Climate Change[222] sets out the requirement in legislation for the Government to ensure the net Welsh emissions for the year 2050 are at least 80% lower than the 1990 baseline[223]. In addition, the Plan sets out the requirement for interim emission targets and carbon budgets for Wales with the first period running 2016 – 2020. The Welsh Government accepted the advice from the Climate Change Committee to reduce emissions by at least 100% (i.e. 'net zero') by 2050[224].

15.2.10 The Act also aims to position Wales to be ready for future climate change with Parts 1 and 7 of particular relevance to climate resilience. Part 1 sets out to ensure that ecosystems are resilient to future climate change whilst Part 7 includes the establishment of the Flood and Coast Erosion Committee alongside provisions for law and other regulatory requirements around flood risk management and drainage[225].

The Climate Change (Carbon Budgets) (Wales) (Amendment) Regulations 2021

15.2.11 The Climate Change (Carbon Budgets) (Wales) (Amendment) Regulations 2021[226] in addition to the net zero targets, sets interim targets for 2030 and 2040, and a series of 5-year carbon budgets for the Welsh Government. The carbon budgets for Wales are set out as a percentage reduction from the 1990 baseline rather than a value. The confirmed longer-term targets from Prosperity for All: A Low Carbon Wales (see paragraph 17.3.3) have been included on the basis of each budget period for ease of comparison. These carbon budgets and targets have been

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[221] Welsh Government (2015). *Wellbeing of Future Generations (Wales) Act 2015.* [online]. Available at: https://www.futuregenerations.wales/wp-content/uploads/2017/01/WFGAct-English.pdf (last accessed September 2024)

[222] Welsh Government (2016); Environment (Wales) Act 2016 [online] available at: Environment (Wales) Act 2016: overview | GOV.WALES (last accessed September 2024).

[223] The Welsh 1990 baseline carbon emissions are 56.4MtCO_2e.

[224] Climate Change Committee: *The path to Net Zero and progress on reducing emissions in Wales 2020* [online] available at: https://www.theccc.org.uk/publication/the-path-to-net-zero-and-progress-reducing-emissions-in-wales/ (last accessed September 2024)

[225] Welsh Government (2019): Prosperity for All: A Climate Conscious Wales. [online]. Available at: https://www.gov.wales/sites/default/files/publications/2019-11/prosperity-for-all-a-climate-conscious-wales_0.pdf (last accessed September 2024)

[226] Welsh Statutory Instruments (2021): *The Climate Change (Carbon Budgets) (Wales) (Amendment) Regulations 2021* [online] available at: https://www.legislation.gov.uk/wsi/2021/332/made: (last accessed September 2024).

estimated by using the reduction percentages and the baseline published by the National Atmospheric Emissions Inventory[227] extrapolated over the number of years associated with the budget or target as shown in **Table 15-2.**Table 15-.15-2: Table 15-2: Wales carbon targets and budget Table -2

Table 15-2: Wales carbon targets and budget

Period	Reduction from baseline (%)	Estimate carbon budget for period ($MtCO_2e$)
1990 baseline	N/A	56.4 (56.4 / yr equivalent)
2021-2025 (Carbon Budget 2)	37	178 (35.5 / yr equivalent)
2026-2030 (Carbon Budget 3)	58	118 (23.7 / yr equivalent)
2030 (2030 target)	63	21 (yr emissions)
2040 (2040 target)	89	6.2 (yr emissions)
2050 (2050 target)	100	Net zero

National policy

National Policy Statement for National Networks (NPSNN)

15.2.12 Although the Scheme is not a Nationally Significant Infrastructure Project, due to the nature of the development the assessment of the Scheme should have regard to key policies of the National Policy Statement for National Networks (NPSNN)[228] in terms of the requirements to take into account climate change.

15.2.13 The NPSNN contains a section on carbon emissions. In particular, paragraph 4.34 sets out the need to take the effects of climate change into account when developing infrastructure applications and why considering climate change mitigation is essential for future development.

15.2.14 Paragraph 5.35 outlines the need for carbon management plans to be developed as part of the DCO submissions, and should include a whole life carbon assessment for the project, including:

- A Whole Life Carbon assessment for the project.
- An explanation of the steps that have been taken to drive down the carbon impacts of the project.
- How construction and operational emissions and, where applicable, emissions from maintenance activities, have been reduced as much as possible using the carbon reduction hierarchy (e.g., as set out in PAS2080) (recognising that in the case of road projects while the developer can estimate the likely emissions from road traffic, it is not solely responsible for controlling them).
- Whether and how any residual carbon emissions will be (voluntarily) offset or removed using a recognised framework (any offsetting of emissions should not be included in the Whole Life Carbon Assessment headline figures).
- Where there are residual emissions, the level of emissions and the impact of those on any relevant statutory carbon budgets.

[227] National Atmospheric Emissions Inventory (2020). Devolved Administration GHG Inventory 1990-2018.

[228] Department for Transport (2024) *National Policy Statement for National Networks (NPSNN)* [online] available at: https://assets.publishing.service.gov.uk/media/65e9c5ac62ff48001a87b373/national-networks-national-policy-statement-web.pdf (last accessed September 2024).

15.2.15 Paragraphs 5.42 of the NPSNN also outline the need for any carbon assessment to include the scope of operational carbon emissions, so they can be appropriately managed, and align with carbon budget targets.

Carbon budget delivery plan 2023

15.2.16 The Carbon budget delivery plan[229] is a government strategy, set out to achieve the previously set legally binding carbon budgets which commit the UK to cap the total amount of greenhouse gases emitted over five-year periods. The plan provides an outline of proposals and policies to be implemented, to specifically meet carbon budgets 4, 5 and 6, which cover the timeline of 2023 – 2037.

Prosperity for All: A Low Carbon Wales 2019

15.2.17 The Prosperity for All Plan[230] sets out the Welsh Governments approach to cut emissions and increase efficiency to maximise wider benefits for Wales. There are 100 policies set out within the Plan in addition to details of the carbon budgets and interim targets for Wales.

Prosperity for All: A Climate Conscious Wales 2019

15.2.18 The Prosperity for All: A Climate Conscious Wales[231] recognises the risks associated with climate change and sets out the actions the Welsh Government plans to take to respond to those risks over the plan period of 2021-2025. The vision for climate change adaptation in Wales is identified in the Plan as: "*In 2030, Wales is a country which has the resources and is prepared, has the knowledge to understand the risk and challenges ahead and has the capacity to adapt to the impact of climate change*". This is to be achieved through building knowledge of the risks and challenges associated with climate change, increasing adaptive capacity across the country and building resilience. There are eight key areas of action set out in the Plan spanning flood protection, water availability and drought, ecosystems and agriculture, amongst others. In addition, the plan recognises the importance of protecting infrastructure from flooding and prioritises delivery of more green infrastructure as part of transport corridors.

Transport decarbonisation plan 2021

15.2.19 The Transport decarbonisation plan 2021[232] was published in July 2021. The plan outlines commitments, actions and timings to decarbonise all forms of transport across the UK, as well as multi-modal decarbonisation and key enablers. Key commitments of the plan that will reduce road use emissions include: an end to the sale of new petrol and diesel cars and vans by 2030; all new cars and vans to be zero emissions at the tailpipe by 2035; all new L category vehicles[233] to be zero emissions by 2035; and the end of the sale of all non-zero emission HGVs by 2040.

[229] Department for Energy Security and Net Zero (2023) Carbon Budget Delivery Plan (2023) [online] available at: Carbon Budget Delivery Plan - GOV.UK (www.gov.uk) (last accessed September 2024).

[230] Welsh Government (2019) Prosperity for All: A Low Carbon Wales 2019 [online] available at: https://gov.wales/sites/default/files/publications/2019-06/low-carbon-delivery-plan_1.pdf (last accessed September 2024).

[231] Welsh Government (2019). *Prosperity for All: A Climate Conscious Wales*. [online] Available at: https://www.gov.wales/sites/default/files/publications/2019-11/prosperity-for-all-a-climate-conscious-wales_0.pdf (last accessed September 2024).

[232] Department for Transport (2021) Transport decarbonisation plan – Decarbonising transport: a better, greener Britain 2021. [online] available at: https://www.gov.uk/government/publications/transport-decarbonisation-plan (last accessed September 2024)

[233] L category vehicles include the following and their sub-categories: L1 – light 2-wheel powered vehicles (including mopeds), L2 – 3-wheel mopeds, L3 – 2-wheel motorcycles, L4 – 2-wheel motorcycles with sidecars, L5 – powered tricycles, L6 – light quadricycles, and L7 – heavy quadricycles.

Future Wales – The National Plan 2040

15.2.20 The Future Wales – The National Plan 2040[234] is a framework for development in Wales across the next two decades. The Plan recognises the climate emergency and the challenges this poses and sets out to achieve decarbonisation and climate resilience as a key outcome. There is a strong correlation between the majority of the Future Wales policies and the decarbonisation and climate resilience outcome.

Llwybr Newydd: The Wales Transport Strategy 2021

15.2.21 The Wales Transport Strategy[235] sets out how the Welsh Government can provide a transport system to create a more prosperous, green and equal society. The strategy outlines the need to make best use of existing transport infrastructure, adapt infrastructure to support a modal shift, and to explore future infrastructure improvements that reduce carbon emissions.

National Transport Delivery Plan 2022 to 2027

15.2.22 The National Transport Delivery Plan[236] sets out how Welsh Government will deliver against the priorities and ambitions set out in Llwybr Newydd: The Wales Transport Strategy 2021. Priority two within the plan places an emphasis on accessible, sustainable and efficient services and infrastructure.

Local planning policy

North and Mid Wales Trunk Road Agency

15.2.23 The North and Mid Wales Trunk Road Agency (NMWTRA), has aligned its carbon goals with the wider Wales national carbon target and budget plan, committing to being net-zero by 2050. This includes ensuring road maintenance, operation, construction, and travel activity become net-zero within this timeframe.

Flintshire County Council

15.2.24 Flintshire County Council (FCC) adopted their Local Development Plan (LDP) 2015-2030[237] in 2023. Climate change and GHG policies within the LDP include:

STR4: Principles of Sustainable Development, Design and Placemaking:

"To promote and create new sustainable places, all development will be designed to a high standard in line with the sustainable placemaking design principles and should achieve local distinctiveness, be inclusive and accessible, and mitigate and adapt to climate change"

STR13: Natural and Built Environment, Green Networks and Infrastructure:

"Development should identify, respect, protect, enhance and connect Flintshire's environmental assets to create a multifunctional network of natural and historic resources. Development should:

- *Promote opportunities to enhance biodiversity and ensure resilience*
- *Support measures to minimise the consequences of climate change"*

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[234] Welsh Government (2021). The Future Wales – The National Plan 2040. [online] available at: https://www.gov.wales/sites/default/files/publications/2021-02/future-wales-the-national-plan-2040.pdf (last accessed September 2024)

[235] Welsh Government (2021) Llwybr Newydd: the Wales transport strategy 2021 [online] available at: https://www.gov.wales/llwybr-newydd-wales-transport-strategy-2021-html (last accessed September 2024).

[236] Welsh Government (2023) National transport delivery plan 2022 – 2027. [Online] available at: https://www.gov.wales/national-transport-delivery-plan-2022-2027 (last accessed September 2024).

[237] Flintshire County Council. (2023) Flintshire Local Development Plan 2015-2030. [online] Available at: https://www.flintshire.gov.uk/en/Resident/Planning/Development-plans--policies.aspx (last accessed September 2024).

STR14: Climate Change and Environmental Protection:

"The Council will seek to mitigate the effects of climate change and ensure appropriate environmental protection in the County through:

- *Adopting a sustainable approach to water resource management including supply, surface water run-off and wastewater treatment*
- *Directing development away from flood risk areas, assessing the implications of development in areas at risk of flooding and ensuring that new development does not increase the risk of flooding elsewhere*
- *Encouraging energy efficient development, environmentally acceptable renewable and zero / low carbon energy generation and combined heat and power and communal / district heating networks*
- *Designing development to be adaptable and resilient to the future effects of climate change"*

PCR4: Sustainability and Resilience of New Development:

- *"be designed so as to be resilient and adaptable to the effects of climate change*
- *incorporate planting, landscaping and design features within a Sustainable Management of Natural Resources (SMNR) approach which mitigate the effects of climate change such as increased rainfall events and high temperatures*
- *make efficient use of resources through sustainable construction techniques and materials, including layout, siting and orientation to maximise solar gain, water conservation and waste reduction*
- *incorporate renewable energy technologies and carbon sinks where appropriate."*

15.2.25 The Cheshire West and Chester council declared a state of climate emergency in 2019, producing a Climate Emergency Response Plan[238] in 2019. The local authority area of Cheshire West and Chester is located 2.5km northeast of the Scheme. Section 5.5 states: *"All future major transport projects will have a carbon assessment as part of their business case".* Additionally, it states in Section 8.6: "*Adaptation is essential in mitigating the detrimental impacts of climate change, such as increased flood risk, sea level rise… and many more adverse effects"*.

15.3 Relevant guidance

Design Manual for Roads and Bridges LA 114 Climate (2021)

15.3.1 The Climate chapter has been prepared in accordance with DMRB LA 114[240], which is considered the most relevant guidance for the project. This guidance, as referred to in further detail through this chapter, describes the methodology for the Effects on climate, and Vulnerability of the scheme to climate change, including approach to significance and mitigation.

[238] Cheshire West and Chester Council (2019) Cheshire West and Chester Climate Emergency Response Plan. [online] available at: https://www.cheshirewestandchester.gov.uk/your-council/councillors-and-committees/the-climate-emergency/documents/climate-emergency-response-plan.pdf (last accessed September 2024).

[240] Standards for Highways (2021). *Design Manual for Roads and Bridges – Sustainability and Environment LA 114 (Climate)* [online] available at: https://www.standardsforhighways.co.uk/dmrb/search/d1ec82f3-834b-4d5f-89c6-d7d7d299dce0 (last accessed September 2024)

Institute of Environmental Management and Assessment Guide to Climate Resilience and Adaptation (2020)

15.3.2 Institute of Environmental Management and Assessment (IEMA) Guide to Climate Resilience and Adaptation (2020)[241] will provide practical guidance to how to incorporate a climate resilience assessment into a project's development strategy. In addition to defining a scope, future baseline, magnitude of effect and mitigation measures.

Royal Institute of Chartered Surveyors Whole Life Carbon Assessment for the Built Environment (2024)

15.3.3 Travel distances Benchmarks and recommended distances from the Royal Institute of Chartered Surveyors (RICS) guidance for whole life carbon emissions[242] will calculate the significance of carbon emissions generated by transportation of construction materials onto and off of site.

British Standards Institution (BSI) Publicly Available Standard (PAS):2080

15.3.4 The assessment and mitigation approach for the Effects on climate will be undertaken in line with the principles of Publicly Available Standard (PAS) 2080:2023 Carbon Management in Buildings and Infrastructure[243].

15.4 Assessment methodology

Effects on Climate

Study area

15.4.1 The construction study area will include construction related activities that occur within the Scheme boundary. Emissions will also include those associated with some activities supporting construction which occur outside the physical Scheme limits, for example GHG emissions from construction related transport of materials.

15.4.2 The construction study area will comprise GHG emissions associated with Scheme construction related activities/materials and their associated transport including:

- Raw material supply
- Transport
- Manufacture
- Transport to site
- Construction/installation processes
- Land use change impacts

15.4.3 The study area to be considered for operation includes:

- All of the modelled traffic links (from the traffic model) for road user carbon (vehicle emissions)
- Regular maintenance and planned replacement of the Scheme aspects

[241] Institute of Environmental and Management and Assessment (2020). Climate Change Resilience and Adaptation. [online] available at: https://www.iema.net/content/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020/ (last accessed September 2024).

[242] Royal Institute of Chartered Surveyors (2024). Whole life carbon assessment for the built environment. [Online] available at: https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/construction-standards/whole-life-carbon-assessment (last accessed September 2024)

[243] BSI (2023). PAS:2080 Carbon management in infrastructure [online] available at: https://www.bsigroup.com/en-GB/insights-and-media/insights/brochures/pas-2080-carbon-management-in-infrastructure-and-built-environment/ (last accessed September 2024).

- Operational energy from lighting within the Scheme extent
- Land use change impacts

Construction

15.4.4 The full assessment of the construction effects on climate will include an assessment of GHGs emitted during construction using credible and recognised calculation methodologies and tools. These include:

- The National Highways Carbon Estimating Tool v2.6.1 will be used to supply emission factors for the embodied carbon assessment.
- The Royal Institute of Chartered Surveyors (RICS) guidance and assumptions on the transport of materials to site will be used where actual supplier information is not known.
- Department for Energy Security and Net Zero GHG reporting conversion factor framework for plant and transport emission factors.
- Environmental Product Declarations (EPDs) detailing the emissions for certain design aspects where appropriate for bespoke items.
- The Woodland Carbon Code (WCC) and Natural England research for the land use carbon change unless an alternative site-specific methodology is determined.

15.4.5 GHG emissions will be assessed using a calculation-based methodology as per the below equation:

Activity data x GHG emissions factor = GHG emissions value

15.4.6 Activity data will be sourced from quantities data used to produce bills of materials that will be available at certain points in the design process. This will be used to make sure all activities have been captured in the same way for carbon as for cost.

15.4.7 In selecting activity data, the project will aim to use that data which is the most complete, up-to-date and referenceable. During the design process, it may be necessary to use interim data in order to support decision making. As far as possible this will follow the same criteria however there may be cases where assumptions are required.

15.4.8 Emission factor data will be selected based on its overall applicability to the project. A number of criteria will be applied:

- Age: the most recently published data will be preferred.
- Geography: data which applies to the location of actual suppliers and/or activities will be preferred.
- Technology: data which represent the actual product/activity in question will be preferred.
- Methodology: data which follow a published methodology or product category rules will be preferred.
- Competency: data which are produced from proficient entities will be preferred.

15.4.9 The construction carbon assessment will be presented against the following life cycle stages (modules) as outlined in the RICS guidance[242], as presented in Table 15-3Table 15-3.

Table 15-3: Construction life cycle stage activities

Life cycle stage	Activities incorporated
Product stage (modules A1-A3)	The extraction, processing and manufacturing of all materials required for the permanent assets. This includes all energy and carbon emissions from manufacturing plants, primary and secondary manufacturing stages as well as any transport emission between these stages.
Construction process stage -transport to site (module A4)	The transportation of all materials required for the permanent assets and construction equipment to site from the point of production (or point of storage in the case of plant and machinery).
Construction process stage -construction and installation (module A5)	Construction site works activities including: • Temporary work, ground works and landscaping; • Materials storage and any energy or otherwise need to maintain necessary environmental conditions; • Transport of materials and equipment on site; • Installation of materials and products into the infrastructure asset; • Emissions associated with site water demand; • Waste management activities (transport, processing, final disposal) associated with waste arising from the construction site; • Emissions from land use change; and • Production, transportation, and waste management of materials/products lost during works.

Operation

15.4.10 The assessment of operational effects on climate will include:

- A road user assessment: the carbon dioxide equivalent (CO_2e) emissions will be calculated from the updated traffic model over a 60-year appraisal period presenting the net GHG emissions: the difference in GHG emissions between the do minimum and do something scenarios which will provide the traffic GHG impact figures for appraisal, using emission factor toolkit version 11 in line with LA 114.
- A routine maintenance assessment: covering expected maintenance and replacement. Utilising assumptions on design life of key aspects and likely carbon intensity of the maintenance and replacement.
- An assessment of the GHG emissions associated with the electricity requirements for the operation of the scheme. This will utilise data determined through design and publicly available emission factors for grid electricity. Future grid decarbonisation trajectories will be used.
- An assessment of the impacts of land use change will consider the habitats present in the with scheme and without scheme scenario and the impact on sequestration using the Natural England research. The operational carbon assessment will be presented against the following life cycle stages (modules). The scope of assessment includes lifecycle stages B1, B2, B4, B6 and B8 as presented in Table 15-4Table 15-4.

Table 15-4: Operational life cycle stage activities

Life cycle stage	Activities incorporated
Use stage – Use (module B1)	New stores of carbon e.g. carbon sequestration from scheme planting.
Use stage – Maintenance (module B2)	The production, transportation (to and from the site) and end of life processing of all materials required for preventative maintenance. The electricity, fuel and water for regular preventative maintenance.
Use stage – Replacement (module B4)	The production, transportation (to and from the site) and end of life processing of all materials required to replace any assets or any components within assets that have a design life of less than 60 years.
Use stage – Operational Energy Use (module B6)	The electricity used to run any scheme lighting, highways communications.
Use stage – User carbon (module B8)	Direct exhaust emissions from vehicles. Assessment to be undertaken in line with WebTAG guidance and requirements.

Significance of effects

15.4.11 DMRB LA 114 Climate and supplementary guidance from IEMA will be used to determine the significance of effects from GHG emissions. DMRB LA 114 will be followed due to the Scheme being a highways project.

15.4.12 DMRB LA 114 Climate requires an assessment of the GHG emissions against UK Government budgets. The Scheme GHG emissions will be contextualised as a percentage against the UK and Welsh carbon budgets. DMRB LA 114 also states that *“projects shall only report significant effects where increases in GHG emissions will have a material impact on the ability of Government to meet its carbon reduction targets”.* It also notes that the NPSNN states: *“It is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plan targets”.* Therefore, it is considered unlikely that road projects will in isolation conclude significant effects on climate. Where carbon budgets for Wales do not yet exist, the Scheme will be compared against the UK carbon budgets.

15.4.13 It is of note that the guidance on evaluating significance of GHG emissions published by IEMA provides an alternative method of assessment. The IEMA guidance states that all emissions contribute to climate change and therefore have the potential lead to significant environmental effects. The guidance outlines criteria for major adverse, moderate adverse, minor adverse, negligible, and beneficial effects. These effects depend upon whether GHG impacts are compliant with legislation, are sufficiently mitigated/reduced, and are aligned to the UK’s net zero trajectory. Major or moderate adverse effects and beneficial effects are considered to be significant. Minor adverse and negligible effects are considered to be not significant.

15.4.14 The IEMA guidance outlines that the carbon impact of a project should be contextualised with relevant budgets consistent with net zero and be mitigated as much as possible and that the level of significance should be determined based on the relevant context. The estimated GHG emissions arising from the Scheme will also be compared with the Wales carbon budgets, and the associated reduction targets.

Vulnerability of the Scheme to climate change

15.4.15 The assessment will use a bespoke methodology adapted from the DMRB LA 114 Climate[244] and the IEMA Guide to Climate Resilience and Adaptation (2020)[245]. The methodology includes:

- Identification of the present-day climate baseline using observed historical data and regional climate summaries from the UK Met Office.
- Identification of future climate projections (future baseline) using the latest projections from the Met Office's UK Climate Projections 2018 (UKCP18) climate tool.
- Undertaking a climate change risk assessment (CCRA). This includes the:
  - Identification of climate risks during the construction and operational phases of the Scheme using the baselines, review of design information and consultation with relevant engineering designers.
  - Identification of climate resilience measures embedded within the Scheme design
  - Assessment of risk, taking into account the likelihood and consequence of potential impacts. Identification of the significance of risks by combining likelihood and consequence.
  - Identification of additional mitigation to reduce potential significant risks, enhance resilience and enable adaptability to future changes in climate.
- Consideration of in-combination climate impacts across other relevant EIA topics using future baseline conditions.

Study area

15.4.16 The vulnerability of the Scheme to climate change relates to the impacts that climate change may have on the Scheme based on projected changes in climate over the Scheme's design life and the adaptive capacity of the Scheme. The study area will be based on the construction footprint and Scheme boundary (including compounds and temporary land take), as well as end-users.

Data sources

15.4.17 The following data sources will be used to inform the climate baseline:

- State of the UK Climate[246]
- Third UK Climate Change Risk Assessment (CCRA3) – Regional Summary for Wales[247]
- Met Office Regional Summary for Wales[248]
- Data from the National Tide and Sea Level Facility[249]

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[244] Standards for Highways (2021). *Design Manual for Roads and Bridges – Sustainability and Environment LA 114 (Climate)* [online] available at: https://www.standardsforhighways.co.uk/dmrb/search/d1ec82f3-834b-4d5f-89c6-d7d7d299dce0 (last accessed September 2024).

[245] IEMA (2022) IEMA EIA Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance. Available from: https://www.iema.net/resources/reading-room/2022/02/24/iema-guide-assessing-greenhouse-gas-emissions-and-evaluating-their-significance (last accessed September 2024).

[246] Kendon, M., McCarthy, M., Jevrejeva, S., Matthews, A., Sparks, T., Garforth, J., & Kennedy, J. (2022). State of the UK Climate 2021. International Journal of Climatology, 42(Suppl. 1)(S1), 1– 80. [online]. Available at: https://rmets.onlinelibrary.wiley.com/doi/10.1002/JOC.7787 (last accessed September 2024).

[247] Committee on Climate Change (2021). *CCRA3 – Regional Summary for Wales*. [online]. Available at: https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA-Evidence-Report-Wales-Summary-Final.pdf (last accessed September 2024)

[248] Met Office (2016) *Wales: climate* [online]. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/regional-climates/wales_-climate---met-office.pdf (last accessed September 2024)

[249] National Tidal and Sea Level Facility (NTSLF) (n.d.) Cromer tide gauge site. [online]. Available at: Cromer tide gauge site | National Tidal and Sea Level Facility (ntslf.org) (last accessed September 2024).

- Met Office UKCP18 Tool[250]

Scheme elements

15.4.18 The construction site would be included within the construction assessment. Whilst the main receptors of the Scheme during the operational phase to be considered during the assessment have been identified through review of design documentation, the Scheme description of the proposed works presented in Section 2.4 and consultation with relevant engineering designers. The Scheme receptors considered within the assessment are presented in Table 15-5Table 15-5.

Table 15-5: Scheme receptors

Receptors	Description (to be constructed or modified)
Bridges	• Renewal of existing A494 River Dee bridge to carry eastbound traffic • New bridge crossing of the River Dee for westbound traffic with shared-use path for cyclists and pedestrians
Drainage	• Culvert alongside new westbound carriageway • Drainage pipes • Ditches • Attenuation ponds • Relocation of pumping station and associated electricity substation
Earthworks	• New embankments to be built for road alignment • New retaining structures
Highways features	• Road pavement • Road restraint systems such as safety barriers • Road lighting • Road markings and signs • Other roadside systems • Pedestrian and cycle routes
Landscape and vegetation	• Planting of native species
End Users	• Motorised users • Non-motorised users

Climate change risk assessment methodology

15.4.19 The Climate Change Risk Assessment (CCRA) is an assessment of the physical risks associated with future climate change on the Scheme.

15.4.20 Risks associated with climate change will be identified using the present-day and future climate baseline alongside the Scheme's design and information from other environmental assessment topics. The risk assessment and determination of significance will consider embedded resilience measures already incorporated within the Scheme design.

15.4.21 Risk in the context of climate risks will be defined for this assessment as the risk that a weather or climate event occurs due to climate change, above and beyond events that currently affect

[250] Met Office (n.d.) UK Climate Projections (UKCP). [online]. Available at: https://ukclimateprojections-ui.metoffice.gov.uk/ui/home (last accessed September 2024)

the Scheme location and results in an adverse impact. Impacts due to weather and climate typically take the following two forms:

- Acute risk - a sudden-onset risk following a specific weather event such as a storm, such as damage to an asset.
- Chronic risk – a slow-onset risk due to cumulative events over time, such as deterioration of a receptor below acceptable standards following years of changing seasonal weather.

Likelihood of impacts

15.4.22 Risks will be assessed by using professional judgement to assign likelihood and consequence ratings. The overall significance of the risk will be determined using a significance matrix. Definitions of likelihoodTable 15-6, consequence Table 15-7and significance Table 15-8ratings will be applied in line with DMRB LA 114 Climate and are set out in the following sections.

15.4.23 Likelihood is the probability and frequency of the potential impact occurring. The criteria for defining the likelihood of impacts from climate change on the Scheme are described in Table 15-6Table 15-6.

15.4.24 Determination of the likelihood category is based on information from climate change projections, together with knowledge and professional judgement on the nature of the impacts and level of certainty associated with the projections. For example, there is a higher degree of certainty within climate projections in relation to temperature change. However, there is a lower level of certainty in relation to the exact change in rainfall patterns or the frequency of extreme rainfall or temperature maximums.

Table 15-6: Likelihood of categories

Likelihood category	Description (probability and frequency of occurrence)
Very high	The impact occurs multiple times during the lifetime of the project (120 years) e.g. approximately annually, typically 120 events.
High	The impact occurs several times during the lifetime of the project (120 years) e.g. approximately once every five years, typically 24 events.
Medium	The impact occurs limited times during the lifetime of the project (120 years) e.g. approximately once every 15 years, typically 8 events.
Low	The impact occurs during the lifetime of the project (120 years) e.g. once in 120 years.
Very low	The impact can occur once during the lifetime of the project (120 years).

Consequence of impact

15.4.28 The measure of consequence is the level of disruption experienced by the receptor for a period of time and the receptors' ability to return to its normal functionality following the occurrence of a climate event.

15.4.29 The criteria for defining consequence of receptors due to climate risks are described in Table 15-7Table 15-7.

Table 15-7: Measure of consequence

Consequence impact	Description
Very large adverse	Operation - national level (or greater) disruption to strategic route(s) lasting more than 1 week.

Consequence impact	Description
Large adverse	Operation - national level disruption to strategic route(s) lasting more than 1 day but less than 1 week or regional level disruption to strategic route(s) lasting more than 1 week.
Moderate adverse	Operation - regional level disruption to strategic route(s) lasting more than 1 day but less than 1 week.
Minor adverse	Operation - regional level disruption to strategic route(s) lasting less than 1 day.
Negligible	Operation - disruption to an isolated section of a strategic route lasting less than 1 day.

Significance matrix

15.4.30 Likelihood and consequence will be combined to identify the significance of each risk identified as outlined in Table 15-8Table 15-8 below. Significance is defined as Not Significant (NS) or Significant (S).

Table 15-8: Significance matrix

		Measure of likelihood				
		Very low	Low	Medium	High	Very high
Measure of consequence	Very large adverse	NS	S	S	S	S
	Large adverse	NS	NS	S	S	S
	Moderate adverse	NS	NS	S	S	S
	Minor adverse	NS	NS	NS	NS	NS
	Negligible	NS	NS	NS	NS	NS

In-combination climate impact assessment

15.4.31 The impacts of the project in combination with climate change will be assessed for relevant environmental topics. A qualitative assessment of the in-combination climate impacts will be carried out in line with the IEMA Guide to Climate Resilience and Adaptation. The assessment will be based on professional judgement of the information available. The assessment will include:

- How the environmental receptors will be affected by the future climate baseline.
- Consideration of appropriate embedded mitigation measures.
- Determine whether the effect is significant.

15.5 Baseline conditions

Effects on climate

15.5.1 The following baseline information is based on national and county-wide data. GHG emissions do not have a local receptor as once they are emitted they are not limited to geographic boundaries. For Flintshire, total GHG emissions for 2022 totalled 1,727 ktCO_2e, a decrease of

7% from 2021 levels[251]. For Wales, the total GHG emissions for 2022 were 36.7 $MtCO_2e$, a decrease of 0.1% from 2021 levels[252]. From a UK perspective, national GHG emissions in 2023 were 384.2. MtCO2e, 6.6% lower than 2022, and 55.7% lower than 1990[253]. Table 15-9Table 15-9 illustrates the proportion transport emissions compared to the total of UK, Wales and Flintshire's total emissions for 2022.

Table 15-9: Transport emission breakdown

Transport Emissions	$ktCO_2e$	% of total emissions
UK	106,671	28%
Wales	5,420	15%
Flintshire	489	28%

15.5.2 The UK construction industry is the largest consumer of natural resources with an average of over 400 million tonnes of material consumed every year. This accounts for approximately 10% of the total UK carbon emissions[254].

Vulnerability of the Scheme to climate change

15.5.3 The vulnerability of the Scheme to climate change will include both a present-day and future baseline, both of which are presented in this section. The present-day baseline is the observed climatic conditions whereas the future baseline is the projected changes in climatic conditions over the Scheme's design life.

Present-day baseline

15.5.4 The present-day baseline will use observations from the UK land weather station network to describe the present climate across the UK and Wales. The baseline will also include localised climate observations from the Hawarden (Flintshire) climate station, which is the closest station to the Scheme location.

15.5.5 The state of the UK Climate Report[255] provides a description of trends that are consistent with a changing climate across the UK using observations from the UK land weather station network. Observations show that in 2023, the UK mean temperature was 10.03 °C which is 0.83 °C above the 1991-2020 long-term average and annual mean daily maximum temperature was 14.9 °C, which is 0.9 °C above the long-term average. The UK rainfall total for winter was 280mm which is 81% of the long-term average. The summer of 2023 was also wetter than average for most of the UK with many regions receiving around 113% the normal amount of rainfall. These observations show that the UK's climate is experiencing change beyond historical averages.

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[251] Department for Energy Security and Net Zero (2024): UK local authority and regional greenhouse gas emissions statistics, 2005 to 2022 [online] Available at: https://www.gov.uk/government/statistics/uk-local-authority-and-regional-greenhouse-gas-emissions-statistics-2005-to-2022 (last accessed September 2024).

[252] Cabinet Secretary for Climate Change and Rural Affairs(2024): Written Statement – Publication of Emissions Data for 2022 [online] Available at: https://www.gov.wales/written-statement-publication-emissions-data-2022#_ftn1 (last accessed September 2024).

[253] Department for Business, Energy & Industrial Strategy (2024): 2023 UK greenhouse gas emissions, provisional figures [online] Available at: https://assets.publishing.service.gov.uk/media/6604460f91a320001a82b0fd/uk-greenhouse-gas-emissions-provisional-figures-statistical-release-2023.pdf (last accessed September 2024).

[254] Institute of Civil Engineers (ICE) (2014): Energy Briefing Sheet: Embodied Energy and Carbon [online]. Available at: https://www.ice.org.uk/ICEDevelopmentWebPortal/media/Documents/Disciplines%20and%20Resources/Briefing%20Sheet/Embodied_Energy_and_Carbon.pdf (last accessed September 2024).

[255] Met Office (2024) *State of the UK's Climate* [online]. Available at: https://rmets.onlinelibrary.wiley.com/doi/10.1002/joc.8553 (last accessed September 2024).

15.5.6 Additional climate trends for the UK are described in the headline findings of the report which include:

- The UK's climate is changing with recent decades being warmer, wetter and sunnier than the 20th century.
- All of the UK's top 10 warmest years from 1884 have occurred this century.
- The UK has warmed at a broadly consistent but slightly higher rate than the observed change in global mean temperature.
- The most recent decade (2012-2021) has had 5% fewer days of both air and ground frost compared to the 1991-2020 average, and 21% fewer compared to 1961-1990.
- The most recent decade (2012-2021) has been on average 2% wetter than 1991-2020 and 10% wetter than 1961-1990 for the UK overall.
- The rate of sea-level rise in the UK is increasing, with some locations recording a range from 3.0 ± 0.9 to 5.2 ± 0.9 mm year−1 over the past 30 years when corrected for vertical land movement, compared to the 1.5 ± 0.1 mm year−1 since 1900s.

15.5.7 The latest UK CCRA3 report[256] outlines the following observed changes in climate for Wales in Table 15-10Table 15-10.

Table 15-10: Observed changes in climate in Wales

Climatic variable	Observed change in Wales
Average annual land temperature	In the decade 2010-2019, average land temperatures have increased by 0.9 °C from the mid-1970s to mid-2010s.
Annual mean rainfall	Annual mean rainfall has increased by 2% in the decade 2010-2019 compared to the mid-1970s to mid-2010s.
Sunshine	Sunshine hours have increased on average by 6.1% in the decade 2010-2019 from the mid-1970s to mid-2010s.
Sea level rise	An approximate 1.4 mm per year in sea level rise has occurred since 1901 (16cm to date) across the UK.

15.5.8 The CCRA3 also notes the evidence of increases in extreme maximum summer temperatures as reflected by the number of record extreme monthly temperature records being set in the UK in the most recent decade. In July 2022, a temperature record of 37.1 °C was recorded at Hawarden Airport in Flintshire, approximately 4 km from the Scheme location[257]. Heatwaves are also becoming more common and extreme with the Met Office issuing their first ever red warning for heat in the lead up to the summer 2022 heatwaves. Heatwave thresholds in the UK vary by country and are defined as having been met when a location records a period of at least three consecutive days with daily maximum temperatures meeting or exceeding that temperature threshold[258].

[256] Committee on Climate Change (2021). *CCRA3 – Regional Summary for Wales* [online]. Available at: https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA-Evidence-Report-Wales-Summary-Final.pdf (last accessed September 2024).

[259] Met Office (2016) *Wales: climate* [online]. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/regional-climates/wales_-climate---met-office.pdf (last accessed September 2024)

[259] Met Office (2016) *Wales: climate* [online]. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/regional-climates/wales_-climate---met-office.pdf (last accessed September 2024)

15.5.9 The Met Office regional summary for Wales presents high-level climate observations over a 30-year averaging period between 1981-2010[259] using observations from the UK weather station network. These are presented in Table 15-11Table 15-11.

Table 15-11: Observed climatic conditions for Wales (30-year average between 1981-2010)

Climatic conditions	Climate observations
Temperature	Mean annual temperature varies from 9.5 °C to 11 °C. Variations in temperature depend on altitude (decrease of 0.5 °C for each 100 metres in increase in altitude). Mean daily minimum temperatures range from 0 °C to 4 °C during the winter months and the mean daily maximum temperatures range from 17 °C to 21 °C in the summer.
Rainfall	The months from October to January are significantly wetter than those between February and September. In north Wales, over 50 days with rainfall of more than 1 mm is the norm in winter (December to February) and over 35 days in summer (June to August).
Wind	Wales is one of the windier parts of the UK, with the windiest areas being over the highest ground and along the coasts, particularly those facing directions between the north-west and south. The frequency and strength of these depressions is greatest in the winter half of the year, especially from November to February, and this is when mean speeds and gusts (short duration peak values) are strongest.
Sunshine	On average, Wales experiences the most sunshine in May and the least in December. Annual averages range from 1200 hours to 1750 hours, with durations of sunshine generally decreasing with increasing altitude in the mountainous areas.

Hawarden (Flintshire climate) station

15.5.10 The Hawarden (Flintshire) climate station (location: 53.174, -2.986) is the closest active station located to the Scheme and describes localised conditions between 1991-2020, which are compared to the rest of Wales. These observations are shown in Table 15-12Table 15-12. Generally, the localised climate conditions are warmer and drier than the average across Wales.

Table 15-12: Hawarden (Flintshire) climate station observations, 1991-2020

Climatic variables	Hawarden (Flintshire) climate station	Wales
Annual Maximum temperature (°C)	14.32	12.93
Annual Minimum temperature (°C)	6.32	5.94
Annual Rainfall (mm)	728.74	1464.65
Annual Days of rainfall >1mm (days)	136.67	173.12
Annual Days of air frost (days)	42.32	44.92

[259] Met Office (2016) *Wales: climate* [online]. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/regional-climates/wales_-climate---met-office.pdf (last accessed September 2024)

Tidal range and storm surge

15.5.11 The National Tide and Sea Level Facility presents historic and predicted data for tides at Liverpool between 2008-2026 which is the closest data available for the Scheme location[260]. Surge heights data between 1973-2012 is also available for Liverpool[261]. The 10 lowest spring tides range from 0.22 metres above ordnance datum (mAOD) recorded in March 2015 and 2019 to 0.09 mAOD as also recorded in March 2019. High spring tides have ranged from 10.24 mAOD as recorded in August 2014 to a maximum during this period of 10.37 mAOD as recorded in September 2015. The 10 highest skew surges[262] range from 1.1 m in March 2004 to 1.570 m in January 2005, representing the additional height of storm surge water above the routine tide for those dates.

Recent notable climatic events

15.5.12 The Met Office provides a summary of past extreme weather events[263] experienced across the UK. Recent weather events which affected the Scheme location include:

- Storm Isha (2024): Storm Isha resulted in heavy rain and winds reaching up to 99 miles per hour. Causing road closures, power outages and travel disruptions to the Flintshire area.
- Heatwave (2022): England and Wales experienced the hottest summer on record with parts of England exceeding 40 °C and a record of 37.1 °C set at Hawarden Airport in Flintshire, approximately 4km from the Scheme location[264]. The hot and dry conditions dried up rivers, damaged crops, exacerbated drought conditions and posed a substantial risk to human health.
- Storm Franklin (2022): Following on a week after Storm Eunice and Storm Dudley, Storm Franklin brought high winds to the Flintshire area in which the Scheme is located. Gusts of around 57 miles per hour (mph) were recorded and the Flintshire bridge (A548) was closed as a result. Flood warnings were issued across the coast and areas along the River Dee in Flintshire due to rising water levels in the River Dee and Dee Estuary.
- Storm Eunice and Storm Dudley (2022): Storm Eunice and Storm Dudley resulted in high winds and heavy rainfall with Eunice triggering red warnings issued by the Met Office. Areas across Flintshire were without power as a result.
- Storm Dennis (2020): Strong winds and heavy rainfall were brought by Storm Dennis in February 2020. Areas across Flintshire were flooded as a result of a burst water mains on the A494 and others were left without water as a result.

Future Baseline

15.5.13 The future climate baseline for the Scheme will be derived from the Met Office UKCP18 tool which provides projections for future climate change across the UK against a range of future climate scenarios. In line with the IEMA Guide to Climate Resilience and Adaptation (2020)[265], a 'precautionary approach' will be taken by using the Representative Concentration Pathway

[260] National Tidal and Sea Level Facility (2022). *Highest & Lowest predicted tides at Cromer* [online]. Available at: https://ntslf.org/tides/hilo?port=Liverpool (last accessed September 2024).

[261] National Tidal and Sea Level Facility (2022). *Skew surge history: Wales*. Available at: https://ntslf.org/storm-surges/skew-surges/wales (last accessed September 2024).

[262] Skew surge is the difference between the maximum observed sea level and the maximum predicted tide regardless of their timing during the tidal cycle.

[263] Met Office (2022) *Past weather events* [online]. Available at: Past weather events - Met Office (last accessed September 2024).

[264] Met Office (2022). *UK Climate Extremes* [online]. Available at: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-extremes (last accessed September 2024).

[265] IEMA (2020) IEMA EIA Guide to: Climate Change Resilience and Adaptation (2020). Available from: IEMA - IEMA EIA Guide to: Climate Change Resilience and Adaptation (2020). [Accessed: September 2024].

(RCP) 8.5 (equivalent to a high emission scenario) from a baseline of 1981-2000. The 50th percentile will be selected representing an 'as likely as not' probability of change[266]. The 10th and 90th percentiles are also presented as these represent a wider range of probabilities. Probabilistic projections will be used to obtain temperature and precipitation projection data using a 25km^2 grid cell in the UKCP18 projections (337500, 362500) which covers the Scheme location. The data presented includes annual values as well as values for summer (June, July, August) and winter months (December, January, February).

15.5.14 DMRB LA 114[267] recommends the use of H++ scenarios used in UKCP09 which typically include projections in the 10th to 90th percentile range. However, as recommended by the IEMA Guide to Climate Resilience and Adaptation (2020)[268], use of UKCP18 is preferred as this supersedes UKCP09, offering the best available information on UK climate projections while also providing projections in the 10th to 90th percentile range.

15.5.15 Given the Scheme is located within the tidal extent of the River Dee, sea level rise projections will be obtained from UKCP18 marine projections against a 1981-2000 baseline for the grid square closest to the Scheme location (latitude(N): 53.39, longitude(E): -3.25) at the estuary of the River Dee. The RCP8.5 scenario and the 70th and 95th percentile will be used to ensure alignment with the Welsh Government's guidance on Sea Level allowances[269].

15.5.16 Given the 120 year design life of the Scheme, and using the approach described above, the following climate change scenarios for given time periods will be chosen for this assessment:

- UKCP18 probabilistic projections, 1981-2000 baseline, RCP8.5, 10th, 50th and 90th percentile, 2040-2059 (2050s) and 2080-2099 (2090s)
- UKCP18 probabilistic extreme projections, RCP8.5, 10th, 50th and 90th percentile, 1 in 20, 1 in 50 and 1 in 100-year return periods, 2055 and 2095

15.5.17 UKCP18 Probabilistic Marine projections, 1981-2000 baseline, RCP8.5, 70th and 95th percentile, 2050 and 2100

15.5.18 The data is presented and summarised in the following sections.

Air Temperature

15.5.19 Air temperature projections are presented in Table 15-3Table 15-13 and Table 15-4Table 15-1415-14, which suggest that temperatures will increase throughout the year. In the 2050s at the 50th percentile, maximum temperatures in the summer are projected to increase by 2.2 °C and minimum temperatures in the winter projected to increase by 1.5 °C. In comparison un the 2090s at the 50th percentile, maximum temperatures in the summer are projected to increase by 5.5 °C and minimum temperatures in the winter are projected to increase by 3.4 °C. This will result in warming winters and hotter summers. Extreme maximum temperatures (Table 15-15Table 15-15Table 15-15) are also projected to increase with extreme temperatures of up

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[266] The 50th percentile is the median line in a probability bell curve of assembled climate model projection data, and as such represents the point at which it is as likely that climate outcomes will lie one side of this median line as the other side, hence the term 'as likely as not'.

[267] Standards for Highways (2021). *Design Manual for Roads and Bridges – Sustainability and Environment LA 114 (Climate)* [online] available at: https://www.standardsforhighways.co.uk/dmrb/search/d1ec82f3-834b-4d5f-89c6-d7d7d299dce0 (last accessed September 2024).

[268] IEMA (2020) *IEMA EIA Guide to: Climate Change Resilience and Adaptation (2020)* [online]. Available at: IEMA - IEMA EIA Guide to: Climate Change Resilience and Adaptation (2020). (last accessed: September 2024).

[269] Welsh Government (2022). *Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk*. [online]. Available at: https://www.gov.wales/sites/default/files/publications/2022-11/guidance-for-flood-and-coastal-erosion-risk-management-authorities-in-wales_0.pdf (last accessed September 2024)

to 40.2 °C (1 in 100-year event) in 2095 at the 50th percentile. This is likely to increase the severity of summer heatwave events in the future.

Table 15-13: Temperature projections for the Scheme location (UKCP18 Probabilistic Projections, 1981-2000 baseline, RCP8.5, 2040-2059

Climate Variable		Climate Projections			
		1981-2000 Baseline	10th Percentile	50th Percentile	90th Percentile
Mean Air Temperature	Annual	10.0 °C	+0.8 °C	+1.6 °C	+2.5 °C
	Summer	15.5 °C	+0.7 °C	+2 °C	+3.3 °C
	Winter	4.6 °C	+0.4 °C	+1.4 °C	+2.6 °C
Maximum Air Temperature	Annual	13.9 °C	+0.8 °C	+1.7 °C	+2.7 °C
	Summer	19.9 °C	+0.6 °C	+2.2 °C	+3.8 °C
	Winter	7.6 °C	+0.4 °C	+1.4 °C	+2.5 °C
Minimum Air Temperature	Annual	6.2 °C	+0.7 °C	+1.6 °C	+2.5 °C
	Summer	11 °C	+0.8 °C	+1.8 °C	+2.9 °C
	Winter	1.6 °C	+0.4 °C	+1.5 °C	+2.8 °C

Table 15-14: Temperature projections for the Scheme location (UKCP18 Probabilistic Projections, 1981-2000 baseline, RCP8.5, 2080-2099)

Climate Variable		Climate Projections			
		1981-2000 Baseline	10th Percentile	50th Percentile	90th Percentile
Mean Air Temperature	Annual	10.0 °C	+2.2 °C	+3.9 °C	+5.6 °C
	Summer	15.5 °C	+2.3 °C	+5 °C	+7.6 °C
	Winter	4.6 °C	+1.2 °C	+3.2 °C	+5.3 °C
Mean Maximum Air Temperature	Annual	13.9 °C	+2.2 °C	+4.0 °C	+5.9 °C
	Summer	19.9 °C	+2.3 °C	+5.5 °C	+8.8 °C
	Winter	7.6 °C	+1.2 °C	+3.2 °C	+5.2 °C
Mean Minimum Air Temperature	Annual	6.2 °C	+2.1 °C	+3.8 °C	+5.7 °C
	Summer	11 °C	+2.2 °C	+4.6 °C	+7 °C
	Winter	1.6 °C	+1.2 °C	+3.4 °C	+5.8 °C

Table 15-15: Extreme temperature projections for the Scheme location (UKCP Probabilistic Extreme Projections, RCP8.5, 10th, 50th and 90th percentile, 1 in 20, 1 in 50 and 1 in 100-year return period[270], 2055 and 2095)

Climate Variable		Climate Projections			
		Return period	10th Percentile	50th Percentile	90th Percentile
Maximum Extreme Air Temperature (2055)	Summer	1 in 20 year	32.8 °C	35.3 °C	38.3 °C
		1 in 50 year	33.5 °C	36.2 °C	39.3 °C
		1 in 100 year	33.9 °C	36.7 °C	40.1 °C
	Winter	1 in 20 year	16.8 °C	17.7 °C	18.7 °C
		1 in 50 year	17.3 °C	18.4 °C	19.7 °C
		1 in 100 year	17.6 °C	18.9 °C	20.5 °C
Maximum Extreme Air Temperature (2095)	Summer	1 in 20 year	33.5 °C	38.6 °C	44.5 °C
		1 in 50 year	34.1 °C	39.6 °C	45.8 °C
		1 in 100 year	34.5 °C	40.2 °C	46.6 °C
	Winter	1 in 20 year	18 °C	19.5 °C	21.4 °C
		1 in 50 year	18.5 °C	20.3 °C	22.5 °C
		1 in 100 year	18.9 °C	20.8 °C	23.4 °C

Precipitation and rainfall intensity

15.5.20 Precipitation projections are presented inTable 15-1615-16 Table 15-16 and Table 15-17Table 15-1715-17Table 15-1715-17, which suggest that precipitation patterns will change in the Scheme location throughout the year. In the 2090s at the 50th percentile, precipitation in the summer is projected to decrease by 36.2% but projected to increase in the winter by 12.2%. This will result in drier summers and wetter winters. Drier summers may lead to an increased frequency and severity of drought events and wetter winters may increase risk of surface water flooding and ponding.

15.5.21 Extreme precipitation events in Wales may become more frequent and intense in the future[271]. During the summer months, despite there being an overall projected decrease in precipitation, intense rainfall events may be more severe in the form of summer storms with up to a 1-day total precipitation[272] of 62.1 mm (1 in 100-year event) and 5-day total precipitation[273] of 93.6 mm (1 in 100-year event) in 2095 at the 50th percentile. During the winter months, the increase in winter precipitation may intensify rainfall events with up to a 1-day total precipitation of 44.2 mm (1 in 100-year event) and 5-day total precipitation of 79 mm (1 in 100-year event) in 2095 at the 50th percentile.

[270] Return period refers to the period over which it is likely that a particular magnitude of an event would be exceeded in any given year. A 1 in 20-year event is the probability that an event will occur once every 20 years.

[271] Committee on Climate Change (2021). *CCRA3 – Regional Summary for Wales* [online]. Available at: https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA-Evidence-Report-Wales-Summary-Final.pdf (last accessed September 2024).

[272] 1-day total precipitation is the largest precipitation total that falls within a single 24-hour day.

[273] 5-day total precipitation is the total precipitation that falls over a consecutive 5-day period.

Table 15-16: Precipitation projections for the Scheme location (UKCP18 Probabilistic Projections, 1981-2000 baseline, RCP8.5, 2040-2059 and 2080-2099)

Climate Variable		Climate Projections			
		1981-2000 Baseline	10th Percentile	50th Percentile	90th Percentile
Precipitation change (2050s)	Annual	756.7 mm	-9.4%	-1.9%	+5.6%
	Summer	6.3 mm	-37%	-14.7%	+6.8%
	Winter	5.7 mm	-3.8%	+4.7%	+13.9%
Precipitation change (2090s)	Annual	756.7 mm	-13.4%	-1.6%	+10.1%
	Summer	6.3 mm	-61.7%	-36.2%	-5.9%
	Winter	5.7 mm	-0.8%	+12.2%	+28.3%

Table 15-17: Extreme precipitation projections for the Scheme location (UKCP Probabilistic Extreme Projections, RCP8.5, 10th, 50th and 90th percentile, 1 in 20, 1 in 50 and 1 in 100-year return period, 2055 and 2095)

Climate Variable		Climate Projections			
		Return period	10th Percentile	50th Percentile	90th Percentile
1-day total precipitation (2055)	Summer	1 in 20 year	34.5 mm	41.9 mm	51.3 mm
		1 in 50 year	40.2 mm	51.5 mm	67.1 mm
		1 in 100 year	44 mm	59.3 mm	82 mm
	Winter	1 in 20 year	26.4 mm	30.4 mm	35.3 mm
		1 in 50 year	29.4 mm	35.1 mm	42.5 mm
		1 in 100 year	31.4 mm	38.7 mm	48.7 mm
1-day total precipitation (2095)	Summer	1 in 20 year	31.2 mm	43.8 mm	58.7 mm
		1 in 50 year	36.6 mm	53.8 mm	77.2 mm
		1 in 100 year	40.6 mm	62.1 mm	94.4 mm
	Winter	1 in 20 year	28.3 mm	34.9 mm	42.9 mm
		1 in 50 year	31.6 mm	40.2 mm	51.3 mm
		1 in 100 year	33.7 mm	44.2 mm	58.4 mm
5-day total precipitation (2055)	Summer	1 in 20 year	69.1 mm	79.7 mm	92.2 mm
		1 in 50 year	74.1 mm	86.7 mm	102.6 mm
		1 in 100 year	77 mm	91.4 mm	110.1 mm
	Winter	1 in 20 year	55.7 mm	61.4 mm	69.8 mm
		1 in 50 year	59.5 mm	67.4 mm	79.5 mm
		1 in 100 year	61.9 mm	72 mm	87.6 mm
	Summer	1 in 20 year	60 mm	81.2 mm	105.9 mm

Climate Variable		Climate Projections			
		Return period	**10th Percentile**	**50th Percentile**	**90th Percentile**
5-day total precipitation (2095)		1 in 50 year	65.2 mm	89 mm	118 mm
		1 in 100 year	68.2 mm	93.6 mm	127 mm
	Winter	1 in 20 year	57.7 mm	68.2 mm	82.6 mm
		1 in 50 year	61.3 mm	74.6 mm	93.9 mm
		1 in 100 year	63.7 mm	79 mm	103.3 mm

15.5.22 The Welsh Government published updated guidance in December 2021[274] recommending climate change allowances to incorporate within a developments design to manage flood risk and improve resilience. Climate change allowances for rainfall intensity in the 2020s, 2050s and 2080s for Wales, in comparison to a 1961-1990 baseline, are reproduced in Table 15-8.

Table 15-18: Change to extreme rainfall intensity (compared to a 1961-90 baseline)

Applies across all of Wales	Total potential change anticipated for 2020s (2015-2039)	Total potential change anticipated for 2050s (2040-2069)	Total potential change anticipated for 2080s (2070- 2115)
Upper estimate	10%	20%	40%
Central estimate	5%	10%	20%

15.5.23 The Welsh Government also produced the following recommended peak rainfall climate change allowances to incorporate within a developments design for the River Dee for the 2020, 2050s and 2080s against a 1961-1990 baseline as shown in Table 15-19.

Table 15-19: Peak river flow allowances for the River Dee (compared to a 1961-90 baseline)

Applies across all of Wales	Total potential change anticipated for 2020s (2015-2039)	Total potential change anticipated for 2050s (2040-2069)	Total potential change anticipated for 2080s (2070- 2115)
Upper estimate	20%	30%	45%
Central estimate	10%	15%	20%
Central estimate	5%	5%	5%

Sea level rise

15.5.24 Sea level rise projections are presented in Table 15-20 which suggest that sea level is projected to increase throughout the Scheme's design life of up to an additional 1.04 m by 2100 at the 90th percentile. Given that the bridge receptors of the Scheme are located within the tidal reach of the River Dee, sea level rise may have an effect on the Scheme.

[274] Welsh Government (2021). *Climate change allowances and flood consequence assessments* [online]. Available at: https://gov.wales/climate-change-allowances-and-flood-consequence-assessments (last accessed September 2024).

Table 15-20: Marine projections (UKCP18 Probabilistic Projections, 1981-2000 baseline, RCP8.5, 70th and 95th percentile, 2050 and 2100

		Marine Projections	
Variable		**70th Percentile**	**90th Percentile**
Mean sea level rise	2050	0.27m	0.35m
	2100	0.77m	1.04m

Lightning and storms

15.5.25 While research into climate change impacts on lightning is uncertain, studies have been undertaken which show evidence of an increase in the frequency of lightning strikes by 12% with each 1 °C average annual increase in air temperature[275].

15.5.26 Studies to understand climate change impacts on the frequency of storms, particularly those related to storms, are also uncertain. However, studies have shown that increases in atmospheric carbon dioxide (CO_2) concentrations show a significant association with global increases in the frequency of intense flood and storm events[276].

15.6 Potential and likely significant effects

Effects on climate

15.6.1 For both construction and operational effects on climate, it is unlikely that the scheme will result in GHG emissions that would be defined as significant considering the GHG emissions from the scheme are unlikely to have a material impact on the Welsh or UK Government achieving their carbon targets. That said, in line with the UK government's Carbon Reduction Plan, the scheme will seek to reduce GHG emissions as far as practicable to contribute to the UK's net reduction in GHG emissions and maximise the potential for reducing GHG emissions. Assessing the level of GHG emissions from each source associated with the scheme is key in assisting and focusing the reduction effort. As such the construction and operation is scoped in to include the sources as noted in Table 15-23 and Table 15-24.

Vulnerability of the Scheme to climate change

Construction

15.6.2 The climate of the study area has already changed from its natural state, as a result of climate change and will change significantly over the lifetime of the project. Whilst the scheme's construction (planned to commence 2027) is not expected to be so far in the future that the climate will adversely change further prior to construction, climate change is expected to impact construction. UKCP18 predicts a 50% likelihood of a 0.8 degree rise in annual temperature from 2010-2029 it has been deemed large enough to potentially impact construction and scoped in for further assessment.

15.6.3 Furthermore, if construction coincides with extreme weather event(s) such as drought or storms there may potentially be further construction impacts.

[275] Romps, D.M., Seeley, J.T., Vollaro, D. and Molinari, J. (2014). *Projected increase in lightning strikes in the United States due to global warming. Science. 346(6211), pp.851–854* [online]. Available at: https://science.sciencemag.org/content/346/6211/851 (last accessed September 2024).

[276] Lopez, R.E., Thomas, V. and Troncoso, P.A. (2020). *Impacts of Carbon Dioxide Emissions on Global Intense Hydrometeorological Disasters. Climate, Disaster and Development Journal. 4(1), pp.30-50* [online]. Available at: https://doi.org/10.18783/cddj.v004.i01.a03 (last accessed September 2024).

15.6.4 Climate events and the anticipated impacts associated with each against the scheme during construction are presented in Table 15-21 below.

Table 15-21: Climate events and the anticipated impacts

Climate Event	Impact
Increased winter precipitation	Damage to construction site and equipment through loss of stability in ground surface. Risk of flooding
Changes in the future precipitation regime (varying from drought conditions to heavy rainfall)	Increasing the risk to earthworks stability Risk of flooding
Increase yearly average temperature	Safer driving conditions in winter if less frost and ice
Increased summer temperature	Damage to plant and machinery in adversely hot temperatures Risk to workforce in extreme heat
Extreme weather events	Damage to plant and machinery in adversely hot temperatures, flooding and high winds Risk to workforce in extreme heat/flooding

Operation

15.6.5 The climate of the study area has already changed from its natural state, as a result of climate change and will change considerably over the lifetime of the project, as such the operational assessment will be scoped in. This assessment will consider the climate projections provided in Section 15.5 over the lifetime of the scheme and identified the following risks in Table 15-22 below.

15.6.6 The potential effects of climate change during operation on the Scheme receptors identified in Table 15-15 will be assessed. The effects will be assigned a significance rating based on the measure of consequence and likelihood of climate events occurring following the consideration of embedded mitigation measures.

Table 15-22: Identified climate risks

Climate Event	Impact
Increased winter precipitation	• Increasing sub-surface moisture and inducing premature pavement failure • Increasing standing water, the build-up of particulates on road surfaces, and flood risk • Increase safety risk for active travel users e.g. cyclists • Increase in occurrence of pot holes (by weakening the soil beneath the carriageway) increasing maintenance requirements and associated traffic disruption
Changes in the future precipitation regime (varying from drought conditions to heavy rainfall)	• Causing pavements to heave. • Increasing the risk to earthworks stability.
Increase yearly average temperature	• Reduced freeze thaw erosion which could damage • underground assets, in turn reducing maintenance requirements and associated traffic disruption.

Climate Event	Impact
	• Safer driving conditions in winter if less frost and ice.
Increased summer temperature	• Greater risk of joint, bearing or surface failure • Accelerating the weathering of road markings • Increased temperatures which may be greater than the rated equipment tolerance and lead to equipment failure • Increased likelihood of disease, and changing precipitation patterns including greater frequency of drought • May cause soil instability (intensify and extend soil moisture deficits and impact groundwater levels and earth pressures) increasing maintenance requirements and associated traffic disruption. • May be an inability to perform maintenance activities during periods of high temperatures, particularly during summer months. • Greater risk of soils drying out and increasing erosion. This causes sedimentation within the schemes drainage infrastructure that reduces its drainage capacity and so increases the risk of flooding which causes traffic disruption. Additional maintenance work to prevent flooding may also cause traffic disruption
Extreme weather events	• Impact to signs from high winds • Safety concerns associated with extreme weather which may result in reduced likelihood of maintenance • Impacts on electrical equipment include more regular lightning strikes and extreme hot temperatures causing thermal over loading of circuits. Repair and maintenance cause traffic disruption
Longer vegetation growing season	• Leading to increased need for maintenance (due to warmer winters and wetter summers)

15.7 Mitigation and enhancements

Effects on climate

15.7.1 The development of the scheme design shall be an iterative process undertaken as part of an integrated design team to adhere to the principles of the design and mitigation hierarchy outlined in DMRB LA 104. The first principle being to avoid adverse effects if at all possible, before seeking to minimise or mitigate for any unavoidable impacts through a well-developed mitigation strategy.

15.7.2 The effective assessment and management of impacts on climate will offer the opportunity to reduce the impact of projects on climate by minimising the magnitude of GHG emissions as far as possible. The project will work with the 80:20 rule in mind where targeted interventions into the largest 20% of causes can impact a large proportion (80%) of the scheme.

15.7.3 The carbon reduction principles as defined within PAS 2080:2023 will be applied to the design and the construction approach for the scheme. Considering the principles of PAS 2080:2023 a Carbon Management Plan (CMP) has been produced to integrate carbon management within the project. This will be a live document which will be updated as the scheme progresses through the design. This ensures the consideration of carbon reduction through all phases of the scheme. It outlines the process to be followed to reduce carbon, the methodology for the carbon assessment, and will be updated with progress made through the design. The following high-level approach to mitigation (as defined within PAS 2080:2023) will be applied and developed, with a particular focus on the hotspots identified through the carbon assessment:

- Avoid: align the outcomes of the project and/or programme of work with the net zero transition at the system level and evaluate the basic need at the asset and/or network level.
- Switch: assess alternative solutions and then adopt one that reduces whole life emissions through alternative scope, design approach, materials, technologies for operational carbon reduction, among others, while satisfying the whole life performance requirements.
- Improve: identify and adopt solutions and techniques that improve the use of resources and design life of an asset/network, including applying circular economy principles to assess materials/products in terms of their potential for reuse or recycling after end of life.

15.7.4 The carbon team will consistently engage with designers via meetings to ensure the best practice for carbon reduction and carbon integration within the construction of the project is going ahead. This will include the facilitation of Design for Resource Efficiency workshops (D4RE). D4RE demonstrates the importance of design decisions in reducing the generation of waste and use of resources on projects as well as associated costs. These can be reduced significantly using established and innovative techniques and through collaboration with clients, contractors and technical specialists as an integrated project team. D4RE involves idea generation on the primary theme of the Scheme's resource efficiency. The ideas are categorised by impact and ease of implementation. These ideas are then prioritised for further investigation and potential incorporation into the project. An initial D4RE workshop has already taken place collaborating carbon and principal designers, to produce a range of design optimisation suggestions documented and recorded within the CMP. The session included an introduction to the principles of PAS 2080:2023 and an explanation of the CMP.

15.7.5 Indicative targets have also already been established within the CMP, which align with NH and the Welsh Governments relevant transport carbon targets. The target is for construction to work towards a 35% reduction between the initial baseline of the project, set from the preliminary design carbon assessment, and the constructed scheme.

Vulnerability of the Scheme to climate change

15.7.6 Any risks arising due to extreme weather events through construction will be addressed by measures in the Construction Environmental Management Plan (CEMP). Such measures may include:

- Workforce health and safety plans and welfare management systems to be put in place by the contractor, including details to be outlined within works plans and task briefs as appropriate. This should consider periods of high temperatures that may lead to risks of heatstroke for construction staff and severe storm events that may lead to slips, falls and risk from flying debris;
- Contingency plans for situations where flooding leads to restricted site access or key staff being unable to get to work, leading to delays in the construction programme;
- Contingency plans for situations where storms, high winds or flooding lead to loss of mains power supply or communications, and the identification of safety critical risks and construction programme consequences; and Include regular monitoring of storm alerts and weather warnings from the Met Office and Natural Resources Wales.

15.7.7 At this stage the mitigation required for Vulnerability of the scheme to Climate Change has not been defined, however as the design progresses and the assessment is undertaken the relevant mitigation will be determined. The key to reducing the vulnerability of the scheme to climate change is to design in line with the future climate projection, as with the Effects on Climate mitigation, engagement with the design team will be undertaken to integrate resilience into the design. As such there will likely be embedded mitigation due to consideration of climate change allowances within the relevant design standards, including for flood risk and drainage. Examples of potential embedded mitigation include:

- Climate change allowances will be incorporated into the design of drainage infrastructure, flood compensation areas and river crossings / modifications.
- The use of polymer modified bitumen in surface course of pavements and heavy-duty macadam in the binder and base course to improve resilience to rutting in hot weather.
- Embankments to be designed from slope-stability analysis using site specific soil. parameters, and compacted and constructed in line with best practice to avoid unexpected ground movements (for example linked to long term changes in ground water levels).
- Sediment traps to prevent silt build up blocking drainage infrastructure.
- Protection of electrical equipment from lightning strikes using Surge Protection Devices.
- New safety infrastructure (technology) to mitigate possible future increases in exposure to dangerous driving conditions, for example more regular heavy rainfall events.

15.7.8 Recommended mitigation measures for consideration to further enhance resilience of the Scheme include:

- Implementation of Hazardous Weather Management Plans, which should include but not be limited to the following climate change risks:
  - Storms and extreme events: weather trigger levels (such as amber and red storm warnings) and the response of the local area to extreme events. Should include plans for safe access routes for motorised and non-motorised users.
  - High temperatures: trigger levels to be set, including temperature thresholds and duration of heatwave events, and assessment of the risk to motorised and non-motorised users.
  - Heavy rainfall / flooding: trigger levels of rainfall and response to rainfall events, including management of known areas of surface water ponding and identification of drainage issues.
  - Low temperatures / snow / ice: trigger levels and response to these events.

15.8 Assumptions and limitations

Effects on climate change

15.8.1 The construction assessment will be based on the available information provided by the design team. However, assumptions will be necessary to ensure the aspects can be assessed. Assumptions may include selection of the closest matching emission factor, assumptions on dimensions and on material type. A list of the key assumptions will be detailed within the assessment results.

15.8.2 Travel distances for the transport of materials (lifecycle stage A4) will be assumed to be sourced from the distances from the construction site in line with RICS methodology. Travel distances will be updated once the procurement of materials is known.

15.8.3 The operational assessment will be based upon outputs from the WelTAG assessment. The assumptions and limitations of this approach will be detailed within the relevant report.

15.8.4 The assessment of land use change will be based upon the level of information available at the time on proposed land use changes.

15.8.5 Emissions associated with the end of the life stage (lifecycle stages C1-4), known as decommissioning, will not be considered given the uncertainty of the length of operation of the Scheme.

Resilience of the Scheme to climate change

15.8.6 Information on the climate baseline and future projections are based on freely available information from third parties, including the historical meteorological variables recorded by the Met Office and the UK Climate Projections (UKCP18) developed by the Met Office.

15.8.7 Climate projections are not predictions or forecasts but simulations of potential scenarios of future climate, under a range of hypothetical GHG emissions scenarios and assumptions. Therefore, the results from running the climate models cannot be treated as exact or factual, but projection options. They represent internally consistent representations of how the climate may evolve in response to a range of potential forcing scenarios, and their reliability varies between climate variables. Scenarios exclude outlying surprise or disaster scenarios in the literature, and any scenario necessarily includes subjective elements and is open to various interpretations. Generally, global projections are more certain than regional, and temperature projections are more certain than those for precipitation. Furthermore, the degree of uncertainty associated with all climate change projections increases for projections further into the future.

15.8.8 Accordingly, any further research, analysis or decision-making should take account of the nature of the data sources and climate projections, and should consider the range of literature, additional observational data, evidence, and research available, and any recent developments in these.

15.9 Conclusions of Scoping

15.9.1 The conclusion for the assessment of Climate is to scope in construction and operation for both Effects on Climate and Vulnerability of the Scheme to Climate Change. The lifecycle stages to be scoped into the Effects of Climate are noted in Table 15-3 and Table 15-23. Whilst key receptors identified for the Vulnerability of the Scheme to Climate Change are detailed within Table 15-5. Below, Table 15-233 and Table 15-24 illustrate the proposed scope of the Schemes effects on climate, and the Schemes vulnerability to climate change.

Table 15-23: Proposed scope of the Schemes effects on climate

Stage	Scoped in	Scoped out	Justification for scoping out
Construction	Carbon life cycle stage A1-A5 emissions	n/a	n/a
Operation	Carbon life cycle stage B1-B7 emissions	B3 Repair, B5 Refurbishment and B7 Water	The B2 and B4 (Maintenance and Replacement) will be assessed, through doing so allowance for both repair and refurbishment will be considered, as such these will not be separated out but captured within the planned assessment. Water use within the operation of the scheme is likely to be de minimis and unlikely to change from the current scenario as such this is not included within the assessment.
Beyond construction and operation		Carbon life cycle stage C and D emissions	As per DMRB LA 114, the C lifecycle stage is not the focus of the assessment. In addition, emissions data for end of life (C) and beyond the systems boundary (D) will not be available to conduct a thorough assessment. There may be a potential to assess specific elements of life cycle stage C and D emissions, however, will be determined by availability of data later in the Scheme's development.

Table 15-24: Proposed scope of the Schemes vulnerability to climate change

Stage	Scoped in	Scoped out	Justification for scoping out
Construction	Impacts on construction	n/a	n/a
Operation	Impacts of changes in temperature, precipitation, sea-level rise and storm conditions.	n/a	n/a

15.10 Consultations and key stakeholders

15.10.1 For Climate there are no statutory stakeholders to engage with or seek approvals. To support developing a robust mitigation strategy for Effects on Climate engagement with Welsh Government and NWMTRA has occurred, and regular engagement will occur as the Scheme progresses.

15.10.2 In addition, engagement within the design team and other environmental disciplines will support the mitigation identification for both Effects on Climate and Vulnerability of the Scheme to Climate Change and support the assessment of Vulnerability of the Scheme to Climate Change.

16 Cumulative Effects

16.1 Introduction

16.1.1 Cumulative effects (CE) result from multiple actions on receptors and resources over time and are generally additive or interactive (synergistic) in nature. Cumulative impacts can also be considered as: '…*impacts resulting from incremental changes caused by other past, present or reasonably foreseeable actions together with the project*.' (European Commission 1999.)

16.1.2 The European Commission describe cumulative impacts as'…*impacts* resulting *from incremental changes caused by other past, present or reasonably foreseeable actions together with the project*.' (European Commission 1999.

16.1.3 There are two 'types' of CE's:

- *Type 1*: Arise from a **single project**: '*inter-related'* and arise from the same project and impact on receptors or receptor groups, such as local residents, users of local rights of way or services, which may be affected simultaneously or concurrently by different environmental effects.
- *Type 2:* Arise **from different projects**: the '*interactio*n' of a proposed project together with any '*other developments'* that are either proposed or are reasonably foreseeable. Cumulative effects may occur where there is the potential for overlapping impacts from the separate projects/ developments.

16.1.4 The two types of Cumulative Effects must be assessed in this ES Chapter. The CE assessment (CEA) would identify the key 'receptors' and effects which would most likely include a potential for 'significant' cumulative effects and will not necessarily include every minor effect in detail[277].

16.1.5 A CEA is completed following the conclusions reported in each of the ES topic chapters.

16.1.6 This ES chapter should identify if there are beneficial and/or adverse significant CE and the potential for relevant measures to address these.

16.2 Legislation and policy context

16.2.1 The relevant legislative and policy context for the Scheme is set out in ES Chapter 3 and is not repeated in detail in this ES Chapter.

16.2.2 The following information is of specific relevance to ES CEA Chapter matters:

Legislation

16.2.3 The EIA Directive requires an EIA to consider cumulative effects[279] as defined:

> *(e)the cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources.*

Policy

16.2.4 The relevant policy specific context for this EA chapter includes the following:

[277] Unless this is a 'significant' impact, for example, with the highest level of receptor sensitivity involved.
[279] Schedule 4 Paragraph 5 (e) of the EIA Regulations 2017

Future Wales: The National Plan 2040

16.2.5 This national plan (NDF) mentions the implications for, and the considerations for cumulative impact. The NDF reflects the highest layer or tier of the 'cumulative' development plan led approach in Wales, with Regional Strategic Development Plans and local development plans representing the second and third layers. These deliver the related planning policy objectives set out in the accompanying Planning Policy Wales (2024) and an emphasis for cumulative action to deliver planning objectives and outcomes.

16.2.6 Strategic Development Plans (SDP) will identify the locations for new development and infrastructure in Wales and arrangements progressing.

16.2.7 The scheme lies within the NDF's North Region Strategic Development Plan[281] National connectivity links, the North Wales Metro and the Ports of Mostyn and Anglesey, national growth for Wrexham and Deeside represent some of the key regional range of strategic objectives for the North Region SDP.

16.2.8 The NDF mentions cumulative impact considerations for existing and consented renewable energy schemes, with PPW referring to the cumulative impacts with other new and incremental developments.

Planning Policy Wales (2024)

16.2.9 PPW refers to the potential for cumulative impacts to arise with new and incremental developments.

Wales National Marine Plan (2019)

16.2.10 Similar to PPW's objectives as a terrestrial land use plan, the Wales Marine Plan (WMP) manages marine and coastal changes. WMP refers to the potential for cumulative impacts to arise with new and incremental developments and contains a specific policy (reference GOV_01) on 'Cumulative effects':

"Proposals should demonstrate that they have assessed potential cumulative effects and should, in order of preference:

- *avoid adverse effects; and/or*
- *minimise effects where they cannot be avoided; and/or*
- *mitigate effects where they cannot be minimised.*

If significant adverse effects cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Proposals that contribute to positive. cumulative effects are encouraged."

Local development plans

16.2.11 The relevant Local Development Plan (LDP) is the 2023 adopted Flintshire Local Development Plan and this covers the 15 year period of 2015 to 2030 and remains with an extant 7-year period (as at 2024). The LDP sets out a safeguarded route for the scheme (policy PC10.5) from the County's northerly boundary with Cheshire West and Chester Council (CWAC), through the settlements of Garden City and Queensferry and alongside the easterly edge of Shotton towards Ewloe.

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[281] At the time of writing this draft ES Scoping ES chapter, the work of the North Wales Joint Collaborative Committee https://democracy.gwynedd.llyw.cymru/ieListMeetings.aspx?CommitteeId=433 are progressing further with the corporate arrangements

16.2.12 The LDP recognises that the adjoining Local Planning Authorities (LPA's) Wrexham County Borough Council (WCBC) and CWAC both have planned strategic urban extensions, the importance of the North Wales Metro work with Transport for Wales, the Green Infrastructure Strategy, and the Framework for NE Wales, Cheshire, and the Wirral. It refers to the potential for cumulative effects to arise with certain types of development and changes including the impact on sites of biodiversity and geodiversity importance. Of direct relevance to the Scheme is policy EN4; Landscape Character: '*New development, either individually or cumulatively, must not have a significant adverse impact on the character and appearance of the landscape. Landscaping and other mitigation measures should seek to reduce landscape impact and where possible bring about enhancement'*.

Supplementary Planning Guidance (SPG)

16.2.13 These provide detailed planning guidance on specific topics set out in adopted LDP's and form part of planning applications submissions and assessments. Flintshire LPA includes SPG No 21' Environmental Impact Assessments', with limited CEA information.

Neighbouring local authority development plans - Wrexham County Borough Council and Cheshire West and Chester Council

16.2.14 Wrexham County Borough Council's (WCBC) northerly boundary is approximately 8 km southeast of the proposed Scheme route. WCBC progressed towards their LDP adoption in December 2023 but is currently awaiting the subject of a Court of Appeal judgement, for the 15th of October 2024. The nearest WCBC settlements as defined are represented by Llay and Burton.

16.2.15 Cheshire West and Chester Council's (CWAC) adopted local plan includes two parts: Strategic Policies adopted 2015 and land allocations and detailed policies, adopted in 2019. The outcome of a 2020 review concluded no changes required to the plan. The nearest CWAC settlements to the proposed scheme route are Shotwick, approximately 2.7km to the north and Saughall approximately 2.7 km to the northeast.

16.3 Relevant guidance

16.3.1 Currently, the established consensus and acceptance is that there is no standardised approach to assessing EIA '*cumulative effects.'*

16.3.2 At the time of drafting this Scoping Opinion, the CEA approach draws on the following guidelines:

- *Guidelines for the Assessment of Indirect and Cumulative Impacts as well as impact Interactions'*. European Communities 1999. EC DG XI Environment, Nuclear Safety & Civil Protection NE80328/D1/3.
- Environmental impact assessment handbook '*A practical guide for planners, developers and communities*.' Second edition. 2009.
- Design Manual for Roads and Bridges (DMRB). Document LA 104 Environmental assessment and monitoring. Paragraphs 3.19- 3.23. August 2020.283 This highlights that the 'assessment of cumulative effects shall adhere to the requirements of LA 104 (Ref 3.N) Environmental assessment and monitoring. A definition of 'Cumulative effects' is included as are several requirements for CEA's:

283 Paragraphs 3.13.2, 3.19- 3.23. www.standardsforhighways.co.uk *on 21-Aug-2024, LA 104, published: 27-Aug-2020 LA 104 Revision*

  - Defining the study area for CEA's: 'the spatial boundary of the receptor/resource with potential to be affected directly or indirectly should be defined'
  - Cumulative effects should be assessed when the conclusions of individual environmental factor assessments have been reached and reported.
  - The assessment of cumulative effects should report on:
    - roads projects which have been confirmed for delivery over a similar timeframe;
    - other development projects with valid planning permissions or consent orders, and for which EIA is a requirement; and
    - proposals in adopted development plans with a clear identified programme for delivery.
  - The assessment of cumulative effects shall:
    - establish the zone of influence of the project together with other projects;
    - establish a list of projects which have the potential to result in cumulative impacts; and
    - obtain further information and detail on the list of identified projects to support further assessment
- Several advisory notes are also included:
  - NOTE 1 The assessment of cumulative impacts can be established through a desk study and mapping exercise, together with a review of planning/development applications and development plans.
  - NOTE 2 There are no defined limits or criteria for selecting the list of projects for cumulative assessment. Professional judgement using Annex III of the EIA Directive 2014/52/EU [Ref 1.N] can be applied and justification provided for developments selected (and excluded).
  - NOTE 3 The temporal and spatial scope, together with characteristics of the identified projects, are key considerations in identifying projects that require further assessment.
  - NOTE 4 The Overseeing Organisation and/or authorities likely to be concerned by a project can provide relevant advice on the scope of the assessment of cumulative effects.
- Planning Inspectorate Advice Notes[284], specifically:
  - *Advice Note 9. (2018) 'Using the Rochdale Envelope'*. This provides guidance on good practice for the assessment of cumulative effects for major infrastructure schemes, particularly for proposals which includes some uncertainty and/or the need for flexibility.
  - *Advice Note 17. 'Cumulative effects assessment relevant to nationally significant infrastructure projects'* (2019) This provides a systematic, staged approach and this include 'other development' assessments and identifies tasks and suggested template formats for documenting the CEA.
  - *Precedence cases -Planning Inspectorate and PEDW (Planning and Environment Decisions Wales) decisions*[286]*.*
- These highlight several key points:
  - The Planning Inspectorate's guidance for Nationally Significant Infrastructure Projects – Advice Note 17: Cumulative Effects Assessment sets out a staged process for assessing cumulative impacts which the Applicant should follow when preparing the list of projects for inclusion in the ES; the Applicant should ensure that relevant schemes identified are addressed in the ES using the tiered approach set out in Advice Note 17.

[284] https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/#register

[286] These include the outcomes of similar EIA CEA outcomes on proposed new road schemes in Wales, for example, the A40 Redstone Cross and the A40 LLanddewi Velfrey schemes, as well as the proposed Junctions improvements for the A55 Expressway

- There may be other types of development that could have cumulative impacts with the proposal, and it should not be assumed that the consideration of cumulative impacts can be restricted to the site.
- Effects deemed individually not significant from the assessment, could cumulatively be significant, so inclusion criteria based on the most likely significant effects from this type of development may prove helpful when identifying what other developments should be accounted for. The criteria may vary from topic to topic.
- Best practice is to include proportionate information relating to projects that are not yet consented, dependent on the level of certainty of them coming forward.
- All of the other developments considered should be documented and the reasons for inclusion or exclusion should be clearly stated. Professional judgement should be used to avoid excluding other development that is close to threshold limits but has characteristics likely to give rise to a significant effect; or could give rise to a cumulative effect by virtue of its proximity to the proposed development. Similarly, professional judgement should be applied to other development that exceeds thresholds but may not give rise to discernible effects. The process of refinement should be undertaken in consultation with consultees, where appropriate.
- The scope of the cumulative assessment should be fully explained and justified in the ES.

16.4 Assessment methodology

16.4.1 Available guidance does not define a specific CEA study area but recommends a proportionate and systematic CEA process.

16.4.2 The CEA would include the following systematic and proportionate four stage approach, as identified:

- Stage 1. Identifying the extent of 'inter- relationships' and other developments.
- Stage 2. Assessment of impacts on the relevant receptors.
- Stage 3. Sensitive receptors and identifying potential impacts.
- Stage 4. Potential effects and mitigation.

16.4.3 A summary description of each of the four methodology stages is set out below.

Stage 1. Identifying the extent of 'inter- relationships' and 'other developments'

Inter-relationships

16.4.4 The CEA process would identify the initial specialist ES study areas, followed by a more defined' *Zone of Influence'* (ZOI) for each topic.

16.4.5 identifying the relevant topic 'ZOI's' sets out the extent of assessment for potential interrelationship effects to be reviewed by each chapter specialist. For example, effects on ecological receptors arising from any combination of land take, noise/visual disturbance, air quality impacts, water quality and transport impacts will be considered within the ecology chapter.

Other developments

16.4.6 Similarly, the potential cumulative impacts with projects and 'other developments' would be assessed through a systematic approach and identified within the defined ZOI's. 'Other developments' would include projects for '*which consent has been sought or granted, as well as those already in existence*' and that these are '*reasonably foreseeable.* 'Other development' would be established through a Matrix approach to establish a final 'short list'.

Stage 2 Assessment of impacts on the relevant receptors

Inter-relationship

16.4.7 Each ES Chapter specialist would consider the inter-relationship between impacts on receptors or receptor groups. The inter-relationships would be reviewed to identify potential significant effects, mitigation, and monitoring requirements. The assessment process would follow the approach set out in Table 16-1:

Table 16-1: Identifying receptors for potential significance of cumulative effects.

Stage	Description	Outcome
1	**Which receptor**/resources are affected by the development	**Scoping out** receptors/resources not affected or where these are assessed wholly in a single EIA topic.
2	Set out **how** will the receptor/resource be affected	Review the assessment of effects section completed in the individual EIA chapter topics to **identify the receptors/resources** affected by more than one effect.
3	Evaluate the **probability** of these **effects** occurring	Review **topic specific assessments** in the EIA chapter topics to identify and present potential **inter- relationship effects on the receptor groups**
4 (See table 16-2).	Establish what **ability** the receptor/resource has to absorb further effects before changes become irreversible?	Assess how individual effects could combine to create interrelated effects on each receptor for: *Project lifetime*: i.e., during construction, operation, closure and post-closure phases *Receptor led*: i.e., multiple simultaneous effects on a single receptor.

'other developments.'

16.4.8 All chapter specialists would consider the potential for an 'in-combination effects' to arise from any or all 'other developments'.

Stage 3 Sensitive receptors and identifying potential impacts.

16.4.9 Receptors with a sensitivity to cumulative change i.e., considering the reversibility of the change or exceedance of thresholds (described in Table 16-1) would be identified. The CEA approach for assigning the 'levels of significance 'would use the descriptions set out in Table 16-2, i.e. not the same standards set out for the ES specialist topic of this scoping report.

16.4.10 The CEA chapter conclusion would focus on those designated *'moderate'* level of significance and above:

Table 16-2: Assigning 'significance'

Level of significance	Effects
Severe	Effects that the decision maker must consider because the receptor/resource is irretrievably compromised.
Major	Effects that are likely to become key to decision-making

Moderate	Effects that are unlikely to become matters that would affect project design or selection, but where, in future, the current environmental performance might need to improve
Minor	Effects that are locally significant
Not significant	Effects that are beyond the current forecasting ability or are within the ability of the resources to absorb the change.

16.4.11 ES chapter specialists will be briefed to ensure the full implications of the '*level of significance'* for a potential for cumulative effects are understood. This is so that the CEA is best placed to consider the potential for 'worst case' and 'best case' implications.

Stage 4 Potential effects and mitigation

16.4.12 ES topic specialists would examine the potential for cumulative impacts, including construction, operational and maintenance phases, and will identify relevant avoidance and mitigation measures.

16.4.13 Permanent effects would include changes to existing 'receptors' for example, nature conservation, visual landscape, and cultural assets. Other effects could include the proximity of nearby land allocated for a specific land use and/or development.

16.5 Baseline conditions

16.5.1 The CEA will include two baselines:

- For **Type 1** cumulative effects, the knowledge of the proposed scheme by reference to the assessments under each ES topic heading and defining 'zones of influence' for each topic. These will be presented with the aid of tables and maps.
- For **Type 2** cumulative effects, all relevant projects and other developments would be identified within the defined ZOI's, as agreed with the relevant Planning Authorities and consultees, and assessed. These will be presented with the aid of tables and maps.

Surveys undertaken to date

16.5.2 An initial '*desktop'* review for Type 2 CEA 'other developments' includes the following:

UK Nationally Significant Infrastructure Projects (NSIP's)[288]

16.5.3 Within the North Wales region, the following projects are identified;

Table 16-3: Nationally Significant Infrastructure Projects – North Wales Region.

	PROJECT	PROPOSED DEVELOPMENT	STAGE	CEA DETAILS
1	Connah's Quay Low Carbon Power Project.	A low-carbon combined cycle gas turbine electricity generating station of up to 1,380 megawatts net electrical output with post-combustion carbon capture; natural gas, cooling water and electricity connections; carbon dioxide connection to the HyNet CO2 Pipeline Project; above ground installations;	Pre-application. The application expected for submission to the Planning	SOS Opinion.

[288] https://infrastructure.planninginspectorate.gov.uk/ accessed 21/08/2024

		utilities; construction laydown areas; access; and other associated and ancillary development.	Inspectorate 31/12/2024.	
2	HyNet Carbon Dioxide Pipeline.	• Newbuild carbon dioxide pipeline: – Ince AGI to Stanlow AGI Pipeline - 4km section; – Stanlow AGI to Flint AGI Pipeline - 32km section and; o Flint AGI to Flint Connection Pipeline - 0.4km section; • Repurposed 24km of existing natural gas pipeline to transport carbon dioxide from the Flint Connection to the Point of Ayr Terminal, Point of Ayr; • Four AGIs- Ince, Stanlow, Northop Hall and Flint; • Six BVSs- three located along the new Stanlow AGI to Flint AGI Pipeline and three located along the existing Flint connection to Point of Ayr Terminal Pipeline; • Other above ground infrastructure, including cathodic protection transformer rectifier cabinets and pipeline marker posts; • Utility connection infrastructure, including power utilities and fibre optic cable and; Temporary ancillary works integral to the construction of the carbon dioxide pipeline, including construction compounds and temporary access tracks.	Development Consent Order made 20/03/2024.	Progression following confirmation that the project is no longer part of the Planning Inspectorate's Early Adopters Programme and trial.

16.5.4 A total of 21 projects are identified in the neighboring Northwest England region, with a range of 'development stages' and these include the following;

Table 16-4 Nationally Significant Infrastructure Projects – Northwest England.

	PROJECT	PROPOSED DEVELOPMENT	STAGE	CEA DETAILS
1	Frodsham Solar Ltd.	Solar photovoltaic array with an electrical generating capacity of over 50MW comprising solar PV modules and related mounting structures, inverters, transformers, switch gear and control equipment, a substation, and underground on and off-site cabling, as well as associated energy storage equipment.	Pre-application. The application expected for submission to the Planning Inspectorate April – June 2024.	SOS Opinion.
2	Morgan Offshore Wind Limited	Development of an offshore wind farm with an approximate capacity of 1500MW in the Irish Sea awarded as part of the Round 4 Offshore Wind Licensing Arrangements. The key components of the Morgan Generation Assets include: * Offshore wind turbines * Offshore Substation Platforms (OSPs) * Foundations (for wind turbines and OSPs) * Scour protection * Cable protection * Inter-array cables linking the individual turbines to the OSPs * Offshore interconnector cables	Pre-examination stage.	The Planning Inspectorate (letter dated 5/08/2024) highlights their approach to dealing with CEA and other projects. Appendices D and G of the letter defines the approach, and this includes specific deadlines and details.

Wales Development of National Significance Applications[290]

16.5.5 Known as '*DNS' applications, these relate* to planning applications for infrastructure projects of national importance assessed by PEDW [292].Within FCC and WCBC authorities, the current projects include:

Table 16-5 Wales 'Development of National Significance' applications.

	PROJECT	PROPOSED DEVELOPMENT	STAGE	CEA DETAILS
Flintshire				
1	Flintshire, CH4 0DF DNS/3251545	A proposed solar farm and grid connection, supporting energy	Decision stage – issued 19/12/2023	**EIA Scoping Direction issued 2020**.

[290] https://planningcasework.service.gov.wales/dnsapplications accessed 21/08/2024
[292] https://planningcasework.service.gov.wales/ accessed 21/08/2024

	Bretton Hall [1] Chester Road,	infrastructure including battery storage and associated site works incorporating partial widening of an existing access, maintenance tracks, perimeter and stock fencing, CCTV cameras and the provision of a customer cabin, outdoor classroom, and parking.		**Notes: that the CEA should clarify why the proposed 5 km radius has been limited to other solar farm development only.**
2	DNS/3279559 Shotton Paper Mill, Weighbridge Road, Deeside Industrial Park, Connah's Quay, Flintshire, CH5 2UL	Combined Heat and Power (CHP) Facility relating to redevelopment and expansion of Shotton Paper Mill. The generation capacity of the CHP Facility will be 69MWe	In Progress – Examination, with report submission estimation by the 27/01/2025.	The 2022 EIA includes a CEA. No ‘other development’ CEA projects are included and no reference to Transport projects.
3	DNS CAS - 02009-WIR127 Padeswood Works, Chester Road, Mold, Flintshire, CH7 4HB	Integrating Hanson UK's Padeswood Cement Works into the HyNet Northwest network through the capture of carbon dioxide (CO2) for transportation and subsequent storage in Eni's Liverpool Bay Storage facilities. The proposed project will capture approximately 7200,000 tonnes of CO2 per year from cement Kiln located at Padeswood. The individual components of the development can be summarised as follows: Access roadways, construction and	Researching. Deadline for submission of application: 18/04/2025.	**EIA Scoping Direction issued 2023.** Notes: • The process of refinement should be undertaken in consultation with Flintshire County Council and other consultees, where appropriate. • The assessment of the cumulative impacts should also consider the construction of the connection to HyNet AGI at Northop Hall.

		laydown compound areas, A Combined Heat and Power (CHP) plant with 12MW electricity (minimum) and 83MW thermal of installed capacity, to produce electricity and heat to power the carbon capture equipment, A post Combustion Carbon Capture and Compression (PCCC) plant, to extract CO2 from waste gases and compress it for transport and storage, An underground CO2 transport pipeline, to transport capture CO2 from Padeswood Cement Works to Northop Hall AGI (above ground installation) forming part of the HyNet CO2 pipeline approximately 10Km in length, The demolition of existing structures comprising a workshop, a block of residential garages, small office building and redundant slurry basins.		
Wrexham County Borough Council – as a neighbouring authority.				
4	DNS/3253253 Plas Power Estate, Ruthin Road, Wrexham LL11 3BS	Proposed ground mounted photo voltaic solar farm, including battery energy storage system, together with associated	Pre-application. Deadline for submission of application: 06/10/2024	**EIA Scoping Direction issued 2020 with an Addendum issued on the 17/10/2023.** Notes:

		equipment, infrastructure and ancillary works.		• The process of refinement should be undertaken in consultation with the LPA, NRW and other consultees, where appropriate. • While developments that have already been constructed will form part of the baseline, this does not mean that they should be excluded when considering cumulative effects. Paragraph 5 of Schedule 4 of the 2017 Regulations makes it clear that consideration of cumulative effects should include existing development. It will be necessary to address the cumulative impacts of the development with the extant Bronwylfa Reservoir solar scheme. • The SR states that the cumulative impact of the proposal and the A438 improvement

				work will be considered with regards to otters and GCN. Other sensitive receptors should be considered, including birds, invertebrates, bats, dormouse, hedgehog and reptiles. The worst-case scenario used in the assessment should be clearly explained, including construction works of the two projects running simultaneously.
5	DNS CAS - 03463-R2W9C2 Land within the existing Kronospan Facility, Maesgwyn Farm, Chirk, LL14 5NT	Low Carbon Combined Heat and Power (CHP) Facility	Pre-application. Deadline for submission of application: 24/06/2025	**EIA Scoping Direction issued July 2024. Notes:** • ‘There may be other types of development that could have cumulative impacts with the proposal, and it should not be assumed that the consideration of cumulative impacts can be restricted to the Kronospan site. • The process of refinement

				should be undertaken in consultation with Wrexham CBC, NRW, Cadw and other consultees, where appropriate. • NRW advise that consideration of other relevant projects may be required to ascertain whether there are possible in-combination effects, even when the Process Contribution is less than 1%. NRW refer the applicant to the Wealden judgement: [2017] EWHC 351)[2]

Welsh Government (WG) Referred and 'Called in' applications[294]

16.5.6 These include proposed new developments referred to Welsh Ministers in accordance with planning circulars and those requested or 'called in', under separate planning applications guidance. Currently, at the time of preparing this CEA Scoping Opinion the current applications for Flintshire and Wrexham include the following:

Table 16-6: Welsh Government 'Referred and called in' planning applications

	PROJECT	PROPOSED DEVELOPMENT	CASE TYPE & STAGE
Flintshire			
1	16212 Land to the north of Gwernaffield Road, Mold, Flintshire.	Erection of residential development together with associated public open space and infrastructure including a new link road between	Call in request. Under Consideration by Senior Officer.

[294] https://www.gov.wales/sites/default/files/publications/2024-08/planning-decisions-being-considered-by-the-welsh-ministers-called-in_1.pdf Accessed 21/08/2024

	Date received by WG: 15/02/2021.	Gwernaffield Road and Denbigh Road.	
Wrexham			
1	1871 Land to the north and south of Lane Farm, Rossett Road, Trevalyn, Rossett, Wrexham. WG: 10/07/2024	Outline application for residential development of 2 parcels of land (northern parcel up to 61 dwellings, southern parcel up to 71 dwellings) and extension to community parking facility.	Revocation Request S 100. Under Processing.

16.6 Potential and likely significant effects

16.6.1 Cumulative effects could arise between several receptors and several other developments. Receptors with a sensitivity to cumulative change i.e. in the consideration of their reversibility to change or exceedance of thresholds[296] would be identified.

16.6.2 The CEA, different to the standard ES approach for assigning 'levels of significance', would use the descriptions as set out in Table 16-2 above.

16.6.3 The CEA chapter conclusion would focus on those designated *'moderate'* level of significance and above[298]

16.7 Mitigation and enhancements

16.7.1 In establishing the CEA levels of significance, the CEA will consider potentially relevant mitigation measures for the Scheme. These form an important and iterative part of refining the CEA and the scheme details.

16.8 Assumptions and limitations

16.8.1 In the absence of topic- specific guidance for the assessment of cumulative effects, the methodology and criteria set out in DMRB is to be used and this includes the determination of the potential level of significance of cumulative effects, as described in Table 16-2.

16.8.2 The CEA will be based on the outcome of all the results of all four stages of the methodology and this will include a wide range of consultations and information gathering.

16.8.3 Land use planning changes, for example, the North Wales Strategic Development Plan timetable programme and the outcome of the first annual Monitoring Report on the Flintshire LDP (due October 2024) could impact on strategic planning policies and current land use. Similarly, the timetable and outcome of the current Welsh Government consultation for a New National Park Designation for Northeast Wales.

16.8.4 Scheme revisions could introduce the potential for a new CE impact. The CEA final baseline will include a final and agreed 'cut -off date' with all relevant consultees and stakeholders. This is to maintain the need for appropriate environmental 'currency' and a credible CEA conclusion.

[296] See table 16-1

[298] Colour shade red rows highlighted in table 16-2.

16.8.5 The CEA conclusion would state if any potential effects would be worse or better than the environmental effects predicted by the Scheme alone and/or in combination with other projects or other developments.

16.9 Conclusions of Scoping

16.9.1 The scale and complexity of the Scheme, the potential separate effects on more than one receptor and for other projects or other developments to impact on the Scheme cannot be discounted at this stage, but their cumulative effects could have a significant effect.

16.9.2 A cumulative effects assessment would be included as part of the ES, with ALL potential receptors SCOPED IN.

16.9.3 The Conclusions reached from this ES chapter should identify if there are beneficial and/or adverse significant CE and the potential for relevant mitigation measures to address these reflect an important and iterative part of refining the CEA and the scheme details.

16.9.4 The potential for cumulative effects also forms part of the accompanying Statement to inform Appropriate Assessment (SIAA) (of Implications for European Sites.

16.10 Consultations and key stakeholders

16.10.1 Guidance[300] advises early consultation during project scheme design and development.

16.10.2 The identification of inter-related impacts for the Scheme would include consultations between the specialist chapters and relevant organisations.

16.10.3 The identification of '*other developments*', and this includes mineral permissions, would be identified through consultations with the relevant planning authorities and other organisations and this would ensure that the following categories are identified:

a) Developments under construction.
b) submitted applications not yet determined, but which if permitted, would add cumulative effects to the project.
c) Planning applications where an EIA scoping report has been submitted and those that have been approved.
d) Development sites in the adopted Development Plans, with appropriate weight given as this moves closer towards formal adoption and/or review status/ new plans.

16.10.4 Other plans and programmes (as appropriate) which set out the framework for future development consent/approval, where such development is reasonably likely to come forward. This could include the emerging North Wales Strategic Development Plan, and the focus for metro works.

16.10.5 Data about developments would be gathered by reference to the Local Development Plans, the Local Planning Authorities and neighboring Local Planning Authorities, The Planning

---

[300] PINS note 17 states:*' Consultation Applicants are strongly advised to take advantage of pre-application consultation with the consultation bodies including the relevant local planning authority(ies) and other relevant organisations, to ensure that the shortlist of 'other existing development and/or approved development' identified for CEA is comprehensive and accurate. Applicants should ideally use completed matrices to identify and discuss issues with the consultation bodies and other relevant organisations. Ultimately this approach should also assist with identifying a robust suite of mitigation measures submitted with the application for development consent that might otherwise remain unresolved and require exploration during the examination. This process may need to be repeated during the pre-application stage and should be based on the most up to date list of developments available. The CEA should include a summary of any such consultations undertaken and evidence of any agreements reached.*

Inspectorate and, the Planning Environment Division Wales and this includes proposals under the 2024 Wales Infrastructure Act.

16.10.6 The CEA final date base will include a final and agreed ‘cut -off date’ with all relevant consultees and stakeholders.

17 Next Steps

17.1.1 This Scoping Report has set out the proposed content and coverage of the Environmental Impact Assessment (EIA) to be undertaken for the A494 River Dee Bridge Replacement Scheme. It has described the extents and nature of the Scheme and the environmental topics and associated methodologies that will be undertaken in the assessment process.

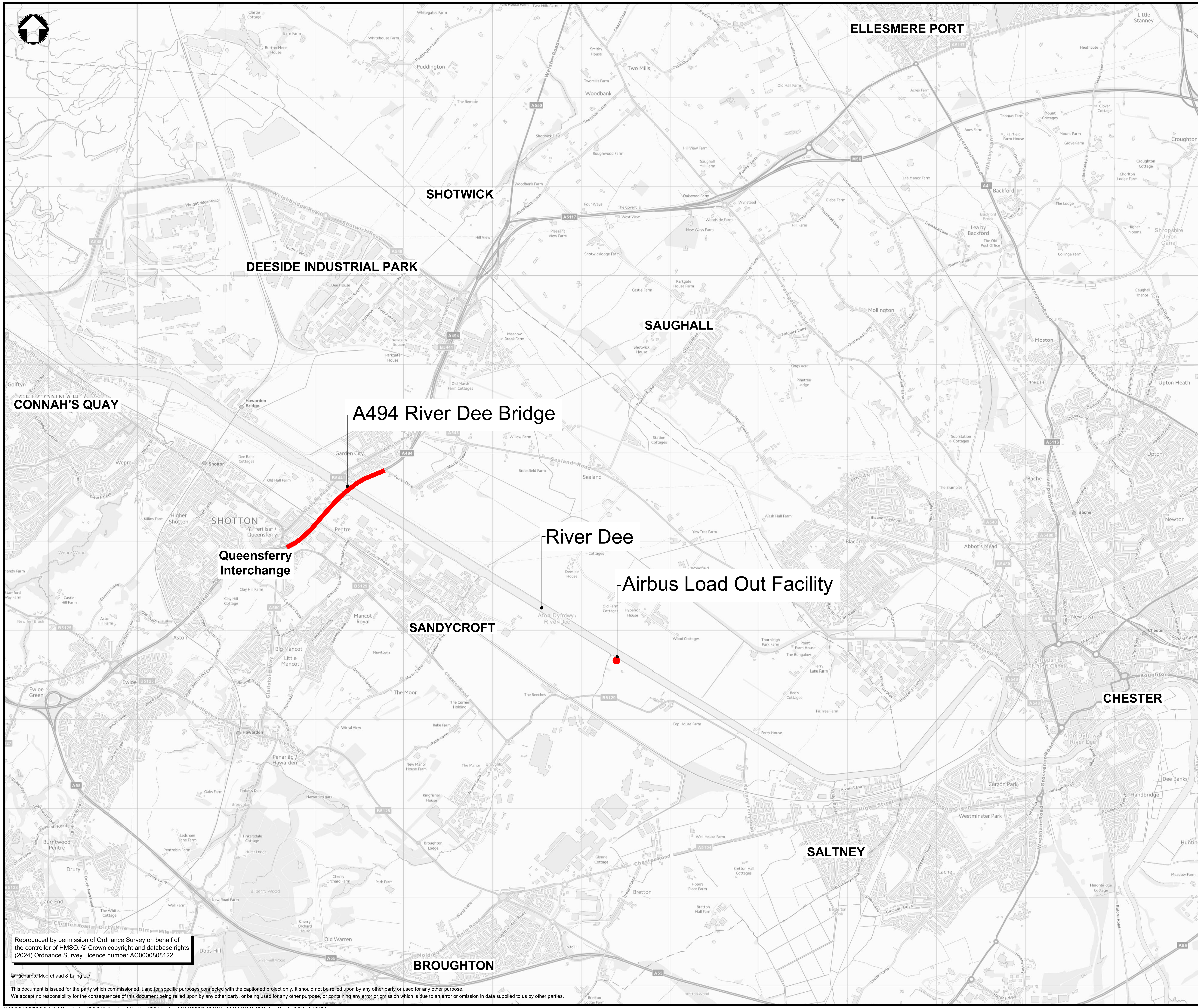
17.1.2 The next steps in the process are to consult with the statutory environmental bodies such as Natural Resources Wales (NRW) and other public bodies such as Flintshire County Council, to obtain their views on the content of the draft Scoping Report. Following receipt of those comments any amendments will be considered, and the report updated accordingly.

17.1.3 The final Scoping Report will then be submitted to Welsh Government as the Overseeing Organisation for review and approval. When approved, the formal EIA process can commence and be undertaken in accordance with the Scoping Report.

A. Figures

A.1 Chapter 1 Figures

A.1.1 Figure 1-1: Location Plan



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r.jones

Notes

1. This drawing details the current Preliminary Design at Key Stage 3 of Welsh Government's Linear Key Stage Approval Process and is subject to further detail design development in the subsequent key stages.
2. This drawing is to be read in conjunction with all other related Mott MacDonald and RML drawings and specifications.
3. Unless otherwise stated all dimensions are in metres and all levels are in metres Above Ordnance Datum (AOD).
4. Information on this drawing is based on topographical data received from PM Surveys in 2018 for the site area and OS mapping data for all other areas.

Key to symbols

- A494 River Dee Bridge Replacement
- Airbus Load Out Facility (ALOF)

Reference drawings

Rev	Date	Drawn	Description	Ch'k'd	App'd
P01	03/12/24	RJ	First issue inclusion of ALOF site	JS	RG

Status Stamp
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Asiant Cefnffyrdd Gogledd a Chanolbarth Cymru
North & Mid Wales Trunk Road Agent

Title
A494 River Dee Bridge Replacement
Figure 1.1
Site Locations

Designed	Rh Edwards	RhE	Eng check	J.Stoddard	JS
Drawn	R.Jones	RJ	Coordination	G.Morgan	GM
Dwg check	D.Hall	DH	Approved	R.Griffiths	RG

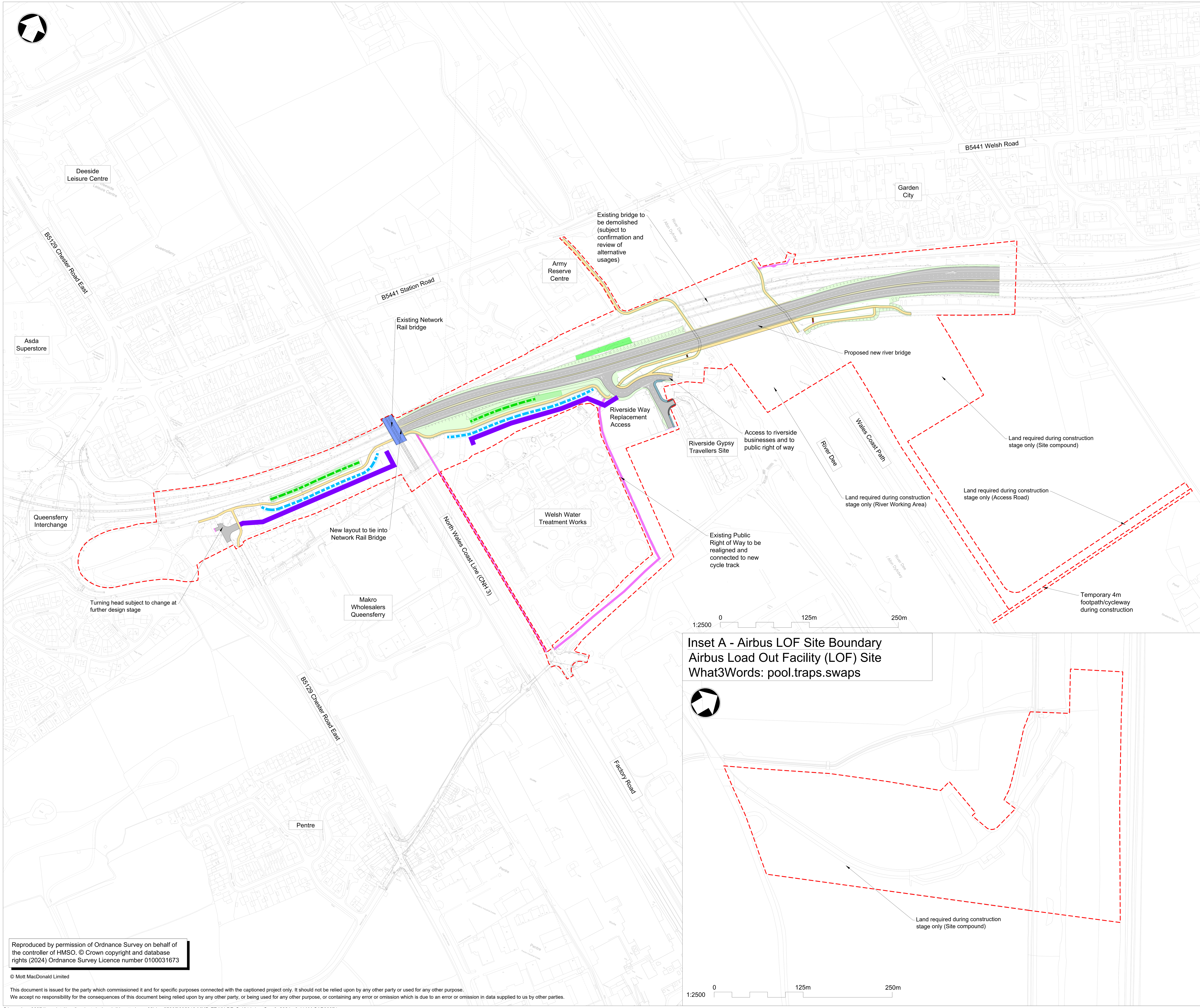
MMD Project Number	Scale at A1	Security
395318	1:20,000	STD

Suitability Description	Suit. Code
Suitable for Review & Comment	S2

Drawing Number	Revision
395318-RML-ZZ-XX-DR-Y-1001	P01

A.2 Chapter 2 Figures

Figure 2-1: General Arrangement



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Notes

1. This drawing details the current Preliminary Design at Key Stage 3 of Welsh Government's Linear Key Stage Approval Process and is subject to further detail design development in the subsequent key stages.
2. This drawing is to be read in conjunction with all other related Mott MacDonald and RML drawings and specifications.
3. Unless otherwise stated all dimensions are in metres and all levels are in metres Above Ordnance Datum (AOD).
4. Information on this drawing is based on topographical data received from PM Surveys in 2018 for the site area and OS mapping data for all other areas.
5. For further details of the proposed drainage, refer to drawing 395318-MMD-ZZ-XX-SK-D-0504.

Key to symbols

- Proposed Scheme Extents
- Existing footway to be maintained
- Shared use cycle track (for use by cyclists and pedestrians)
- Proposed carriageway
- Proposed paved verge / Central Reserve
- Top / Bottom — Earthworks slope / verge
- Proposed footpath
- Integral pedestrian path of the Trunk Road
- Proposed footway
- Rail Bridge Deck
- Proposed Swale (Assumed 1in5 side slopes)
- Proposed Open Channel (Assumed 1in3 side slopes)
- Potential area for attenuation/water treatment systems
- Maintenance Access Track (Indicative)

WORKING DRAFT
05/09/2024
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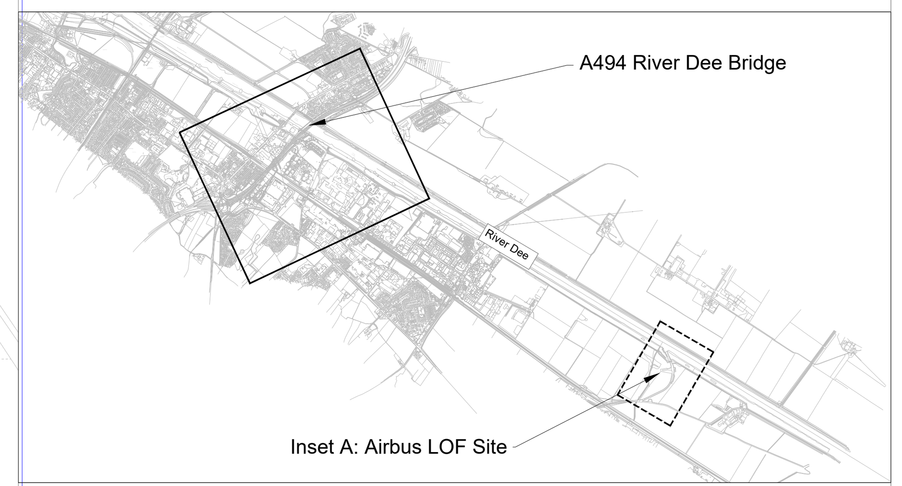
Site Location Plan



Reference Drawings

395318-MMD-ZZ-XX-DR-C-4008: Package E General Arrangement
395318-MMD-ZZ-XX-SK-D-0504: Drainage Package E

Rev	Date	Drawn	Description	Ch'k'd	App'd
P01.1	04/09/24	CC	Preliminary Issue		

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North & Mid Wales Trunk Road Agent

Title

A494 River Dee Bridge Replacement Scheme
EIA Scoping - General Arrangement Package E

Designed	C.CAPLEN	CC	Eng check	---
Drawn		---	Coordination	---
Dwg check		---	Approved	---

MMD Project Number	Scale at A1	Security
395318	1:2500	STD

Suitability Description	Suit. Code
Work In Progress	S0

Drawing Number	Revision
395318-MMD-ZZ-XX-DR-C-4014	P01.1

A.3 Chapter 6 Figures

Figure 6-1: Superficial Geology

Figure 6-2: Bedrock Geology

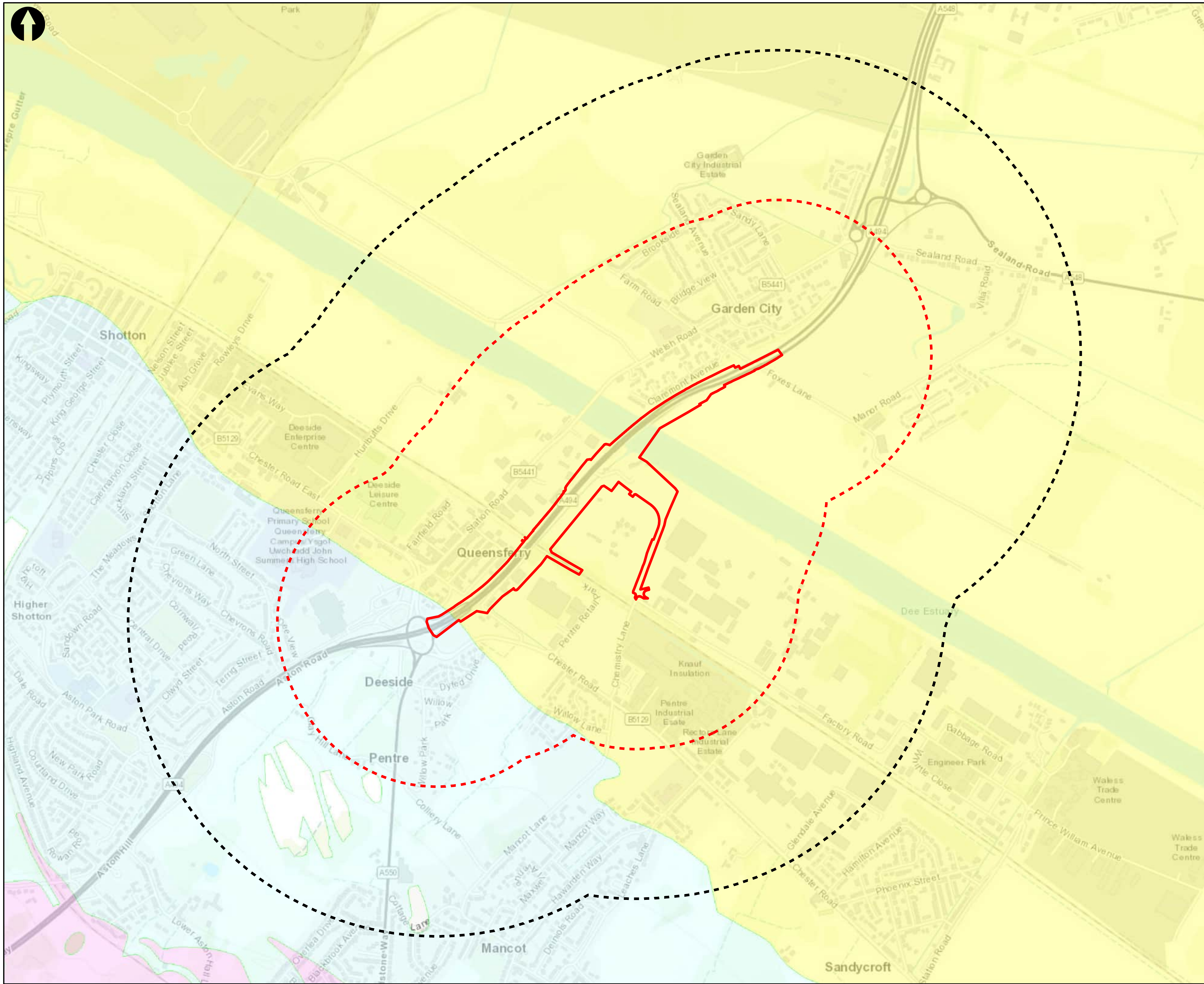
Figure 6-3: Aquifer Designations Superficial

Figure 6-4: Aquifer Designations Bedrock

Figure 6-5: Agricultural Land Classification

Figure 6-6: Potentially Contaminated Land

Figure 6-7: Stability and Mine Entries



Location Map

Key to Symbols

- 1000m buffer
- 500m buffer
- Approximate site extent
- Head - clay, silt, sand and gravel
- Glaciofluvial deposits, devensian - sand and gravel
- Till, devensian - diamicton
- Tidal flat deposits - clay, silt and sand

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Title

A494 River Dee Bridge Replacement
Superficial Geology
Figure 6.1

Designed	B Marrinan	BM	Eng Check	B Marrinan	BM
Drawn	T Ruff	TR	Coordination	B Marrinan	BM
GIS Check	M Hayward	MH	Approved	I Duncan	ID

Scale at A3	Status	Rev	Security
1:20,000	INF	P1	STD

Drawing Number
395318-MMD-ZZ-XX-DR-G-0001

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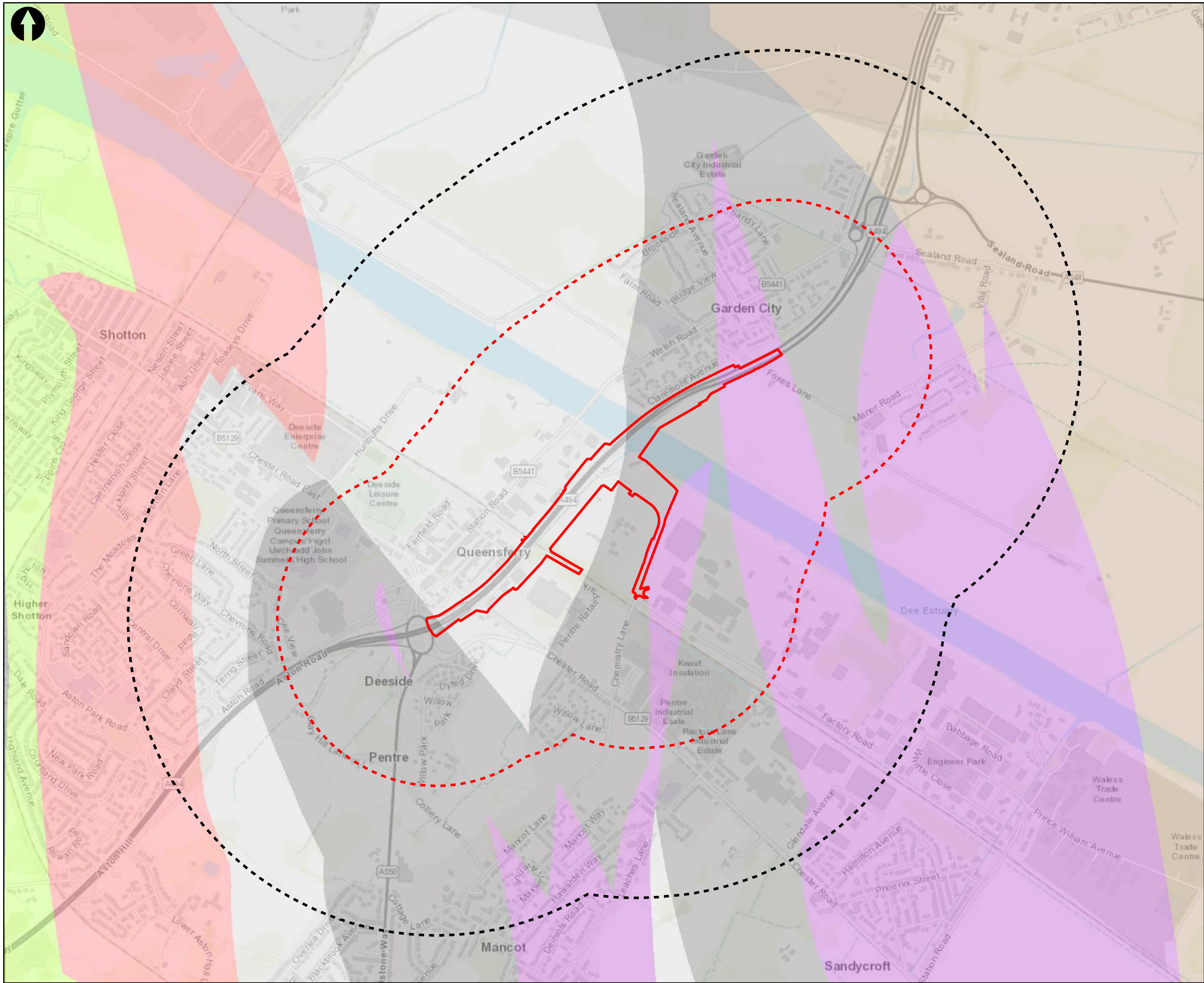

Location Map

Key to Symbols

- 1000m buffer
- 500m buffer
- Approximate site extent
- Kinnerton sandstone formation - sandstone
- Bowland shale formation - mudstone
- Etruria formation - mudstone, sandstone and conglomerate
- Pennine lower coal measures formation - mudstone, siltstone and sandstone
- Pennine middle coal measures formation - mudstone, siltstone and sandstone
- Gwespyr sandstone - sandstone and [subequal/subordinate] argillaceous rocks, interbedded

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A494 River Dee Bridge Replacement
Bedrock Geology
Figure 6.2

Designed	B Marrinan	BM	Eng Check	B Marrinan	BM
Drawn	T Ruff	TR	Coordination	B Marrinan	BM
GIS Check	M Hayward	MH	Approved	I Duncan	ID

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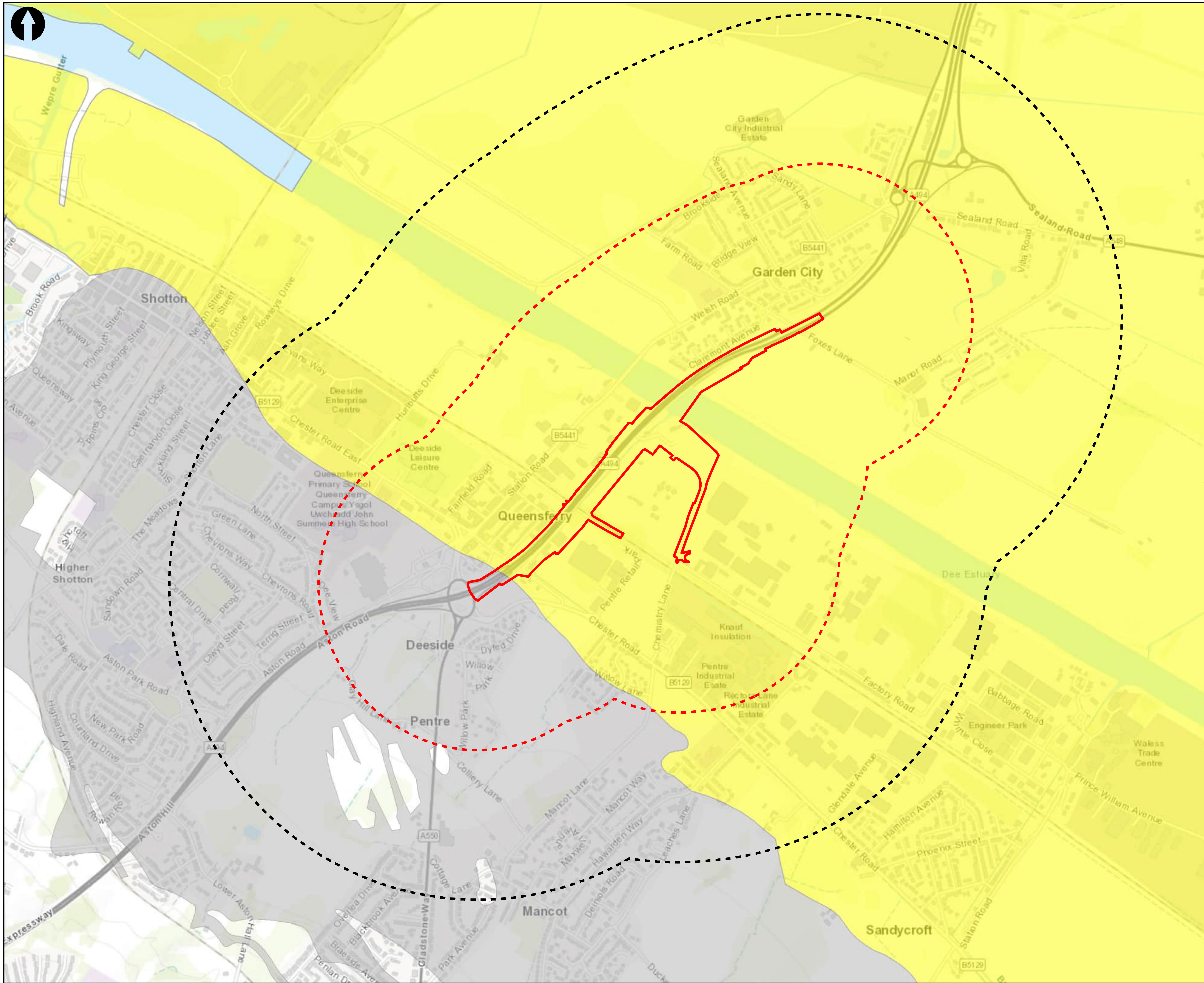

Location Map

Key to Symbols

- 1000m buffer
- 500m buffer
- Approximate site extent

Superficial aquifer designation

- Secondary (undifferentiated)
- Unproductive

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Title

A494 River Dee Bridge Replacement
Aquifer Designations Superficial
Figure 6.3

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Drawn	T Ruff	TR	Coordination	B Marrinan	BM
GIS Check	F Lastname	MH	Approved	I Duncan	ID

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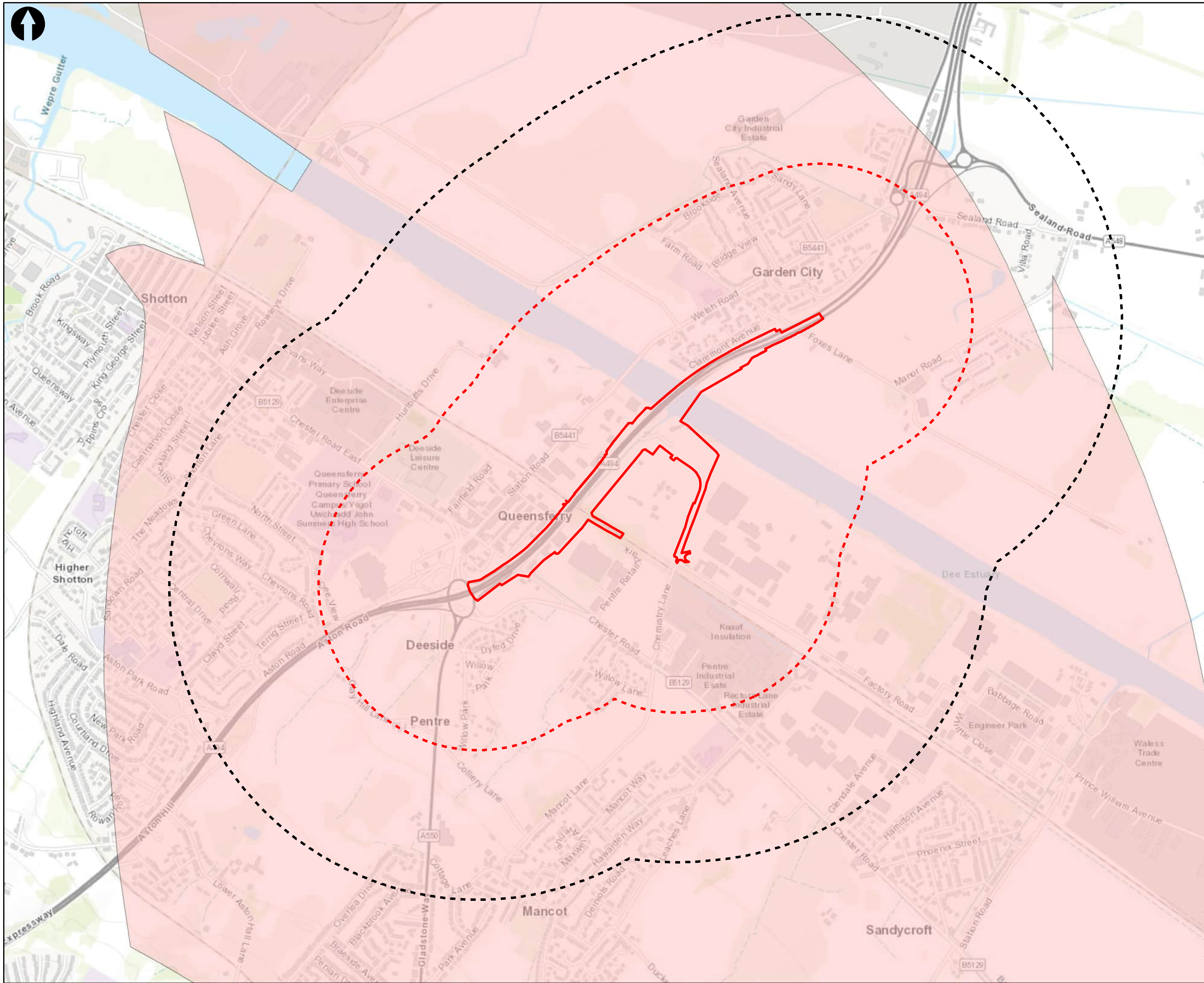

Location Map

Key to Symbols

- 1000m buffer
- 500m buffer
- Approximate site extent

Bedrock aquifer designation

- Secondary A

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A494 River Dee Bridge Replacement
Aquifer Designations Bedrock
Figure 6.4

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Drawn	T Ruff	TR	Coordination	B Marrinan	BM
GIS Check	M Hayward	MH	Approved	I Duncan	ID

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Drawing Number
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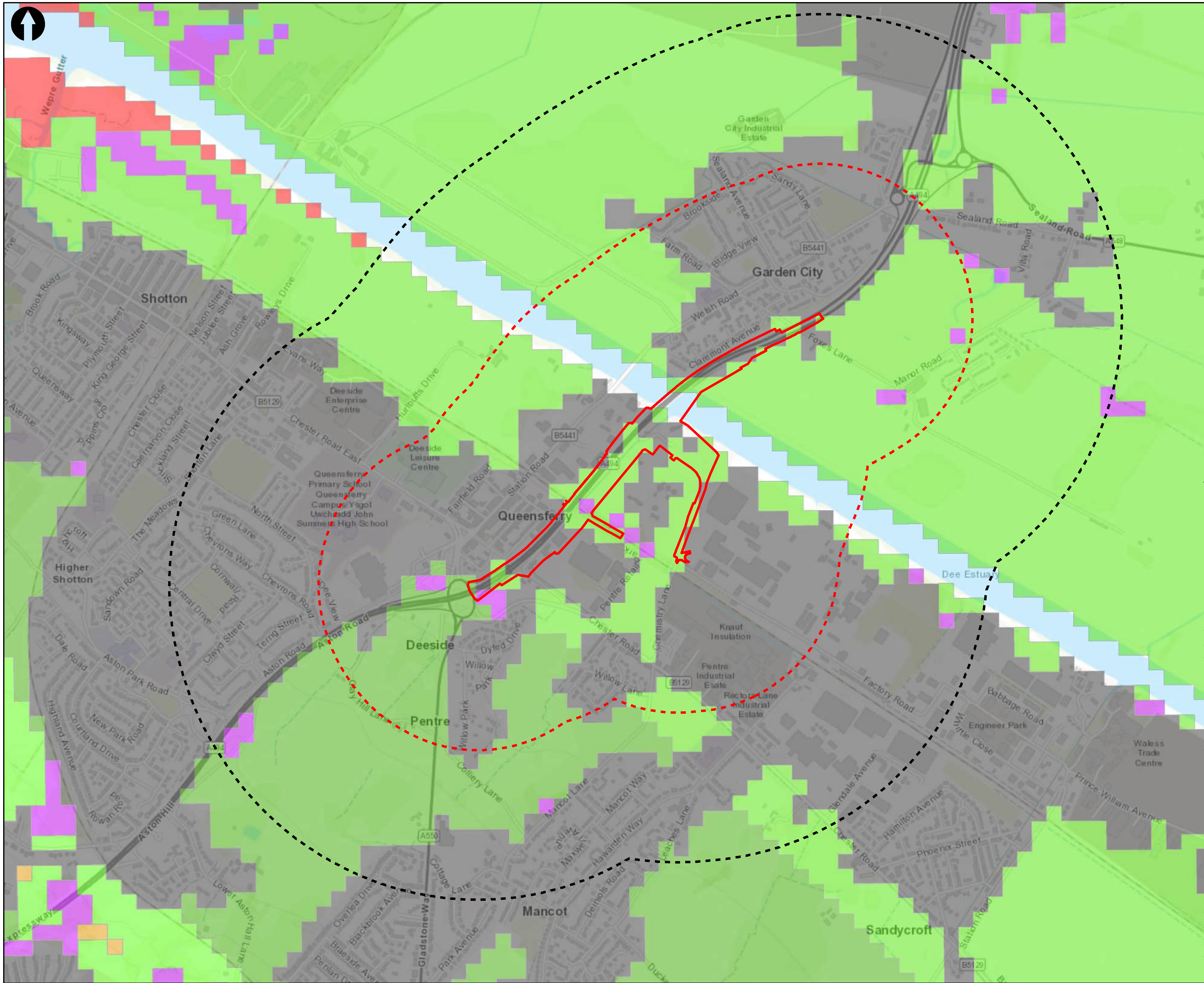

Location Map

Key to Symbols

- 1000m buffer
- 500m buffer
- Approximate site extent

Agricultural land classification (grade)

- 1
- 2
- 3a
- 3b
- 4
- 5
- N/A
- U

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A494 River Dee Bridge Replacement
Agricultural Land Classification
Figure 6.4

Designed	B Marrinan	BM	Eng Check	B Marrinan	BM
Drawn	T Ruff	TR	Coordination	B Marrinan	BM
GIS Check	M Hayward	MH	Approved	I Duncan	ID

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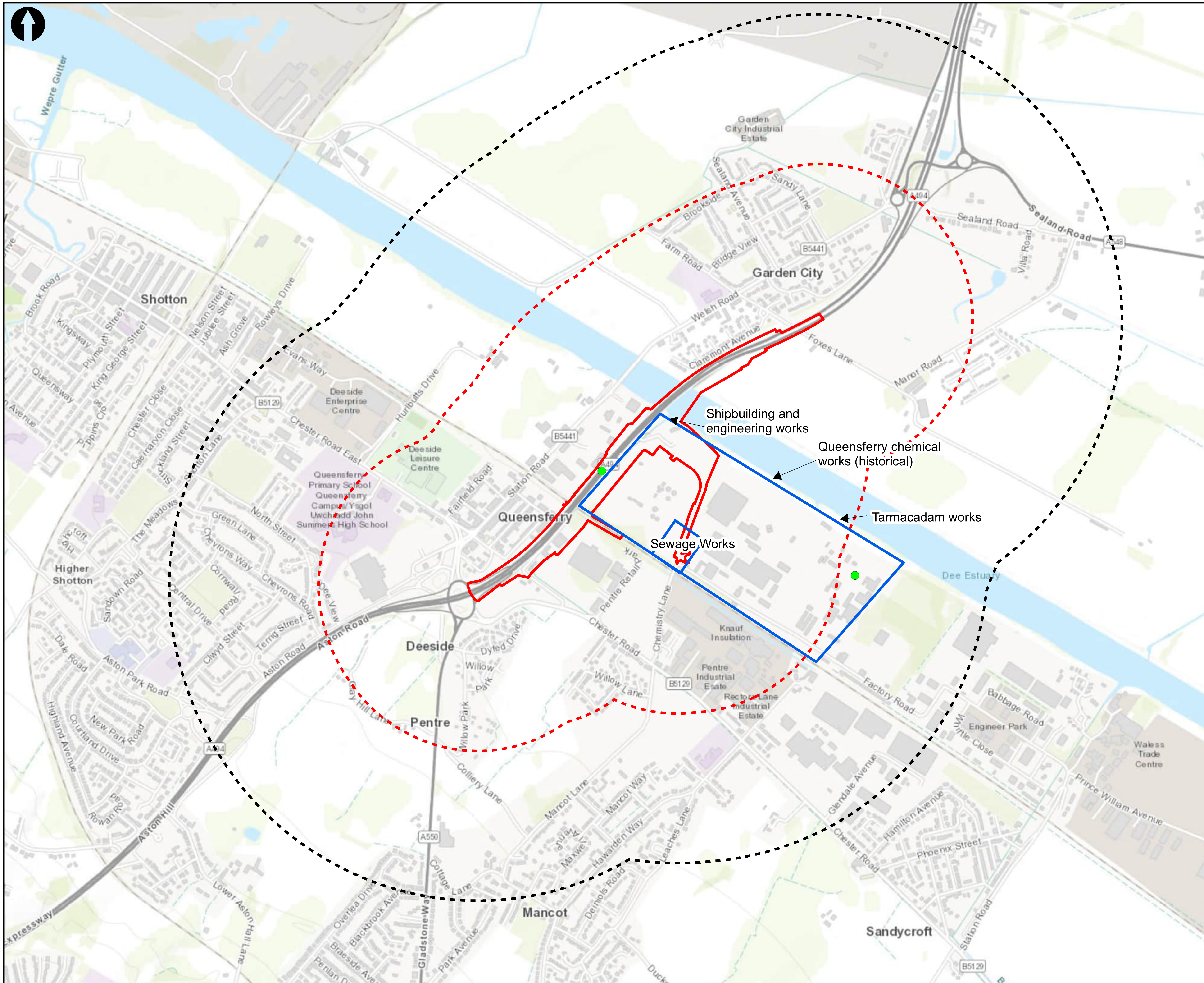

Location Map

Key to Symbols

- 1000m buffer
- 500m buffer
- Approximate site extent
- Atmospheric pollutants and effects
- Potentially contaminated land

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Title

A494 River Dee Bridge Replacement Potentially Contaminated Land Figure 6.6

Designed	B Marrinan	BM	Eng Check	B Marrinan	BM
Drawn	T Ruff	TR	Coordination	B Marrinan	BM
GIS Check	G O'Donovan	GO	Approved	I Duncan	ID

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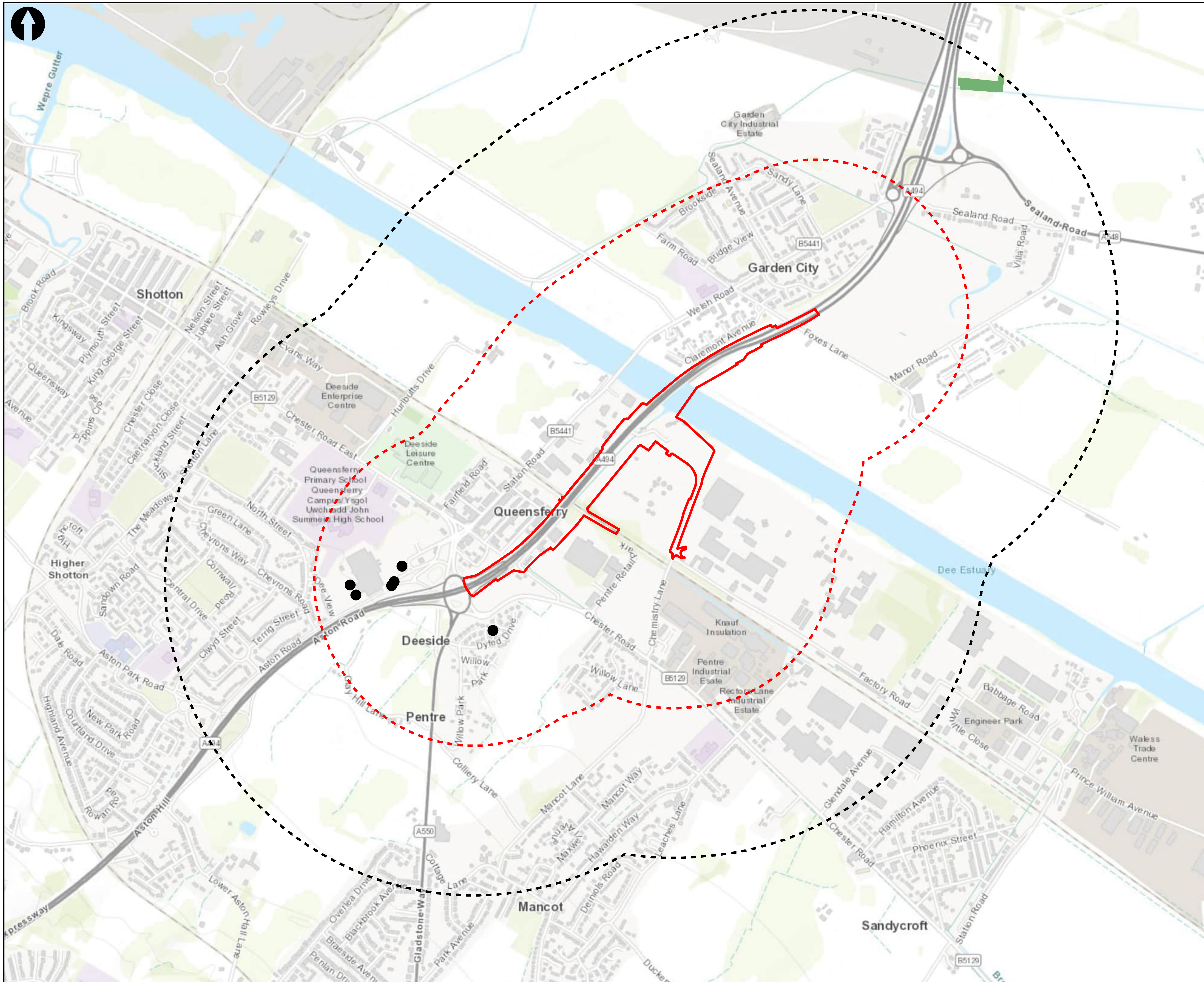

Location Map

Key to Symbols

- Approximate site extent
- 500m buffer
- 1000m buffer
- Ancient woodland
- Approximate mine shaft location

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Title

A494 River Dee Bridge Replacement
Stability and Mine Entries
Figure 6.7

Designed	B Marrinan	BM	Eng Check	B Marrinan	BM
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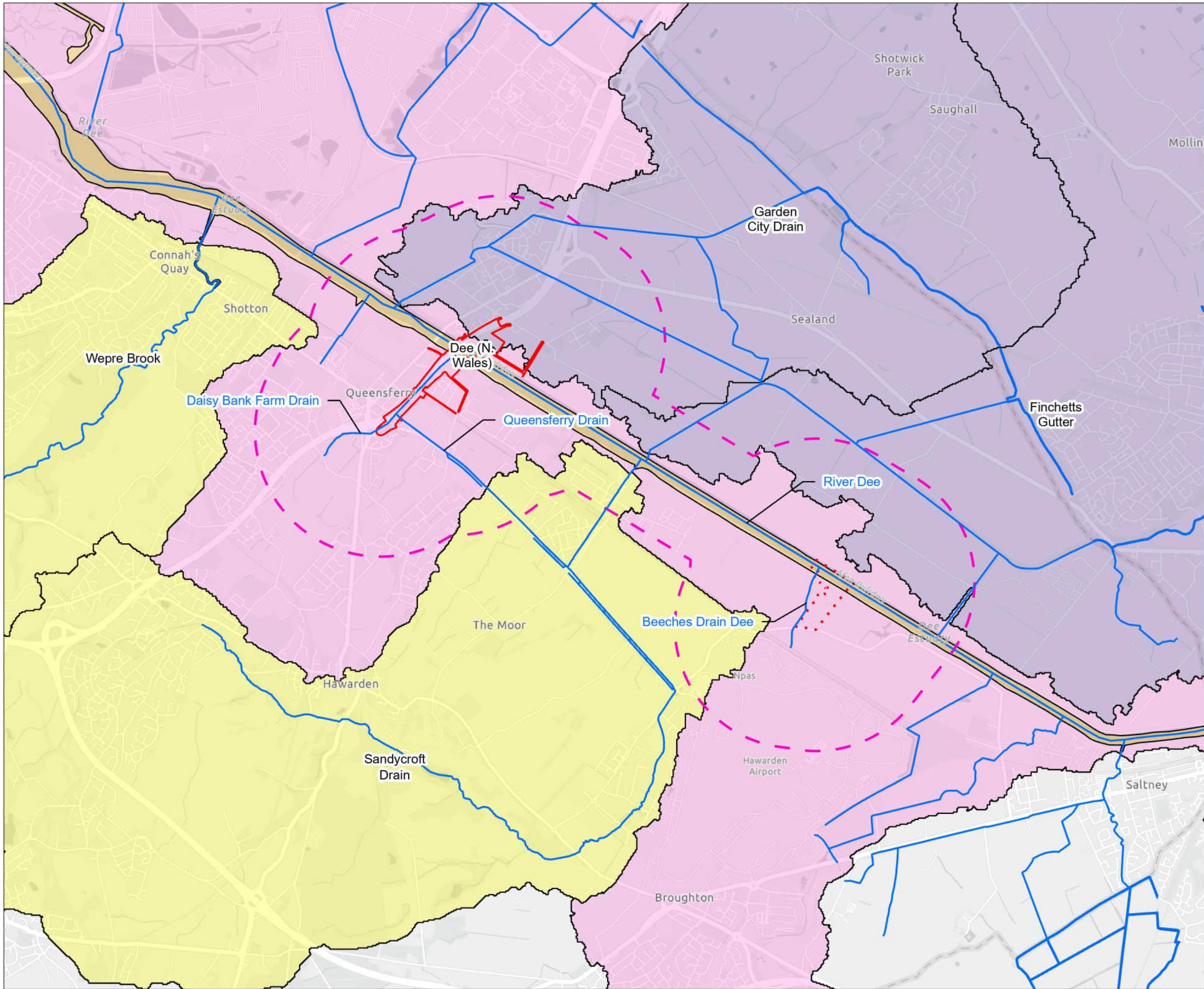
A.4 Chapter 7 Figures

Figure 7-1: Water Environmental Scheme Study Area



- Site boundary
- Airbus load out facility
- Study area (1km buffer)
- Main river

English WFD data

- River Waterbody Catchment Cycle 2
- Coastal Waterbody Catchment Cycle 2

Welsh WFD data

- River Waterbody Catchment Cycle 3
- Transitional Waterbodies Cycle 3

Coordinate system: British National Grid; Datum: OSGB 1936

Data sources:
Site boundary and airbus load out facility data: Mott MacDonald, 2024.
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Contains OS data © Crown Copyright and database right, 2024.
Esri UK, Esri, TomTom, Garmin, FourSquare, GeoTechnologies, Inc, METI/NASA, USGS, Esri UK, Esri, TomTom, Garmin, FAO, NOAA, USGS

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Working on behalf of the Welsh Government

Asiant Cefnffyrdd Gogledd a Chanolbarth Cymru
North & Mid Wales Trunk Road Agent

A494 River Dee Bridge Replacement
Environmental Scoping Report
Figure 7.1
Water Environment Scheme Study Area

Drawn	GIS Checked	Checked	Approved
CD/JL	S Glover	E Ryder	C Postlethwaite
Scale at A3	Status	Revision	Security
1:30,000	INF	01	STD

0 0.5 1 1.5 2 km

395318-MMD-00-XX-DR-Z-0001

A.5 Chapter 8 Figures

Figure 8-1: Internationally Designated Nature Conservation Sites

Figure 8-2: Nationally Designated Nature Conservation and Wildlife Sites

Figure 8-3a: Habitat Classification Sheet 1 of 6

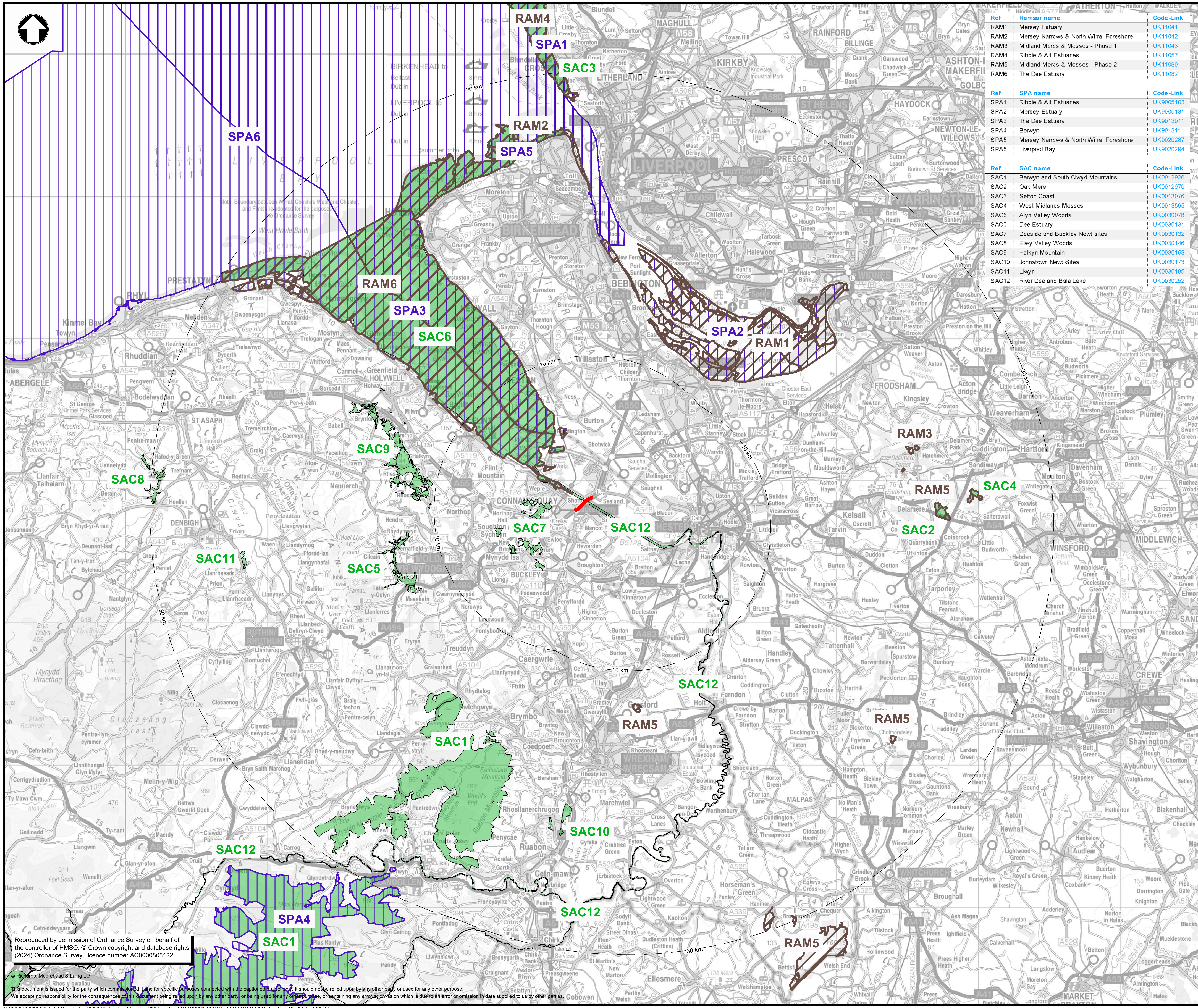
Figure 8-3b: Habitat Classification Sheet 2 of 6

Figure 8-3c: Habitat Classification Sheet 3 of 6

Figure 8-3d: Habitat Classification Sheet 4 of 6

Figure 8-3e: Habitat Classification Sheet 5 of 6

Figure 8-3f: Habitat Classification Sheet 6 of 6



Ref	Ramsar name	Code-Link
RAM1	Mersey Estuary	UK11041
RAM2	Mersey Narrows & North Wirral Foreshore	UK11042
RAM3	Midland Meres & Mosses - Phase 1	UK11043
RAM4	Ribble & Alt Estuaries	UK11057
RAM5	Midland Meres & Mosses - Phase 2	UK11080
RAM6	The Dee Estuary	UK11082

Ref	SPA name	Code-Link
SPA1	Ribble & Alt Estuaries	UK9005103
SPA2	Mersey Estuary	UK9005131
SPA3	The Dee Estuary	UK9013011
SPA4	Berwyn	UK9013111
SPA5	Mersey Narrows & North Wirral Foreshore	UK9020287
SPA6	Liverpool Bay	UK9020294

Ref	SAC name	Code-Link
SAC1	Berwyn and South Clwyd Mountains	UK0012926
SAC2	Oak Mere	UK0012970
SAC3	Sefton Coast	UK0013076
SAC4	West Midlands Mosses	UK0013595
SAC5	Alyn Valley Woods	UK0030078
SAC6	Dee Estuary	UK0030131
SAC7	Deeside and Buckley Newt sites	UK0030132
SAC8	Elwy Valley Woods	UK0030146
SAC9	Halkyn Mountain	UK0030163
SAC10	Johnstown Newt Sites	UK0030173
SAC11	Llwyn	UK0030185
SAC12	River Dee and Bala Lake	UK0030252

Notes

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Key to symbols

- A494 River Dee Bridge Improvement
- Fixed distance buffer (10 and 30 km)

Designated Sites

- Ramsar site (Wetland of International Importance)
- Special Protection Area
- Special Area of Conservation

Reference drawings

NRW_RAMSARPolygon.shp
NRW_SPASPolygon.shp
NRW_SACPolygon.shp
Ramsar_England.shp
Special_Protection_Areas_England.shp
Special_Areas_of_Conservation_England.shp

Rev	Date	Drawn	Description	Ch'k'd	App'd
P01	15/11/24	RJ	First issue inclusion of ALOF site	JS	RG

Status Stamp

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Working on behalf of the Welsh Government

Asiant Cefnffyrdd Gogledd a Chanolbarth Cymru
North & Mid Wales Trunk Road Agent

Title

A494 River Dee Bridge Replacement
Figure 8.1
Internationally Designated
Nature Conservation Sites

Designed	Rh.Edwards	RhE	Eng check	J.Stoddard	JS
Drawn	R.Jones	RJ	Coordination	G.Morgan	GM
Dwg check	D.Hall	DH	Approved	R.Griffiths	RG

MMD Project Number	Scale at A1	Security
395318	1:125000	STD

Suitability Description	Suit. Code
Suitable for Review & Comment	S2

Drawing Number	Revision
395318-RML-ZZ-XX-DR-Y-8001	P01

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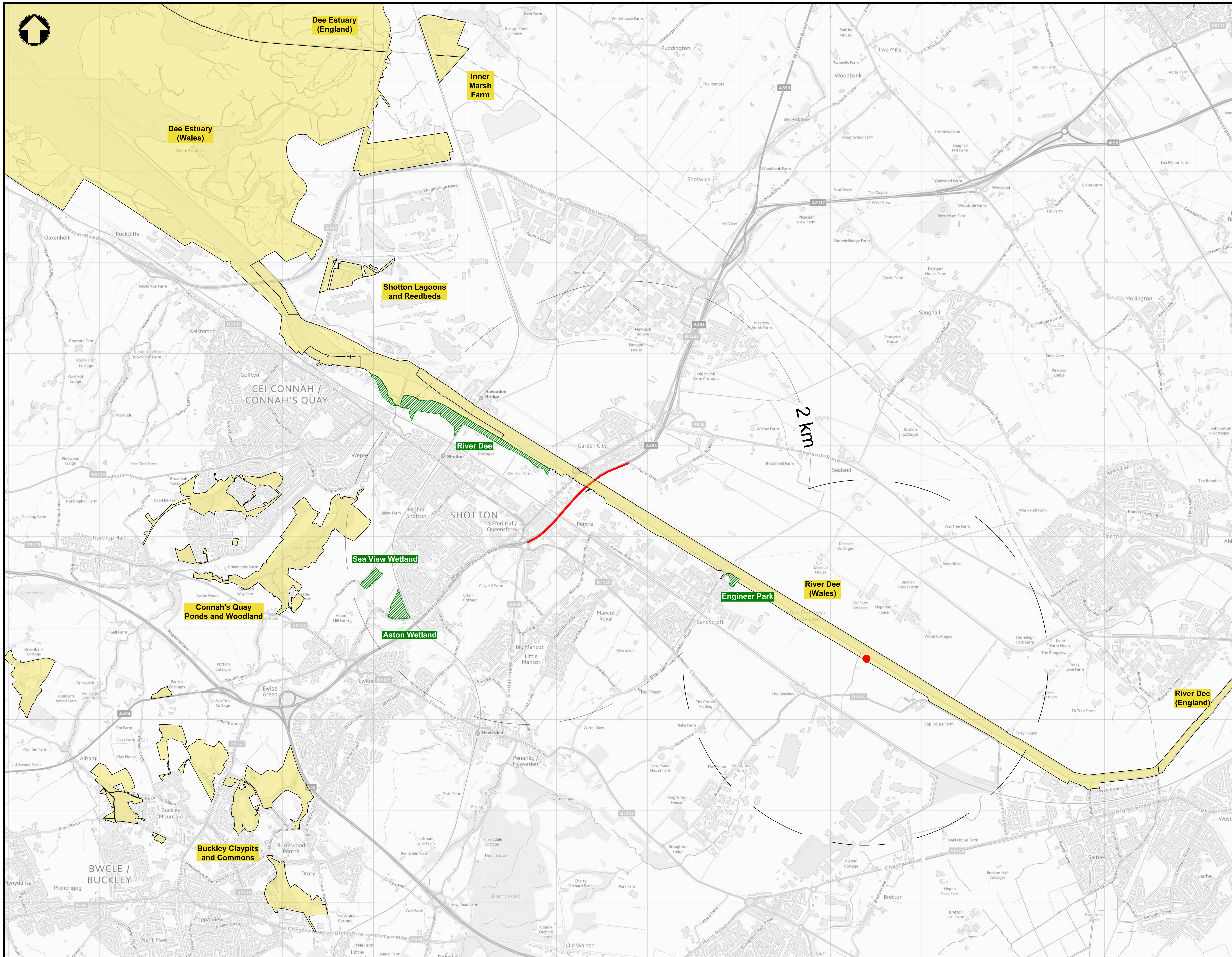
r.jones



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r.jones

Notes

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Key to symbols

- A494 River Dee Bridge Improvement
- ALOF Site
- Study Area (2 km buffer)

Designated Sites

- Site of Special Scientific Interest
- Wildlife Sites

Reference drawings

NRW_SSSIPolygon.shp
Sites_of_Special_Scientific_Interest_England.shp
3094_A494_WildlifeSites.shp

Rev	Date	Drawn	Description	Ch'k'd	App'd
P01	15/11/24	RJ	First issue inclusion of ALOF site	JS	RG

Status Stamp

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North & Mid Wales Trunk Road Agent

Title

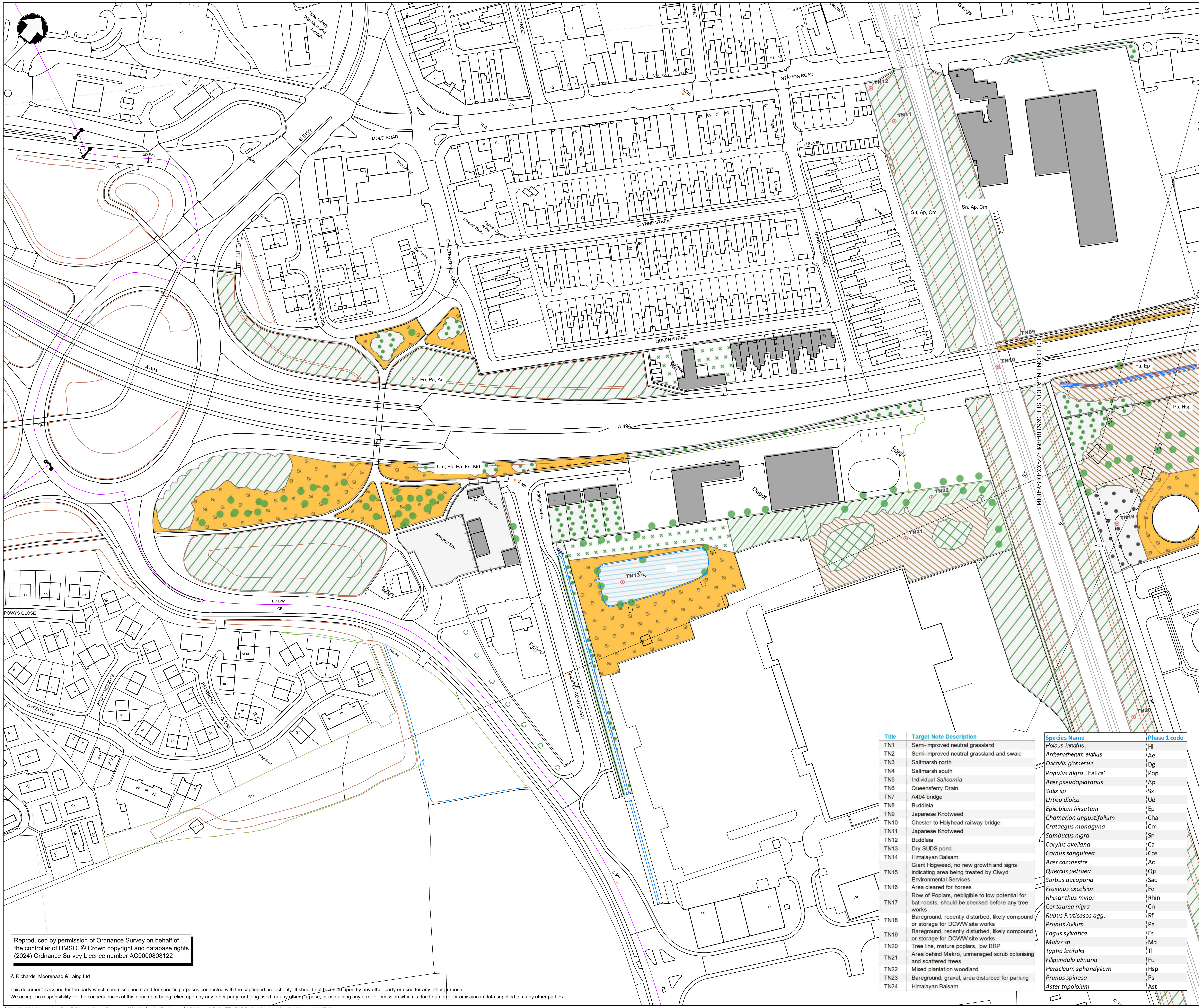
A494 River Dee Bridge Replacement
Figure 8.2
Nationally Designated Nature Conservation and Wildlife Sites

Designed	Rh Edwards	RhE	Eng check	J.Stoddard	JS
Drawn	R.Jones	RJ	Coordination	G.Morgan	GM
Dwg check	D.Hall	DH	Approved	R.Griffiths	RG

MMD Project Number	Scale at A1	Security
395318	1:20000	STD

Suitability Description	Suit. Code
Suitable for Review & Comment	S2

Drawing Number	Revision
395318-RML-ZZ-XX-DR-Y-8002	P01



Title	Target Note Description
TN1	Semi-improved neutral grassland
TN2	Semi-improved neutral grassland and swale
TN3	Saltmarsh north
TN4	Saltmarsh south
TN5	Individual *Salicornia*
TN6	Queensferry Drain
TN7	A494 bridge
TN8	Buddleia
TN9	Japanese Knotweed
TN10	Chester to Holyhead railway bridge
TN11	Japanese Knotweed
TN12	Buddleia
TN13	Dry SUDS pond
TN14	Himalayan Balsam
TN15	Giant Hogweed, no new growth and signs indicating area being treated by Clwyd Environmental Services
TN16	Area cleared for horses
TN17	Row of Poplars, nebligible to low potential for bat roosts, should be checked before any tree works
TN18	Bareground, recently disturbed, likely compound or storage for DCWW site works
TN19	Bareground, recently disturbed, likely compound or storage for DCWW site works
TN20	Tree line, mature poplars, low BRP
TN21	Area behind Makro, unmanaged scrub colonising and scattered trees
TN22	Mixed plantation woodland
TN23	Bareground, gravel, area disturbed for parking
TN24	Himalayan Balsam

Species Name	Phase 1 code
Holcus lanatus ,	Hl
Arrhenatherum elatius ,	Ae
Dactylis glomerata	Dg
Populus nigra 'Italica'	Pop
Acer pseudoplatanus	Ap
Salix sp	Sx
Urtica dioica	Ud
Epilobium hirsutum	Ep
Chamerion angustifolium	Cha
Crataegus monogyna	Cm
Sambucus nigra	Sn
Corylus avellana	Ca
Cornus sanguinea	Cos
Acer campestre	Ac
Quercus petraea	Qp
Sorbus aucuparia	Sac
Fraxinus excelsior	Fe
Rhinanthus minor	Rhin
Centaurea nigra	Cn
Rubus Fruticosos agg.	Rf
Prunus Avium	Pa
Fagus sylvatica	Fs
Malus sp.	Md
Typha latifolia	Tl
Filipendula ulmaria	Fu
Heracleum sphondylium	Hsp
Prunus spinosa	Ps
Aster tripoloium	Ast

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r.jones

Notes

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Key to symbols

Phase 1 survey hierarchical alphanumeric reference and mapping colour codes

A1.1.2	Woodland - Broad-leaved - Plantation
A1.3.2	Woodland - Mixed - Plantation
A2.1	Scrub - Dense / Continuous
A2.2	Scrub - Scattered
A3.1	Parkland / Scattered Trees - Broad-leaved
B2.2	Neutral Grassland - Semi-improved
B4	Improved Grassland
C3.1	Tall herb and fern - Tall ruderal
F2.2	Marginal and inundation - Inundation vegetation
G1	Standing Water
G2	Running Water
H1.1	Intertidal - Mud / Sand
H2.4	Saltmarsh - Scattered Plants
H2.6	Saltmarsh - Dense / Continuous
I2.2	Spoil
J1.1	Cultivated / Disturbed Land - Arable
J1.2	Cultivated / Disturbed Land - Amenity
J1.4	Cultivated / Disturbed Land - Introduced shrub
J2.1.2	Boundaries - Intact hedge - Species-poor
J2.2.2	Boundaries - Defunct hedge - Species-poor
J2.3.2	Boundaries - Hedge and trees - Species-poor
J2.4	Boundaries - Fence
J3.6	Built-up areas - Buildings
J4	Bare ground
n/a	Target note

Rev	Date	Drawn	Description	Ch'k'd	App'd
P01	15/11/24	RJ	First issue inclusion of ALOF site	JS	RG

Status Stamp

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Working on behalf of the Welsh Government

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North & Mid Wales Trunk Road Agent

Title

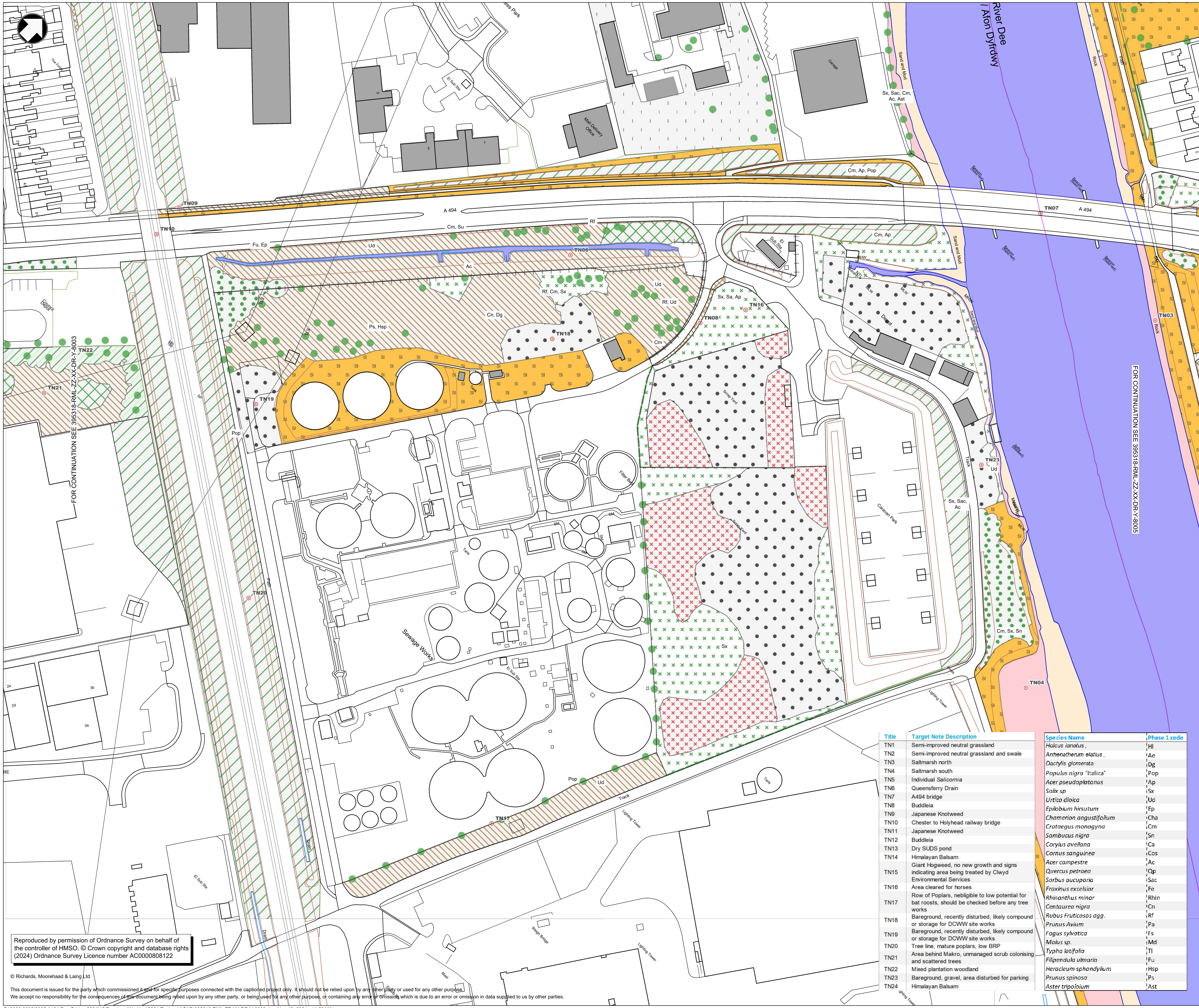
A494 River Dee Bridge Replacement
Figure 8.3A
Phase 1 Survey
Habitat Classification
Sheet 1 of 6

Designed	R.Jones	RJ	Eng check	J.Stoddard	JS
Drawn	R.Jones	RJ	Coordination	G.Morgan	GM
Dwg check	D.Hall	DH	Approved	R.Griffiths	RG

MMD Project Number	Scale at A1	Security
395318	1:1000	STD

Suitability Description	Suit. Code
Suitable for Review & Comment	S2

Drawing Number	Revision
395318-RML-ZZ-XX-DR-L-8003	P01



Title	Target Note Description
TN1	Semi-improved neutral grassland
TN2	Semi-improved neutral grassland and swale
TN3	Saltmarsh north
TN4	Saltmarsh south
TN5	Individual *Salicornia*
TN6	Queensferry Drain
TN7	A494 bridge
TN8	Buddleia
TN9	Japanese Knotweed
TN10	Chester to Holyhead railway bridge
TN11	Japanese Knotweed
TN12	Buddleia
TN13	Dry SUDS pond
TN14	Himalayan Balsam
TN15	Giant Hogweed, no new growth and signs indicating area being treated by Clwyd Environmental Services
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TN18	Bareground, recently disturbed, likely compound or storage for DCWW site works
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TN20	Tree line, mature poplars, low BRP
TN21	Area behind Makro, unmanaged scrub colonising and scattered trees
TN22	Mixed plantation woodland
TN23	Bareground, gravel, area disturbed for parking
TN24	Himalayan Balsam

Species Name	Phase 1 code
Holcus lanatus ,	Hl
Arrhenatherum elatius ,	Ae
Dactylis glomerata	Dg
Populus nigra 'Italica'	Pop
Acer pseudoplatanus	Ap
Salix sp	Sx
Urtica dioica	Ud
Epilobium hirsutum	Ep
Chamerion angustifolium	Cha
Crataegus monogyna	Cm
Sambucus nigra	Sn
Corylus avellana	Ca
Cornus sanguinea	Cos
Acer campestre	Ac
Quercus petraea	Qp
Sorbus aucuparia	Sac
Fraxinus excelsior	Fe
Rhinanthus minor	Rhin
Centaurea nigra	Cn
Rubus Fruticosos agg.	Rf
Prunus Avium	Pa
Fagus sylvatica	Fs
Malus sp.	Md
Typha latifolia	Tl
Filipendula ulmaria	Fu
Heracleum sphondylium	Hsp
Prunus spinosa	Ps
Aster tripoloium	Ast

Notes

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A1.1.2	Woodland - Broad-leaved - Plantation
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A2.2	Scrub - Scattered
A3.1	Parkland / Scattered Trees - Broad-leaved
B2.2	Neutral Grassland - Semi-improved
B4	Improved Grassland
C3.1	Tall herb and fern - Tall ruderal
F2.2	Marginal and inundation - Inundation vegetation
G1	Standing Water
G2	Running Water
H1.1	Intertidal - Mud / Sand
H2.4	Saltmarsh - Scattered Plants
H2.6	Saltmarsh - Dense / Continuous
I2.2	Spoil
J1.1	Cultivated / Disturbed Land - Arable
J1.2	Cultivated / Disturbed Land - Amenity
J1.4	Cultivated / Disturbed Land - Introduced shrub
J2.1.2	Boundaries - Intact hedge - Species-poor
J2.2.2	Boundaries - Defunct hedge - Species-poor
J2.3.2	Boundaries - Hedge and trees - Species-poor
J2.4	Boundaries - Fence
J3.6	Built-up areas - Buildings
J4	Bare ground
n/a	Target note

Rev	Date	Drawn	Description	Ch'k'd	App'd
P01	15/11/24	RJ	First issue inclusion of ALOF site	JS	RG

Status Stamp

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North & Mid Wales Trunk Road Agent

Title

A494 River Dee Bridge Replacement
Figure 8.3B
Phase 1 Survey
Habitat Classification
Sheet 2 of 6

Designed	R.Jones	RJ	Eng check	J.Stoddard	JS
Drawn	R.Jones	RJ	Coordination	G.Morgan	GM
Dwg check	D.Hall	DH	Approved	R.Griffiths	RG

MMD Project Number	Scale at A1	Security
395318	1:1000	STD

Suitability Description	Suit. Code
Suitable for Review & Comment	S2

Drawing Number	Revision
395318-RML-ZZ-XX-DR-L-8004	P01

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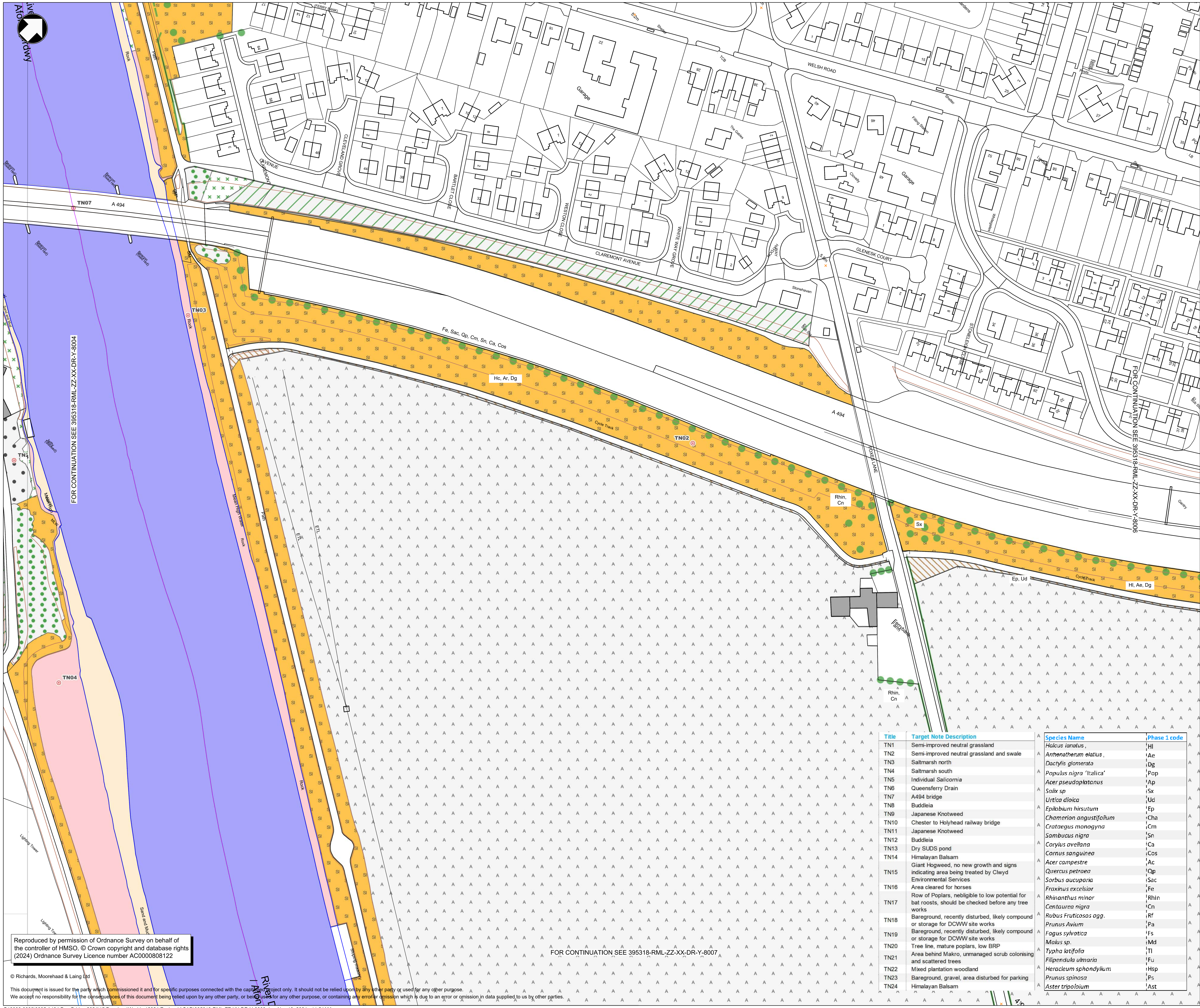

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TN4	Saltmarsh south
TN5	Individual *Salicornia*
TN6	Queensferry Drain
TN7	A494 bridge
TN8	Buddleia
TN9	Japanese Knotweed
TN10	Chester to Holyhead railway bridge
TN11	Japanese Knotweed
TN12	Buddleia
TN13	Dry SUDS pond
TN14	Himalayan Balsam
TN15	Giant Hogweed, no new growth and signs indicating area being treated by Clwyd Environmental Services
TN16	Area cleared for horses
TN17	Row of Poplars, nebligible to low potential for bat roosts, should be checked before any tree works
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TN23	Bareground, gravel, area disturbed for parking
TN24	Himalayan Balsam

Species Name	Phase 1 code
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Arrhenatherum elatius ,	Ae
Dactylis glomerata	Dg
Populus nigra 'Italica'	Pop
Acer pseudoplatanus	Ap
Salix sp	Sx
Urtica dioica	Ud
Epilobium hirsutum	Ep
Chamerion angustifolium	Cha
Crataegus monogyna	Cm
Sambucus nigra	Sn
Corylus avellana	Ca
Cornus sanguinea	Cos
Acer campestre	Ac
Quercus petraea	Qp
Sorbus aucuparia	Sac
Fraxinus excelsior	Fe
Rhinanthus minor	Rhin
Centaurea nigra	Cn
Rubus Fruticosos agg.	Rf
Prunus Avium	Pa
Fagus sylvatica	Fs
Malus sp.	Md
Typha latifolia	Tl
Filipendula ulmaria	Fu
Heracleum sphondylium	Hsp
Prunus spinosa	Ps
Aster tripoloium	Ast

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Notes

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B4	Improved Grassland
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J1.1	Cultivated / Disturbed Land - Arable
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J2.4	Boundaries - Fence
J3.6	Built-up areas - Buildings
J4	Bare ground
n/a	Target note

Rev	Date	Drawn	Description	Ch'k'd	App'd
P01	15/11/24	RJ	First issue inclusion of ALOF site	JS	RG

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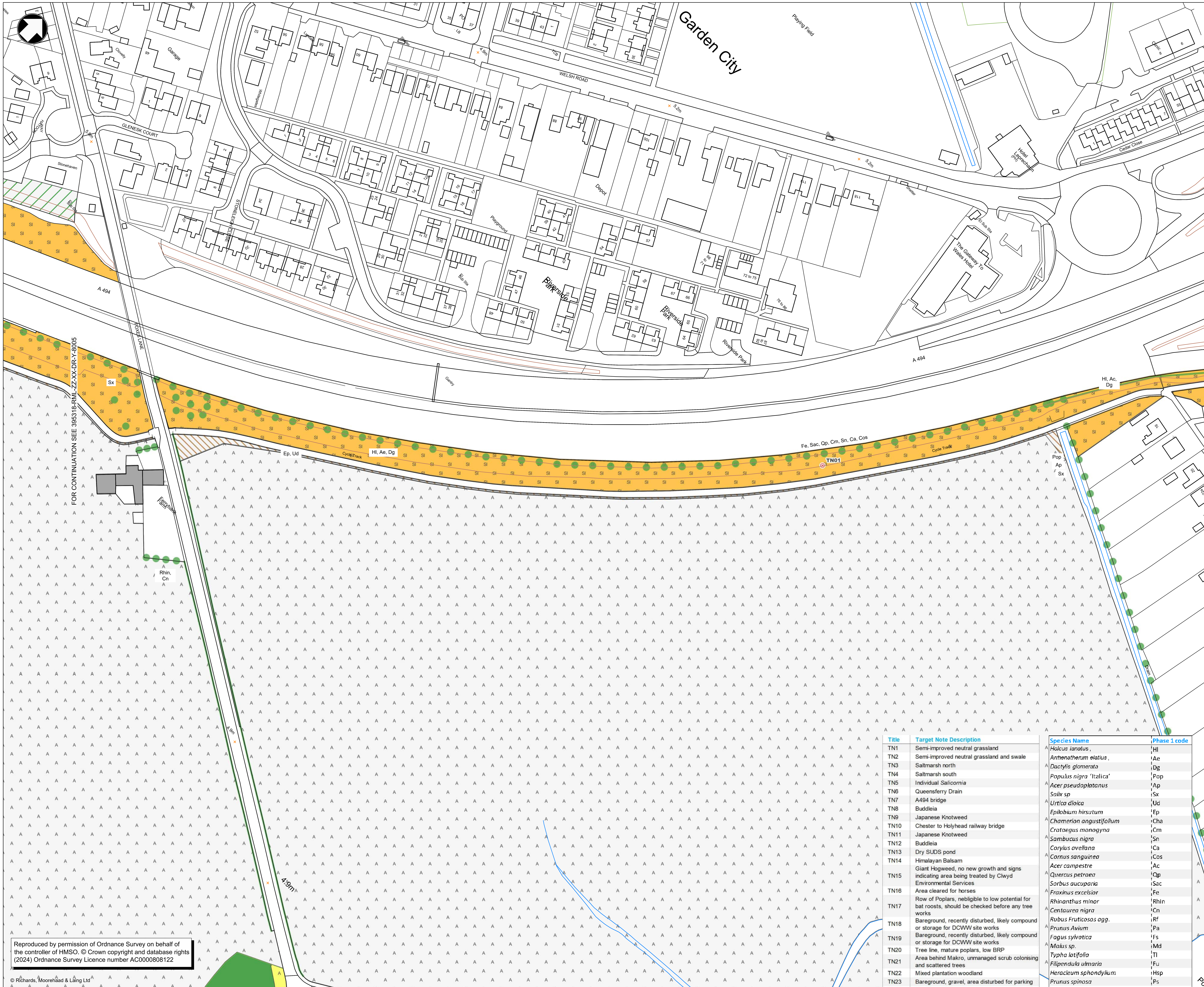
North & Mid Wales Trunk Road Agent

Title
A494 River Dee Bridge Replacement
Figure 8.3C
Phase 1 Survey
Habitat Classification
Sheet 3 of 6

Designed	R.Jones	RJ	Eng check	J.Stoddard	JS
Drawn	R.Jones	RJ	Coordination	G.Morgan	GM
Dwg check	D.Hall	DH	Approved	R.Griffiths	RG

MMD Project Number: 395318
Scale at A1: 1:1000
Security: STD
Suitability Description: Suitable for Review & Comment
Suit. Code: S2
Drawing Number: 395318-RML-ZZ-XX-DR-L-8005
Revision: P01



Title	Target Note Description
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TN3	Saltmarsh north
TN4	Saltmarsh south
TN5	Individual *Salicornia*
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TN7	A494 bridge
TN8	Buddleia
TN9	Japanese Knotweed
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Corylus avellana	Ca
Cornus sanguinea	Cos
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Sorbus aucuparia	Sac
Fraxinus excelsior	Fe
Rhinanthus minor	Rhin
Centaurea nigra	Cn
Rubus Fruticosos agg.	Rf
Prunus Avium	Pa
Fagus sylvatica	Fs
Malus sp.	Md
Typha latifolia	Tl
Filipendula ulmaria	Fu
Heracleum sphondylium	Hsp
Prunus spinosa	Ps
Aster tripoloium	Ast

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r.jones

Notes

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Key to symbols

Phase 1 survey hierarchical alphanumeric reference and mapping colour codes

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A1.3.2	Woodland - Mixed - Plantation
A2.1	Scrub - Dense / Continuous
A2.2	Scrub - Scattered
A3.1	Parkland / Scattered Trees - Broad-leaved
B2.2	Neutral Grassland - Semi-improved
B4	Improved Grassland
C3.1	Tall herb and fern - Tall ruderal
F2.2	Marginal and inundation - Inundation vegetation
G1	Standing Water
G2	Running Water
H1.1	Intertidal - Mud / Sand
H2.4	Saltmarsh - Scattered Plants
H2.6	Saltmarsh - Dense / Continuous
I2.2	Spoil
J1.1	Cultivated / Disturbed Land - Arable
J1.2	Cultivated / Disturbed Land - Amenity
J1.4	Cultivated / Disturbed Land - Introduced shrub
J2.1.2	Boundaries - Intact hedge - Species-poor
J2.2.2	Boundaries - Defunct hedge - Species-poor
J2.3.2	Boundaries - Hedge and trees - Species-poor
J2.4	Boundaries - Fence
J3.6	Built-up areas - Buildings
J4	Bare ground
n/a	Target note

Rev	Date	Drawn	Description	Ch'k'd	App'd
P01	15/11/24	RJ	First issue inclusion of ALOF site	JS	RG

Status Stamp
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North & Mid Wales Trunk Road Agent

Title
A494 River Dee Bridge Replacement
Figure 8.3D
Phase 1 Survey
Habitat Classification
Sheet 4 of 6

Designed	R.Jones	RJ	Eng check	J.Stoddard	JS
Drawn	R.Jones	RJ	Coordination	G.Morgan	GM
Dwg check	D.Hall	DH	Approved	R.Griffiths	RG

MMD Project Number	Scale at A1	Security
395318	1:1000	STD

Suitability Description	Suit. Code
Suitable for Review & Comment	S2

Drawing Number	Revision
395318-RML-ZZ-XX-DR-L-8006	P01

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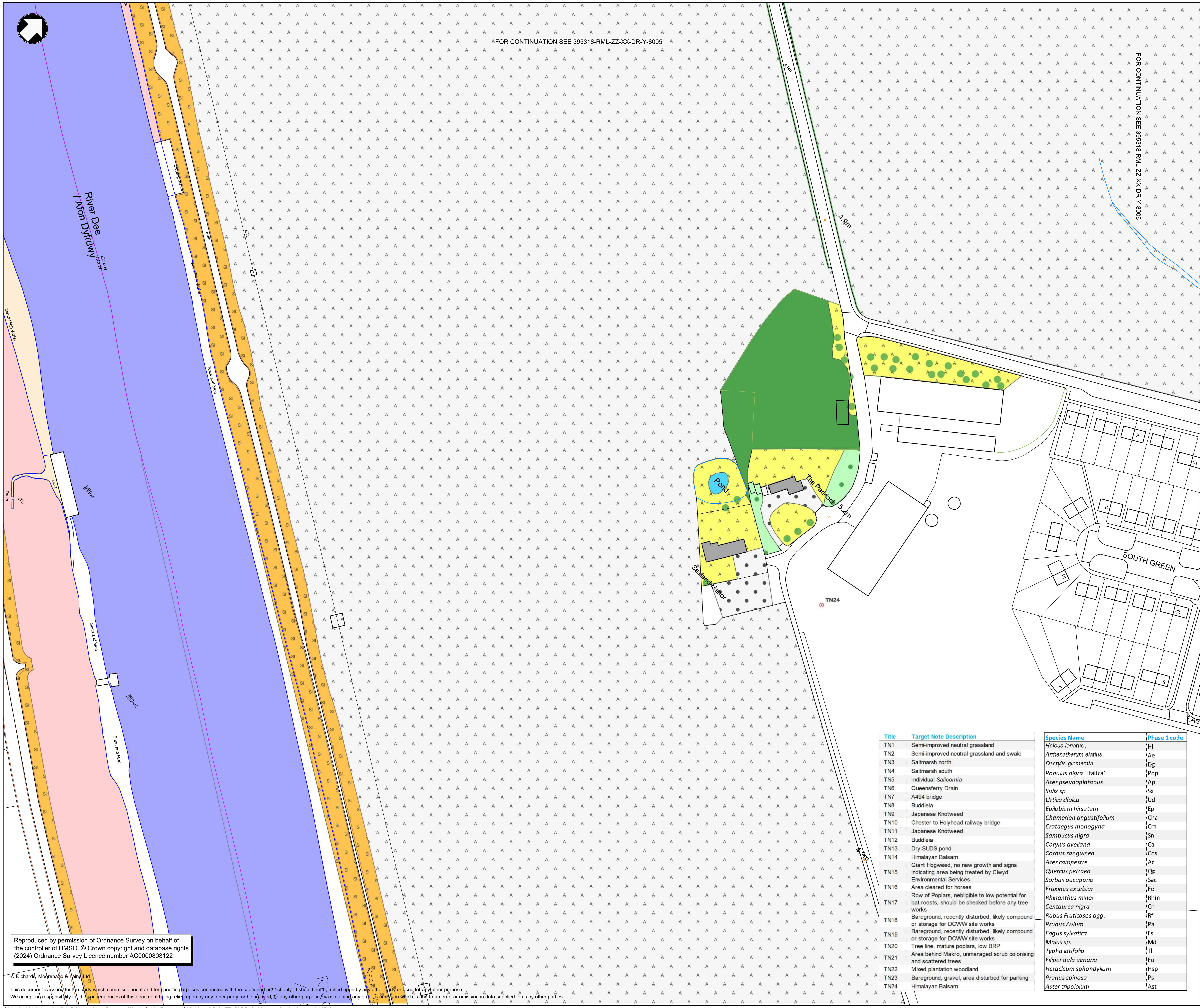
n/a	Target note



Title	Target Note Description
TN1	Semi-improved neutral grassland
TN2	Semi-improved neutral grassland and swale
TN3	Saltmarsh north
TN4	Saltmarsh south
TN5	Individual *Salicornia*
TN6	Queensferry Drain
TN7	A494 bridge
TN8	Buddleia
TN9	Japanese Knotweed
TN10	Chester to Holyhead railway bridge
TN11	Japanese Knotweed
TN12	Buddleia
TN13	Dry SUDS pond
TN14	Himalayan Balsam
TN15	Giant Hogweed, no new growth and signs indicating area being treated by Clwyd Environmental Services
TN16	Area cleared for horses
TN17	Row of Poplars, nebligible to low potential for bat roosts, should be checked before any tree works
TN18	Bareground, recently disturbed, likely compound or storage for DCWW site works
TN19	Bareground, recently disturbed, likely compound or storage for DCWW site works
TN20	Tree line, mature poplars, low BRP
TN21	Area behind Makro, unmanaged scrub colonising and scattered trees
TN22	Mixed plantation woodland
TN23	Bareground, gravel, area disturbed for parking
TN24	Himalayan Balsam

Species Name	Phase 1 code
Holcus lanatus ,	Hl
Arrhenatherum elatius ,	Ae
Dactylis glomerata	Dg
Populus nigra 'Italica'	Pop
Acer pseudoplatanus	Ap
Salix sp	Sx
Urtica dioica	Ud
Epilobium hirsutum	Ep
Chamerion angustifolium	Cha
Crataegus monogyna	Cm
Sambucus nigra	Sn
Corylus avellana	Ca
Cornus sanguinea	Cos
Acer campestre	Ac
Quercus petraea	Qp
Sorbus aucuparia	Sac
Fraxinus excelsior	Fe
Rhinanthus minor	Rhin
Centaurea nigra	Cn
Rubus Fruticosos agg.	Rf
Prunus Avium	Pa
Fagus sylvatica	Fs
Malus sp.	Md
Typha latifolia	Tl
Filipendula ulmaria	Fu
Heracleum sphondylium	Hsp
Prunus spinosa	Ps
Aster tripoloium	Ast

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North & Mid Wales Trunk Road Agent

Title

A494 River Dee Bridge Replacement
Figure 8.3E
Phase 1 Survey
Habitat Classification
Sheet 5 of 6

Designed	R.Jones	RJ	Eng check	J.Stoddard	JS
Drawn	R.Jones	RJ	Coordination	G.Morgan	GM
Dwg check	D.Hall	DH	Approved	R.Griffiths	RG

MMD Project Number	Scale at A1	Security
395318	1:1000	STD

Suitability Description	Suit. Code
Suitable for Review & Comment	S2

Drawing Number	Revision
395318-RML-ZZ-XX-DR-L-8007	P01

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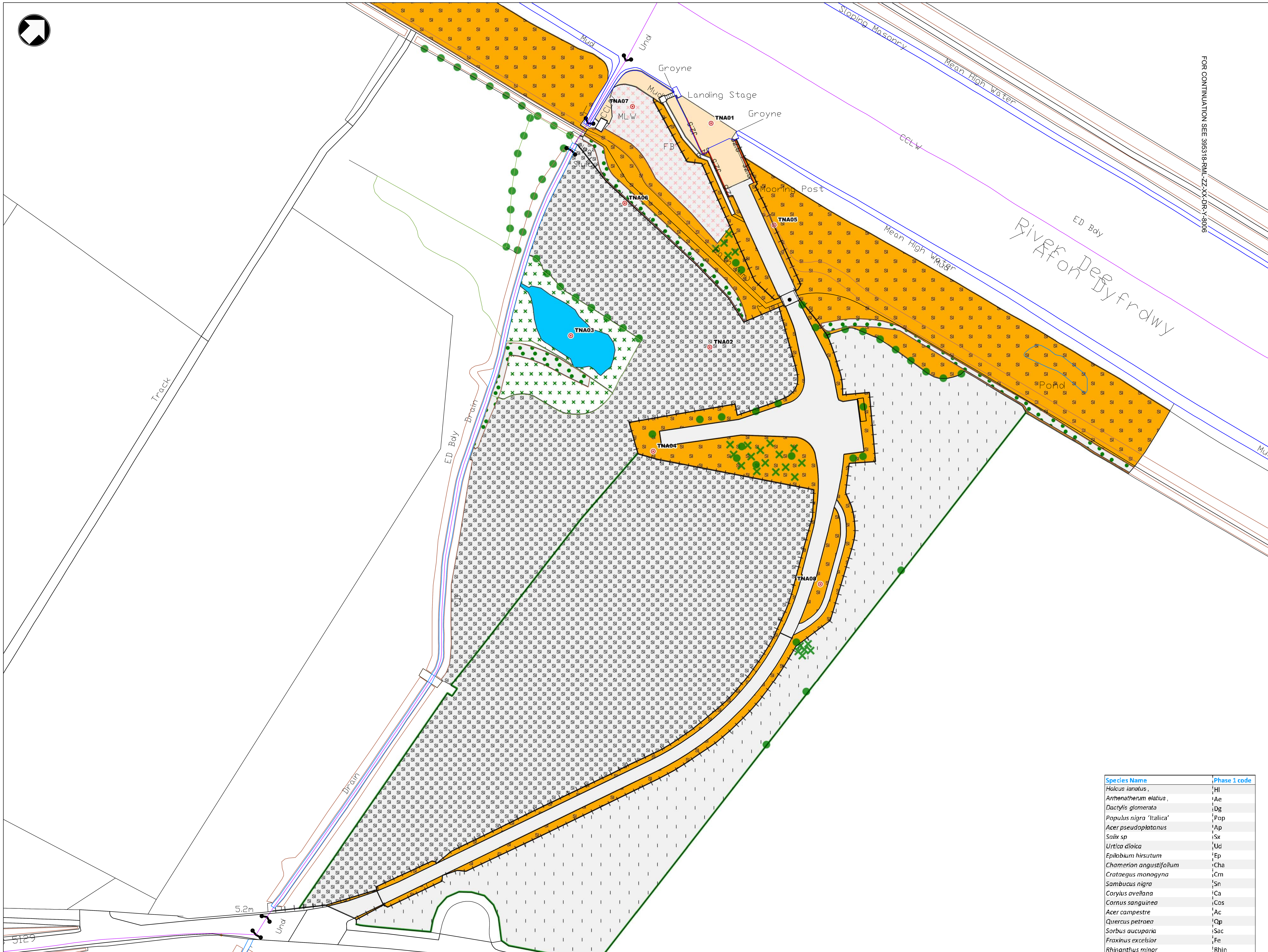
r.jones



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Title	Target Note Description
TNA01	Exposed mud/silt deposits
TNA02	Poor semi-improved grassland
TNA03	Drain/Pond
TNA04	Tall herb and grases
TNA05	Clumps of Tansey and tall grass
TNA06	Gappy hedgeline with trees
TNA07	Saltmarsh
TNA08	Poor semi-improved grassland

Species Name	Phase 1 code
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Arrhenatherum elatius ,	Ae
Dactylis glomerata	Dg
Populus nigra 'Italica'	Pop
Acer pseudoplatanus	Ap
Salix sp	Sx
Urtica dioica	Ud
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r.jones

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A494 River Dee Bridge Replacement
Figure 8.3F
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395318	1:1000	STD

Suitability Description	Suit. Code
Suitable for Review & Comment	S2

Drawing Number	Revision
395318-RML-ZZ-XX-DR-L-8008	P01

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AGRICULTURAL LAND CLASSIFICATION & SOIL MANAGEMENT PLAN

A494 River Dee Bridge Improvements

3 April 2020

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AGRICULTURAL LAND CLASSIFICATION & SOIL MANAGEMENT PLAN

A494 River Dee Bridge Improvements

3 April 2020

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8-10 Sydenham Road, Croydon CR0 2EE,
United Kingdom

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	13.02.2020	M Barker Z Liu	N Reid	G Morgan	ALC Report and Soil Management Plan – A494 River Dee
B	18.03.2020	M Barker Z Liu	N Reid	G Morgan	Minor updates to sections: 1.1, 5.2.1, 5.3.2.2, 5.6
C	03.04.2020	M Barker Z Liu	N Reid	G Morgan	Minor update to text in 5.3.2.2

Document reference: 395318 | 0080 | C

Information class: Standard

Contents

Tables

Figures

Executive summary

Pertaining to the Welsh Government's proposed A494 River Dee Bridge Improvement, Mott MacDonald Limited was commissioned to undertake an Agricultural Land Classification (ALC) survey for the area proposed for the construction Site Compound. The Site comprises a 2.8-hectare area of arable land situated between Queensferry and Garden City, directly north of the River Dee (easting 332191, northing 368401).

The survey was undertaken on 3 December 2019, with a view to identifying the key characteristics of on-site soil resources and informing appropriate Soil Management Plan measures to ensure sustainable soil handling during construction. These measures broadly pertain to the sustainable treatment of soils during stripping, stockpiling, reinstatement and aftercare following the culmination of construction, as outlined in Defra guidance within '*The Construction Code of Practice for the Sustainable Use of Soils on Construction Sites'* (2009).

Such soil management guidance comprises a key mitigation measure as proposed in the Environmental Statement for the Scheme, which highlights a Soil Management Plan as one of the requirements for a full Construction Environmental Management Plan (CEMP).

At the time of surveying, land was covered with maize stubble. Five auger borings and one soil pit were excavated to a maximum depth of 120 cm within an evenly spaced 100 m^2 grid spanning the Site. The ALC survey included examination of soil horizons, depths, texture, colour, mottling and stoniness.

These factors allowed subsequent calculation of ALC grade as well as the likely volumes of soil to be disturbed by construction, both of which informed Soil Management Plan guidance. Analysing ALC grade was also sought as a means of examining the classification of baseline Natural Resources Wales mapping, which suggests that the land comprises Grade 2 ('Very Good') quality agricultural land, falling under the categorisation of Best and Most Versatile (BMV) land. This resulted in the categorisation of the Site as exclusively comprising Grade 1 ('Excellent) soil resources, surpassing the land quality suggested by baseline mapping.

Average soil thicknesses were calculated as 33.2 cm, 41.3 cm and 45.5 cm for the topsoil, upper subsoil and lower subsoil, respectively. In line with these figures, estimated topsoil, upper subsoil and lower subsoil volumes to be generated by construction were calculated as 9,400 m^3, 11,700 m^3 and 12,900 m^3, respectively. Notably, in the absence of detailed design information at the time of writing, these figures assume total Site area excavation to a maximum depth of 120 cm.

Soil samples obtained during the survey were also sent for external laboratory analysis of key soil nutrients and texture (Particle Size Distribution). This confirmed field observations typically comprising medium clay loam or sandy silty loam topsoils overlying loamy sand subsoils, while confirming that the concentrations of phosphorus, potassium and magnesium were broadly at an optimal fertility level according to Agriculture and Horticulture Development Board (ADHB) '*RB209'* guidance (2020).

1 Introduction

1.1 Background

Mott MacDonald Limited was commissioned to undertake an Agricultural Land Classification (ALC) survey for the proposed A494 River Dee Bridge Improvements, with a view to informing soil management measures aimed at ensuring the sustainable handling of on-site soils during construction.

The aim of the A494 River Dee Bridge Improvements Scheme is to maintain the existing function of the A494. The proposed scheme comprises of a 1.5km long Dual 3 lane Road providing three lanes and hard shoulder in each direction. The scheme will also include new or diverted Public Rights of Way (PRoW) and Private Means of Access would be provided to replace those affected by the scheme. The scheme will include new river bridge structures, and a new railway underbridge.

The key point to note from the above is that the A494 River Dee Bridge Improvements Scheme is a resilience scheme whose main focus is maintaining the existing function of the A494.

The area targeted by the ALC survey is proposed as an area to accommodate the Site Compound. This is located approximately 8.4 km to the north-east of Chester (easting 332191, northing 368401). The Site location is depicted in drawing 395318-MMD-ZZ-XX-DR-G-0110 (Appendix A).

1.2 Scope of work

A soil survey was undertaken for the purpose of investigating and identifying the key characteristics of on-site soil resources, informing appropriate Soil Management Plan measures to ensure sustainable soil handling.

Such soil management guidance comprises a key mitigation measure as proposed in the Environmental Statement for the Scheme[1], which highlights a Soil Management Plan as one of the requirements for a full Construction Environmental Management Plan (CEMP).

To this end, the Environmental Statement outlines that the *'the inclusion of a Soils Management Plan (SMP) within the CEMP would ensure works are undertaken in accordance with appropriate guidelines such as Defra's Code of Practice for the Sustainable Use of Soils on Construction Sites[2] and BS3882:2015[3], particularly in areas where the reinstatement of agricultural land would be required after construction'.*

The inclusion of ALC derivation within the survey seeks to confirm the on-site ALC predictive mapping outlined in Section 2.5.2, fundamentally determining whether the Site comprises Best and Most Versatile (BMV, Grades 1 – 3a) agricultural land[4].

[1] Environmental Statement: Volume 1: Chapter 06: Geology and Soils, 2nd September 2019, Document reference: 395318-0039-CH06-A; A494 River Dee Bridge Improvement Key Stage 3-4

[2] Department for Environment, Food and Rural Affairs (Defra) (2009). The Construction Code of Practice for the Sustainable Use of Soils on Construction Sites.

[3] British Standard (2015). BS3882:2015: Specification for topsoil.

[4] Ministry of Housing, Communities and Local Government – National Planning Policy Framework (NPPF) (2019).

Determining land ALC grade also offers a robust methodology for accurately delineating on-site soil quality, knowledge of which is imperative for most effectively tailoring soil management guidance. For the same reason, the survey methodology included the collection of soil samples for external laboratory analysis of key soil nutrient contents and texture, providing a further platform from which to determine overall soil quality.

The scope of the ALC survey also included the identification of soil horizons and associated soil depths, allowing the calculation of approximate soil volumes likely to be disturbed by construction. This represents a key constituent of the Soil Management Plan requirements offered by Defra[2].

2 Baseline information

2.1 Land-use

The survey area comprises 2.8 ha arable land, which aerial imagery suggests has long-since been used in arable use. This land comes under the ownership of Ferrybank Farm, which lies adjacent to the canalised River Dee.

At the time of the survey, the proposed Site was covered in maize stubble, as demonstrated in Figure 2.1, below.

Figure 2.1: Site View

2.2 Topography

The Site is predominantly flat, lying at approximately 5m AOD throughout the survey area and with very little topographic variability.

2.3 Geology

Geology represents a crucial control on key soil characteristics and agricultural productivity, particularly in relation to soil formation. Accordingly, prior to the intrusive ALC survey, British Geological Survey (BGS) maps[5] were consulted to determine on-site geology. This includes both the superficial (drift) and bedrock (solid) geological constituents.

[5] British Geological Survey (2019). Geology of Britain Viewer (accessed January 2020).

2.3.1 Superficial geology

The superficial geology of the Site is shown to be exclusively characterised by Tidal Flat Deposits. These are described by the BGS as ‘mud flat and sand flat deposits’ which are ‘deposited on extensive nearly horizontal marshy land in the intertidal zone’. They consist of unconsolidated sediments comprising mainly mud and sand.

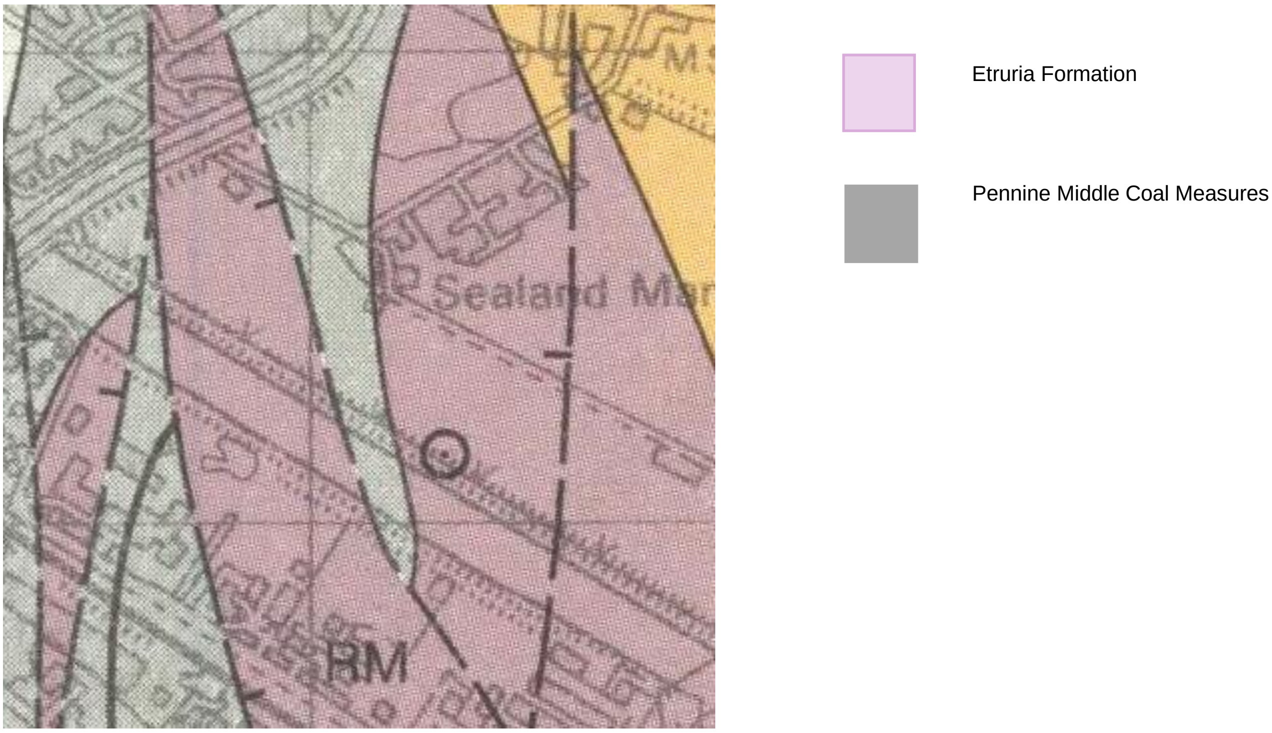
2.3.2 Bedrock geology

BGS mapping suggests that the bedrock geology of the Site comprises the Etruria Formation and the Pennine Middle Coal Measures Formation. Their relative distribution across the Site is displayed in Figure 2.2, below.

The Etruria Formation underlies the bulk of the study area and the vast majority of the centre of the Site, consisting of ‘red, purple, brown, ochreous, green, grey and commonly mottled mudstone, with lenticular sandstones and conglomerates’.

The Pennine Middle Coal Measures is shown to underlie the eastern and western portions of the Site, consisting of ‘interbedded grey mudstone, siltstone, pale grey sandstone and commonly coal seams, with a bed of mudstone containing marine fossils at the base’.

Figure 2.2: Bedrock Geology



2.4 Climatological data and flood risk

Climate represents a key control on soil formation, properties and the agricultural potential of land. Accordingly, it represents one of the key physical factors taken into account for the derivation of Agricultural Land Classification.

Similarly, flooding also exerts significant impacts on the capability of agricultural soils, with the most notable detriments comprising damages to soil structure, such as aggregation.

2.4.1 Climatological data

'Climatological Data for Agricultural Land Classification[6]' was consulted to obtain data relevant to the Site. The data were averaged and summarised as below.

Table 2.1: Climatological data for the Site area.

Variable	Measurement
National Grid Reference	SJ327686
Altitude in meters (ALT)	6
Average annual rainfall (AAR) in mm	705
Lapse rate for average annual rainfall (LAAR) in mm / metre	0.6
Average summer rainfall (ASR) (April to September) in mm	330
Accumulated temperature above 0° C (AT0) (January to June)	1461
Accumulated temperature above 0° C (ATS) (April to September)	2373
Moisture deficit for winter wheat (MDMWHT) in mm (from regressions on ATS and ASR)	107
Moisture deficit for potatoes (MDMPOT) in mm (from regressions on ATS and ASR)	99
Median duration of field capacity (FCD) in days, when the soil moisture deficit is zero	159

2.4.2 Flood risk

Natural Resources Wales Long-term Flood Risk[7] mapping indicates that the area is categorised as a Flood Zone 3 (**Figure 2.3**). These areas have a 1% (1 in 100) chance or greater of flooding in any given year.

[6] Met. Office (1989) Climatological Data for Agricultural Land Classification. Met. Office: Bracknell.

[7] Natural Resources Wales (2019). Long term flood risk maps (accessed February 2020).

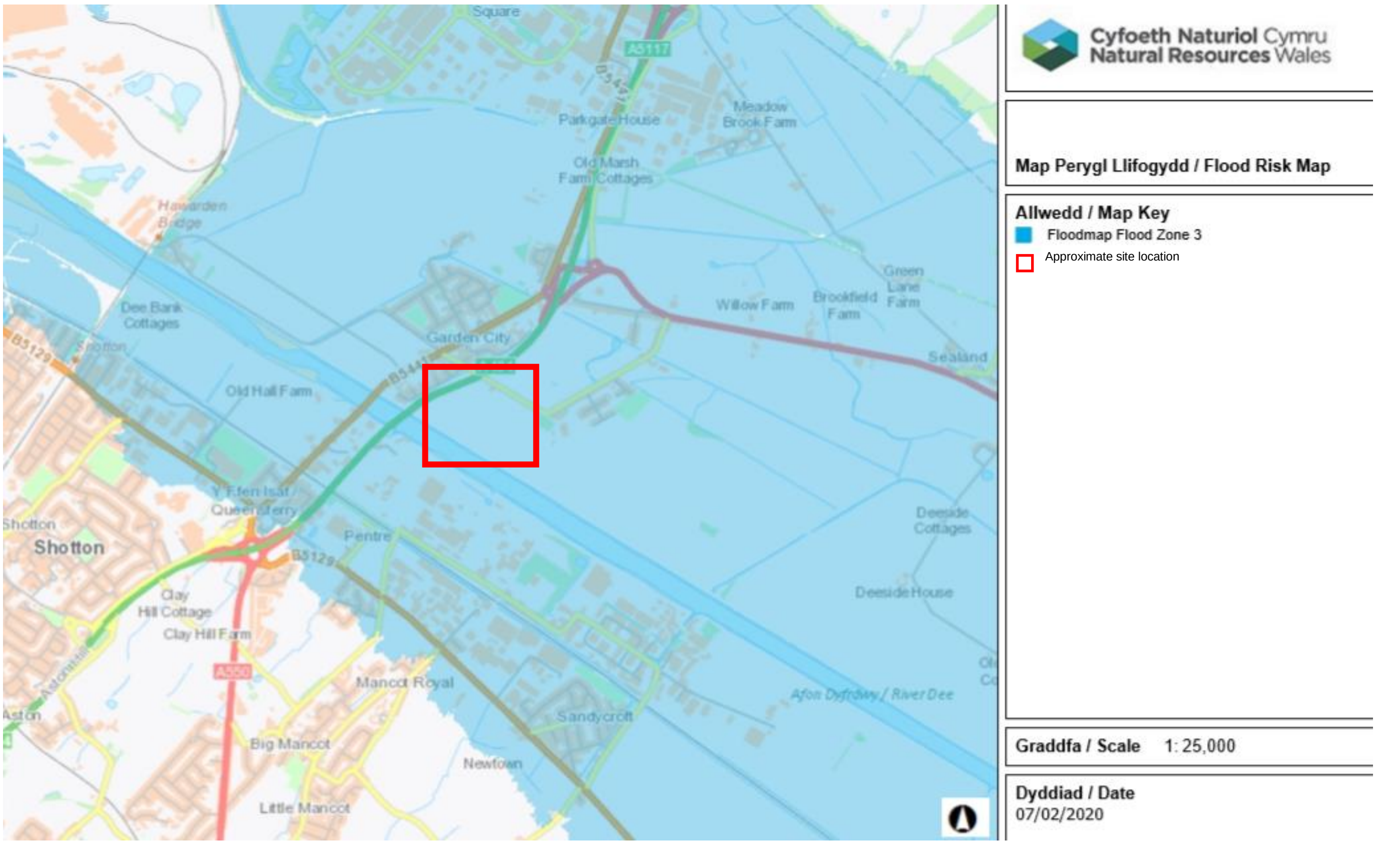


Figure 2.3: Flood Risk Map for the Site area (Natural Resources Wales, 2019).

2.5 Previous soil surveys

2.5.1 Soil types

National Soil Map[8] suggests that Site soils comprise the Wisbech Association. The Association consists mainly of coarse silty calcareous alluvial gley soils over stoneless marine alluvium. Mottling of subsoils can be extensive, reflecting that the soils are waterlogged for long periods during winter (Wetness Class IV).

Given the riverside location, the identification of this soil type in mapping corroborates the preconception that the soils would consist of silty soils created from past salt marshes associated with the canalisation of the river during the early 18th century.

2.5.2 Expected Agricultural Land Classification

The Welsh Government's Predictive Agricultural Land Classification (ALC) Map[9] shows that there is no previous ALC survey in the Site and the Site is ALC Grade 2. Grade 2 agricultural

[8] Soil Survey of England and Wales (1984). Soils and their Use in Southwest England – Bulletin 14.

[9] Welsh Government, Natural Resources Wales (2019). Predictive Agricultural Land Classification (ALC) Map (accessed February 2020).

land is defined as ‘very good quality agricultural land[10]’ from which ‘a wide range of agricultural and horticultural crops can usually be grown’ with only ‘minor limitations which affect crop yield, cultivations or harvesting’.

The Welsh Government’s Post 1988 Agricultural Land Classification (ALC) Surveys[11] indicates that one previous ALC survey[12] has been conducted within Ferry Bank Farm, in the field adjacent to the north-east of the field surveyed here by ADAS in 1995.

This surveyed approximately 19.2 hectares of agricultural land and was undertaken in 1995. This recorded the land to be of ALC Grade 2 ‘as a result of the high fine sand content of the soils present, rendering them liable to slight agricultural limitations relating to structural instability’.

[10] Ministry of Agriculture, Fisheries and Food (MAFF) (1988). Agricultural Land Classification of England and Wales: Revised guidelines and criteria for grading the quality of agricultural land.

[11] Welsh Government, Natural Resources Wales (2019). Post 1988 Agricultural Land Classification (ALC) Surveys.

[12] ADAS (1995). Agricultural Land Classification Survey, Ferry Bank Farm, Sealand, Clwyd. 712: Ferry Bank Farm, Sealand (1995) 054-95.

3 Methodology

The survey was undertaken on December 3rd, 2019 by a suitably qualified Mott MacDonald Soil Scientist.

Prior to the intrusive survey, baseline environmental information impacting soil resource characteristics was compiled. This is detailed in Section 2 and 2 and includes aspects such as relief, geology, soil types, weather, maps, satellite images and land-use.

The intrusive survey was undertaken in accordance with the guidance included within the guidelines of 'Agricultural Land Classification of England and Wales' and the 'Soil Survey Field Handbook'[13].

Soil profiles were examined to a depth of 120 cm. This included 5 hand auger bores for the Site area, satisfying and exceeding the requirement for 1 auger bore per hectare. 1 soil pit was also included to further examine soil profile and structure. The hand auger points in the field were positioned using a handheld GPS with a pre-loaded Site boundary and ager bore locations, while additional auger points and soil boundaries were also were also recorded. Throughout, an Edelman (Dutch) auger was used. Please refer to drawing 395318-MMD-ZZ-XX-DR-G-0110 (Appendix A) for mapping of the auger bore locations throughout the Site.

For assessing soil calcareousness, 10% hydrogen chloride was used. A Munsell Soil Colour Chart[14] was used to judge soil colours, while a clinometer was used to measure slope gradients. Throughout, Cable Avoidance Tool and Generator (CAT and Genny) equipment was used to scan auger locations and ensure that buried services were avoided. This was combined with buried service plans.

Soil sampling was also undertaken to obtain samples for laboratory analysis of nutrient content and Particle Size Distribution (PSD) at NRM Laboratories (UKAS Accredited).

Sampling for nutrient analysis followed guidance outlined in the ADHD Nutrient Management Guide RB209[15], adhering to a W-shaped transect to obtain 21 sub-samples to form a composite sample. One topsoil sample were taken at 15 cm depth for the analysis of

- extractable phosphorus (P);
- extractable potassium (K);
- extractable magnesium (Mg);
- organic matter; and
- pH.

Two samples of topsoil and lower subsoil were taken from soil pit for PSD analysis by pipette method.

[13] Hodgson, J. M (1997). The Soil Survey Handbook: Describing and Sampling Soil Profiles.

[14] Munsell Colour (2010). Munsell soil colour charts: with genuine Munsell colour chips.

[15] Agriculture and Horticulture Development Board (AHDB) (2020). Nutrient Management Guide (RB209).

4 Survey Results

4.1 Soil resources

The soils within the Site generally comprise deep stoneless calcareous light loam. Topsoil comprises dark brown (7.5YR3/2) stoneless calcareous fine sandy silt loam (or locally medium clay loam) with 3.5% organic matter up to 36 cm depth; upper subsoil comprises brown (7.5YR5/2) stoneless calcareous fine sandy silt loam (or locally medium clay loam) between approximately 30-75 cm with occasional mottles; lower subsoils typically consist of light brown (7.5YR7/2) stoneless calcareous with common mottling and texture varying between loamy fine sand, fine sandy silt loam and heavy clay loam.

Detailed soil auger bore descriptions are included within Appendix B.

4.1.1 Soil thicknesses and volumes

Table 4.1**: Summary of average soil horizon thicknesses and approximated volumes** (below) summarises the average horizon thicknesses of topsoil, upper subsoil and lower subsoil at the Site, as well as detailing the approximate soil volumes likely to be generated by soil stripping (rounded to the nearest 100 m^3). Without detailed design information, calculation of soil volumes assumes soil excavation to 120 cm depth.

Table 4.1: Summary of average soil horizon thicknesses and approximated volumes

Area (m^2)	Average horizon thickness (cm)			Approximate volume (m^3)		
	Topsoil	Upper subsoil	Lower subsoil	Topsoil	Upper subsoil	Lower subsoil
28,300	33.2	41.3	45.5	9,400	11,700	12,900

4.1.2 Soil nutrient and texture analysis

Soil samples – as outlined in Section 3 – were analysed at NRM Laboratories. Table 4.2 and Table 4.3 summarise these results, while Appendix C includes the raw data received from the laboratory.

Table 4.2: Summary of laboratory soil nutrient concentration results.

	Soil pH	Available nutrient concentration (mg/l)			Organic matter (%)
		Phosphorus (P)	Potassium (K)	Magnesium (Mg)	
Topsoil	8.0	26.4	194	66	3.4

The laboratory nutrient analysis indicates that the fertility level of the Site is generally at an optimal level. According to the Nutrient Management Guide RB209, available phosphorus (P) comes within Index 3, while available potassium and magnesium within Index 2, relating to the maintenance level. RB209 guidance generally considers it an unnecessary expense to continue to apply fertilisers to Index 3 soils, and instead only required to maintain Index 2. However, the P concentration is only 0.4 mg/l within the 26 – 45 mg/l Index 3 threshold (26.4 mg/l).

Table 4.3: Summary of laboratory Particle Size Distribution results.

	Particle Size Distribution (PSD) (% w/w)			Textural class
	Sand (0.063 – 2.0 mm)	Silt (0.002 – 0.063 mm)	Clay (<0.002 mm)	
Topsoil	46	36	18	medium clay loam / sandy silty loam
Lower subsoil	74	20	6	loamy sand

The soil samples for texture analysis summarises in Table 4.3. Notably, the measurement of 18% of clay particles places soil texture on the borderline between medium clay loam and sandy silt loam. However, given that the texture of the topsoil within the soil pit was logged as fine sandy silt loam in the field, this was used for the soil wetness and droughtiness calculation.

4.2 Agricultural land classification

4.2.1 Climatic limitations

With 1,461°C of accumulated temperature above 0°C and 705 mm of average annual rainfall (Table 1), climatic conditions do not represent factors limiting crop production. Therefore, the ALC Grade according to climatic limitations is classified as Grade 1.

4.2.2 Site limitations

The site is level, meaning that gradient and microrelief do not represent limiting factors.

Natural Resource Wales interactive mapping (Section 2.4.2) suggests that the risk of flooding of the Site is 1% annually, meaning that the flooding frequency is categorised as rare according to ALC flood risk guidelines. Therefore, the ALC Grade in relation to flood risk is Grade 1.

4.2.3 Soil limitations

As soils typically comprise deep stoneless calcareous fine sandy silty loam over loamy fine sand to substantial depth, neither soil texture, depth nor stone content represent limiting factors.

There is also no long-term physical limitation induced by soil chemical properties, and as such no chemical limitation with regard to ALC grade.

As such, the absence of significant limitations to any of these factors means that the ALC Grade in relation to soil limitations is Grade 1.

4.2.4 Interactive limitations

Assessment using the data derived from the soil survey indicates that neither soil wetness nor droughtiness represent limiting factors, classifying the Site within ALC Grade 1 with regard to interactive limitations. The calculations used to determine soil wetness and droughtiness are included within Appendix B.

4.2.5 ALC grades

Given that all factor-specific ALC grades have been classified as Grade 1, the overall ALC Grade of the land surveyed is similarly ALC Grade 1. The characterisation of the Site as ALC Grade 1 is reflected in the Site location mapping included in drawing 395318-MMD-ZZ-XX-DR-G-0110 (Appendix A).

5 Soil management guidance

Inappropriate handling of on-site soils may have consequences for soil structure, quality and eventual suitability for reinstatement by exacerbating erosion, run-off, compaction and contamination. Working and handling soils in adverse weather conditions may have similarly adverse effects.

Soils on-site generally comprise light loams throughout the soil profile, with relatively weak structures associated with low stability. In line with this, this Section provides soil management guidance to limit detrimental impacts to overall soil quality, both during and after construction. These are in line with the 'Good Practice Guide for Handling Soils[16]' and the 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[2]'. These documents provide industry best-practice guidance concerning the handling of soils during construction, including during stripping, stockpiling and reinstatement. Should soils be required for import or export, guidelines for this can be found within British Standard documents BS3882:2015[3] and BS8601:2013[17].

5.1 Soil handling constraints

The term 'handling' refers to all stages of the construction process with regard to soil resources. Most notably, this includes soil stripping, storage and reinstatement. To ensure suitability for reinstatement, soils should be handled in accordance with appropriate weather conditions (Section 5.1.1) and at suitable soil moisture and consistency states (Section 5.1.2). In this manner, handling soils in a sufficiently dry and friable state ensures that compaction and smearing are reduced, both of which may result in the deterioration of overall soil quality.

5.1.1 Appropriate weather conditions

If sustained heavy rainfall (>10mm in 24 hours) occurs during soil stripping, stockpiling or placement operations, work must be suspended. It cannot be restarted until the ground has had at least a full dry day, or soil can be demonstrated to pass the soil field test (outlined in Section 5.1.2).

Similarly, it is recommended that handling is not undertaken when: (1) rain – however heavy – has persisted for more than 15 minutes; (2) there is heavy rain (i.e. slow-moving depressions or intense showers); or (3) there are other forms of heavy precipitation (e.g. hail, snow). In these instances, following the end of precipitation, soil must be demonstrated to pass the field tests before it may be handled again.

5.1.2 Soil field test

The following summarises a field test method to determine whether soils are in an acceptable state for handling.

When a small, palm-sized soil sample has been obtained, handling is acceptable when:

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[16] Ministry for Agriculture, Fisheries and Food (MAFF) (2000). Good Practice Guide for Handling Soils.

[17] British Standard (2013). BS8601:2013: Specification for subsoil and requirements for use.

- Peds (structures) readily break and crumble when they are squeezed in the hand without forming into a cohesive ‘ball’. In this instance, it is not necessary for the sample to undergo a consistency test.
- Soil cannot be moulded into a cohesive ‘ball’ because it is too hard (dry);
- Soil cannot be moulded into a cohesive ‘ball’ because it is too loose (dry); or
- Soil can be rolled into a cohesive ‘ball’ but cannot be rolled into a thread (of approximately 3 mm diameter) on a flat, non-adhesive surface as it disintegrates or crumbles.

Handling is not acceptable when:

- Soil is visibly wet, with clear films of water seen on the surfaces of aggregates and grains; or
- When squeezed in the hand, soil readily deforms into a cohesive ‘ball’.
- Soil cannot be moulded into a cohesive ‘ball’ because it is too loose (wet); or
- Soil can be rolled into a cohesive ‘ball’ and may also be rolled into a thread (of approximately 3 mm diameter) on a flat, non-adhesive surface, demonstrating that plasticity is too high.

5.2 Soil stripping

5.2.1 Topsoil stripping

Vegetation must be cleared prior to stripping. If it is necessary to spray vegetation with herbicide, this should be undertaken two weeks before stripping. Topsoil should be stripped from all areas to be disturbed by earthworks and construction.

Areas of the Site which are not to be stripped or used for stockpiling, haul routes or compounds must be clearly marked by signs and barrier tape and protected from earthworks and construction. Areas such as these should be covered by grass vegetation to limit soil erosion from wind and water.

In areas designated as haul routes, the width of the haul route should be designed to accommodate two passing vehicles to avoid traversing surrounding soils. Topsoil in the area of the designated route must be stripped to avoid soil compaction before the route is used.

The below list should be adhered to at all times during the construction process:

- Stripping should be undertaken during the driest possible conditions;
- Where possible, tracked equipment should be used to reduce compaction;
- Dust should be kept at a minimum level to avoid air pollution;
- Soil stripping should be stopped during or directly after heavy rain, or when water is pooled on the surface;
- Topsoil should not be stripped below the depth of 33 cm specified in Section 4.1.1. Stripping soils too deep will reduce topsoil fertility and overall quality;
- Vegetation should not be incorporated within topsoil to be stockpiled;
- Vehicles required for stripping and haulage should stay on the designated routes to avoid additional compaction;
- Wheeled vehicles should be kept off topsoil where possible;
- The stripping operation should be supervised and monitored at all times. Excavators, bulldozers, towed earth scrapers, self-propelled scrapers and dump trucks may be used for stripping, which should be undertaken in line with the process from ‘Good Practice Guide for Handling Soils’ outlined in Figure 5.1 to Figure 5.5. Topsoil should be dug to its maximum depth – and no deeper – and then loaded onto a transportation truck.

Figure 5.1: Topsoil stripping with excavator and dump truck (Defra, 2009)

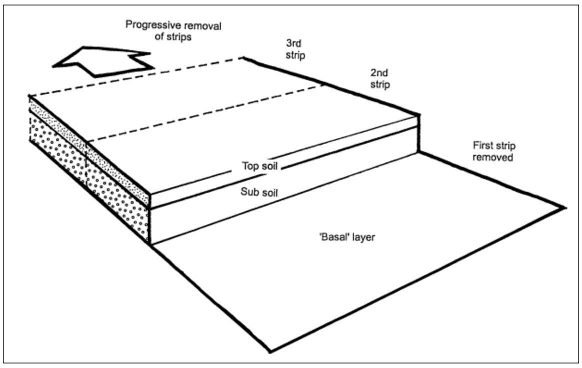


Figure 5.2: Topsoil stripping with towed earth scraper (Defra, 2009)

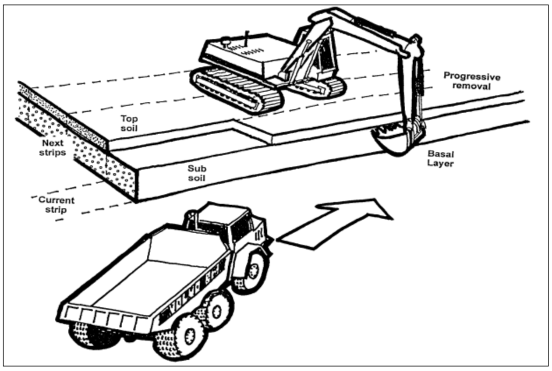


Figure 5.3: Topsoil stripping with self-propelled scrapers (Defra, 2009)

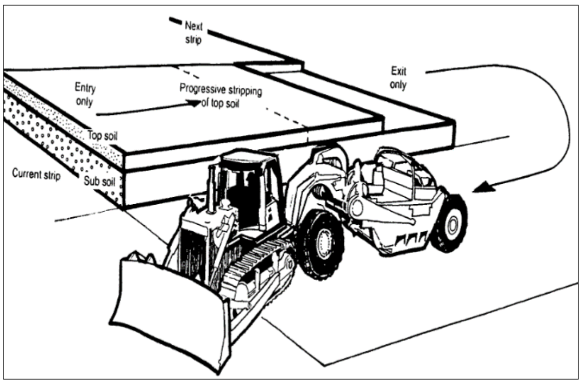


Figure 5.4: Topsoil stripping with bulldozer and dump truck (Defra, 2009)

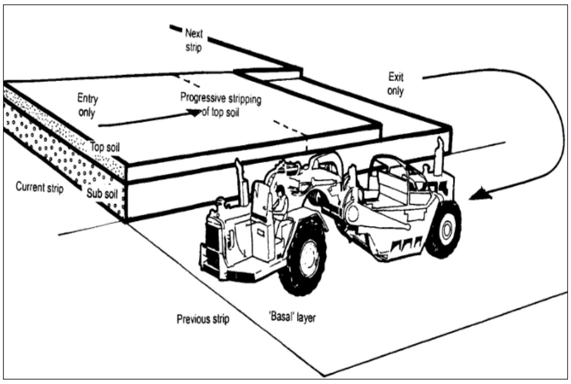
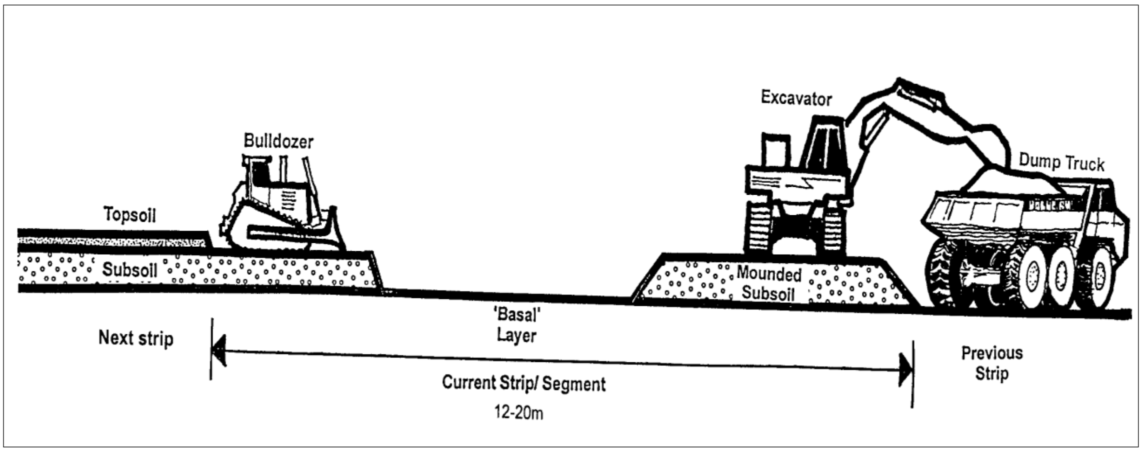


Figure 5.5: Topsoil stripping with bulldozer and dump truck (Defra, 2009)



5.2.2 Subsoil stripping

Following the stripping of topsoil, subsoils should be stripped from all marked areas. During subsoil stripping, the following list should be adhered to at all times:

- Stripping should be undertaken during the driest possible conditions;
- Where possible, tracked equipment should be used to reduce compaction;
- Dust should be kept at a minimum level to avoid air pollution;
- Soil stripping should be stopped during or directly after heavy rain, or when water is pooled on the surface;
- Upper and lower subsoils should be stripped separately. Upper subsoil should be stripped between 33 – 74 cm and lower subsoil between 74 – 120 cm, as detailed in Section 4.1.1;
- Vehicles required for stripping and haulage should stay on the designated routes to avoid additional compaction;
- The stripping operation should adhere to this Section's soil stripping guidance at all times; and
- The stripping operation should be supervised and monitored at all times.

Again, excavators, bulldozers, towed earth scrapers, self-propelled scrapers and dump trucks may be used for stripping, which should be undertaken in line with the process outlined in Figure 5.6 to Figure 5.9.

Figure 5.6: Subsoil stripping with excavator and dump truck (Defra, 2009)

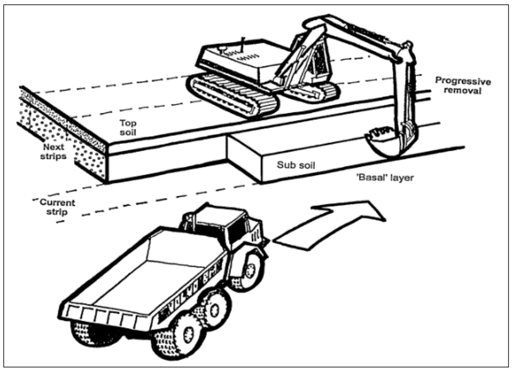


Figure 5.7: Subsoil stripping with towed earth scraper (Defra, 2009)

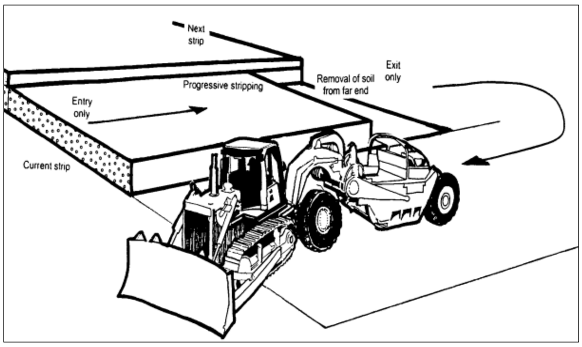


Figure 5.8: Subsoil stripping with self-propelled scrapers (Defra, 2009

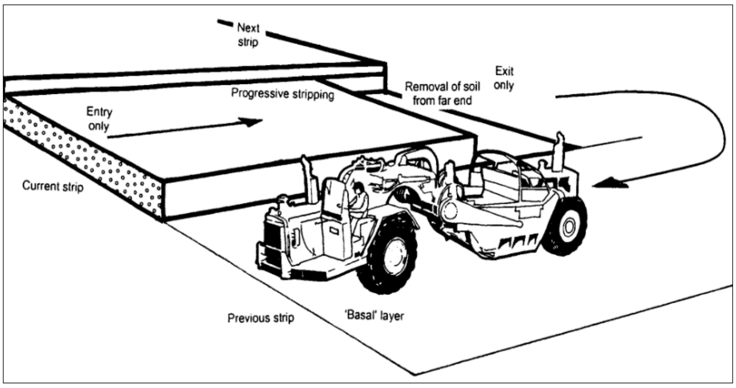
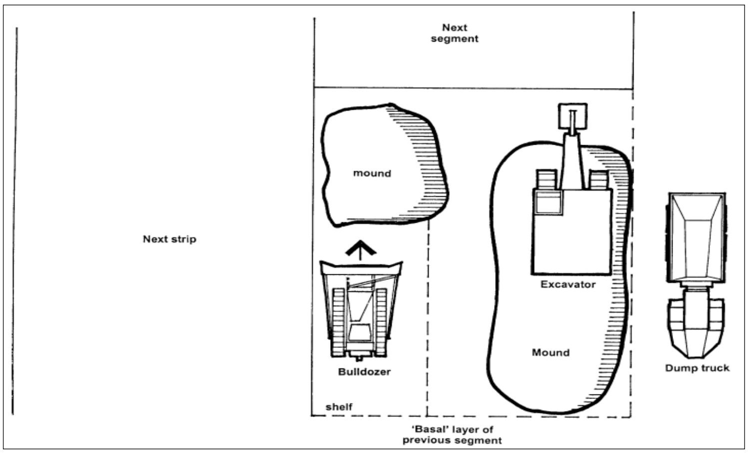


Figure 5.9: Subsoil stripping with bulldozer and dump truck (Defra, 2009)



5.3 Soil stockpiling

To ensure suitability for reinstatement – it is imperative that soils are stockpiled in a sustainable manner to limit degradation.

5.3.1 Stockpile storage locations

Stockpiles locations in the Site should be located on dry and flat ground, avoiding hollows. Vegetation must be cleared prior to stockpiling.

It will be ideal to store soils locally. This limits the possibility of double-handling, which vastly increases the likelihood of damaging the soil structure. If spatial constraints in these areas apply, stockpiles may be heightened above specifications (detailed in Section 5.3.2) if a justifiable argument can be made. If it becomes necessary to store topsoil further from their site of reinstatement, it is paramount that guidance relating to soil transport is followed to minimise soil degradation during extra handling associated with the added transportation. In particular this relates to ensuring that soils are dry and non-plastic before loading vehicles and transporting them. Tailoring design timing – constructing embankments, for instance, over the two earthworks seasons – may also represent a tool for overcoming spatial constraints for stockpile storage.

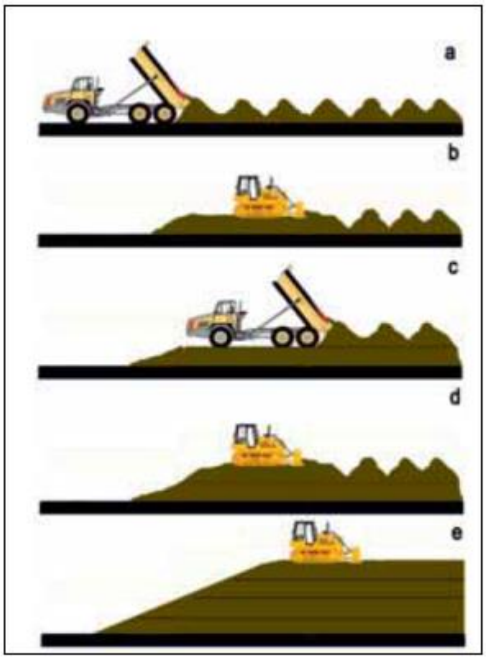
5.3.2 Stockpile formation

Soil moisture status and soil consistency (plastic or non-plastic) are key factors influencing decisions regarding the sizes and heights of stockpiles, for which the method of formation also represents a crucial control. In line with Defra's 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites', there are two methods to form soil stockpiles based on soil plastic limit. These are detailed in Sections 5.3.2.1 and 5.3.2.2, below.

5.3.2.1 Method 1: Soil stockpile formation on dry non-plastic soils

The excavated soils contained within dump trucks should be tipped in heaps as demonstrated in Figure 5.10-a. This should be undertaken in order, starting with the furthest end of the stockpile site from the access entrance. After designated stockpile areas are filled with soil heaps, tracked excavators or dozers may start to level and firm soil heaps, as demonstrated in Figure 5.10-b and Figure 5.10-c. Following this, the sequence may be repeated as depicted in Figure 5.10-d and Figure 5.10-e. When stockpiles reach their planned height and size, a tracked vehicle should firm soils and shape and smooth sides to the planned slope angle.

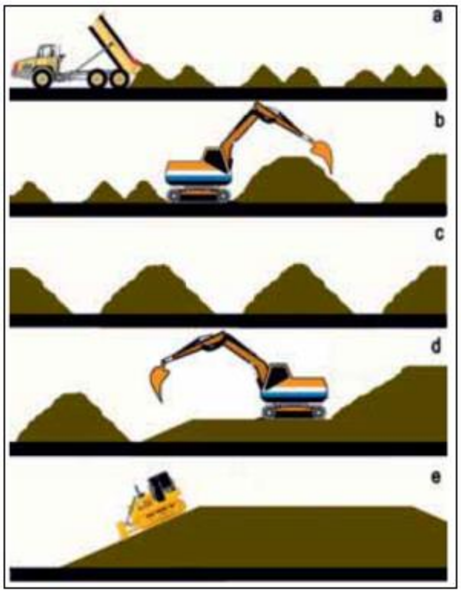
Figure 5.10: Stockpile formation from dry soils (Defra, 2009)



5.3.2.2 Method 2: Soil stockpile formation on wet plastic soils

Excavated soils from dump trucks should be tipped in heaps to form 'windrows', as depicted in 5.11-a. This should again be undertaken in order, beginning with the furthest end of the stockpile site to the access entrance. Space between 'windrows' should be sufficient for tracked vehicles to work between them to form larger 'windrows', which may be up to 2 m maximum height for dry soils (Figure 5.11-a, b, c). Once soils are dry, 'windrows' may be formed into a larger stockpile (Figure 5.11-d, e), for which the surface of stockpile should be firmed and shaped to the planned gradient.

Figure 5.11: Stockpile formation from wet soils (Defra, 2009)



5.3.2.3 Stockpile size, height and gradient

Stockpile height is normally 3-4 m for topsoil at dry state but can be greater where stockpile space is limited. The height of subsoils can be 5m to 6m.

Soils will have a natural angle of repose of up to 40°. However, for stable stockpiles to be formed, slope angles should be 30° to reduce the risk of erosion and guard the integrity of the soil structure.

For stockpiles to be maintained over six months and grass seeded, a maximum side slope angle of 25° should be adopted.

Gaps between stockpiles should be left for passing vehicles, which should not run over stockpiles unnecessarily.

5.3.3 Stockpile maintenance

Once soil stockpiles have been formed, the area should be cordoned off with secure fencing to prevent any disturbances or contamination by other construction activities.

If stockpiles are to be stored for a period of over six months, they should be seeded with a grass/clover mixture to minimise soil erosion and reduce ingression by weeds which may spread seed onto adjacent land. If weeds appear during the summer months, they should be removed by herbicide spraying or by mowing/strimming to prevent seed spreading.

A storage database should be produced to accurately record all appropriate details regarding stored soils. This should include:

- Field name;
- Field vegetation type;
- Whether stockpile or windrow;
- Soil ownership;
- Projected end-use;
- Soil type;
- Soil depth stripped;
- Topsoil or subsoil;
- Soil plasticity status, including dates and results of all consistency tests undertaken;
- Date stripped and date moved to stockpile / windrow, or from stockpile to windrow;
- Any non-compliances of monitoring / auditing criteria outlined in Section 5.6;
- Sign off upon eventual reinstatement.

The above list is also summarised in Section 5.6, which also details the required monitoring and auditing processes required for stockpiles and windrows.

5.4 Soil reinstatement

Soils should be reinstated to their original horizon sequence and state. This is crucial for soils to be restored to their original functions.

5.4.1 Prior soil reconditioning

Prior to reinstatement, soils may need to be reconditioned to restore quality and structure. In particular, any observations of plastic soils or anaerobic conditions will need to be corrected by the soil reconditioning method outlined in Defra (2009). This is summarised below:

1. Tip soils in heaps to form ‘windrows’. This should start at the furthest point along the stockpile area and run toward the access point. Windrows should be spaced to allow for vehicles between them;
2. Windrows should be produced with a rough surface to maximise drying;
3. No machinery should traverse the windrows avoid compaction, which may damage the suitability of the soil for re-use;
4. Windrows should be turned until all soil has been exposed to the air to facilitate drying;
5. Once drying is complete, the windrows can again be combined to produce larger stockpiles (without mixing topsoil and subsoil); and
6. After this, the surface of the stockpile may be regraded and compacted using a tracked machine to inhibit the infiltration of rainwater.

As part of this list, windrows should be monitored according to the monitoring checklist included in Section 5.6.

In addition, receiving substrates must be de-compacted prior to receiving topsoil or subsoil for land restoration. This recommendation is made on the basis of the likely compaction of the receiving basal layer during construction activities or soil stockpile storage. De-compaction promotes deeper root growth and reduces flood risk by reducing the impedance of water drainage.

The type of de-compaction method suitable for an area is dependent on both the amount of compaction that has occurred and the space available. The various methods of de-compaction – in conjunction with the rationale behind using each one – are listed below:

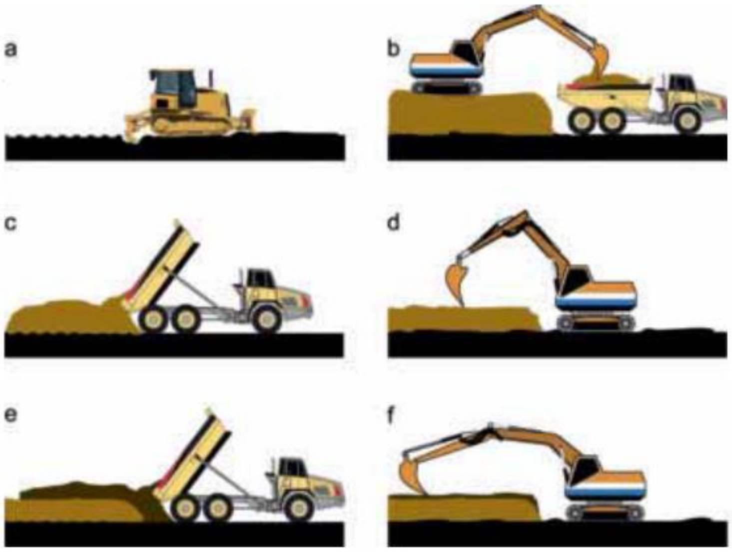
- A small (1t to 5t) to medium sized (13t) tracked excavator, fitted with a single rigid tine is effective in restricted areas, such as in planting beds and road verges;
- In more open areas, a tractor-drawn subsoiler is capable of loosening soil that is not too heavily or deeply compacted. Compressed air injection can also be used to de-compact the soil profile in such locations; and
- Deep compaction can only be effectively relieved using heavy duty ripper equipment, such as a single rigid tine device.

5.4.2 Soil placement

Defra guidance (2009) outlines how stripped soils must be tipped and spread with minimum damage to soil structure according to the 'Loose-tipping' method below, which is also graphically demonstrated in **Figure 5.12** and **Figure 5.13**.

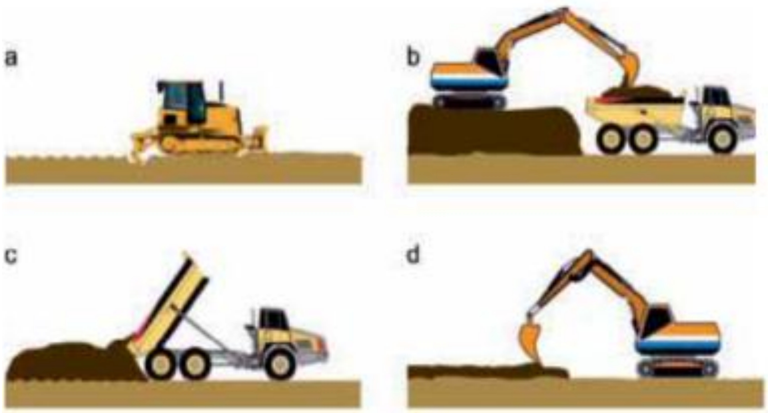
- Soils must only be handled when dry or slightly moist and work must be suspended if sustained heavy rainfall occurs during or immediately before spreading. Work should not be restarted until the ground has had at least one full day to dry;
- All alien objects (i.e. construction debris, wire, rope, wood, metal, plastic) should be removed from both receiving land and stockpiled soils before reinstatement;
- Soil handling must be minimised where possible as this damages the integrity of the soil structure;
- The specified method entails working to a strip system;
- Prior to soil placement, the receiving ground (whether a basal layer or compacted subsoil) must first be loosened with a wing-tine ripper to an appropriate depth;
- A hydraulic excavator (fitted with a toothed-bucket to avoid excessive smearing) should be used to load soil from stockpiles into dump-trucks. Dump-trucks may then discharge soils onto receiving surfaces;
- In order to spread the freshly dumped soil to the required thickness, an excavator must be situated adjacent to where the soil was discharged;
- Soils should be spread to the appropriate depth for the area of reinstatement, which is dependent on the depth of the soils being replaced and the end-use of the land;
- If topsoil and subsoils are being reinstated in an area, the whole strip length must be restored with subsoil first before the process is repeated with topsoil;
- Where topsoil and subsoil are being placed, topsoil must be lifted onto subsoil without the excavator travelling on the newly placed subsoil. Only when one strip has been completed should the next be started;
- For soils which are cloddy in structure, the excavator bucket must be used to break up the clods; and
- Once tipped or spread the soil must not be trafficked by construction vehicles.

Figure 5.12: Loose tipping method for topsoil and subsoil placement (Defra, 2009)



a) Loosening the substrate of the receiving ground
b) Loading the subsoil from stockpile
c) Back-tipping subsoil onto loosened substrate
d) Levelling subsoil
e) Back-tipping topsoil
f) Spreading topsoil over subsoil using excavator working on substrate

Figure 5.13: Loose tipping method for topsoil placement (Defra, 2009)



a) Loosening the subsoil of the receiving ground
b) Loading of topsoil from the stockpile
c) Back-tipping topsoil onto the loosened subsoil
d) Levelling topsoil

Areas where soil resources have been placed following excavation must be clearly marked by barrier tape and exclusion signs. Soils in these areas must not be disturbed by trafficking or used for material storage, soil stockpile areas or as temporary construction compounds.

5.5 Soil aftercare

Although well-executed soil management will minimise damage to soil resources, it is crucial to adhere to a set period of aftercare to ensure that reinstated soils are functional to the required level. For instance, even if recommended soil guidance is followed closely, adverse weather or other external factors may comprise the structure of reinstated soils, elevating the risk of compaction (and consequently anaerobism and waterlogging) as they settle.

For this reason, Defra guidance usually suggests that reinstated soils are subject to a period of five years of aftercare. During this period, it is required that both soil and plant health is closely monitored in order to swiftly identify and rectify deficiencies. Guidance also recommends 'hand digging small trial pits or auger holes at representative locations 2-3 times during each year', including 2-3 weeks following soil reinstatement. Typically, 2-3 weeks allows sufficient time for soils to show clear signs of adverse impacts, such as water seepage (indicating waterlogged conditions) or grey / olive coloration and a sour odour (typical of soils suffering from anaerobic conditions). To document aftercare assessments, annual aftercare reports should be produced by a soil scientist undertaking them, reporting upon the inspections conducted, results and dates.

Although aftercare represents a crucial stage of the soil management process, an aftercare plan should not be relied upon as an alternative to sound soil handling procedures at any stage of the management process.

5.6 Soil monitoring

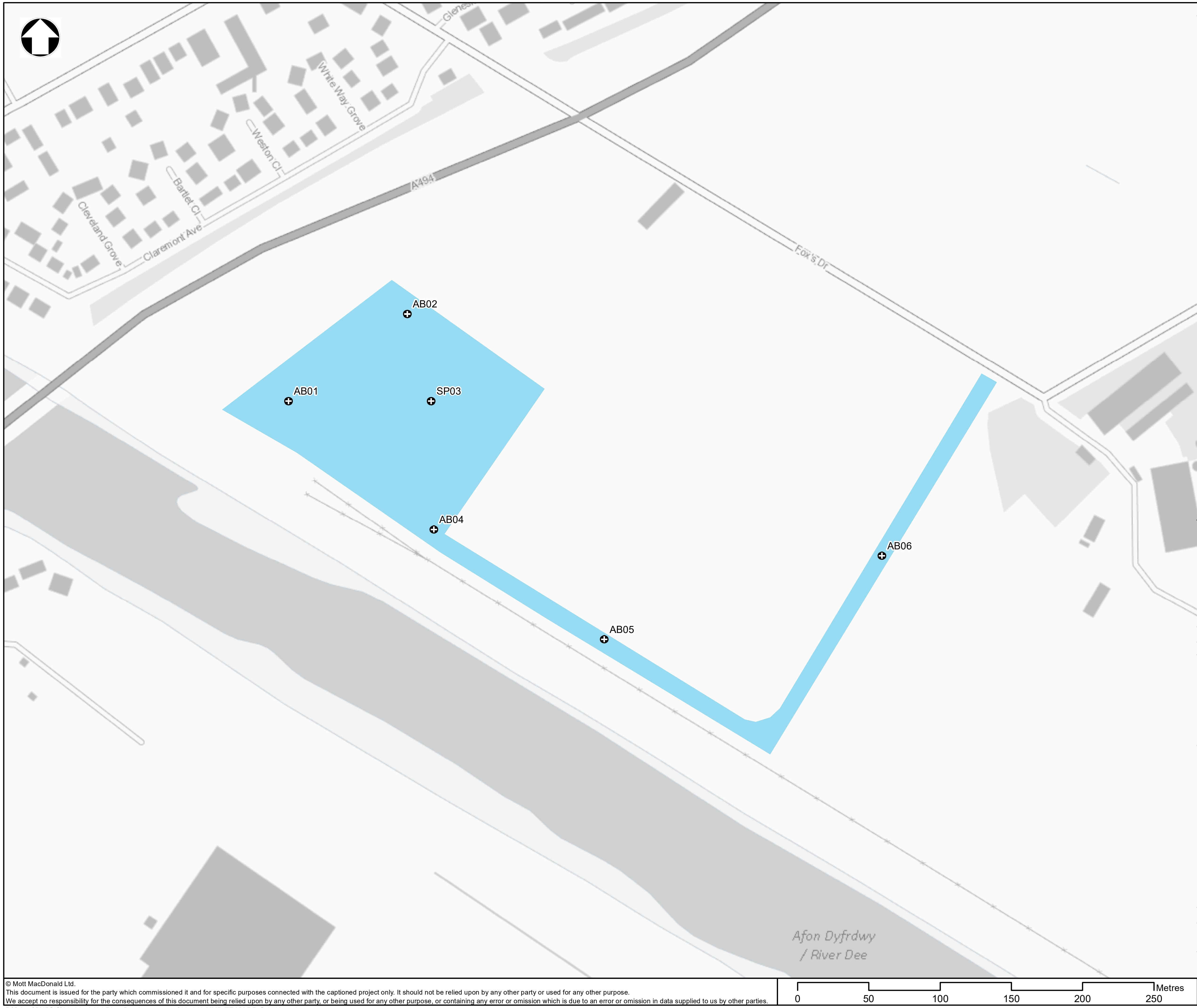
To minimise the risk to soil health and quality throughout the construction process, it is recommended that soil specialists monitor key stages of the soil handling process. This helps to ensure that the measures outlined in the recommendations for soil handling are being implemented to the required standard, during both construction and aftercare. As part of this, the Client should be notified if areas of soil resources are at risk of damage. Outside of key soil handling stages (stripping, stockpiling and reinstatement), auditing procedures will also be necessary to ensure that the appropriate inspections and checks continue to be undertaken, including the identification and rectification of non-compliances.

It is recommended that monitoring follows the guidance outlined in Defra's guidance, including:

- Initial training and communication to Site staff focusing on the sustainable handling of soils at all stages, including key Soil Management Plan information and why this is important;
- Soil stripping, including verification of horizon depths and soil plasticity, moisture and weather condition assessment prior to soil stripping (as outlined in Section 5.1.2);
- Soil stockpiling, including routine testing of soils in all stockpiles, confirmation of soil segregation, stockpile structure (checking for surface signs of erosion, water infiltration and intact boundaries between stockpiles) and appropriate stockpile recording (as outlined in Section 5.3);
- Soil reconditioning, including the visual assessment of windrows and routine testing of key soil characteristics to deduce the effectiveness of reconditioning (as outlined in Section 5.4.1);
- Soil reinstatement monitoring to verify the effectiveness of restoration at representative locations, as well as ensuring that soils have been reinstated in correct sequence (as described in Section 5.4).

Appendices

A. Site Location, Auger Hole Positions and ALC Grade Map



Location Map

Key to Symbols

- Auger bore number
- AB: Auger bore
- SP: Soil pit
- Survey area - ALC Grade 1

Notes

1. For information only, not for construction.
2. Contains public sector information licensed under the Open Government Licence v2.0.
3. Contains Ordnance Survey data © Crown copyright and database right 2019

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	13/02/20	MB	Preliminary issue	ZL	NR

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Client

Asiant Cefnffyrdd Gogledd a Chanolbarth Cymru
North & Mid Wales Trunk Road Agent

Yn gweithio ar ran Llywodraeth Cymru
Working on behalf of the Welsh Government

Title

A494 River Dee Improvement
ALC and soil management plan
Appendix A
Site location, auger hole positions and ALC grade map

Designed	M Barker	MB	Eng Check	Z Liu	ZL
Drawn	M Barker	MB	Coordination	N Reid	NR
GIS Check	H Wheldon	HW	Approved	N Reid	NR

Scale at A3	Status	Rev	Security
1:2,500	PRE	P1	STD

Drawing Number
395318-MMD-ZZ-XX-DR-G-0110

P:\Bristol\BNI\GIS\39531 - A494 River Dee Improvement\395318-MMD-ZZ-XX-DR-G-0110.mxd

B. Soil Auger Bore Log and Soil Wetness and Droughtiness

Table B.1: Soil auger bore log and the grade of soil wetness and droughtiness

Auger Bore Number	Horizon (cm)	Texture	Soil Colour		CaCO3	Stones	Soil Wetness Grade	Soil Droughtiness Grade	
			Matrix	Mottling				Wheat	Potato
1	0-32	fSZL	7.5YR3/1		<10%	0	1	1	1
	32-70	fSZL	7.5YR5/3		<10%	0			
	70-100	fSL	7.5YR6/2		<10%	0			
	100-120	LfS	7.5YR7/2	Few - 7.5YR4/1	<10%	0			
2	0-35	fSZL	7.5YR6/3		<10%	0	1	1	1
	35-68	fSZL	7.5YR5/2	Few - 7.5YR4/1	<10%	0			
	68-120	fSZL	7.5YR7/2	Common - 5YR5/4	<10%	0			
3 (pit)	0-32	fSZL	7.5YR3/2		<10%	0	1	1	1
	32-75	fSZL	7.5YR5/2	Few - 5YR5/4	<10%	0			
	75-120	LfS	7.5YR7/2	Common -5YR5/4	<10%	0			
4	0-34	fSZL	7.5YR3/1		<10%	0	1	1	1
	34-95	fSZL	7.5YR5/3		<10%	0			
	95-120	fSZL	7.5YR7/2	Common -2.5YR3/4	<10%	0			
5	0-30	fSZL	7.5YR3/1		<10%	0	1	1	1
	30-39	fSZL	7.5YR3/2		<10%	0			
	39-120	fSZL	7.5YR7/2	Common -7.5YR4/1	<10%	0			
6	0-36	MCL	7.5YR3/1		<10%	0	1	1	1
	36-60	MCL	7.5YR3/2	Few	<10%	0			
	60-100	fSZL	7.5YR7/2	Common	<10%	0			
	100-120	HCL	7.5YR7/2	Few	<10%	0			

Key: LfS - loamy fine sand; fSZL - fine sandy silt loam; SL - fine sandy loam; MCL - medium clay loam; HCL - heavy clay loam

C. Soil Texture and Nutrient Analysis

ANALYTICAL REPORT

Report Number	**81317-19**	**W680**	**MATT BARKER**	**Client A494 RIVER DEE**
Date Received	**16-DEC-2019**		**MOTT MACDONALD**	**JOB 395318**
Date Reported	**20-DEC-2019**		**10 TEMPLE BACK**	
Project	**SOIL**		**BRISTOL**	
Reference	**A494 RIVER DEE**		**BS1 6FL**	
Order Number	**395318CE66**			

Laboratory Reference		**SOIL465313**	**SOIL465314**								
Sample Reference		**TOPSOIL PSD**	**SUBSOIL PSD**								
Determinand	**Unit**	**SOIL**	**SOIL**								
Sand 2.00-0.063mm	% w/w	46	74								
Silt 0.063-0.002mm	% w/w	36	20								
Clay <0.002mm	% w/w	18	6								
Textural Class **		MCL/SZL	LS								

Notes

Analysis Notes
The sample submitted was of adequate size to complete all analysis requested.
The results as reported relate only to the item(s) submitted for testing.
The results are presented on a dry matter basis unless otherwise stipulated.

** Please see the attached document for the definition of textural classes.

Reported by
Myles Nicholson
Natural Resource Management, a trading division of Cawood Scientific Ltd.
Coopers Bridge, Braziers Lane, Bracknell, Berkshire, RG42 6NS
Tel: 01344 886338
Fax: 01344 890972
email: enquiries@nrm.uk.com

Contact : MATT BARKER MOTT MACDONALD 10 TEMPLE BACK BRISTOL BS1 6FL Tel. : 0117 9069500 **W680**	Client : A494 RIVER DEE JOB 395318

Please quote the above code for all enquiries

Distributor : 395318CE66

Sample Matrix : Agricultural Soil

Laboratory Reference

Card Number 21567/19

Date Received	16-Dec-19
Date Reported	20-Dec-19

SOIL ANALYSIS REPORT

Laboratory Sample Reference	Field Details			Index			mg/l (Available)		
	No.	Name or O.S. Reference with Cropping Details	**Soil pH**	**P**	**K**	**Mg**	**P**	**K**	**Mg**
92655/19	1	**A494 RIVER DEE** *No cropping details given*	**8.0**	**3**	**2+**	**2**	**26.4**	**194**	**66**

If general fertiliser and lime recommendations have been requested, these are given on the following sheets.
The analytical methods used are as described in DEFRA Reference Book 427
The index values are determined from the DEFRA Fertiliser Recommendations RB209 9th Edition.

Released by Katie Dunn On behalf of NRM Ltd Date 20/12/19

MICRO NUTRIENT REPORT

DATE **20th December 2019**

SAMPLES FROM **A494 RIVER DEE, JOB 395318**

MATT BARKER
MOTT MACDONALD
10 TEMPLE BACK
BRISTOL
BS1 6FL

Tel: 0117 9069500

Reference: **21567/92655/19** Field Name: **A494 RIVER DEE**	**Result**	**(*)**	**Deficient**	**Marginal**	**Target**	**Marginal**	**Excessive**
Organic matter (LOI) %	3.4	**1**	*OM level data not available for this crop*				

Notes (*)

(1) NRM considers Organic soils to contain between 10-20% organic material with Peaty soils containing over 20% . The optimum ranges for Organic Matter which have been set are dependent on the soil type and the cropping but these must be viewed as guidance values only.

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This title page to be deleted before formal publication to external parties.

Llywodraeth Cymru / Welsh Government

A494 RIVER DEE BRIDGE REPLACEMENT

Technical Appendix 7.A

Volume 3: Technical Assessment Report

River Dee Surface Water Quality Baseline Report

Document reference: 395318 | MMD-00-XX-RP-Z-0021 | Rev 1

Report Issue | Revision | August 2025

Issue and Revision Record

Revision	Date	Originator	Checker	Co-ordination check	Description
R01	August 2025	K. Brown	J. Cunningham C. Postlethwaite	J. Stoddard	First draft

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Llywodraeth Cymru / Welsh Government

A494 RIVER DEE BRIDGE REPLACEMENT

Technical Appendix 7.A

Volume 3: Technical Assessment Report

River Dee Surface Water Quality Baseline Report

395318 | MMD-00-XX-RP-Z-0021

Report Issue | Revision | August 2025

Contents

Tables

Figures

1. Introduction

1.1.1 Baseline water quality monitoring is proposed to support the A494 River Dee Bridge Replacement Scheme (herein referred to as 'the Scheme') planning application. The findings and analysis of these surveys were used to inform the EIA Volume 1: Road Drainage and Water Environment chapterError! Bookmark not defined.; Technical Appendix: 7 .C: HEWRAT AssessmentError! Bookmark not defined. and Technical Appendix: 7.B: A494 Water Framework Directive Assessment[1].

1.2 Project description

1.2.1 The Scheme is located in Flintshire, North Wales on a tidally influenced reach of the River Dee (National Grid Reference (NGR): SJ 32420 68583), as shown in Figure 1-1 The total length of the Scheme (that includes the approaches to the bridge) is approximately 1.25km.

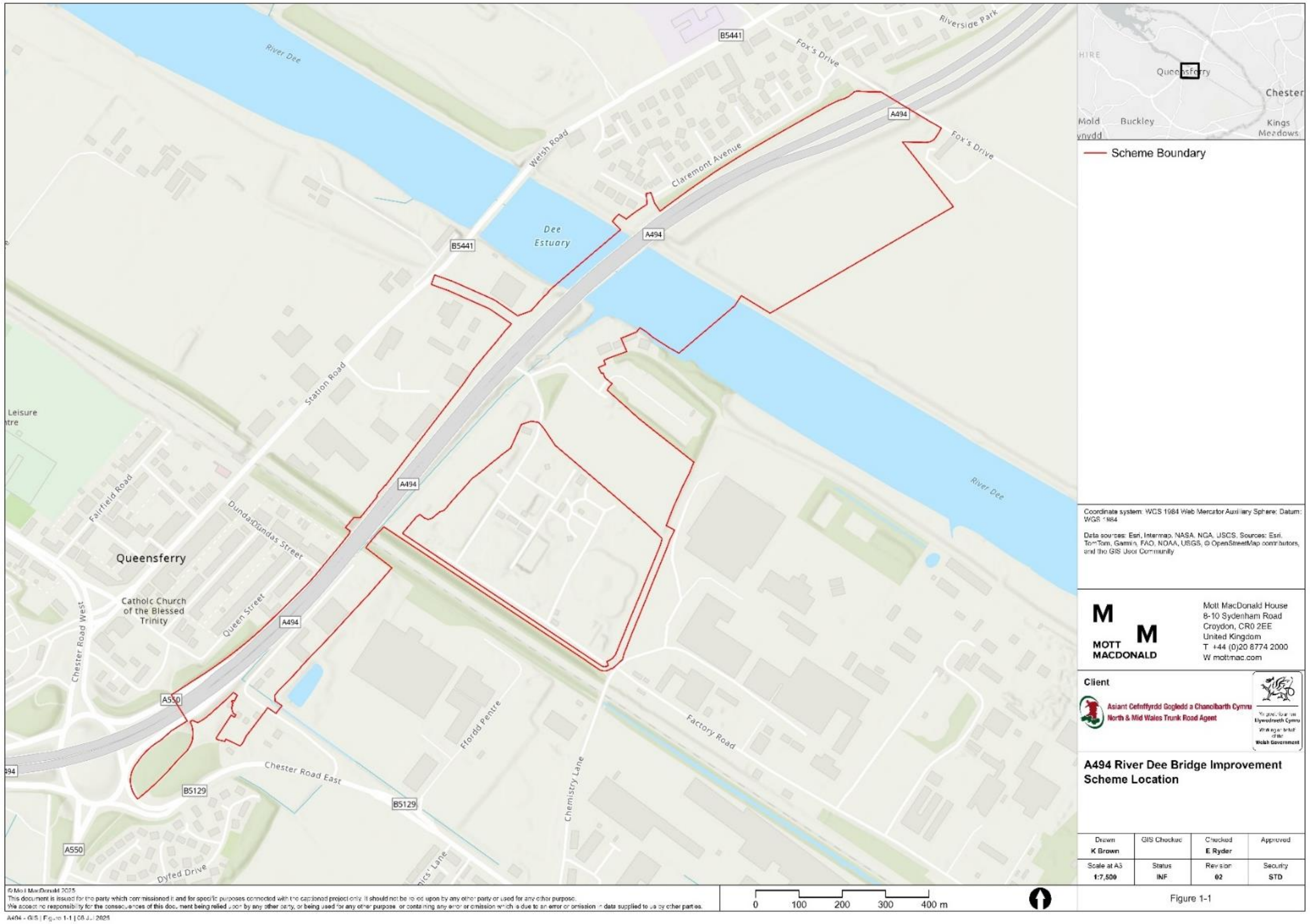
1.2.2 The Scheme involves replacing the existing road bridge that crosses the tidal River Dee with a new bridge approximately 36.5m wide and 140m in length to carry two lanes of eastbound and westbound traffic, hard shoulder and shared use path.

1.2.3 The Scheme includes the realignment of the 'the Queensferry Drain' (main river[1]) including the creation of new sections of open channel either side of North Wales Coast Railway Line, while maintaining a section of the existing culvert beneath the railway.

1.2.4 The Scheme includes changes to the existing road drainage network, creation of a new drainage outfall to the River Dee and a new Queensferry Drain Pumping Station facility provided adjacent of the River Dee.

[1] Large or key river within a drainage basin or river system. Watercourses are designated 'main rivers' due to criteria such as flood risk, catchment management, infrastructure support and strategic importance (Environment Agency, 2017).

Figure 1-1 Overview of the A494 River Dee Bridge Replacement Scheme



1.3 Baseline

Hydrological catchments

1.3.1 The Scheme lie over the tidal reach of the River Dee. This is influenced by both tidal and fluvial processes which affect water levels and flow patterns. The area tidally influenced extends approximately 11km upstream from the Scheme location.

1.3.2 The Scheme is located on the reach of the River Dee which is within the Dee (N. Wales) WFD transitional water body (GB531106708200). The Scheme is underlain by the Dee Carboniferous Coal Measures (GB41102G204800) groundwater body, which currently has overall poor classification (2021). Further information can be found in Technical Appendix: 7.B: A494 Water Framework Directive Assessment[2].

Designated sites

1.3.3 Volume 1, EIA Chapter 16: Marine Ecology provides detail on the baseline conditions, designations and potential impact on the habitats and species within the Dee Estuary. The Dee has multiple designations (Ramsar, Special Area of Conservation (SAC), Special Protection Area (SPA), Site of Special Scientific Interest (SSSI)) within the 2km study area and supports a diverse array of marine life including fish and invertebrates, particularly within its extensive intertidal mudflat and sandflat habitats.

1.3.4 These designated sites support ecologically sensitive habitats and species that are highly dependent on water quality. It is therefore essential to understand the baseline water quality to ensure no deterioration occurs during the construction and operation of the

[2] Mott MacDonald, 2025. Technical Appendix: 7.B: A494 Water Framework Directive Assessment. Document reference: 395318-MMD-00-XX-RP-Z-0020

Scheme. There is also an area of saltmarsh habitat (167,501m^2) downstream of the Scheme. Saltmarsh is a nationally important and rare habitat, recognised as a Priority Habitat under Section 7 of the Environment (Wales) Act 2016 and as an Annex I habitat of the Dee Estuary SAC.

Tidal

1.3.5 The Scheme is located within the tidally influenced section of the River Dee, which is channelised and flows into the Dee Estuary. Tidal influence extends upstream to Chester Weir, approximately 11 km from the Scheme[3].

1.3.6 The Zone of Influence (ZoI) for hydrologically connected statutory designated sites extends 12 km upstream and downstream, based on the maximum tidal excursion[3].

1.3.7 Hydrodynamic and water quality parameters – such as current speed, salinity, and suspended solid concentrations – vary over each tidal cycle in response to changing tidal and fluvial conditions.

1.3.8 Sediment transport in the estuary is determined by tidal and fluvial conditions. During periods of low river discharge, the flood tide dominates, driving suspended solids upstream. Deposition primarily occurs around and downstream of the bridge piles and within the central channel. As a result, sediment bound metals tend to accumulate upstream, and zone of deposition may experience reduced dissolved oxygen (DO) levels. Current velocities are higher during flood tides, at approximately 2.5m/s at peak flood[4].

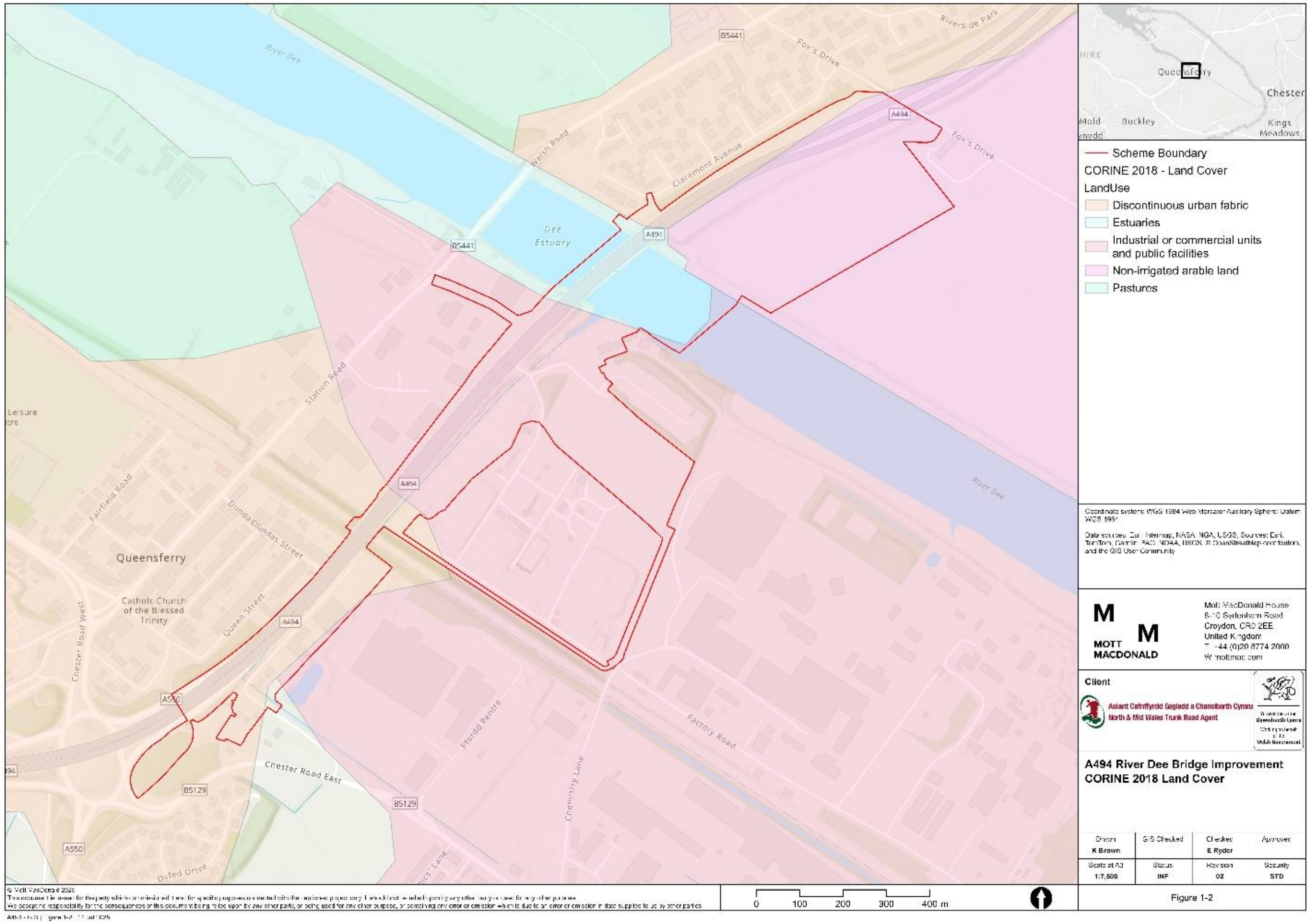
[3] Mott MacDonald, 2025. Environmental Statement: Volume 1, Chapter 16: Marine Environment. Document reference: 395318-RML-00-XX-RP-L-0002.
[4] Mott MacDonald, 2025. Technical Appendix: 7.E: Hydrodynamic and Sediment Modelling Report. Document reference: 395318-MMD-00-XX-RP-Z-0023.

1.3.9 Under high river discharge conditions, the ebb tide becomes dominant, transporting suspended solids downstream. Deposition shifts to areas upstream of the bridge piles and along the south bank. This may reduce the accumulation of sediment-bound metals and DO may fluctuate. Current velocities are around 1.4m/s[4].

1.4 Land use

1.4.1 Within the Scheme boundary lies the existing A494 carriageway and bridge is as well as an area of arable use on the right bank adjacent to the A494 carriageway. Immediately surrounding the Scheme footprint is industrial, commercial and residential developments (Figure 1.1). Queensferry Wastewater Treatment Works (WwTW) and Sludge Treatment Centre (STC) is located within the Queensferry Industrial Estate adjacent to the River Dee and the A494. The final effluent discharges into Queensferry drain, flowing into the River Dee just upstream of the Scheme boundary. A new housing development (Dee Gardens) currently being constructed adjacent to the River Dee (around 300m downstream of the Scheme).

Figure 1-2 CORINE 2018 land cover of the areas adjacent to the River Dee



1.5 Water quality

1.5.1 The Natural Resources Wales (NRW) publicly available data[5] within 20km of the Scheme was reviewed from the last 5 years (2018 -2019 and 2022 – July 2025). Data from 2020 and 2021 was excluded due to reduced monitoring activity during the COVID-19 pandemic.

1.5.2 Of the samples near the Scheme only three are within the River Dee (two located downstream of the Scheme (around 6km and 8km) and one within the Scheme boundary focusing on the Queensferry Drain outfall. All three samples only measure a limited number of parameters and do not measure at regular intervals.

[5] Natural Resources Wales, 2025. NRW Water Quality Data – ShareFile Download. Available at: Natural Resources Wales - Citrix FileShare. Accessed July 2025.

2. Monitoring methodology

2.1.1 Five locations over three watercourses were monitored on a monthly basis from November 2024 to April 2025 for identified key parameters. Monitoring methodology has been produced in line with Environment Agency (2020) guidance[6].

2.1.2 During the consultation with NRW in March 2025, no comments were made regarding the proposed monitoring locations or methodology.

2.1 Visual observation

2.1.1 Visual observations were conducted at each monitoring location to collect information on river flow, water levels, colour, opacity, sheen and any upstream activities observed. Photographs were taken at each location to show the conditions at the time of monitoring.

2.2 Sample collection

2.2.1 Samples were taken at high tide for laboratory analysis by an ISO17025 or MCERTS accredited laboratory using a monitoring rope, beaker and funnel was carried on site to ensure surveyors could remain in a safe location whilst collecting samples. Samples were decanted into the bottles provided and the monitoring equipment was rinsed between sites to reduce cross contamination. Samples and sample containers were transported in temperature-controlled storage for analysis within 24hrs of collection.

[6] Environment Agency, 2020. *Monitoring discharges to water: guidance on selecting a monitoring approach*. Available at: [Monitoring discharges to water: guidance on selecting a monitoring approach - GOV.UK](). Accessed March 2025.

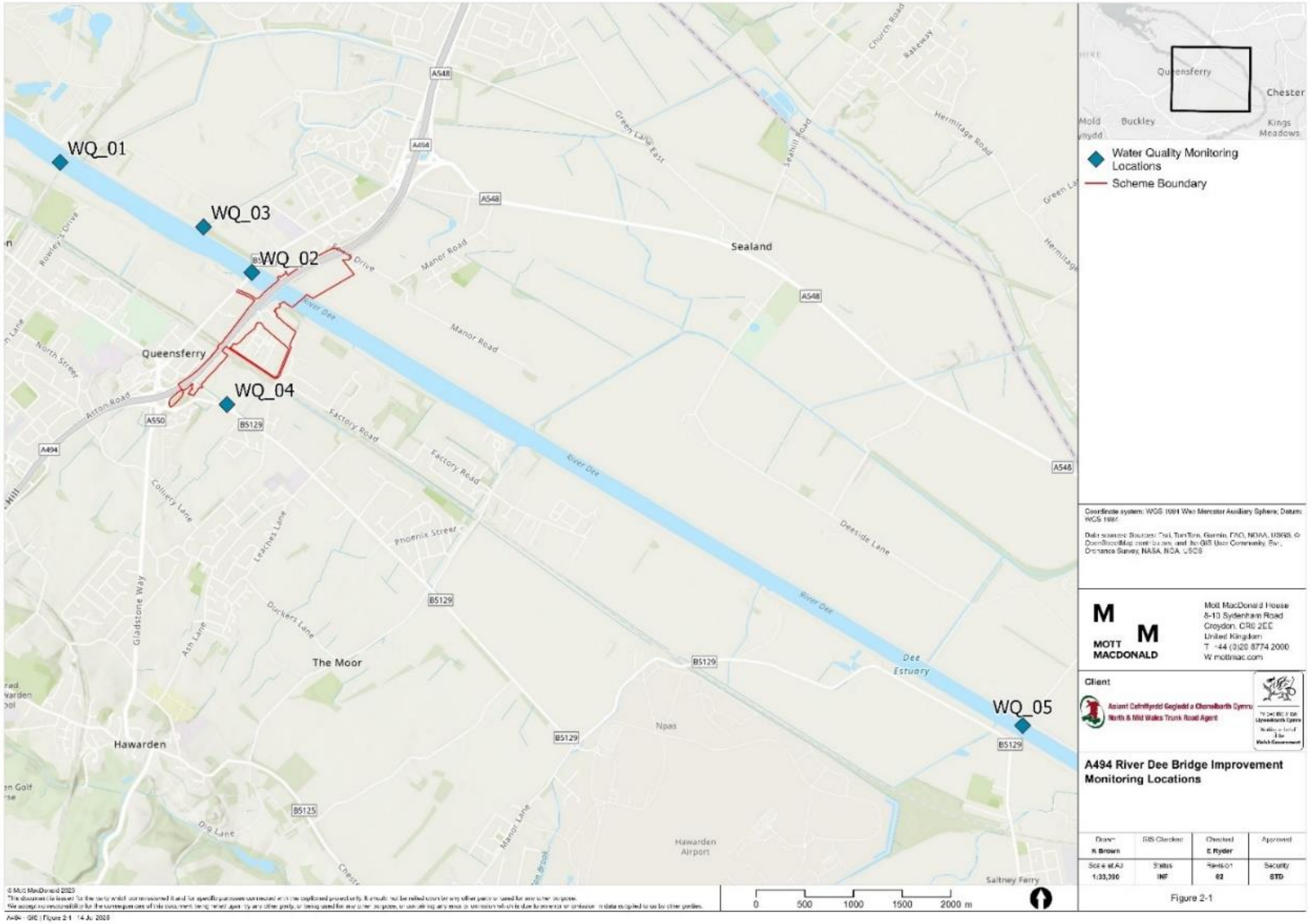
2.3 Monitoring locations

2.3.1 Monitoring locations have been selected to provide comprehensive baseline water quality characteristics of the Scheme and the surrounding area. Six locations were chosen after an initial walkover conducted October 2024. This was reduced to five during the first survey due to one location (Garden City Swale) not having a constant flow of water in the watercourse. Due to restrictions with land access and safe access to watercourses no monitoring locations are within the Scheme boundary. The monitoring locations cover the following watercourses:

a) River Dee
b) Queensferry Drain
c) Garden City Drain.

2.3.2 The monitoring sample locations are shown in Figure 2-1 Further information about each location is detailed in Appendix 5.1.

Figure 2-1 A494 monitoring locations



2.4 Monitoring frequency

2.4.1 The baseline water quality monitoring programme includes 6 monthly rounds of monitoring (November 2024 to April 2025).

2.5 Limitations and assumptions

2.5.1 The following limitations and assumptions were identified:

a) The data is based on spot sampling, with six samples collected between November 2024 and April 2025 . While this does not represent a full year's monitoring, it does capture some seasonal variation with lower and higher fluvial flows represented and is therefore considered to be adequate for the purposes of the EIA. However, it is recommended that monitoring be continued to also capture periods of low flows, if possible.

b) All samples were taken from the surface layer of the water column, which is assumed to be representative of conditions in deeper layers.

c) Samples were taken at high tide, so results will be dominated by saline water.

d) Rainfall data from the Hawarden[7] rainfall gauge was used, which is assumed to be representative of the Scheme location. This is the nearest gauge, located about 5 km southeast of the Scheme.

e) Although WQ04 is classified as a freshwater site, as it is not on a tidal influenced section of the Queensferry Drain. However, the same monitoring suite was used to maintain consistency with other monitoring locations.

f) WQ04 was the furthest downstream monitoring site accessible on Queensferry Drain. Although a site further downstream would have been preferable, it was not feasible due to land access constraints and lack of safe access to the watercourse.

g) No monitoring was undertaken in February and March 2025 as the river level was too low to sample from the bridge edge due to early/late high tides outside of sampling time.

h) Due to a broken container there may be some sample discrepancy for the results of the April 2025 survey.

i) Some Polycyclic Aromatic Hydrcarbons (PAHs) could not be compared to the EQS standards as the standards were below the limit of detection (LOD) of the laboratory equipment.

[7] Meteostat, 2025. *Hawarden | Weather History & Climate*. Available at: https://meteostat.net/en/station/03321?t=2024-11-01/2025-04-30. Accessed August 2025.

2.6 Parameter suite

2.6.1 Due to the Scheme being located on the transitional reach of the River Dee, the transitional monitoring suite provided by Eurofins was chosen for monitoring locations, as the parameters reflect the transitional nature of the water body. The full list of parameters included are outlined in Table 2-1 below.

Table 2-1 All parameters in transitional suite and relevance

Parameter	Unit	Accreditation	Relevance
Temperature	°C	N/A	Inform understanding of general baseline characteristics.
Salinity	ppt	N/A	
Dissolved Oxygen	mg O2/l	N/A	Inform understanding of general baseline characteristics including potential pollution sources (such as sewage and outfalls) and water quality concentrations for supporting aquatic species including fish. Parameter potentially impacted by construction and operational activities.
Suspended solids at 105°C	mg/l	UKAS	Inform understanding of general baseline characteristics including runoff and its potential impact on sediment loads. Key parameter potentially impacted by construction and operational activities.
Total Hardness as CaCO3	mg/l	UKAS	Inform understanding of general baseline characteristics and input into the HEWRAT assessment.
pH at 20°C	N/A	UKAS	Inform understanding of general baseline characteristics. Concentrations used to input into the HEWRAT assessment and M-BAT. Key parameter potentially impacted by construction activities e.g., concrete may increase alkalinity which could have an adverse impact on aquatic ecology.
Calcium (Dissolved)	mg/l	UKAS	Inform understanding of general baseline characteristics and inputs to the HEWRAT assessment and M-BAT.
Dissolved Organic Carbon (DOC)	mg/l	UKAS	
Copper (Dissolved)	µg/l	UKAS	Inform understanding of general baseline characteristics and inputs to the HEWRAT assessment. Zinc has a harmful effect on biological quality UKTAG[8].
Zinc (Dissolved)	µg/l	UKAS	
Arsenic (Dissolved)	µg/l	UKAS	Heavy metal concentrations could be increased as a result of construction and operational activities. Sampling to inform understanding of general baseline characteristics for heavy metals.
Chromium (Dissolved)	µg/l	UKAS	
Mercury (Dissolved)	µg/l	UKAS	
Nickel (Dissolved)	µg/l	UKAS	
Lead (Dissolved)	µg/l	UKAS	
Cadmium (Dissolved)	µg/l	UKAS	Heavy metal concentrations could be increased as a result of construction and operational activities. Sampling to inform understanding of general baseline characteristics for heavy metals. Cadmium is a priority hazardous substance under the WFD.
Ammonium (NH4+)	mg/l	UKAS	Concentrations are WFD elements and nutrient loading could impact sensitive habitats present such as salt marshes.
Nitrite as NO2	mg/l	UKAS	

[8] UK Technical Advisory Group

Parameter	Unit	Accreditation	Relevance
Nitrate as NO3	mg/l	UKAS	
Phosphate	mg/l	UKAS	
Total Of 16 PAH's	µg/L	UKAS	PAHs could be increased as a result of operational activities (e.g., road drainage runoff). Sampling to inform understanding of general baseline characteristics. PAHs are priority hazardous substances under WFD and have a Moderate classification status in Dee (N.Wales) transitional water body. PAHs are recognised as ubiquitous persistent, bioaccumulative, and toxic (uPBT) compounds. In addition, five of the included PAHs are listed in Annex III of the Persistent Organic Pollutants (POPs) Regulation (EC 850/2004).
Benzo(b)fluoranthene	µg/l	UKAS	
Benzo(k)fluoranthene	µg/l	UKAS	
Benzo(a)pyrene	µg/l	UKAS	
Indeno(1,2,3-cd)pyrene	µg/l	UKAS	
Benzo(g,h,i)perylene	µg/l	UKAS	
Naphthalene	µg/l	UKAS	
Acenaphthalene	µg/l	UKAS	
Acenaphthene	µg/L	UKAS	
Fluorene	µg/L	UKAS	
Phenanthrene	µg/L	UKAS	
Anthracene	µg/L	UKAS	
Fluoranthene	µg/L	UKAS	
Pyrene	µg/L	UKAS	
Benzo(a)anthracene	µg/L	UKAS	
Chrysene	µg/L	UKAS	
Dibenz(a,h)Anthracene	µg/L	UKAS	
2,2',4,4',6-pentabromodiphenyl ether (BDE-100)	µg/L	N/A	BDPEs are recognised as priority hazardous substances under WFD. There are ongoing concerns related to continuous sewage discharge and the presence of contaminated bed sediment.
2,2',3,4,4',5'-hexabromodiphenyl ether (BDE-138)	µg/L	N/A	
2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153)	µg/L	N/A	
2,2',4,4',5,6'-hexabromodiphenyl ether (BDE-154)	µg/L	N/A	

Parameter	Unit	Accreditation	Relevance
2,2',3,4,4',5',6-heptabromodiphenyl ether (BDE-183)	µg/L	N/A	
2,4,4'-tribromodiphenyl ether (BDE-28)	µg/L	N/A	
2,2',4,4'-tetrabromodiphenyl ether (BDE-47)	µg/L	N/A	
2,3',4,4'-tetrabromodiphenyl ether (BDE-66)	µg/L	N/A	
2,2',3,4,4'-pentabromodiphenyl ether (BDE-85)	µg/L	N/A	
2,2',4,4',5-pentabromodiphenyl ether (BDE-99)	µg/L	N/A	

2.7 Environmental Quality Standards

Suspended solids

2.7.1 Suspended solids could not be assessed against any established environmental standards, such as Environmental Quality Standards (EQS) or Water Framework Directive (WFD) thresholds, as none currently exist for this parameter. Therefore, a limit of 78 mg/l has been used as a proxy maximum threshold, based on average background levels in NRW data at Dee at Queensferry Blue Bridge, which is considered appropriate using professional judgement. It should be noted that the average was created from NRW data from 2000 to 2004[9], as this was the only data available.

Metals

2.7.2 Among the metals measured in the transitional suite, three have applicable EQS standards: arsenic (25 µg/l for estuarine and 50 µg/l for freshwater), copper (a DOC-dependent formula for estuarine and 1 µg/l for freshwater) and zinc (6.8 µg/l for estuarine and 10.9 µg/l for freshwater). Road runoff contains metals, with copper and zinc being two of the most common contaminants, both of which are assessed using the HEWRAT. The sample results were compared to the EQS thresholds to determine if the baseline levels in the environment are acceptable and whether the current levels have the potential to cause harm.

pH

2.7.3 pH has a EQS standards of 8.5 for estuarine environments and 6-9 for freshwater environments. pH impacts the solubility of metals and is used as an input in HEWRAT assessments. Changes in pH could influence ecology, with many species being sensitive to small changes in pH. The sample results will be compared to the EQS thresholds to determine if the baseline levels are acceptable and if current levels have the potential to cause harm.

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[9] Natural Resources Wales, 2025. NRW Water Quality Data – ShareFile Download. Available at: Natural Resources Wales - Citrix FileShare. Accessed July 2025.

PAHs

2.7.4 Of the PAHs measured as part of the transitional suite, seven have applicable EQS standards: naphthalene (2 µg/l for annual average and 130 µg/l for maximum allowable for both estuarine and freshwater), anthracene (0.1 µg/l for both estuarine and freshwater), floranthene (0.01 µg/l for annual average and 0.12 µg/l for maximum allowable for both estuarine and freshwater), benzo[b]fluoranthene (0.02 µg/l for both estuarine and freshwater), benzo[k]fluoranthene (0.02 µg/l for both estuarine and freshwater), benzo[a]pyrene (0.03 µg/l for both estuarine and freshwater), and benzo[g,h,i]perylene (0.00082 µg/l for both estuarine and freshwater). Road runoff can include PAHs and can be highly persistent in the environment and pose ecological risks.

3. Analysis of results

3.1.1 The following section presents the results of the surveys for each of the monitoring locations and a discussion of key trends observed. The full results for each location are presented in Appendix 5.1 in Table 5-2 to Table 5-6 and graphs of the key parameters are presented in Appendix 5.3 in Figure 5-1 to Figure 5-5 Comparison to EQS have also been considered with full results in Appendix 5.4.

3.2 Downstream of Scheme

WQ01- River Dee

3.2.1 Suspended solids concentrations remained consistently high across all four monitoring events, ranging from 140 mg/l in January 2025 to a peak of 380 mg/l in November 2024. All samples were above the 78 mg/l reference proxy threshold determined for suspended solids and therefore are considered elevated. This may indicate substantial active sediment transport, runoff contributions, or resuspension processes. The notably high value (380 mg/l) recorded in November 2024 coincided with a period of prolonged moderate precipitation, which likely increased surface runoff. Such conditions can enhance erosion and mobilise sediments from surrounding land surfaces, further contributing to the elevated suspended solids observed.

3.2.2 Copper concentrations remained relatively stable throughout the monitoring period, generally ranging between 2 and 3 µg/l. An exception was observed in April 2025, where levels dropped to 1.2 µg/l. All four samples did not exceed the EQS standards for transitional waters (Table 5-7 The variability observed may indicate the presence of intermittent sources, such as industrial or wastewater discharges, or road runoff, particularly during rainfall events, and the tidal influence could contribute to fluctuations in copper concentrations through mixing or resuspension processes.

3.2.3 WQ01 recorded the highest average and peak zinc concentrations across all monitored sites, with values ranging from 11 µg/l to 25 µg/l over the four monitoring visits, all of which are higher than the EQS standard (Table 5-7 The highest zinc concentration, recorded in November 2024 coincided with a peak in suspended solids. As WQ01 is the most downstream site on the River Dee and exhibits the highest zinc levels, this may indicate the presence of a pollution source between WQ03 and WQ01 or the elevated concentrations could be influenced by tidal processes, which may enhance the mobilisation or resuspension of zinc-containing sediments.

3.2.4 Arsenic concentrations across the four samples ranged from 1.5 to 4 µg/l, with the highest concentration recorded in January 2025 which was the highest value recorded across all sites throughout the monitoring period. All measured concentrations remained below the EQS threshold (25 µg/l for estuarine and 50 µg/l for freshwater).

3.2.5 Chromium concentrations across the four samples ranged from below the limit of detection (<0.5 µg/l) to 26 µg/l. Two samples had detectable concentrations: 26 µg/l in November 2024 and 3.7 µg/l in January 2025. The November result was notably higher and not observed at any other site, while the January concentration was consistent across all sites.

WQ02- River Dee

3.2.6 Suspended solids concentrations ranged from a minimum of 5 mg/l in March 2025 to a maximum of 390 mg/l in April 2025, this large variation was not seen downstream at WQ01. Although maximum concentrations at both sites were similar (380 mg/l at WQ01), the lowest concentration at site WQ01 was 140 mg/l. The sharp increases in April 2025 could correspond with runoff events, tidal resuspension, disturbance of bottom sediments or a potential discharge event.

3.2.7 Dissolved copper concentrations remained relatively stable at WQ02, with only minor fluctuations observed across the monitoring events. The lowest recorded value was 0.97 µg/L in March 2025, while all other measurements ranged between 1.2 µg/l (April 2025) and 2.7 µg/l (January 2025).

3.2.8 Zinc concentrations ranged from a minimum of 5.8 µg/l in January 2025 to a maximum of 15 µg/, recorded in both November 2024 and March 2025, compared to EQS values of 6.8 µg/l for estuarine and 10.9 µg/l for freshwater.

3.2.9 Arsenic concentrations across the six samples ranged from 0.7 to 3.5 µg/l, with the lowest concentration in March 2025 and highest concentration recorded in February 2025. All measured concentrations remained below the EQS threshold.

3.2.10 Chromium (VI) concentrations ranged from <0.5 (limit of detection) to 4 µg/l across the six samples, with the highest concentration recorded in January 2025. This increase was consistent with similar elevations observed at all other sites during the same month.

WQ03 – Garden City Drain

3.2.11 An increase in suspended solids was observed at this site in April 2025, reaching a concentration of 400 mg/l.

3.2.12 Copper concentrations ranged from a peak of 3.1 µg/l in November 2024 to a low of 0.98 µg/l in March and April 2025. Zinc concentrations displayed some variability over the six-month monitoring period, ranging from 8.8 µg/l in April to a peak of 16 µg/l in March 2025.

3.2.13 Arsenic concentrations across the six samples ranged from 1.3 to 3.1 µg/l, with the lowest concentration in January 2025 and highest concentration recorded in April 2025. All measured concentrations remained below the EQS threshold (25 µg/l).

3.2.14 Chromium (VI) concentrations ranged from <0.5 (limit of detection) to 3.9 µg/l across the six samples, with the highest concentration recorded in January 2025. This increase was consistent with similar elevations observed at all other sites during the same month.

3.3 Upstream of Scheme

WQ05- River Dee

3.3.1 Suspended solids concentrations ranged from a low of 7 mg/l in March 2025 to a peak of 130 mg/l in December 2024. These variations reflect the dynamic nature of the River Dee and may be influenced by both anthropogenic activities and natural processes. On average, suspended solids levels at WQ05 were lower than those recorded at downstream site WQ02.

3.3.2 Copper concentrations remained relatively stable throughout the six-month monitoring period, with a slight decline to 0.74 µg/l observed in March 2025. All other values ranged between 1.5 µg/l (April 2025) and 2.7 µg/l (January 2025), following a similar pattern to that observed at WQ02. Similarly, downstream at WQ02, concentrations remained relatively consistent across all months and matched peak concentration seen at site WQ05.

3.3.3 WQ05 recorded the most stable zinc concentrations across all monitored sites during the six-month monitoring period, with values ranging between 7.7 µg/l and 11 µg/l. This limited variability in zinc concentrations suggests minimal influence from intermittent pollution sources such as road runoff or industrial discharges. The consistent and low levels may reflect relatively undisturbed conditions, effective dilution, or the absence of inputs. As WQ05 is the most upstream site within the transitional section of the River Dee and is therefore the least affected by tidal influence, these results may highlight the role of tidal processes in elevating zinc concentrations further downstream. A similar pattern was observed downstream at WQ02, though with larger fluctuations in concentration. This further supports the influence of tidal activity, which would be less pronounced at WQ05 as it is further inland.

3.3.4 Arsenic concentrations across the six samples ranged from 0.6 to 1.8 µg/l, with the lowest concentration in February 2025 and highest concentration recorded in November 2024. All measured concentrations remained below the EQS threshold (25 µg/l).

3.3.5 Similar to WQ02, chromium concentrations ranged from <0.5 (limit of detection) to 4 µg/l across the six samples, with the highest concentration recorded in January 2025. This increase was consistent with similar elevations observed at all other sites during the same month.

3.3.6 Concentrations of the Total of 16 PAHs remained below 2.0 µg/l until an increase was recorded in March 2025, reaching 270 µg/l. Several individual PAHs, also recorded an increase including naphthalene, acenaphthylene, acenaphthene, fluorene, and phenanthrene. These findings closely mirror those observed at WQ04. WQ04 is located on a separate watercourse (Queensferry Drain) which discharges into the River Dee downstream of WQ05. Additionally, the sample from WQ04 was collected approximately two hours earlier than the one from WQ05, making it unlikely that the observed increase in concentration originates from the same point source. Given that WQ05 is tidally influenced, sediment resuspension or water column mixing could also contribute to elevated PAH levels.

WQ04 – Queensferry Drain

3.3.7 WQ04 is located on the Queensferry Drain, approximately 600 metres upstream from the discharge point into the River Dee, just upstream of the Scheme.

3.3.8 Suspended solids concentrations remained generally low throughout the six-month monitoring period compared to other sites, with values ranging from a minimum of 11 mg/l in March 2025 to a maximum of 90 mg/l in December 2024.

3.3.9 Copper concentrations at WQ04 ranged from a peak of 5.8 µg/l in November 2024, the highest recorded across all sites, to a low of 0.97 µg/l in April 2025. This downward trend suggests a reduction in copper inputs over time, which could also reflect broader seasonal trends.

3.3.10 Zinc concentrations demonstrated high variability over the six-month monitoring period, ranging from a low of 3.4 µg/l in April 2025 to a peak of 21 µg/l in November 2024.

3.3.11 Arsenic concentrations were relatively stable at this location ranging from 1.1 to 1.5 µg/l, with the lowest concentration in December 2024/January 2025 and highest concentration recorded in November 2024. All measured concentrations remained below the EQS threshold (50 µg/l).

3.3.12 Chromium concentrations ranged from <0.5 (limit of detection) to 3.8 µg/l across the six samples, with the highest concentration recorded in January 2025. This increase was consistent with similar elevations observed at all other sites during the same month.

3.3.13 Dissolved oxygen levels ‘high’ under WFD classification[10] for river water bodies throughout the monitoring period, except for a single ‘good’ classification recorded in January. This indicates generally favourable oxygenation conditions, which are important for supporting aquatic life.

3.3.14 pH levels remained in the ‘High/Good’ WFD classification range (> or = pH 6 to < or = pH 9) for the entire monitoring period indicating stable neutral to alkaline conditions in the water body.

3.3.15 Concentrations of the ‘Total of 16 PAHs’ remained below 2.0 µg/l throughout most of the monitoring period, except for an increase to 45 µg/l recorded in February 2025. Individual PAHs, including naphthalene, acenaphthylene, acenaphthene, fluorene, and phenanthrene, all recorded associated increases.

3.4 All sites

3.4.1 All readings for the below elements are noted as ‘unknown’ for all sites and dates throughout the monitoring period. This is due to the EQS standard being lower than the laboratory’s limit of detection.

- Benzo[b]fluoranthene
- Benzo[k]fluoranthene
- Benzo[a]pyrene
- Benzo[g,h,i]perylene
- Fluoranthene (maximum allowable concentrations of these elements are present and are noted as a ‘pass’ for all monitoring periods at all locations)

3.4.2 All values for cadmium and pyrene were below the detection limit for all sites (0.11µg/l and 0.1µg/l respectively), indicating low or negligible levels.

[10] Secretary of State and Welsh Ministers, 2015. *The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015*. Available at: https://www.legislation.gov.uk/uksi/2015/1623/pdfs/uksiod_20151623_en_auto.pdf. Accessed August 2025.

3.4.3 Zinc concentrations exceeded the EQS threshold at all transitional sites (WQ01, WQ02, WQ03, and WQ05), except for a single sample collected at WQ02 in January 2025.

3.4.4 Arsenic concentrations were consistently below EQS threshold for all samples collected across all monitoring sites.

3.4.5 All monitoring sites recorded an increase in chromium (VI) concentrations to approximately 4 µg/l in January 2025.

3.4.6 Dissolved oxygen levels were consistently classified as a 'High' status under WFD classification[10] for all samples across the transitional monitoring sites (WQ01, WQ02, WQ03 and WQ05) throughout the monitoring period.

4. Summary

4.1.1 This baseline water quality report outlines the methodology that was used for surveying the baseline water quality. Spot samples were obtained at five locations surrounding the Scheme during high tide to gather baseline water quality data over a six month period.

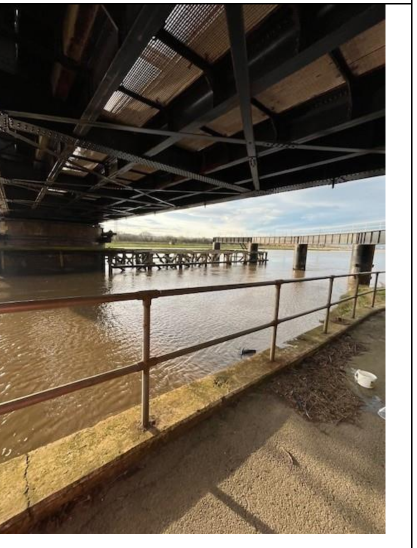
4.1.2 Most of the survey locations are within the transitional section of the River Dee, so the transitional suite was chosen as the most appropriate parameters to be analysed. This suite covers a wide range of parameters which will allow assessment of the baseline water quality and potential risks during construction and operation and to support the HEWRAT**Error! Bookmark not defined.** and WFD a ssessment[2] [1].

4.1.3 Elevated levels, above relevant thresholds (e.g. EQS), of suspended solids, metals (notably chromium and zinc), and PAHs were detected at various times often across multiple sites, with peaks in November 2024 (zinc) January 2025 (chromium) and March 2025 (PAHs).

5. Appendices

5.1 Monitoring sites

Table 5-1 Monitoring locations and rationale

Sample reference and location	Eastings	Northings	Watercourse	Rationale	Photos (Taken from survey on 17/12/2024)
WQ_01 (Hawarden Bridge)	331053	369380	River Dee	Sample ~1.5 km downstream of Scheme for general baseline characteristics.	

WQ_02 **(B5441 Bridge)**	332224	368688	River Dee	Sample ~0.5 km downstream of Scheme for general baseline characteristics	
WQ_03 **(Garden City Drain outfall)**	331904	368932	Garden City Drain	Outfall location for general baseline catchment characteristics. HEWRAT not carried out as discharging into tidal water body.	

WQ_04 (Queensferry Drain near Chester Road E)	332064	367879	Queensferry Drain	Outfall location for HEWRAT assessment and general baseline catchment characteristics	
WQ_05 (Higher Ferry Saltney Footbridge)	336933	365838	River Dee	Sample ~5 km upstream of Scheme for general baseline characteristics	

5.2 Water quality survey results

WQ01

Table 5-2 WQ01 survey results

Determinand	Unit	19/11/2024 12:39	17/12/2024 13:19	29/01/2025 11:49	30/04/2025 13:45
Temperature	°C	9.90	9.80	8.10	18.3
pH at 20C		7.80	7.80	7.70	7.7
Salinity	ppt	18.00	18.00	< 2.0	31
Suspended Solids At 105C	mg/l	380.00	260.00	140.00	370
Dissolved Oxygen	mg O2/l	10.00	8.10	8.20	8.3
Ammonium	mg/l	1.20	1.20	0.15	0.85
Nitrite as NO2	mg/l	0.26	0.12	0.10	0.028
Nitrate as NO3	mg/l	0.57	< 0.50	4.80	< 0.50
Phosphate	mg/l	0.31	< 0.20	0.21	< 0.20
Calcium (Dissolved)	mg/l	330.00	180.00	45.00	360
Total Hardness as CaCO3	mg/l	810.00	2400.00	380.00	900
Arsenic (Dissolved)	µg/l	4.00	2.00	1.50	3.1
Cadmium (Dissolved)	µg/l	< 0.11	< 0.11	< 0.11	< 0.11
Chromium (Dissolved)	µg/l	26.00	< 0.50	3.70	< 0.50
Copper (Dissolved)	µg/l	3.20	2.40	3.00	1.2
Mercury (Dissolved)	µg/l	< 0.05	< 0.05	< 0.05	< 0.05
Nickel (Dissolved)	µg/l	19.00	0.81	3.00	0.96
Lead (Dissolved)	µg/l	< 0.50	< 0.50	< 0.50	< 0.50
Zinc (Dissolved)	µg/l	25.00	12.00	11.00	16
Dissolved Organic Carbon	mg/l	4.80	4.40	8.10	3.5
Naphthalene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Acenaphthylene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Acenaphthene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10

Determinand	Unit	19/11/2024 12:39	17/12/2024 13:19	29/01/2025 11:49	30/04/2025 13:45
Fluorene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Phenanthrene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Anthracene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Fluoranthene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Pyrene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Benzo[a]anthracene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Chrysene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Benzo[b]fluoranthene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Benzo[k]fluoranthene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Benzo[a]pyrene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Dibenz(a,h)Anthracene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Benzo[g,h,i]perylene	µg/l	< 0.10	< 0.10	[D] < 0.10	< 0.10
Total Of 16 PAH's	µg/l	< 2.0	< 2.0	[D] < 2.0	< 2.0
2,2',4,4',6-pentabromodiphenyl ether (BDE-100)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01
2,2',3,4,4',5'-hexabromodiphenyl ether (BDE-138)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4',5,6'-hexabromodiphenyl ether (BDE-154)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01
2,2',3,4,4',5',6-heptabromodiphenyl ether (BDE-183)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01
2,4,4'-tribromodiphenyl ether (BDE-28)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4'-tetrabromodiphenyl ether (BDE-47)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01
2,3',4,4'-tetrabromodiphenyl ether (BDE-66)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01
2,2',3,4,4'-pentabromodiphenyl ether (BDE-85)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4',5-pentabromodiphenyl ether (BDE-99)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01

[D] – Damaged - broken container

WQ02

Table 5-3 WQ02 survey results

Determinand	Unit	19/11/2024 12:07	17/12/2024 12:54	29/01/2025 12:28	25/02/2025 11:44	25/03/2025 11:16	30/04/2025 13:20
Temperature	°C	9.9	9.8	8.1	10.8	10.6*	18.3
pH at 20C		8.4	7.9	7.8	7.6	8.2	7.8
Salinity	ppt	< 2.0	12	< 2.0	< 2.0	< 2.0	28
Suspended Solids At 105C	mg/l	120	170	21	66	5	390
Dissolved Oxygen	mg O2/l	11	8.2	7.8	8.4	11	9.8
Ammonium	mg/l	0.16	0.83	0.083	0.087	5.4	0.96
Nitrite as NO2	mg/l	0.12	0.11	0.089	< 0.020	0.23	0.071
Nitrate as NO3	mg/l	18	0.82	5.9	5.8	16	< 0.50
Phosphate	mg/l	0.5	< 0.20	< 0.20	< 0.20	0.63	0.24
Calcium (Dissolved)	mg/l	52	160	24	16	64	340
Total Hardness as CaCO3	mg/l	220	2100	92	54	360	850
Arsenic (Dissolved)	µg/l	2.3	2	1.2	0.7	3.5	3.3
Cadmium (Dissolved)	µg/l	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11
Chromium (Dissolved)	µg/l	0.53	< 0.50	4	< 0.50	< 0.50	< 0.50
Copper (Dissolved)	µg/l	2.6	2.4	2.7	1.7	0.97	1.2
tMercury (Dissolved)	µg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel (Dissolved)	µg/l	1.5	0.74	3.2	0.7	1.1	0.81
Lead (Dissolved)	µg/l	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Zinc (Dissolved)	µg/l	15	13	5.8	9	15	11
Dissolved Organic Carbon	mg/l	7.2	5.8	5.4	7	5.7	3.2
Naphthalene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Determinand	Unit	19/11/2024 12:07	17/12/2024 12:54	29/01/2025 12:28	25/02/2025 11:44	25/03/2025 11:16	30/04/2025 13:20
Fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	µg/l	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
2,2',4,4',6-pentabromodiphenyl ether (BDE-100)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',3,4,4',5'-hexabromodiphenyl ether (BDE-138)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4',5,6'-hexabromodiphenyl ether (BDE-154)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',3,4,4',5',6-heptabromodiphenyl ether (BDE-183)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,4,4'-tribromodiphenyl ether (BDE-28)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4'-tetrabromodiphenyl ether (BDE-47)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,3',4,4'-tetrabromodiphenyl ether (BDE-66)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',3,4,4'-pentabromodiphenyl ether (BDE-85)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4',5-pentabromodiphenyl ether (BDE-99)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

* Appropriate cooling measures were not taken for sample

WQ03

Table 5-4 WQ03 survey results

Determinand	Unit	19/11/2024 11:38	17/12/2024 12:35	29/01/2025 11:32	25/02/2025 11:04	25/03/2025 10:58	30/04/2025 11:17
Temperature	°C	10.1	9.8	8.1	10.8	10.6*	15.9
pH at 20C		8.3	8	7.8	7.4	8.3	7.7
Salinity	ppt	< 2.0	13	< 2.0	< 2.0	2.5	30
Suspended Solids At 105C	mg/l	150	180	78	76	73	400
Dissolved Oxygen	mg O2/l	12	8.6	8	8.7	12	8.7
Ammonium	mg/l	0.18	1	0.17	0.17	< 0.050	1.2
Nitrite as NO2	mg/l	0.14	0.12	0.061	0.02	0.073	0.033
Nitrate as NO3	mg/l	12	0.58	5.5	6.1	1.3	< 0.50
Phosphate	mg/l	0.22	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Calcium (Dissolved)	mg/l	55	170	39	18	99	350
Total Hardness as CaCO3	mg/l	210	2300	290	68	580	880
Arsenic (Dissolved)	µg/l	2.4	1.9	1.3	1.7	2.9	3.1
Cadmium (Dissolved)	µg/l	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11
Chromium (Dissolved)	µg/l	0.78	0.5	3.9	< 0.50	< 0.50	< 0.50
Copper (Dissolved)	µg/l	3.1	2.2	2.7	1.9	1.1	0.98
Mercury (Dissolved)	µg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel (Dissolved)	µg/l	1.4	0.94	3.1	0.66	0.78	< 0.50
Lead (Dissolved)	µg/l	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Zinc (Dissolved)	µg/l	14	13	8.9	9.5	16	8.8
Dissolved Organic Carbon	mg/l	7	4.2	4.6	7	6.9	3.7
Naphthalene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	2.2	< 0.10
Acenaphthylene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Determinand	Unit	19/11/2024 11:38	17/12/2024 12:35	29/01/2025 11:32	25/02/2025 11:04	25/03/2025 10:58	30/04/2025 11:17
Fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	µg/l	< 2.0	< 2.0	< 2.0	< 2.0	2.2	< 2.0
2,2',4,4',6-pentabromodiphenyl ether (BDE-100)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',3,4,4',5'-hexabromodiphenyl ether (BDE-138)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',4,4',5,6'-hexabromodiphenyl ether (BDE-154)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',3,4,4',5',6-heptabromodiphenyl ether (BDE-183)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,4,4'-tribromodiphenyl ether (BDE-28)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',4,4'-tetrabromodiphenyl ether (BDE-47)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,3',4,4'-tetrabromodiphenyl ether (BDE-66)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',3,4,4'-pentabromodiphenyl ether (BDE-85)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',4,4',5-pentabromodiphenyl ether (BDE-99)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01

[T] – No monitoring time provided
* Appropriate cooling measures were not taken for sample

WQ04

Table 5-5 WQ04 survey results

Determinand	Unit	19/11/2024 14:25	17/12/2024 15:10	29/01/2025 14:31	25/02/2025 13:27	25/03/2025 11:57	30/04/2025 11:31
Temperature	°C	10.1	9.8	8.1	10.8	10.6*	15.9
pH at 20C		8.3	8.6	8.1	8.5	8.6	8.4
Salinity	ppt	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	2.7
Suspended Solids At 105C	mg/l	37	90	15	77	11	33
Dissolved Oxygen	mg O2/l	11	8.5	7.9	8.6	12	9.2
Ammonium	mg/l	0.28	< 0.050	0.16	0.17	< 0.050	0.51
Nitrite as NO2	mg/l	0.1	0.12	0.062	0.092	0.14	0.29
Nitrate as NO3	mg/l	9.9	11	7.3	9.7	12	14
Phosphate	mg/l	0.27	< 0.20	0.28	< 0.20	< 0.20	0.33
Calcium (Dissolved)	mg/l	60	85	69	81	83	75
Total Hardness as CaCO3	mg/l	200	290	240	270	290	260
Arsenic (Dissolved)	µg/l	1.5	1.1	1.1	1.2	1.1	1.3
Cadmium (Dissolved)	µg/l	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11
Chromium (Dissolved)	µg/l	0.58	< 0.50	3.8	< 0.50	< 0.50	< 0.50
Copper (Dissolved)	µg/l	5.8	2.6	4	1	1	0.97
Mercury (Dissolved)	µg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel (Dissolved)	µg/l	2.8	1.6	4.3	1.3	1.1	< 0.50
Lead (Dissolved)	µg/l	0.63	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Zinc (Dissolved)	µg/l	21	8.6	6.1	8.7	16	3.4
Dissolved Organic Carbon	mg/l	12	7.2	7.3	5.3	4.8	3.9
Naphthalene	µg/l	< 0.10	< 0.10	< 0.10	36	< 0.10	< 0.10
Acenaphthylene	µg/l	< 0.10	< 0.10	< 0.10	0.85	< 0.10	< 0.10
Acenaphthene	µg/l	< 0.10	< 0.10	< 0.10	4.8	< 0.10	< 0.10
Fluorene	µg/l	< 0.10	< 0.10	< 0.10	1.6	< 0.10	< 0.10
Phenanthrene	µg/l	< 0.10	< 0.10	< 0.10	1.7	< 0.10	< 0.10
Anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Determinand	Unit	19/11/2024 14:25	17/12/2024 15:10	29/01/2025 14:31	25/02/2025 13:27	25/03/2025 11:57	30/04/2025 11:31
Fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	µg/l	< 2.0	< 2.0	< 2.0	45	< 2.0	< 2.0
2,2',4,4',6-pentabromodiphenyl ether (BDE-100)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',3,4,4',5'-hexabromodiphenyl ether (BDE-138)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',4,4',5,6'-hexabromodiphenyl ether (BDE-154)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',3,4,4',5',6-heptabromodiphenyl ether (BDE-183)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,4,4'-tribromodiphenyl ether (BDE-28)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',4,4'-tetrabromodiphenyl ether (BDE-47)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,3',4,4'-tetrabromodiphenyl ether (BDE-66)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',3,4,4'-pentabromodiphenyl ether (BDE-85)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01
2,2',4,4',5-pentabromodiphenyl ether (BDE-99)	µg/L	< 0.01	< 0.01	< 0.01	[T] < 0.01	< 0.01	< 0.01

[T] – No monitoring time provided
* Appropriate cooling measures were not taken for sample

WQ05

Table 5-6 WQ05 survey results

Determinand	Unit	19/11/2024 14:25	17/12/2024 14:47	29/01/2025 14:00	25/02/2025 13:06	25/03/2025 13:14	30/04/2026 12:30
Temperature	°C	10.3	9.8	8.1	10.2	11.6*	15.6
pH at 20C		8.2	8.5	8	7.6	8.3	8
Salinity	ppt	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Suspended Solids At 105C	mg/l	34	130	40	55	7	120
Dissolved Oxygen	mg O2/l	10	8.1	7.5	11	12	7.3
Ammonium	mg/l	0.29	0.13	0.077	0.13	< 0.050	0.94
Nitrite as NO2	mg/l	0.29	0.096	0.085	0.036	0.18	0.17
Nitrate as NO3	mg/l	23	9.1	5.8	5.7	16	15
Phosphate	mg/l	0.43	0.23	< 0.20	< 0.20	< 0.20	0.33
Calcium (Dissolved)	mg/l	52	28	20	17	48	38
Total Hardness as CaCO3	mg/l	220	93	65	56	170	150
Arsenic (Dissolved)	µg/l	1.8	0.83	0.66	0.6	0.82	1.5
Cadmium (Dissolved)	µg/l	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11
Chromium (Dissolved)	µg/l	< 0.50	< 0.50	4	0.54	< 0.50	< 0.50
Copper (Dissolved)	µg/l	2.2	2.4	2.7	1.8	0.74	1.5
Mercury (Dissolved)	µg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel (Dissolved)	µg/l	1.7	0.92	3.1	1.1	0.93	0.89
Lead (Dissolved)	µg/l	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Zinc (Dissolved)	µg/l	11	8.7	8	11	11	7.7
Dissolved Organic Carbon	mg/l	7.7	6.6	5.4	8	5.3	5.4
Naphthalene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	260	< 0.10
Acenaphthylene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	4	< 0.10
Acenaphthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	4.7	< 0.10
Fluorene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	1.3	< 0.10
Phenanthrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	1.8	< 0.10
Anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Determinand	Unit	19/11/2024 14:25	17/12/2024 14:47	29/01/2025 14:00	25/02/2025 13:06	25/03/2025 13:14	30/04/2026 12:30
Fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	µg/l	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	µg/l	< 2.0	< 2.0	< 2.0	< 2.0	270	< 2.0
2,2',4,4',6-pentabromodiphenyl ether (BDE-100)	µg/L	[TXH] < 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',3,4,4',5'-hexabromodiphenyl ether (BDE-138)	µg/L	[TXH] < 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153)	µg/L	[TXH] < 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4',5,6'-hexabromodiphenyl ether (BDE-154)	µg/L	[TXH] < 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',3,4,4',5',6-heptabromodiphenyl ether (BDE-183)	µg/L	[TXH] < 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,4,4'-tribromodiphenyl ether (BDE-28)	µg/L	[TXH] < 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4'-tetrabromodiphenyl ether (BDE-47)	µg/L	[TXH] < 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,3',4,4'-tetrabromodiphenyl ether (BDE-66)	µg/L	[TXH] < 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',3,4,4'-pentabromodiphenyl ether (BDE-85)	µg/L	[TXH] < 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2,2',4,4',5-pentabromodiphenyl ether (BDE-99)	µg/L	[TXH] < 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

[TXH] - Holding time exceeded (monitoring to extraction and monitoring to receipt). No sample time provided
* Appropriate cooling measures were not taken for sample

5.3 Water quality results – graphs

Figure 5-1 Suspended solid survey results for all sites across 6 month sampling period

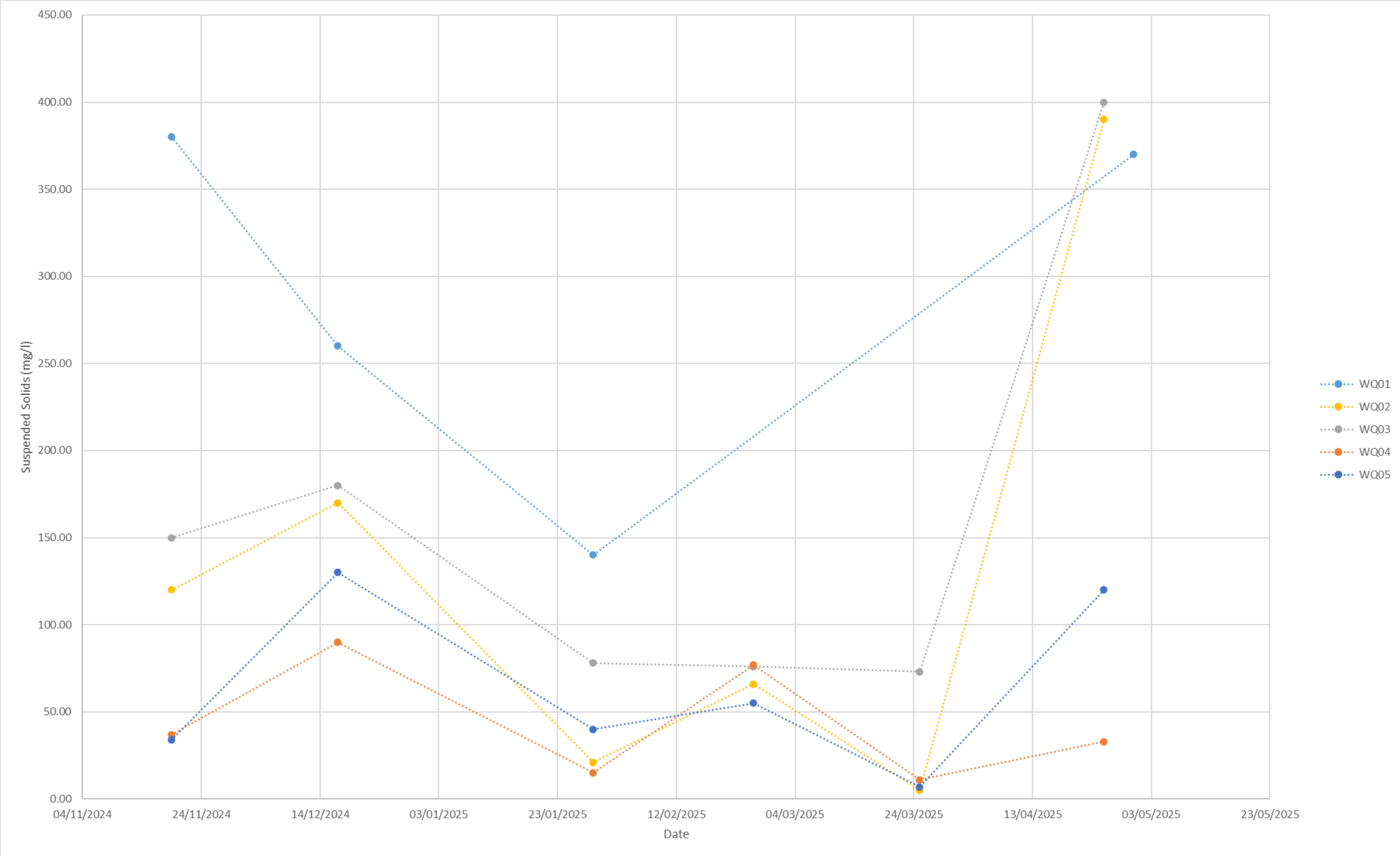


Figure 5-2 Copper survey results for all sites across 6 month sampling period

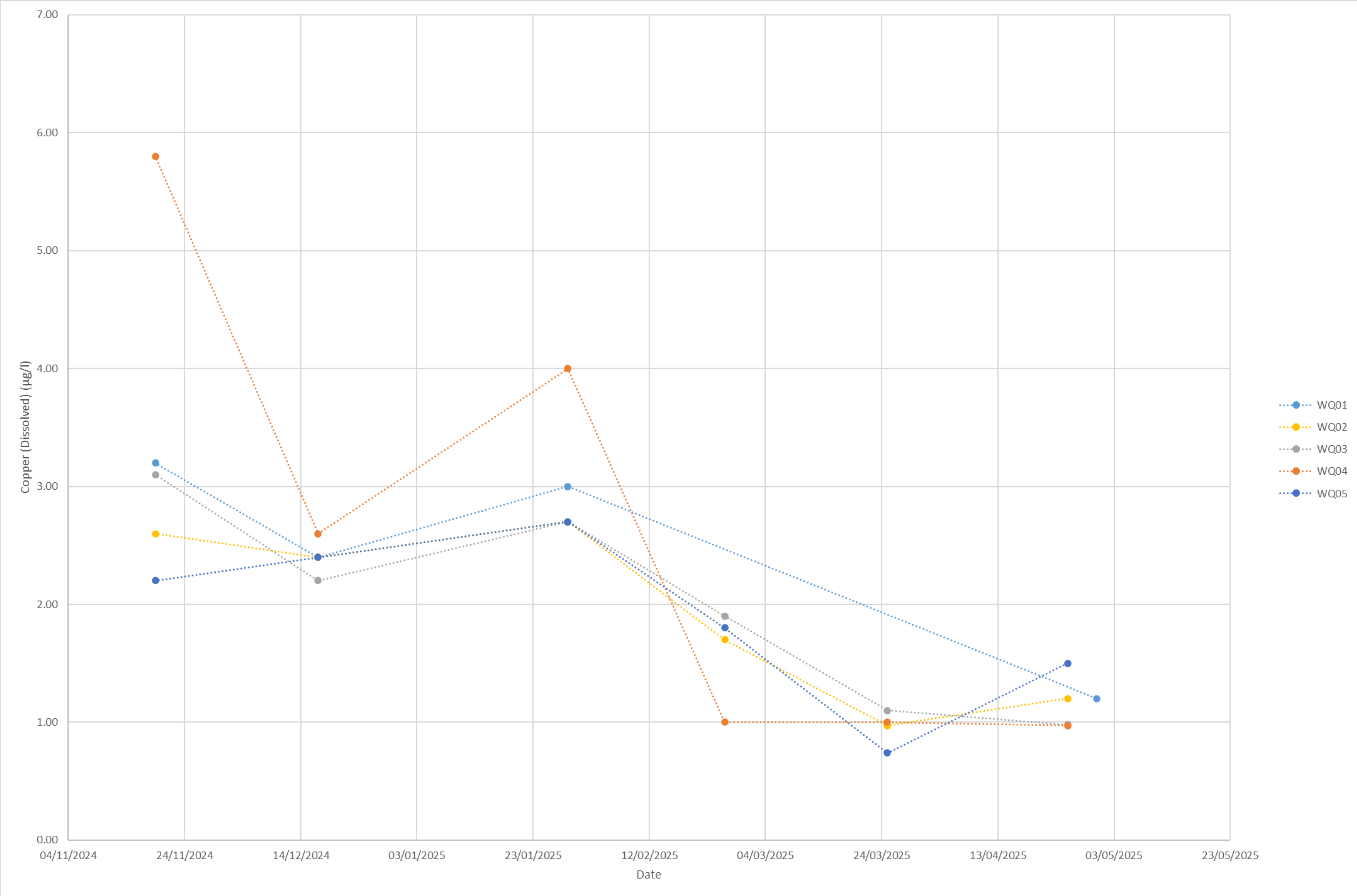


Figure 5-3 Zinc survey results for all sites across 6 month sampling period

Figure 5-4 Arsenic survey results for all sites across 6 month sampling period

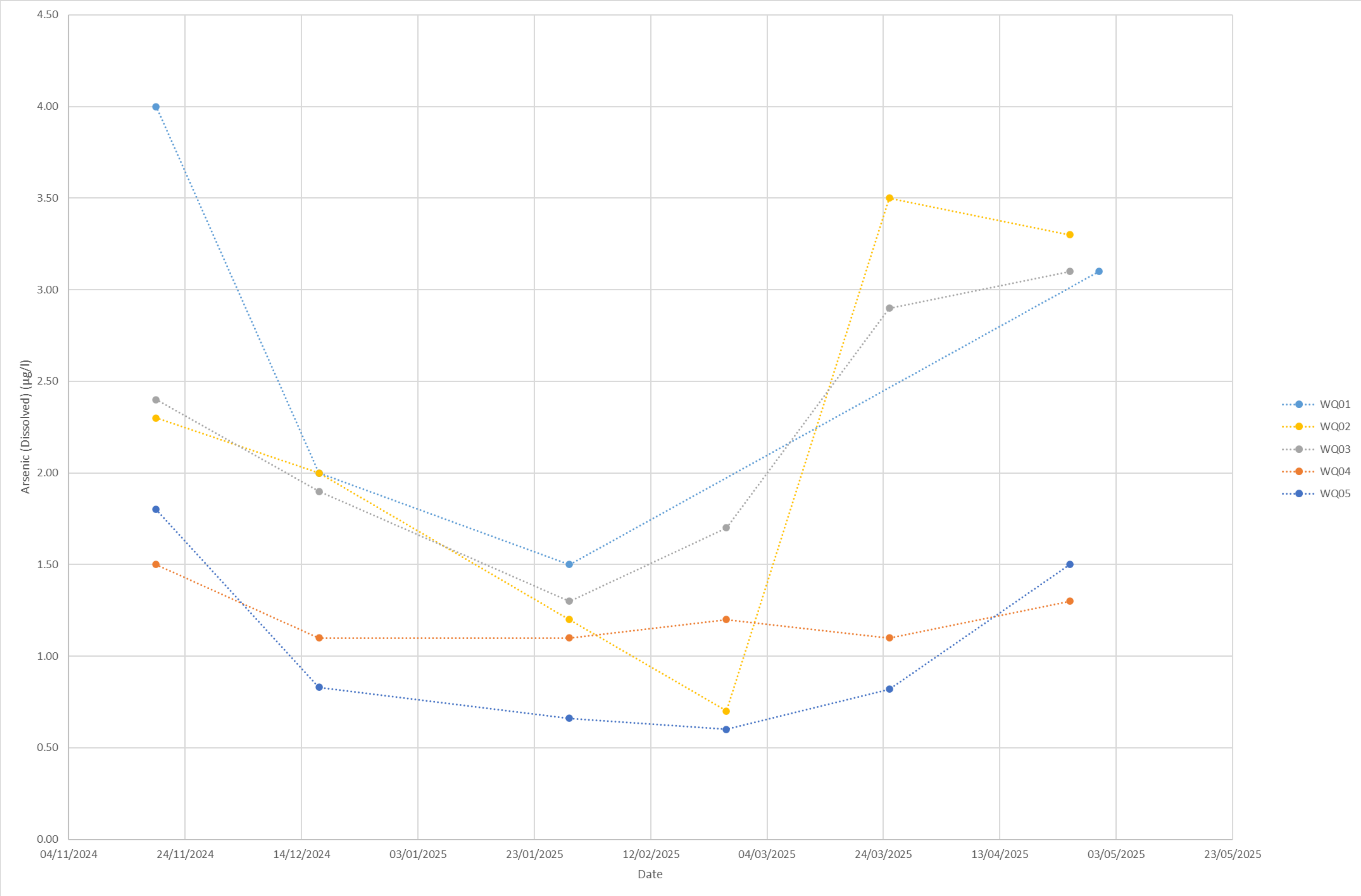
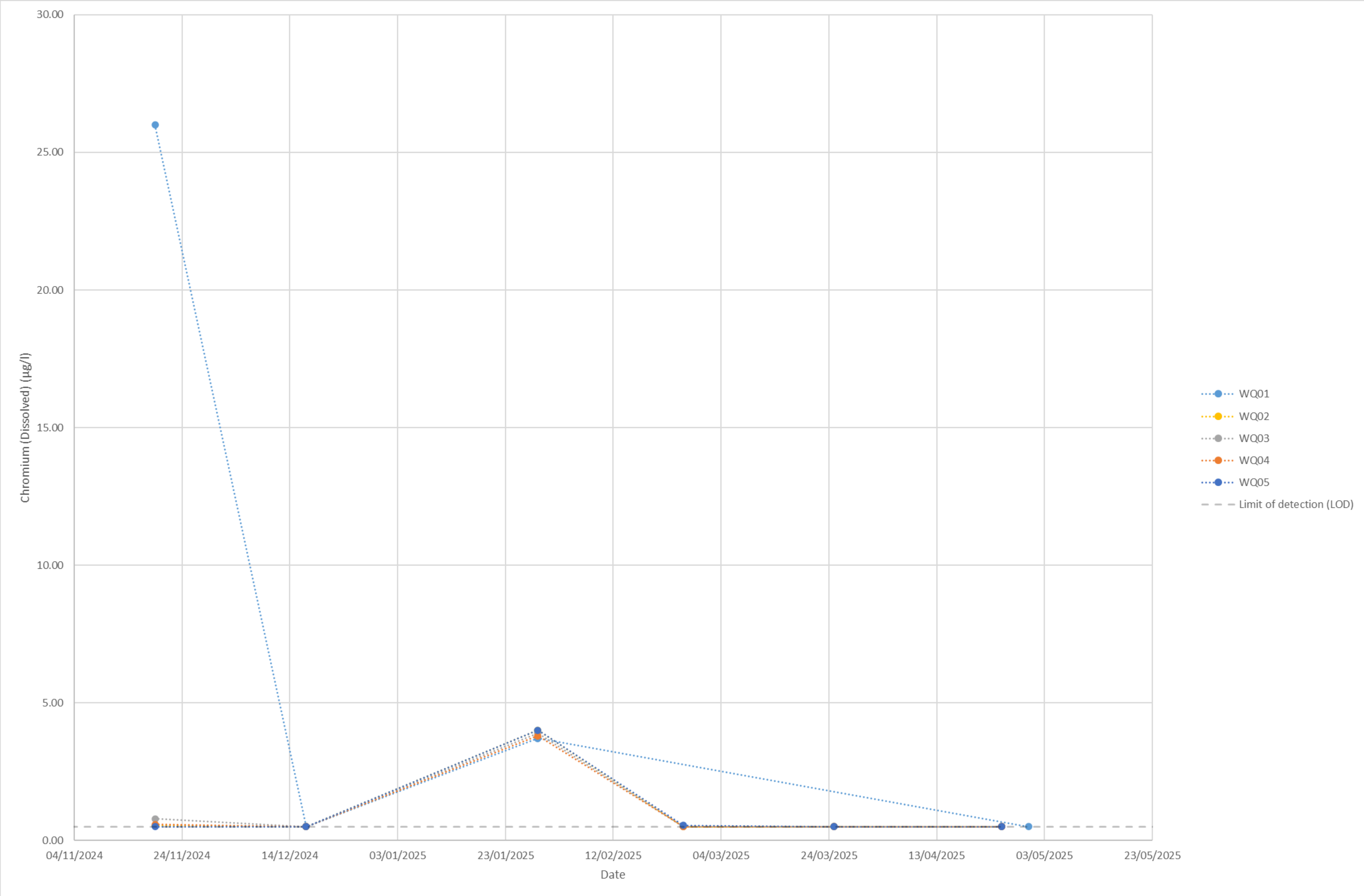


Figure 5-5 Chromium survey results for all sites across 6 month sampling period



Limit of detection (LOD) – lowest concentration that can be detected

5.4 EQS standards

Estuarine and coastal

Table 5-7 EQS standards for WQ01

	Standards		Nov		Dec		Jan		Apr	
	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)
pH	Not applicable	8.5 (95th percentile)		Pass		Pass		Pass		Pass
Arsenic	25	Not applicable	Pass		Pass		Pass		Pass	
Copper - dissolved (Dissolved organic carbon (DOC) greater than 1mg/l)	3.76 + (2.677x ((DOC/2)-0.5))	Not applicable	Pass		Pass		Pass		Pass	
Zinc	6.8	Not applicable	Fail		Fail		Fail		Fail	
Naphthalene	2	130	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Anthracene	0.1	0.1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Floranthene	0.0063	0.12	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass
Benzo[b]fluoranthene	Not applicable	0.017		Unknown		Unknown		Unknown		Unknown
Benzo[k]fluoranthene	Not applicable	0.017		Unknown		Unknown		Unknown		Unknown
Benzo[a]pyrene	Not applicable	0.027		Unknown		Unknown		Unknown		Unknown
Benzo[g,h,i]perylene	Not applicable	0.00082		Unknown		Unknown		Unknown		Unknown

Unknown – EQS standard is below limit of detection
Source: Environment Agency and Department for Environment, Food & Rural Affairs, 2016. *Estuaries and coastal waters: specific pollutants and operational environmental quality standards*. Available at: https://assets.publishing.service.gov.uk/media/60e85aa08fa8f50c75b6ad32/Estuaries_and_coastal_waters_specific_pollutants_and_operational_environmental_quality_standards.ods. Accessed August 2025 and Environment Agency and Department for Environment, Food & Rural Affairs, 2016). *Estuaries and coastal waters: priority hazardous substances, priority substances and other pollutants environmental quality standards*. Available at: https://assets.publishing.service.gov.uk/media/6217c303e90e0710be035467/Estuaries_and_coastal_waters_priority_hazardous_substances__priority_substances_and_other_pollutants_environmental_quality_standards__2_.ods. Accessed August 2025.

Table 5-8 EQS standards for WQ02

	Standards		Nov		Dec		Jan		Feb		Mar		Apr	
	Annual average environmental quality standard (ug/l)	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**
pH	Not applicable	8.5 (95^{th} percentile)		Pass		Pass		Pass		Pass		Pass		Pass
Arsenic	25	Not applicable	Pass		Pass		Pass		Pass		Pass		Pass	
Copper - dissolved (Dissolved organic carbon (DOC) greater than 1mg/l)	3.76 + (2.677x ((DOC/2)-0.5))	Not applicable	Pass		Pass		Pass		Pass		Pass		Pass	
Zinc	6.8	Not applicable	Fail		Fail		Pass		Fail		Fail		Fail	
Naphthalene	2	130	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Anthracene	0.1	0.1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Floranthene	0.0063	0.12	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass
Benzo[b]fluoranthene	Not applicable	0.017		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[k]fluoranthene	Not applicable	0.017		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[a]pyrene	Not applicable	0.027		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[g,h,i]perylene	Not applicable	0.00082		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown

Unknown – EQS standard is below limit of detection

Source: Environment Agency and Department for Environment, Food & Rural Affairs, 2016. *Estuaries and coastal waters: specific pollutants and operational environmental quality standards*. Available at: https://assets.publishing.service.gov.uk/media/60e85aa08fa8f50c75b6ad32/Estuaries_and_coastal_waters_specific_pollutants_and_operational_environmental_quality_standards.ods. Accessed August 2025 and Environment Agency and Department for Environment, Food & Rural Affairs, 2016). *Estuaries and coastal waters: priority hazardous substances, priority substances and other pollutants environmental quality standards*. Available at: https://assets.publishing.service.gov.uk/media/6217c303e90e0710be035467/Estuaries_and_coastal_waters_priority_hazardous_substances__priority_substances_and_other_pollutants_environmental_quality_standards__2_.ods. Accessed August 2025.

Table 5-9 EQS standards for WQ03

	Standards		Nov		Dec		Jan		Feb		Mar		Apr	
	Annual average environmental quality standard (ug/l)	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**
pH	Not applicable	8.5 (95^{th} percentile)		Pass		Pass		Pass		Pass		Pass		Pass
Arsenic	25	Not applicable	Pass		Pass		Pass		Pass		Pass		Pass	
Copper - dissolved (Dissolved organic carbon (DOC) greater than 1mg/l)	3.76 + (2.677x ((DOC/2)-0.5))	Not applicable	Pass		Pass		Pass		Pass		Pass		Pass	
Zinc	6.8	Not applicable	Fail		Fail		Fail		Fail		Fail		Fail	
Naphthalene	2	130	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass
Anthracene	0.1	0.1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Floranthene	0.0063	0.12	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass
Benzo[b]fluoranthene	Not applicable	0.017		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[k]fluoranthene	Not applicable	0.017		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[a]pyrene	Not applicable	0.027		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[g,h,i]perylene	Not applicable	0.00082		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown

Unknown – EQS standard is below limit of detection

Source: Environment Agency and Department for Environment, Food & Rural Affairs, 2016. *Estuaries and coastal waters: specific pollutants and operational environmental quality standards*. Available at: https://assets.publishing.service.gov.uk/media/60e85aa08fa8f50c75b6ad32/Estuaries_and_coastal_waters_specific_pollutants_and_operational_environmental_quality_standards.ods. Accessed August 2025 and Environment Agency and Department for Environment, Food & Rural Affairs, 2016). *Estuaries and coastal waters: priority hazardous substances, priority substances and other pollutants environmental quality standards*. Available at: https://assets.publishing.service.gov.uk/media/6217c303e90e0710be035467/Estuaries_and_coastal_waters_priority_hazardous_substances__priority_substances_and_other_pollutants_environmental_quality_standards__2_.ods Accessed August 2025.

Table 5-10 EQS standards for WQ05

	Standards		Nov		Dec		Jan		Feb		Mar		Apr	
	Annual average environmental quality standard (ug/l)	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**	**Annual average environmental quality standard (ug/l)**	**Maximum allowable concentration (ug/l)**
pH	Not applicable	8.5 (95th percentile)		Pass		Pass		Pass		Pass		Pass		Pass
Arsenic	25	Not applicable	Pass		Pass		Pass		Pass		Pass		Pass	
Copper - dissolved (Dissolved organic carbon (DOC) greater than 1mg/l)	3.76 + (2.677x ((DOC/2)-0.5))	Not applicable	Pass		Pass		Pass		Pass		Pass		Pass	
Zinc	6.8	Not applicable	Fail		Fail		Fail		Fail		Fail		Fail	
Naphthalene	2	130	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass
Anthracene	0.1	0.1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Floranthene	0.0063	0.12	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass
Benzo[b]fluoranthene	Not applicable	0.017		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[k]fluoranthene	Not applicable	0.017		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[a]pyrene	Not applicable	0.027		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[g,h,i]perylene	Not applicable	0.00082		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown

Unknown – EQS standard is below limit of detection

Source: Environment Agency and Department for Environment, Food & Rural Affairs, 2016. *Estuaries and coastal waters: specific pollutants and operational environmental quality standards*. Available at: https://assets.publishing.service.gov.uk/media/60e85aa08fa8f50c75b6ad32/Estuaries_and_coastal_waters_specific_pollutants_and_operational_environmental_quality_standards.ods. Accessed August 2025 and Environment Agency and Department for Environment, Food & Rural Affairs, 2016). *Estuaries and coastal waters: priority hazardous substances, priority substances and other pollutants environmental quality standards*. Available at: https://assets.publishing.service.gov.uk/media/6217c303e90e0710be035467/Estuaries_and_coastal_waters_priority_hazardous_substances__priority_substances_and_other_pollutants_environmental_quality_standards__2_.ods Accessed August 2025.

Freshwater

Table 5-11 EQS standards for WQ04

	Standards		Nov		Dec		Jan		Feb		Mar		Apr	
	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)	Annual average environmental quality standard (ug/l)	Maximum allowable concentration (ug/l)
pH	Not applicable	69 (95th percentile)		Pass		Pass		Pass		Pass		Pass		Pass
Arsenic	50	Not applicable	Pass		Pass		Pass		Pass		Pass		Pass	
Copper	1 (bioavailable)	Not applicable	Fail		Fail		Fail		Pass		Pass		Pass	
Zinc	10.9 (bioavailable)	Not applicable	Fail		Pass		Pass		Pass		Fail		Pass	
Naphthalene	2	130	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
Anthracene	0.1	0.1	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Floranthene	0.0063	0.12	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass	Unknown	Pass
Benzo[b]fluoranthene	Not applicable	0.017		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[k]fluoranthene	Not applicable	0.017		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[a]pyrene	Not applicable	0.27		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown
Benzo[g,h,i]perylene	Not applicable	0.0082		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown

Unknown – EQS standard is below limit of detection

Source: Environment Agency and Department for Environment, Food & Rural Affairs, 2021. *Freshwaters: specific pollutants and operational environmental quality standards.* Available at: https://assets.publishing.service.gov.uk/media/611299b08fa8f506a5bf13ca/Freshwaters_specific_pollutants_and_operational_environmental_quality_standards.ods Accessed August 2025 and Environment Agency and Department for Environment, Food & Rural Affairs, 2022. *Freshwaters: priority hazardous substances, priority substances and other pollutants environmental quality standards*. Available at: https://assets.publishing.service.gov.uk/media/6217c3eee90e0710c4506c57/Freshwaters_priority_hazardous_substances__priority_substances_and_other_pollutants_environmental_quality_standards__1_.ods Accessed August 2025.

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A494 RIVER DEE BRIDGE REPLACEMENT

Technical Appendix 7.B

Volume 3: Technical Assessment Report

Water Framework Directive Assessment

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A494 RIVER DEE BRIDGE REPLACEMENT

Technical Appendix 7.B

Volume 3: Technical Assessment Report

Water Framework Directive Assessment

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1. Introduction

1.1.1 Mott MacDonald Ltd has been appointed by the North & Mid Wales Trunk Road Agent ’the Applicant’ to develop the design and undertake environmental assessments for the A494 River Dee Bridge Improvement Scheme (hereinafter referred to as ‘the Scheme’). This report has been produced to support the Environmental Impact Assessment (EIA) Volume 1, Chapter 7: Environmental Statement Road Drainage and Water Environment for the Scheme.

1.1.2 A Water Framework Directive (WFD) assessment is necessary in order to assess potential impacts on WFD elements, as a result of the Scheme, that may cause a deterioration in the status of a water body or prevent it from reaching good status or good ecological potential in the future.

1.2 Scheme location

1.2.1 The Scheme is located in North Wales on a tidally influenced reach of the River Dee (National Grid Reference (NGR) SJ 32420 68583). A detailed description of the Scheme is provided in EIA Volume 1, Chapter 2: The Project.

1.2.2 The Scheme comprises the replacement of an existing road bridge that crosses the tidal River Dee with a new bridge upstream (see Figure 7.2). The new bridge would be approximately 36.5 m wide and would span approximately 140m, to carry two lanes of eastbound and westbound traffic, hard shoulders and a shared use path. The bridge would be located approximately 6.65m to the southeast of the existing A494 river bridge and would be supported by two sets of river piers.

1.2.3 Upon completion of the bridge, the existing A494 River Dee bridge is to be dismantled with the bridge deck removed, abutments demolished, and the piers left in place.

1.2.4 The Scheme includes the diversion of the ‘Queensferry Drain’ (main river) including creation of new sections of open channel.

1.2.5 The Scheme includes changes to the existing road drainage network incorporating Sustainable Drainage Systems (SuDS), creation of a new drainage outfall to the

River Dee and a new Queensferry Drain Pumping Station facility to the west of the River Dee.

1.2.6 Further details on ecological mitigation and biodiversity enhancement are provided in EIA Volume 1, Chapter 8: Terrestrial Biodiversity, including wildflower seeding and tree planting.

1.3 Purpose of this report

1.3.1 This assessment considers the potential impacts associated with the Scheme activities on WFD water bodies and their current status and objectives. It comprises of the following steps:

a) Baseline and screening assessment – to identify which Scheme activities could potentially affect WFD water bodies, and to determine which WFD water bodies and associated protected areas might be impacted and therefore require screening in for further assessment. The report summarises information on the WFD baseline conditions for screened in WFD water bodies.

b) Scoping assessment – to assess the potential WFD effects and the overall compliance risks of the Scheme, for both the construction and operational phases.

1.3.2 The WFD assessment considers the potential for the Scheme to lead to non-compliance with the objectives of the WFD and provides details of mitigation to alleviate any potential adverse effects identified.

2. Legislation and Policy Framework

2.1.1 The WFD is originally European legislation which aims to protect and improve the water environment within river catchments. Following the United Kingdom's exit from the European Union (EU), the WFD was transposed into UK law and therefore still applies. It is transposed into UK law by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017[1].

[1] The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. Available online at: The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. Accessed February 2025.

2.1.2 Natural Resources Wales (NRW) is the statutory body responsible for implementing the WFD in Wales. The Environment Agency (EA) is the statutory body responsible for implementing the WFD in England.

2.1.3 The WFD requires objectives to be identified and set to protect and improve the status of all 'water bodies'. Water bodies include: rivers, stream, lakes, reservoirs, estuaries, coastal waters, canals and groundwaters. The standard objective is to achieve 'good status', or 'good potential' (if the water body is artificial or is heavily modified). Further to this, the WFD must prevent deterioration in status for all water bodies. The original target date for all water bodies to achieve 'good status' was 2015; however, this was extended to either 2021 or 2027.

2.1.4 Good 'status' or 'potential' is designated based on the assessment of ecological and chemical components in surface waters. Ecological status consists of biological quality elements, physico-chemical supporting elements and hydromorphological supporting conditions. For groundwaters, status consists of quantitative and qualitative elements.

2.1.5 The WFD environmental objectives are outlined in Table 2-1.

Table 2-1 WFD environmental objectives

Environmental objectives (Regulation 13)	Reference and Description
(2) Surface water	Prevent deterioration of the status of each body of surface water.
	Protect, enhance and restore each body of surface water (other than an artificial or heavily modified water body) with the aim of achieving good ecological status and good surface water chemical status, if not already achieved, by 22nd December 2021.
	Protect and enhance each artificial or heavily modified water body with the aim of achieving good ecological potential and good surface water chemical status, if not already achieved, by 22nd December 2021.
	Aim progressively to reduce pollution from priority substances and aim to cease or phase out emissions, discharges and losses of priority hazardous substances.
(5) Groundwater	Prevent deterioration of the status of each body of groundwater.

Environmental objectives (Regulation 13)	Reference and Description
	Prevent or limit the input of pollutants into groundwater.
	Protect, enhance and restore each body of groundwater, and ensure a balance between abstraction and recharge of groundwater, with the aim of achieving good groundwater chemical status and good groundwater quantitative status, if not already achieved, by 22nd December 2021.
	Reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity in order to progressively reduce pollution of groundwater.
	Prevent deterioration of the status of each body of groundwater.

Source: Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

2.1.6 River Basin Management Plans (RBMPs) set out how organisations, stakeholders and communities will work together to improve the water environment. There are three RBMPs covering the 3 River Basin Districts (RBDs) in Wales. RBMPs report the baseline status of water bodies within each RBD, corresponding to WFD reporting cycles. The first RBMPs were published in 2009 for RBMP Cycle 1 and were updated for Cycle 2 in 2015 and Cycle 3 in 2022.

2.1.7 The Scheme lies within the Dee RBD which is reported within The Dee RBMP[2]. NRW and the EA work jointly in the Dee RBD as some water bodies form the boundary or cross between Wales and England. Information on how the water environment is managed in the English part of the Dee River Basin District is available from the EA[3].

3. Assessment Methodology

3.1 Methodology

3.1.1 This WFD assessment has been completed based on the available Scheme information provided (details in Section 1.2). The assessment has been

[2] National Resources Wales and Environment Agency, 2022. Dee River basin management Plan 2021- 2027 Summary. Available online at: Dee RBMP 2021-2027 Summary Accessed: 30/05/2025.
[3] Environment Agency, 2024. Policy Paper Dee River Basin Management Plan. Available online at: Dee River Basin Management Plan - GOV.UK Accessed: 30/05/2025.

undertaken using the Clearing the Waters for All guidance[4] which describes an approach for transitional water bodies, with reference to NRW guidance[5] for marine water bodies. There are three stages of assessment:

i) **Stage 1: WFD Screening** – identifies the relevant water bodies and designated areas. An overview of the current baseline is provided in relation to the water environment. In addition, activities and characteristics of the project in the construction and operational phases and their potential generic impacts are identified. This helps establish the risk from project activities to the water bodies and their WFD elements. Activities are either screened in for further assessment or screened out if they do not require further assessment (Stage 2 and 3).

ii) **Stage 2: WFD Scoping** – identifies the receptors that are potentially at risk from the planned activity and the need for impact assessment.

iii) **Stage 3: WFD Impact Assessment** – considers the potential impacts of the activity, identifies ways to avoid or minimise impacts, and shows if your activity may cause deterioration or jeopardise the water body achieving good status.

3.2 Study Area

3.2.1 For the purpose of this assessment, the study area extends 2 km upstream and downstream of the Scheme boundary as shown in Figure 7.2.

3.2.2 In line with NRW guidance[6], the chemical status of WFD water bodies has been considered for up to 12 nautical miles (22.2km) within the tidally influenced area (Hilbre Island at the estuary mouth downstream of the Scheme to Chester Weir upstream of the Scheme).

3.3 Data Sources

3.3.1 The WFD assessment has been informed by a desk-based analysis of publicly available information which are listed below:

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[4] Environment Agency 2016. How to assess the impact of your activity in estuarine (transitional) and coastal waters for the Water Framework Directive (WFD). Clearing the Waters for All. Available online at: Water Framework Directive assessment: estuarine and coastal waters - GOV.UK (www.gov.uk) (Accessed January 2025).

[5] NRW, 2024. How to carry out a Water Framework Directive (WFD) assessment for a marine licence application. Available online at: https://naturalresources.wales/permits-and-permissions/marine-licensing/marine-licensing-and-the-water-framework-directive/?lang=en Accessed January 2025.

[6] NRW, 2024. How to carry out a Water Framework Directive (WFD) assessment for a marine licence application. Available online at: https://naturalresources.wales/permits-and-permissions/marine-licensing/marine-licensing-and-the-water-framework-directive/?lang=en Accessed January 2025.

a) National Library of Scotland historical georeferenced OS maps[7]

b) British Geological Survey (BGS) Geology of Britain Viewer[8]

c) Catchment Data Explorer[9]

d) Magic Maps[10]

e) Data Map Wales[11]

f) National River Flow Archive[12]

g) Cycle 3 (2021) Rivers and Waterbodies Map[13]

h) Bing Ordnance Survey (OS) mapping[14] .

3.3.2 Available project information was also used including:

a) Surveyed currents, salinity, and suspended solids measurements[15]

b) Bathymetry data (collected by Partrac Ltd. on 9th September 2021; 28th September 2021; 3rd December 2021; 25th January 2022; 31st March 2022 and 26th May 2022)[15].

c) Surface water site walkover (19 November 2024).

d) 6 months (November 2024 to April 2025) of spot sampling water quality monitoring[16].

3.4 Limitations and Assumptions

3.4.1 This WFD assessment has been undertaken in line with the following assumptions and limitations:

a) The assessment has been based on currently available WFD baseline data and design information for the Scheme. Conclusions should be reviewed if NRW update or provide additional WFD baseline data for the relevant water bodies, or if significant changes to the nature, spatial extent, scale or construction methods of the Scheme are made.

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7 National Library of Scotland, 2024. Side by Side. Available online at: Side by side georeferenced maps viewer - Map images - National Library of Scotland (nls.uk). Accessed January 2025.
8 British Geological Survey (BGS), 2024. Geology of Britain Viewer. Available online at: https://www.bgs.ac.uk/map-viewers/geoindex-onshore/. Accessed January 2025.
9 Environment Agency, 2024. Dee Estuary Operational Catchment. Available online at: Dee Estuary Operational Catchment | Catchment Data Explorer. Accessed January 2025.
10 DEFRA, 2024. Magic Map Viewer. Available online at: Magic Map Application (defra.gov.uk). Accessed January 2025.
11 Welsh Government, 2025. Data Map Wales. Available online at: New map | DataMapWales. Accessed January 2025.
12 NFRA, 2024. Station Data. Available online at: NRFA Station Data for 67027 - Dee at Ironbridge (ceh.ac.uk). Accessed January 2025.
13 NRW, 2024. Cycle 3 (2021) Rivers and Waterbodies Map. Available online at: https://waterwatchwales.naturalresourceswales.gov.uk/en/. Accessed January 2025.
14 Microsoft Bing, 2024. Maps. Available online at: Bing Maps - Directions, trip planning, traffic cameras & more. Accessed January 2025.
15 Partrac Ltd. 2021. A494 Dee Survey Data Report. Document reference: M5006.05.03.D01.V01.
16 Mott MacDonald, 2025. Volume 3, Technical Appendix 7.A: Water Quality Monitoring Plan.

b) This assessment has been undertaken using a precautionary approach.

c) Information provided by third parties, including publicly available information and databases, are considered correct at the time of publication.

d) Cumulative effects on WFD water bodies (for both intra and inter) have been excluded from this assessment.

4. WFD Baseline and Screening Assessment

4.1 Baseline Conditions

Hydrology

4.1.1 The headwaters of the River Dee originate in Eryri National Park and descend into Llyn Tegid and the valleys of Corwen and Llangollen. The River Dee then meanders northwards through the Cheshire Plain. The river is modified downstream of Chester where it has been historically canalised in the tidal reach during the 1730s. It discharges into the River Mersey estuary.

4.1.2 The River Dee has a total catchment area of approximately 2,251km^2. The A494 River Dee Bridge currently crosses the River Dee, at National Grid Reference (NGR) SJ323685, where the river is tidally influenced.

4.1.3 The '67033 – Dee at Chester Suspension Bridge' is the closest National River Flow Archive (NRFA) gauging station to the Scheme and is located 10km upstream at Chester Weir, this marks the tidal limit of the River Dee. The gauge has not recorded daily flow data since September 2013 due to issues with ultrasonics.

4.1.4 The '67027 – Dee at Ironbridge' NRFA gauging station is located a further 10km upstream of the Scheme beyond the tidal limit of the River Dee and holds daily flow data from 1993 to 2023.

Geology and hydrogeology

4.1.5 Detailed information on geology is available in EIA Volume 1, Chapter 6: Geology and Soils. In summary, the Scheme is underlain by mudstone and sandstone dominated bedrock consisting of bands of the Etruria Formation east of the Scheme and Pennine Coal Measures (Middle Coal Measures and Lower Coal Measures) interbedded grey mudstone, siltstone and sandstone with coal seams[8].

4.1.6 The superficial deposits underlying the River Dee and adjacent areas are predominantly tidal flat deposits consisting of clay, silt, sand and gravel anticipated to be approximately 15m thick underlying the proposed bridge[17]. The south-western region of the study area consists of Till (Devensian- diamicton) and some localised glaciofluvial deposits (Devensian - sand and gravel)[8].

4.1.7 The Scheme is underlain by a Secondary A bedrock aquifer and Secondary (undifferentiated) superficial aquifer which are classified as a 'High' groundwater vulnerability. This suggests that the aquifers are capable of supporting water supplies at a local rather than strategic scale and, potentially forming an important source of base flow to rivers. There is likely to be some horizontal movement of groundwater through permeable sand and gravel layers. Vertical movement of the groundwater would be impeded by impermeable clay layers that are interbedded with the granular material. Bedrock is likely to be impermeable through the mudstone. There is common faulting in the area that could act as groundwater pathways.

Hydromorphology

4.1.8 The River Dee is a WFD estuarine and coastal water body (Dee, North Wales) which has extensive anthropic influence including abstractions and impoundment upstream of the study area and canalisation and flood defence embankments in the reach located within the study area.

4.1.9 The Scheme is located within the Afon Dyfrdwy (River Dee) SSSI which is of special interest for its fluvial geomorphology, carboniferous geology, range of river habitat types, saltmarsh transition habitats and species of interest.

[17] Mott MacDonald. 2018. A494 River Dee Bridge Improvement – Preliminary Sources Study Report, ref. 395318-0044-B, dated 06/09/2018

4.1.10 Within the study area at the bridge location, the banks on both sides are steep with the inter tidal areas consisting primarily of saltmarsh habitat dominated by fine sediment.

4.1.11 The transport of sediments upstream by the flood tide dominates when the river discharge is low. The flood tide dominance is reversed when the river discharge is high, leading to net downstream sediment transport and erosion. Flood tidal current speeds are higher than the ebb currents in the Dee Estuary. This asymmetry results in the net importation and retention of sediment within the tidal reach.

4.1.12 The water body has a dynamic regime with rapid bed adjustment recorded in recent bathymetry surveys. Around the existing piles localised bed elevation changes of +/-1.8 m were observed over a relatively short period. Existing scour holes were observed up to 3 m below the bed level in the main channel.

Aquatic ecology

4.1.13 Volume 1, EIA Chapter 16: Marine Ecology provides detail on the baseline conditions, designations and potential impact on the habitats and species within the Dee Estuary. In summary, the Dee has multiple designations (Ramsar, Special Area of Conservation (SAC), Special Protection Area (SPA), Site of Special Scientific Interest (SSSI)) within the study area and supports a diverse array of marine life including fish and invertebrates, particularly within its extensive intertidal mudflat and sandflat habitats.

4.1.14 These areas within the intertidal habitats are used for roosting, foraging and refuge and adjacent fields and sand bars are used for high tide refuge, depending on food availability and the state of the tide by species of interest including breeding waterfowl and waders.

4.1.15 Fish species migrating through the study area on the Dee include those which are features of interest of the protected areas. This includes Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*) and European smelt (*Osmerus eperlanus*).

4.1.16 No Invasive Non-Native Species (INNS) were identified during intertidal walkover surveys conducted in March 2025. However, Chinese mitten crab (*Eriocheir sinensis*) was recorded previously within 2km of the Scheme in Wepre Brook, NRW have previously stated there is thought to be a substantial population of Chinese mitten crab on the River Dee, however this is based on anecdotal evidence[18].

4.2 WFD receptor screening

4.2.1 The following sections assess which WFD water bodies and protected area receptors have been screened in for further assessment.

WFD water body screening

4.2.2 Several WFD water bodies are located within 2 km of the Scheme or are hydrologically connected to it. These are summarised in Table 4-1.

4.2.3 Queensferry Drain is not a designated WFD surface water body, however potential construction and operational impacts have been assessed within EIA Volume 1, Chapter 7: Road Drainage and the Water Environment. For this WFD assessment, Queensferry Drain has considered as part of the assessment of the Dee (N. Wales) WFD transitional water body, as it is a tributary and is hydrologically connected to it.

[18] Falkingham et al., 2016. Monitoring of Chinese Mitten Crabs (*Eriocheir sinensis*) on the River Dee. Report No. 154. Available online at: https://naturalresourceswales.gov.uk/media/684745/evidence-report-154-chinese-mitten-crabs-eriocheir-sinensis-river-dee.pdf. Accessed July 2025.

Table 4-1 Summary of WFD water bodies within 2 km of the Scheme or hydrologically connected

Water body name	Type	Statutory Authority	Screening outcome	Justification
Dee (N. Wales)* (ID: GB531106708200)	Transitional water body	NRW	Screened in	The Scheme is located on a tidal reach of the River Dee and the water body could potentially be impacted. The water body has therefore been screened in for further assessment.
Garden City Drain (ID: GB111067056960)	Surface water body	EA	Screened out	Garden City Drain discharges to the Dee (N. Wales) WFD water body approximately 0.6km downstream of the existing A494 River Dee Bridge. This water body is unlikely to have significant tidal influence in its lower reaches due to its flapped outlet to the River Dee and is unlikely to be impacted from activities associated with the Scheme. No permanent in-channel modifications are proposed to the water body as part of the Scheme. Operational activities could increase drainage discharge within the Garden City Drain WFD catchment which could potentially impact the water body downstream of activities. Risks to water quality from pollution and routine runoff associated with the operation of the Scheme are assessed within the EIA, Volume 1, Chapter 7: Road Drainage and the Water Environment. Any impact on drainage or water quality is likely to be highly localised and will not have an impact at the WFD water body scale, therefore this water body has been screened out of the assessment.
Dee Carboniferous Coal Measures (ID: GB41102G204800)	Groundwater body	NRW	Screened in	The water body is directly underlying the Scheme and activities including excavations and piling into the river and/or banks which could potentially impact the water body. The water body has therefore been screened in for further assessment.
Sandycroft Drain (ID: GB111067052160)	Surface water body	NRW	Screened out	The water body is located within the study area and discharges to the River Dee approximately 1.5 km upstream of the Scheme. The Scheme activities do not include physical modifications of this water body. Furthermore, it is unlikely that the water body's status or objectives will be impacted by the Scheme activities even in the lower reaches which may be tidally influenced due to the distance upstream. Therefore, this water body has been screened out of the assessment.
Wepre Brook (ID: GB111067056880)	Surface water body	NRW	Screened out	It is unlikely that the water body's status or objectives will be impacted by the Scheme activities even in the lower reaches which may be tidally influenced as the water body confluence with the River Dee is greater than 2km downstream of the Scheme. The Scheme activities do not include physical modifications of this water body or works within the catchment.
Finchetts Gutter Water Body (ID:)	Surface water body	EA	Screened out	The water body is located within the study area and discharges to the River Dee approximately 1.5 km upstream of the Scheme. The Scheme activities do not include physical modifications of this water body. Furthermore, it is unlikely that the water body's status or objectives will be impacted by the Scheme activities even in the lower reaches which may be tidally influenced due to the distance upstream. Therefore, this water body has been screened out of the assessment.
North Wales (ID:)	Coastal water body	NRW	Screened out	The water body is located at a distance greater than 12 nautical miles downstream of the Scheme. At this distance it is unlikely the water body status or objectives will be impacted by the Scheme. The WFD guidance[4] indicates that chemical status should be considered for water bodies up to 12 nautical miles and therefore this water body has been screened out of the assessment.
Mersey Mouth (ID:)	Coastal water body	EA	Screened out	The water body is located at a distance greater than 12 nautical miles downstream of the Scheme. At this distance it is unlikely the water body status or objectives will be impacted by the Scheme. The WFD guidance[4] indicates that chemical status should be considered for water bodies up to 12 nautical miles and therefore this water body has been screened out of the assessment.

*Note: Assessment of Dee (N. Wales) incorporates Queensferry Drain.

4.2.4 Two WFD water bodies with potential to be impacted by the Scheme have been identified and screened in for further assessment:

a) Dee (N. Wales) (water body ID: GB531106708200) transitional water body and is designated as a heavily modified water body. At RBMP Cycle 3, the overall status was ‘Moderate’.

b) Dee Carboniferous Coal Measures (water body ID: GB41102G204800) groundwater body. At RBMP Cycle 3, the overall status was ‘Poor’.

4.2.5 Full WFD status classification data for both screened in water bodies are included in Appendix A.

WFD Protected Area Screening

4.2.6 WFD Protected Areas are those designated under other EU Directives that have been transposed to the main WFD legislation and those designated under the Habitats and Species Regulations 2017. Several protected areas are located within site boundary of the Scheme or within the 2km study area (see Table 4-2 and shown in EIA Volume 2, Figure 16.1 Marine Environment Zones of Interest).

Table 4-2 Protected areas within 2km or hydrologically connected to the Scheme

Site	Designation	Reasons for designation	Distance from Scheme	Screening outcome	Justification
River Dee and Bala Lake/ Afon Dyfrdwy a Llyn Tegid	SAC - UK	Designated for its coastal habitats and fish species.	Within the Scheme site boundary.	Screened In	Due to the nature of the works proposed, the Scheme has the potential to impact the protected area.
River Dee/ Afon Dyfrdwy	SSSI	Designated for its fluvial geomorphology, carboniferous geology, range of river habitat types and fish species.	Within the Scheme site boundary.	Screened In	Due to the nature of the works proposed, the Scheme has the potential to impact the protected area.
Shotwick Brook NVZ	Nitrate Vulnerable Zone	Area at risk from agricultural nitrate pollution.	Within the Scheme site boundary.	Screened In	Due to the nature of the works proposed, the Scheme has the potential to impact the protected area.
Dee Carboniferous Coal Measures	Groundwater Drinking Water Protected Areas (DWPA)	Area not at risk (2020).	Underlying the Scheme site boundary.	Screened In	Due to the nature of the works proposed, the Scheme has the potential to impact the protected area.
The Dee Estuary	Ramsar Site	Designated for its bird species, wetland habitat saltmarsh, intertidal mudflats and sandflats.	Located within the 2km study area, approximately 1 km northwest of the Scheme (tidally linked).	Screened in	Due to the nature of the works proposed, the impacts as a result of the Scheme have the potential to propagate downstream.

Site	Designation	Reasons for designation	Distance from Scheme	Screening outcome	Justification
The Dee Estuary	SPA - UK	Designated for its wintering, breeding and migratory bird assemblages.	Located within the 2km study area, approximately 1 km northwest of the Scheme (tidally linked).	Screened in	Due to the nature of the works proposed, the impacts as a result of the Scheme have the potential to propagate downstream.
Dee Estuary/ Aber Afon Dyfrdwy	SAC - UK	Designated for its mudflats, coastal habitats and fish species.	Located within the 2km study area, approximately 1 km northwest of the Scheme (tidally linked).	Screened in	Due to the nature of the works proposed, the impacts as a result of the Scheme have the potential to propagate downstream.
Dee Estuary/ Aber Afon Dyfrdwy	SSSI	Designated for its wintering bird populations and coastal habitat.	Located within the 2km study area, approximately 1 km northwest of Scheme (tidally linked).	Screened in	Due to the nature of the works proposed, the impacts as a result of the Scheme have the potential to propagate downstream.
Dee West	Urban Wastewater Treatment Regulations sensitive shellfish waters	Sensitive shellfish waters.	Approximately 9km northwest of the Scheme (tidally linked).	Screened out	Due to the nature of the works proposed, it is not anticipated the impacts will propagate that far downstream.

4.2.7 A Habitats Regulations Assessment (HRA) screening report[19] was carried out which concluded that with consideration to the objectives of screened in protected sites, likely significant effects on qualifying features could not be ruled out at this stage in the absence of appropriate mitigation during construction and operation. An Appropriate Assessment is required on the qualifying features of the River Dee and Bala Lake SAC, Dee Estuary SAC, SPA and Ramsar sites.

Higher sensitivity habitats present

4.2.8 Higher sensitivity habitats are present within the 2km study area. They have a low resistance to, and recovery rate from, human pressures. These include:

a) Saltmarshes (2648 ha): on River Dee banks at the location of the Scheme and downstream.

b) Mussel beds (36.77 ha): within Dee Estuary located approximately 16km downstream of the Scheme.

Lower sensitivity habitats present

4.2.9 There are four lower sensitivity habitats within the Scheme boundary. These include:

a) Gravel and Cobbles (4.3 ha): within the Dee Estuary, approximately 15km downstream of Scheme.

b) Intertidal soft sediments (8240 ha): on river banks at the Scheme, downstream and within the Dee Estuary.

c) Subtidal soft sediment (680 ha): within Dee Estuary, approximately 6.5km downstream of the Scheme.

d) Rocky shore (44 ha): on river banks at the Scheme, downstream and within the Dee Estuary.

Summary

4.2.10 Following the screening process, the following WFD receptors have been screened in for further assessment:

[19] Llywodraeth Cymru / Welsh Government, 2025. Habitat Regulations Assessment, Document Reference:

a) Dee (N. Wales) transitional WFD water body and the associated protected areas: Dee Estuary Ramsar Site, SAC, SPA, and SSSI.

b) Dee Carboniferous Coal Measures groundwater WFD body.

c) Protected areas (River Dee and Bala Lake/ Afon Dyfrdwy SSSI; River Dee/ Afon Dyfrdwy SSSI; Dee Estuary/ Aber Afon Dyfrdwy SSSI, SAC, SPA and Ramsar; Shotwick Brook NVZ and Dee Carboniferous Coal Measures groundwater DWPA.

4.3 Activities Screening (Stage 1)

4.3.1 Table 4-3 details the construction activities which will be confirmed by the Contractor at the detailed design stage.

Table 4-3 Summary of the construction activities

Construction activity	Description
Replacement bridge	• Construction of a temporary crane platform on the eastern river bank to enable the jack up barge and service barge to be mobilised and allow plant (e.g., cranes and piling equipment and material and waste to be transferred from and to land to the jack up barge and service barge. • The temporary pier will have up to six temporary 600mm diameter steel tubes vibrated into the river bank to support a structural steel deck. • The intention would be to undertake all barge movements during high tide removing the need for silt removal from within the river.
River piers	• Mobilisation of 'jack-up' barge and loading of equipment to the position of the new pier and installation of temporary anchor piles on river banks, if required to provide fixed points for tethering floating barge(s). • From the jack up barge, steel casing tubes will be inserted into river bed to depth sufficient to achieve stability and a seal to minimise water ingress and contain disturbed silts. The casings are expected to be installed into the glacial till to an estimated total depth below river bed level of approximately 13m. Tubes to be lifted by crane from floating support barge alongside and lowered to position to be oscillated or driven in with vibration. Drilling fluid, Polymer or Bentonite will be introduced to stabilise the ground. • Using a piling rig positioned on the jack-up barge, rotary boring within the steel tubes will be used to remove river bed silt and underlying glacial till deposits to full pile depth required (approximately 34m below river bed level, assuming river bed level is at 0m AOD) and reinforcement inserted. Arisings will be captured from auger rotary bore and removed to land, minimising any loss of material into the river. • Concrete will be prepared on land and to be placed using a tremie pipe (watertight pipe) to form the piles and displaced drilling fluid will be pumped off for recycling.

Construction activity	Description
	• It is anticipated that the piles will be installed in groups of two and the jack up barge will move between the east and west piers to enable strength to be gained within newly formed piles to minimise in-channel work programme timescales. • Temporary formwork or a precast concrete caisson will be installed at the top of piles above river bed level and reinforcement and pumped concrete will be placed to form a continuous pile cap and piers.
Abutments and construction	• The Queensferry Drain, River Pumping Station and outfall will be replaced with a new pumping station and outfall. • Services within the banks will be protected or diverted. • For construction of the abutments, excavation in the banks is required down to formation level and temporary sheet piles will be installed within the river bank (outside 'wet' zone) to maintain the integrity of flood bank level. These are anticipated to be temporarily installed to a depth of approximately 10m below ground level. • Piles will be installed within the formation and cropped to fit the abutment which will be in-situ cast concrete. The abutment will then be backfilled to allow the placement of bridge beams. The temporary riverbank support piles will be removed and the river bank regraded to restore it to the original levels. • Removal of the temporary riverbank support piles and regrading the river bank. New earthwork embankment approaches to new abutments will be constructed. • Temporary crane support platforms will be constructed either on or immediately to the rear of the new bridge abutments to allow the installation of side-span bridge beams. Central beams will be installed either from bank-based cranes. • Permanent formwork and reinforcement will be fixed to the beams and concrete pumped to form the bridge deck incorporating pre-cast edge beams. • The new deck will be finished with waterproof spray-applied bitumen system, apply bitumen-macadam / asphalt carriageway surfacing and lining and installing barriers, services and street lighting columns.
Earthworks	• Earthwork embankment approaches to new abutments will be constructed. Other movements of natural earth and made ground would be needed to construct the new drainage system, including ditches and attenuation ponds, and for the construction of new structures. There would also be a requirement for earth movement for initial site clearance e.g., stripping and storing topsoil and for final landscaping throughout the works area. • Outline plans for environmental protection during earthworks are set out in the Outline Construction Environmental Management Plan (CEMP) which forms Technical Appendix 17.A to the EIA.

Construction activity	Description
Existing bridge demolition	• Diversion and removal of existing sewers crossing river on the pipe bridge below the road bridge structure. • A temporary 'crash deck' platform will be installed under the existing bridge, mounted on existing abutments and piers and steel beams, to capture any loose materials. Progressively the surfacing, deck and any other equipment will be removed for recycling. • Using the crane(s) positioned on banks, the centre span steel beams and side-span beams will be removed and place on barge(s) in river or onto river banks. Abutments will be demolished and material removed for recycling. • Existing river piles will remain in-situ. • Landscaping will be carried out along the river banks upon completion of the bridge removal.

4.3.2 The Scheme will be operational as a road traffic and shared use bridge with associated drainage, services and ongoing maintenance.

4.3.3 Associated drainage includes a new outfall for road runoff into Queensferry Drain and a replacement pumping station on the west side of the bridge. On the east side of the bridge a drainage connection will discharge road runoff via a swale to Garden City Drain. All drainage will eventually discharge to the River Dee.

4.3.4 Professional judgment has been used to determine whether an activity has been screened in or out of this assessment depending on whether it is considered to impact the screened in WFD water bodies or Protected Areas identified in Section 4.2 WFD receptor screening.

Scheme activities – screened out

4.3.1 The WFD assessment: estuarine and coastal waters guidance[4] lists the following activities relevant to the Scheme which are considered low risk activities. The following activities have therefore been screened out from further assessment:

a) Maintaining pumps at pumping stations – avoid low dissolved oxygen levels during maintenance and minimise silt movement when restarting the pumps.

b) Removing blockages or obstacles like litter or debris within 10m of an existing structure to maintain flow.

c) Replacing or removing existing pipes, cables or services crossing over a water body – but not including any new structure or supports, or new bed or bank reinforcement.

Scheme activities – screened in

4.3.2 Some of the main activities for the Scheme are not contained within the low risk activity list and professional judgement has been used to determine whether they should be scoped in for further assessment.

4.3.3 The following activities are not considered to be low risk and have therefore been screened in for further assessment:

a) Disturbance to the bed and banks during construction of the Scheme (including piling works, excavations, bank reprofiling and embankments).

b) Construction of temporary platforms and associated piling.

c) Noise and vibration disturbance to habitats during construction activities (e.g., piling and use of jack up barge).

d) New drainage system and increased surface water run-off from new carriageway and other new areas of hard standing.

e) Potential dewatering during construction activities.

f) Temporary construction compounds and working areas.

g) Disturbance and changes to inter-tidal habitats and vegetation management.

h) New outfall structure discharging road drainage runoff to the River Dee.

i) Permanent in-channel operational activities (piers and abutments)

Summary

4.3.4 Professional judgement has been used to screen in several activities associated with the construction and operation phases for further assessment.

5. WFD Scoping Assessment (Stage 2)

5.1 Overview

5.1.1 This stage considers the receptors that should be considered in the impact assessment.

5.1.2 Receptors are based on the WFD water body quality elements for screened in water bodies that define the overall water body status. The surface water receptors include the following WFD elements:

i) hydromorphology
ii) biology – habitats including protected sites
iii) biology – fish
iv) water quality
v) protected areas

5.1.3 INNS are also considered at the scoping stage.

5.1.4 The groundwater receptors include the following WFD elements:

i) Chemical
ii) Quantitative

5.1.5 The WFD baseline for Cycle 3 (2021) elements for the screened in water bodies is detailed in Appendix A.

5.1.6 The risks from the Scheme activities to each scoped in receptor are discussed in the WFD impact assessment in Section 6.

6. WFD impact assessment (Stage 3)

6.1 Overview

6.1.1 This stage considers the potential impacts of both construction and operation of screened in Scheme activities and water bodies for the scoped in receptors. Consideration is given to the mitigation measures that reduce or avoid potential impacts on the two identified water bodies. The assessment concludes if the activity may cause deterioration or prevent any quality element within any water body achieving good status/potential and any additional mitigation that may be required.

6.2 Dee (N.Wales)

Construction

6.2.1 Table 6-1 identifies potential effects of the Scheme construction activities on hydromorphological, physio-chemical and biological quality elements, protected areas and INNS for the Dee (N. Wales) transitional water body.

Table 6-1 Summary of Scheme construction methods on the Dee (N. Wales) transitional WFD water body

Quality element/receptor	Construction activities potential impact(s)	Embedded design and good practice mitigation measures(s)	Assessment outcome	Additional mitigation required
Hydromorphological supporting conditions Hydrological regime Morphological conditions	Use of the jack up barge and in-channel construction works (abutments, piers etc.,) may disturb morphological conditions and mobilise potentially contaminated sediment and cause disturbance to the river bed and sediment plumes. This may potentially impact sediment transport and affect scour. In-channel works including piling for installation of the new bridge piers will alter river flows and will result in localised permanent disturbance to the bed morphology and silt. Excavation and temporary sheet piling to install the abutments on both banks including adjacent intertidal areas and shoreline areas will likely cause disturbance to the bank morphology. In addition, temporary platforms and associated piles installed in the banks will result in temporary disturbance to bank morphology and silt. Disturbance and permanent removal of vegetation, intertidal habitat such as saltmarsh and trees for access and construction works (if not reinstated).	All barge movements are planned to occur during high tide to minimise disturbance of silt. Temporary piling for the temporary platform will be carried out during low tide conditions to minimise silt disturbance. Use of the jack up barge and temporary platform for piling and construction of piers will allow the containment of any arisings without the need to form dry working areas around the piers. This will minimise disruption to flows. Piling activities will be carried out in line with a piling risk assessment to minimise disturbance to the water body's hydromorphological supporting conditions. Temporary sheet piling is anticipated during installation of the abutments to separate the construction works from the watercourse and prevent sediment entering the watercourse. The contractor will manage construction works in accordance with good practice guidance as detailed in the CEMP (EIA, Volume 3, Technical Appendix 17.A) to manage pollution risk and potential release of sediment. The CEMP incorporates guidance from the Guidance for Pollution Prevention (GPPs) including: GPP 1: Understanding your environmental responsibilities - good environmental practices20; Works and maintenance in or near water21; and GPP 6: Working at construction and demolition sites22. Where possible, like for like or improved habitat will be reinstated following construction to support morphological conditions.	The Dee (N. Wales) WFD water body is a heavily modified water body with a hydrological regime of 'not high'. No information is allocated for the morphology. The water body has a dynamic regime with rapid bed adjustment as supported by the bathymetry surveys undertaken in 2021/2022. Impacts from construction of the Scheme on the hydromorphology of the river are anticipated to be localised and are unlikely to cause deterioration of the water body with adherence to good practice. There is potential for short term impacts, however there would be no permanent impact to the WFD status.	No additional mitigation and no further WFD assessment is required.

[20] Scottish Environment Protection Agency (2021) Guidance for Pollution Prevention. Understanding your environmental responsibilities- good environmental practices GPP1. Version 1.2 (accessed December 2024), accessible from: guidance-for-pollution-prevention-1-2022-update.pdf
[21] Scottish Environment Protection Agency (2018) Guidance for Pollution Prevention. Works and maintenance in or near water GPP5. Version 1.2 (accessed November 2024), accessible from: gpp-5-works-and-maintenance-in-or-near-water.pdf
[22] Scottish Environment Protection Agency (2023b) Guidance for Pollution Prevention: Working at construction and demolition sites: GPP 6. Version 1 (accessed December 2024), accessible from: gpp6-working-on-construction-and-demolition-sites.pdf

Quality element/receptor	Construction activities potential impact(s)	Embedded design and good practice mitigation measures(s)	Assessment outcome	Additional mitigation required
Water quality Physico-chemical Ammonia Biochemical Oxygen Demand Dissolved inorganic nitrogen Dissolved oxygen pH Temperature Phosphate Total Nitrogen Total Phosphorous Salinity Chemical Specific pollutants, other pollutants, priority substances and priority hazardous substances	There is potential that the Scheme activities could affect local water turbidity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days). Where construction activities are planned in close proximity to or in water (e.g., bridge deck construction) there is a greater risk of sediment loading and contaminants being rapidly transported into the water body. Mobilisation of silt and potentially contaminated sediment may occur as a result of construction activities involving earthworks and piling. This has the potential to impact on WFD elements for water quality. Generation of dust and debris, chemical spills, siltation, hazardous substances (concrete) and contamination from released sediment (e.g., heavy metals and pesticides) as a result of construction activities (earthworks and piling) may impact water quality concentrations of WFD elements. There is potential for surface water and groundwater interactions. The underlying WFD groundwater body status is Poor. There is a risk that poor quality groundwater during dewatering activities associated with piling could impact the overlying surface water body quality.	Good practice measures including sediment management and pollution prevention are detailed in the Outline CEMP (EIA Volume 3, Technical Appendix 17.A). Adherence to these will reduce the potential for contaminated sediment to be mobilised during construction activities (including earthworks and piling) and from pollution from runoff or leaching contaminants from exposed soils and accidental spills. Concrete will be placed for the permanent piles in precast units sealed to prevent loss into water and concrete will be delivered to the piles using a tremie (watertight) pipe to prevent concrete from contaminating the water body and impacting water quality parameters such as pH. The Outline CEMP (EIA Volume 3, Technical Appendix 17.A) will state that fuel and chemicals will be stored in designated bunded areas to contain any spills and the Contractor will ensure that emergency spill kits are available during construction.	The contractor will manage construction works in accordance with good practice as detailed in the Outline CEMP (EIA Volume 3, Technical Appendix 17.A) to manage pollution risk and potential release of sediment to prevent a deterioration to water quality. Any temporary impacts from construction of the Scheme are anticipated to be minimal, and unlikely to result in permanent deterioration of the water quality elements at a WFD water body scale.	No additional mitigation and no further WFD assessment is required.

Biological quality elements Invertebrates Macroalgae Fish Angiosperm Phytoplankton Infaunal Quality Index Opportunistic macroalgae Fuciod extent Rocky shore macroalgae Imposex	Construction activities such as piling have the potential to generate noise and vibration and light pollution which might impact fish and aquatic life within the water body. Biological quality elements are at risk of being impacted through generation of dust and debris, siltation, hazardous substances (concrete) and contamination from released sediment (e.g. heavy metals and pesticides) as a result of construction activities (earthworks and piling). Hydrocarbons may form a film on the surface of the water body and may deplete oxygen levels. Concrete is highly alkaline and can impact fish (physically damaged and gills blocked) and habitats. High sediment loading may have a direct adverse effect on the water body elements through increasing turbidity (reducing light penetration and plant growth) and smothering vegetation and bed substrates which may impact on invertebrate and fish communities (disturbance of feeding areas, refuges and breeding / spawning areas). Excessive fine sediment and pollution can harm fish, such as salmonids and lampreys, by reducing oxygen levels and hindering migration. This can lead to population losses in upstream habitats. In addition, the Dee Estuary hosts various marine invertebrates, especially in its intertidal mudflat and sandflat habitats, which serve as food for fish and waders. Exposure to underwater sound affects fish behaviour based on their hearing abilities. Due to significant differences in ear anatomy and physiology among species, fish detect sound in various ways. The most sensitive period is February to April for river lamprey and from May to September inclusive for sea lamprey and salmonids. Both species are features of interest within the SSSI, SPA and SAC and rely on good water quality. Construction can impact migratory fish through chemical spills, increased sediment movement, noise and vibration during migration seasons, and temporary lighting. Further information is included within EIA, Volume 1, Chapter 16: Marine Ecology.	In-river working including the installation of pile casings will be undertaken in the period November to February or during period March to October observing 0800 to 1700hrs working hours limit and no work in the 3hr period leading up to high tide at Chester weir as agreed with Marine Area Advice and Management Team to minimise disturbance to migrating fish (particularly at night when migration activity is generally higher). The construction methodology employs the use of a jack up barge which will reduce the disruption of river flows for fish passage and removes the need for channel constriction and caissons to form dry working areas around the bridge piers. When the piled steel tubes for the bridge piers reach the required depth, bored piles will be constructed by positioning an auger inside the steel tube. This way the disturbance of the silt and vibration at the riverbed will be kept to a minimum and restricted only to the steel tube-driving operations thus reducing the quantity of suspended particulates and noise within the water course which may indirectly affect fish. An underwater noise assessment was carried out to inform the impact assessment in EIA, Volume 1, Chapter 16: Marine Environment. Lighting for works will be switched off outside working hours (8am to 5pm), and security lighting minimised to avoid deterring fish movement and the passage of otters. In addition, soft-start approach will be undertaken to minimise the risk of disturbance to migrating fish. Pre-construction site walkovers and any necessary surveys would be carried out. Site clearance would consider the seasonal environmental constraints The diversion of Queensferry Drain would be considered during the construction phase in case eels (*Anguilla anguilla*), or other fish species may inhabit the drain, flounders have been recorded within the drain. Should eels or other fish species be identified as present the contractors should halt works halt works and consult the	Potential impacts include localised noise, vibration and light disturbance which will be short term during construction programme and adherence to mitigation measures will ensure that no deterioration of element status will occur at a WFD water body scale or prevent qualifying features of designated sites to maintain their condition status.	No additional mitigation and no further WFD assessment is required.

Quality element/receptor	Construction activities potential impact(s)	Embedded design and good practice mitigation measures(s)	Assessment outcome	Additional mitigation required
		Ecological Clerk of Works (ECoW) to determine if fish rescue should be carried out. With adherence to standard good practice (detailed in the CEMP), sediment and chemical pollution will be avoided. In the event of a pollution incident including a concrete spill, the Contractors will follow emergency response procedures as detailed in the PPP. This will minimise potential impacts from construction pollution on biological quality elements. Further information is included within EIA Volume 1, Chapter 16: Marine Ecology.		
Protected Areas River Dee and Bala Lake/ Afon Dyfrdwy SSSI River Dee/ Afon Dyfrdwy SSSI Dee Estuary/ Aber Afon Dyfrdwy SSSI, SAC, SPA and RAMSAR Shotwick Brook NVZ **Biological quality- habitats** Saltmarsh Sea grass Sensitive habitats	Sensitive habitats are present within the study area and are at risk of physical damage from siltation and contamination from released sediment and surface runoff. Physical disturbance and overshadowing could lead to deterioration and permanent removal of saltmarsh due to enabling construction works (temporary platform) and the replacement bridge including abutments (if not reinstated). The replacement and demolition of the existing bridge will lead to the loss and disruption of intertidal and saltmarsh habitats. Temporary structures such as platforms to facilitate construction will cast additional shade, further affecting these areas. In addition, construction will impact a saltmarsh on the eastern bank of the River Dee.	Efforts have been made to minimise disturbance and removal of saltmarsh and sensitive habitat through following the avoidance design principal. Contractors will adhere to good practice construction guidance for pollution prevention to minimise release of sediment and habitat disturbance as per the Outline CEMP (EIA, Volume 3, Technical Appendix 17.A). The north-eastern bank of the river beneath the existing bridge is a concrete revetment currently devoid of any vegetation. This would be either removed or adapted to encourage a growing medium to form and encourage natural recolonisation of plants from the adjacent riverbank. Localised excavation or formation of pockets by mechanical coring would be required with the use of geotextiles to secure the growing medium to prevent washout during periods of high spring tides. The proposals aim to preserve and monitor the area for natural saltmarsh colonisation by removing the old embankment rubble. If needed, manual enrichment may be implemented to enhance species, while ensuring the greenspace remains intact and public recreational rights are maintained.	Localised permanent habitat disturbance and loss is anticipated. The total area of saltmarsh likely to be affected is anticipated to be around 0.015 hectares which represents roughly 0.000095% of the wider SAC that covers a total area of 15,805 hectares. Removing the existing bridge is expected to improve conditions over time, allowing saltmarsh to thrive in sunlight. Also, establishing pioneer saltmarsh species may take two to three years, while reaching a mature saltmarsh could take decades. Therefore, this area should be included in an environmental monitoring and management plan following construction. There is a localised risk of deterioration to qualifying features from habitat loss and shading during construction. This does not align with the protected sites objectives of maintaining and restoring the qualifying features including extent and distribution, therefore additional mitigation is required.	Additional mitigation has been to ensure that the Scheme aligns with the protected sites objectives. Additional off-site mitigation is proposed at an area called “Greenfield Marsh” which located about fifteen kilometres northwest of the Scheme in the Dee Estuary Further information is provided in Section 6 Additional Mitigation.

Quality element/receptor	Construction activities potential impact(s)	Embedded design and good practice mitigation measures(s)	Assessment outcome	Additional mitigation required
INNS	Construction activities occurring in, over or adjacent to water bodies creates a risk of potential for spread of INNS associated with aquatic, marine and riparian habitats. The jack-up barge and other equipment may have had contact with other water bodies which could introduce INNS to the River Dee. Vegetation management vegetation (both riparian and aquatic) will be required during construction activities adjacent to the water body.	The Outline CEMP (EIA, Volume 3, Technical Appendix 17.A) will include a biosecurity plan for construction activities. Introduction and spreading of INNS will be avoided through the following clean, check and dry biosecurity measures including: clean and drying equipment that has come into contact with other water bodies including removal of any visible mud, plants, fish, or animals before transporting equipment to the River Dee, following the International Maritime Organization (IMO) ballast water management [23]. Vegetation clearance will only be undertaken following an ecological assessment of habitats and their ability to support protected species (e.g. nesting birds etc.,) and the risk posed by INNS. Further information about vegetation management is presented in the EIA Volume 1, Chapter 8: Terrestrial Biodiversity.	No INNS were identified during the 2025 intertidal walkover surveys. With adherence to the mitigation detailed and following biosecurity measures the risk of introducing and spreading INNS is low.	No additional mitigation required and no further WFD assessment is required.

Operation

6.2.2 Table 5-2 identifies potential effects of the Scheme operation activities on hydromorphological, physio-chemical and biological quality elements, and protected areas for the Dee (N. Wales) transitional water body. INNS have not been included in the scoping assessment for the operation phase.

[23] Compilation of relevant Guidelines and guidance documents - 2025-05.pdf

Table 6-2 Summary of Scheme operation methods on the Dee (N. Wales) transitional WFD water body

Quality element/receptor	Construction activities potential impact(s)	Embedded design and good practice mitigation measures(s)	Assessment outcome	Additional mitigation required
Hydromorphological supporting conditions Hydrological regime Morphological conditions	The Dee (N. Wales) WFD water body is a heavily modified water body with a hydrological regime of ‘not high’. Changes to flow, velocity or sediment dynamics within the River Dee as a result of the presence of the proposed bridge piers. No information is allocated for the WFD morphology element. Potential for changes to the morphology of the River Dee system including adjacent intertidal areas and shorelines in the long term. Potential for riverbed primary and secondary scour around the bridge supports over medium to long term. An area of road drainage runoff will be captured and diverted into the Queensferry Drain during and following rainfall events. The Queensferry Drain is estimated to have a baseflow of 0.02m^3/s which will create a constant discharge. The Queensferry Drain will pass through a pumping station and discharge to the River Dee via a new outfall.	The new pier design and alignment is consistent with the existing piers to minimise flow disruption. Abutments will be set back from the bank which will minimise the impact on the bank morphology through embedded design. The water body has a dynamic regime with rapid bed adjustment as supported by findings from bathymetry surveys (2021 to 2022). Scour protection has not been included in the design to allow the riverbed to maintain its natural mobility without artificial constraints. Discharge from the new outfall (maximum rate is 2.275m^3/s for 1 in 100 year event plus 40% climate change allowance) will contribute a minimal indiscernible increase to the hydrological flow in the River Dee. The design of the outfall will be confirmed at the detailed design including provision for scour protection if required.	Hydrodynamic and sediment transport assessment considered the flow effects, scour and distribution of sediment that could arise as a result permanent structures in the River Dee. The findings indicate the Scheme will not significantly alter water levels but will lead to localised changes in current speeds and flow patterns near the bridge piles, the broader impact on tidal regime and sediment transport will be limited and there will be no permanent impact at the WFD water body scale. Impacts from operation of the Scheme on the hydromorphological supporting conditions of the river are anticipated to be localised and are unlikely to cause deterioration at a water body scale.	No additional mitigation and no further WFD assessment required.

Quality element/receptor	Construction activities potential impact(s)	Embedded design and good practice mitigation measures(s)	Assessment outcome	Additional mitigation required
Water quality **Physico-chemical** Ammonia Biochemical Oxygen Demand Dissolved inorganic nitrogen Dissolved oxygen pH Temperature Phosphate Total Nitrogen Total Phosphorous Salinity **Chemical** Specific pollutants, other pollutants, priority substances and priority hazardous substances	Road drainage runoff has the potential to cause pollution through increasing parameter concentrations of WFD chemical pollutants where insufficient treatment is in place which could lead to a deterioration of water quality in the water body for longer than a spring neap tidal cycle (14 days). Algae blooms can be caused by an increase in nutrients from the wider catchment which can be transported in runoff via drainage channels. The water body has a phytoplankton WFD status of Good, however, the Dee has a history of harmful algae blooms.	The incorporation of SuDS in the drainage network will positively impact water quality in the River Dee. A vortex separator or similar has been proposed to treat surface flows which have been captured along the Riverside Way access road. Penstock devices are currently proposed for the highway drainage networks which can prevent contaminants reaching the water body. Non return flap valve on the Queensferry Drain outfall to prevent tidal ingress upstream to the pumping station. Further consultation required with NRW and Dŵr Cymru Welsh Water at detailed design on the outfall design. The existing Queensferry Drain watercourse will be reinstated from a culvert to vegetated open channel providing approximately 60m length of additional open channel. This will provide additional filtration of sediments prior to discharge to the WFD water body immediately downstream.	Operational embedded drainage design will provide an improvement on the baseline of some water quality WFD elements through the proposed treatment train which includes swales and pollution control devices. The HEWRAT assessment included a spillage risk assessment which concluded that no mitigation is required for spillage risk for the parameters assessed including WFD element copper. The River Dee provides significant dilution potential for the treated road runoff discharges. The Scheme operation will not result in deterioration of the WFD water body water quality elements.	No additional mitigation required and no further WFD assessment is required.

Quality element/receptor	Construction activities potential impact(s)	Embedded design and good practice mitigation measures(s)	Assessment outcome	Additional mitigation required
Biological quality elements Invertebrates Macroalgae Fish Angiosperm Phytoplankton Infaunal Quality Index Opportunistic macroalgae Fuciod extent Rocky shore macroalgae Imposex	Algae blooms can be caused by an increase in nutrients from the wider catchment which can be transported in runoff via drainage channels. The water body has a phytoplankton WFD status of Good, however, the River Dee has a history of harmful algae blooms. The species most likely affected are demersal species, such as flounder, sole, and plaice, along with elasmobranchs like the tope shark and thornback ray. However, these mobile species can easily relocate away from the impacted area. A permanent loss or disturbance of benthic habitat in the River Dee could lead to a decrease in infaunal and epibenthic marine invertebrates, reducing food availability for fish and affecting local fish populations. The replacement pumping station on Queensferry Drain includes a debris screen at the pumping station inlet which creates a risk of entrapment to aquatic species.	The proposed changes to the drainage network include several treatment measures including sections of open channel vegetated swales. This will provide additional filtration of sediments prior to discharge to the WFD water body immediately downstream. This is anticipated to improve the current water quality discharged from the Queensferry Drain. New bridge piers will not result in a physical barrier to prevent fish migration due to their positioning away from the centre of the channel. As concluded in the Volume 1, Chapter 16: Marine Environment, noise and vibration from the operational Scheme is not anticipated to impact on normal fish behaviour subject to embedded mitigation detailed in the Outline CEMP (Volume 3, Technical Appendix 17.A) being adhered to. Fish pass will be considered for trash screen design (appropriate mesh size and spacing) and water intake velocities should be kept low to minimise risk of fish being pulled to screen. As the Queensferry Drain channel is likely to be shallow depth most of the time it is considered to have limited suitability for fish habitat.	Proposed drainage design will improve the current water quality discharged from the Queensferry Drain and therefore would not cause deterioration of the water quality elements or increase sediment which could impact on biological quality elements like fish. The benthic habitat is common in the intertidal and subtidal zones and removing it will not significantly affect the overall extent, as the removal area is only 0.019% of the total habitat in the River Dee and Bala Lakes SAC, SSSI. The habitat lost is outside the boundary of the Dee Estuary SAC, which is situated 1km away. Key species can quickly recruit and recolonise disturbed areas, enabling rapid recovery. While migratory fish have high conservation value, they are unlikely to be sensitive to this impact due to their ability to avoid the demersal area and their minimal reliance on the small habitat that will be lost. The affected benthic area is small and surrounded by large suitable habitat. And is therefore unlikely to have an impact at the WFD water body scale.	No additional mitigation required and no further WFD assessment is required.

Quality element/receptor	Construction activities potential impact(s)	Embedded design and good practice mitigation measures(s)	Assessment outcome	Additional mitigation required
Protected Areas – River Dee and Bala Lake/ Afon Dyfrdwy SSSI River Dee/ Afon Dyfrdwy SSSI Dee Estuary/ Aber Afon Dyfrdwy SSSI, SAC, SPA and Ramsar Shotwick Brook NVZ **Biological quality- habitats** Saltmarsh Sea grass Sensitive habitats	Sensitive habitats are present within the study area and are at risk of physical damage from siltation and contamination from road drainage runoff. Overshadowing of saltmarsh habitat potentially leading to deterioration and permanent removal of saltmarsh associated with abutments.	Disturbance and removal of saltmarsh and sensitive habitat will be minimised where possible. The north-eastern bank of the River Dee beneath the existing bridge is a concrete revetment currently devoid of any vegetation. The concrete revetment would be either removed or adapted to encourage a growing medium to form and encourage natural recolonisation of plants from the adjacent riverbank. Localised excavation and mechanical coring would be required as part of the concrete revetment removal. Geotextiles would be used to secure the growing medium to prevent washout during periods of high spring tides.	Localised permanent habitat disturbance and loss is anticipated. The total area of saltmarsh likely to be affected is anticipated to be around 0.015 hectares. which represents roughly 0.000095% of the wider SAC that covers a total area of 15,805 hectares. There is a localised risk of deterioration to qualify features. This does not align with the protected sites objectives of maintaining and restoring the qualifying features including extent and distribution, therefore compensatory habitat creation is required.	Habitat creation has been proposed to ensure that the Scheme aligns with the protected sites objectives. Further information is provided in Section 6 Additional Mitigation.

Summary

6.2.3 There are several activities identified for the construction and operation phases of the Scheme that could impact on the quality elements of the Dee (N. Wales) transitional WFD water body and the associated protected areas. However, in most cases, the potential impacts would be highly localised and would not have an impact at the WFD water body scale. In these instances, no additional mitigation is required.

6.2.4 Nevertheless, the loss of saltmarsh habitat associated with the construction of the new bridge does not align with the objectives of the protected sites. Additional habitat creation has been proposed to ensure the Scheme does not adversely impact the protected sites or have a detrimental impact at the WFD water body scale. Further information can be found in Section 7.

6.3 Dee Carboniferous Coal Measures

Construction

6.3.1 Table 6-3 details the scoping assessment for the screened in WFD groundwater body Carboniferous Coal Measures. The assessment considers the potential construction impacts on WFD elements and potential mitigation.

Table 6-3 Summary of Scheme construction methods on the Dee Carboniferous Coal Measures groundwater WFD water body

Quality element	Construction activities and potential impact(s)	Embedded design and mitigation measure(s)	Assessment outcome	Additional mitigation
Chemical Chemical Groundwater tests Chemical Drinking Water Protected Area General Chemical Test Chemical Groundwater Dependent Terrestrial Ecosystems test Chemical Dependent Surface Water Body Status Chemical Saline Intrusion Trend Assessment - Groundwater supporting element	Temporary sheet piling for abutments, piling for the temporary platform and piling for bridge piers construction have the potential to create vertical preferential pathways for pollution (sediment; chemical e.g., alkalinity increased by concrete spills; or saline intrusion resulting in deterioration of groundwater WFD status for quality elements. Potential for leaching and migration of contaminants from soils excavated during construction and reused/stored on site e.g., for embankments.	Embedded design measures and construction good practice as detailed in the Outline CEMP (EIA, Volume 3, Technical Appendix 17.A) e.g., concrete will be contained during construction within precast units sealed to prevent loss into water and delivered to the pile locations by watertight tremie pipe. Other good practice measures include stockpile management and contamination pollution prevention measures. Temporary piles for the temporary platform and jetty will be removed and capped. A piling risk assessment will be undertaken by the Contractor prior to carrying out works. The Contractor will obtain a discharge permit for groundwater dewatering activities.	Previous ground investigations which reached a depth of 34m bgl did not encounter the boundary between the overlying superficial deposits and the Coal Measures. Piles are anticipated to be installed to a depth of approximately 34m and it is possible that the WFD groundwater body may be reached. With consideration to the scale of the Carboniferous Coal Measures groundwater body in comparison to the footprint of the piling activities for construction, and adherence to good practice mitigation measures, any changes in groundwater quality are anticipated to be localised and negligible. A change or deterioration at the water body scale (which currently has a WFD groundwater chemical status of poor) is unlikely.	None required and no further WFD assessment is required.
Quantitative Groundwater quantitative tests Quantitative Groundwater Dependent Terrestrial Ecosystems test Quantitative Dependent Surface Water Body Status Quantitative Saline Intrusion Quantitative Water Balance	Permanent piling for bridge piers (concrete cast in-situ) has the potential to disrupt groundwater flows. Dewatering activities could potentially disrupt groundwater flows locally.	The Contractor will obtain a discharge permit for groundwater dewatering activities. A piling risk assessment will be undertaken by the Contractor prior to carrying out works.	Dewatering will be highly localised at the pile locations. With adherence to best practice any impact will be minimised. Any impact is anticipated to be temporary and highly localised. As a result of substrate material compression surrounding the sheet piles structure this is unlikely to result in a significant preferential pathway, and it is not anticipated that there would be an impact at the WFD waterbody scale.	None required and no further WFD is assessment required

Operation

6.3.2 Table 5-4 details the scoping assessment for the screened in WFD groundwater body Carboniferous Coal Measures. The assessment considers the potential operational impacts on WFD elements and potential mitigation.

Table 6-4 Summary of Scheme operation methods on the Dee Carboniferous Coal Measures groundwater WFD water body

Quality element	Construction activities and potential impact(s)	Embedded design and mitigation measure(s)	Assessment outcome	Additional mitigation
Chemical Chemical Groundwater tests Chemical Drinking Water Protected Area General Chemical Test Chemical Groundwater Dependent Terrestrial Ecosystems test Chemical Dependent Surface Water Body Status Chemical Saline Intrusion Trend Assessment - Groundwater supporting element DWPA	Permanent presence of bored piles reaching a depth of approximately 34m could create vertical pathways for contaminants or allow saline intrusion to reach the WFD groundwater body. This could result in deterioration of groundwater WFD status for quality elements.	The proposed bridge design sought to minimise the number of piers and to align with the existing bridge piles to minimise the disruption to groundwater flow pathways. The permanent piles will be capped upon completion of construction which will reduce the risk of preferential pathways for contaminants.	Previous ground investigations which reached a depth of 34m bgl have not encountered the boundary between the overlying superficial deposits and the Coal Measures. Piles are anticipated to be installed to a depth of approximately 34m and it is possible that the groundwater body may be reached. With consideration to the scale of the Carboniferous Coal Measures groundwater body in comparison to the footprint of the permanent piles for operation, any changes in chemical groundwater receptors are anticipated to be localised and negligible and would not result in a change or deterioration at the WFD water body scale.	None required and no further WFD assessment is required.
Quantitative Groundwater quantitative tests Quantitative Groundwater Dependent Terrestrial Ecosystems test Quantitative Dependent Surface Water Body Status Quantitative Saline Intrusion Quantitative Water Balance DWPA	Permanent presence of bored piles has the potential to locally impact groundwater flows.	The proposed bridge design sought to minimise the number of piers and to align with the existing bridge piles to minimise the disruption to groundwater flows.	Previous ground investigations which reached a depth of 34m bgl have not encountered the boundary between the overlying superficial deposits and the Coal Measures. Piles are anticipated to be installed to a depth of approximately 34m and it is possible that the groundwater body may be reached. With consideration to the scale of the Carboniferous Coal Measures groundwater body in comparison to the footprint of the permanent piles for operation, any changes in quantitative groundwater receptors are anticipated to be localised and negligible and would not result in a change or deterioration at the WFD water body scale.	None required and no further WFD assessment is required.

Summary

6.3.3 There are several activities identified for the construction and operation phases of the Scheme that could impact on the quality elements of the Dee Carboniferous Coal Measures groundwater WFD water body. The potential impacts would be highly localised and would not have an impact at the WFD water body scale, therefore no additional mitigation is required.

7. Additional Mitigation

7.1.1 There is anticipated to be localised permanent saltmarsh habitat disturbance and loss during the construction and operation phases associated with the following activities:

a) Construction activities:

i) Siltation and contamination from released sediment and surface runoff.

ii) Physical disturbance and overshadowing due to enabling construction works e.g., temporary platforms.

iii) Demolition of the existing bridge.

iv) Habitat disturbance and loss.

b) Operation activities:

v) Siltation and contamination from released sediment and surface runoff.

vi) Overshadowing of the saltmarsh habitat by the new bridge.

7.1.2 The potential impact on saltmarsh habitats could adversely impact the Dee Estuary SSSI which is a protected site within the Dee (N. Wales) transitional WFD water body. This does not align with the protected sites objectives of maintaining and restoring the qualifying features including extent and distribution. Therefore, additional habitat creation has been incorporated.

7.1.3 A suitable offsite area of 1.35 hectares at Greenfield Marsh (15 km downstream of the Scheme near Walwen) has been selected for compensation for saltmarsh loss. The selected area contains areas of saltmarsh habitat of variable condition and has patches of rubble left as vestiges from an old tip. The patches of rubble will be removed and disposed of in line with relevant waste management to encourage the natural colonisation of the habitat. The Welsh Government will collaborate with Flintshire County Council (FCC) and NRW to progress with these proposals should the Scheme be consented. More information on the compensation measures at Greenfield Marsh is presented in EIA Volume 1, Chapter 8: Terrestrial Biodiversity.

7.1.4 The offsite area is located immediately outside of the Dee (N. Wales) transitional WFD water body boundary, however it is assumed that any betterment created as a result of the establishment of the habitat would impact the Dee (N. Wales) water body due to its proximity.

8. Conclusions and recommendations

8.1.1 The WFD screening and scoping assessment has been undertaken to establish if the Scheme could cause WFD compliance risk to the impacted water bodies and protected areas.

Screening assessment outcomes (Stage 1)

8.1.2 The screening assessment identified one transitional WFD water body and associated protected areas and one groundwater WFD body and an associated protected area that could be impacted by the screened in construction and operation activities. The following WFD receptors were scoped in for further assessment:

i) Dee (N. Wales) transitional WFD water body.

ii) Dee Carboniferous Coal Measures WFD groundwater body.

iii) Protected areas (River Dee and Bala Lake/ Afon Dyfrdwy SSSI; River Dee/ Afon Dyfrdwy SSSI; Dee Estuary/ Aber Afon Dyfrdwy SSSI, SAC, SPA and Ramsar; Shotwick Brook NVZ and Dee Carboniferous Coal Measures groundwater DWPA.

Scoping assessment outcomes (Stage 2)

8.1.3 WFD receptors were identified based on the WFD water body quality elements for screened in water bodies that define the overall water body status. Those potentially at risk from screened in activities were taken forward for further assessment.

WFD impact Assessment (Stage 3)

8.1.4 The WFD impact assessment involved assessing the potential impacts on the scoped in receptors for hydromorphological, physico-chemical water quality and biological quality elements for the transitional water body, qualitative and chemical groundwater elements for the groundwater body, and the scoped in protected areas.

Construction

8.1.5 The impact assessment identified potential construction impacts on WFD receptor elements including water quality and hydromorphology from activities resulting in silt mobilisation, pollution and disturbance. These impacts are not anticipated to cause any deterioration at a water body scale with adherence to good practice mitigation measures detailed (including adherence to the EIA, Volume 3, Technical Appendix 17.A Outline CEMP). No additional mitigation is required.

8.1.6 Potential construction impacts on WFD receptor elements on biology elements (fish, habitats and protected sites) from activities resulting in sedimentation, pollution noise and habitat disturbance were identified. Sedimentation, pollution and noise will be managed through mitigation measures and no deterioration at a water body scale is anticipated and no additional mitigation is required.

8.1.7 There is potential for permanent disturbance to sensitive habitats including saltmarsh during construction. Additional habitat creation has been proposed which involves restoration of 1.35 hectares of existing saltmarsh habitat at Greenfield Marsh 15k downstream of the Scheme.

8.1.8 No additional mitigation is proposed for groundwater assuming adherence to good practice construction measures during construction and no impacts are anticipated at a WFD water body scale.

8.1.9 INNS do not pose a risk to the River Dee, assuming mitigation measures are followed which will prevent potential cross-contamination of equipment from other water bodies during the construction phase.

Operation

8.1.10 The Scheme is unlikely to impact on the hydromorphological WFD elements of the River Dee during the operational phase. Modelled sediment transport results indicate that while the new bridge influenced localised flow conditions, its broader impact on tidal regime and sediment transport remained limited.

8.1.11 Water quality WFD elements of the River Dee are anticipated to receive beneficial impacts from the Scheme due to drainage design improvements. This is not anticipated to result in deterioration of water quality and therefore no impact on salmon and lamprey supporting conditions. Details of embedded mitigation measures for drainage and information on the water environment can be found in the EIA Volume 1 Chapter 7: Drainage and the Water Environment.

8.1.12 There is a localised risk of deterioration to qualifying biological features from the operational period associated with permanent loss of habitat and shading causing disturbance to saltmarsh habitat. This does not align with the protected sites objectives of maintaining and restoring the qualifying features including extent and distribution, therefore compensation has been proposed in the form of off-site habitat creation. Other biological elements are not anticipated to be at risk from deterioration at a water body scale.

8.1.13 With consideration to the nature and highly localised impacts of potential operational impacts on groundwater, no deterioration is anticipated at a WFD water body scale.

8.1.14 Assuming mitigation measures are followed which will prevent potential cross-contamination of equipment from other water bodies during maintenance in the operational phase, INNS are not considered a significant risk for WFD.

9. Appendix A

9.1.1 The WFD baseline for Cycle 3 (2021) for the screened in water bodies is detailed in Tables 8-1 and 8-2.

Table 9-1 Cycle 3 WFD Classification for the Dee (N. Wales)

WFD Classification	Dee (N. Wales)
Water body ID	GB531106708200
Water body category	Transitional
Area	109 km^2
Hydromorphological Designation	Heavily Modified
Overall water body status	Moderate
Ecological	Good
Eco-bio	Good
Eco-gen	Good
Biological quality elements	Good
Invertebrates	Good
Fish	Good
IQI	Good
Salt Marsh	Good
Phytoplankton	Good
Angiosperm	Good
Macroalgae	Good
OppMac_Sub	High
Fucoid extent	Good
Hydrological regime	Not High
Mitigation measures assessment	Good
Hydromorph	Not high
Physico-chemical quality elements	Moderate
Dissolved oxygen	High
Dissolved Inorganic Nitrogen	Good
Specific Pollutants	High
Arsenic	High
Copper	High
Iron	High
Manganese	High
Toulene	High
Zinc	High

WFD Classification	Dee (N. Wales)
Anthracene	High
BDPE	Moderate
Cadmium	High
Chemical C	Moderate (PAH and BDPEs are reported as "moderate" whilst all other chemical sub-elements are "high")

Table 9-2 Cycle 3 WFD classification for Dee Carboniferous Coal Measures

WFD Classification	Dee Carboniferous Coal Measures
Water body ID	GB41102G204800
Water body category	Groundwater
Hydromorphological designation	Natural
Overall water body status	Poor
Groundwater Chemical	Poor
Chemical Drinking Water Protected Area	Good
General Chemical Test	Poor
Chemical Groundwater Dependent Terrestrial Ecosystems test	Good
Chemical Dependent Surface Water Body Status	Poor
Chemical Saline Intrusion	Good
Trend Assessment - Groundwater supporting element	Moderate
Groundwater Quantitative Tests	Good
Quantitative Groundwater Dependent Terrestrial Ecosystems Test	Good
Quantitative Dependent Surface Water Body Status	Good
Quantitative Saline Intrusion	Good
Quantitative Water Balance	Good

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Llywodraeth Cymru / Welsh Government

A494 RIVER DEE BRIDGE REPLACEMENT

Technical Appendix 7:C

Volume 3: Technical Assessment Report

Highways England Water Risk Assessment Report

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1. Introduction

1.1 Purpose of report

1.1.1 This report forms a technical appendix to the Road Drainage and Water Environment chapter, contained in Volume 7 of the Environmental Statement (ES) for the A494 River Dee Bridge Replacement Scheme (hereafter referred to as the 'the Scheme'). This report presents a summary of the water quality assessment undertaken to assess the potential impacts of highway runoff to watercourses resulting from the Scheme.

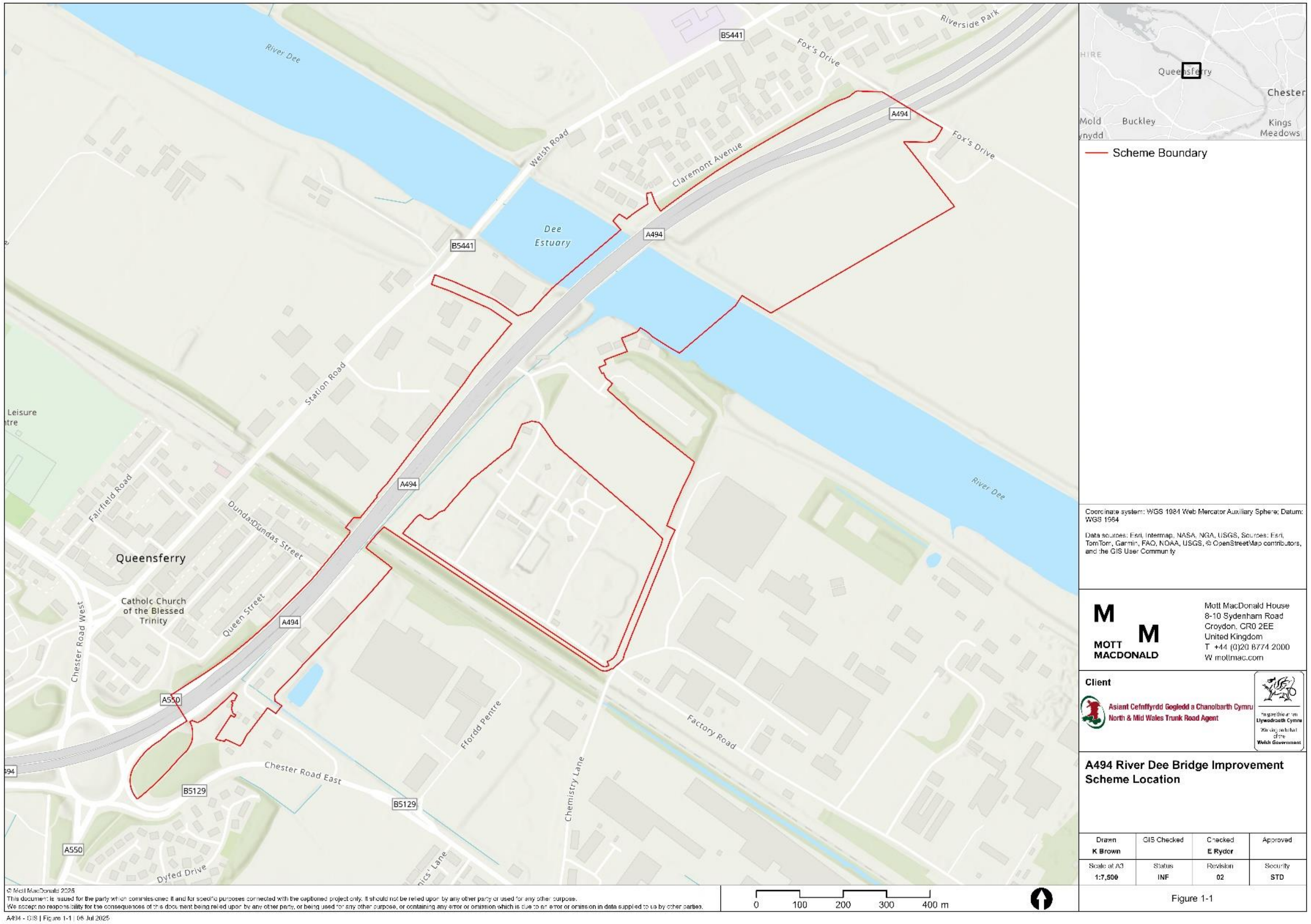
1.1.2 The purpose of the Highways England Water Risk Assessment Tool (HEWRAT) is to assess the potential impacts that the Scheme will have water quality on receiving watercourses (National Highways, 2025). The assessment confirms the baseline water quality and determines if the Scheme (and the mitigation planned) will cause a deterioration in water quality.

1.1.3 The assessment does not account for any construction impacts of the Scheme. This is because the HEWRAT tool is designed to evaluate only the permanent impact on water quality, lacking the capacity to do temporary impact assessments.

1.2 Proposed scheme

1.2.1 The Scheme is located in Flintshire, North Wales on a tidally influenced reach of the River Dee (National Grid Reference (NGR) SJ 32420 68583) as shown in Figure 1.1. The Scheme involves replacing the existing road bridge, over the tidal River Dee, with a new bridge approximately 36.5m wide and 140m in length to carry two lanes of eastbound and westbound traffic, hard shoulder and shared use path.

Figure 1-1 Proposed A494 Bridge Replacement Scheme



1.2.2 The Scheme includes the diversion of the 'the Queensferry Drain' (main river[1]) including the creation of new sections of open channel either side of North Wales Coast Railway Line, while maintaining a section of the existing culvert beneath the railway.

1.2.3 The Scheme includes changes to the existing road drainage network, creation of a new drainage outfall to the River Dee and a new Queensferry Drain Pumping Station facility provided adjacent of the River Dee.

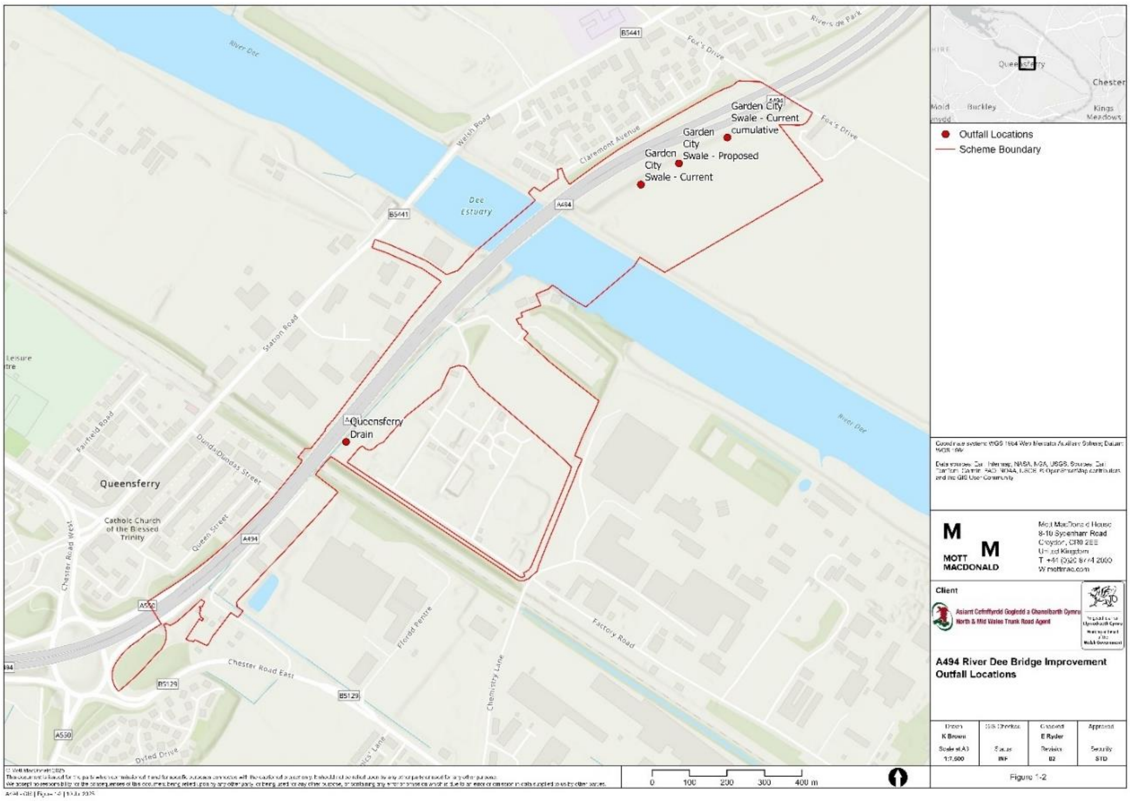
Outfalls

1.2.4 The outfalls assessed in this HEWRAT assessment are shown in 0:

a) Queensferry Drain

b) Garden City Swale

Figure 1-2 Locations of the outfalls assessed



[1] Large or key river within a drainage basin or river system. Watercourses are designated 'main rivers' due to criteria such as flood risk, catchment management, infrastructure support and strategic importance (Environment Agency, 2017).

2. Methodology

2.1 Guidance

2.1.1 The assessment methodology follows the guidance set out in the Design Manual for Roads and Bridges (DMRB) LA 113 – Road drainage and the water environment[2].

2.2 HEWRAT

2.2.1 The HEWRAT assessment tool assesses the impact of soluble pollutants (acute pollution) and sediment related pollutants (chronic pollution) on freshwater[3].

Three stage approach

2.2.2 The HEWRAT assessment adopts a stepped approach as follows:

2.2.3 Step 1: Runoff quality. Predicts concentrations of pollutants in untreated and undiluted highway runoff prior to any treatment and dilution in a waterbody.

2.2.4 Step 2: In-river impacts. Predicts concentrations of pollutants after mixing within the receiving waterbody. At this stage, the ability of the receiving watercourse to disperse sediments is considered. Step 2 also incorporates 2 'tiers' of assessment for sediment accumulation, based on different levels of input parameters. If 1 or more risks are defined as unacceptable at Tier 1, i.e. 'fail', then a more detailed Tier 2 assessment is undertaken, requiring values for additional parameters relating to the physical dimensions of the receiving watercourse.

2.2.5 Step 3: In-river impacts with mitigation. Steps 1 and 2 assume that the road drainage system incorporates no mitigation measures to reduce the risk. Step 3

[2] National Highways (2020) Design Manual For Roads and Bridges LA113 Road drainage and the water environment [online] available at: https://www.standardsforhighways.co.uk/tses/attachments/d6388f5f-2694-4986-ac46-b17b62c21727?inline=true (last accessed April 2025),
[3] National Highways. (2020). LA113 DMRB Vol. 11, Section 3, Part 10 Road Drainage and the Water Environment (Revision 1) [online].

includes mitigation in the form of Sustainable Drainage Systems (SuDS), considering the risk reduction associated with any existing or proposed measures.

2.2.6 Table 2-5 defines all possible outcome combinations for the routine runoff and surface water quality assessment and the action shall be applied to the relevant scenario.

Table 2-1 Assessment outcomes and actions

Acute-soluble and chronic-sediment impacts	Annual average concentrations (compliance with EQS)	Action
Pass	Pass	No further action
Fail	Pass	Factor in effect of proposed mitigation and reassess Determine implications of redesign and reassess Weigh up benefits over whole project Discuss with Overseeing Organisation and EPA (Environmental Protection Agency) and agree action
Pass	Fail	Factor in effects of proposed mitigation and reassess Check sensitivity of modelling to input parameters e.g. Q95 Discuss with Overseeing Organisation and EPA and agree action
Fail	Fail	Factor in effect of proposed mitigation and reassess Redesign and assess Discuss with Overseeing Organisation and EPA and agree action

Cumulative assessment

2.2.7 HEWRAT assessments should include cumulative assessments that consider other outfalls located within 100m and 1km of each other that drain the same watercourse, in accordance with DMRB methodology. Beyond 1km it is assumed dilution would occur and impacts would be less significant. For outfalls within 100m, cumulative assessments are needed for soluble pollutants and sediments, for outfalls between 100m and 1km apart cumulative assessments are needed for soluble pollutants only.

2.3 M-BAT

2.3.1 Where the discharge fails the HEWRAT simple assessment for annual average concentrations (EQS) of soluble pollutants, and proportionate mitigation cannot be readily incorporated, a detailed assessment must be carried out using the UKTAG Rivers and Lakes Metal Bioavailability Assessment Tool (M-BAT) to provide a representative picture of bioavailability.

2.3.2 The M-BAT takes account of the water chemistry, particularly the pH, dissolved calcium and dissolved organic carbon, to calculate the bioavailable copper and zinc, since these factors influence the toxicity of metals to aquatic organisms.

2.3.3 To comply with the Water Environment (WFD) (England and Wales) (Amendment) Regulations WFD 2015 the annual average concentrations predicted by HEWRAT, or M-BAT, must be lower than the EQS given in those regulations.

2.4 Spillage Risk Assessment

2.4.1 Spillage risk assessments aim to ensure provision of appropriate drainage design measures if there is a serious risk of a pollution incident. If a spillage incident is more frequent than the 1% Annual Exceedance Probability (AEP) (1 in 100-year return period) or 0.5% AEP (1 in 200 years) for sensitive watercourses e.g. designated sites downstream, the assessment will fail and mitigation will be required.

2.4.2 The results of the assessment are reported as ‘pass’ or ‘fail’. The risk of an acute pollution incident, due to accidental spillage or vehicle fire, is considered proportionate to the risk of a Heavy Goods Vehicle (HGV) road traffic collision, and the volume of traffic.

2.5 Groundwater Assessment

2.5.1 Depending on a range of factors this can affect surface runoff within basins which can impact underlying groundwater. To assess the risk from runoff on groundwater, a groundwater assessment (also known as a soakaway assessment) is undertaken if there is a soakaway present or if there are low flows within the receiving watercourse.

2.5.2 When Q95 values are equal to or below 0.001 m^3/s, a groundwater assessment will be triggered due to the impacts the very low flow rates can have on drainage efficiency, water quality and wider environment. A groundwater assessment is initiated to evaluate the feasibility and effectiveness of the basin as a drainage solution.

2.5.3 The groundwater assessment is designed to assess the potential overall risk to groundwater and to highlight any high-risk sites, where any additional mitigation measures will be required. Impacts of infiltration of routine road runoff on the quality of the underlying groundwater at surface water drainage networks have been assessed in accordance with the assessment method set out in DMRB LA 113: Road drainage and the water environment[4].

2.5.4 The DMRB LA113 (Table C1.2) provides a matrix designed to evaluate the potential overall risk to groundwater and to identify high risk sites that may require additional measures. The risk assessment matrix uses the Source-Pathway-Receptor (S-P-R) protocol developed for use in risk assessment procedures for contaminated land evaluation. For road systems, the road drainage provides the source term. The pathway is represented by the processes through which road drainage is transported and discharged.

2.5.5 The overall risk score is calculated by multiplying the weighting factor for each parameter by the corresponding category risk score (low risk – 1, medium risk – 2, high risk – 3). The corresponding overall risk categories are determined as:

a) Overall risk score <150 – Low risk of impact
b) Overall risk score 150 to 250 – Medium risk of impact
c) Overall risk score >250 – High risk of impact.

2.6 Assumptions and limitations

2.6.1 Some of the parameters used in the groundwater assessment are based upon assumptions (unsaturated zone, clay content and organic carbon), large resolution data (pH) or from old data records (>20 years). This reduces the accuracy of the assessments and may have led to an overestimation of the risk to groundwater associated with each outfall.

[4] National Highways (2020) Design Manual For Roads and Bridges LA113 Road drainage and the water environment [online] available at: https://www.standardsforhighways.co.uk/tses/attachments/d6388f5f-2694-4986-ac46-b17b62c21727?inline=true (last accessed April 2025),

2.6.2 Estimating the organic carbon risk using the Countryside Survey (CS) topsoil carbon concentration (g/kg) data to calculate carbon percentage. As stated by Eurofins[5], a guideline soil organic carbon makes up about 50% of organic matter. This can be factor was used to convert the carbon percentage.

2.6.3 The clay content has been estimated by dividing the depth of clay (determined from lowest point where clay is seen in strata based on the borehole data) by the depth of the groundwater (also derived from the borehole data).

2.6.4 As shown by the borehole data, the presence of groundwater was near the surface (<5m depth), but no value was given for the groundwater level. Given the proximity to the River Dee, it is likely that the groundwater level is closely related to the river water level[6]. Therefore, a higher groundwater table is assumed as a worst-case scenario.

2.6.5 No proposed mitigation assessment was undertaken for Queensferry Drain as the existing baseline and post-scheme conditions will be same.

2.6.6 As part of the Scheme, there are potential water quality impacts to the River Dee, as a result of highways runoff. However, as HEWRAT designed using freshwater EQS standards and the River Dee at this location is tidal, a HEWRAT assessment is not applicable for this watercourse. Impacts on the River Dee are covered in the River Dee Surface Water Monitoring Report (395318-MMD-00-XX-RP-Z-022).

2.6.7 The water quality surveys were only conducted over a six-month period (Nov – Apr), which may not account for all seasonal variations.

2.6.8 The swale at Garden City Drain is ephemeral and as a result, it was not possible to collect water samples. This absence of samples and no open-source data available on or near the swale, the copper and M-BAT values used may not accurately reflect the conditions within the swale. The values were derived from

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[5] Eurofins Agro, n.d. *What is the relation between soil organic matter and soil organic carbon?.* Available at: https://www.eurofins-agro.com/en/faq/what-is-the-relation-between-soil-organic-matter-and-soil-organic-carbon [Accessed 1 May 2025].
[6] Leone, G., Ginolfi, M., Esposito, L & Fiorillo. 2024. Relationships between River and Groundwater Flow in an Alluvial Plain by Time Series Analysis and Numerical Modeling. *Water Resources Management*. **38**, 2851-2868

samples of Queensferry Drain. Given the limitations state above, these values are deemed most representative.

2.6.9 Water quality data for both outfalls were obtained from water quality surveys undertaken at WQ04 – Queensferry Drain (National Grid Reference SJ 32097 68269). This site was selected as a safe and accessible area for surveys.

2.6.10 There will be no change in channel dimensions between the current and proposed designs. As the exact modifications to the Garden City Swale channel dimensions are unknown, the existing dimensions have been retained to illustrate the potential scale of impact from the drainage changes.

2.6.11 The Q95 values were determined from LowFlows, due to no flow gauges available. Catchment areas used in LowFlows were manually created (using Scalgo[7] and LiDAR). As both watercourses are small with small catchment areas, and Garden City Swale being ephemeral, the low flows are likely representative.

2.6.12 In addition channel dimensions for Tier 1 were estimated using aerial imagery from Google Earth, while Tier 2 channel dimensions were derived from LiDAR Composite DTM with a 1m resolution. Due to both the dim

2.6.13 The AADT data used for all outfalls is from 2019, as 2020-2021 data were excluded due to the impact of COVID-19. The Scheme is not expected to increase traffic flows and it is assumed that traffic flows have remained similar since 2019.

2.6.14 The current drainage layout for Garden City Swale is based on the ‘as built’ from August 2003, which depicted the proposed drainage before the swale was constructed (as seen on Google Earth). It has been assumed these plans accurately reflect the current drainage system. However, any modifications to the drainage or road area over the past 20 years have not been accounted for. A verification using Streetview was conducted, revealing a couple of visible outlets, though not all outlets shown in the ‘as built’ were identifiable.

[7] https://scalgo.com/

2.6.15 Whilst the HEWRAT has been undertaken taking into account these assumptions and limitation. The assessment is considered to be valid and a precautionary approach has been undertaken where information is absent.

3. HEWRAT Assessment

3.1 Model input parameters

3.1.1 The HEWRAT assessment requires inputs to determine the impacts of routine runoff from the Scheme. The HEWART employs a multi-tiered, outcome-based method for assessment and reports results at three different stages:

- Step 1: Runoff quality (prior to any pre-treatment)
- Step 2: In-river impacts (after dilution and dispersion)
- Step 3: In-river impacts (post mitigation)

3.1.2 The inputs required at each stage are shown in Table 3-1

Table 3-1 HEWRAT – Model input parameters

Stage of assessment	Inputs
Step 1 (run off quality)	Outfall information (location) Traffic volume (AADTs) Geographic location 10 years of rainfall data (Standard Annual Average Rainfall (SAAR) values embedded in HEWRAT) for various areas around the country
Step 2 (in river impacts)	Area draining to outfall (impermeable and permeable) Characteristics of receiving watercourse: Q95[8] Base flow index[9] Water hardness EQS values River width Bed width Manning's coefficient[10] Side slope Long slope

[8] The flow within the watercourse in cubic metres per second that is equalled or exceeded for 95% of the flow record i.e. the low flow value.
[9] Base flow index is a measure of the ratio of long-term base flow to a watercourse and gives an indication of the groundwater contribution to river flow.
[10] A measure of the roughness of the riverbed, and the effects that this friction has on flow speeds.

Step 3 (post mitigation)	Existing and proposed mitigation measures Treatment of soluble pollutants Flow attenuation Settlement of sediments

3.2 Baseline drainage conditions

3.2.1 The HEWRAT assessments consider the existing mitigation of the receiving watercourses as part of 'Step 3' to determine if with current mitigation there in limited risk from road runoff.

Queensferry Drain

3.2.2 Queensferry Drain receives inputs from Sandycroft Drain, Mancot and the Daisy Bank Drain. Before reaching the A494 the drain enters a culvert, takes a right-angled turn northeast and continues parallel to the A494 and then under the A494 westbound carriageway via the eastern portal of the rail bridge. Downstream of the railway crossing, the drain re-emerges in an open channel for approximately 260m before entering a culvert beneath the Riverside Ways access road. Gullies along the access road adjacent to the traveller site indicate an existing drainage network, though no outfall has been located. The Queensferry drain is the most likely discharge point given its proximity, but this connection has not been verified. From there, it flows into a pumping station and discharges into the River Dee through a pumped outfall 50m upstream of the existing A494 bridge.

Garden City Swale

3.2.3 Most of the existing drainage located east of the River Dee discharges into the Garden City Swale. The swale flows eastward, passing beneath Foxes Lane via a culvert, and continues for approximately 400m before discharging into the Garden City Culvert.

3.2.4 However, no culvert under Foxes Lane was identified on the topographical survey. Street view mapping of the Scheme also does not show an outfall to be visible. The outfall may have become blocked by vegetation and debris. Garden City Culvert conveys a watercourse that ultimately outfalls into the River Dee through the Garden City Development to the north. There are seven surface water channel outlets that discharge into the Garden City Swale; however, the six outlets located furthest downstream serve only the surrounding land and do not drain the road. Further information can be in the Highway Drainage Developed Design Strategy Report. 100395318-002 | P01 | 395318-MMD-00-XX-RP-D-0007.

3.3 Proposed drainage strategy

Queensferry Drain

3.3.1 Runoff will be collected via a piped drainage network, which discharges into the Queensferry Drain ditch. Further information can be in the Highway Drainage Developed Design Strategy Report. 100395318-002 | P01 | 395318-MMD-00-XX-RP-D-0007.

Swale at Garden City Drain

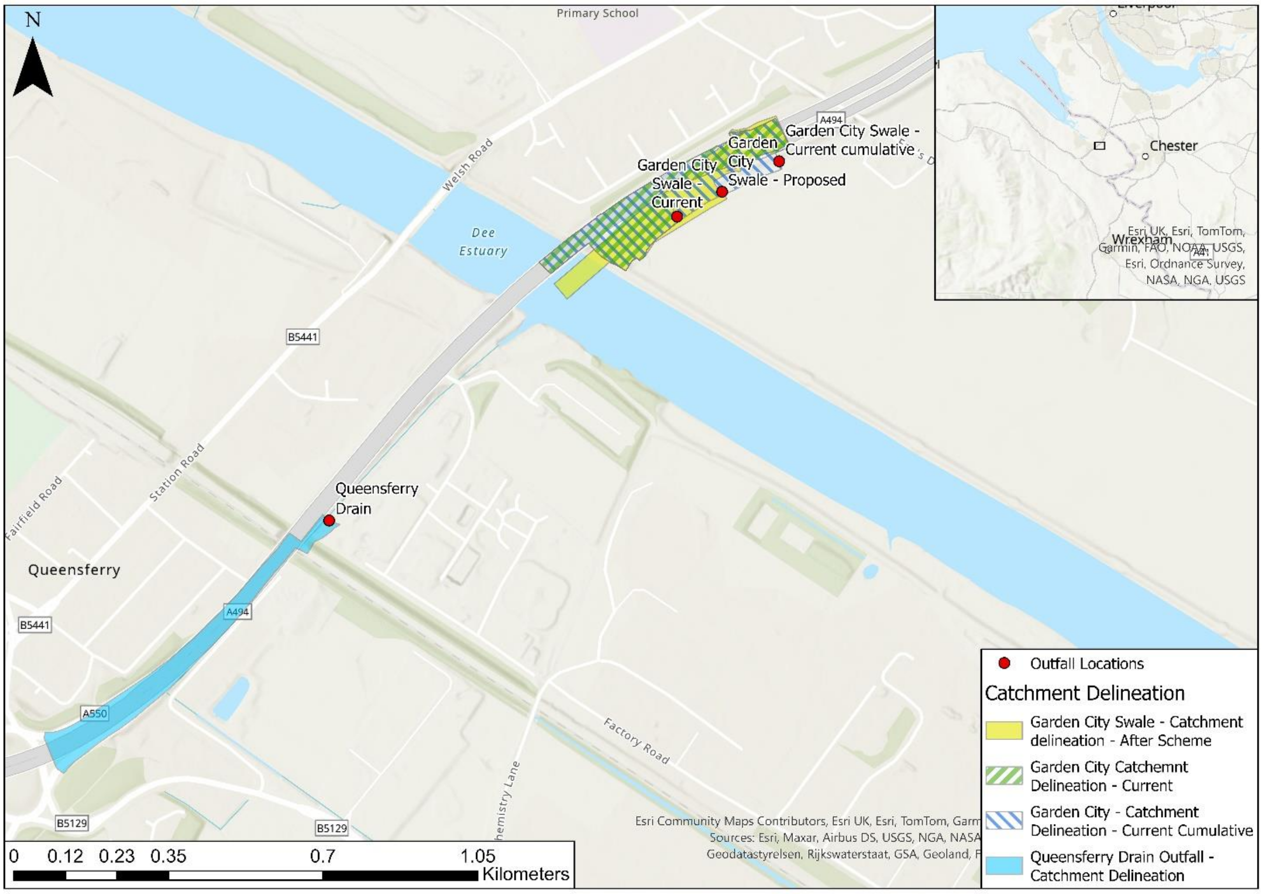
3.3.2 The proposed drainage design includes a kerb and gully system that channels surface runoff into a carrier pipe network, which then discharges into Garden City Swale, maintaining the current drainage regime. To increase the swale's capacity, the southern bank will be regraded from a 1 in 8 to a 1 in 3 side slope. Further information can be in the Highway Drainage Developed Design Strategy Report. 100395318-002 | P01 | 395318-MMD-00-XX-RP-D-0007.

3.4 Catchment delineation

3.4.1 To determine the area that contributes water to each outfall, manual catchment delineations were undertaken. Due to the low-lying nature of the area, each catchment had to be manually drawn in ArcGIS using the know drainage area (provided by the drainage team), LiDAR and contour data. By using both layers the likely direction of flow can estimated, and a catchment boundary can be drawn.

3.4.2 The final catchment delineations are shown in Figure 3-1.

Figure 3-1 Catchment delineations of each outfall



3.5 HEWRAT parameters

3.5.1 Step 1 and 2 assume that the road drainage system incorporates no mitigation measures, showing the 'baseline' of what currently exists at each site. Mitigation is considered as part of the assessment after the HEWRAT has been carried out. The input parameters for the HEWRAT model are summarised in Table 3-2 and Table 3-3

Table 3-2 HEWRAT step 1 parameters

Parameter	Description	Source
AADT & HGV%	AADT flows along on the A494 (Garden City) are within the 50,000 – 100,000 category. HGV% on the A494 is 5.83%. AADT and HGV% were used for both current and proposed drainage, as no significant change expected (73,536 and 86,252 predicted AADT	Counts managed by Welsh Government[11]

[11] Results presented on Department for Transport website

	flows in 2029 and 2044 respectively). 2019 used as latest year counts taken (excluding 2020-2021).	
Climatic region	Cold Wet	HEWRAT Help Guide v1.0
Rainfall site	SAAR rainfall has been taken from the Warrington rainfall series (830mm). The nearest SAAR rainfall measurement was at Queensferry Drain A494 River Dee Crossing (FEH catchment data) which is 717mm. While this is lower, no other appropriate sites were nearby (no rainfall sites in Wales).	HEWRAT Help Guide v1.0

Table 3-3 HEWRAT step 2 parameters

Outfall	Q95 (m^3/s)	Impermeable road area drained (ha)	Permeable road area drained (ha)	Baseflow index	Water Hardness	Proximity of designated sites	Ambient background copper concentration	Structure in vicinity	Estimated river width (m)	Outfall watercourse
	Sources									
	Estimated from LowFlows	Project drainage team	Project drainage team	Estimated from LowFlows	Averaged from survey results	Natural Resources Wales (NRW) data	Averaged from survey results	River Obstacles data (The Rivers Trust)	Obtained from aerial imagery	Online mapping
	Values									
Queensferry Drain	0 (0.001 used*)	1.39	0	0.603	High (>200mgCaCO3/l)	Yes (River Dee SSSI, The Dee Estuary SPA & River Dee and Bala Lake SAC)	2.56	No	0.7	Queensferry Drain
Garden City Swale (current)	0 (0.001 used*)	0.892	0	0.68	High (>200mgCaCO3/l)	No (none within 1km downstream)	2.56	No	0.35	Garden City Swale
Garden City Swale (proposed)	0 (0.001 used*)	1.12	0	0.68	High (>200mgCaCO3/l)	No (none within 1km downstream)	2.56	No	0.35	Garden City Swale

* 0.001 lowest Q95 value that can be used in HEWRAT tool

3.5.2 Step 3 of the HEWRAT assessment considers the in-river impacts with current mitigation. Step 3 included mitigation in the forms of SuDS, considering the risk reduction associated with any current and proposed measures.

3.6 HEWRAT Results

3.6.1 The following section presents the results of the non-cumulative HEWRAT assessments, based on the parameters outlined above in Table 3-3

Non-cumulative

Tier 1

3.6.2 A Tier 1 assessment was conducted using the estimated river width to calculate water quality impacts, with the results presented in Table 3-4

3.6.3 The overall results of the Tier 1 assessment for all outfalls were 'Fail' due to the copper values failing the EQS assessment and the failure of the sediment (chronic impact) assessment, therefore a Tier 2 assessment was carried out.

3.6.4 The HEWRAT Tier 1 results for acute impacts show that Queensferry Drain fails for copper but passes for zinc. For both Garden City Swale assessments, acute impacts indicate that both copper and zinc would pass.

3.6.5 However, Queensferry Drain and Garden City Swale (current and proposed drainage) all fail copper EQS due to the high ambient copper concentration value obtained from the water quality surveys. The Tier 1 assessment also demonstrates that all outfalls fail the sediment (chronic impact) assessment.

Table 3-4 Tier 1 HEWRAT results

Outfall	EQS – Annual Average Concentration		Acute Impact		Sediment – Chronic Impact			Overall Result
	Copper (µg/l)	Zinc (µg/l)	Copper	Zinc	Accumulating? And low flow velocity (m/s)	Extensive?	Result	
Queensferry Drain	Fail – 3.45	Pass – 3.48	Fail	Pass	Yes - 0.02	Yes - 385	Fail	Fail
Garden City Swale (Current Drainage)	Fail – 3.21	Pass – 2.56	Pass	Pass	Yes – 0.05	Yes - 206	Fail	Fail
Garden City Swale (Proposed Drainage)	Fail – 3.34	Pass – 3.03	Pass	Pass	Yes – 0.05	Yes – 259	Fail	Fail

Tier 2

3.6.6 A Tier 2 assessment used the channel dimensions (including longitudinal slope), in addition to the river width from Tier 1. The channel dimensions used for the Tier 2 assessment are presented in Table 3-5

Table 3-5 Channel dimensions used in Tier 2 assessment

Outfall	Bed width (m)	Manning's n	Side slope (m/m)	Long slope (m/m)
Source	Measured from LiDAR (LiDAR Composite DTM 1m)	Appropriate value chosen based characteristics of the watercourse	Measured from LiDAR (LiDAR Composite DTM 1m)	Measured from LiDAR (LiDAR Composite DTM 1m)
Queensferry Drain	1.285	0.027	0.645	0.009
Garden City Swale (Current Drainage)	1.263	0.08	0.222	0.00016
Garden City Swale (Proposed Drainage)	1.247	0.08	0.301	0.001

3.6.7 The overall result for all outfalls is 'Fail' due to the copper values failing the EQS assessment, necessitating step 3 and including mitigation.

3.6.8 The HEWRAT Tier 2 assessment did not alter the acute impacts and EQS, thus the results remained consistent with those of Tier 1 (as mentioned above).

3.6.9 Due to the downstream protected area, no result could be determined for the Tier 2 sediment assessment for Queensferry Drain. Garden City Swale fails the Tier 2 sediment assessment for both current and proposed drainage, requiring 26% and 51% mitigation respectively. With existing mitigation measures (swale/grassed channel) Garden City Swale has an 80% sediment efficiency so no additional mitigation would be required. The results from the Tier 2 assessment are outlined in Table 3.6.

Table 3-6 Tier 2 HEWRAT results

Outfall	EQS – Annual Average Concentration		Acute Impact		Sediment – Chronic Impact			Overall Result
	Copper (µg/l)	Zinc (µg/l)	Copper	Zinc	Accumulating? And low flow velocity	Extensive? If yes, % settlement needed to pass, and deposition index	Result	
Queensferry Drain	Fail – 3.45	Pass – 3.48	Fail	Pass	No – 0.13	No	Alert. Protected Area	Fail
Garden City Swale (Current Drainage)	Fail – 3.21	Pass – 2.56	Pass	Pass	Yes – 0.02	Yes – 133 (26% needed)	Fail	Fail
Garden City Swale (Proposed Drainage)	Fail – 3.34	Pass – 3.03	Pass	Pass	Yes – 0.04	Yes – 201 (51% needed)	Fail	Fail

Step 3 – mitigation

3.6.10 As all outfalls at Tier 2 failed EQS and acute impact due to high copper concentrations, therefore the mitigation was included in the assessment.

3.6.11 Details of the mitigation measures applied to each outfall are presented in Table 3-7

Table 3-7 Mitigation measures and associated efficiency for non-cumulative outfalls

Outfall	Mitigation measures	Percentage of impermeable area served (%)	Copper efficiency (%)	Zinc efficiency (%)	Sediment efficiency (%)
Queensferry Drain	Ditch (vegetated)	100	15	15	25
Garden City Swale (current drainage)	Swale/grassed channel	100	50	50	80
Garden City Swale (proposed drainage)					

3.6.12 The mitigation did not alter the overall result of acute impacts and EQS, with all outfalls still resulting in a ‘Fail’ due to the copper values failing the EQS assessment, necessitating a M-BAT.

3.6.13 Due to the presence of a downstream protected area, a sediment assessment result could not be determined for the Queensferry Drain. However, given the high sediment removal efficiency of the swale, both the existing and proposed Garden City Swale outfalls meet the pass the sediment assessment, and no additional mitigation is required.

3.6.14 The results from the assessment are provided in Table 3-8 .

Table 3-8 Tier 2 HEWRAT results including current mitigation measures for non-cumulative outfalls

Outfall	EQS – Annual Average Concentration		Acute Impact		Sediment – Chronic Impact			Overall Result
	Copper (µg/l)	Zinc (µg/l)	Copper	Zinc	Accumulating? And low flow velocity	Extensive? If yes, % settlement needed to pass, and deposition index	Result	
Queensferry Drain	Fail – 1.03	Pass – 2.95	Fail	Pass	No – 0.13	No	Alert. Protected Area	Fail
Garden City Swale (Current Drainage)	Fail – 2.84	Pass – 1.28	Pass	Pass	Yes – 0.02	No	Fail	Fail
Garden City Swale (Proposed Drainage)	Fail – 2.90	Pass – 1.51	Pass	Pass	Yes – 0.04	No	Fail	Fail

3.7 M-BAT

3.7.1 Since all outfalls failed the EQS annual average concentration for copper all required a M-BAT. The HEWRAT assessment assumes that all dissolved copper is bioavailable. However, since measured copper concentrations represent total copper, the assessment may overestimate the potential ecological impact.

3.7.2 For all outfalls, the bioavailable copper concentration was below the 1 µg/l EQS limit, therefore all passed. These revised values were re-entered into the HEWRAT assessment. Both Garden City Swale outfalls passed the assessment; however, the Queensferry Drain outfall still failed. To achieve a 'Pass', an additional 4% mitigation is required to meet EQS standards, and a further 15% is needed to address acute impact.

3.7.3 The input parameters and the M-BAT results, including subsequent HEWRAT assessment results, are detailed in Table 3-9 .

Table 3-9 Input parameters and results of M-BAT assessments

Outfall	Input parameters				Results	HEWRAT results (using M-BAT value)	
	Measured copper concentration (µg/l)	**pH**	**DOC (mg/l)**	**Calcium (mg/l)**	**Bioavailable copper concentration (µg/l) results from M-BAT**	**Copper - EQS – annual average concentration (µg/l)**	**Copper - Acute impact**
Queensferry Drain	2.56	8.41	6.75	75.5	0.2	Fail – 1.03	Fail
Garden City Swale (Current drainage)						Pass – 0.56	Pass
Garden City Swale (Proposed drainage)						Pass – 0.62	Pass

3.8 Cumulative HEWRAT assessment

3.8.1 No cumulative assessment was undertaken for Queensferry Drain, as there are no other contributing outfalls associated with the one assessed.

3.8.2 A cumulative assessment was undertaken for swale at Garden City Drain, due to multiple outfalls located within 1km of the assessed outfall. As outfalls located within this cumulative cluster only drain to the same surrounding area, the impermeable and permeable areas used do not differ from the non-cumulative HEWRAT.

3.8.3 Input parameters used in the cumulative assessment are shown in Table 3.10.

Table 3-10 Cumulative HEWRAT input parameters

Parameter	Source	Garden City Swale
Q95 (m3/s)	Estimated from LowFlows	0 (0.001 used)
Impermeable road area drained (ha)	Project drainage team	0.892
Permeable road area drained (ha)	Project drainage team	0
Baseflow index (BFI)	Estimated from LowFlows	0.68
Water hardness	Averaged from survey results	High
Proximity of designated sites	NRW data	No (none within 1km downstream)
Ambient background copper concentration	Averaged from survey results	2.56
Structure in vicinity	NRW data	No
Estimated river width (m)	River Obstacles data (The Rivers Trust)	0.33
Bed width (m)	Obtained from aerial imagery	2.029
Manning's n		0.08
Side slope (m/m)	Obtained from LiDAR data	0.093 (0.1 used*)
Long slope (m/m)	Obtained from LiDAR data	0.000964739

3.8.4 The results of the cumulative HEWRAT are detailed in Table 3-11 .

3.8.5 The cumulative HEWRAT (outfalls within 100m) acute impacts indicate both copper and zinc would pass (both Tier 1 and 2). However, the results of the EQS indicates that copper would fail and pass for zinc, necessitating step 3 and including mitigation. This failure is due to the high ambient copper concentration value obtained from the water quality surveys.

3.8.6 The sediment (chronic impact) assessment indicates that the cumulative effects of the outfall would fail at Tier 1 but pass at Tier 2.

Table 3-11 Tier 1 and 2 cumulative HEWRAT results

Outfall	EQS – Annual Average Concentration		Acute Impact		Sediment – Chronic Impact						Overall results
	Copper (µg/l)	Zinc (µg/l)	Copper	Zinc	Accumulating? And low flow velocity		Extensive? If yes, % settlement needed to pass, and deposition index		Result		
					Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2	
Garden City Swale (cumulative current drainage)	Fail – 3.21	Pass - 2.56	Pass	Pass	Yes - 0.05	Yes – 0.03	Yes - 188	No - 92	Fail	Pass	Fail

Step 3 – mitigation

3.8.7 The cumulative outfalls failed EQS and acute impact at Tier 2, due to high copper concentrations, therefore the mitigation was included in the assessment.

3.8.8 Details of the mitigation measures are presented in **Error! Reference source not found.**

Table 3-12 Mitigation measures and associated efficiency for Garden City Swale (cumulative current drainage)

Mitigation measure	Swale/grassed channel
Percentage of impermeable area served (%)	100
Copper efficiency (%)	50
Zinc efficiency (%)	50
Sediment efficiency (%)	80

3.8.9 The mitigation did not alter the overall result of acute impacts and EQS, with all outfalls still resulting in a 'Fail' due to the copper values failing the EQS assessment, necessitating a M-BAT.

3.8.10 The results from the assessment are outlined in Table 3-13

Table 3-13 Tier 2 HEWRAT results including current mitigation measures for Garden City Swale (cumulative current drainage)

EQS – Annual Average Concentration	Copper (µg/l)	Fail – 2.84
	Zinc (µg/l)	Pass – 1.28
Acute impact	Copper	Pass
	Zinc	Pass
Sediment – Chronic impact	Accumulating? And low flow velocity	Yes – 0.03

	Extensive? If yes, % settlement needed to pass and deposition index	No
	Result	Pass
Overall Result		Fail

Cumulative M-BAT

3.8.11 Copper concentrations were obtained from the cumulative HEWRAT Tier 2 assessment results.

3.8.12 The bioavailable copper concentration as calculated in the M-BAT, was below the 1 µg/l EQS limit, therefore all pass. These values were then put back into the HEWRAT assessment and the outfall passed.

3.8.13 The input parameters and the M-BAT results, included subsequent HEWRAT assessment results, are detailed in Table 3.14.

Table 3-14 Input parameters and results of cumulative M-BAT

Outfall	Input parameters				Results	HEWRAT results (using M-BAT value)	
	Measured copper concentration (µg/l)	**pH**	**DOC (mg/l)**	**Calcium (mg/l)**	**Bioavailable copper concentration (µg/l) results from M-BAT**	**Copper - EQS – annual average concentration (µg/l)**	**Copper - Acute impact**
Garden City Swale (Current drainage)	4.74	8.33	7.3	71.33	0.27 - Pass	Pass – 0.56	Pass

4. Spillage risk assessment

4.1.1 According to DMRB LA 113[12], when considering spillage risk from highways and the potential pollution risk, the following factors should be considered:

a) The calculated spillage risk return period must not be greater than 1 in 100 (1% AEP) years.

b) The calculated spillage risk return period must not be greater than 1 in 200 (0.5% AEP) years where spillage could affect protected areas for conservation, important drinking water supplies or important commercial activities.

c) Spillage risk from existing outfalls must not be increased.

4.1.2 The values used as part of the spillage assessment are described in Table 4-1 .

4.1.3 All outfalls pass the spillage risk assessment with no mitigation considered.

[12] (National Highways, 2025)

Table 4-1 Spillage risk assessment values and results

Outfall	Water body type	Road length (m)	Road type	Junction type	Response time	AADT	%HGV	Probability pass	Probability of spillage	Pass / Fails
Queensferry Drain	Watercourse	745	A road (Urban)	No junction	Rural (response time to site <1 hour)	70479	5.83	1 in 200 years	0.0003 (1 in 3849 years)	Pass
Garden City Swale (current drainage)	Watercourse	620	A road (Urban)	No junction	Rural (response time to site <1 hour)	70479	5.83	1 in 100 years	0.0002 (1 in 4626 years)	Pass
Garden City Swale (current drainage- cumulative)										
Garden City Swale (proposed drainage)										

5. Groundwater assessment

5.1.1 The groundwater assessment was triggered during the HEWRAT process by low Q95 values (<=0.001 m^3/s), Due to the low flows in both receiving watercourses, there is a possibility of groundwater infiltration for all outfalls, potentially impacting the underlying groundwater body (Dee Carboniferous Coal Measures).

5.1.2 Due to the assumptions and limitations (see Section 2.6) all outfalls were assessed using the same input parameters, the results are resulting outputs are summarised in Table 5.1.

5.1.3 Groundwater assessments for all outfalls, including Queensferry Drain and Garden City Swale (current drainage, cumulative current drainage and proposed drainage).

Table 5-1 Groundwater input parameters and scoring

	Property/ Parameter	Risk score	Source	Component score	Weighted component score
Source	Traffic flow	50,000 to 100,000 AADT	HEWRAT traffic band (from Department for Transport road traffic statistics)	2	20
	Rainfall depth (annual average)	>740 mm to <1060 mm	HEWRAT band	2	20
	Drainage area ratio	≤50	Road drainage/basin drainage (impermeable/permeable)	1	10
Pathway	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	Aerial imager and site visit, identified as a unlined ditch	1	15

	Unsaturated zone	Depth to water table <=5 m	Conservative value chosen as groundwater present at shallow depths, but no water table height stated in nearby borehole data.	3	60
	Flow type	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	Based on BGS maps	1	20
	Unsaturated zone clay content	≥15 % clay minerals	Approximation based on borehole data (depth of clay / water table depth x 100)	1	5
	Organic carbon	<15% to >1% soil organic matter	Approximate based on Soil Observatory maps	2	10
	Unsaturated zone soil pH	pH <8 to >5	Approximate based on Soil Observatory maps	2	10
Total Score	**170**				
Risk	**Medium**				

5.1.4 The groundwater assessments indicate that all outfalls present a medium risk to groundwater. However, a precautionary approach was taken due to the absence of data. Summary

5.1.5 The A494 Bridge Replacement Scheme has the potential to road drainage and surface runoff, which in turn will impact the water quality of the receiving watercourses.

5.1.6 All outfalls, including cumulative, failed Tier 1 and Tier 2 assessments for copper. The dissolved copper measured during the water quality surveys exceeded the EQS limits, which caused the HEWRATs to Fail.

5.1.7 The spillage risk assessment indicates that all outfalls would not have experience accidental spillage with a frequency greater than a 1 in 100 return period (1%) for Garden City Swale and 1 in 200 return period (2%) for Queensferry Drain. Therefore, all outfalls pass, and no mitigation is required for spillage risk.

5.1.8 Due to the low flows (<=0.001 m^3/s), all outfalls required soakaway assessments. The soakaway assessment determined a low risk for all outfalls, with Garden City Swale presented a lower risk due to the presence of a swale/grassed channel.

5.1.9 The HEWRAT assessments identified limited risk from runoff both currently and for the Scheme. The only risk noted were related to copper, attributed to the high dissolved copper concentrations measured as part of the water quality surveys and low flows that triggered a soakaway assessment. However, the M-BAT determined the bioavailable copper was below the EQS limit, and all soakaway assessments indicated a low risk. This low risk indicates that no further mitigation would be required on these watercourses.

5.1.10 The HEWRAT tool can only assess freshwater watercourses, which limited the scope of assessment and the locations where assessments could be conducted. Since the Scheme primarily involves tidally influenced watercourses, not all potential impacts of runoff were evaluated. Consequently, the conclusions of this report are limited to freshwater watercourses and do not fully reflect the runoff risk for the entire Scheme.

6. Appendices

6.1 HEWRAT results

Non-cumulative HEWRAT assessments

Figure 6-1 HEWRAT Step 3 mitigation assessment – Queensferry Drain

highways england

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble						Sediment - Chronic Impact
EQS - Annual Average Concentration				Acute Impact		
	Copper	Zinc		Copper	Zinc	Alert. Protected Area.
Step 2	3.45 ~~Tier 1 fail. Go to Tier 2 (using UK TAG M-BAT tool), or Step 3 mitigation.~~	3.48	ug/l	River Fails Toxicity Test. Try more mitigation	Pass	Sediment deposition for this site is judged as: Accumulating? No; 0.13 Low flow Vel m/s
Step 3	3.30 ~~Tier 1 fail. Go to Tier 2 (using UK TAG M-BAT tool), or increase Step 3 mitigation~~	2.95	ug/l			Extensive? No; - Deposition Index

Road number	A494		HE Area / DBFO number		
Assessment type	Non-cumulative assessment (single outfall)				
OS grid reference of assessment point (m)	Easting	332083	Northing	368259	
OS grid reference of outfall structure (m)	Easting	332083	Northing	368259	
Outfall number			List of outfalls in cumulative assessment		
Receiving watercourse	Queensferry Drain				
EA receiving water Detailed River Network ID	N/A		Assessor and affiliation	Kelsea Brown - Mott MacDonald	
Date of assessment	17/06/2025		Version of assessment	2	
Notes					

Step 1 Runoff Quality

AADT: >=50,000 and <100,000 | Climatic region: Colder Wet | Rainfall site: Warrington (SAAR 830mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.001
Impermeable road area drained (ha)	1.20
Permeable area draining to outfall (ha)	0
Base Flow Index (BFI)	0.603

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1
Bioavailable dissolved zinc (µg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Y

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For dissolved copper only Ambient background concentration (µg/l): [illegible]

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

○ Tier 1 Estimated river width (m): 0.7

◉ Tier 2 Bed width (m): 1.285 | Manning's n: 0.027 | Side slope (m/m): 0.645 | Long slope (m/m): 0.008

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		15	No restriction	25
Proposed measures		15	No restriction	25

Figure 6-2 HEWRAT Step 3 mitigation using M-BAT copper values – Queensferry Drain

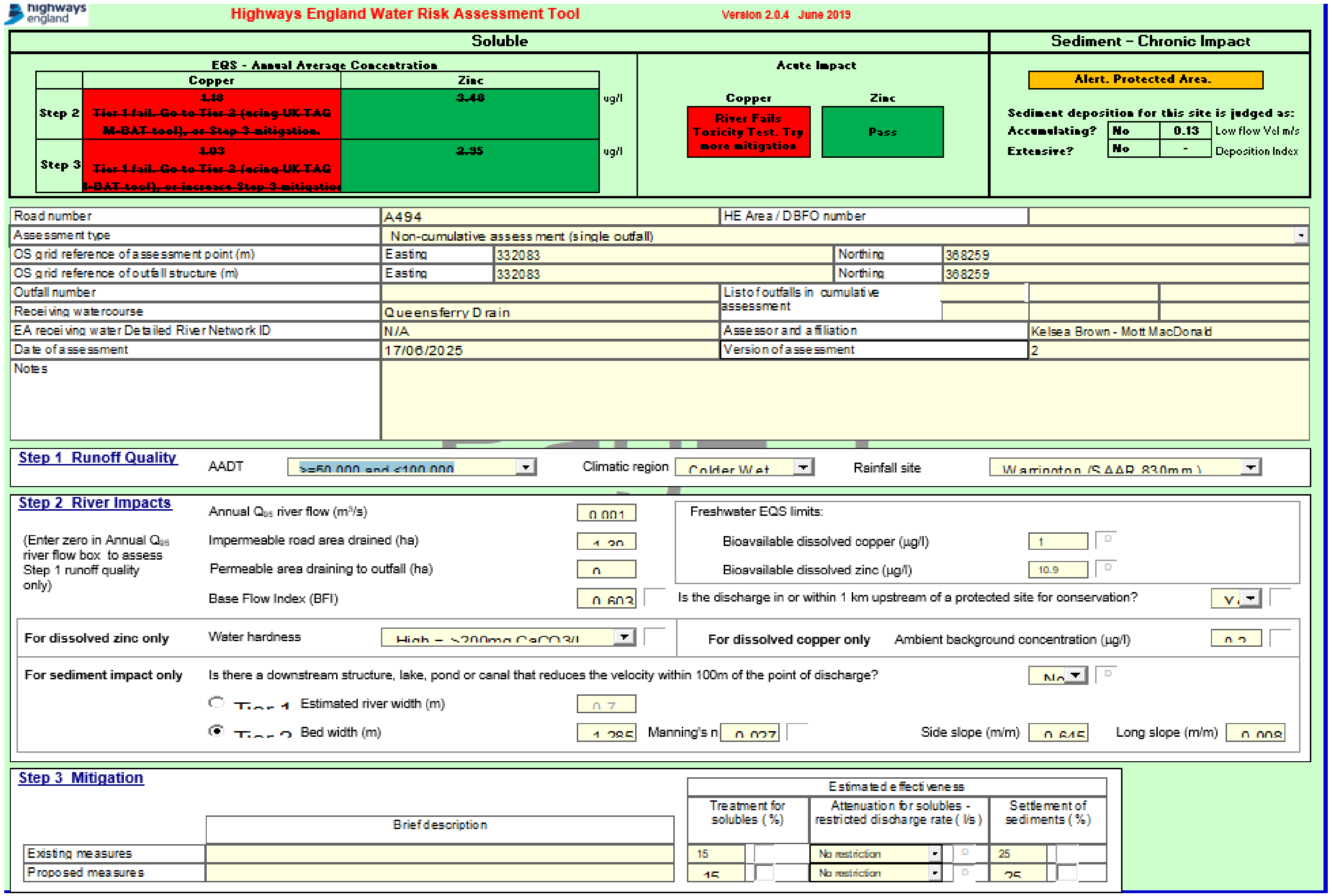


Figure 6-3 HEWRAT Cu Acute Mitigation assessment – Queensferry Drain

highways england

Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble						Sediment – Chronic Impact
EQS - Annual Average Concentration				Acute Impact		Alert. Protected Area.
	Copper	Zinc		Copper	Zinc	Sediment deposition for this site is judged as:
Step 2	~~1.18~~ ~~Tier 1 fail. Go to Tier 2 (using UK TAG M-BAT tool), or Step 3 mitigation.~~	~~3.48~~	ug/l	Pass	Pass	Accumulating? No 0.13 Low flow Vel m/s
Step 3	~~0.89~~	~~2.43~~	ug/l			Extensive? No - Deposition Index

Road number	A494	HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting 332083	Northing	368259
OS grid reference of outfall structure (m)	Easting 332083	Northing	368259
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse	Queensferry Drain		
EA receiving water Detailed River Network ID	N/A	Assessor and affiliation	Kelsea Brown - Mott MacDonald
Date of assessment	17/06/2025	Version of assessment	2
Notes			

Step 1 Runoff Quality

AADT: >=50,000 and <100,000 | Climatic region: Colder Wet | Rainfall site: Warrington (SAAR 830mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.001
Impermeable road area drained (ha)	1.30
Permeable area draining to outfall (ha)	0
Base Flow Index (BFI)	0.603

Freshwater EQS limits:

Bioavailable dissolved copper (µg/l)	1
Bioavailable dissolved zinc (µg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? Y

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For dissolved copper only Ambient background concentration (µg/l): 0.2

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 Estimated river width (m): 0.7

Tier 2 Bed width (m): 1.285 | Manning's n: 0.027 | Side slope (m/m): 0.645 | Long slope (m/m): 0.008

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		15	No restriction	50
Proposed measures		30	No restriction	50

Figure 6-4 HEWRAT Step 3 mitigation – Garden City Swale (baseline)

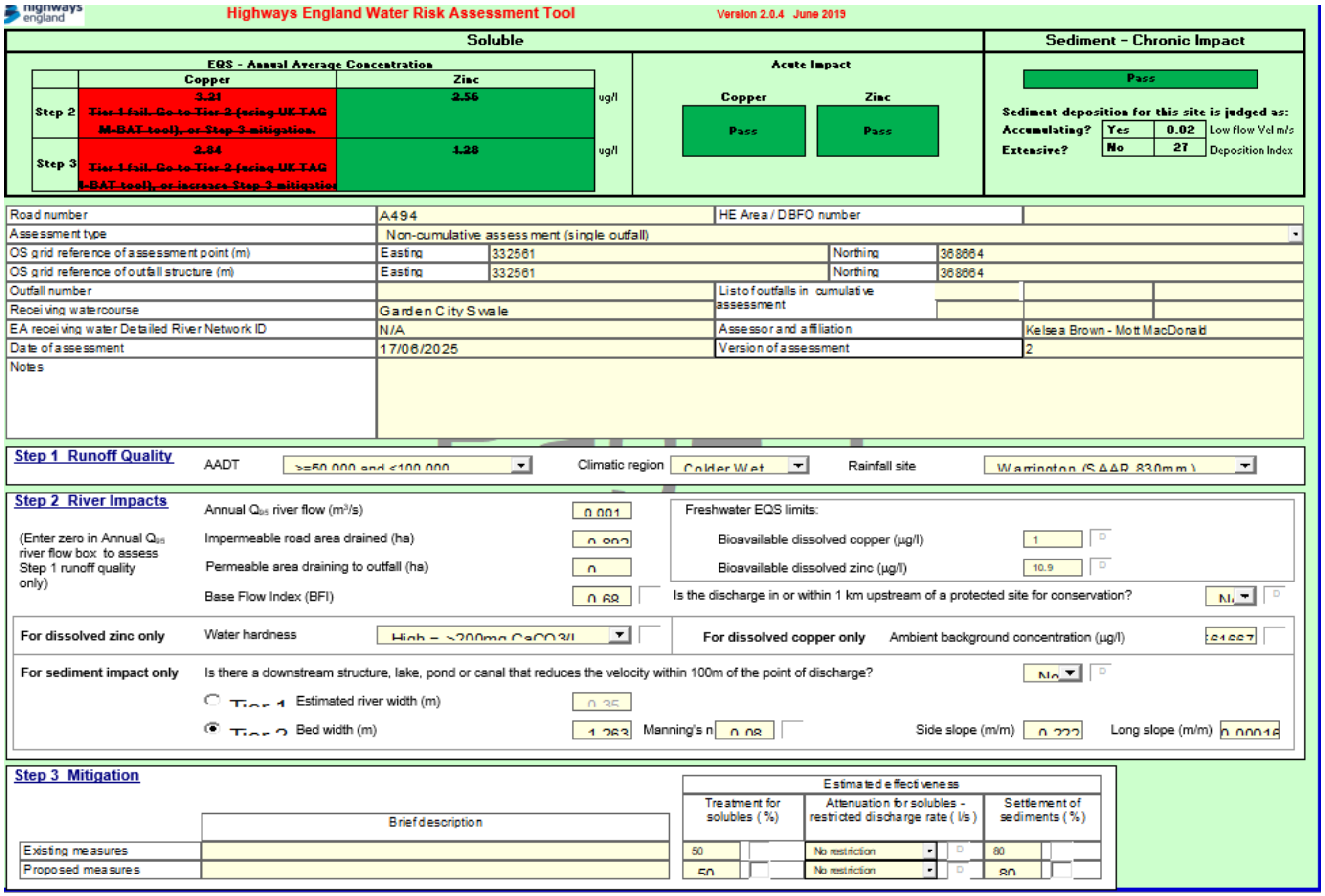


Figure 6-5 HEWRAT Step 3 mitigation using M-BAT copper values – Garden City Swale (baseline)

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Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble						Sediment - Chronic Impact
EQS - Annual Average Concentration				Acute Impact		Pass
	Copper	Zinc		Copper	Zinc	Sediment deposition for this site is judged as:
Step 2	0.92	2.56	ug/l	Pass	Pass	Accumulating? Yes 0.02 Low flow Vel m/s
Step 3	0.56	1.28	ug/l			Extensive? No 27 Deposition Index

Road number	A494	HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting 332561	Northing	368864
OS grid reference of outfall structure (m)	Easting 332561	Northing	368864
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse	Garden City Swale		
EA receiving water Detailed River Network ID	N/A	Assessor and affiliation	Kelsea Brown - Mott MacDonald
Date of assessment	17/06/2025	Version of assessment	2
Notes			

Step 1 Runoff Quality AADT >=50,000 and <100,000 Climatic region Colder Wet Rainfall site Warrington (SAAR 830mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.001	Freshwater EQS limits:	
Impermeable road area drained (ha)	0.802	Bioavailable dissolved copper (µg/l)	1
Permeable area draining to outfall (ha)	0	Bioavailable dissolved zinc (µg/l)	10.9
Base Flow Index (BFI)	0.68	Is the discharge in or within 1 km upstream of a protected site for conservation?	No

For dissolved zinc only Water hardness High = >200mg CaCO3/l

For dissolved copper only Ambient background concentration (µg/l) 0.2

For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 Estimated river width (m) 0.35

Tier 2 Bed width (m) 1.263 Manning's n 0.08 Side slope (m/m) 0.222 Long slope (m/m) 0.00016

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
Existing measures		50	No restriction	80
Proposed measures		50	No restriction	80

Figure 6-6 HEWRAT Step 3 mitigation – Garden City Swale (proposed drainage)

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Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	3.34 ~~Tier 1 fail. Go to Tier 2 (using UK TAG M-BAT tool), or Step 3 mitigation.~~	3.03	ug/l
Step 3	2.30 ~~Tier 1 fail. Go to Tier 2 (using UK TAG M-BAT tool), or increase Step 3 mitigation~~	1.51	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment – Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.04	Low flow Vel m/s
Extensive?	No	40	Deposition Index

Road number	A494	HE Area / DBFO number	
Assessment type	Non-cumulative assessment (single outfall)		
OS grid reference of assessment point (m)	Easting 332623	Northing	368697
OS grid reference of outfall structure (m)	Easting 332623	Northing	368697
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse	Garden City Swale		
EA receiving water Detailed River Network ID	N/A	Assessor and affiliation	Kelsea Brown - Mott MacDonald
Date of assessment	17/06/2025	Version of assessment	2
Notes			

Step 1 Runoff Quality

AADT: >=50,000 and <100,000 | Climatic region: Colder Wet | Rainfall site: Warrington (SAAR 830mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.001
Impermeable road area drained (ha)	1.42
Permeable area draining to outfall (ha)	0
Base Flow Index (BFI)	0.68

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1
Bioavailable dissolved zinc (μg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For dissolved copper only Ambient background concentration (μg/l): .01667

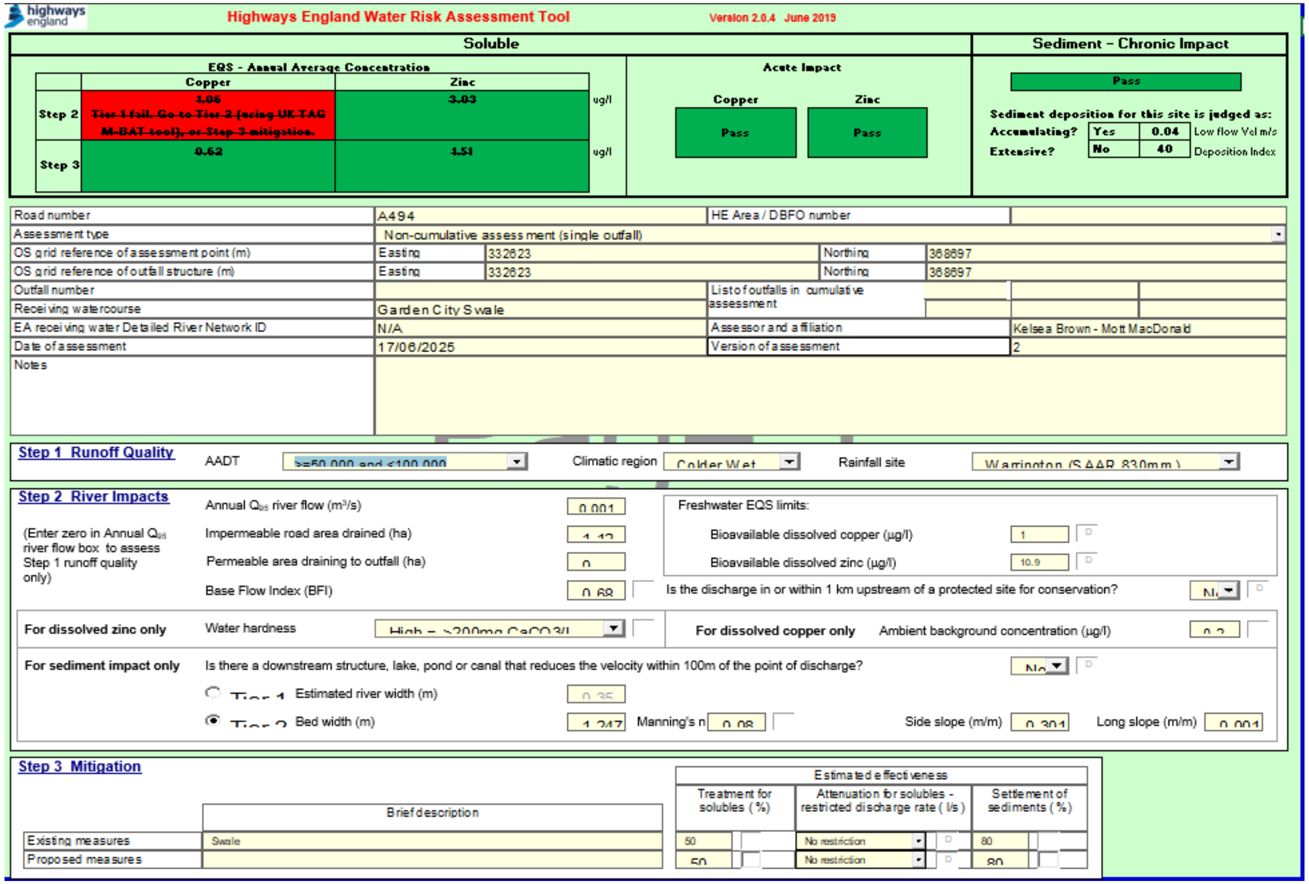
For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- ○ Tier 1 Estimated river width (m): 0.35
- ◉ Tier 2 Bed width (m): 1.247 Manning's n: 0.08 Side slope (m/m): 0.301 Long slope (m/m): 0.001

Step 3 Mitigation

	Brief description	Estimated effectiveness: Treatment for solubles (%)	Estimated effectiveness: Attenuation for solubles - restricted discharge rate (l/s)	Estimated effectiveness: Settlement of sediments (%)
Existing measures	Swale	50	No restriction	80
Proposed measures		50	No restriction	80

Figure 6-7 HEWRAT Step 3 mitigation using M-BAT copper values – Garden City Swale (proposed drainage)



Cumulative HEWRAT assessments

Figure 6-8 HEWRAT Step 3 mitigation – Garden City Swale (current cumulative drainage)

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Highways England Water Risk Assessment Tool Version 2.0.4 June 2019

Soluble

EQS - Annual Average Concentration

	Copper	Zinc	
Step 2	~~3.21 Tier 1 fail. Go to Tier 2 (using UK TAG M-BAT tool), or Step 3 mitigation.~~	~~2.56~~	ug/l
Step 3	~~2.84 Tier 1 fail. Go to Tier 2 (using UK TAG M-BAT tool), or increase Step 3 mitigation~~	~~1.28~~	ug/l

Acute Impact

Copper	Zinc
Pass	Pass

Sediment - Chronic Impact

Pass

Sediment deposition for this site is judged as:

Accumulating?	Yes	0.03	Low flow Vel m/s
Extensive?	No	18	Deposition Index

Road number	A494	HE Area / DBFO number	
Assessment type	Cumulative assessment including sediments (outfalls within 100m)		
OS grid reference of assessment point (m)	Easting 332701	Northing 368738	
OS grid reference of outfall structure (m)	Easting 332701	Northing 368738	
Outfall number		List of outfalls in cumulative assessment	
Receiving watercourse	Garden City Swale		
EA receiving water Detailed River Network ID	N/A	Assessor and affiliation	Kelsea Brown - Mott MacDonald
Date of assessment	17/06/2025	Version of assessment	2
Notes			

Step 1 Runoff Quality

AADT: >=50,000 and <100,000 | Climatic region: Colder Wet | Rainfall site: Warrington (SAAR 830mm)

Step 2 River Impacts

(Enter zero in Annual Q_{95} river flow box to assess Step 1 runoff quality only)

Annual Q_{95} river flow (m^3/s)	0.001
Impermeable road area drained (ha)	0.802
Permeable area draining to outfall (ha)	0
Base Flow Index (BFI)	0.68

Freshwater EQS limits:

Bioavailable dissolved copper (μg/l)	1
Bioavailable dissolved zinc (μg/l)	10.9

Is the discharge in or within 1 km upstream of a protected site for conservation? No

For dissolved zinc only Water hardness: High = >200mg CaCO3/l

For dissolved copper only Ambient background concentration (μg/l): [illegible]

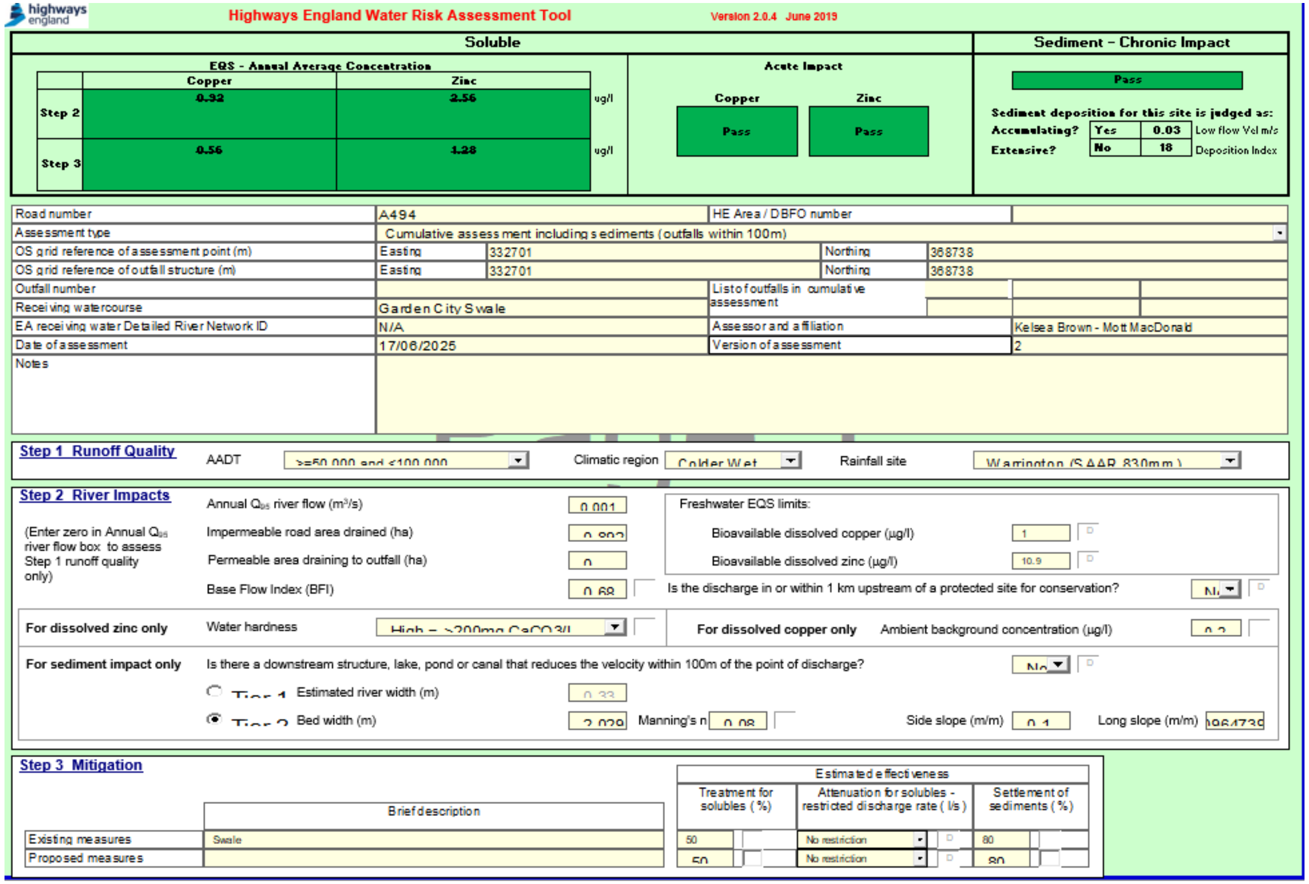
For sediment impact only Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- Tier 1 Estimated river width (m): 0.33
- Tier 2 Bed width (m): 2.029 Manning's n: 0.08 Side slope (m/m): 0.1 Long slope (m/m): [illegible]

Step 3 Mitigation

	Brief description	Treatment for solubles (%)	Attenuation for solubles - restricted discharge rate (l/s)	Settlement of sediments (%)
		Estimated effectiveness		
Existing measures	Swale	50	No restriction	80
Proposed measures		50	No restriction	80

Figure 6-9 HEWRAT Step 3 mitigation using M-BAT copper values – Garden City Swale (current cumulative drainage)



6.2 M-BAT results

Figure 6-10 M-BAT assessment – Queensferry Drain

INPUT DATA											RESULTS (Copper)			
ID	Location	Waterbody	Date	Measured Cu Concentration (dissolved) (μg l^{-1})	Measured Zn Concentration (dissolved) (μg l^{-1})	Measured Mn Concentration (dissolved) (μg l^{-1})	Measured Ni Concentration (dissolved) (μg l^{-1})	pH	DOC	Ca	Site-specific PNEC Dissolved Copper (μg l^{-1})	BioF	Bioavailable Copper Concentration (μg l^{-1})	Risk Characterisation Ratio
1	Queensferry	Queensferry Drain	17/06/2025	2.561667	10.633			8.416667	6.75	75.5	12.76	0.08	0.20	0.20

Figure 6-11 M-BAT assessment – Garden City Swale (current drainage, proposed drainage and cumulative current drainage)

INPUT DATA											RESULTS (Copper)				
ID	Location	Waterbody	Date	Measured Cu Concentration (dissolved) (μg l^{-1})	Measured Zn Concentration (dissolved) (μg l^{-1})	Measured Mn Concentration (dissolved) (μg l^{-1})	Measured Ni Concentration (dissolved) (μg l^{-1})	pH	DOC	Ca	Site-specific PNEC Dissolved Copper (μg l^{-1})	BioF	Bioavailable Copper Concentration (μg l^{-1})	Risk Characterisation Ratio	P
1	Garden City Swale		17/06/2025	2.561667	10.63333			8.416667	6.75	75.5	12.76	0.08	0.20	0.20	

6.3 Spillage assessments

Figure 6-12 Spillage assessment – A494

Assessment of Priority Outfalls

Method D - assessment of risk from accidental spillage

		A (main road)	B	C	D	E	F	Totals	Return Period (years)
			Additional columns for use if other roads drain to the same outfall						
D1	Water body type	Surface watercourse							
D2	Length of road draining to outfall *(m)*	745							
D3	Road Type *(A-road or Motorway)*	A							
D4	If A road, is site urban or rural?	Urban							
D5	Junction type	No junction							
D6	Location (response time for emergency services)	> 1 hour							
D7	Traffic flow (AADT two way)	70,479							
D8	% HGV	5.83							
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.31							
D9	Risk of accidental spillage	0.00035	0.00000	0.00000	0.00000	0.00000	0.00000		
D10	Probability factor	0.75							
D11	Risk of pollution incident	0.00026	0.00000	0.00000	0.00000	0.00000	0.00000		
D12	Is risk greater than 0.01?	**No**							
D13	Return period without pollution reduction measures	0.00026	0.00000	0.00000	0.00000	0.00000	0.00000	0.0003	3849
D14	Existing measures factor	1							
D15	Return period with existing pollution reduction measures	0.00026	0.00000	0.00000	0.00000	0.00000	0.00000	0.0003	3849
D16	Proposed measures factor	1							
D17	Residual with proposed Pollution reduction measures	0.00026	0.00000	0.00000	0.00000	0.00000	0.00000	0.0003	3849

6.4 Groundwater assessments

Figure 6-13 Groundwater assessments – all outfalls

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Reset GW Assessment | Go To Interface

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	>50,000 to <100,000 AADT	2	20
2		10	Rainfall depth (annual averages)	>740 to <1060 mm rainfall	2	20
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table <=5 m	3	60
6		20	Flow type (incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	>=15% clay minerals	1	5
8		5	Organic Carbon	<15% to >1% SOM	2	10
9		5	Unsaturated zone soil pH	pH <8 to >5	2	10

TOTAL SCORE	170
RISK SCREENING LEVEL	Medium

A494 River Dee Bridge Improvement Scheme

Flood Consequences Assessment

September 2025

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A494 River Dee Bridge Improvement Scheme

Flood Consequences Assessment

September 2025

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Tables

Figures

Executive summary

The Scheme

The North & Mid Wales Trunk Road Agent (NMWTRA) has appointed Mott MacDonald Ltd as the lead consultant to provide multi-disciplinary consultancy services for the A494 River Dee Bridge Replacement Scheme (“the Scheme”), covering Welsh Government’s Key Stage Approval Stages 3 and 4.

Following the Welsh Government’s response to the Roads Review in February 2023, the Scheme was re-appraised to ensure that it would not result in additional traffic, it would minimise carbon and encourage modal shift. As an outcome of this re-appraisal, a revised layout was developed and incorporates:

- A new bridge to carry two lanes of traffic in both directions. The new bridge would be located approximately 12 metres to the southeast of the existing A494 River Dee Bridge.
- A new shared use path for pedestrians and cyclists
- Improvements to the existing A494 and a new access/exit to leave the A494 towards the Riverside area
- Diversion of the Queensferry Drain (Main River) situated on the southeast side of the A494. New sections of open channel would be provided either side of the railway as well as a new river pumping station and drainage outfall to the River Dee.
- Environmental mitigation and biodiversity enhancement works including wildflower verges, swales, native woodland plantations, hedgerows and amenity grassland.
- Demolition of the existing A494 River Dee Bridge, except for the river piers.

Flood assessment

This Flooding Consequences Assessment Report (FCA) will be used to inform the Environmental Impact Assessment (EIA) for the Scheme, and draws upon the guidance provided in Planning Policy Wales and Technical Advice Note 15: Development, flooding and coastal erosion (TAN 15) (dated March 2025). The FCA was undertaken in consultation with Natural Resources Wales (NRW) and Flintshire County Council, Lead Local Flood Authority for the area.

The Flood Map for Planning indicates that the scheme is in Flood Zone 3 for tidal (defended), fluvial and surface water and small watercourses. The FCA considers all sources of flood risk to the Scheme with appropriate allowances for sea level rise and increases in rainfall due to climate change based on the assumed lifetime of the development (2100, 75 years). The predominant sources of flood risk for the scheme are from tidal and fluvial sources; namely the River Dee (tidal and fluvial), and Queensferry Drain (fluvial). The Scheme benefits from substantial flood defences alongside the River Dee, that offer a good standard of protection and are strategically important in the area, so likely to be maintained in perpetuity by NRW.

This redevelopment (replacement bridge) secures this critical link between north Wales and England and is identified in the Local Development Plan. The Scheme is therefore considered justifiable in accordance with the principles set out in section 8 of TAN15.

The evidence and assessments contained within this FCA confirm that the redevelopment has predominantly met or is consistent with the acceptability considerations in section 11 of TAN15.

- The required design standard for less vulnerable development (to be flood free during the 1% Annual Exceedance Probability (AEP) fluvial and the 0.5% AEP tidal events, incorporating an allowance for climate change over the lifetime of development) are not met for River Dee Tidal flooding. However, as permitted by the TAN, these criteria can be more flexibly applied for redevelopment. The FCA concludes that the proposals provide betterment when compared with existing, and the proposed levels of all built infrastructure are maximised as far as reasonably practicable.

- For less vulnerable development**,** under extreme event flood conditions, the maximum depth of flooding should not exceed 600mm and velocity of flood waters should not exceed 0.15 m/s. Exceedance of these conditions is only expected in discrete, water-compatible areas e.g. the location of the proposed new Queensferry Ditch inlet; and in residual flood risk scenarios – i.e. where the defences have breached. TAN15 allows for judgement taken in the context of the circumstances which could prevail at that Scheme. The assessment concludes that proposed levels of the new carriageway are already maximised at this location and via implementation of an updated Local Contingency Plan, flood risk for these extreme future climate change events can be adequately managed and is acceptable to the owner and maintainer of the Scheme (NMWTRA).
- The owner of the Scheme (NWMTRA) is aware of the scale and nature of flood risk posed to the Scheme, evacuation routes are present, and plans and procedures will be updated and in place prior to use, so the Scheme poses minimal risk to life to people living and working in the area.
- The redevelopment will be resilient to flooding for the duration of its lifetime, and can be inspected, repaired, cleaned and returned to use quickly after a flooding event, minimising disruption to people living and working in the area. The new Queensferry Drain pump station will be designed with electrics and control kiosks located above floodwater levels so they remain operational and maintainable during times of flooding.
- In the majority of cases, the Scheme is not expected to cause nor increase the frequency of flood risk elsewhere. Furthermore, with respect to Queensferry Drain flood risk, the expected overall trend is for flood depths to reduce across the catchment. However, in relation to River Dee tidal sources, in the extreme 0.1% AEP 2100 event only, the hydraulic modelling completed for the Scheme predicts increases in flood levels in areas of Garden City and Queensferry. Maximum flood depth increases are predicted to be less than 0.03m (water compatible open spaces) and 0.01m (flood risk sensitive receptors). The magnitude, spatial and temporal scale of the increases reported are not considered to pose an unmanageable risk to receptors. Therefore, no further mitigations to manage this impact are proposed.

Surface water management

Section 7 of TAN15 has been satisfied. The proposed surface water drainage strategy has been developed into an appropriate detailed SuDS drainage design, based upon the constraints of the Scheme, and the proposed design does not increase flood risk elsewhere.

Conclusions and recommendations

The FCA provides a full understanding of the potential risks and consequences, and sufficient information to consider flooding implications and to balance them against other considerations. The Scheme design delivers a development that is considered safe and there is minimal risk to life or disruption to people living and working in the area. The FCA demonstrates that flood risk can be managed within acceptable limits, and there is no reason from a flood risk standpoint not to proceed.

The assessment has identified the following activities, or further works will be required in relation to flood risk matters:

- Prior to the Scheme being operational, the local contingency plan should be updated with flood risk procedures, roles, responsibilities, and triggers for evacuating.

- The Environmental Permitting (England and Wales) Regulations 2016 require a Flood Risk Activity Permit (FRAP) is obtained for any works in, over, under or adjacent to Main Rivers.

1 Introduction

The North & Mid Wales Trunk Road Agent (NMWTRA) has appointed Mott MacDonald Ltd as the lead consultant to provide multi-disciplinary consultancy services for the A494 River Dee Bridge Replacement Scheme ("the Scheme"), covering Welsh Government's Key Stage Approval Stages 3 and 4.

Key Stage 3 involves development of the business case, preliminary Scheme design, Environmental Impact Assessment, and preparation of draft Orders documentation.

Key Stage 4 covers completion of statutory processes, including publication of the draft Orders, public exhibitions, managing objections and representations, and preparation for and participation in a Public Inquiry (if required).

This Flooding Consequences Assessment Report (FCA) will be used to inform the Environmental Impact Assessment (EIA) for the Scheme. The purpose of the FCA is to identify the acceptability of flooding consequences in accordance with Planning Policy Wales and Technical Advice Note 15: Development, flooding and coastal erosion (TAN 15) (dated March 2025).

This assessment has been carried out by suitably qualified, competent persons, and has informed the process of detailed design and the selection of mitigation measures, where appropriate.

1.1 Project history

The A494 River Dee Bridge provides a vital connection for cross border traffic between north Wales, the north-west of England and beyond, connecting people, communities and businesses.

The high volume of traffic using the bridge means that closure of the bridge to replace the deteriorated parts would cause severe disruption for people travelling in the area and adversely impact the economy in north Wales.

The need for a new bridge is driven by the poor structural condition of the existing bridge deck. The inspections and monitoring to date have concluded that the frequency of repairs and the risk of major repair and intervention requiring the closure of the bridge is growing year-on-year. If nothing is done, the bridge will continue to deteriorate which may require measures such as further weight restrictions and lane closures in the short to medium term and result in closure in the medium to long term.

In 2018, the Welsh Government undertook an appraisal that looked at options to replace the A494 River Dee Bridge. Following the Welsh Government's response to the Roads Review in February 2023 the Welsh Government reviewed the Scheme Transport Planning Objectives to align with the new four road building tests. The Scheme was the re-appraised using the updated Welsh Transport Appraisal Guidance (WelTAG) published in February 2024. Considerations for the Scheme include not creating additional traffic, minimising carbon and encouraging modal shift. As an outcome of the re-appraisal, a revised layout for the proposed works has been developed (see Section 1.3).

1.2 Location and description

The existing A494 River Dee Bridge is located in Queensferry, Flintshire, north Wales and is centred at National Grid Reference SJ 32387 68597 (Figure 1.1 overleaf).

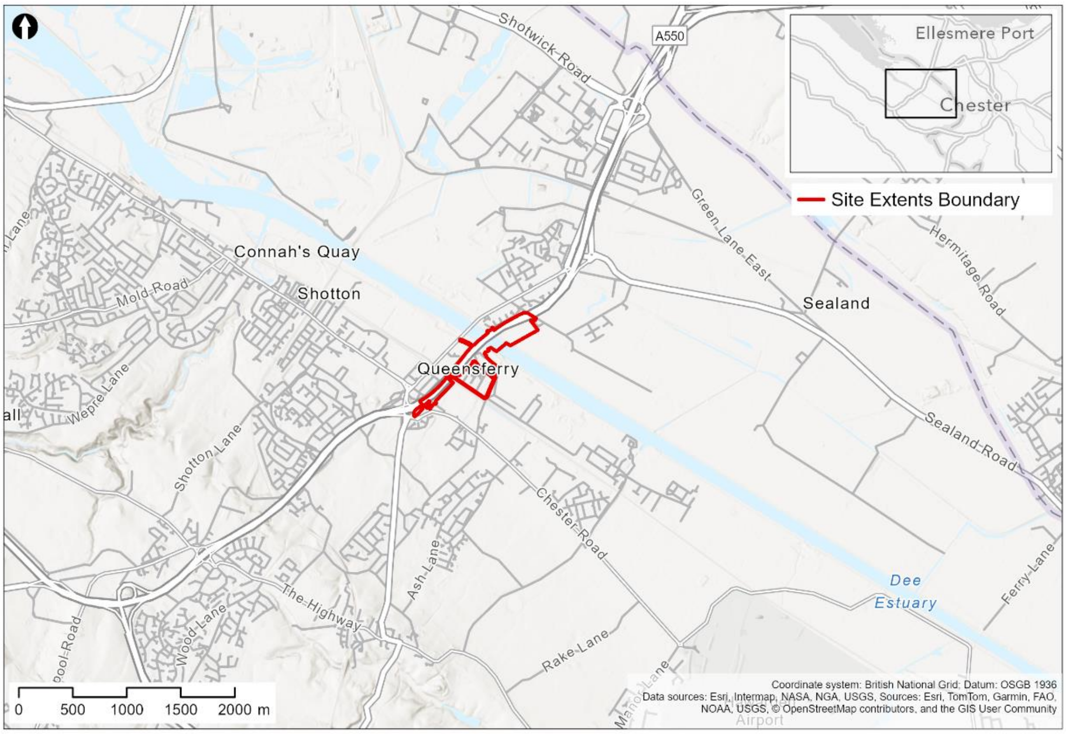
The A494 from the River Dee Bridge to the Queensferry roundabout consists of a dual carriageway. To the north-west of this section of the A494 is the town of Queensferry, comprising a mix of residential and commercial properties. To the south-east of this section of the A494 there is a sewage treatment works and a number of derelict buildings. A railway line passes over the A494 south of the River Dee Bridge.

The existing dual carriageway from the River Dee Bridge to the Queensferry roundabout is approximately 1km in length and covers an area of approximately 1.9ha.

The Scheme spans and lies adjacent to the River Dee, which is classified as a 'Main River' by NRW and is tidally influenced. There is a second 'Main River' in the vicinity of the Scheme, the Queensferry Drain, which flows along the south-east boundary of the A494. The Queensferry Drain is culverted upstream of the railway crossing but is an open watercourse downstream of the railway. The Queensferry Drain discharges into the River Dee via gravity during periods of low water / tide levels in the River Dee and is pumped during periods of high water / tide levels. The pumping station is located on the south bank of the River Dee, adjacent to the sewage treatment works.

The locations of key features in the vicinity of the Scheme are shown in Figure 1.2.

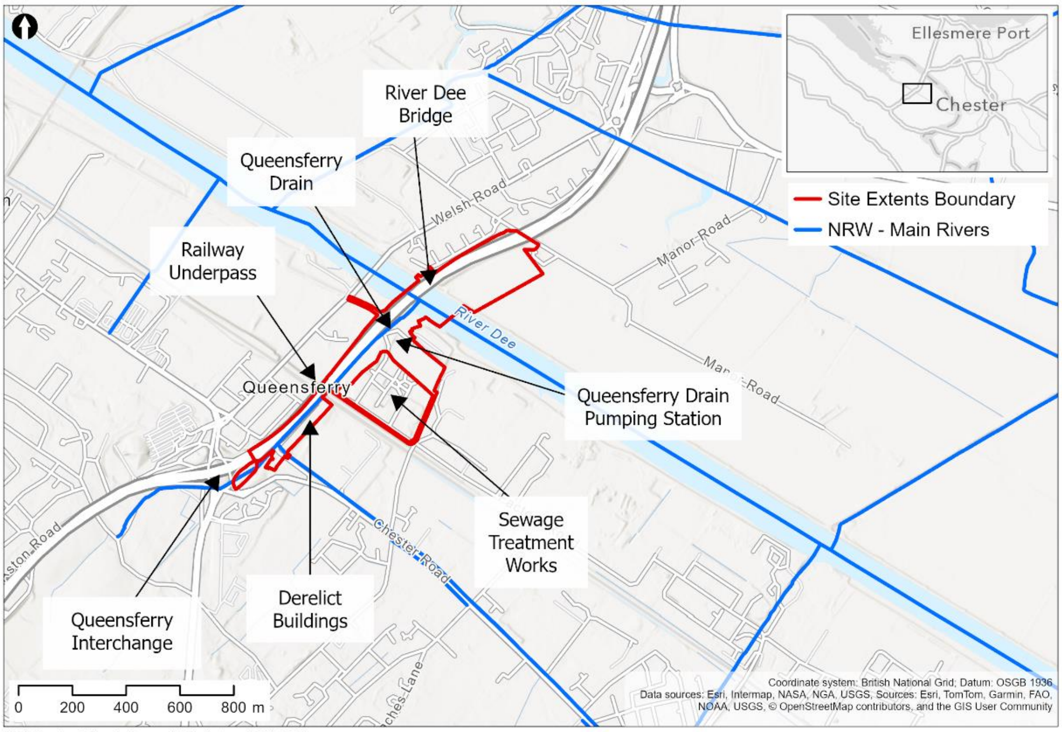
Figure 1.1: Scheme location plan



A494 River Dee Bridge Replacement | Site Location | 22 Jul 2025

Source: Mott MacDonald 2025. Contains OS data © Crown copyright and database right 2019

Figure 1.2: Key features plan



Source: Mott MacDonald 2025. Contains OS data © Crown copyright and database right 2019

A topographic survey of the existing area was undertaken in 2018 and is provided in Appendix A for reference. The existing River Dee crossing is at a maximum elevation of approximately 11.9m AOD and the Queensferry Interchange bridge at a maximum of around 14.7m AOD.

1.3 Scope of works

A general arrangement plan of the proposed works is included in Appendix B.

The proposed works consists of constructing a new bridge to carry two lanes of eastbound and westbound traffic and a shared use path for cyclists and pedestrians. The new bridge would be located approximately 12 metres to the southeast of the existing A494 River Dee Bridge.

Construction works are proposed to take place ‘offline’ of the existing highway to allow the road to remain open during the majority of construction.

The key features of the Scheme are:

1. A new bridge to carry two lanes of traffic in both directions.

2. A new shared use path for pedestrians and cyclists, running along the southeast side of the westbound carriageway. This would connect to the Wales Coast Path and other active travel routes in the area.

3. Improvements to the existing A494 to the east of where the road passes under the North Wales Coast Railway Line. This would include introducing a new hard shoulder in each direction connecting to the existing hard shoulders to the east of the River Dee, alignment improvements and sustainable drainage systems.

4. A new access/exit to leave the A494 towards the Riverside area just past the river crossing. Road users will also be able to join the A494 from the same junction, turning left towards Queensferry.

5. Diversion of the Queensferry Drain (a NRW Main River), which is situated on the southeast side of the A494 and currently flows in a culvert beneath it, west of the North Wales Coast Railway Line and in open channel east of the railway line. New sections of open channel would be provided either side of the railway with a section of existing culvert beneath the railway line being retained.

6. A new river pumping station and drainage outfall to the River Dee for Queensferry Drain.

7. Environmental mitigation and biodiversity enhancement works with earthworks and areas of soft estate including wildflower verges, swales, native woodland plantations, hedgerows and amenity grassland.

8. Demolition of the existing A494 River Dee Bridge, with the exception of the river piers, which will remain in-situ.

The Scheme will cover an area of approximately 18.6ha.

Analysis of the design estimates that entire development (Features 1-8 above) will result in a net volume, in the order of 2468 m^3, of material being imported.

1.4 Assessment limitations

The information presented within this report is dependent upon the accuracy and reliability of the supplied information, correspondence, and data available to Mott MacDonald, at the time of the assessment. In particular, Section 6 of the River Dee and Queensferry Drain Hydraulic Modelling Reports (ref. 395318-MMD-00-XX-RP-D-0010 or -0011, both dated September 2025) provide information on the assumptions and known limitations of the site-specific flood modelling prepare to support this FCA. Any third parties developing any design should not rely on assumptions made in these reports but should satisfy themselves in that regard.

The FCA, River Dee and Queensferry Drain Hydraulic Modelling Reports include an assessment of the predicted effects of climate change over the lifetime of the development. The assessment of the effects of climate change is based on guidance provided by Welsh Government in place at the date of this report. These recommendations may change in the future, increasing the extent of predicted effects, and we would recommend that further advice is sought should this occur during the lifetime of the project.

Mott MacDonald has followed accepted procedure in providing the services, but given the residual risk associated with any prediction and the variability which can be experienced in flood conditions, Mott MacDonald takes no liability for and gives no warranty against actual flooding of any property (client’s or third party) or the consequences of flooding in relation to the performance of the service. This FCA has been prepared for the purposes of supporting an EIA for the proposed development to replace the A494 River Dee crossing only.

2 Sources of information

2.1 Information used

Mott MacDonald accessed the following sources of information in the preparation of this FCA:

- Planning Policy Wales (PPW) Edition 12, dated February 2024[1].
- Technical Advice Note 15: Development, flooding and coastal erosion (TAN 15) (dated March 2025)[2].
- Welsh Government guidance on climate change allowances for flood consequence[3]
- Recorded Flood Extents[4]
- NRW Flood Risk Assessment Wales Map[5]
- NRW Flood Map for Planning (FMfP)[6]
- Flintshire Strategic Flood Consequences Assessment (SFCA) dated July 2018[7]
- Flintshire Strategic Flood Consequence Assessment Draft, dated July 2020[8]
- Flintshire County Council Preliminary Flood Risk Assessment, dated June 2011[9].
- Flintshire County Council Local Flood Risk Management Strategy, dated December 2013[10].
- Flintshire County Council Local Flood Risk Management Strategy (Draft for Public Consultation), dated April 2025[11].
- Flintshire County Council – Northern River Dee Embankment Strengthening Works - Planning Application, dated April 2013[12].
- Welsh Government "Flood Consequences Assessments: Climate change Allowances", dated September 2021 Climate change allowances and flood consequence assessments | GOV.WALES, last accessed March 2022.
- Natural Resources Wales – North Wales Routine Maintenance Program, 2019/20[13]

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[1] Welsh Government (2024). Planning Policy Wales (PPW): Edition 11. Available online: Planning Policy Wales - Edition 12. Last accessed by Mott MacDonald: April 2025.

[2] Welsh Government (2025). Technical Advice Note 15: Development, flooding and coastal erosion. Available online: Technical Advice Note 15: Development, flooding and coastal erosion. Last accessed by Mott MacDonald: April 2025.

[3] Welsh Government (2018). Flood Consequence Assessments: Climate change allowances,. Available online: FCA's - draft climate change allowances Last accessed by Mott MacDonald: July 2025.

[4] DataMapWales (2024). Recorded Flood Extents. Available online: Recorded Flood Extents | DataMapWales. Last accessed by Mott MacDonald May 2025.

[5] NRW (2025). Flood Risk Assessment Wales (FRAW). Available online: Flood and Coastal Erosion Risk Maps. Last accessed by Mott MacDonald: April 2025.

[6] NRW (2025). Flood Map for Planning. Available online: https://flood-map-for-planning.naturalresources.wales/ . Last accessed by Mott MacDonald: April 2025.

[7] LDP-EBD-EN1 Strategic Flood Consequences Assessment Final Report 2018 (flintshire.gov.uk) Last accessed by Mott MacDonald: April 2025.

[8] Flintshire Strategic Flood Consequence Assessment Draft (2020), Available at: LDP-EBD-EN2 Updated SFCA re PE1 Employment Allocations and PE2 Principal Employment Areas, Last accessed by Mott MacDonald: July 2025

[9] Flintshire County Council Preliminary Flood Risk Assessment (2011), Available at: Preliminary Flood Risk Assessment June 2011 (PDF 1MB new window), Last accessed by Mott MacDonald: July 2025.

[10] Flintshire County Council Local Flood Risk Management Strategy (2013), Available at: Flintshire Local Flood Risk Management Strategy 2013, Last accessed by Mott MacDonald: July 2025.

[11] Flintshire County Council Draft Local Flood Risk Management Strategy (2025), Available at: Local Flood Risk Management Strategy 2025 - Public Consultation Draft, Last accessed by Mott MacDonald: July 2025.

[12] 050730 - Full Application - Engineering works to provide flood defence strengthening along 1.5 km of.pdf, Last accessed by Mott MacDonald: July 2025.

[13] https://cdn.cyfoethnaturiol.cymru/688477/north-wales-routine-maintenance-2019_20eng.xlsx?rmode=pad&v=1d4e2ffb0121560, Last accessed by Mott MacDonald: July 2025.

- Natural Resources Wales - Developing hydraulic models for flood risk, dated 17 January 2025[14]
- Natural Resources Wales - Modelling for Flood Consequence Assessments, dated 2 June 2025[15]
- River Dee Hydraulic Modelling Report, ref. 395318-MMD-00-XX-RP-D-0010 dated September 2025, by Mott MacDonald (see further details below).
- Queensferry Drain Hydraulic Modelling Report, ref. 395318-MMD-00-XX-RP-D-0011, dated September 2025, by Mott MacDonald (see further details below).
- Highway Drainage Developed Design Strategy Report, ref. 395318-MMD-00-XX-RP-D-0007, by Mott MacDonald
- Canal and River Trust: Wales and South West waterways map online mapping data[16]
- British Geological Survey GeoIndex Map[17]
- Soilscapes Viewer[18]
- Statement of Intent, 395318-MMD-00-XX-RP-C-0014, dated March 2025, by Mott MacDonald
- Preliminary Sources Study Report, 395318-0044 Rev C, dated April 2025, by Mott MacDonald
- Ground Investigation Report, 395318-0022 Rev F, dated April 2025, by Mott MacDonald
- 1m Digital Terrain Model (DTM) Light Detection and Ranging (LiDAR) data[19]

2.2 Hydraulic models

The following site-specific models have been used for the detailed assessment of fluvial and tidal flooding consequences (Section 5).

River Dee

NRW first provided the River Dee hydraulic model to Mott MacDonald in August 2018. This was used by Mott MacDonald to create an updated model, which was used as the starting point for the development of the final model. This was updated with information from the latest hydraulic model held by NRW, and provided to Mott MacDonald in June 2024. The final model (2025) has been used to inform this FCA. The approach has been laid out and agreed with NRW through consultation as recorded in the Scoping Report[20]. The results from the final model are provided in River Dee Hydraulic Modelling Report.

Queensferry Drain

NRW provided Mott MacDonald with the current hydraulic model for Queensferry Drain in July 2024. This was used as the starting point for the development of the final model (2025). The approach has been laid out and agreed with NRW through consultation as recorded in the

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[14] Natural Resources Wales / Developing hydraulic models for flood risk (2025), Last accessed by Mott MacDonald: July 2025

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

[16] Canal and River Trust (2022). Our canal and river network. Available online: https://canalrivertrust.org.uk/enjoy-the-waterways/canal-and-river-network . Last accessed by Mott MacDonald: April 2025.

[17] The British Geological Society (BGS) (2025). British Geological Survey GeoIndex. Available online: BGS Geology Viewer (BETA). Last accessed by Mott MacDonald: June 2025.

[18] Cranfield University (2025). Soilscapes Viewer. Available online: LandIS - Land Information System - Soilscapes soil types viewer. Last accessed by Mott MacDonald: June 2025

[19] Welsh Government (2023). LiDAR viewer. Available online: LiDAR viewer | DataMapWales. Last accessed by Mott MacDonald: June 2025.

[20] 395318-1015 – A494 River Dee Bridge Replacement Scheme – River Dee Model, Emerging Preferred Option Modelling Scoping Report, by Mott MacDonald, Oct 2024

Scoping Report[21]. The results from the final model are provided in Queensferry Drain Hydraulic Modelling Report.

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21 395318-1016 A494 Queensferry Scoping Report.docx, October 2024

3 Flood risk and development planning policy and guidance

3.1 National planning policy and guidance (TAN15)

3.1.1 Context

Technical Advice Note 15 (TAN 15) provides technical guidance relating to development planning and managing flood and coastal erosion risks in Wales. TAN 15 provides a framework within which the flood risks arising from rivers, the sea and surface water, and the risk of coastal erosion can be assessed. The approach set out in the most recent update to TAN 15 ensures flooding and coastal erosion are carefully considered in the context of planning and development management decisions.

TAN 15 reflects the core principles of the National Strategy for Flood and Coastal Erosion Risk Management in Wales[22] to adopt a risk-based approach in respect of development in areas at risk of flooding and coastal erosion. The National Strategy recognises the varying degrees of flood risk, now and in the future.

Section 6 of TAN 15 states that "*The prime objective of a Flood Consequences Assessment is to develop a full appreciation of:*

- *The risk and consequences of flooding on the development; and*
- *The risk and consequences (i.e. the overall impacts) of the development on flood risk elsewhere*"

It is to be noted that the latest TAN 15 on 'Development, flooding and coastal erosion' issued in March 2025 supersedes the 2004 edition of TAN 15 on 'Development and flood risk' and the 1998 release of TAN 14 on 'Coastal Planning'. As such, the latest TAN 15 also incorporates guidance on coastal erosion and, by its nature, is not intended to be considered within the scope of FCAs. Information and assessment of impacts on sedimentation and coastal processes can be found in Volume 3 Technical Appendix 7E.

3.1.2 Flood Map for Planning

Section 4 of TAN 15 states that "*The Flood Map for Planning is the starting point for consideration of flood risk in the planning system. The map uses flood zones to indicate the degree to which land is at risk of flooding from rivers, the sea, surface water and small watercourses. This TAN outlines the actions that should be taken when considering development in the different flood zones*."

Figure 1 of TAN 15 outlines the definitions for different flood zones, which are the basis for considering development, reproduced as Table 3.1 below. The Flood Map for Planning displays predicted future flood risk with an allowance made for climate change over a 100-year lifetime of the development under the central climate change estimate.

[22] Welsh Government (2021). National Strategy for Flood and Coastal Erosion Risk Management in Wales. Available online: National Strategy for Flood and Coastal Erosion Risk Management in Wales | GOV.WALES. Last accessed by Mott MacDonald: May 2025.

Table 3.1: Definition of Flood Map for Planning Zones

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	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 Areas where flood risk management infrastructure provides a minimum standard of protection against flooding from rivers of 1:100 (plus climate change and freeboard).	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.

Source: Adapted from Figure 1 of TAN 15.

Table 3.2 summarises the flood risk posed to the Scheme from tidal, fluvial, and surface water sources, based on the FMfP zones.

Table 3.2: Assessment of flooding based on FMfP zones

Zone	Flooding from rivers	Flooding from the sea	Flooding from surface water and small watercourses
1	✓	✓	✓
2	✓	✓	✓
3	✓	✓	✓
TAN 15 Defended Zones	✗	✓	Not applicable.

Source: NRW, 2025. Collated by Mott MacDonald Ltd. 2025.

3.1.3 Form of development

TAN 15 recognises two key forms of development, defined as follows:

- **New Development**: Any development on greenfield land
- **Redevelopment**: Any development on previously developed land as defined in Planning Policy Wales

The ability to avoid or minimise risk when undertaking development varies according to the type of development proposed. The proposed construction of a new bridge structure and highway to replace an old bridge crossing will be on predominantly ‘brownfield’ previously developed land. As such, the proposed development is considered to be classed as ‘Redevelopment’.

3.1.4 Vulnerability classification

TAN 15 classifies developments under one of the three following flood risk vulnerability categories, as shown in Table 3.3.

Table 3.3: TAN 15 Vulnerability classification

Vulnerability category	Types
Highly vulnerable development	All residential premises (including hotels, Gypsy and Traveller sites, 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 in Highly Vulnerable category and 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.

Source: Reproduction of Figure 4, TAN15

As a form of transport infrastructure, the proposed development is considered to be classed as 'Less vulnerable development'.

However, it should be noted that Paragraph 9.4 of TAN 15 states that "*Water compatible developments include developments which are required to be located near water by virtue of their nature, and developments that are resilient to the effects of occasional flooding.*" As such, there may also be an argument that the bridge element of the development be classed as 'Water compatible development'.

Paragraph 9.6 of TAN 15 recognises that for larger developments a single vulnerability category may not be appropriate. However, based on professional judgement and assuming worst case scenario for the purposes of this assessment, a single 'Less vulnerable development' classification has been adopted for this FCA.

3.1.5 Lifetime of development

Section 10.28 of TAN 15 states that '*Generally, it is appropriate to think of new dwellings as having a lifetime of 100 years. Lifetimes for other types of development will vary, but 75 years is considered a reasonable rule of thumb'.* In line with the TAN, a 75-year lifetime of the development has been adopted for the Scheme, which has also been agreed in pre-application discussions with NRW.

3.1.6 Climate change allowances

Fluvial

Welsh Government guidance on climate change allowances for flood consequence assessments recommends that the central allowance (20% uplift) for the 2080s epoch for the relevant river basin district is used to assess the potential impact of climate change as part of a FCA and to inform design levels.

If a figure other than the central estimate is used, applicants are expected to provide full justification within the FCA. It also recommended that, where appropriate, an assessment of risk should be made using the upper end allowance (45% uplift) to inform mitigation measures that help to ensure the long-term resilience of the development.

Tidal

Sea level rise has been calculated in accordance with Table 2 of Welsh Government guidance on climate change allowances for FCAs. This gives a 0.66m rise in sea levels between 2025 and 2100.

3.1.7 Principles of the TAN for development plan and development management purposes

The proposed redevelopment secures this critical link between north Wales and England and the Scheme has been identified in the Local Development Plan (LDP) see Section 3.3.1. The Scheme is therefore considered justifiable in accordance with the principles set out in Section 8 of TAN15

3.2 Local planning policy and flood risk management plans

3.2.1 Local Development Plan (LDP)

The proposed A494 road improvement Scheme is included in the Flintshire County Council LDP[23]. The Scheme has been safeguarded under the Development Management Policies – Creating Sustainable Places and Communities as the road is part of the core highway network and the Scheme aims to provide the following benefits to the local area:

- Improve reliability and journey times;
- Improve safety;
- Improve connections for business;
- Improve access between residential areas and places of employment;
- Reduce carbon emissions along the road; and

[23] Flintshire County Council Local Development Plan 2015-2030 (FINAL LDP Written Statement English), Adopted 24th January 2023, Last Accessed: June 2025

- Make more efficient use of the existing transport infrastructure.

3.2.2 Strategic Flooding Consequences Assessment (SFCA)

Flintshire County Council produced a Strategic Flooding Consequences Assessment (SFCA) in 2018 as part of the evidence base to inform the update to the LDP. This document was updated with regards to proposed PE1 Employment Allocations and PE2 Principal Employment Areas in July 2020, however only a draft version of the SFCA has been published on Flintshire County Council's website.

3.3 Consultation and guidance from NRW

3.3.1 Pre-application consultations

A number of pre-application consultations have been held with NRW to inform the FCA. A comprehensive list of NRW pre-application correspondence is provided in Chapter 7 (Water) of the ES.

3.3.2 NRW guidance

Flood modelling guidance previously contained in NRW Guidance Notes (GN028) Modelling for Flood Consequence Assessments and (GN43) Modelling Blockage and Breach Scenarios has now been replaced with the following web-based publications:

- "Developing hydraulic models for flood risk" provides guidance for all flood modelling projects, on areas like model scenario, topographic data, representing defended area etc.
- "Modelling for Flood Consequence Assessments" provides further detailed guidance on how to prepare and submit models in support of FCAs.

3.4 Consultation and guidance from the Lead Local Flood Authority

The Lead Local Flood Authority for the area is Flintshire County Council, which is also a key stakeholder on the Scheme and is represented on the Scheme's Project Board.

3.4.1 Preliminary Flood Risk Assessment (PFRA)

The EC Flood Directive has been transposed into UK law through the Flood Risk Regulations (2009) and the Flood and Water Management Act (FWMA) (2010). Under the Flood Risk Regulations (2009), Flintshire County Council prepared and undertook a Preliminary Flood Risk Assessment (PFRA) in 2011 to assess the harmful consequences of past and potential future floods, and to identify significant flood risk areas (called 'Flood Risk Areas'). Flood Risk Management Plans (FRMPs), setting out risk management objectives and strategies for each of the Flood Risk Areas, are identified in the PRFA.

The PFRA concluded that there were no potential Flood Risk Areas within the Flintshire County Council administrative area. The PFRA was reviewed in 2017 and found that there was no new information to change the understanding of future flood risk to the area.

3.4.2 Flintshire Local Flood Risk Management Strategy (LFRMS)

The Flintshire Local Flood Risk Management Strategy (LFRMS) is currently undergoing an update and consequently both the 2025 draft version for public consultation and the current 2013 publication have been consulted. The LFRMS identifies risks of flooding with a focus on local sources that the LLFA are responsible for. This includes surface water runoff, groundwater and ordinary watercourses. Flood risk management policies for these sources in the Local Authority area are set out and explained in relation to the objectives, measures and legislation in Welsh Government’s National Flood Risk Management Strategy.

3.4.3 SuDS approval board (SAB) function

Flintshire County Council are the SuDS Approving Body (SAB). However, as the project is a road for the Welsh Ministers as the highway authority, the Scheme is exempt from SAB Approval. Regardless, application of the statutory standards for SuDS is still recognised as best practice and opportunities for SuDS have been incorporated into the Scheme, where possible.

4 Initial assessment of flooding consequences

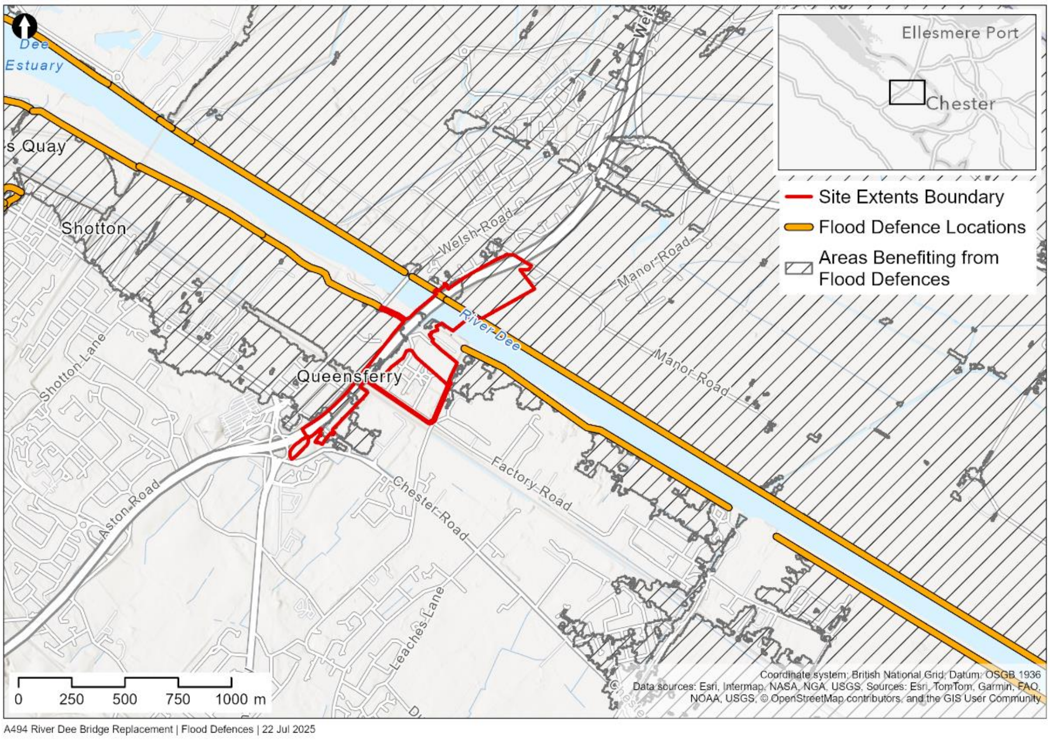
This Section provides an assessment of existing (pre-development) flooding consequences, in line with TAN15.

The assessment makes use of readily available online data and does not consider site or catchment specific modelling or information which is covered later in Section 5 of this report.

4.1 Existing flood defences

The banks of the River Dee currently benefit from extensive tidal flood defences, as shown in Figure 4.1. NRW maintain these defences, as indicated by the NRW flood defence structures dataset. The defences consist of embankments on either side of the river and protect a considerable area, particularly Sealand and Shotwick. The northern embankment had strengthening works completed in 2013 which included sheet piling to improve structural integrity. A minimum embankment level of 7.2mAOD is provided along the northern bank. NRW has confirmed that the current defences on both north and south sides offer a 1 in 200 year current-day standard of protection, with additional freeboard.

Figure 4.1: Flood Defence Locations



Source: Mott MacDonald (2025), Contains NRW data.

NRW has permissive powers (but not a duty) to carry out flood and coastal risk management work, including maintenance of flood defences. There are four published plans that indicate whether these flood defences will be maintained by NRW in the long term:

- River Dee Flood Risk Management Strategy.
- River Dee Catchment Flood Management Plan (CFMP).
- North West England and North Wales Shoreline Management Plan 2 (SMP2).
- North Wales Routine Maintenance Programme, where the assets are designated as 'high' consequence for flood risk management in the NRW.

These plans highlight the importance of these assets for wider flood protection on Deeside, and provide reassurance that NRW will continue to maintain these defences in the long term.

4.2 Initial assessment

Using readily available data, Table 4.1 below provides an initial assessment of flooding consequences. All mapping associated with the initial assessment is provided in Appendix C.

Table 4.1: Initial assessment of flooding consequences

Flood Risk Mechanism	Source	Flooding Risk	Description
Past flood events	Queensferry Drain	Yes - High	Figure C.1 displays the NRW Recorded Flood Extents. This indicates past flooding within the south-western extents of the Scheme, relating to two flood events occurring in 1976 and 2000. Given the extents are centred around the Queensferry Drain, it is assumed this flooding originated from this watercourse.
Fluvial	River Dee and Queensferry Drain	Yes - High	Figure C.2 displays the Flood Risk Assessment Wales (FRAW) – Rivers dataset. This indicates small areas at high risk of fluvial flooding (>3.3% AEP) which appear to be confined to the watercourses within the Scheme area. Within the southern extents of the Scheme, and in an area proposed for an access road in the north, there are small areas at low risk of flooding (0.1% - 1% AEP). The Flood Map for Planning (FMfP) – Rivers (Figure 0) represents an undefended, 100-year climate change scenario. It is indicated that the Scheme is partially within Flood Zones 2 and 3. This is in areas adjacent to the northern bank of the River Dee and surrounding Queensferry Drain (Flood Zone 3) and within the southern extents of the Scheme (Flood Zone 2). Whilst a large proportion of the Scheme is at very low risk, overall, the Scheme is considered to be at high risk for fluvial flooding.
Tidal	River Dee	Yes - High	Figure 0, the FRAW – Seas, indicates that much of the Scheme is at low risk of tidal flooding (0.1% - 0.5% AEP). Figure 0 displays the FMfP – Seas dataset which represents an undefended, 100-year climate change scenario. This indicates that the majority of the Scheme is located within Flood Zone 3 for tidal flooding. The FRAW suggests the Scheme is at much lower risk from tidal flooding than the FMfP. This is due to the FRAW taking into account areas

			benefiting from flood defences as well as the effects of climate change. Areas benefiting from defences are indicated in Figure 4.1. Whilst a proportion of the Scheme is at low risk, overall, the Scheme is considered to be at high risk for tidal flooding.
Surface Water	Surface water flows and accumulation	Yes - Medium	The FRAW – Surface Water and Small Watercourses dataset (Figure C.6) indicates only small areas of the Scheme are at risk of surface water flooding. These areas are located near the existing railway underpass and interchange with Chester Road in the south, both of which are shown as low (0.1%-1% AEP) or medium (1%-3.3% AEP) risk. The FMfP – Surface Water and Small Watercourses Figure C.7 represents an undefended, 100-year climate change scenario. Mirroring the picture provided FRAW, small areas of Flood Zone 2 and 3 are located at the existing railway underpass and interchange with Chester Road in the south. Both surface water flood maps show localised surface water issues and no large-scale pooling or overland flow paths indicative of small watercourses. Overall, the Scheme is considered to be at medium risk of surface water flooding.
Groundwater	Groundwater within bedrock and superficial layers.	Yes - Low	Historical groundwater flooding has not been documented in any information reviewed for this FCA. Groundwater monitoring was undertaken in four boreholes since October 2019 (see Railway Cofferdam Assessment 395318-TN63-V2, Mott MacDonald, 2021). Groundwater levels are generally consistent across the Scheme, with phreatic groundwater generally recorded at 4mAOD and the highest levels at 4.5mAOD. These levels are between 0.2m and 0.7m below existing ground levels at the lowest point of the Scheme (i.e. at the existing rail underpass). The data is inconclusive on whether the tide influences groundwater levels at the Scheme (Railway Cofferdam Assessment 395318-TN63-V2, Mott MacDonald, 2021). Overall, the Scheme is considered to be at low risk for groundwater flooding.
Sewer Exceedance	Portable water, foul and combined systems.	Yes - Low	Flintshire SFCA indicates that Dŵr Cymru Welsh Water have records of approximately 236 sewer flooding events in the Queensferry and Conah's Quay area between 1990 and 2016. Of these, approximately four cases are recorded near to the Scheme as indicated by Figure 5.1 of the SFCA however there are no recorded incidents within the Scheme area. Welsh Water records saw the presence of sewer within the scheme extent, and the Queensferry

			Sewerage Treatment Works lies immediately adjacent to the scheme. Overall, the Scheme is considered to be at low risk for sewer flooding.
Reservoirs and Large Waterbodies	Llyn Brenig	Yes - Low	The NRW Flood and Coastal Erosion Risk Map[24] 'Flood Risk from Reservoirs' indicates a small area of the Scheme north of the River Dee at risk of flooding from Llyn Brenig. The reservoir is more than 100km upstream of the Scheme. All large reservoirs must be inspected and supervised by reservoir panel engineers. The enforcement authority for the Reservoirs Act 1975 in Wales is NRW. They ensure that reservoirs are inspected regularly, and that essential safety work is carried out. Given the safety legislation in place, flood risk from reservoirs is considered to be low.
Canals and Manmade Waterways	n/a	No	There are no canals or manmade waterways in the vicinity of the Scheme.

Source: Various data sources, collated by Mott MacDonald, 2025

The above analysis indicates that the Scheme is at high risk of flooding from tidal (River Dee) and fluvial (River Dee and Queensferry Drain) source, and hence these are haven taken forward for further assessment in Section 5.

The above analysis indicates that the Scheme is also at medium risk of flooding from surface water sources. The proposed management of surface water risk are further explored in Section 7.

[24] NRW Flood and Coastal Erosion Risk Maps (Flood and Coastal Erosion Risk Maps), Last Accessed by Mott MacDonald: June 2025

5 Detailed assessment of flooding consequences

This Section provides an assessment of the flooding consequences under existing and future conditions, for both the existing (pre-development) and proposed (post-development) Scheme, as required by TAN15.

The Section builds on the initial screening completed in Section 3, and contains information obtained from site-specific hydraulic modelling completed to inform the design and FCA for the Scheme. It will provide a full understanding of the potential risks and consequences of High Risk sources identified in Section 4 (namely River Dee Fluvial, River Dee tidal and Queensferry Drian Fluvial). The assessment also includes both exceedance (overtopping) and residual (breach / blockage) scenarios, as required by the TAN.

The assessments presented in this section will be used to determine whether the Scheme meets the acceptability criteria for flooding consequences (section 11 of TAN15) which is covered later in Section 6 of this report.

5.1 Existing (pre-development) scenario

5.1.1 River Dee

The following tables show the scenarios that have been modelled and will be assessed in this FCA.

5.1.1.1 Summary of modelled existing (pre-development) scenarios

Table 5.1: Current day (2025) modelled existing (pre-development) scenarios

Model Run	Hydrological event
Dee_Def_Q1000_2025_existing	0.1% AEP fluvial flood event
Dee_Def_T200_2025_existing	0.5% AEP tidal event in 2025
Dee_Def_T1000_2025_existing	0.1% AEP tidal event in 2025

Source: Mott MacDonald, 2025

Note: The ‘Lower’ climate change allowance (5%) has been adopted for the 0.1% 2100 Fluvial event instead of the recommended ‘Central allowance (20%), as the additional flows in the latter scenario cause the model to become unstable upstream of the Scheme, at Chester, and result in the model failing.

Table 5.2: In the future (2100) modelled existing (pre-development) scenarios considering the lifetime of the development

Model Run	Hydrological event
Dee_Def_Q100cc20_2100_existing	1% AEP fluvial with Central (20%) climate change allowance until the 2080s (representing bridge design life to 2100)
Dee_Def_Q100cc45_2100_existing	1% AEP fluvial with Upper (45%) climate change allowance until the 2080s (representing bridge design life to 2100)
Dee_Def_Q1000-cc05_2100_existing	0.1% AEP fluvial with Lower (5%) climate change allowance until the 2080s (representing bridge design life to 2100)
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 existing breach at location 1
Dee_Def_T200_2100_existing_breach2	0.5% AEP tidal event in 2100 with existing breach at location 2

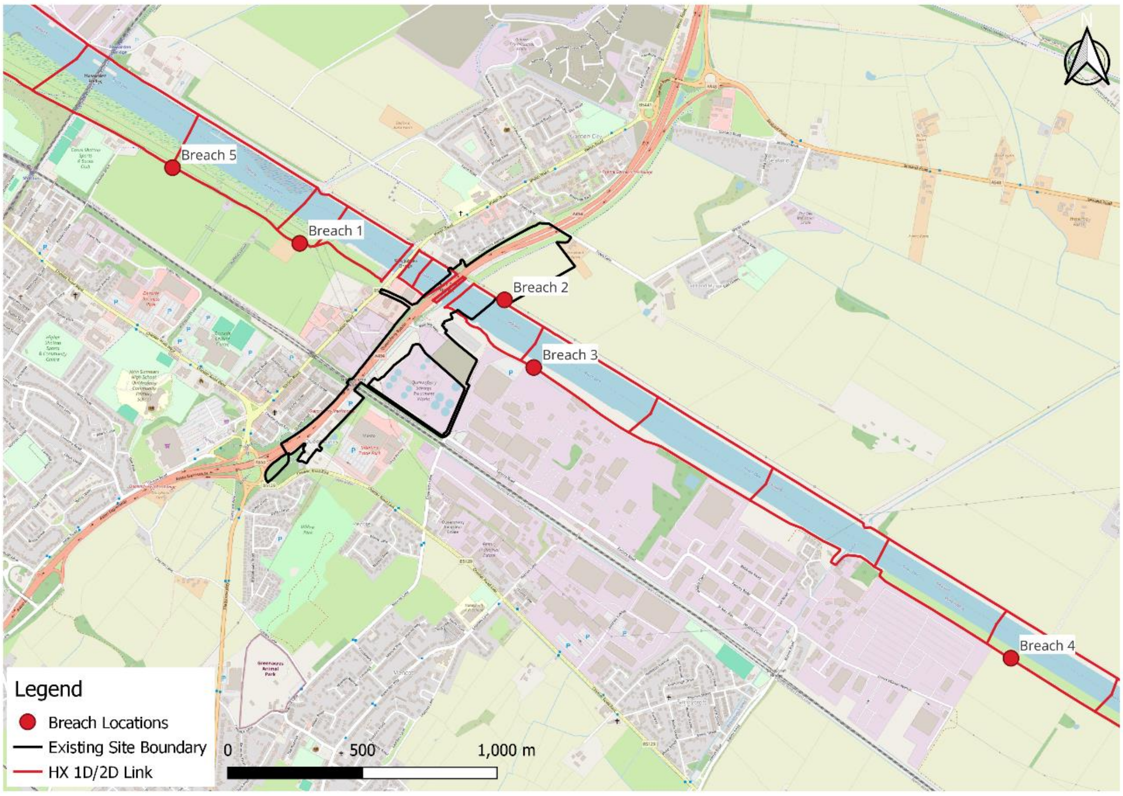
Model Run	Hydrological event
Dee_Def_T200_2100_existing_breach3	0.5% AEP tidal event in 2100 with existing breach at location 3
Dee_Def_T200_2100_existing_breach4	0.5% AEP tidal event in 2100 with existing breach at location 4
Dee_Def_T200_2100_existing_breach5	0.5% AEP tidal event in 2100 with existing breach at location 5
Dee_Def_T1000_2100_existing_breach1	0.1% AEP tidal event in 2100 with existing breach at location 1
Dee_Def_T1000_2100_existing_breach2	0.1% AEP tidal event in 2100 with existing breach at location 2
Dee_Def_T1000_2100_existing_breach3	0.1% AEP tidal event in 2100 with existing breach at location 3
Dee_Def_T1000_2100_existing_breach4	0.1% AEP tidal event in 2100 with existing breach at location 4
Dee_Def_T1000_2100_existing_breach5	0.1% AEP tidal event in 2100 with existing breach at location 5

Source: Mott MacDonald, 2025

As required by the TAN, breach scenarios have been assessed in the modelling. Five locations were selected for assessment as justified below (see Figure 5.1 overleaf for locations). These have been agreed with NRW in pre-application discussions. As recommended by NRW Guidance[14,15] for earth embankments, the breach width selected for all scenarios was 50m.

- Tidal Breach 1 – chosen due to known problems with badger burrowing along the riverbank coupled with a distinct lack of vegetation. 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 2 – 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 3 – 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 4 – 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 5 – 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 1.

Figure 5.1: Tidal Breach Locations



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

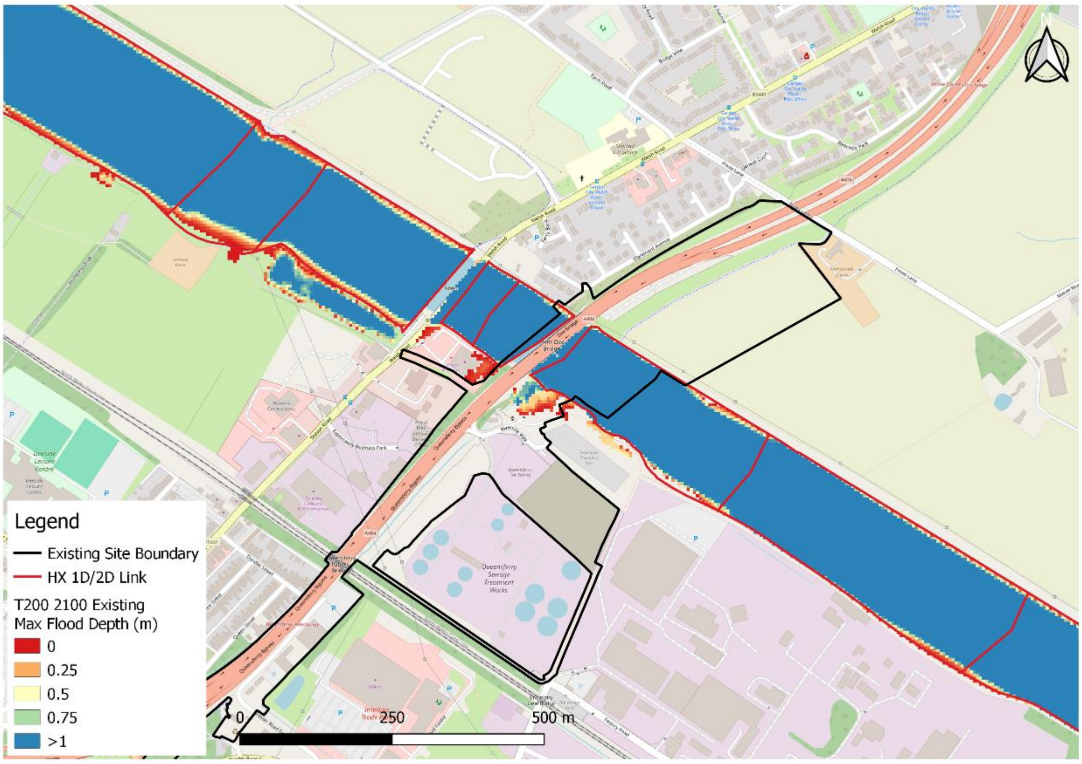
5.1.1.2 Existing (pre-development) fluvial flood risk

- For the 0.1% AEP and 1% plus climate change events, no flooding is predicted along the channelised section of the River Dee (adjacent to the Scheme), and the river is only predicted to go out of bank upstream of the Scheme, at Chester.
- Flooding extends north into Chester and depths exceed 1m for much of the area across Towergate.
- Figures A1-A4 in the River Dee modelling report provide maps showing the predicted extents of existing fluvial flood risk in Chester.

5.1.1.3 Existing (pre-development) tidal flood risk

- For the 0.5% and 0.1% AEP events, no flooding is predicted along the channelised section of the River Dee adjacent to, and within the Scheme extent. However, flooding is further afield, within the model extent; downstream at Wepre Gutter and Connah's Quay, and upstream at Chester (in the 0.1% AEP event only). Figures A5-A8 in the River Dee modelling report provide maps showing the predicted extents.
- For the 0.5% AEP event, incorporating allowances for climate change, the modelling indicates overtopping of flood defences at and adjacent to the Scheme extent. Overtopping is predicted to occur both within the Scheme boundary (on the left bank upstream of the existing bridge) and just outside the Scheme boundary (again on the left bank upstream however this time downstream of the existing bridge), as Figure 5.2 below shows.

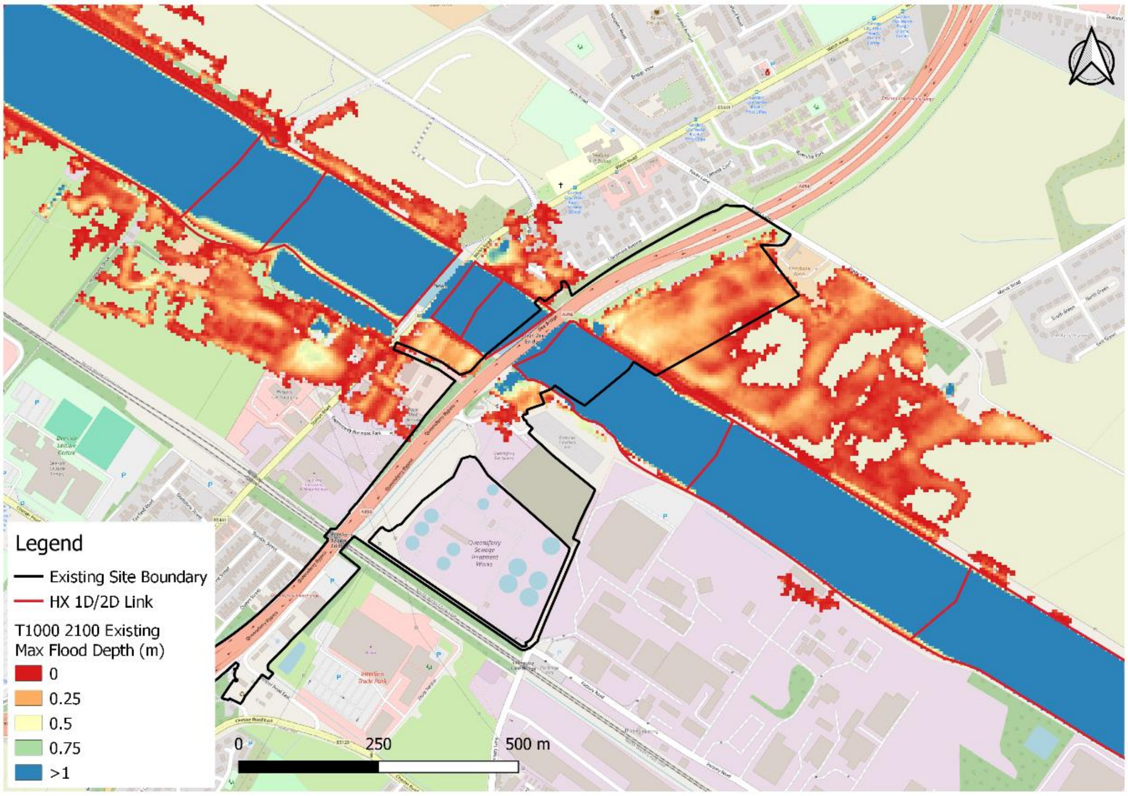
Figure 5.2: 0.5% AEP Tidal Existing Scenario Flood Depth at Existing Scheme in 2100



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

- For the 0.1% AEP event, incorporating allowances for climate change, out of bank flooding it expected to occur on both sides of the River Dee within the Scheme extent, as shown in Figure 5.3 below.

Figure 5.3: 0.1% AEP Tidal 2100 Flood Depth at Existing Scheme



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- Figures A9-A16 in the River Dee modelling report provide maps showing the predicted extents of existing tidal flood risk. These maps also report on the 97.5% confidence bound (C2) additional sensitivity test, as an upper limit of the likely sea level for the 0.5% and 0.1% events, as requested by NRW in pre-application discussions.

5.1.1.4 Existing (pre-development) tidal flood risk - breach scenarios

- All 5 scenarios show that a breach of the flood defences along the tidal River Dee would result in far greater flood extents when compared against the existing (pre-development) tidal flood risk where only overtopping occur (described in Section 5.1.1.3). The modelling assessment reinforces the importance of the protection provided by the current tidal flood defences in the area.
- Of the five breach scenarios assessed, only a single scenario (Breach 4) does not result in flooding within the Scheme boundary.
- Figures A17-A36 in the River Dee modelling report provide maps showing the predicted extents of these breach scenarios.

5.1.2 Queensferry Drain

The following tables show the scenarios that have been modelled and will be assessed in this FCA.

5.1.2.1 Summary of modelled existing (pre-Scheme) scenarios

Table 5.3: Current day (2025) modelled existing (pre-development) scenarios

Model Run	Hydrological event
QFD_BAS_DES_SD_10_25_0100_005	1% AEP Fluvial
QFD_BAS_DES_SD_10_25_01000_005	0.1% AEP Fluvial

Source: Mott MacDonald, 2025

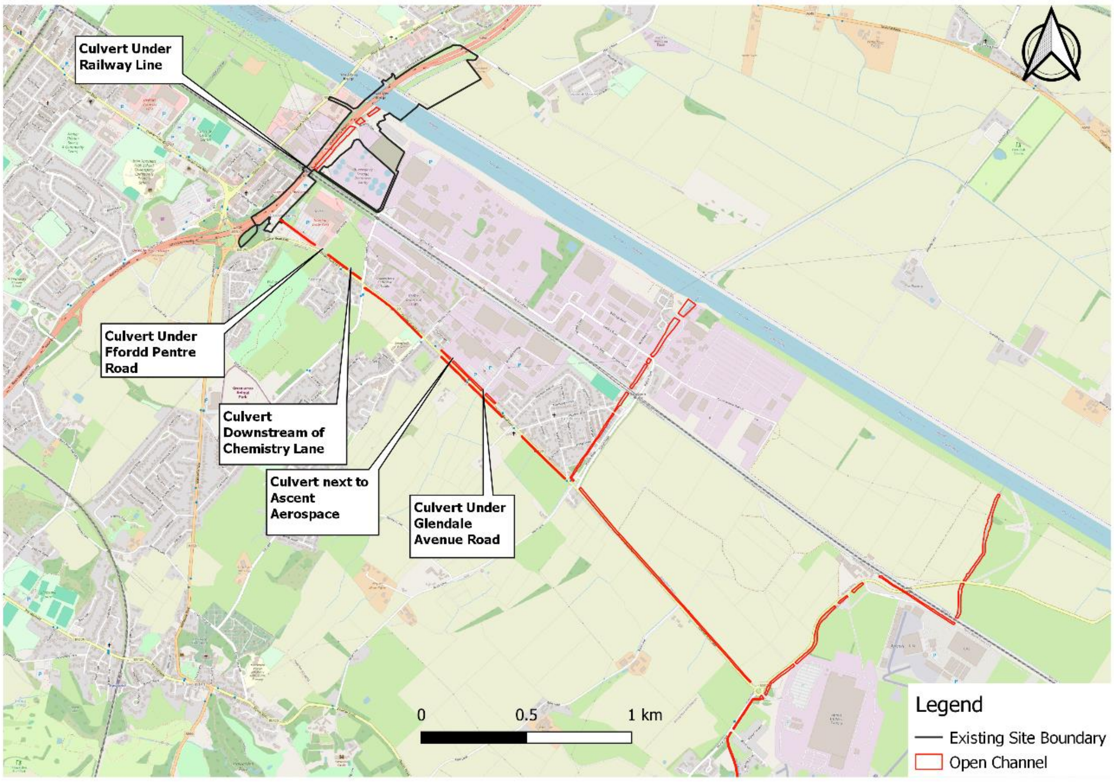
Table 5.4: In the future (2100) modelled existing (pre-development) scenarios considering the lifetime of the development

Model Run	Hydrological event
QFD_BAS_DES_SD_10_25_0100_20CC_005	1% AEP + 20 CC Fluvial
QFD_BAS_DES_SD_10_25_01000_20CC_005	0.1% AEP + 20 CC Fluvial
QFD_BAS_SEN_B67P_SD_10_25_0100_20CC_005	1% AEP + 20 CC Fluvial + 67% blockage
QFD_BAS_SEN_B67P_SD_10_25_01000_20CC_005	0.1% AEP + 20 CC Fluvial + 67% blockage

Source: Mott MacDonald, 2025

As required by the TAN, blockage scenarios have been assessed. The scenario has been agreed in pre-application discussions with NRW and assumes the blocking of five critical structures shown in Figure 5.4 by 67%.

Figure 5.4: Location of 5 nr. blocked structures assessed



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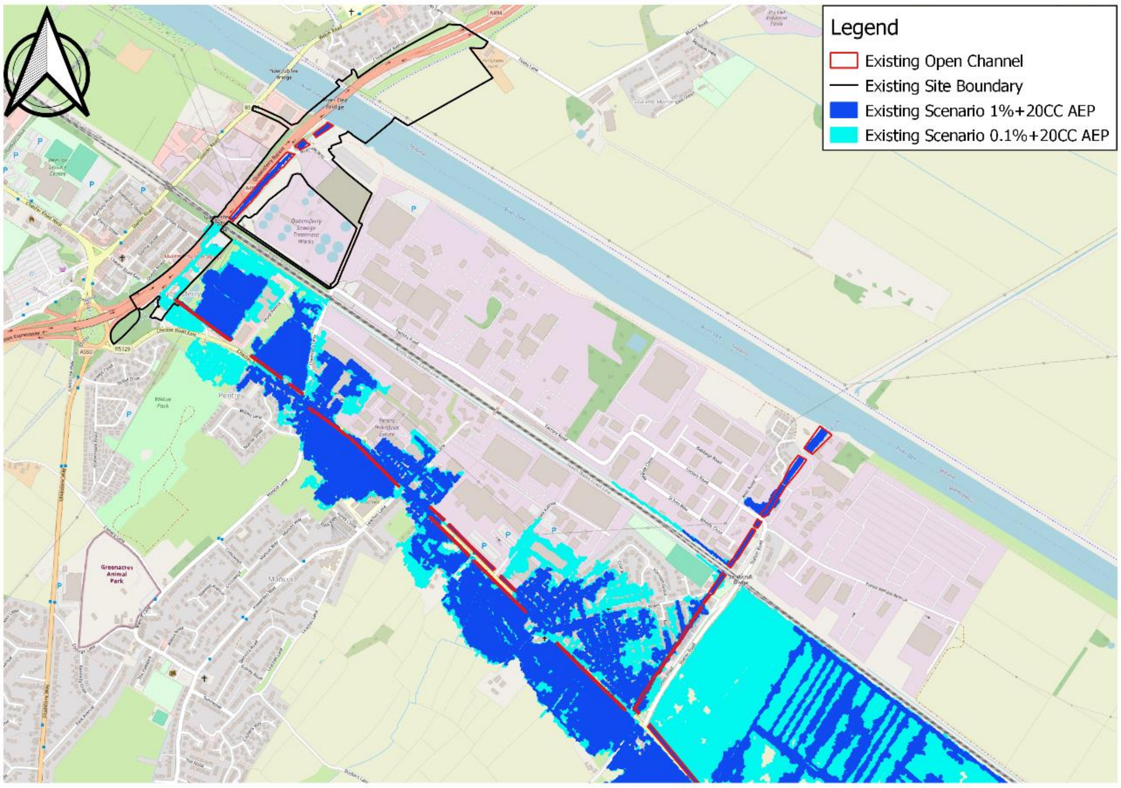
5.1.2.2 Existing (pre-development) fluvial flood risk

The Scheme is not at risk in the 1% and 0.1% AEP present day events, nor the 1% AEP 2100 event. It is predicted to be at risk in the extreme event (0.1% AEP 2100), as shown in Figure 5.5 below. In this event, flooding is expected to affect the southern half of the Scheme boundary, south of the railway line.

Figure 5.5: Map comparing the 1% and 0.1% AEP 2100 flood exents for the existing scenario Queensferry Drain free-flowing (without blockage)



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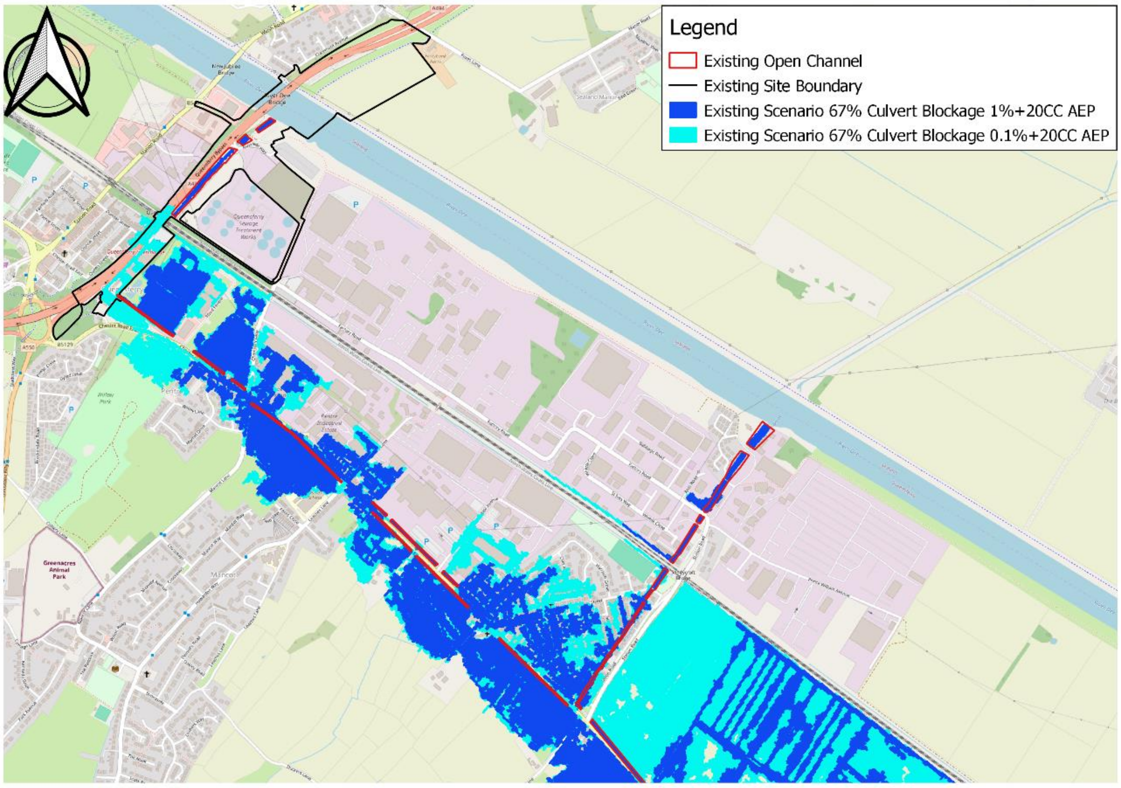
5.1.2.3 Existing (pre-development) fluvial flood risk – blockage scenarios

The blockage event shows a similar pattern to the free-flowing event, in that the Scheme is not at risk in the 1% and 0.1% AEP present day events, nor the 1% AEP 2100 event. It is predicted to be at risk in extreme event (0.1% AEP 2100), affecting the southern half of the Scheme, south of the railway line, see Figure 5.6 below.

Figure 5.6: Map comparing the 1% and 0.1% AEP 2100 flood exetns for the existing scanrio Queensferry Drain with blockage



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

5.2 Proposed (post-development) scenario

5.2.1 River Dee

The following tables show the scenarios that have been modelled and will be assessed in this FCA.

5.2.1.1 Summary of modelled proposed (post-development) scenarios

Table 5.5: Current day (2025) modelled proposed (post-development) scenarios

Model Run	Hydrological event
Dee_Def_Q1000_2025_proposed	0.1% AEP fluvial flood event
Dee_Def_T200_2025_ proposed	0.5% AEP tidal event in 2025
Dee_Def_T1000_2025_ proposed	0.1% AEP tidal event in 2025

Source: Mott MacDonald, 2025

Table 5.6: In the future (2100) modelled proposed (post-development) scenarios considering the lifetime of the development

Model Run	Hydrological event
Dee_Def_Q100cc20_2100_proposed	1% AEP fluvial with Central (20%) climate change allowance until the 2080s (representing bridge design life to 2100)
Dee_Def_Q100cc45_2100_proposed	1% AEP fluvial with Upper (45%) climate change allowance until the 2080s (representing bridge design life to 2100)

Model Run	Hydrological event
Dee_Def_Q1000-cc05_2100_proposed	0.1% AEP fluvial with Lower (5%) climate change allowance until the 2080s (representing bridge design life to 2100)
Dee_Def_T200_2100_proposed	0.5% AEP tidal event in 2100
Dee_Def_T1000_2100_proposed	0.1% AEP tidal event in 2100 with lower (30%
Tidal Flooding (Breach Scenarios)	
Dee_Def_T200_2100_ proposed_breach1	0.5% AEP tidal event in 2100 with existing breach at location 1
Dee_Def_T200_2100_ proposed_breach2	0.5% AEP tidal event in 2100 with existing breach at location 2
Dee_Def_T200_2100_ proposed_breach3	0.5% AEP tidal event in 2100 with existing breach at location 3
Dee_Def_T200_2100_ proposed_breach4	0.5% AEP tidal event in 2100 with existing breach at location 4
Dee_Def_T200_2100_ proposed_breach5	0.5% AEP tidal event in 2100 with existing breach at location 5
Dee_Def_T1000_2100_ proposed_breach1	0.1% AEP tidal event in 2100 with existing breach at location 1
Dee_Def_T1000_2100_ proposed_breach2	0.1% AEP tidal event in 2100 with existing breach at location 2
Dee_Def_T1000_2100_ proposed_breach3	0.1% AEP tidal event in 2100 with existing breach at location 3
Dee_Def_T1000_2100_ proposed_breach4	0.1% AEP tidal event in 2100 with existing breach at location 4
Dee_Def_T1000_2100_ proposed_breach5	0.1% AEP tidal event in 2100 with existing breach at location 5

Source: Mott MacDonald, 2025

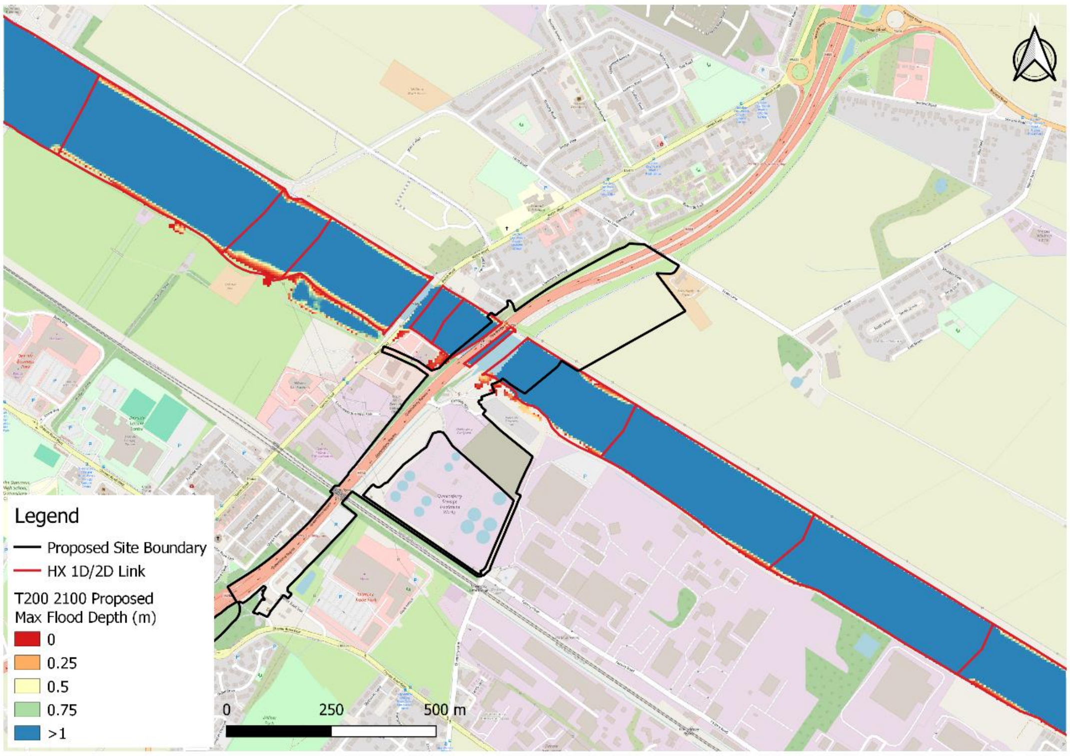
5.2.1.2 Proposed (post-development) fluvial flood risk

Similar to the existing scenario, the river is only predicted to go out of bank upstream of the Scheme, at Chester. No flooding is predicted within the Scheme boundary, and it remains flood free for the 1% AEP and 0.1% AEP 2100 events.

5.2.1.3 Proposed (post-development) tidal flood risk

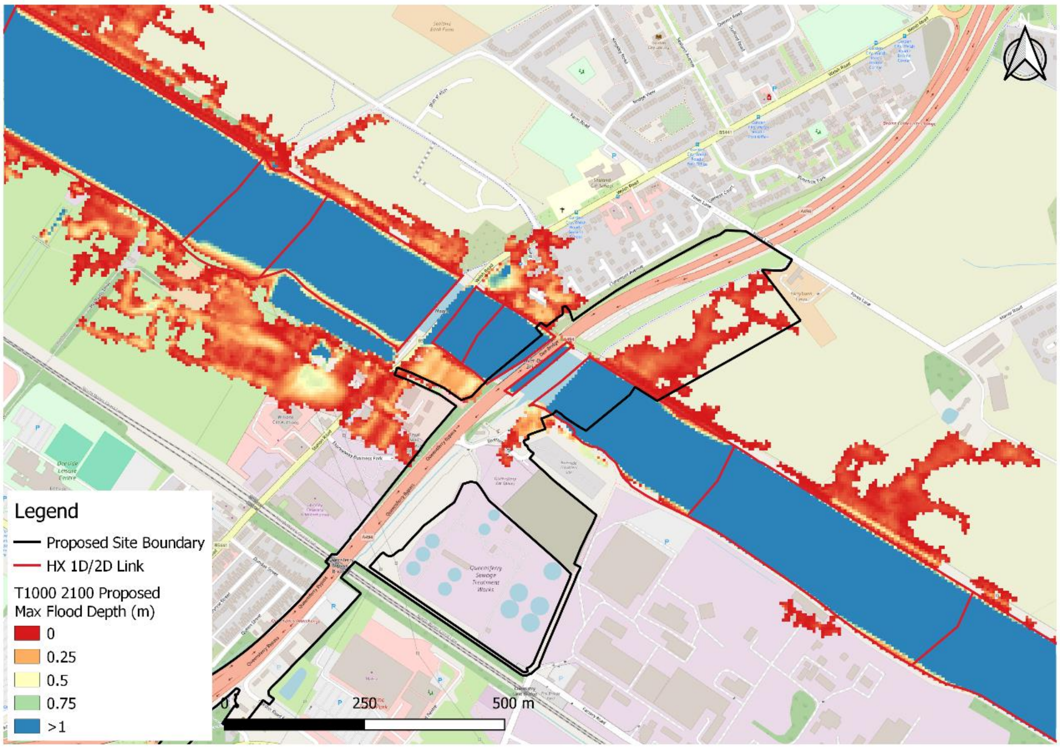
- The proposed scenario produces the same flood extents compared to the existing scenario for the 0.5% and 0.1% AEP present day tidal overtopping events.
- The proposed scenario produces very similar flood extents compared to the existing scenario for the 0.5% AEP 2100 event and flood is only expected in the area of the new Queensferry Drian inlet. (see Figure 5.7 overleaf).
- The proposed scenario produces very similar flood extents compared to the existing scenario for the 0.1% AEP 2100 event. In this event, out of bank flooding continues to be predicted to occur on both sides of the River Dee within the Scheme extent, although the extent of flooding on the right bank is reduced as shown in Figure 5.8 overleaf.

Figure 5.7: 0.5% AEP 2100 Tidal Proposed Scenario Flood Depth



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

Figure 5.8: 0.1% AEP 2100 Tidal Proposed Scenario Flood Depth



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

5.2.1.4 Proposed (post-development) tidal flood risk - breach scenarios

- Like the existing scenario, all 5 breach scenarios show that a breach of the flood defences along the tidal River Dee would result in far greater flood extents when compared against tidal flood risk where only overtopping occurs.
- Figures B6-B51 in the River Dee modelling report provides maps showing the predicted extents and velocities of these breach conditions.

5.2.2 Queensferry Drain

5.2.2.1 Summary of modelled proposed (post-development) scenarios

The following tables show the scenarios that have been modelled and will be assessed in this FCA.

Table 5.7: Current day (2025) modelled proposed (post-development) scenarios

Model Run	Hydrological event
QFD_SCH_DES_SD_10_25_0100_008	1% AEP Fluvial
QFD_SCH_DES_SD_10_25_01000_008	0.1% AEP Fluvial

Source: Mott MacDonald, 2025

Table 5.8: In the future (2100) modelled proposed (post-development) scenarios considering the lifetime of the development

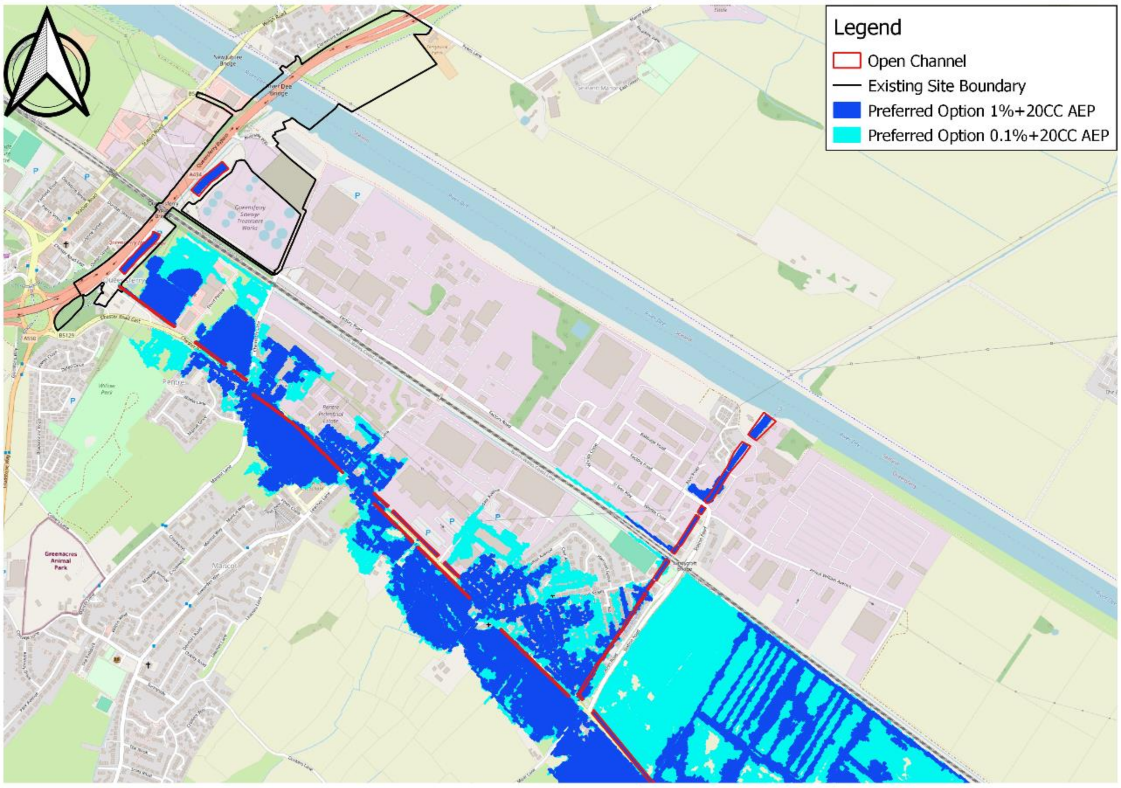
Model Run	Hydrological event
QFD_SCH_DES_SD_10_25_0100_20CC_008	1% AEP + 20 CC Fluvial
QFD_SCH_DES_SD_10_25_01000_20CC_008	0.1% AEP + 20 CC Fluvial
QFD_SCH_SEN_B67P_SD_10_25_0100_20CC_008	1% AEP + 20 CC Fluvial + 67% blockage
QFD_SCH_SEN_B67P_SD_10_25_01000_20CC_008	0.1% AEP + 20 CC Fluvial + 67% blockage

Source: Mott MacDonald, 2025

5.2.2.2 Proposed (post-development) fluvial flood risk

Flood water would be wholly contained within the proposed new open channel section of the Queensferry Drain within the Scheme. As a result, flood risk within the Scheme area is expected to improve as a result of the development, and be flood-free in all events up to and including the 0.1% AEP 2100 event. See Figure 5.9 below. Like the existing scenario, in the proposed scenario, there is expected to be extensive flooding south-east of the Scheme.

Figure 5.9: Map comparing the 1% and 0.1% AEP 2100 flooding extents in the proposed scenario for Queensferry Drain fee-flowing (without blockage)

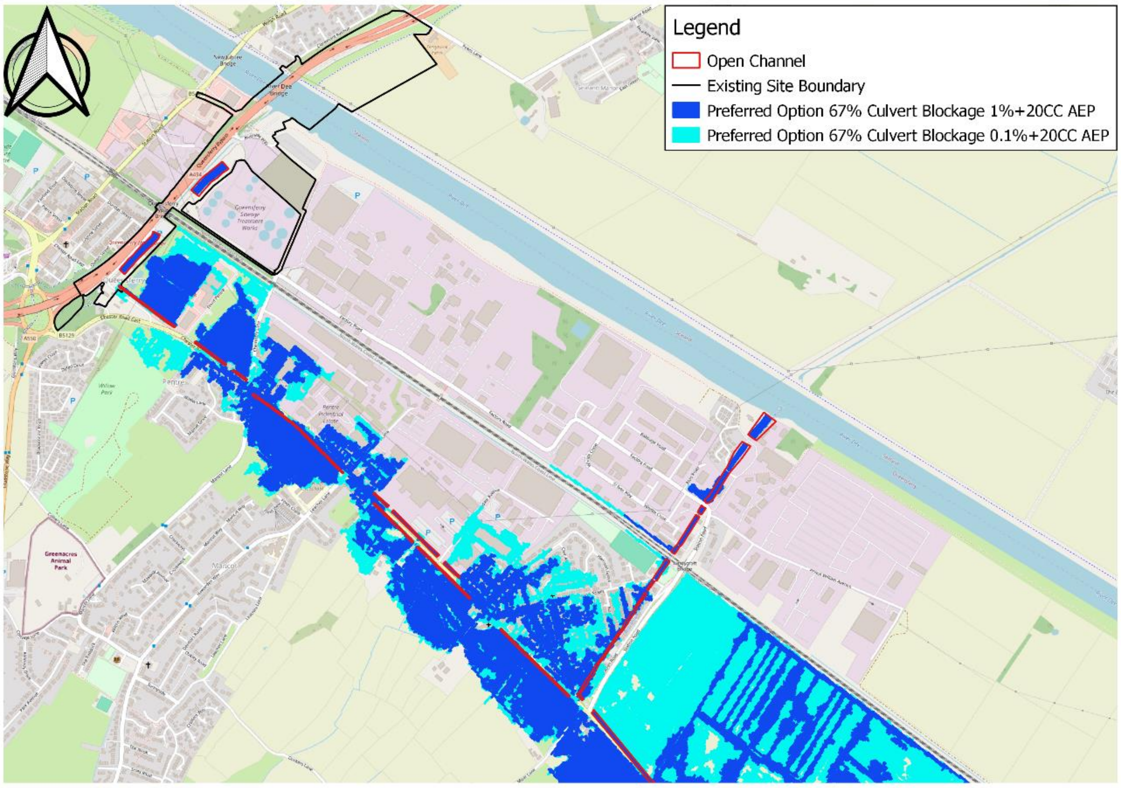


Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

5.2.2.3 Proposed (post-Scheme) fluvial flood risk – blockage scenarios

As with the free flowing event, the Scheme is expected to be flood-free in all events up to and including the 0.1% AEP 2100 event, with flood water wholly contained within the proposed new open channel section of the Queensferry Drain within the Scheme, see Figure 5.10 below. Like the existing scenario, in the proposed scenario, there is expected to be extensive flooding south-east of the Scheme.

Figure 5.10: Map comparing the 1% and 0.1% AEP 2100 flooding extents in the proposed scenario for Queensferry Drain with blockage



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

5.3 Summary

The detailed assessment of flooding consequences has shown:

- In either existing or proposed scenarios, the Scheme is not at risk of
  - fluvial flooding from the River Dee in events up to and including the 0.1% AEP 2100 event.
  - tidal flooding from the River Dee in the 0.5% and 0.1% AEP present day events.
- In the proposed scenario, the Scheme is not at risk of
  - flooding from Queensferry Ditch in events up to and including the 0.1% AEP 2100 event including in a 67% blockage scenario.
- In either existing or proposed scenarios, the Scheme is at risk of
  - tidal flooding from the River Dee in the 0.5% and 0.1% AEP 2100 events
  - tidal flooding from the River Dee in a breach scenario.

6 Assessment against acceptability criteria

As described in Section 11.3 of the TAN, the decision on whether a development should proceed or not will depend upon whether the consequences of flooding can be safely managed, including its effects on flood risk elsewhere.

This section will determine whether this redevelopment is consistent with the acceptability criteria for flooding consequences, using the information that has been provided in Sections 4 and 5 of this report.

6.1 Acceptable consequences for type of use

6.1.1 Development to be flood free (Section 11.7-11.8 of TAN15)

Figure 5 of the TAN summaries the frequency thresholds for different types of development. For less vulnerable development or water compatible' development (see Section 3.1.4) development should be flood free in the 1% AEP event plus an allowance for climate change (Rivers) and 0.5% AEP event plus an allowance for climate change (Sea).

As demonstrated in Section 4 and 5, in the proposed scenario, and for overtopping (exceedance) cases:

- River Dee (fluvial) – the Scheme is predicted to be flood-free in the 1% AEP 2100 event
- River Dee (tidal) – the majority of the Scheme is predicted to be flood-free in the 0.5% AEP 2100 event, with the exception of a small area coinciding with the proposed new Queensferry Drain inlet.
- Queensferry Drain (fluvial) -- the Scheme is predicted to be flood-free in the 1% AEP 2100 event, and flood water will be wholly contained within the proposed new open channel section of the Queensferry Drain.

For residual risk scenarios:

- River Dee (tidal) breach – the Scheme is predicted to be flooded in 4 of the 5 scenarios assessed
- Queensferry Drain (fluvial) blockage - the Scheme is predicted to be flood-free in the 1% AEP 2100 event, and flood water will be wholly contained within the proposed new open channel section of the Queensferry Drain within the Scheme.

The criteria set in Figure 5 of the TAN are not met for River Dee Tidal flooding, in either overtopping (exceedance) or residual risk (breach) scenarios. However, the TAN does go on to permit '*thresholds may be applied with more flexibility for redevelopment, changes of use, conversions and extensions, where the ability to substantially redesign a development is limited'*. The proposed development is redevelopment, so flexibility could be applied, and to support this it should be noted that:

- In the existing (pre-development) scenario, which incorporate the existing road and bridge, the Scheme does not meet the requirements of Section 11.7-11.8, and the Scheme will not make this worse. In fact, the Scheme will result in a small decrease in flood risk within the Scheme area in certain cases (see Section 6.2.2.2 and Figure 6.2).
- The proposed levels of all built infrastructure are maximised as far as reasonably practicable within the constraints of the Scheme , i.e. the need to tie in with existing infrastructure.
- The new Highway construction is generally more resilient to floodwater compared to other types of infrastructure. In addition, any new Highway construction will be modernised compared with existing.

- The residual risks outline here are acceptable to the owner and maintainer of the Scheme (NMWTRA).

6.1.2 Manageable consequences in an extreme flood (Section 11.9-11.11 of TAN15)

The TAN recognises that it may not be possible to keep all development flood-free in extreme floods. Under these circumstances, the TAN asks that FCA demonstrate that conditions within the development during an extreme event will be tolerable.

Figure 6 of the TAN summaries the tolerable conditions for different types of development. For less vulnerable development or water compatible' development (see Section 3.1.4) the maximum depth of flooding on Scheme in extreme conditions should not exceed 600mm and velocity of flood waters should not exceed 0.15 m/s.

In the case of exceedance (overtopping) scenarios:

- River Dee (fluvial) – the Scheme is predicted to be flood-free in the 0.1% AEP 2100 event.
- River Dee (tidal) – for the 0.1% AEP 2100 event, out of bank flooding is predicted to occur on both sides of the River Dee within the Scheme extent (section 5.2.1.3).
  - For the right bank: worse case flood depths are 0.23m, and velocities 0.26m/s. These values do not exceed the tolerable conditions provided in the TAN. Applying Figure 7 of the TAN (flood hazard matrix) the hazard to people classification is predicted to be *'very low'* under this scenario at the Scheme. It should also be noted that this area of the Scheme will only being used for temporary construction-phase activities (see Appendix A) and will be demobilised and returned to pre-development use within approximately 4 years, and before 2100. In addition, flood depth, velocities and hazards on the right bank will be reduced due to the Scheme. Considering these two factors, it is considered that the Scheme presents an opportunity for improvement (betterment) when compared to the existing situation.
  - For the left bank: worse case flood depths are 0.63m and velocities 0.82 m/s. This relates to an area of the Scheme that has been earmarked for the proposed new location of the Queensferry Drain open water course and outfall.
- Queensferry Drain (fluvial) – the Scheme is predicted to be to be flood-free in the 0.1% AEP 2100 event, and flood water will be wholly contained within the proposed new open channel section of the Queensferry Drain within the Scheme.

For residual risk scenarios, the following conditions are expected;

- River Dee (tidal) breach:
  - For Breach 4, the Scheme is predicted to be flood-free in the 0.1% AEP 2100 event.
  - For Breaches 1-3 and 5, flood depths at the Scheme would be greater than 1m deep (see Figure B9 of the River Dee Modelling Report), and velocities 0.9 m/s or greater (see Figure B8 in the River Dee Modelling Report). These values exceed the tolerable conditions provided in the TAN. Applying Figure 7 of the TAN (flood hazard matrix) the hazard to people classification would be 'Danger for all' under this scenario at the Scheme boundary.
- Queensferry Drain (fluvial) blockage scenario: the Scheme is predicted to be flood-free in the 1% AEP 2100 event, and flood water would be wholly contained within the proposed new open channel section of the Queensferry Drain within the Scheme.

Exceedance of the tolerable conditions under extreme event flood conditions is only expected;

- In discrete, water-compatible areas e.g. the location of the proposed new Queensferry Ditch inlet; and,
- In residual flood risk scenarios – i.e. where the defences have breached.

In using the above to assess whether the Scheme can be considered to provide a safe environment during an extreme flood event, the TAN recognises that each site should be considered individually, and a judgement be taken in the context of the circumstances which could prevail at the Scheme. To this end, the local planning authority should also consider:

- The proposed levels of the new carriageway are already maximised at this location, and it would not be practicable to increase them as it is necessary for the Scheme to tie in with the levels of the existing A494.
- It is expected that with an updated Local Contingency Plan (see Section 6.5), flood risk to the Scheme for these extreme future climate change events can be adequately managed.
- These risks are acceptable to the owner and maintainer of the Scheme (NMWTRA).

6.2 No increase in flooding elsewhere

The Scheme may occupy space that would otherwise be available for storage or conveyance of flood waters. The following assessment covers the 3 predominant flood sources (River Dee fluvial, River Dee tidal and Queensferry Drain fluvial) in both exceedance (overtopping) and residual (River Dee tidal breach / Queensferry Drain fluvial blockage) scenarios, as required by the TAN.

6.2.1 Assessment approach

The reporting of flood risk changes is in line with NRW Guidance[15] e.g. model results rounded to the nearest 0.005m, depth and levels results to two decimal places and velocity and hazard values to one decimal place. The following sections also provide a series of mapping outputs from the River Dee and Queensferry Drain modelling data. These show both changes in flood extent (through ‘was wet now dry’ and ‘was dry now wet’ layers), and flood depths (depth difference). Depth difference is presented as Proposed minus Existing, so that negative values represent predicted reductions in depth as a result of the Scheme, whilst positive values represent expected increases in depths as a result of the Scheme. The presentation of this data, including the depth change categorisations, was agreed in pre-application discussions with NRW.

The reporting focuses on flood risk changes outside of any river channels, in line with NRW Guidance[15].

It should be noted that a separate assessment of the flood storage volume that would be lost and/or displaced from the Scheme boundary has not been undertaken, as the extent of the proposed development is fully represented in both the River Dee and Queensferry Drain models, and the model results therefore account for any potential effect of any changes in flood storage volume.

6.2.2 River Dee

With respect to flood risk elsewhere, the FCA has assess the following scenarios for the River Dee.

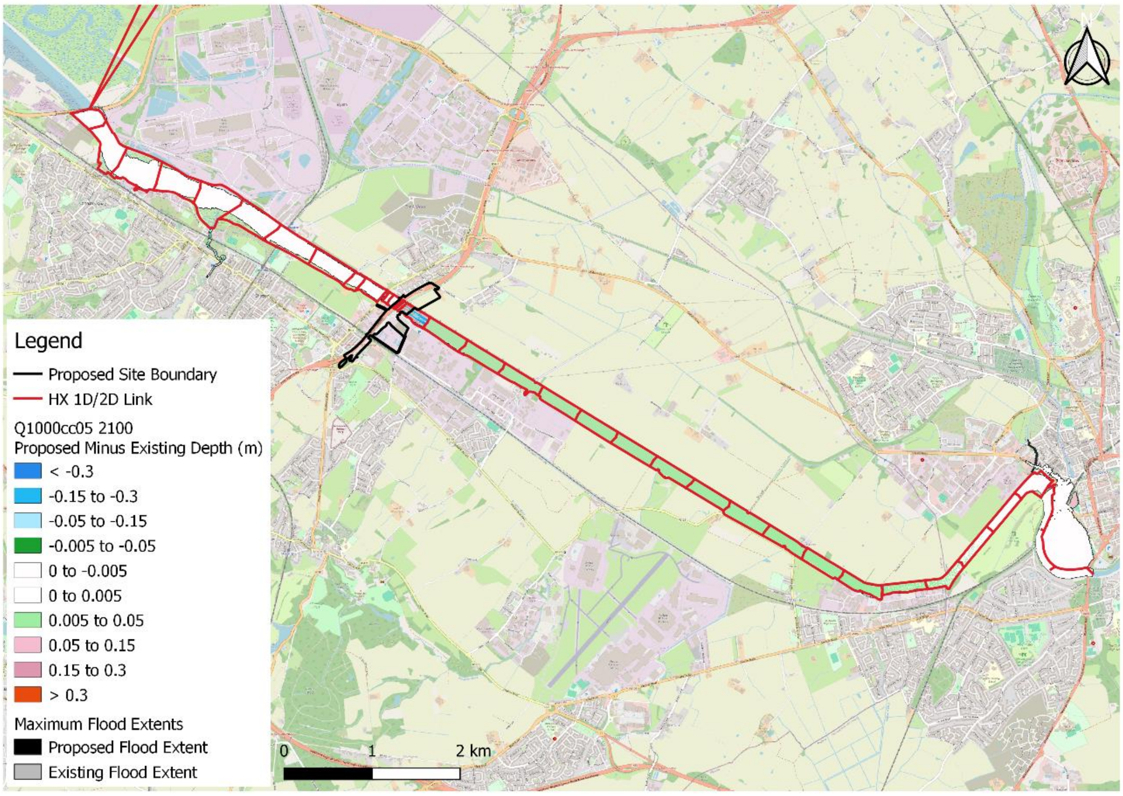
- Exceedance (overtopping) events, where the defences are overtopped but not breached.
- Residual risk in a tidal breach scenario

6.2.2.1 Fluvial exceedance (overtopping)

There are three areas away from the Scheme where flood risk impacts could change as a result of the Scheme. These are shown for the 0.1% AEP 2100 event in Figure 6.1 and described below.

- Inside the River Dee channel immediately upstream of the Scheme, where the current bridge is removed, and the proposed bridge is added. This is expected to have a localised impact and will change water levels inside the channel only.
- Inside the River Dee channel upstream of the proposed development, towards Chester, as shown in light green on Figure 6.1 below. This increase in water levels is limited to inside the River Dee channel only.
- At Fitchett's Gutter (Main River) in Chester (shown by small area of black on Figure 6.1). This expected increase in flood extent relates to the channel only.

Figure 6.1: Change in flood depth and extent for the 0.1% AEP 2100 fluvial events



Map source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2020)

6.2.2.2 Tidal exceedance (overtopping)

Figure 6.2 shows the predicted flood risk change in the immediate surrounds of the Scheme and the locations of six comparison points representing nearby residential, commercial and open space receptors which have been selected for producing tabulated data of the changes to flood depths in Table 6.1.

Figure 6.2: Change in flood depth and extent for the 0.1% AEP 2100 tidal event – immediate surrounds

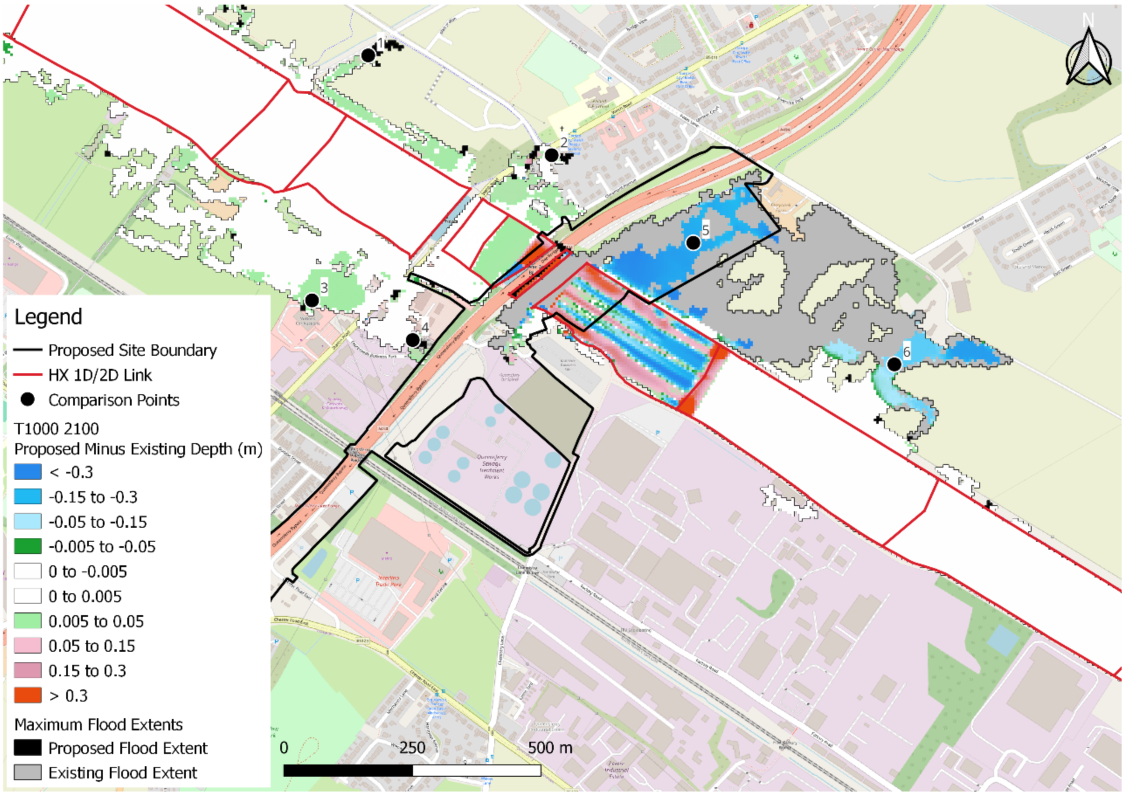


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Table 6.1: Comparison of Existing and Preferred flood levels for 0.1% AEP 2100 tidal event – immediate surrounds

Comparison Point	Existing Model (m)	Proposed Model (m)	Change in depth (m)
1 (open space)	0.027	0.060	0.033
2 (residential)	0.077	0.089	0.012
3 (commercial)	0.106	0.114	0.008
4 (commercial)	0.041	0.050	0.009
5 (open space)	0.297	0.095	-0.202
6 (open space)	**0.186**	**0.096**	**-0.090**

Source: Mott MacDonald, 2025

In areas adjacent to the Scheme, there are large areas that are expected to be flood-free as a result of the redevelopment (see light grey areas on Figure 6.2). In addition, there are notable areas on the right bank where flood depths are also expected to reduce as a result of the redevelopment, as shown by blue areas on Figure 6.2. Table 6.1 shows that flood depths could reduce by up to 0.20m in these areas (Comparison Point 6).

However, and relating to this extreme scenario (0.1% AEP in 2100) only, there are some areas where both flood depths (see light green areas on Figure 6.2) and flood extents (see black areas on Figure 6.2) may increase.

- On the right bank, this effects both residential and open space areas in Garden City. Table 6.1 shows that flood depths could increase by up to 0.01m in residential areas of Garden

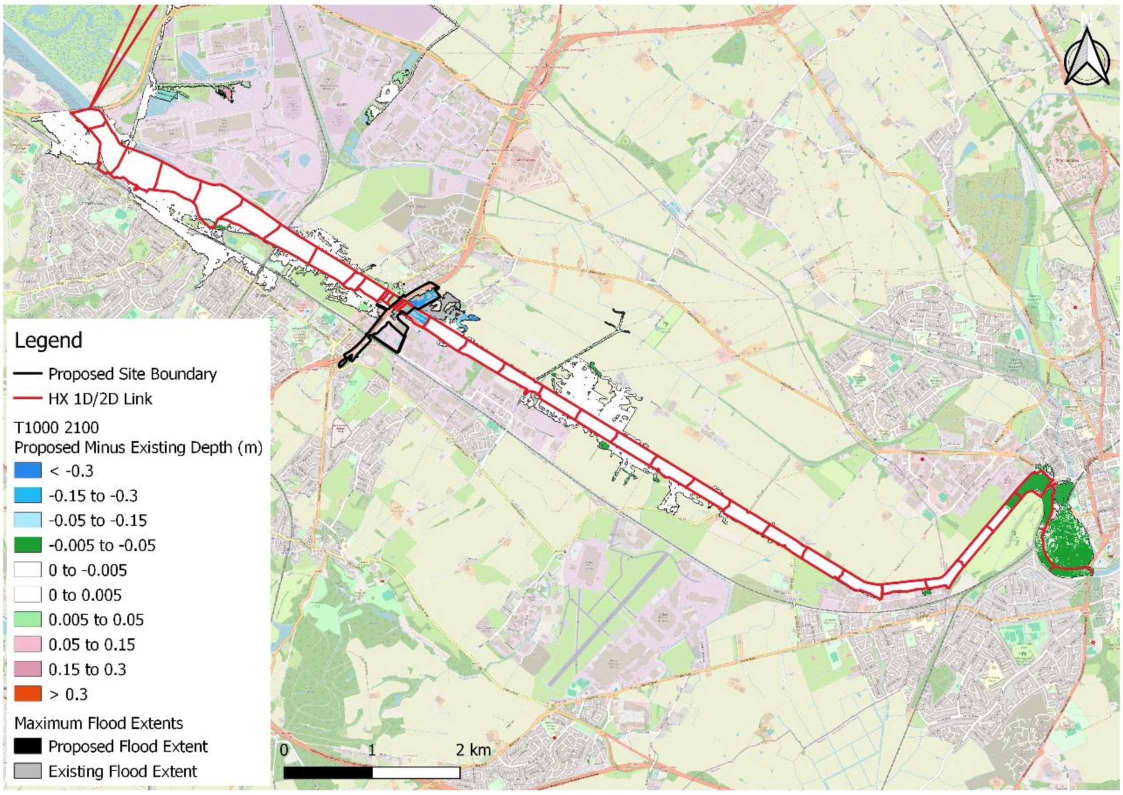
City (Comparison Point 2) and up to 0.03m in water compatible (ditches/swales) open space areas of Garden City (Comparison Point 1).

- On the left bank these changes relate to commercial areas in Queensferry. Table 6.1 shows that flood depths could increase by up to 0.01m in this area (Comparison Points 3 and 4)

Also, within the immediate surrounds of the Scheme, the construction of the proposed new bridge piers within the River Dee is expected to impact water levels within the river, however any backwater effect is predicted to be limited to a 400m reach upstream of the Scheme, as shown in Figure 6.2.

Further away from the Scheme, in all events up to and including the 0.1% AEP 2100, there are largely no changes between pre- and post- development flood extents of depths (see white areas, Figure 6.3). However, flood depths are predicted to be reduced by up to 0.05m in the Chester area. These changes apply in the main to in-channel and in open space areas (see Figure 6.3).

Figure 6.3: Change in flood depth and extent for the 0.1% AEP 2100 tidal event – wider area



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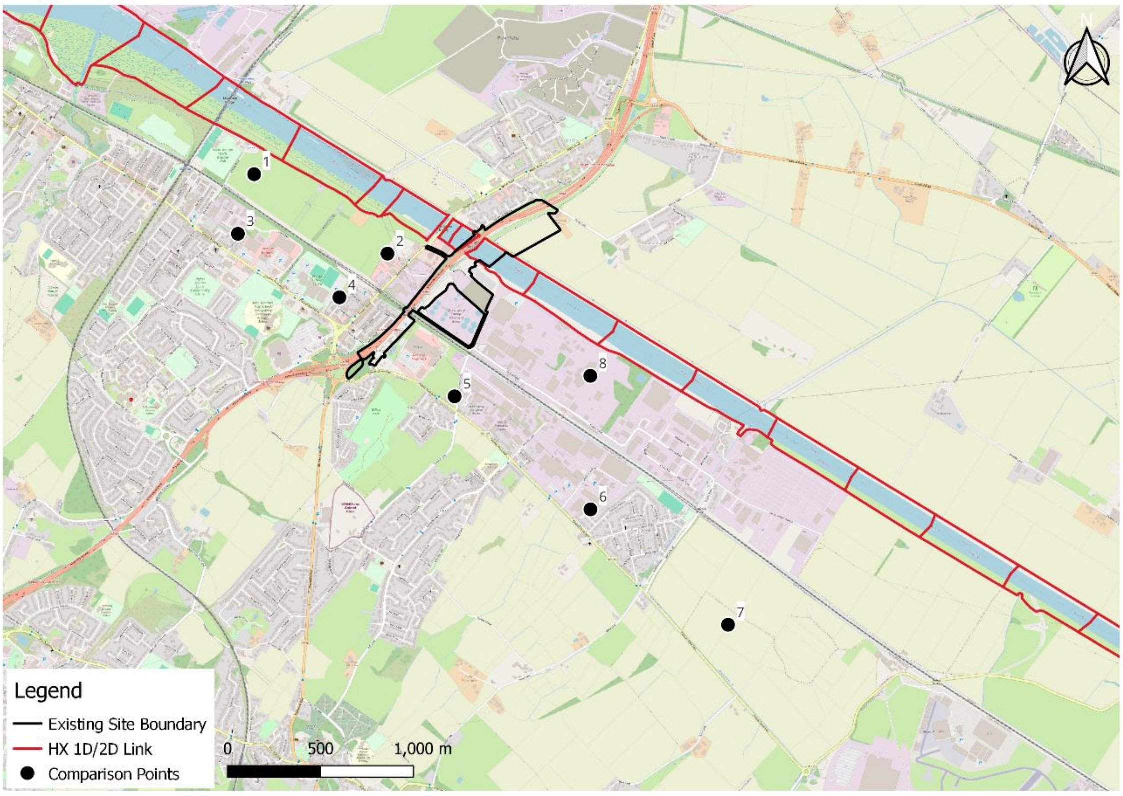
6.2.2.3 Residual risk (tidal breach)

As outlined in Section 5, tidal Breach scenarios 1, 3 and 5 on the left bank of the River Dee show the greatest flood risk impacts relevant to the Scheme, and hence have been taken forward for further assessment here.

Figure 6.4 gives the location of eight points, representing nearby residential, commercial and open space receptors, have been selected for producing tabulated data of the changes to flood depths. Four points are located around the Shotton area and four are located around the Sandycroft area.

Figure 6.4: Comparison Points selected for reporting the impacts of the Scheme in breach scenarios



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The subsequent sections further explore the changes in flood risk that may occur post-Scheme in a breach scenario.

Breach 1

In this scenario, there is an increase in flood depths across Sandycroft and a decrease around Shotton. The change in flood risk can be attributed to the proposed ground levels of the Scheme, which are generally lower and allow a larger exchange of flood water and overland flows between the Shotton and Sandycroft areas.

Under both AEP events, flood depths can be seen to increase by up to 0.12m in Sandycroft. By comparison, flood levels are expected to decrease by less than half of those amounts in areas around Shotton.

These changes are summarised and reported in Table 6.1 and Figure 6.5-6.6.

Table 6.2: Impact of the Scheme on Flood Depth (m) for Tidal Breach 1

0.5% AEP Flood Event				
Location	Comparison Site No	Existing	Post-development	Depth Difference (m) to 2 dp,
Shotton	1 (open space)	1.183	1.172	-0.011
	2 (commercial)	1.409	1.396	-0.013

	3 (residential)	0.710	0.664	-0.046
	4 (residential)	0.888	0.840	-0.048
Sandycroft	5 (commercial)	0.383	0.503	0.120
	6 (residential)	0.166	0.253	0.087
	7 (open space)	0.800	0.900	0.100
	8 (commercial)	No Data	No Data	No Data
0.1% AEP Flood Event				
Location	Comparison Site No	Existing	Post-development	Depth Difference (m)
Shotton	1 (open space)	1.309	1.296	-0.013
	2 (commercial)	1.529	1.514	-0.015
	3 (residential)	0.824	0.780	-0.044
	4 (residential)	1.000	0.954	-0.046
Sandycroft	5 (commercial)	0.440	0.553	0.113
	6 (residential)	0.188	0.303	0.115
	7 (open space)	0.843	0.945	0.102
	8 (commercial)	No Data	No Data	No Data

Source: Mott MacDonald, 2025

Figure 6.5: 0.5% AEP Tidal 2100 Breach One Flood Depth Difference

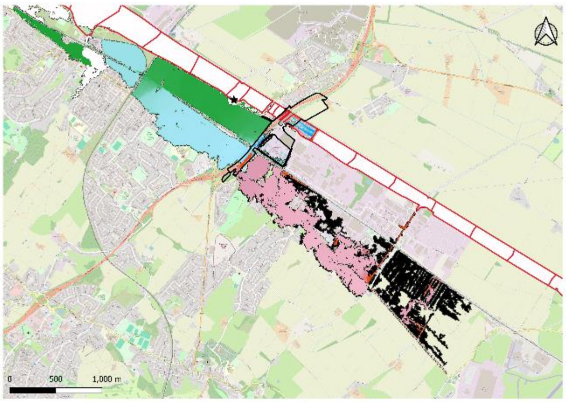
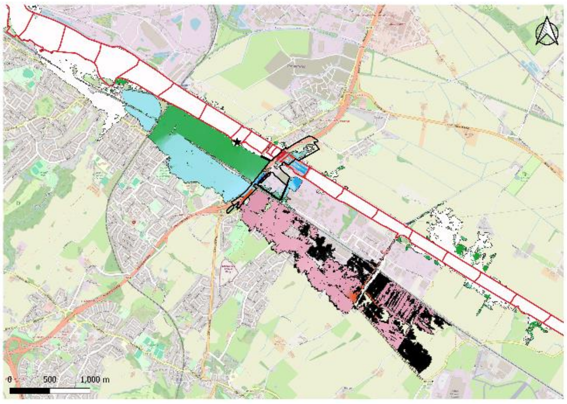
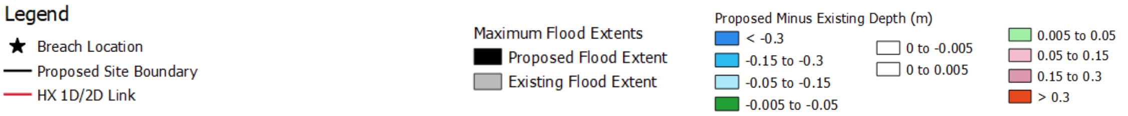


Figure 6.6: 0.1% AEP Tidal 2100 Breach One Flood Depth Difference





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Breach 3

Breach 3 is located upstream of the Scheme, which results in different impacts compared to Breaches 1 and 5. For Breach 3, flood depths increase in areas around Shotton, whilst decreasing in areas around Sandycroft (see Figure 6.7 and 6.8). For Comparison Site 1, relating to Open Space in Shotton, the modelling suggests a 0.08m increase in water levels in the largest (0.1% AEP 2100) event. However, across the majority of other assessed locations, the flood levels are expected to be reduced or show no change.

For the reporting locations, Table 6.3 shows the scale of flood depths differences is smaller than Breach 1 – typically not exceeding +/- 0.02m.

Table 6.3: Impact of the Scheme on Flood Depth (m) for Tidal Breach 3

0.5% AEP Flood Event				
Location	Comparison Site No	Existing	Post-development	Depth Difference (m) 2 dp.
Shotton	1 (open space)	0.114	0.122	0.008
	2 (commercial)	0.473	0.479	0.006
	3 (residential)	No Data	No Data	No Data
	4 (residential)	0.303	0.279	-0.024
Sandycroft	5 (commercial)	0.565	0.553	-0.012
	6 (residential)	0.453	0.443	-0.01
	7 (open space)	1.053	1.055	0.002
	8 (commercial)	0.379	0.376	-0.003
0.1% AEP Flood Event				
Location	Comparison Site No	Existing	Post-development	Depth Difference (m) 2 dp.
Shotton	1 (open space)	0.163	0.242	0.079
	2 (commercial)	0.516	0.539	0.023
	3 (residential)	No Data	No Data	No Data
	4 (residential)	0.339	0.326	-0.013
Sandycroft	5 (commercial)	0.736	0.713	-0.023
	6 (residential)	0.648	0.649	0.001
	7 (open space)	1.173	1.170	-0.003
	8 (commercial)	0.471	0.468	**-0.003**

Source: Mott MacDonald, 2025

Figure 6.7: 0.5% AEP 2100 Breach 3 Depth Difference

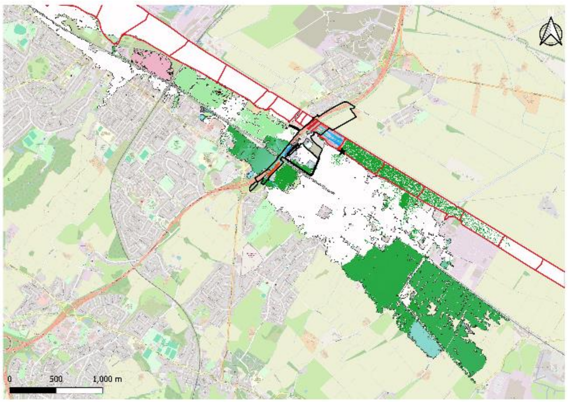
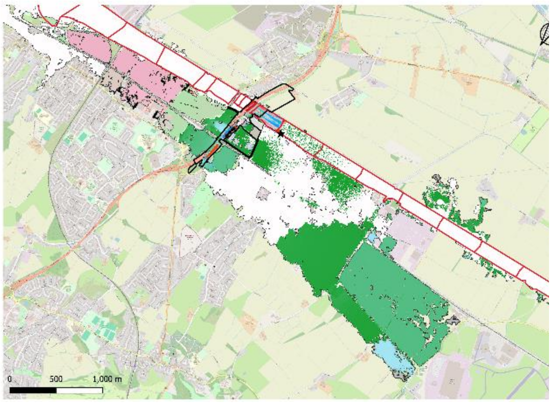
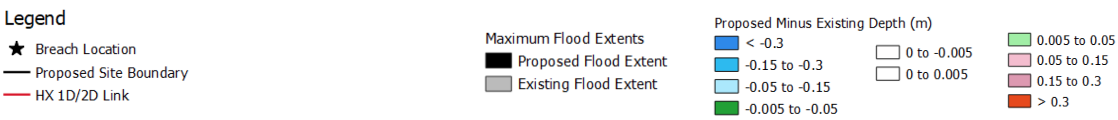


Figure 6.8: 0.1% AEP 2100 Breach 3 Depth Difference





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Breach 5

In this scenario, for both the 0.5% and 0.1% 2100 AEP events, the pattern of changes in flood depth are similar to those in Breach 1, with an increases in flood depths across Sandycroft and a decrease around Shotton in the post-development scenario.

Under both AEP events, flood depths can be seen to increase by up to 0.12m in commercial areas around Sandycroft and 0.15m in residential areas in Sandycroft. By comparison, flood levels are expected to decrease by up to 0.04m in residential areas of Shotton and up to 0.02 m in commercial areas of Shotton.

Table 6.4: Impact of the Scheme on Flood Depth (m) for Tidal Breach 5

0.5% AEP Flood Event				
Location	Comparison Site No	Existing	Post-development	Depth Difference (m)
Shotton	1 (open space)	1.471	1.467	-0.004
	2 (commercial)	1.565	1.553	-0.012
	3 (residential)	0.913	0.887	-0.026
	4 (residential)	1.097	1.065	-0.032
Sandycroft	5 (commercial)	0.444	0.546	0.102
	6 (residential)	0.193	0.307	0.114
	7 (open space)	0.861	0.964	0.103
	8 (commercial)	No Data	No Data	No Data
0.1% AEP Flood Event				
Location	Comparison Site No	Existing	Post-development	Depth Difference (m)
Shotton	1 (open space)	1.638	1.631	-0.007
	2 (commercial)	1.735	1.719	-0.016
	3 (residential)	1.150	1.119	-0.031
	4 (residential)	1.331	1.291	-0.040
Sandycroft	5 (commercial)	0.509	0.623	0.114
	6 (residential)	0.253	0.402	0.149
	7 (open space)	0.944	1.060	0.116
	8 (commercial)	No Data	No Data	No Data

Figure 6.9: 0.5% AEP Tidal 2100 Breach Five Depth Difference

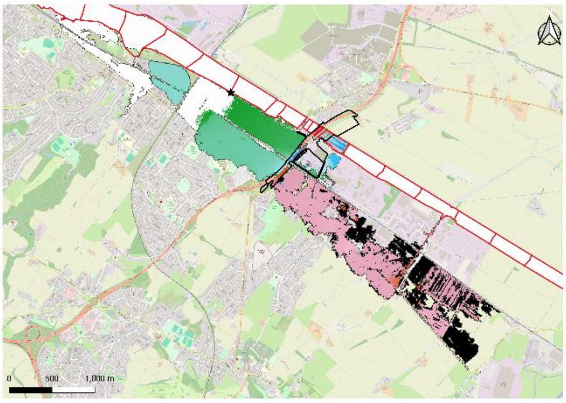
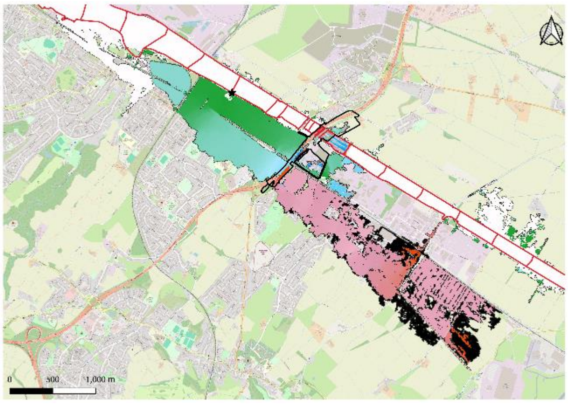
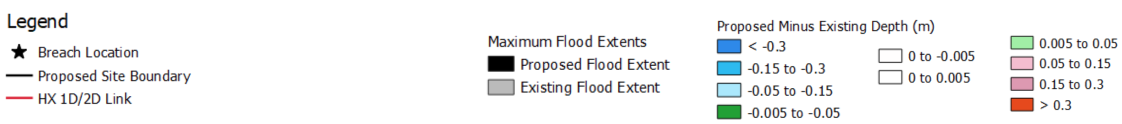


Figure 6.10: 0.1% AEP Tidal 2100 Breach Five Depth Difference





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Summary and analysis of breach analysis

Representative values for post-Scheme changes across 3 breach scenarios are:

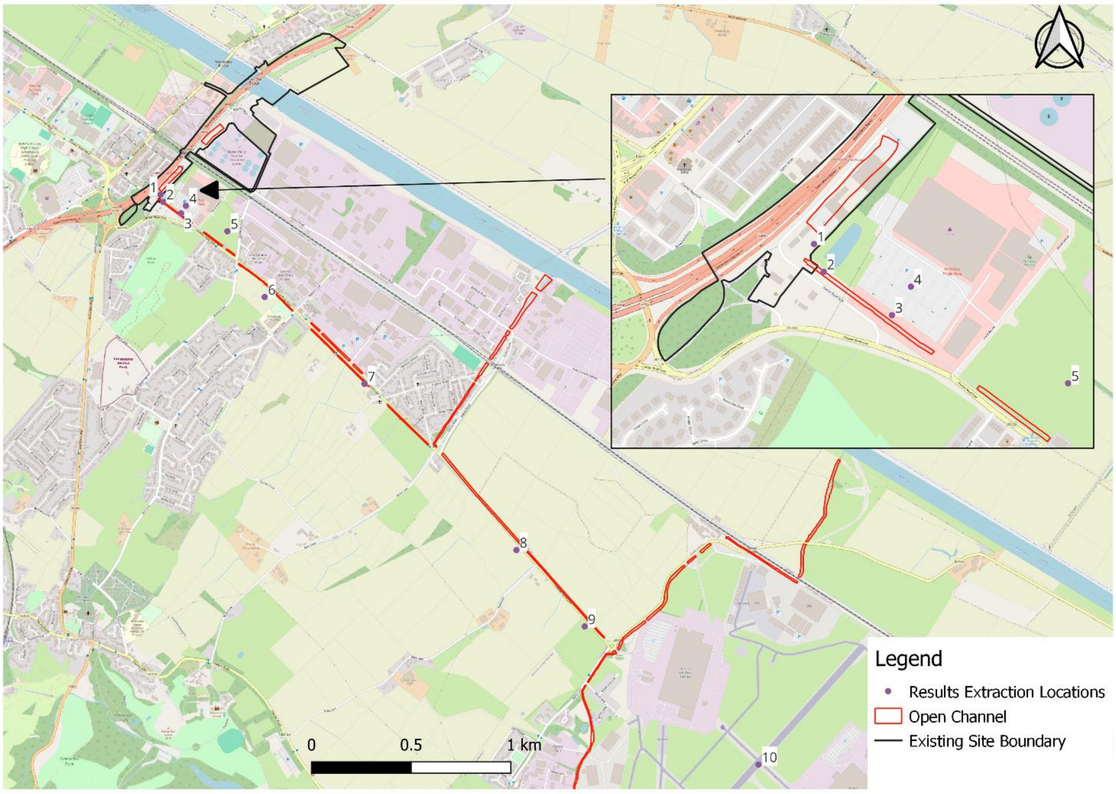
- Breaches 1 and 3 (downstream of the Scheme) appear to be more sensitive to the proposed development.
- The Scheme may result in changes in the order of +0.12m to -0.05m for the 0.5% AEP 2100 event.
- In the most extreme 0.1% AEP 2100 event, the Scheme may result in changes in the order of +0.15m to -0.05m.
- Overall, the occurrence of negative change is greater than positive change for the 8 points reported, and 3 breach scenarios assessed.

It is worth noting that these conditions are only expected the specified 'theoretical' residual risk scenario – where the defences have breached to a width of 50m in locations 1, 3 or 5, and 75 years into the future, with climate change. The results in this assessment are not indicative of any other possible combination of breach scenario factors on the River Dee, which would have different impacts.

6.2.3 Queensferry Drain

Figure 6.11 details the location of ten comparison points representing nearby residential, commercial and open space receptors, have been selected for producing tabulated data of the changes to flood depths. These the entire catchment, up to and including the Airbus facility at Hawarden (Comparison Point 10).

Figure 6.11: Comparison Points selected for reporting the impacts of the Scheme (Queensferry Drain)



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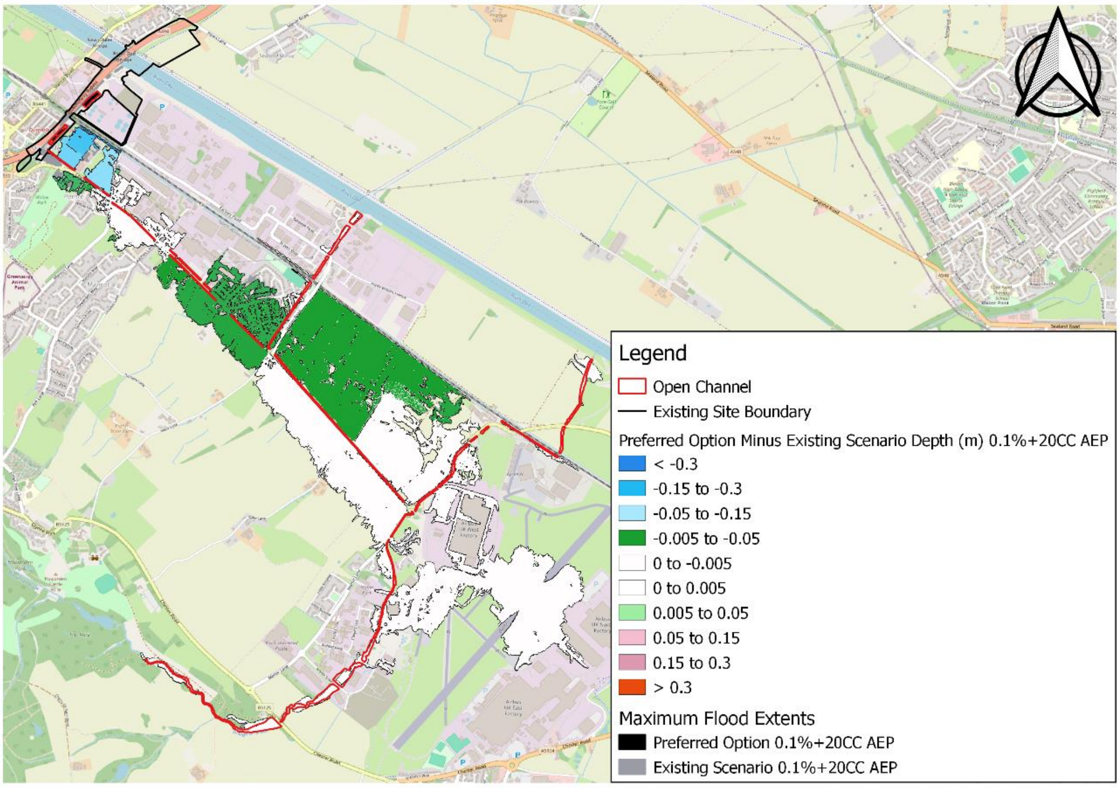
Results for the 0.1% AEP 2100 event are provided in Figure 6.12 and Table 6.5 below and are representative of other return periods, data for which is contained within the Queensferry Modelling Report.

Figure 6.12: Map showing depth difference in the 0.1% AEP 2100 event



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The expected overall trend is for flood depths to reduce across the catchment as a result of the development. The greatest decreases are expected to be immediately adjacent to the Scheme boundary, where a reduction of up to around 0.15m could occur. This trend reduces as you move upstream towards no change. At a mid-point in the catchment, comparison point 7 (residential), the modelling indicates a reduction in water levels of up to 0.01m.

Table 6.5: Comparison of Existing and Preferred Scenario flood levels for 0.1% AEP 2100 event

Comparison Point	Ground Level	Existing Model	Preferred Option Model	Change in depth (m)
1 (commercial)	5.380	5.475	no flooding	-0.092
2 (commercial)	4.230	5.486	5.394	-0.092
3 (commercial)	4.960	5.495	5.407	-0.088
4 (commercial)	4.930	5.495	5.406	-0.089
5 (open space)	4.800	5.509	5.440	-0.069
6 (open space)	5.280	5.636	5.635	-0.001
7 (residential)	4.850	5.255	5.245	-0.010
8 (open space)	4.810	5.472	5.472	0.000

9 (open space)	5.095	5.505	5.505	0.000
10 (commercial)	4.255	4.437	4.437	0.000

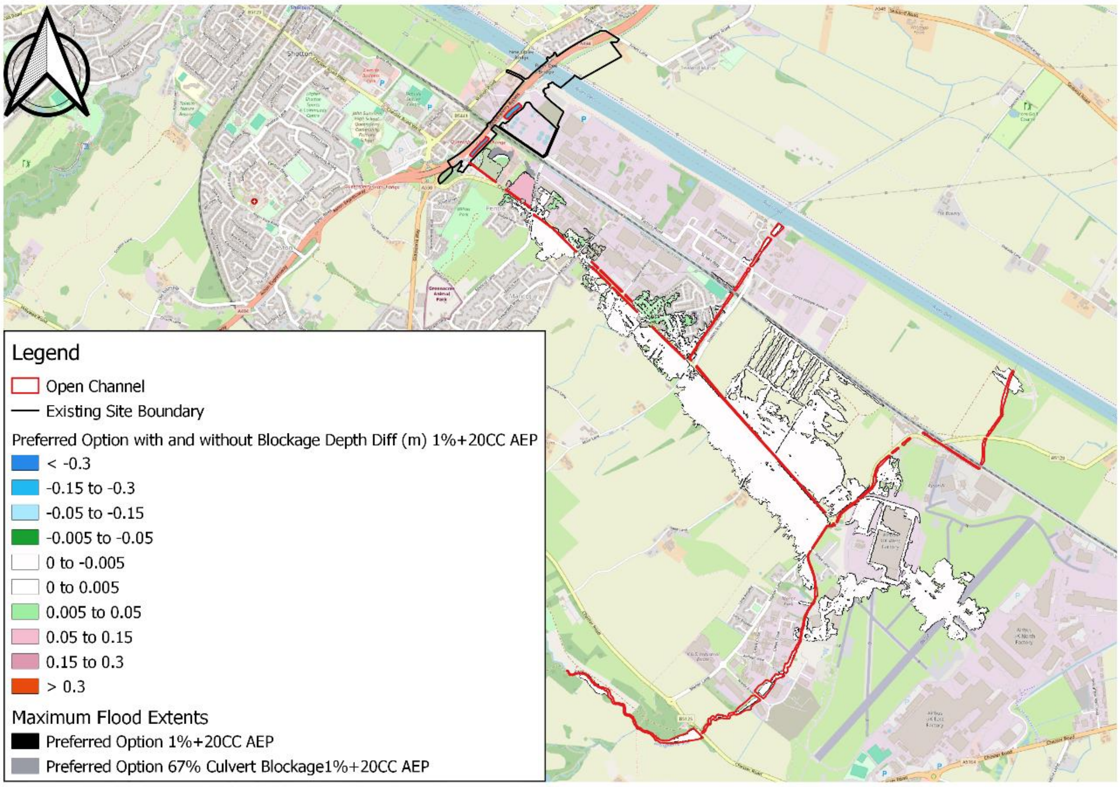
Source: Mott MacDonald, 2025

6.2.3.1 Blockage scenario

Comparing the free flow and blockage scenarios, large areas of the catchment indicate no change in flood depths or extents. However, the modelling does indicate there will be some changes in flood depths close to the Scheme.

Of the locations assessed, Comparison Point 5 (also see pink Figure 6.13), relating to Open Space in Sandycroft, indicates an increase in water level of up to 0.07m for the 1% AEP 2100 event. For Comparison Points 2, 3 and 4, relating to commercial areas in Sandycroft, water levels could increase by up to 0.03m in the 1% AEP 2100 event. However, across the majority of the scheme area, there is no change to flood risk (see white area, Figure 6.13).

Figure 6.13: Map showing depth difference in the 1% AEP 2100 free flowing and 67% blockage events



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

Table 6.6: Comparison of water levels, with and without 67% blockage, for the post-development 1% AEP 2100 flood event

Comparison Point	Sample Point	Ground Level	Existing Model	Preferred Option Model	Change in depth (m)
1 (commercial)	1	5.380	no flooding	no flooding	N/A
2 (commercial)	2	4.230	5.175	5.201	0.026
3 (commercial)	3	4.960	5.185	5.212	0.027
4 (commercial)	4	4.930	5.185	5.212	0.027

5 (open space)	5	4.800	5.190	5.258	0.068
6 (open space)	6	5.280	5.599	5.601	0.002
7 (residential)	7	4.850	5.152	5.155	0.003
8 (open space)	8	4.810	5.447	5.447	0.000
9 (open space)	9	5.095	5.470	5.470	0.000
10 (commercial)	10	4.255	4.288	4.288	0.000

Source: Mott MacDonald, 2025

The above highlights how the consequences of flooding may change in the area due to blockage. In terms of the probability of these structures' blockage, the assessment concludes:

- The proposed diversion of Queensferry Drain, which includes new sections of open channel, new river pumping station and drainage outfall, and two trash screens, will reduce the probability of blockages within the Scheme boundary.
- The Scheme will not affect the chances of existing structures blocking as they are all located upstream of the Scheme extent. They will have the same probability of blocking whether the Scheme proceed or not.

6.2.3.2 Conclusions – no increase in flood risk elsewhere

The assessment of how flood risk elsewhere may change as a result of the development covers the 3 predominant flood sources (River Dee fluvial, River Dee tidal and Queensferry Drain fluvial) in both exceedance (overtopping) and residual (River Dee tidal breach / Queensferry Drain fluvial blockage) scenarios, as required by the TAN.

It is considered that the exceedance (overtopping) scenarios are the appropriate design event for this location, for the following reasons.

- River Dee - the likelihood of a breach occurring in the tidal defences is significantly influenced by defence type, location, condition, ownership and predicted loading. Additionally, once a defence experiences overtopping during a flood event greater than its design standard, unless that defence has been specifically designed to withstand overtopping, the chance of breach markedly increases. Given the high Standard of Protection provided by the River Dee defences, in that;
  - In the vicinity of the Scheme, they are not expected to overtop in the 0.5% AEP with climate change in 2100 event;
  - There is an average of around 0.10m of freeboard between crest levels of the defenced immediate adjacent to the Scheme and the 0.5% AEP 2100 event;
  - The River Dee defences are considered by NRW to be in good and serviceable condition; and,
  - Are strategically important in the area, and likely to be maintained in perpetuity by NRW.

  As such the residual probability of flooding from a breach event is considered to very low, and therefore the exceedance (overtopping) scenario has been adopted as the appropriate design event for River Dee flood sources.

- Queensferry Drain - the likelihood of a blockage is significantly influenced by local factors such as proximity of blocking debris, size of structure, and maintenance regime. Within the Scheme boundary, the proposed works to Queensferry Drain and pumping station will reduce the probability of blockage in this location. The Scheme will not affect the probability other existing structures blocking as they are all located upstream of the Scheme. Therefore, the probability of a blockage occurring at or adjacent to the Scheme is considered to very low, and therefore the free-flowing (no blockage) scenario has been adopted as the appropriate design event for Queensferry Drain flood sources.

In line with this, in terms potential increase in flood risk elsewhere, the assessment concludes:

- River Dee fluvial – no increase in flood risk elsewhere, as the Scheme only impacts water levels within the River Dee and Fitchett's Gutter river channels.
- River Dee tidal – flood extents and depth may increase, by up to 0.01m in residential areas of Garden City, up to 0.03m in water compatible open space areas of Garden City and by up to 0.01m in commercial areas of Queensferry.
- Queensferry fluvial - no increase in flood risk elsewhere. The expected overall trend is for flood depths to reduce across the catchment as a result of the development. Immediately adjacent to the Scheme boundary, a maximum reduction of up to around 0.15m is expected.

The assessment shows that in the majority of cases, the Scheme is not expected to cause nor increase the frequency of flood risk elsewhere. Therefore, the impacts of this redevelopment are considered to be consistent with the acceptability considerations in section 11 of TAN15. The assessment has identified a potential increase in flood risk for one source (River Dee tidal) in one event (0.1% AEP 2100). For flood risk sensitive receptors, the expected increase in flood depths this scenario is 0.01m. Flood models are only representation of predicted conditions, and there are industry-accepted inherent uncertainties associated with flood estimation which should be taken into account when considering flood risk change, especially when the change is small. Notwithstanding this, the magnitude, spatial and temporal scale of the increases reported are not considered to pose an unmanageable risk to receptors elsewhere. Therefore, no further mitigations to manage this impact are proposed.

6.3 Occupiers aware of flood risk

As a highway infrastructure project, there are no 'occupiers' of the Scheme.

NMWTRA is a member of the North Wales Local Resilience Forum (LRF), other members include the regional emergency services and local principal councils. As a member, NMWTRA is included within the Regional Flood Advisory Service response structure and receives timely and detailed information on likely flooding conditions. This enables NMWTRA and the other members of the North Wales LRF to manage the consequences of flooding incidents collectively. NMWTRA also receives other products from the Flood Forecasting Centre and the Met Office for this area.

The NRW online maps indicate that the Scheme is located within the 'Hawarden Embankment' (River Dee left/south bank) and "Northern Embankment" (north/right bank) Flood Warning Areas and the 'North Wales Coast' Flood Alert Area. It should be noted that these flood warnings cover only tidal and fluvial flooding from the River Dee and there are no flood warnings in place for fluvial flooding from the Queensferry Drain. NMWTRA receives flood warnings and alerts from NRW.

6.4 Escape/evacuation routes present

The modelling has indicated that, up to and including the 0.1% AEP 2100 event, the new road and bridge will not be affected in an exceedance (overtopping) event. Flood water is only expected on the new road and bridge as a residual risk (breach event). In a breach event, flood depths could exceed 1m and velocities be greater than 1 m/s. In these conditions, hazard to people classification would be 'Danger for all' under this scenario at the Scheme, which indicates that parts of the road will be unsafe for even Emergency Services.

Procedures, roles and responsibilities, and triggers for evacuating the Scheme, will be clearly set out in the local contingency plan, as flooding is included as part of the over-arching contingency plan for highway incidents. NWMTRA would, where possible, prevent vehicles approaching the affected area through closures and diversions; clear signage of a diverted route would minimise risk to motorists. If required, any evacuation would be undertaken under the management and guidance of the highway authority or emergency services as appropriate. The emergency services will be able to gain access/egress to stranded vehicles via unflooded section of the hard shoulder. Road users would be directed to turn around within the carriageway and evacuate away from the flooded section of carriageway from the same direction that they approached the area via sections of the A494 outside of the flood extents.

A Vehicle Management System (VMS) is being considered, which could advise motorists that the A494 is closed and divert vehicles onto alternative routes which would reduce the number of vehicles approaching the section of carriageway which could be at risk of flooding.

6.5 Flood emergency plans and procedures agreed and in place

Whilst there is no dedicated Flood Emergency Plan in place, there is a local contingency plan, which outlines procedures for westbound, eastbound, and full closures in both directions. This will be reviewed and updated once the Scheme is operational in consultation with the LLFA, Highways England and local stakeholders.

NMWTRA receives flood warnings and alerts from NRW. These alerts are issued for the general area and are not specific to the A494. In the event of a credible risk of flooding affecting the A494, a multi-agency Tactical / Strategic Coordination Group meeting would likely be convened to assess and respond to the situation.

6.6 Flood resistant and resilient design

TAN15 guidance encourages the incorporation of flood resilient construction measures within new developments to mitigate against flooding. Flood resilient infrastructure is designed and constructed to reduce the impact of floodwater so that no permanent damage is caused, and the infrastructure can be returned to normal use as quickly as possible following a flood event.

The proposed levels of the new carriageway are maximised within the constraints of the site topography and the need to tie-in with the existing carriageway levels. As a result, flood water is only expected on the Scheme as a residual risk (breach event).

Highway construction is relatively resilient to floodwater compared to other types of infrastructure; however it can be damaged by floodwaters. Given the criticality of the road, after a flood event, the road will need to be inspected, repaired where necessary, cleaned and returned to use quickly after a flooding event.

With respect to the new Queensferry Drain pump station, this will be designed with electrics and control kiosks located above floodwater levels to ensure that they remain operational and maintainable during times of flooding.

6.7 Summary

The development has been assessed against the Acceptability Criteria as outlined in Section 11 of TAN15, and summary is presented in Table 6.7. As required by the TAN, any redevelopment proposals should be consistent with the acceptability considerations in section 11.

Table 6.7: Assessment of Acceptability Criteria

TAN-15 Acceptability Criteria	Consistent / met criteria	Comments
No increase in flooding elsewhere	Consistent	Given the high Standard of Protection provided by the River Dee defences, it is considered that the exceedance (overtopping) scenario is the appropriate design event for the River Dee. In these scenarios: ● River Dee fluvial - minimal impact on the water levels within the River Dee channel immediate upstream of the Scheme, further upstream of the scheme towards Chester and at Fitchett's Gutter, west of Chester. These changes are expected to affect water levels inside those channels only. ● River Dee tidal - isolated 'was dry now wet' spots at Garden City and Queensferry. Maximum flood depth increases of less than 0.03m (water compatible open spaces) and 0.01m (flood risk sensitive receptors) ● Queensferry Drain - expected overall trend is for flood depths to reduce across the catchment. As required by the TAN, the FCA also assesses residual risk (breach and blockage). In the breach scenarios, the Scheme would affect the exchange of flood water flow between the Shotton and Sandycroft areas. The occurrence of negative change (benefit) is greater than positive change (detriment) for the eight location points assessed, however peak flood levels in some areas may increase by up to 0.15m. For Queensferry Drain blockage assessment, the consequence of flooding would vary between free-flowing and 67% blockage scenarios. Across most of the catchment flood risk change is considered to be nil or negligible. However, in Open Space in Sandycroft, there could be a 0.07m increase in flood levels in the 0.1% AEP 2100 event.
Occupiers aware of flood risk	Met	As a highways infrastructure project, there are no 'occupiers' on the Scheme. NMWTRA is a member of the North Wales LRF and receives flood warnings and alerts from NRW.
Escape / evacuation routes present	Met	Flood water is only expected on the new road and bridge as a residual risk (breach event) and in this scenario the hazard to people classification would be 'Danger for all' which indicates that parts of the Scheme would be unsafe for even Emergency Services. NWMTRA would, where possible, prevent vehicles approaching the affected area through closures and diversions. If required, any evacuation would be undertaken under the management and guidance of the highway authority or emergency services as appropriate A Vehicle Management System (VMS) is being considered, which could advise motorists that the A494 is closed and divert vehicles onto alternative routes which would reduce the number of vehicles approaching the section of carriageway which could be at risk of flooding.
Flood emergency plans and procedures are agreed and in place	Met	Flooding is included as part of the over-arching contingency plan for highway incidents. This sets out flood emergency plans and procedures. This will be reviewed and updated once the Scheme is operational in consultation with the LLFA, Highways England and local stakeholders.

TAN-15 Acceptability Criteria	Consistent / met criteria	Comments
Flood-resistant and resilient design	Met	Highway construction is relatively resilient to floodwater compared to other types of infrastructure however after a flood event, the road will need to be inspected, repaired where necessary, cleaned and returned to use quickly after a flooding event. With respect to the new Queensferry Drain pump station, this will be designed with electrics and control kiosks located above floodwater levels to ensure that they remain operational and maintainable during times of flooding.
Acceptable consequences for the type of use - Section 11.7-11.8	Consistent	The required design standard for less vulnerable development is to be flood free during the 1% AEP fluvial and the 0.5% AEP tidal event, incorporating an allowance for climate change over the lifetime of development. These are not met for River Dee Tidal flooding, in either overtopping (exceedance) or residual risk (breach) scenarios. As permitted by the TAN, the above criteria can be more flexibly applied for redevelopment. The development proposals provide betterment when compared with existing and the proposed levels of all built infrastructure are maximised as far as reasonably practicable within the constraints of the Scheme.
Acceptable consequences for the type of use - Section 11.9-11.11	Consistent	For less vulnerable development, the maximum depth of flooding on site in extreme conditions should not exceed 600mm and velocity of flood waters should not exceed 0.15 m/s. Exceedance of the tolerable conditions under extreme event flood conditions is only expected in discrete, water-compatible areas e.g. the location of the proposed new Queensferry Ditch inlet; and in residual flood risk scenarios – i.e. where the defences have breached. The TAN recognises that each site should be considered individually, and a judgement taken in the context of the circumstances which could prevail at the Scheme. The assessment concludes that proposed levels of the new carriageway are already maximised at this location and via implementation of an updated Local Contingency Plan, flood risk for these extreme future climate change events can be adequately managed and is acceptable to the owner and maintainer of the Scheme (NMWTRA).

Source: Mott MacDonald, 2025

As summarised above, the evidence and assessments contained within this FCA confirm that the redevelopment has predominantly met or is consistent with the acceptability considerations in section 11 of TAN15.

7 Drainage Statement

The Highway Drainage Developed Design Strategy Report, ref. 395318-MMD-00-XX-RP-D-0007 details the existing area, the current drainage arrangements and proposed drainage design. The Scheme lies on Previously Developed (brownfield) and the drainage strategy identifies existing hardstanding of approximately 23,480m² will be redeveloped into new permeable areas totalling approximately 24,690m² (and net increase of approximately 1,210 m²).

The drainage design will include the following SuDS drainage features:

- Vegetated open channel (approx. 158 metres)
- Vegetated open channel (approx. 130 metres)
- Swale (approx. 250 metres)

As well as the following regular drainage features:

- New lengths of Daisy Bank Farm and Queensferry Drain culverts
- No.13 inlet headwalls into the swale
- No.10 headwalls for watercourse and swale extents
- Carrier pipes, manholes, gullies, combined kerb drainage units
- Trash screen in the culvert inlet upstream of the pumping station
- Penstock control chambers
- Vortex separator chamber

The proposed surface water drainage strategy has been developed into an appropriate detailed SuDS drainage design, based upon the constraints of the Scheme, and the proposed design does not increase flood risk elsewhere. Section 7 of TAN15 has therefore been satisfied.

8 Conclusions and recommendations

8.1 Conclusions

The predominant sources of flood risk for the Scheme are from tidal and fluvial sources; namely the River Dee (tidal and fluvial), and Queensferry Drain (fluvial). The Scheme benefits from substantial flood defences alongside the River Dee, that offer a good standard of protection and are strategically important in the area, so likely to be maintained in perpetuity by NRW.

This redevelopment secures this critical link between north Wales and England and is identified in the LDP. The Scheme is therefore considered justifiable in accordance with the principles set out in section 8 of TAN15.

The evidence and assessments contained within this FCA confirm that the redevelopment has predominantly met, or is consistent with, the acceptability considerations in section 11 of TAN15, as summarised below:

- The required design standard for less vulnerable development is for it to be flood free during the 1% AEP fluvial and the 0.5% AEP tidal events, incorporating an allowance for climate change over the lifetime of development. This is not met for River Dee Tidal flooding however, as permitted by the TAN, these criteria can be more flexibly applied for redevelopment, which applies to this Scheme. The FCA concludes that the Scheme would provide betterment when compared with existing, and the proposed levels of all built infrastructure are maximised as far as reasonably practicable.
- For less vulnerable development**,** under extreme event flood conditions, the maximum depth of flooding should not exceed 600mm and velocity of flood waters should not exceed 0.15 m/s. Exceedance of these conditions is only expected in discrete, water-compatible areas e.g. the location of the proposed new Queensferry Ditch inlet; and in residual flood risk scenarios – i.e. where the defences have breached. TAN 15 allows for judgement taken in the context of the circumstances which could prevail at the Scheme. The assessment concludes that proposed levels of the new carriageway are already maximised at this location and via implementation of an updated Local Contingency Plan, flood risk for these extreme future climate change events can be adequately managed and is acceptable to the owner and maintainer of the Scheme (NMWTRA).
- The owner of the Scheme (NWMTRA) is aware of the scale and nature of flood risk posed to the Scheme, evacuation routes are present, and plans and procedures will be updated and in place prior to use, minimal risk to life to people living and working in the area.
- The redevelopment will be resilient to flooding for the duration of its lifetime, and can be inspected, repaired, cleaned and returned to use quickly after a flooding event, minimising disruption to people living and working in the area. The new Queensferry Drain pump station will be designed with electrics and control kiosks located above floodwater levels so that they remain operational and maintainable during times of flooding.
- In the majority of cases, the Scheme is not expected to cause nor increase the frequency of flood risk elsewhere. Furthermore, with respect to Queensferry Drain flood risk, the expected overall trend is for flood depths to reduce across the catchment. However, in relation to River Dee tidal sources, in the extreme 0.1% AEP 2100 event only, the hydraulic modelling completed for the Scheme predicts increases in flood levels in areas of Garden City and Queensferry. Maximum flood depth increases are predicted to be less than 0.03m (water compatible open spaces) and 0.01m (flood risk sensitive receptors). The magnitude, spatial and temporal scale of the increases reported are not considered to pose an unmanageable risk to receptors. Therefore, no further mitigations to manage this impact are proposed.

- The proposed surface water drainage strategy has been developed into an appropriate detailed SuDS drainage design, based upon the constraints of the Scheme, and the proposed design does not increase flood risk elsewhere. Section 7 of TAN15 has therefore been satisfied.

The FCA provides a full understanding of the potential risks and consequences, and sufficient information to consider flooding implications and to balance them against other considerations. The Scheme design delivers a development that is considered safe and there is minimal risk to life or disruption to people living and working in the area. The FCA demonstrates that flood risk can be managed within acceptable limits, and there is no reason from a flood risk standpoint not to proceed.

8.2 Recommendations

The assessment has identified the following activities, or further works will be required in relation to flood risk matters:

- Prior to the Scheme being operational, the local contingency plan should be updated with flood risk procedures, roles, responsibilities, and triggers for evacuating.
- The Environmental Permitting (England and Wales) Regulations 2016 require a Flood Risk Activity Permit (FRAP) is obtained for any works in, over, under or adjacent to Main Rivers.

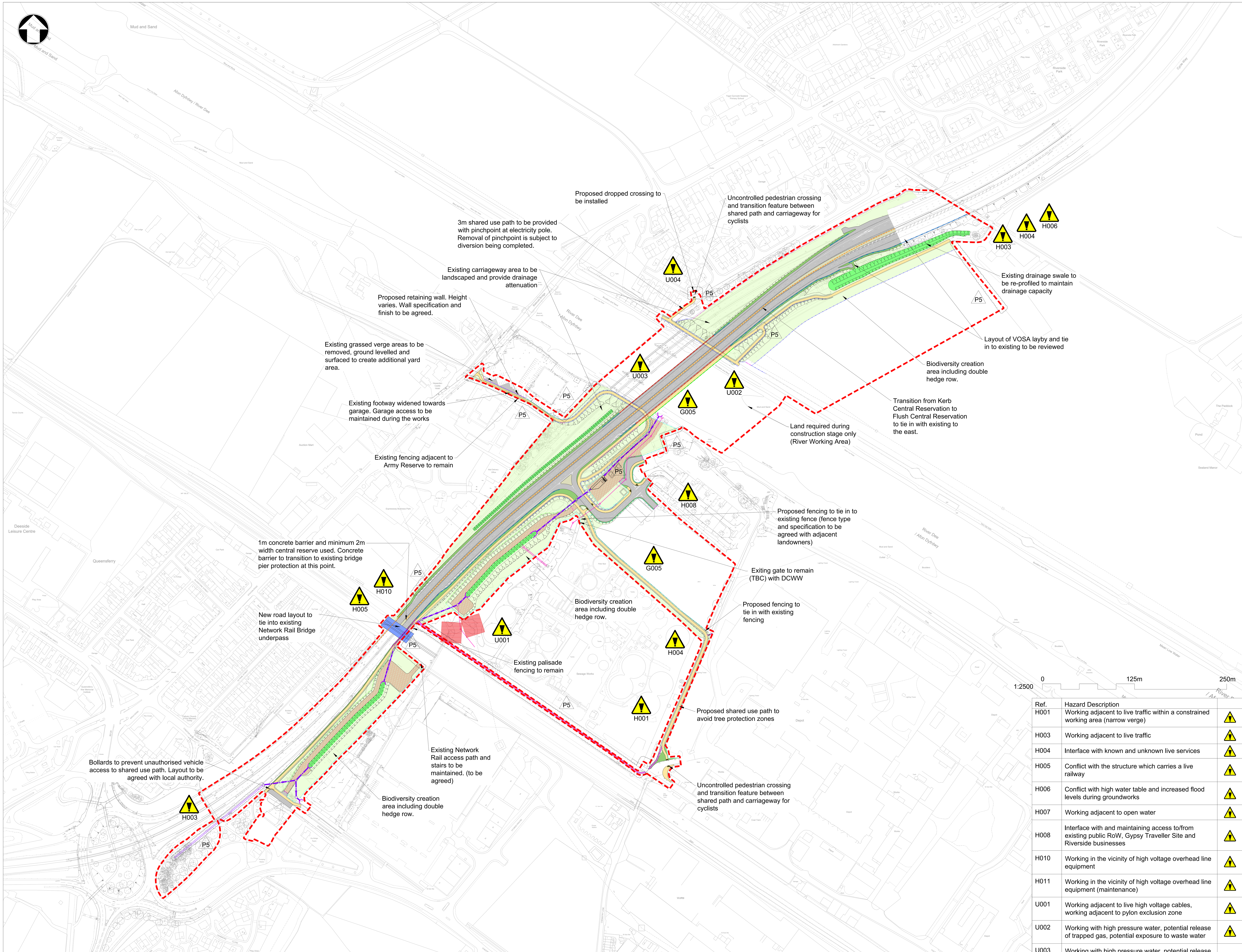
Appendices

A. Topographic survey


MOLD
Q'FERRY
CONWY
B'HEAD

B. General arrangement of proposed development

Drawing number 395318-MMD-00-XX-DR-C-0002-A1 2



RESIDUAL RISK ASSESSMENT
Wherever possible, risk is designed out of this proposal during the design process. Where this is not practicable, the risk will be minimised and any residual significant risk will be noted and indicated by the symbol. Refer to discipline specific risk management schedule, document number XXX

C:\users\pro83318\appdata\local\projectwise\workdir\mott-gb-pw-03\dms27384\395318-MMD-00-XX-DR-C-0002.dwg Aug 12, 2025 - 1:31PM
PRO83318

Ref.	Hazard Description
H001	Working adjacent to live traffic within a constrained working area (narrow verge)
H003	Working adjacent to live traffic
H004	Interface with known and unknown live services
H005	Conflict with the structure which carries a live railway
H006	Conflict with high water table and increased flood levels during groundworks
H007	Working adjacent to open water
H008	Interface with and maintaining access to/from existing public RoW, Gypsy Traveller Site and Riverside businesses
H010	Working in the vicinity of high voltage overhead line equipment
H011	Working in the vicinity of high voltage overhead line equipment (maintenance)
U001	Working adjacent to live high voltage cables, working adjacent to pylon exclusion zone
U002	Working with high pressure water, potential release of trapped gas, potential exposure to waste water
U003	Working with high pressure water, potential release of trapped gas, potential exposure to waste water, working at height
U004	Working with high voltage cables
U005	Exposure to asbestos fibres
G005	Working in contaminated land areas

Refer to DHEMR for full hazard description (395318-MMD-00-XX-RP-U-0004).

Notes

1. This drawing details the current Developed Design at Key Stage 3 of Welsh Government's Linear Stage Approval Process and is subject to further detail design development.
2. This drawing is to be read in conjunction with all other related Mott MacDonald and RML drawings and specifications.
3. Unless otherwise stated all dimensions are in metres and all levels are in metres Above Ordnance Datum (AOD).
4. Information on this drawing is based on topographical data received from PM Surveys 2018 for the site area and OS mapping data for all other areas.
5. Proposed embankments shown are 1:2 slope for fill and 1:3 slope for cut (subject to confirmation in the Geotechnical Design Report). Extents of embankments shown are subject to further rationalisation and development.

Key to symbols

- Proposed Site Boundary
- Proposed Shared use cycle track (for use by cyclists and pedestrians)
- Proposed carriageway
- Central Reservation
- Soft Estate (Refer to Environmental Master Plans for details)
- Soft Verge
- Proposed footpath
- Rail Bridge Deck
- Proposed drainage swale/open channel
- Proposed maintenance access road / compound area
- Proposed Gate
- Proposed 400x400mm Buff Tactile Paving
- Proposed Palisade Fence
- Proposed Paladin Fencing
- Proposed Railing Fence
- Proposed Post and Rail Fence
- Proposed Noise Barrier - Subject to EIA
- Proposed H2W1 Concrete VRS
- Proposed H4bW2 Concrete VRS with railing (min 1400mm high)
- Proposed N2W2 Steel VRS
- Proposed N2W3 Bridge Parapet
- Proposed Class 3C Pedestrian Parapet
- Proposed Culvert
- Existing Retained Culvert
- Proposed Drainage Headwall including retaining feature at connection to ditch
- 10m Construction Exclusion Zone to Face of Pylons
- Proposed Retaining Wall
- Proposed Bollard
- Proposed diverted Welsh Water outfall pipe - details TBC by Welsh Water

Rev	Date	Drawn	Description	Ch'k'd	App'd
P05	12/08/25	EP	Updated alignment and boundary	SH	GM

Status Stamp
NOT FOR CONSTRUCTION

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North & Mid Wales Trunk Road Agent
Yn gweithio ar ran Llywodraeth Cymru
Working on behalf of the Welsh Government

Title
A494 River Dee Bridge Replacement Scheme
Developed Design
Highways General Arrangement

Designed	B.Bowers	BB	Eng check	S.HORSFALL	SH
Drawn	E.PROBERT	EP	Coordination	G.MORGAN	GM
Dwg check	S.HORSFALL	SH	Approved	G.MORGAN	GM

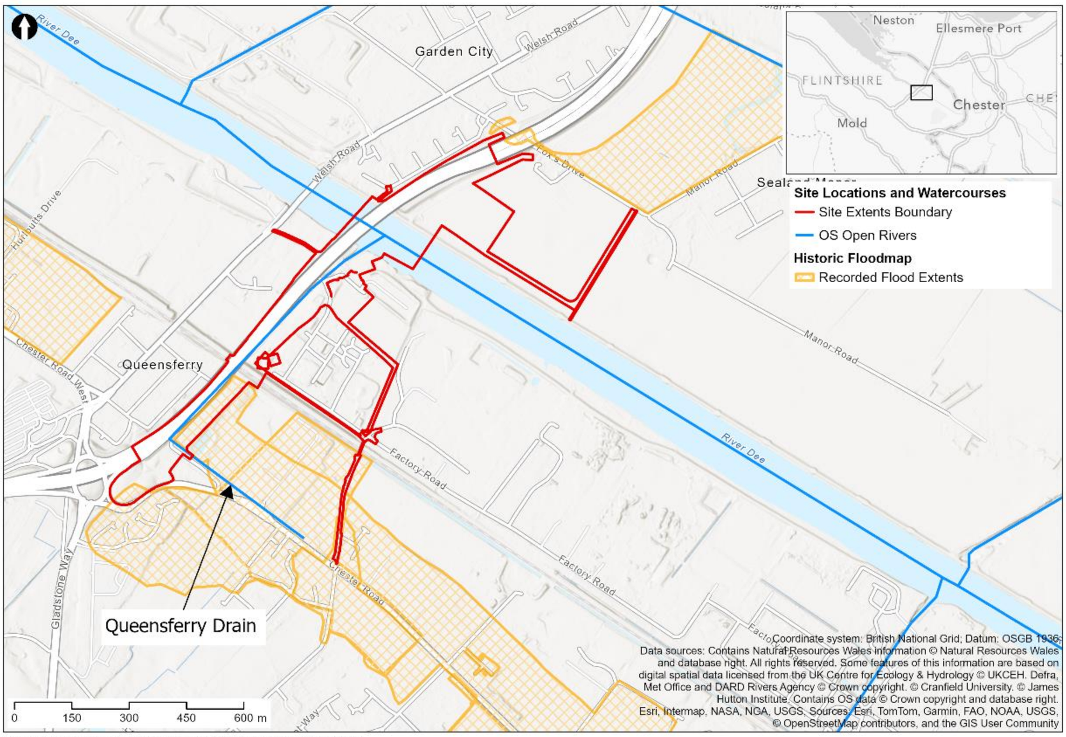
MMD Project Number	Scale at A1	Security
395318	1:2500	Rstd

Suitability Description	Suit. Code
Suitable for Information	S2

Drawing Number	Revision
395318-MMD-00-XX-DR-C-0002	P05

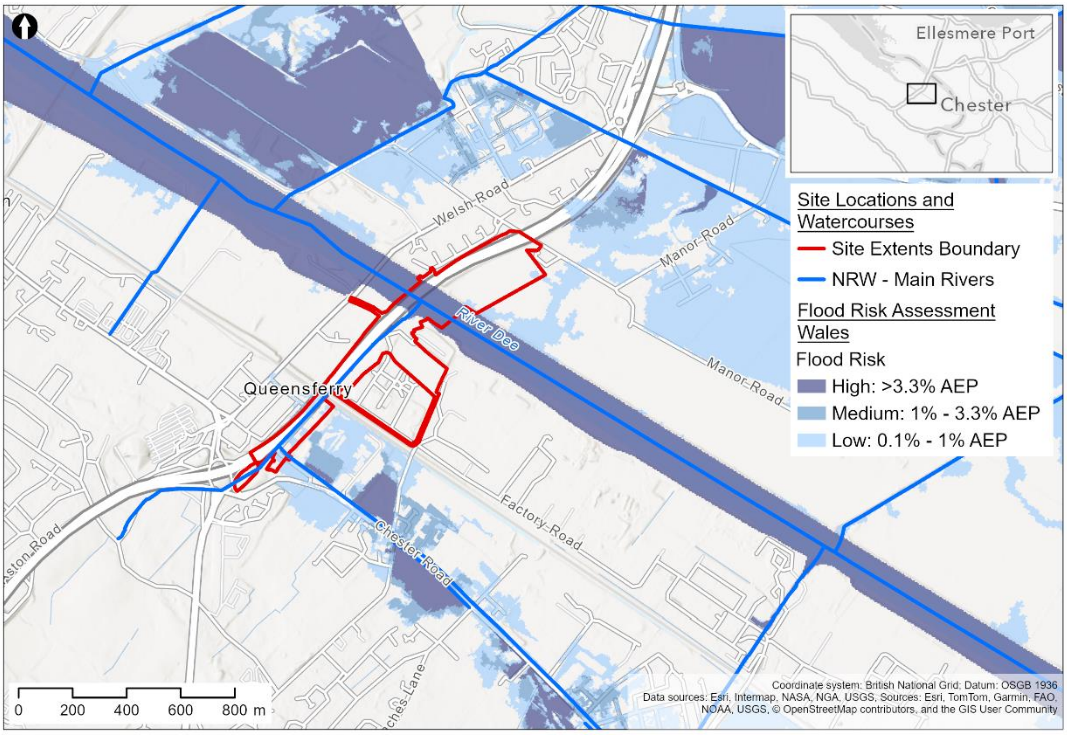
C. Initial assessment – mapping

C.1 Recorded flood extents



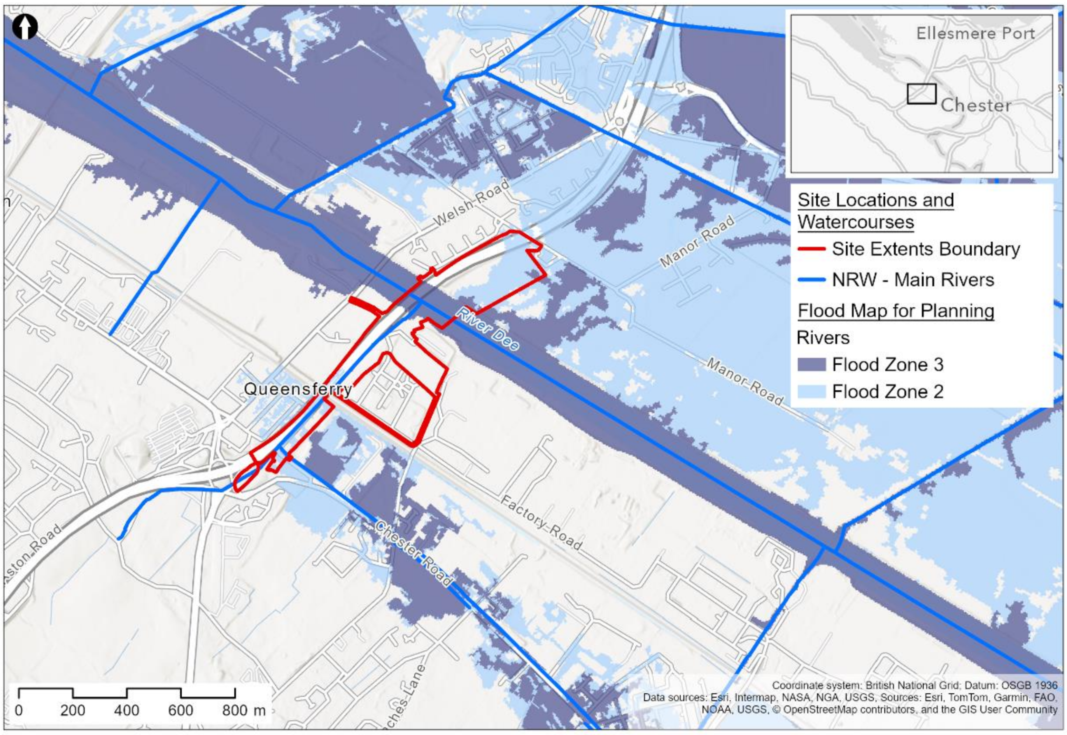
A494 River Dee Bridge Replacement | Recorded Flood Extents | 17 Jun 2025

C.2 Flood Risk Assessment Wales (FRAW) – Rivers



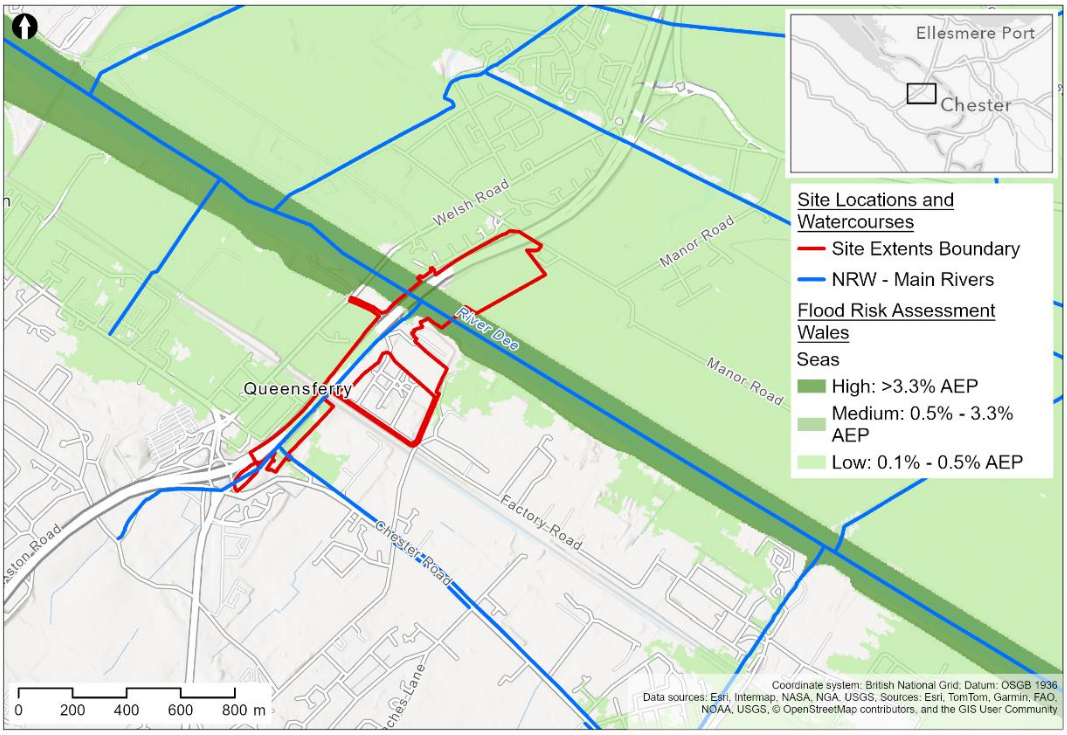
A494 River Dee Bridge Replacement | Flood Risk Assessment Wales | 22 Jul 2025

C.3 Flood Map for Planning (FMfP) – Rivers



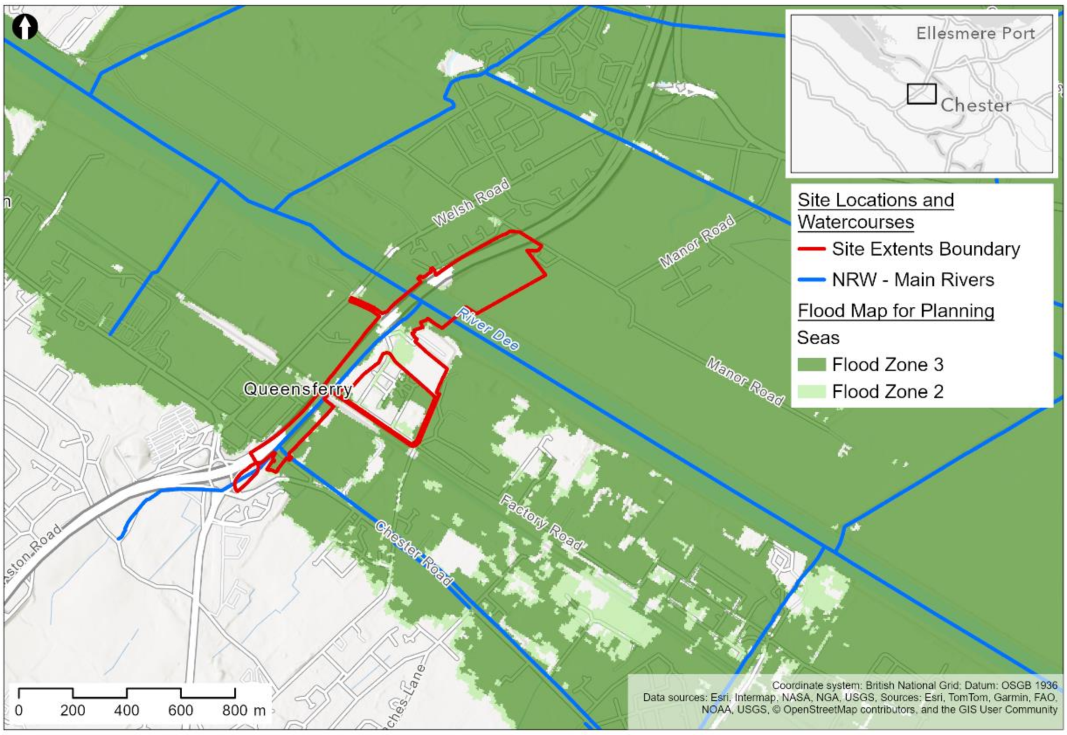
A494 River Dee Bridge Replacement | Flood Map for Planning | 22 Jul 2025

C.4 Flood Risk Assessment Wales (FRAW) – Seas



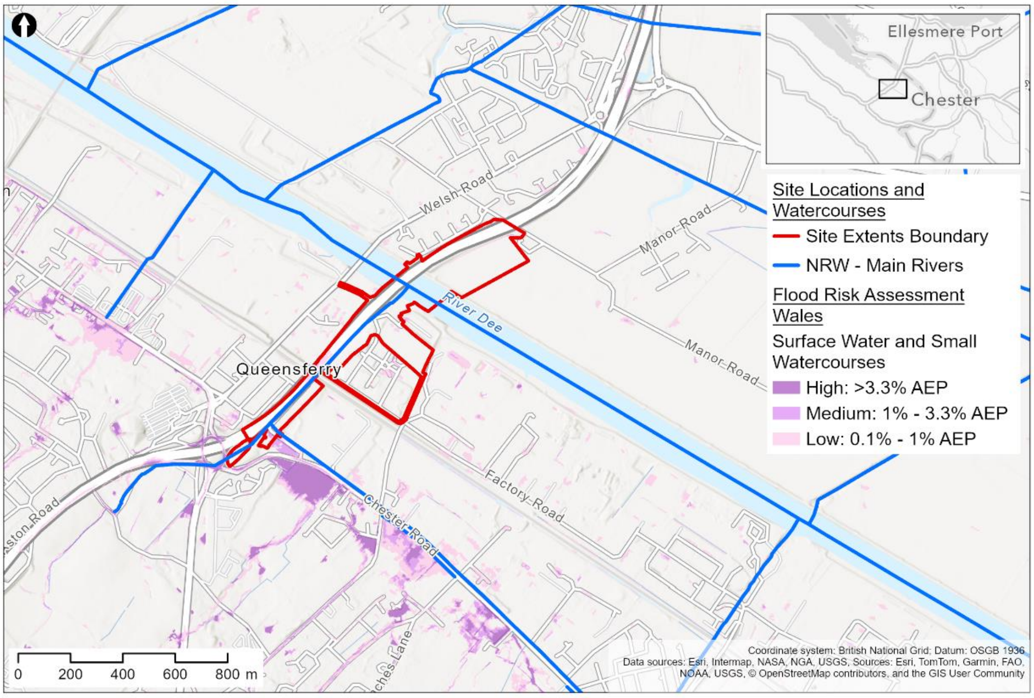
A494 River Dee Bridge Replacement | Flood Risk Assessment Wales | 22 Jul 2025

C.5 Flood Map for Planning (FMfP) – Seas



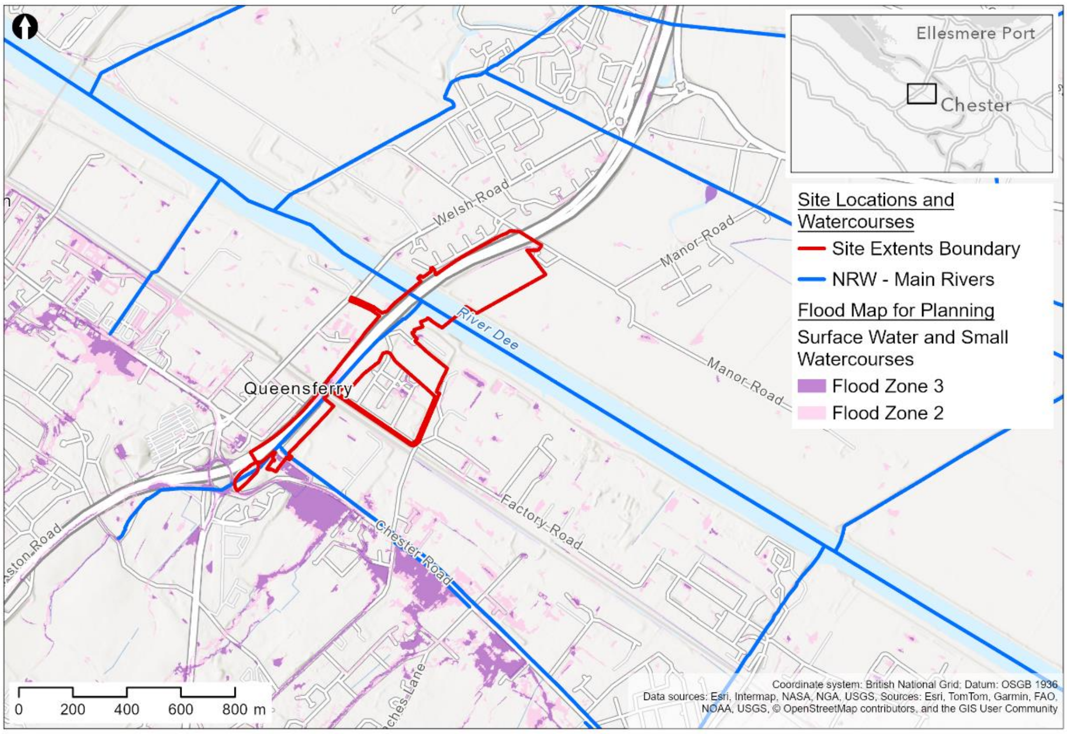
A494 River Dee Bridge Replacement | Flood Map for Planning | 22 Jul 2025

C.6 Flood Risk Assessment Wales (FRAW) – Surface Water and Small Watercourses



A494 River Dee Bridge Replacement | Flood Risk Assessment Wales | 22 Jul 2025

C.7 Flood Map for Planning (FMfP) – Surface Water and Small Watercourses



A494 River Dee Bridge Replacement | Flood Map for Planning | 22 Jul 2025

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Llywodraeth Cymru / Welsh Government

A494 RIVER DEE BRIDGE REPLACEMENT

Technical Appendix 7.E

Volume 3: Technical Assessment Report

Hydrodynamic and Sediment Transport modelling report

Document reference: 395318 | MMD-00-XX-RP-Z-0023 | Rev D

Report Issue | Revision | March 2025

Issue and Revision Record

Revision	Date	Originator	Checker	Co-ordination check	Description
A	04/05/2022	S.Costa	J.Williams	D. Price/G. Morgan	Draft for comments
B	22/05/2022	D.Price	G.Morgan	G.Morgan	Update of draft with comments from client
C	04/08/2022	S. Costa	J. Williams	G.Morgan	Updated with final bathymetry analysis
D	05/02/2025	N. Del Estal	D. Price	A. Wright	Draft for comments after new proposed Bridge design and construction scenarios (only MHWS)
E	06/03/2025	N. Del Estal	D. Price	A. Wright	Draft for comments after new proposed Bridge design and construction scenarios (high river flow update)

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A494 RIVER DEE BRIDGE REPLACEMENT

Technical Appendix 7.E

Volume 3: Technical Assessment Report

Hydrodynamic and Sediment Transport modelling report

395318 | MMD-00-XX-RP-Z-0023

Report Issue | Revision | March 2025

Contents

1 Hydrodynamic and Sediment Transport modelling

1.1 Introduction

Project background

Mott MacDonald Limited (MML) is working on behalf of North & Mid Wales Trunk Road Agent (NMWTRA) to progress the construction of a widened crossing over the River Dee at Queensferry (Figure 1-1). It is planned to build the Wales-bound carriageway immediately upstream from the existing A494 crossing. As part of the preliminary design in 2019, MML investigated the impacts of the new Bridge piers on the hydrodynamic regime and sediment transport in the Dee.

Whilst the current 2025 modelling uses a 3D MIKE3 modelling approach, the previous 2019 modelling used a two-dimensional (2D) Flexible Mesh (FM) MIKE21 hydrodynamic (HD) model. A MIKE21 sand transport (ST) model was also used to understand the broader impacts on the estuary related to a series of temporary piles used to construct the new carriageway. Simulations with this older model enabled quantification of the predicted extent of scour and the accretion of the suspended sediments arising from local scour processes. Predicted changes in flow patterns, tidal currents, and scour impacts were presented in Mott MacDonald (2019). The 2019 report was updated by MML in 2022 (to use the 3D MIKE3 model) following a change in the construction approach for the Bridge which considered keeping the existing carriageway (for westbound traffic) and constructing a new Bridge for eastbound traffic only.

This Chapter presents the modelling conducted for the latest construction approach. Here, a new Bridge is proposed which will be constructed to carry both carriageways, with the existing Bridge likely to be removed. Although removing the existing Bridge is probable, the simulations documented in this report also consider the scenario where the existing Bridge piers remain in place. This Chapter, repeats the introduction and calibration Chapters of Mott MacDonald (2022).

Site description

The sites located in the Upper Dee Estuary at Queensferry (Figure 1-1 and Figure 1-2). The Dee is a macro-tidal, funnel-shaped estuary situated in the eastern Irish Sea between the Wirral Peninsula in England and Wales that becomes canalised in the upper reaches from Connah's Quay to Chester.

Figure 1-1 Existing A494 Bridge at Queensferry.

The River Dee rises in the eastern part of Snowdonia and drains a catchment area of approximately 2,088 km^2. The estuary can be considered to extend from a line between Point of Ayr and Hilbre Point at the mouth to the normal tidal limit at Chester Weir (Figure 1-2).

The Dee estuary has an effective length of 30 km, with a maximum width of 8.5 km at the estuary mouth. The main conveyance channel bifurcates 12 km seaward from the canalised river at the head of the estuary (Figure 1-2), resulting in the deep Mostyn and Hilbre channels that extend into Liverpool Bay (Moore et al., 2009).

Figure 1-2 The main Dee Estuary features and location of the A494 Bridge.

Source.: Mott MacDonald, 2021

The mean spring tidal range at Hilbre Island of 8 m and the strong tidal currents make the Dee a very dynamic system (Moore et al., 2009). The average tidal prism in the Dee is $4x10^8$ m^3, representing a volumetric increase of over 80% between mean low water and mean high water. As the mean river discharge of 31 m^3/s is comparatively small, the estuary is tide-dominated, with the river discharge contributing only around 0.35 % of the tidal prism over the tidal cycle.

Flood tidal current speeds are higher than the ebb currents in the Dee Estuary. This asymmetry results in the net importation and retention of sediment within the estuary. This process is assisted by the residual currents within Liverpool Bay, which contribute to the net landward transport of sand and silt into the mouth of the estuary. The estuary interacts with processes in Liverpool Bay as far west as the River Clwyd and eastwards to the River Mersey (Halcrow, 2013). The average salinity of the estuary varies from about 26 ppt near the head to about 33 ppt near the mouth. The estuary can be classified as being partially mixed (Halcrow, 2013).

Report structure

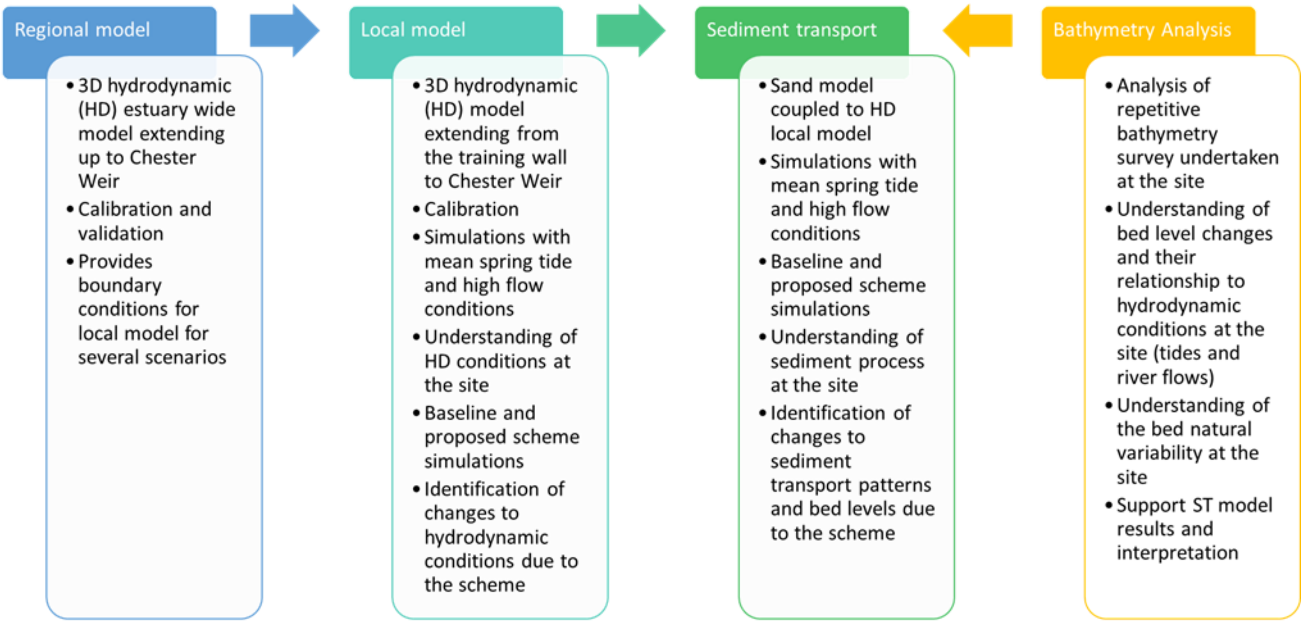
The report comprises:

- Chapter 1.2: Modelling approach;
- Chapter 6.3: Existing data used to build and calibrate both the hydrodynamic and the sediment (sand) transport models;
- Chapter 6.4: Setup of the regional MIKE3 hydrodynamic model of the Dee estuary and includes the model calibration;
- Chapter 6.5: Setup of the local MIKE3 hydrodynamic and sediment transport model of the Dee estuary and includes the model calibration;
- Chapter 6.6: Bathymetry analysis undertaken to understand the bed variability at the A494 Bridge site;
- Chapter 6.7: Baseline hydrodynamics from the regional model simulations under normal conditions;
- Chapter 6.8: Hydrodynamic and sediment transport results from the models for baseline and the scheme for normal conditions. It summarises the key results from the study and considers the expected bed level changes; and
- Chapter 6.9: Summary of the key results and conclusions.

1.2 Approach

To simulate the hydrodynamic and sediment transport regimes for the baseline (existing layout) and proposed scheme layout, regional and local three-dimensional (3D) MIKE by DHI models of the Dee Estuary were set up and calibrated. These models enabled the prediction of changes to local bed levels and hydrodynamics resulting from the proposed Bridge piers for several different scenarios. The modelling approach is summarised schematically in Figure 1-3 .

Figure 1-3 A494 Dee Crossing modelling approach



Source.: Mott MacDonald, 2022

1.3 Data

Introduction

The performance of a hydrodynamic model is closely related to the accuracy of the bathymetry/topography used to build the model and the boundary conditions used to drive the model. Care is needed to ensure that observed water levels and currents are represented as accurately as possible within the constraints imposed by the data available to the study.

To support the numerical model, MML contracted Partrac Ltd. to collect data at 2 locations on water levels, current speeds, salinity, temperature, suspended sediment concentrations and bathymetry (Figure 1-4).

- Site A at the upriver eastern side of the Flintshire Bridge; and
- Site B at the upriver eastern side of the A494 Queensferry Bridge.

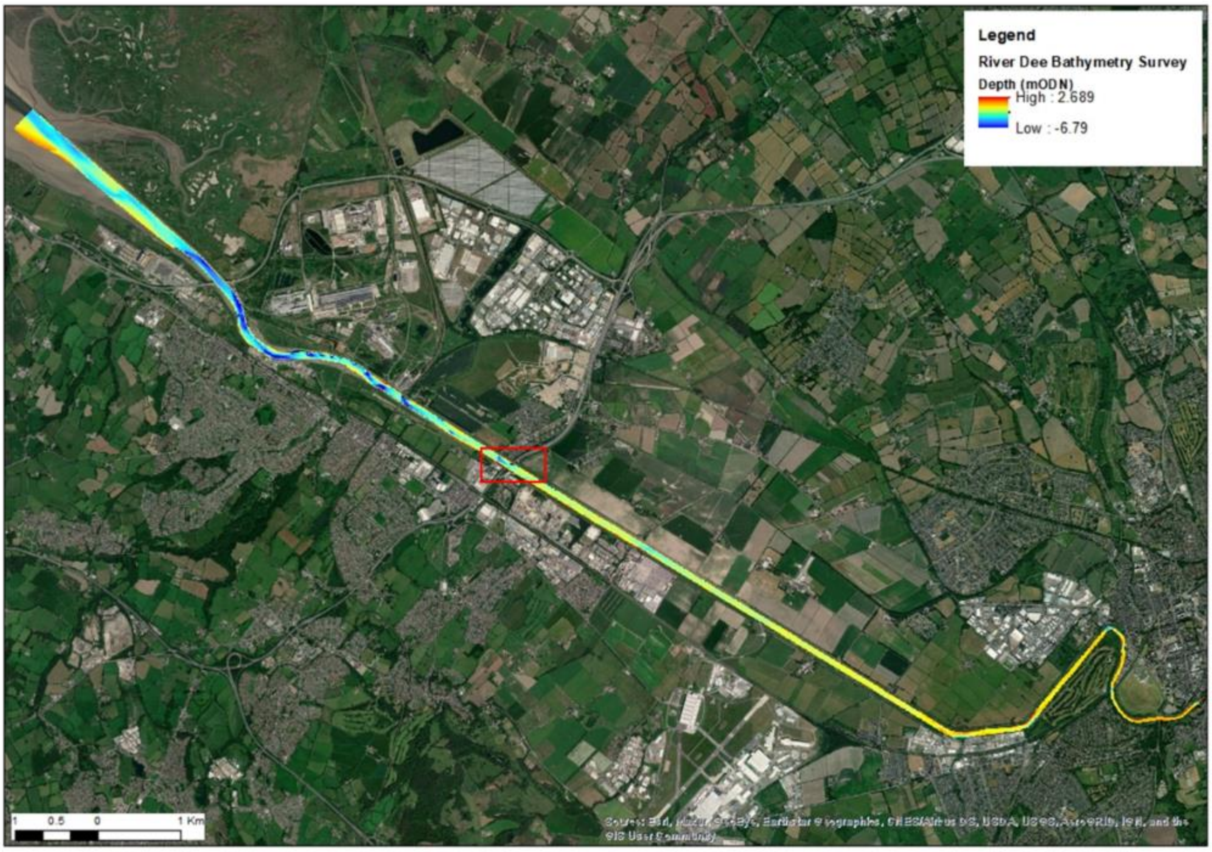
Figure 1-4 Data collection locations

Source.: Partrac, 2021.

Bathymetric data

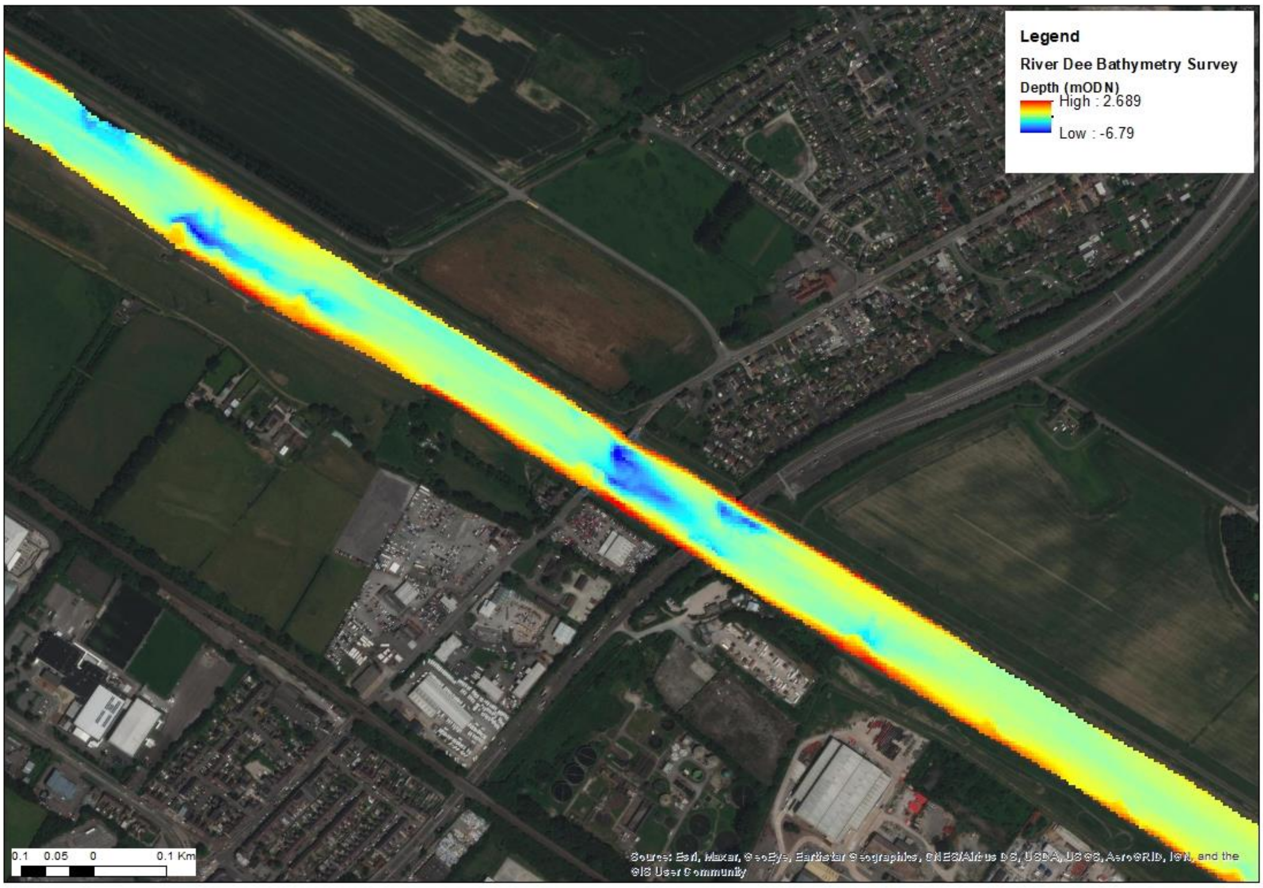
A bathymetric survey including the area from the weir at Chester to the training wall (Figure 1-2) west of the project site was carried out by Partrac on the 6th of September 2021 (Figure 1-5). The survey data has a horizontal resolution of 0.5 m. Figure 1-6 shows the extent of the bathymetric data collected during the September 2021 survey.

Figure 1-5 Full extent of the bathymetry survey undertaken in September 2021. The red box highlights the site.



Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

Figure 1-6 Bathymetry around the site from the September 2021 survey. Please note the scour holes around the piles of the existing bridges (A494 and Jubilee Bridge).



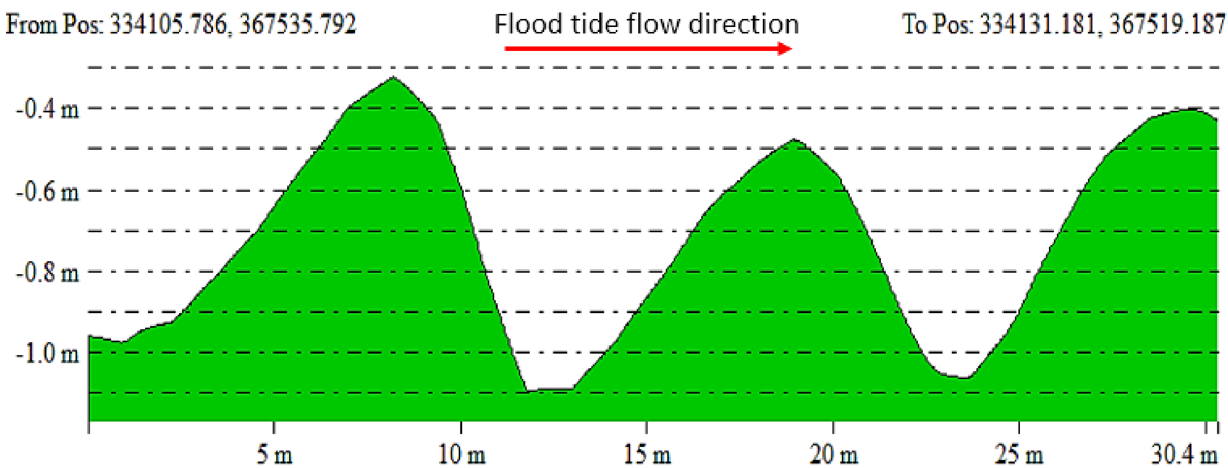
Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

Figure 1-7 shows a well-developed sand wave field located 2 km upstream of the site and extending for approximately 3.5 km. The sand waves are up to 1 m high and have a wavelength between 10 m to 15 m. The sand waves are asymmetrical, with the stoss slope in the direction of the flood tide (Figure 1-8).

Figure 1-7 Area of sand waves located 2km upstream of the site.

Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

Figure 1-8 Example of sand waves located in the River Dee, approximately 2km upstream of the site. Please note the asymmetry of the features.



Source.: Mott MacDonald, 2021

To record changes to the seabed in the vicinity of the A494 Bridge, 6 bathymetric surveys were undertaken on:

- 9th September 2021
- 28th September 2021
- 3rd December 2021
- 25th January 2022
- 31st March 2022
- 26th May 2022

A detailed analysis of the measured bathymetric changes is given in Chapter Analysis of bathymetric survey data.

Additional data sources used in this study included:

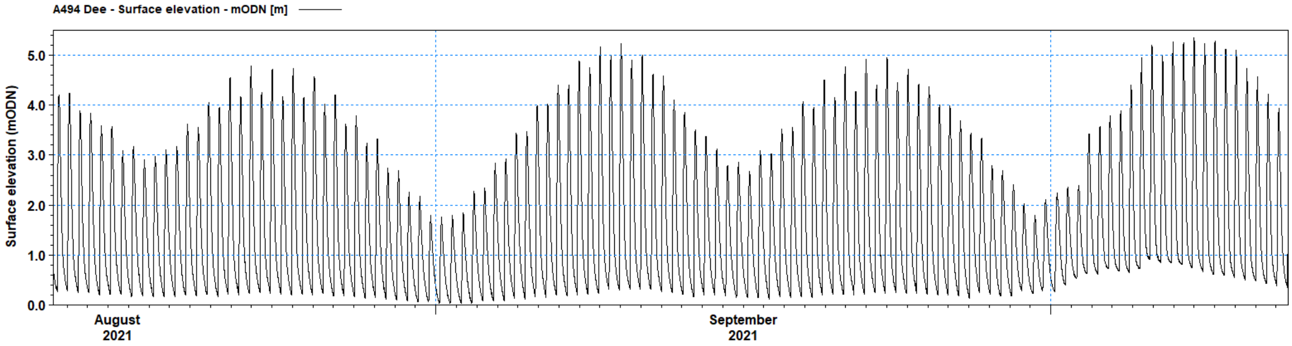
- UKHO bathymetry data covering the outer estuary with variable resolution and survey dates; and
- Composite 1 m resolution EA and NRW LiDAR (2017 and 2020) covering the area between the outer estuary and Chester.

Reflections from surface water giving false elevation readings were removed from the LiDAR dataset, and several cross-sections were created to identify a threshold level below which LiDAR data would be discarded. This threshold varied in the estuary, but all LiDAR data less than -3 m ODN was generally removed. The LiDAR data was then merged with the bathymetry to give seamless coverage of the estuary and all the land areas in the study area.

Water levels

Water level data provides boundary conditions for the hydrodynamic model and the data for model calibration and validation. At the A494 Bridge, a radar tide gauge was installed by Partrac on 13th August 2021, and since then, the gauge has recorded the water surface elevation every 6 min (m ODN, Figure 1-9). These data provided water level boundary conditions for the model in the upper part of the estuary.

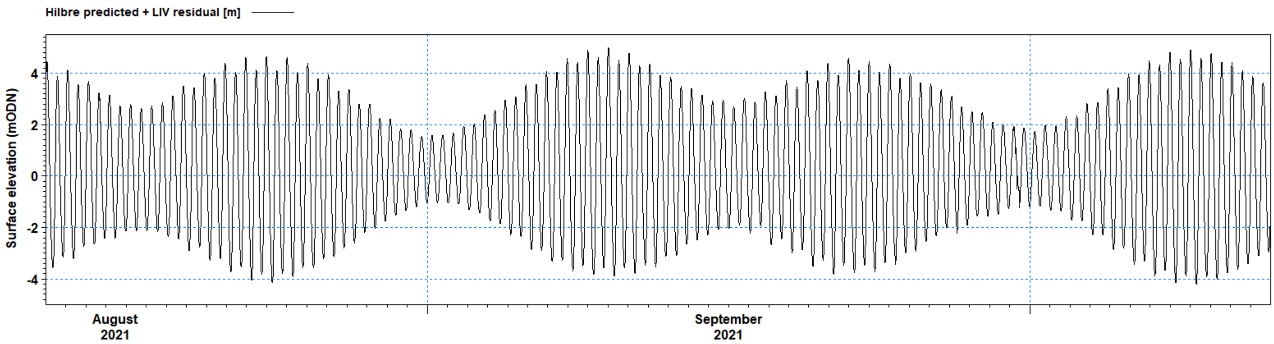
Figure 1-9 Measured water levels (m ODN) at the tide gauge located at the A494 Bridge.



Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

Water levels to drive the regional hydrodynamic model in the mouth of the estuary were obtained for Hilbre Island using Hydrographic Office TotalTide software (Figure 1-10). When available, the measured surge at Liverpool's Gladstone Dock (obtained from ntslf.org) was added to the predicted astronomical tide to capture the meteorological effects.

Figure 1-10 Hilbre Island water levels (m ODN), including the measured surge component from Liverpool Gladstone Dock.



Source.: Mott MacDonald, 2021. Contains BODC and UKHO data.

Tide levels

Table 1-1 shows the tide levels at several outer and inner Dee Estuary locations. The tidal range for spring and neap tides are 7.7 m and 4.1 m, respectively, at the mouth of the estuary.

Table 1-1 Tide levels (m ODN) for several locations in the Dee Estuary.

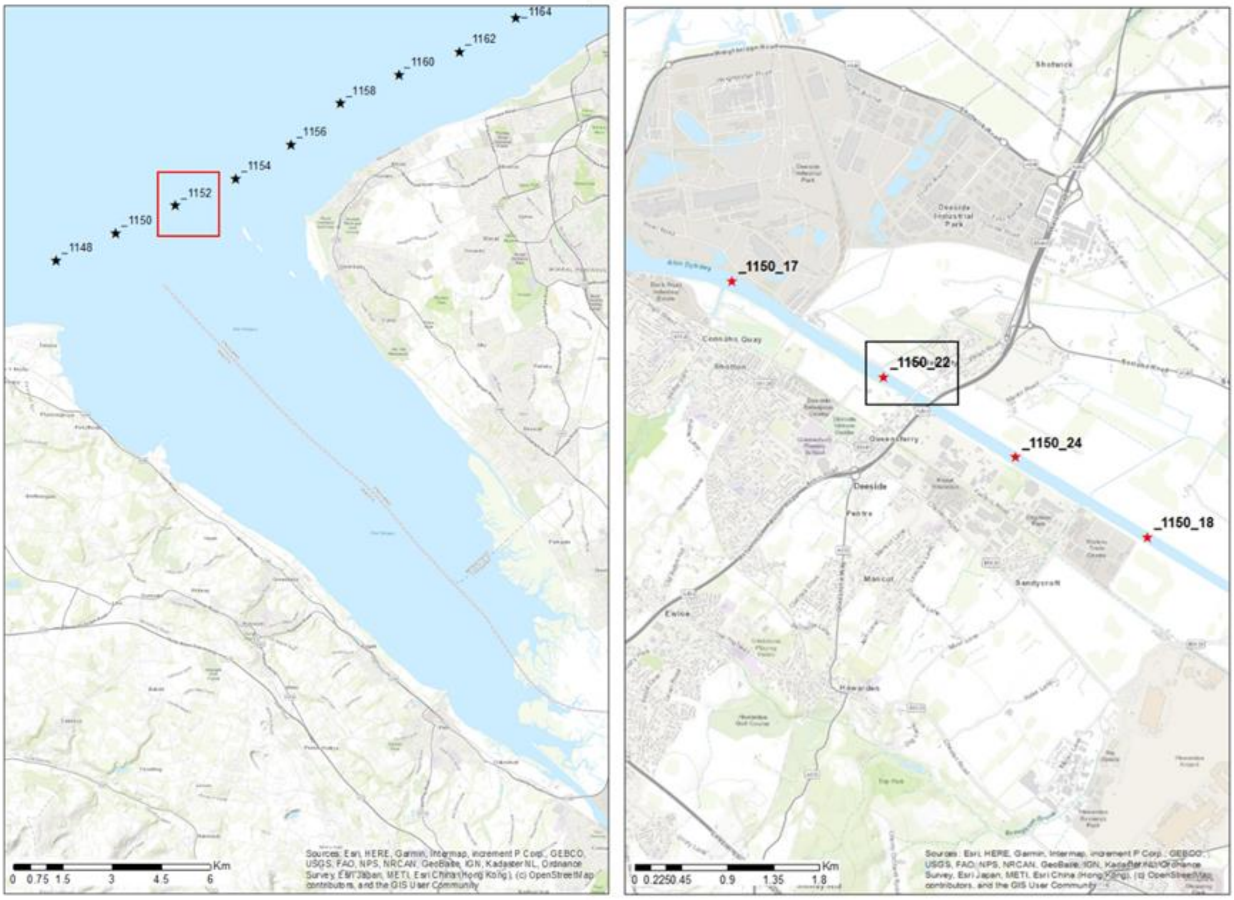
Tidal level	Hilbre Island	Mostyn Docks	Connah's Quay	Chester
Highest Astronomical Tide (HAT)	5.27	5.30	4.75	5.60
Mean High Water Springs (MHWS)	4.07	4.40	3.95	4.60
Mean High Water Neaps (MHWN)	2.27	2.50	2.25	2.60
Mean Sea Level (MSL)	0.22	0.39	--	--
Mean Low Water Neaps (MLWN)	-1.83	-1.60	--	--
Mean Low Water Springs (MLWS)	-3.63	-3.40	--	--
Lowest Astronomical Tide (LAT)	-4.83	-4.30	--	--

Source.: Admiralty Total Tide, 2021

Extreme water levels

Extreme water levels at the mouth of the Dee Estuary and the A494 Bridge were obtained from the Coastal Flood Boundary (CFB) conditions datasets (EA, 2018) for Point 1152 and Point 1150_22 (Figure 1-11 and Table 1-2).

Figure 1-11 Extreme water levels from CFB conditions for the mouth of the Dee estuary (left image) and at the A494 Bridge (right image).



Source.: Mott MacDonald, 2021. Contains EA data, 2018

Table 1-2 Extreme water levels from CFB conditions (baseline of 2017) for the mouth of the Dee estuary (Point 1152) and at the A494 Bridge (Point 1150_22).

Return period	Dee Estuary Point 1152	A494 Bridge Point 1150_22
1	5.19	5.89
2	5.31	5.97
5	5.42	6.04
10	5.52	6.11
20	5.61	6.17
25	5.64	6.19
50	5.75	6.28
75	5.79	6.30

Return period	Dee Estuary Point 1152	A494 Bridge Point 1150_22
100	5.82	6.32
150	5.88	6.36
200	5.91	6.39

Source.: Mott MacDonald, 2021. Contains NRFA, 2021.

Current speeds

Current speeds were measured at Sites A and B (Table 1-1) during spring and neap tides in August 2021. The data were obtained using a vessel-mounted TRDI 1200 kHz Workhorse Sentinel ADCP. Each survey day was divided into 30-minute intervals either on the hour (HW± XX:00) or the half-hour (HW± XX:30). For further information regarding the ADCP survey, please refer to “A494 Dee Survey Data Report” (Partrac, 2021).

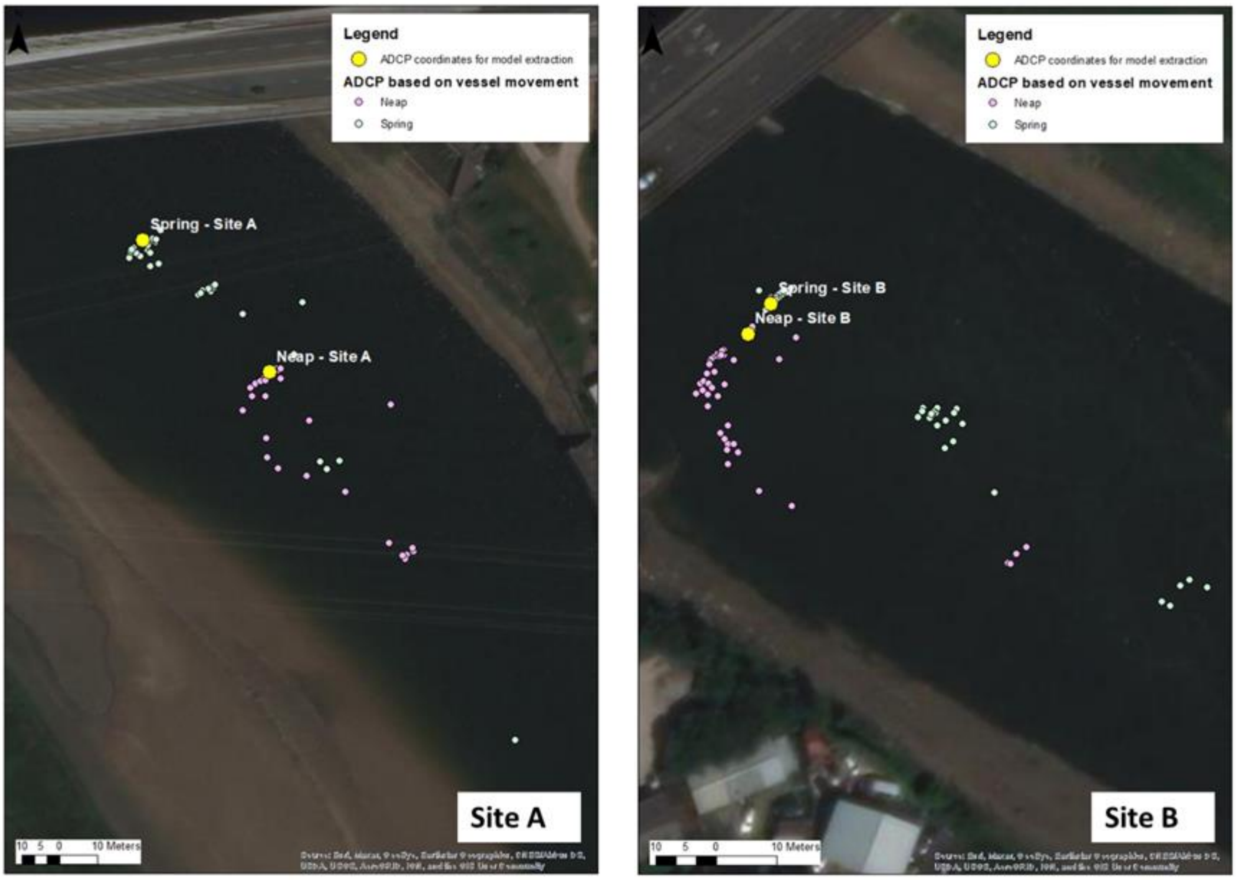
Table 1-3 summarises the surveys days and locations. Time-series, vertical profiles and spanwise transects were obtained at both sites. Figure 1-12 shows the minimum and maximum extent of the spring and neap survey at both sites.

Table 1-3 Summary of Partrac surveys

Date	Survey	Coordinates of current profiles (Lat, Long – WGS84)	
10/08/2021	Spring Survey Site B	53.229058	-3.066225
11/08/2021	Spring Survey Site A	53.209897	-3.013524
18/08/2021	Neap Survey Site B	53.228748	-3.065717
19/08/2021	Neap Survey Site A	53.209852	-3.013578

Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

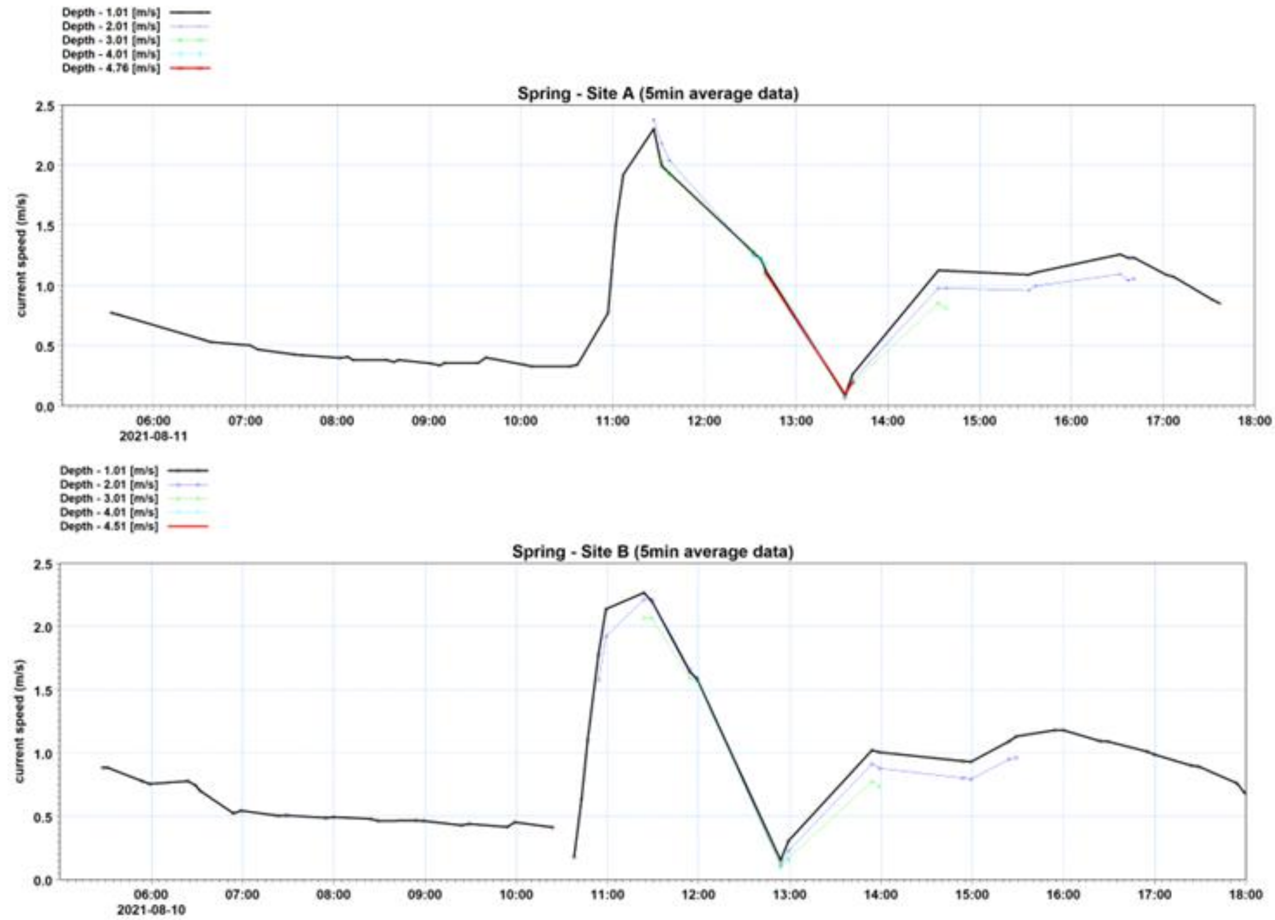
Figure 1-12 ADCP locations during the vessel-mounted survey. The yellow points indicate where data were extracted for calibration purposes. Green and pink points indicate spring and neap survey locations, respectively.



Source: Mott MacDonald, 2021

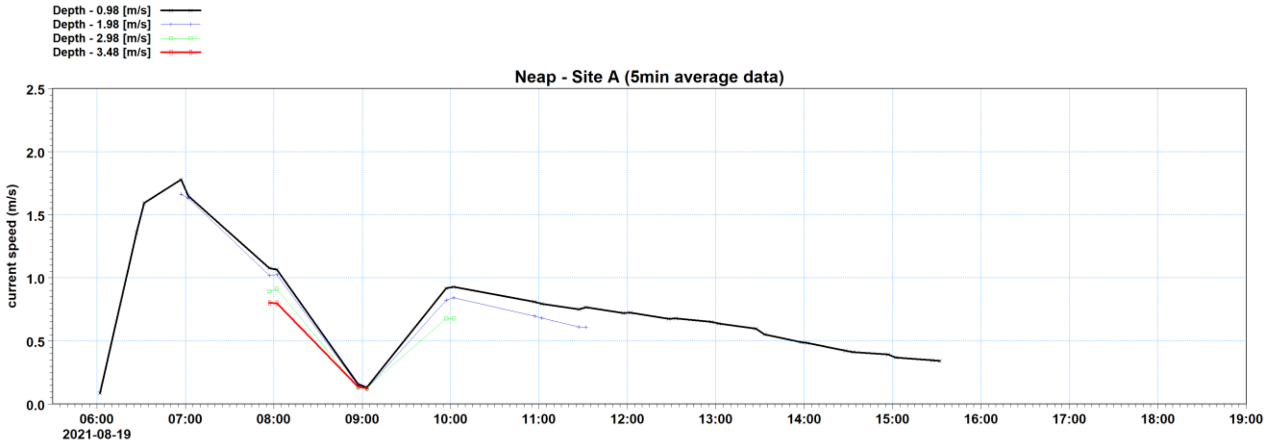
The current speed measurements were recorded at approximately 0.3 Hz and were post-processed to obtain smoothed 5 min average values. Figure 1-13 and Figure 1-14 show the current speed during the Spring and Neap tide surveys of August 2021. Higher current speeds during the flood tide are recorded at both sites, with the maximum current velocity at the surface reaching almost 2.5 m/s during the peak flood flow.

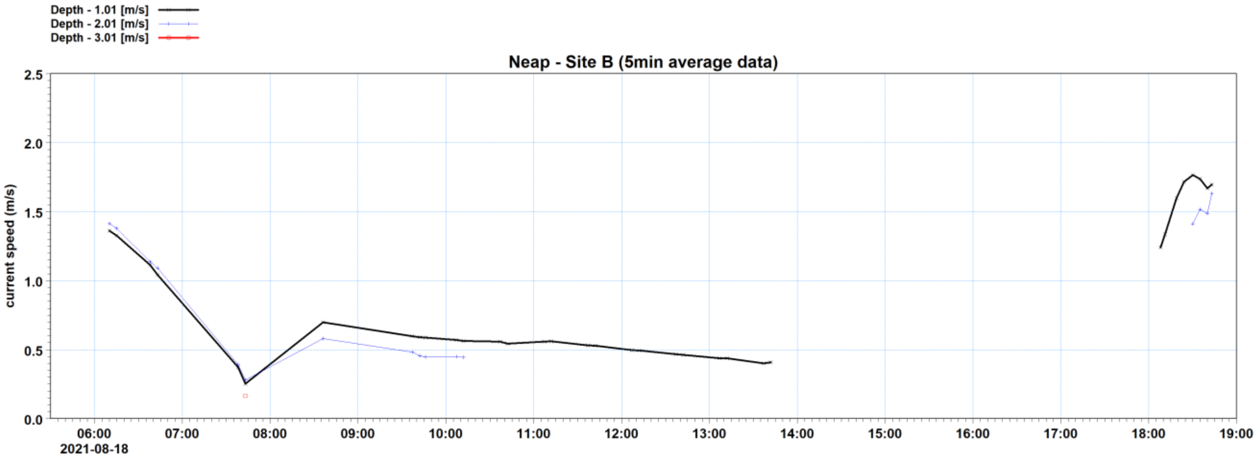
Figure 1-13 Spring tide current speeds at different water depths during the spring tide of 10th and 11th August 2021 for Site A and B. The black line represents the currents near the surface.



Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

Figure 1-14 Neap tide current speed at different water depths during the neap tide of 18th and 19th August 2021 for Sites A and B. The black line represents the currents near the surface.





Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

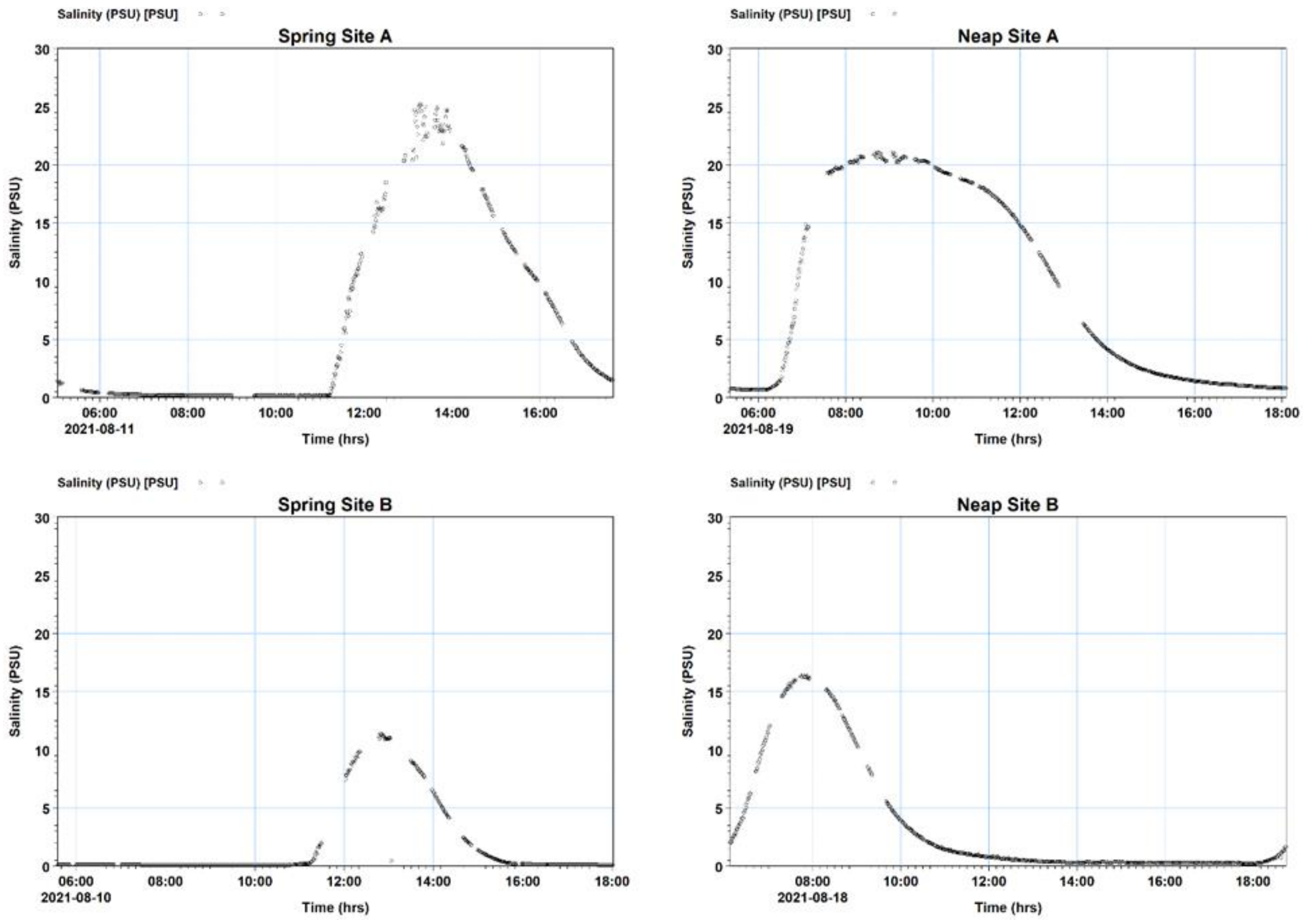
Salinity

Salinity measurements (Figure 1-15) were obtained as time-series, vertical profiles, and transects simultaneously with the current measurement (Figure 1-13). Figure 1-16 shows the time-series at both site locations for the spring and neap survey. Salinity vertical profiles Figure 1-17 shows homogeneous vertical mixing on all profiles except for HW-0.5 to HW+0.5 hours, where slightly fresher water was observed at the surface. For further information, please refer to Partrac (2021).

Figure 1-15 CTD location during the salinity time-series and vertical profiles survey. Green and pink points indicate spring and neap survey locations, respectively

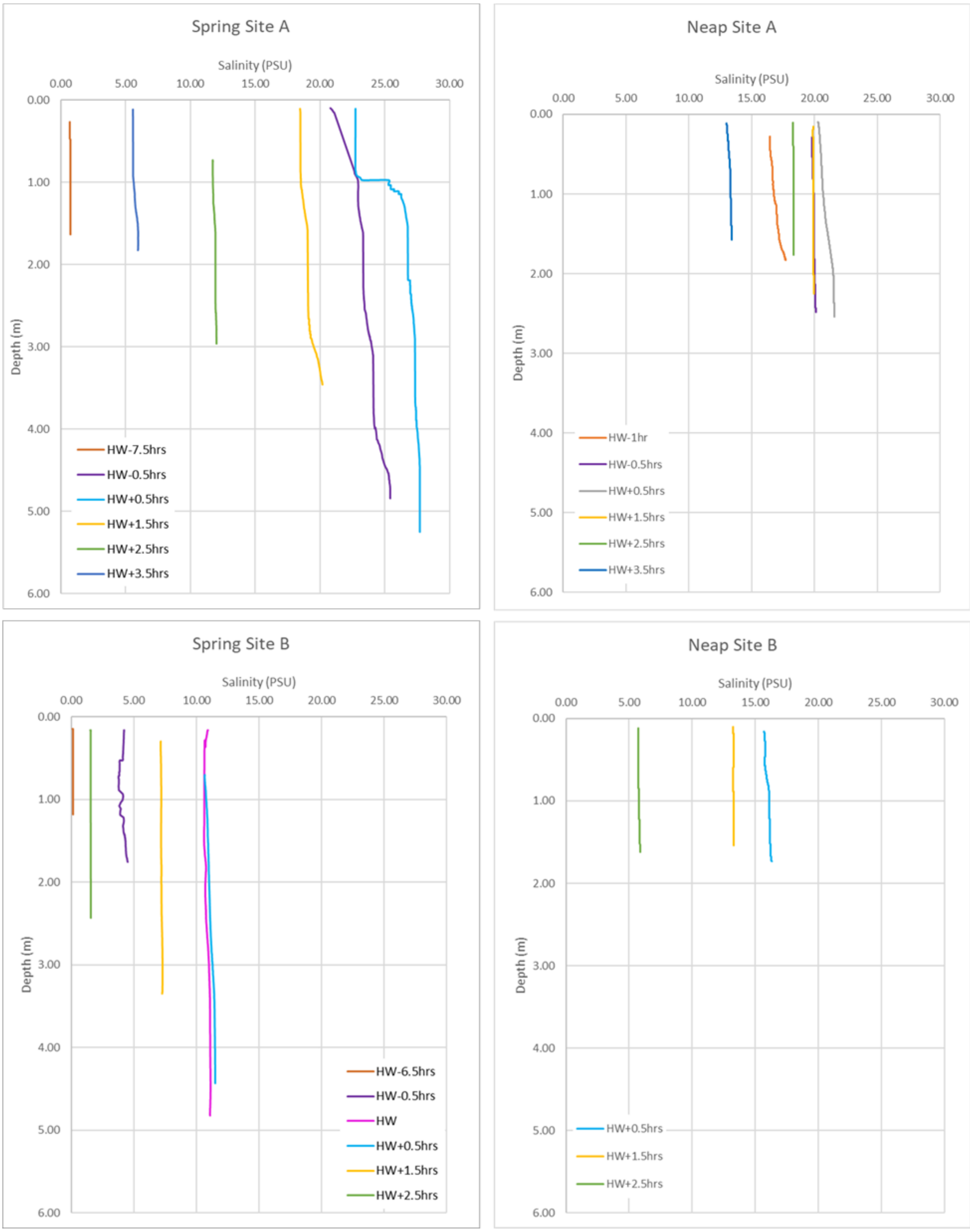
Source: Mott MacDonald, 2021

Figure 1-16 Salinity time-series, at a depth of 1 m from the surface, for Sites A and B during spring and neap tides in August 2021.



Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

Figure 1-17 Salinity vertical profiles Sites A and B during spring and neap tide in August 2021.



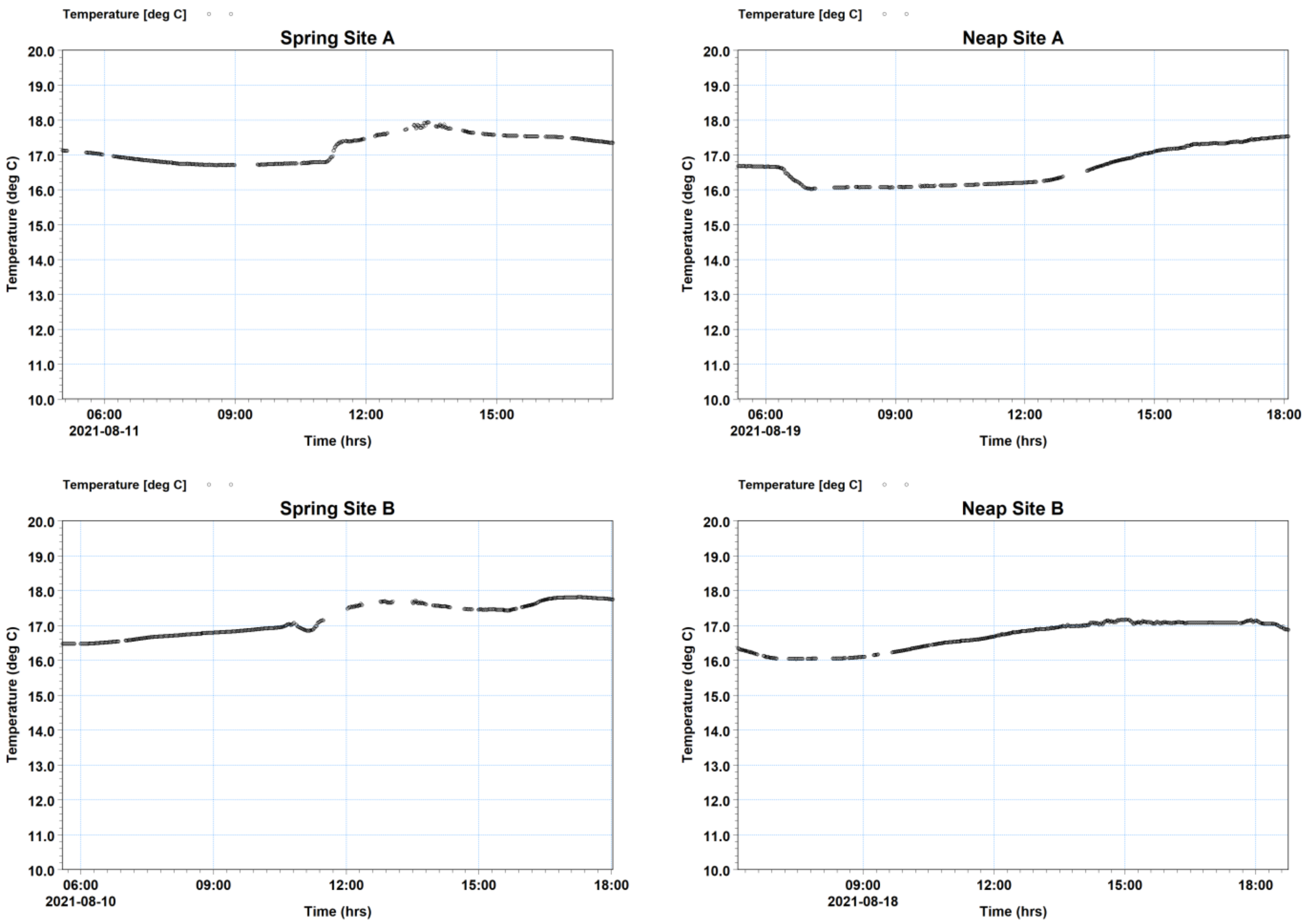
Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

Temperature

Temperature measurements were also obtained as time-series, vertical profiles and spanwise transects with the salinity and currents measurements (Table 1-3). The location of the vertical profiles and the time series is the same as the salinity (Figure 1-15). For further information, please refer to Partrac (2021).

Figure 1-18 shows the temperature time-series at both site locations for the spring and neap survey. The figure shows the temperature variation over the tidal cycle is of the order of 1 ºC. For vertical profiles and transects of temperature across the river, please refer to the Partrac Survey report (Partrac, 2021).

Figure 1-18 Temperature time-series, at a depth of 1 m from the surface, for Sites A and B during spring and neap tides in August 2021.



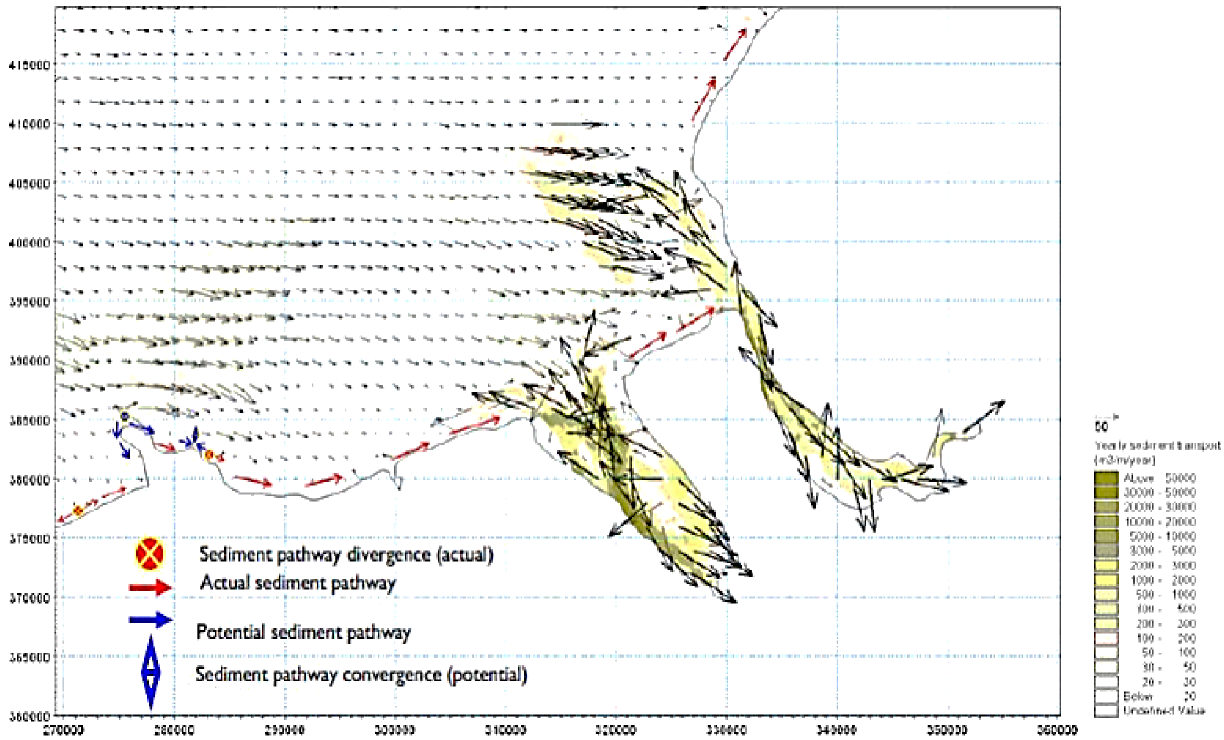
Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

Sediment processes

The Dee estuary is a significant sink for both mud and sand. The onshore transport of sand from the Irish Sea has led to the formation of sandbanks at the mouth of the Dee Estuary. These banks provide some protection against waves along the shores of the outer Dee and the open coast on either side (Halcrow, 2013). Within the estuary, the eroding till cliffs also provides relatively small quantities of sediment. Although the Dee Estuary acts as a primary sink for muds and silts, sand transport occurs across the mouth of the estuary via West Hoyle Bank and East Hoyle Spit (Halcrow, 2013).

Annual average littoral and subtidal transport vectors based on numerical modelling from the Cell Eleven Tide and Sediment Study (CETaSS) (Halcrow, 2010) are shown in Figure 1-19 . This figure shows that the sediment pathways from offshore and alongshore are directed towards the mouths of the Dee and Mersey estuaries.

Figure 1-19 Map showing sediment transport in the vicinity of the Dee Estuary



Source.: Halcrow, 2010

Bed sediments

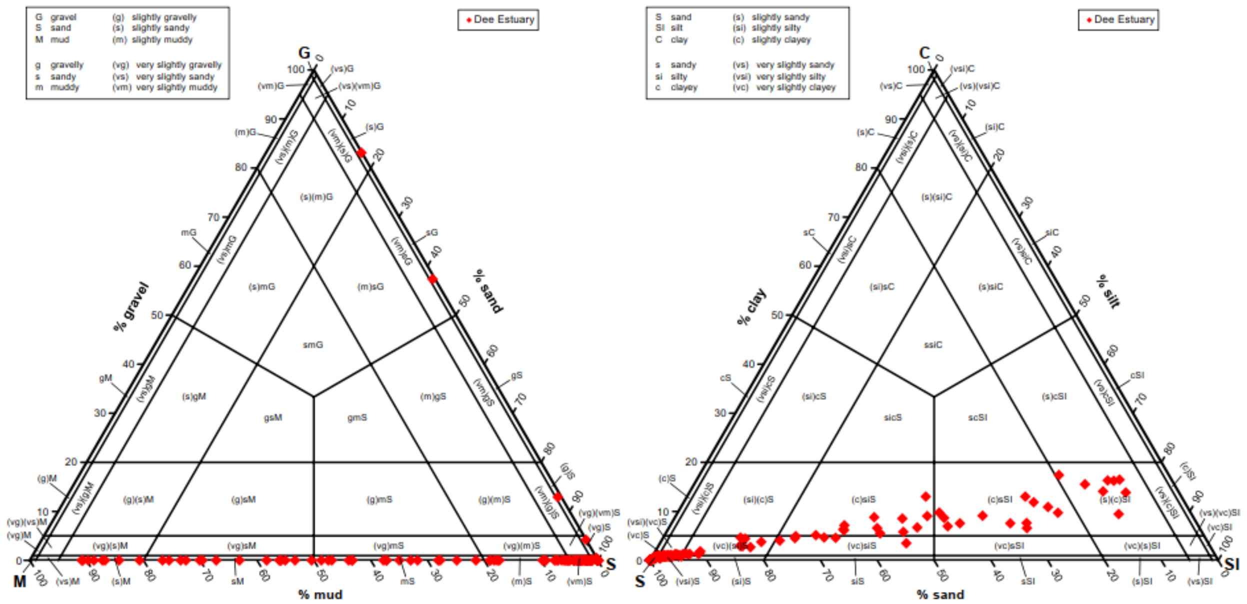
While much of the lower intertidal and subtidal zone of the Dee Estuary is sandy, there is a trend towards more muddy sediments in the up-estuary direction. Extensive sediment sampling has been undertaken as part of the Cell Eleven Regional Monitoring Strategy (CERMS) in the middle and outer estuary. However, the inner estuary and large sand banks at the mouth of the estuary have not been sampled (Halcrow, 2013).

The samples collected from the intertidal zone as part of the CERMS campaign from 2009 to 2010 revealed various sediment types ranging from clean sand to very slightly sandy mud. Gravel is rare except at the top of the beach in the outer part of the estuary[1] (Figure 1-20). Further sediment sampling in 2012 indicated that the central and outer estuary sand banks and channels are also composed mainly of sands and slightly muddy sands. However, it should be noted that there are very few samples from the subtidal and lower intertidal areas in the inner part of the estuary (Halcrow, 2013) so the evidence of sediment distribution may be subject to change.

Median grain size values (D_{50}, mm) of samples from the CERMS campaign from 2009 to 2010 are shown in Figure 1-21 .This figure shows that the outer estuary is mainly dominated by sand, with some coarser material around the Point of Ayr. The lack of samples in the inner estuary is also evident in the figure.

[1] Especially on the English side and at the Point of Ayr (Halcrow, 2013)

Figure 1-20 Gravel - Sand - Mud and Sand - Silt - Clay trigons, based on the classification of Blott and Pye (2012), for sediment samples collected within the Dee Estuary from 2009 to 2012 (data from Pye et al., 2010).



Source.: Halcrow, 2013

Figure 1-21 Sediment sample locations and D_{50} (mm) from the CETaSS survey campaign of 2009-2010.

Source.: Mott MacDonald, 2022. Contains Halcrow, 2010 data

Closer to the study site, the "Drome Corner to Ewloe" project (Soil Mechanics, 2007) provides a particle size distribution analysis of three riverbed sediment samples from the surface, 0.45 m and 0.5 m below the surface (Soil Mechanics, 2007). While the precise sample locations are unknown, Drome Corner and Ewloe are on either side of the A494 Bridge. It is assumed that the samples probably reflect the bed sediment's nature in the study area's vicinity. Table 1-4 summarises the particle size analysis and shows that the material comprises fine/medium sand with some gravel present in samples OW4 and OW2.

Table 1-4 Particle size distribution analysis

Borehole No	Sample depth (mBGL)	D_{25} mm	D_{50} mm	D_{75} mm
OW4	0.00	0.15	0.18	0.20
OW2	0.45	0.09	0.15	1.50
OW7	0.50	0.15	0.19	0.21

Source.: Soil Mechanics, 2007

Furthermore, boreholes and grab samples were collected as part of the Overwater Ground Investigation undertaken by Fugro (2019) at the A494 site. 0shows the location of the boreholes and the grab samples. The results of the investigation are summarised in Table 1-5 . For additional information, please refer to Fugro's (2019) report.

Figure 1-22 Boreholes and grab samples location plan

Source.: Fugro, 2019

Table 1-5 Ground investigation summary results

Hole No	Sample depth (m)	D_{50} mm	Description	% of sand
BH111	1	0.16	MADE GROUND. Grey silty SAND with rare to occasional fragments of possible lignite/coal. Sand is fine and medium.	99.2
BH112	2	0.17	MADE GROUND. Light grey and grey slightly silty SAND. Sand is fine and medium.	95.0
BH115	1	0.16	MARINE DEPOSITS. Medium dense grey becoming dark grey with depth calcareous slightly silty SAND with frequent shell fragments, with rare to frequent coal/lignite fragments with rare pockets of soft possibly organic silty clay (moderate organic odour). Sand is fine and medium.	98.3
GS01	0.5	0.08	MARINE DEPOSITS. Greyish brown very silty SAND. Sand is fine to coarse, predominantly fine.	59.4
GS02	0.5	0.10	MARINE DEPOSITS. Greyish brown silty SAND. Sand is fine to coarse, predominantly fine and medium.	76.5
GS03	0.5	0.09	MARINE DEPOSITS. Grey silty SAND. Sand is fine to coarse, predominantly fine and medium.	67.1
GS04	0.5	0.11	MARINE DEPOSITS. Grey slightly silty SAND. Sand is fine to coarse, predominantly fine and medium.	90.7

Hole No	Sample depth (m)	D_{50} mm	Description	% of sand
GS05	0.5	0.11	MARINE DEPOSITS. Grey slightly silty SAND. Sand is fine to coarse, predominantly fine and medium.	90.6
GS06	0.5	0.09	MARINE DEPOSITS. Grey very silty SAND. Sand is fine to coarse, predominantly fine and medium.	76.2

Source.: Mott MacDonald, 2022. Contains Fugro data 2019

The results show that the surface sediment at the site is dominated by fine to medium sand, which is slightly coarser towards the centre of the channel and finer in the intertidal areas. Additional borehole information was also available from the British Geological Survey (BGS)[2] , which reported that fine to medium surface sediments is dominated by fine to medium sand material.

Suspended sediment concentrations

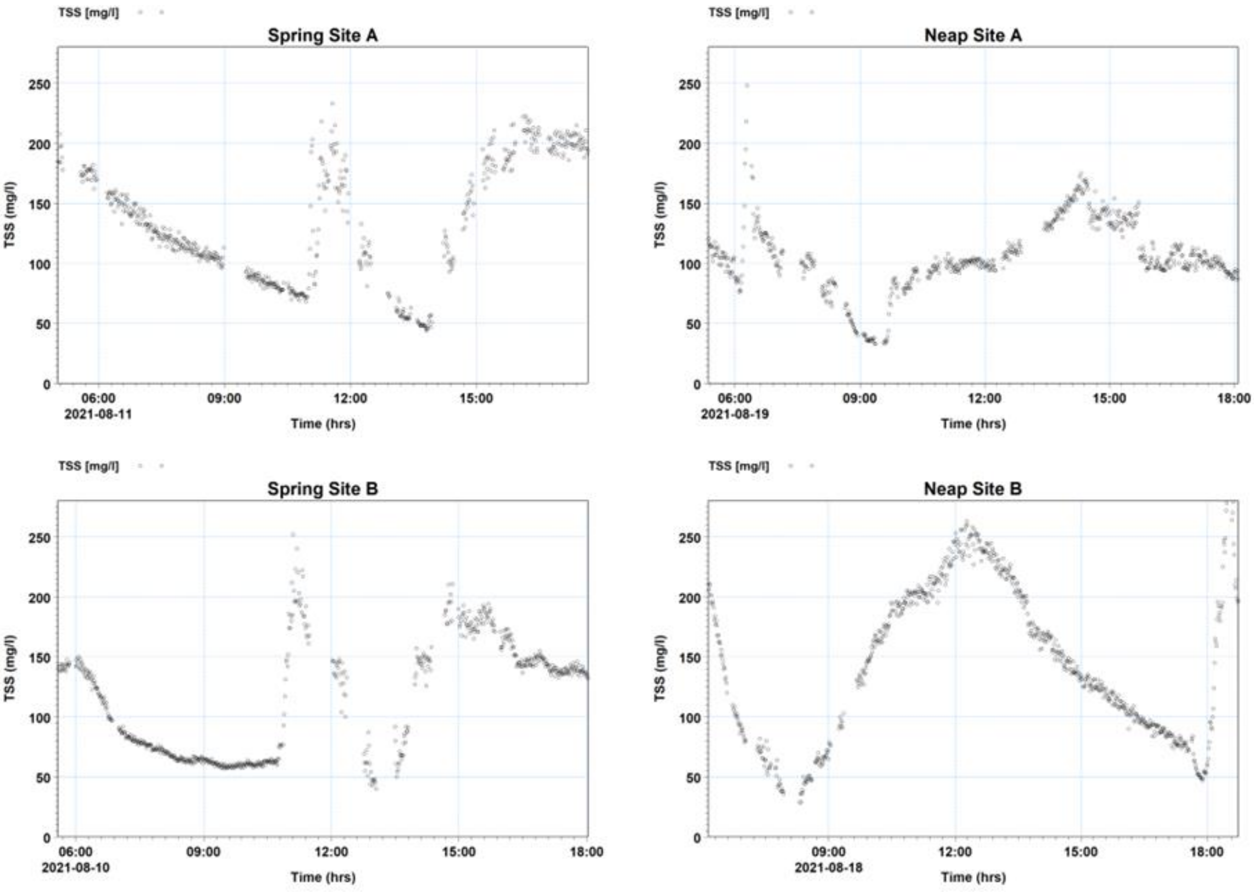
Measured suspended sediment concentrations at the site were derived from turbidity measurements obtained simultaneously as the salinity, temperature and current measurement (Table 1-3). The data were collected as time-series, vertical profiles and transects. The location of the vertical profiles and the time-series are shown in Figure 1-12 . Water samples were also collected to convert turbidity to total suspended solids (TSS) by a specialist laboratory during the data collection period for suspended sediment concentration. Calibration was obtained through linear regression between the TSS values derived from the water samples and the recorded turbidity values. For further information, please refer to Partrac (2021).

Figure 1-23 shows the TSS time-series measured at 1 m below the surface at both site locations for the spring and neap tide surveys. Peak TSS values are shown to exceed 250 mg/l. Vertical profiles of TSS are shown in Figure 1-24 . These show, as expected, higher TSS values near the bed (double the near-surface values). Higher concentrations are

[2] Geology of Britain viewer | British Geological Survey (BGS)

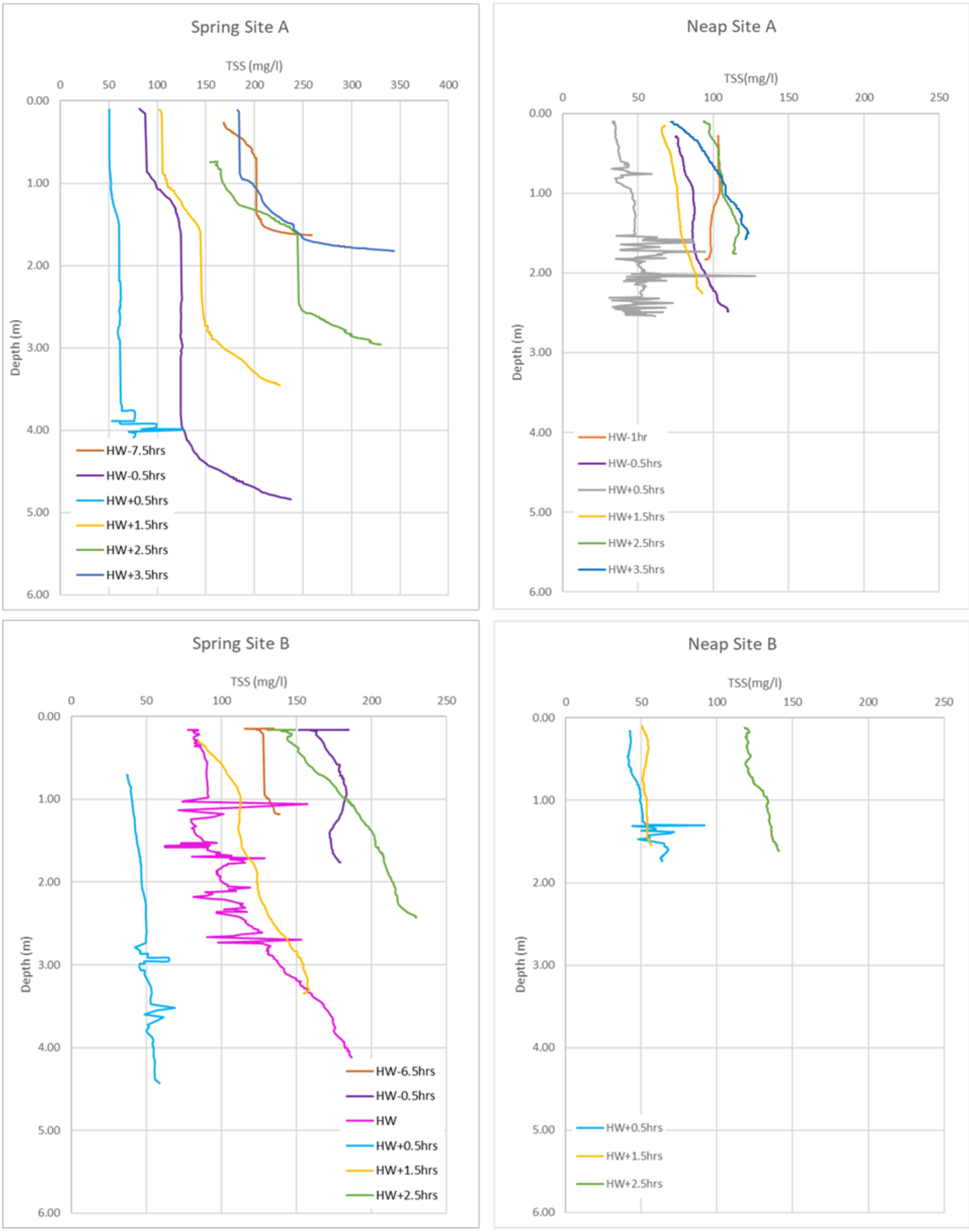
recorded during ebb tide, 2.5 to 3.5 hrs after high water, and during peak flood due to the higher current speeds.

Figure 1-23 Suspended sediment concertation time-series, at a depth of 1m, for Sites A and B during spring and neap tides in August 2021.



Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

Figure 1-24 Suspended sediment concentrations vertical profiles Sites A and B during spring and neap tides in August 2021.

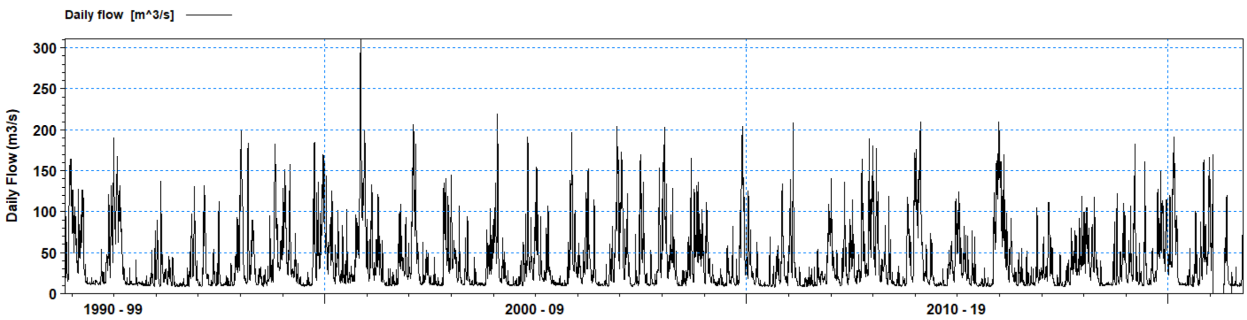


Source.: Mott MacDonald, 2021. Contains Partrac data, 2021.

River flows

River flow data from the NRFA website[3] are provided as daily mean flows from 1993 onwards (Figure 1-25). The data gave a mean daily mean flow rate for the river Dee at station 67027 (Ironbridge) of approximately 38 m^3/s. According to NRFA data, the fluvial discharge at Chester Weir reaches a maximum between October and March and usually is at a minimum between May and September. NRFA provides extreme river flow values up to 5% exceedance. Additional extreme return periods have been extrapolated up to 0.005% (Table 1-6).

Figure 1-25 Daily flow rates for Station 67027 - Ironbridge.



Source.: Mott MacDonald, 2022. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

Table 1-6 Extreme flows for Station 67027 - Ironbridge.

Exceedance	Daily flow (m^3/s)	Return period
0.95	10	1.1
0.70	14	1.4
0.50	22	2
0.10	94	10
0.05	124	20
0.01	187	100
0.005	215	200

Source.: Mott MacDonald, 2021. Contains NRFA, 2021.

3 http://www.ceh.ac.uk/data/nrfa/data/search.html

1.4 Regional hydrodynamic model

Introduction

The Flexible Mesh (FM) of the MIKE3 HD (hydrodynamic) model of the Dee Estuary allows the resolution to be varied across the model domain. The mesh gives higher resolution in the areas of interest (i.e. the A494 Bridge) and reduced resolution further away or in areas with less bathymetric variability. This approach makes the model computationally more efficient than one using a regular model grid.

Model setup

Horizontal and vertical references

The model was set up using the British National Grid (BNG), based on the OSGB36 horizontal datum. The vertical reference datum used was Ordnance Datum Newlyn (ODN), defined as being 4.93 m above Chart Datum (CD) at Hilbre Island. Table 1-7 shows CD relative to ODN for other locations in the model domain from the Admiralty Tide Tables.

Table 1-7 Height of Chart Datum relative to Ordnance Datum for locations in the Dee estuary.

ID	Name	Lat	Long	CD to ODN transformation (m)
461	Hilbre Island	53.383	-3.23	-4.93
464	Mostyn Docks	53.316	-3.26	-4.50
463	Connah’s Quay	53.216	-3.05	-0.75
462	Chester	53.200	-2.90	+0.60

Source: UKHO, 2021

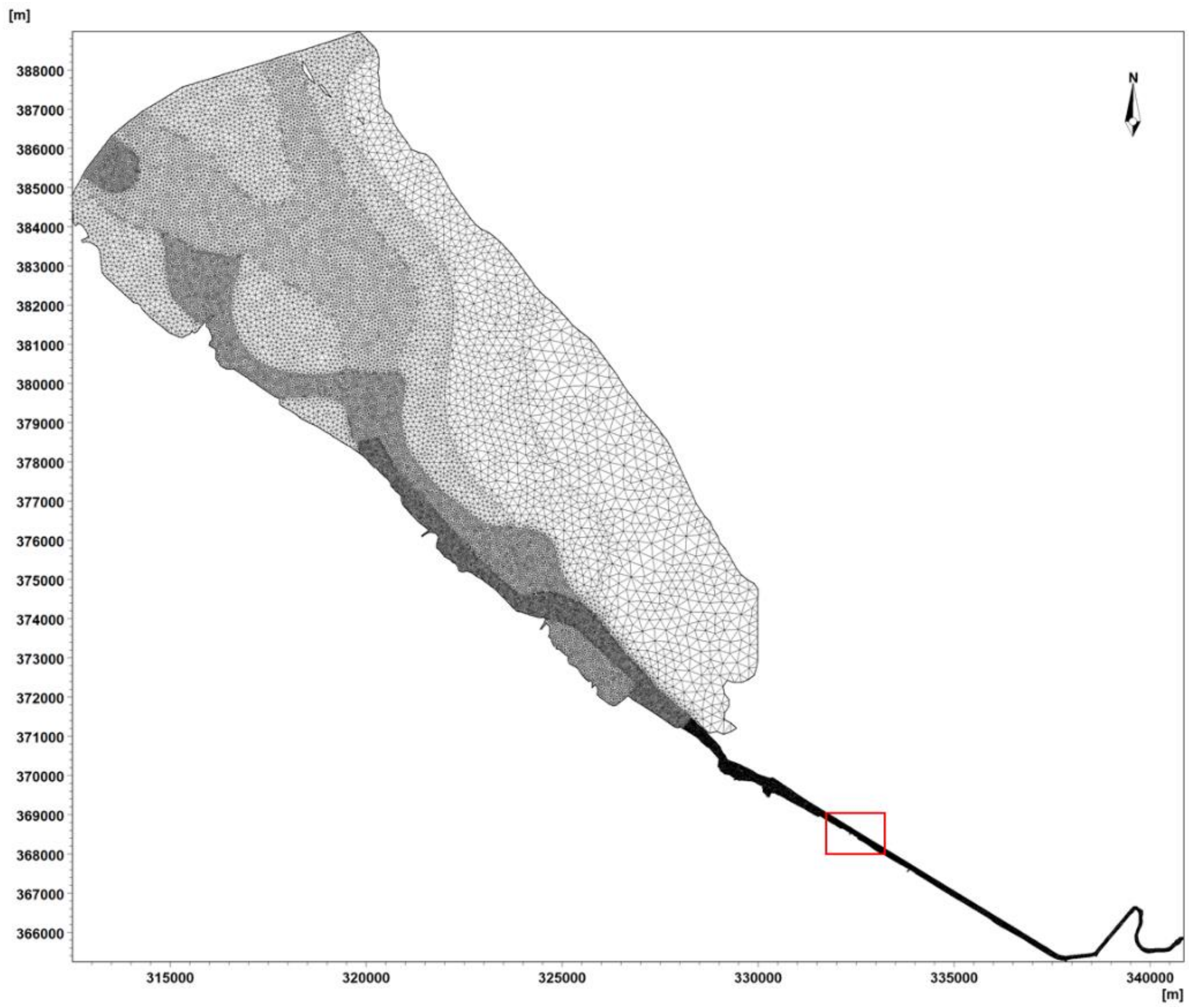
Regional model mesh and extent

The MIKE3 FM HD mesh comprises a combination of triangular and quadrilateral elements. The resolution of the model mesh is coarser in the offshore region, with element sides of approximately 100 m in length. The mesh resolution increases in the estuary in the following way:

- Both Mostyn Channel, to the west, and Hilbre Channel, to the east, are refined to a resolution of approximately 50 m in order to resolve the steep side gradients of both channels at the boundary of the model;
- The 50 m resolution is maintained for most of the estuary channel up to the training wall, where it is increased to between 10 and 20 m;
- Several areas of small quadrilateral elements were used in the upper estuary to provide a smooth transition between the triangular element in the outer estuary; and
- The resolution at the site was increased to 5 m.

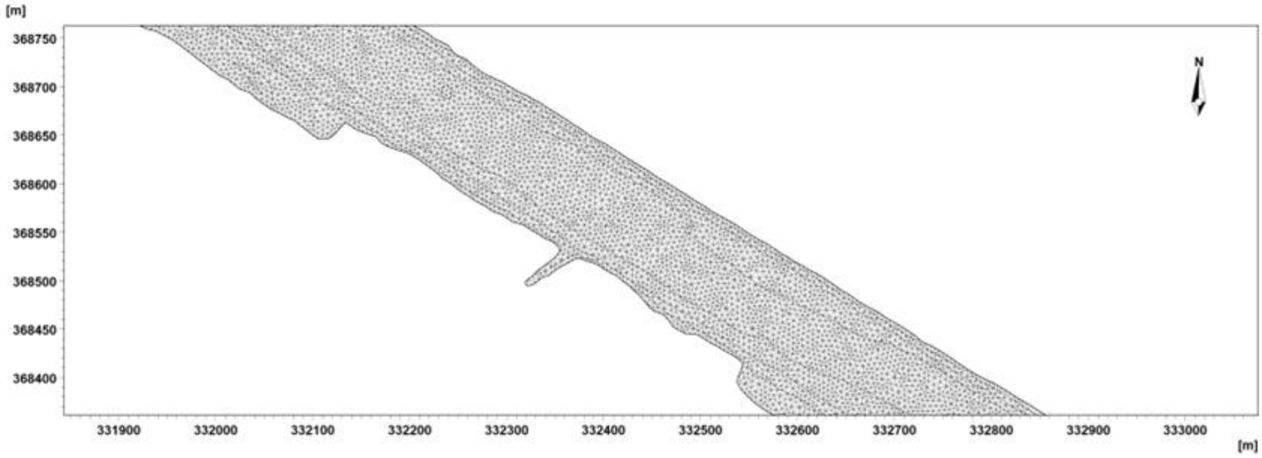
Figure 1-26 and Figure 1-27 show the overall model mesh and details of the high-resolution mesh around the Project site, respectively.

Figure 1-26 Overall MIKE3 FM model mesh.



Source.: Mott MacDonald, 2021

Figure 1-27 Refined MIKE3 FM model mesh in the study area.



Source: Mott MacDonald, 2021

Model vertical layers

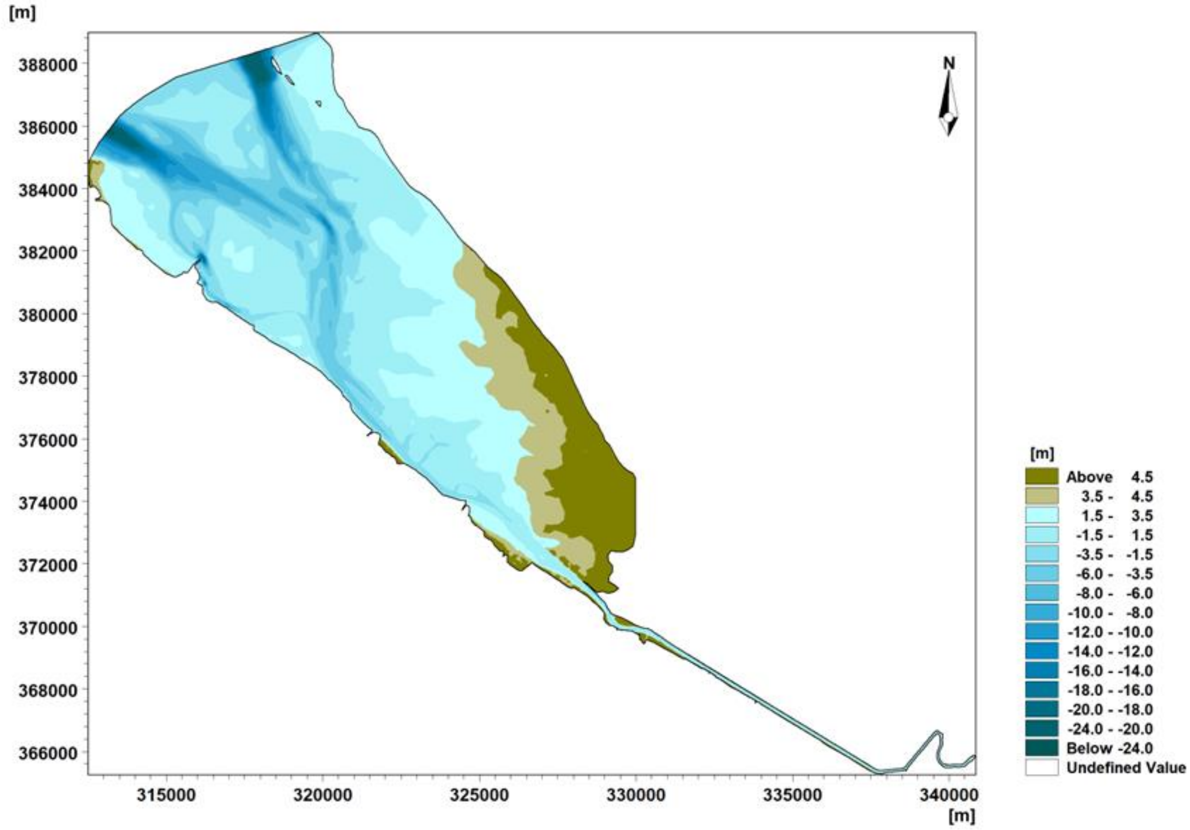
To correctly represent the observed surface currents and salinity variations, the model was set up with four vertical sigma layers, with the bottom and top layers occupying 40 and 10% of the flow depth respectively.

Model bathymetry

Bathymetric data from the sources described in Section Bathymetric data were combined and transformed to ODN and the BNG geographic coordinates system. Due to the comprehensive cover provided for the site and the River Dee, the August 2021 survey was used to create the model bathymetry. These data were interpolated onto the model mesh.

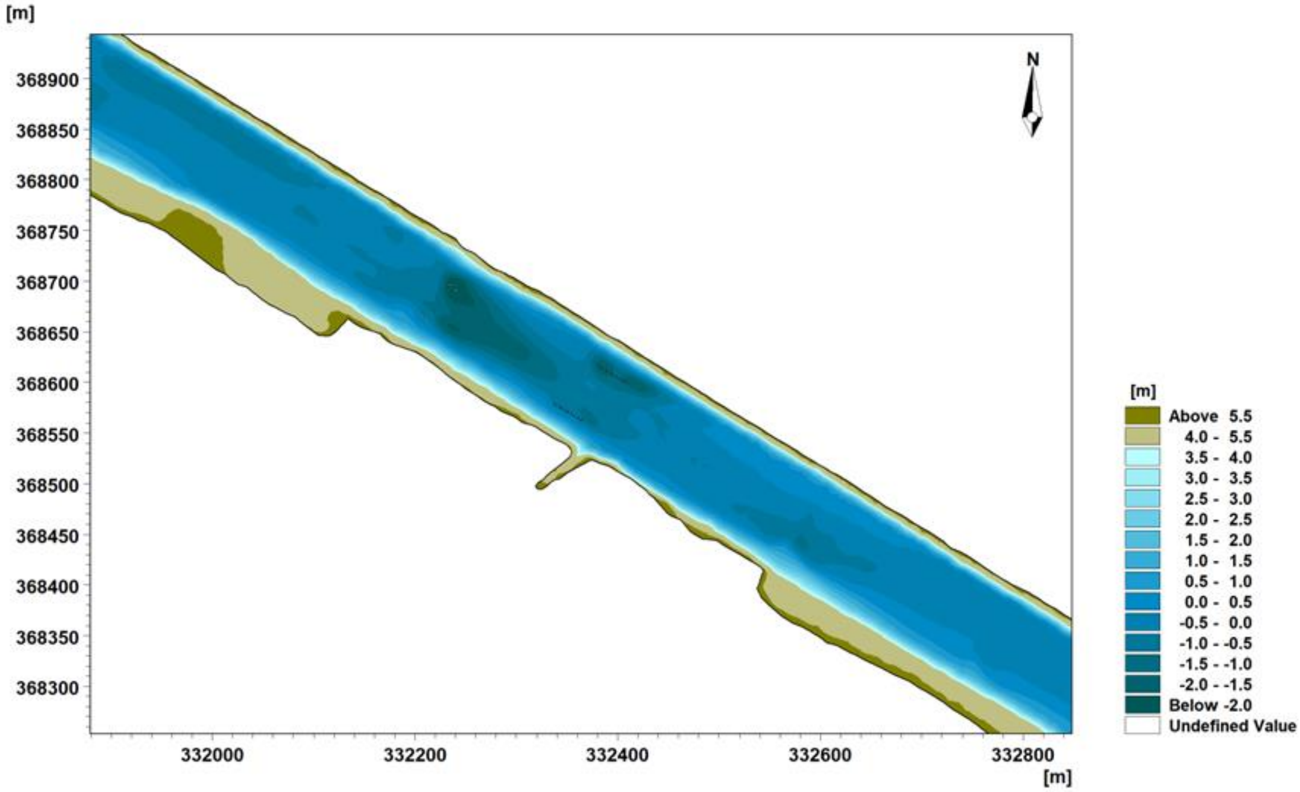
Figure 1-28 and Figure 1-29 show the model bathymetry of the whole model domain and the detailed bathymetry of the study area.

Figure 1-28 Model bathymetry for the whole model domain.



Source.: Mott MacDonald, 2021

Figure 1-29 Detailed model bathymetry in the study area.



Source: Mott MacDonald, 2021

Figure 1-28 show the two deep (> -20 m ODN) main channels in the mouth of the estuary with additional tidal channels leading towards the inner estuary. Large intertidal areas and saltmarsh with elevations above 3.5 m ODN are observed in the inner estuary. Figure 1-29 shows evidence of scour at the site, with bed levels at around –2 m ODN around the pier structures of both A594 and Jubilee bridges. The bed level of the central channel is between 0 and -1 m ODN, with a steep slope to the intertidal areas above 4 m ODN.

Model boundary conditions

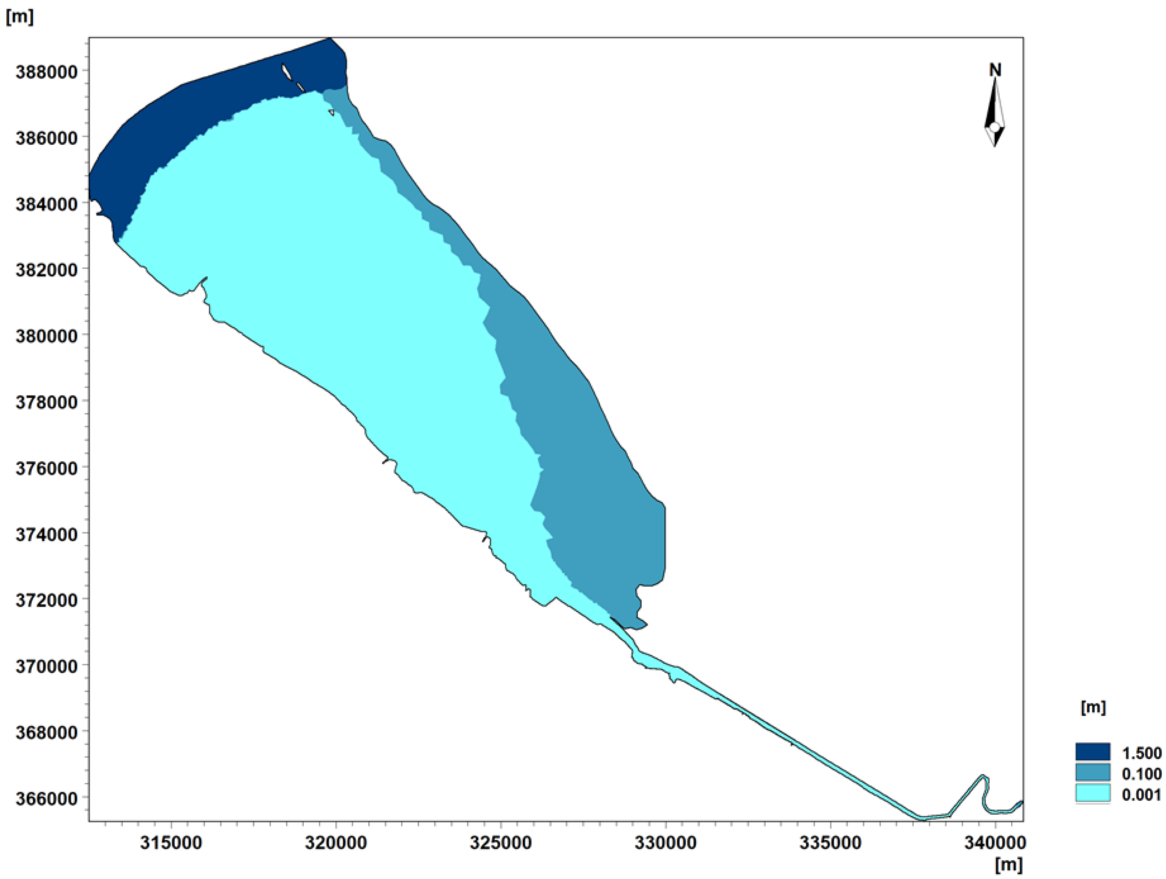
Two boundary conditions are applied to the Dee model:

- The predicted tide for Hilbre Island, combined with the measured surge from Liverpool Gladstone Dock tide gauge (Section Water levels), provided the offshore boundary for the model at the mouth of the Dee Estuary; and
- The mean daily river flow at Station 67027 (Ironbridge, Section River flows) defined the upstream boundary of the model at Chester Weir.

Bed roughness

Bed roughness adds friction between the moving water and the bed of the estuary, which in turn influences the current speeds and water levels. Following the standard modelling procedure, several iterative sensitivity tests were undertaken in which the bed roughness was varied between 0.1 and 0.001 m. In the final simulation, bed roughness for most of the estuary was defined as 0.001 m, with the saltmarsh areas given a roughness value of 0.1 m that reflect the vegetation effects on the flow. A roughness of 1.5 m was applied at the boundaries to prevent unrealistic flows and ensure boundary stability. The final bed roughness map is shown in Figure 1-30 .

Figure 1-30 Bed roughness (m) map for the model domain.



Source: Mott MacDonald, 2021

Eddy viscosity

Eddy viscosity expresses the distribution of shear stress in a fluid and is related to the amount of flow turbulence. The present model selected horizontal eddy viscosity with a constant Smagorinsky (CS) formulation with the recommended CS value of 0.28. The boundary value was set to 0.9 to ensure model stability.

Temperature and salinity module

The temperature/salinity (TS) module is invoked from the specification in the model of the baroclinic density, which depends on temperature and/or salinity. In this case, due to the freshwater input from the River Dee, the model density was set to be a function of salinity only. The TS module sets up additional transport equations for salinity, and the calculated salinity is feed-back to the hydrodynamic equations to express the buoyancy forcing induced by density gradients. A salinity of 32 PSU was applied to the offshore boundary and 0 PSU to the upstream boundary. A ‘warm up’ period was used to derive an initial condition salinity map, and the model was run for several tides.

Structures

The existing Bridge piers were included in the model as sub-grid features with a diameter of 1.2 m.

Hydrodynamic model calibration and validation

The model calibration and validation process optimises the predicted and observed values agreement. Noting the constraints imposed by the specific model application and data limitations, model calibration involves varying model parameters, boundary conditions, bathymetry and bed roughness to reproduce measured data at key locations within the model domain as accurately as possible.

By keeping the same model parameters/setup derived during the calibration, model validation is progressed to establish that the model can replicate the hydrodynamic processes from a different period and/or location with the required accuracy. This approach is widely accepted as demonstrating that the model is robust enough to be applied in subsequent simulations of different periods or input conditions.

Performance Criteria

Whether an established model provides a sufficiently accurate description of the environment depends on the specific objective for the individual model. Traditionally, performance evaluation has been based on visual comparisons, e.g., time-series plots or instantaneous plan/transect plots of modelling results and monitoring data.

Simple statistics that demonstrate the agreement between measured/observed data and model prediction at a chosen location in the model domain include the mean and peak differences (often expressed as a percentage) and the standard deviation. More recently, a quantitative approach for performance control has been introduced, whereby the general discrepancy (or match) between model and monitoring data is expressed numerically.

Following the specifications for the present study, the "Guidance on Setup, Calibration, and Validation of Hydrodynamic, Wave, and Sediment Models for Shelf Seas and Estuaries" (Williams & Esteves, 2018), is utilised to assess the calibration and validation performance of the hydrodynamic model. This approach uses the Root Mean Square Error (RMSE), a measure of the residuals between the model prediction and measured observation. A smaller value indicates a better agreement.

Table 1-8 summarises a minimum level of performance for coastal and estuarine models.

Table 1-8 Statistical guidelines to establish calibration standards for a minimum level of performance for coastal and estuarine hydrodynamic and sediment models

Predictions	RMSE	Bias	R^2	SI
Water level (coast)	± 10 % of the measured level.	< 0.10	> 0.95	< 10%
Water level (estuary)	± 10 % (mouth); ± 25 % (head) of the measured level.	< 0.20	> 0.95	< 15%
Water level phase (coast)	± 15 % of the measured phase.	< 0.20	> 0.90	< 20%
Water level phase (estuary)	± 15 % (mouth); ± 25 % (head) of the measured phase.	< 0.25	> 0.90	< 20%

Predictions	RMSE	Bias	R^2	SI
Average current speed	± 10 % to 20 % of the measured speed.	< 0.10	> 0.95	< 10%
Peak current speed	Within <0.05 m/s (very good), <0.1 m/s (good); <0.2 m/s (moderate) & < 0.3 m/s (poor) of the measured peak speed.	< 0.15	> 0.90	< 15%
Current direction (coastal)	± 10° of the measured direction.	< 0.25	> 0.90	< 20%
Current direction (estuary)	± 15° of the measured direction.	< 0.30	> 0.90	< 20%
Bed shear stress	± 10 % N/m^2 of the measured mean stress.	< 0.10	> 0.95	< 10%
Mean SPM concentration	± 20 % of the mean measured SPM concentration	< 0.20	> 0.90	< 20%

Source: Williams & Esteves, 2018

Model calibration

The HD model calibration was undertaken using the water level, current and salinity data, described in Chapter 2, for the spring tide period between August and September 2021:

- Water level calibration: 08/09/2021 23:50 to 10/09/2021 23:50; and
- Current speed and salinity calibration: 10/08/2021 00:00 to 12/08/2021 00:00.

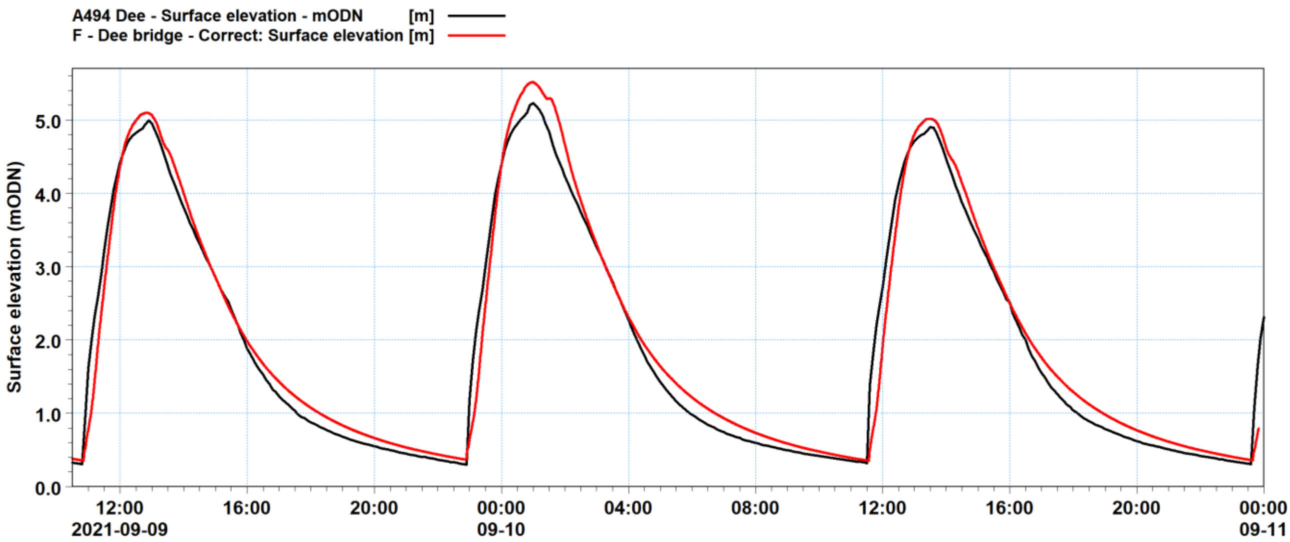
The calibration period covered two days (4 tides). During the calibration process, bed roughness, eddy viscosity, bathymetry and boundary conditions were adjusted iteratively to obtain the best agreement between measured and predicted values.

Water levels

The water levels predicted by the model were compared with the measured tides at the site (Figure 1-31). The error statistics expressing agreement between the observed and simulated water levels are shown in Table 6-9. The water level calibration is considered good, with the model generally representing the shape of the tide correctly and only slightly overestimating the second high water.

The statistics and visual results show excellent levels of agreement with a small RMSE value, 5.2 % (0.26 m) of the spring tide tidal range (4.9 m), with an R2=0.98. As per Table 1-8 , the modelled water levels in an estuary are expected to have 10 % RMSE and a R^2 >0.95, and therefore, the model results exceed these criteria.

Figure 1-31 Comparison between measured (black line) and predicted water levels (red line) for the spring tide at the A494 Bridge from 08/09/2021 23:50 to 10/09/2021 23:50.



Source.: Mott MacDonald, 2021. Contains Partrac data, 2021

Table 1-9 Summary of model calibration statistics for surface elevation at the A494 Bridge

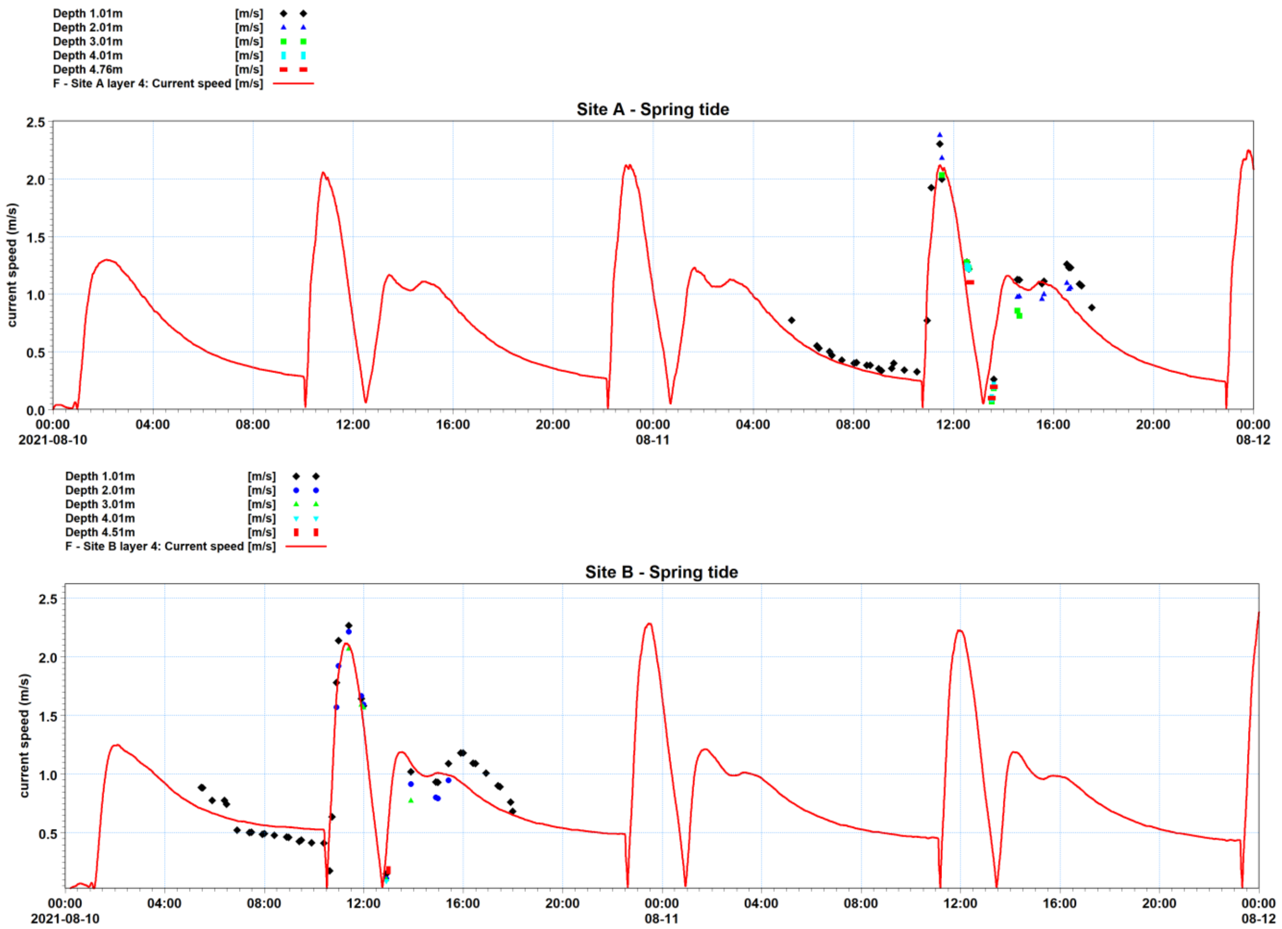
Station	RMSE(m)	Bias(m)	STD(m)	R^2	SI
A494 Bridge	0.26	-0.07	0.25	0.98	0.99

Source: Mott MacDonald, 2021.

Current speeds

The MIKE3 FM HD model was also calibrated against measured current speed data. Figure 1-32 shows that the model reproduces the current speed at both sites well. The results show that the model surface layer (red line) tends to slightly underpredict the current speed, mainly during flood tide, by around 0.2 m/s, compared to the near-surface current measurement (black points) at both sites.

Figure 1-32 Comparison between observed (point) and simulated (red line) spring current speed at Sites A and B. The observed data is plotted at different depths, while the model data is extracted from the surface layer (i.e. the upper 10% of the water depth).

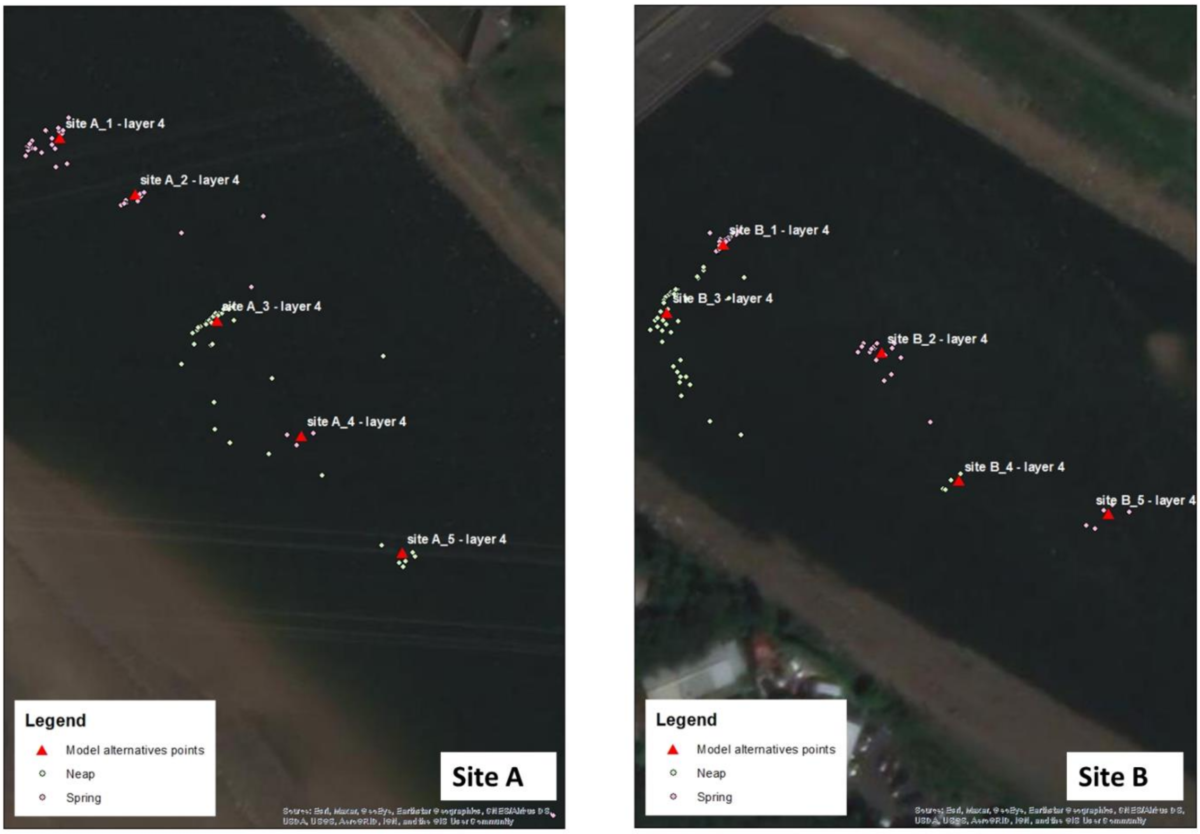


Source: Mott MacDonald, 2021. Contains Partrac data, 2021

An improved current speed calibration of the model was achieved by accounting for the movement of the survey vessel. Figure 1-33 shows five additional locations where data were extracted from the model to account for the different vessel locations (Section Current speeds). This analysis shows that the current speeds are better represented at these alternative locations for some cases.

It is important to note that the ADCP survey vessel was continually moving during the survey, and thus the currents were measured at a different location for each survey cycle. As it was impossible to represent the movement of the survey vessel in the model (Current speeds and Figure 1-33), understanding the changes in the currents around these locations was considered adequate for the model calibration.

Figure 1-33 Movement of the boat during spring (pink points) and neap (green point) surveys at sites A and B. The red triangles show the additional current extraction locations selected to capture the boat mobility during the model calibration.

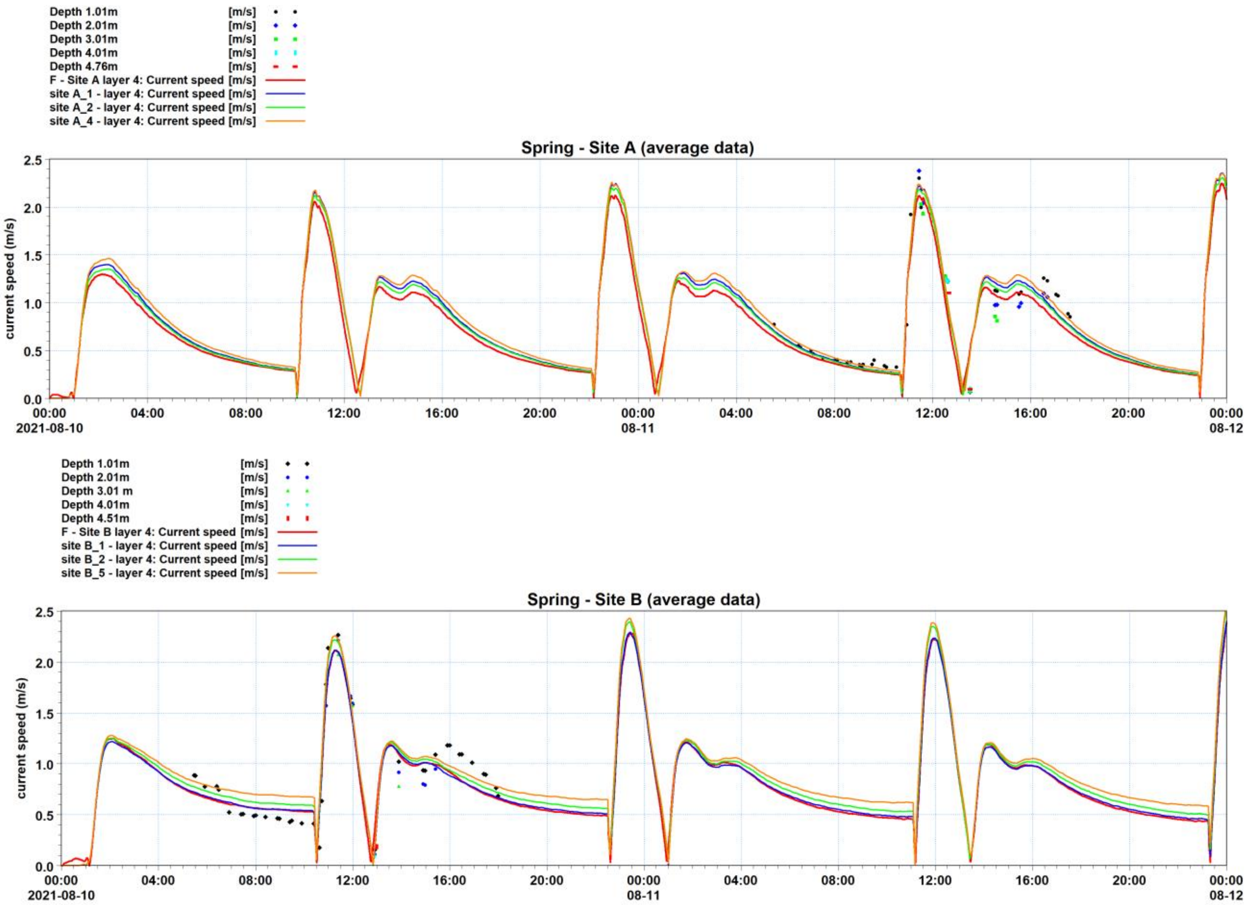


Source: Mott MacDonald, 2021. Contains Partrac data, 2021

A comparison between observed (point) and simulated (red line) spring current speed at Site A and Site B, including alternative extraction locations, is shown in Figure 1-34 .Table 1-10 summarises the model performance metrics of all current results for the calibration period for sites A and B. Some alternative model data extraction locations are better at reproducing the measured surface current speeds (e.g. A_4 and B_2).

At all locations, the RMSE is low (0.15 to 0.19 m/s), which corresponds to the 6.5 to 8.7% of peak speeds of 2.3 m/s. According to the guidance (Table 1-8), peak currents RMSE within <0.2 m/s is considered moderately good, with $R^2 > 0.90$. The model results for some alternative locations comply with the guidance of model performance.

Figure 1-34 Comparison between observed (point) and simulated (red line) Spring current speed at sites A and B, including alternative extraction locations. Please note that the observed data are plotted at different depths, while the model data is extracted from the surface layer.



Source: Mott MacDonald, 2021. Contains Partrac data, 2021

Table 1-10 Summary of model calibration statistics for surface spring current at Sites A and B.

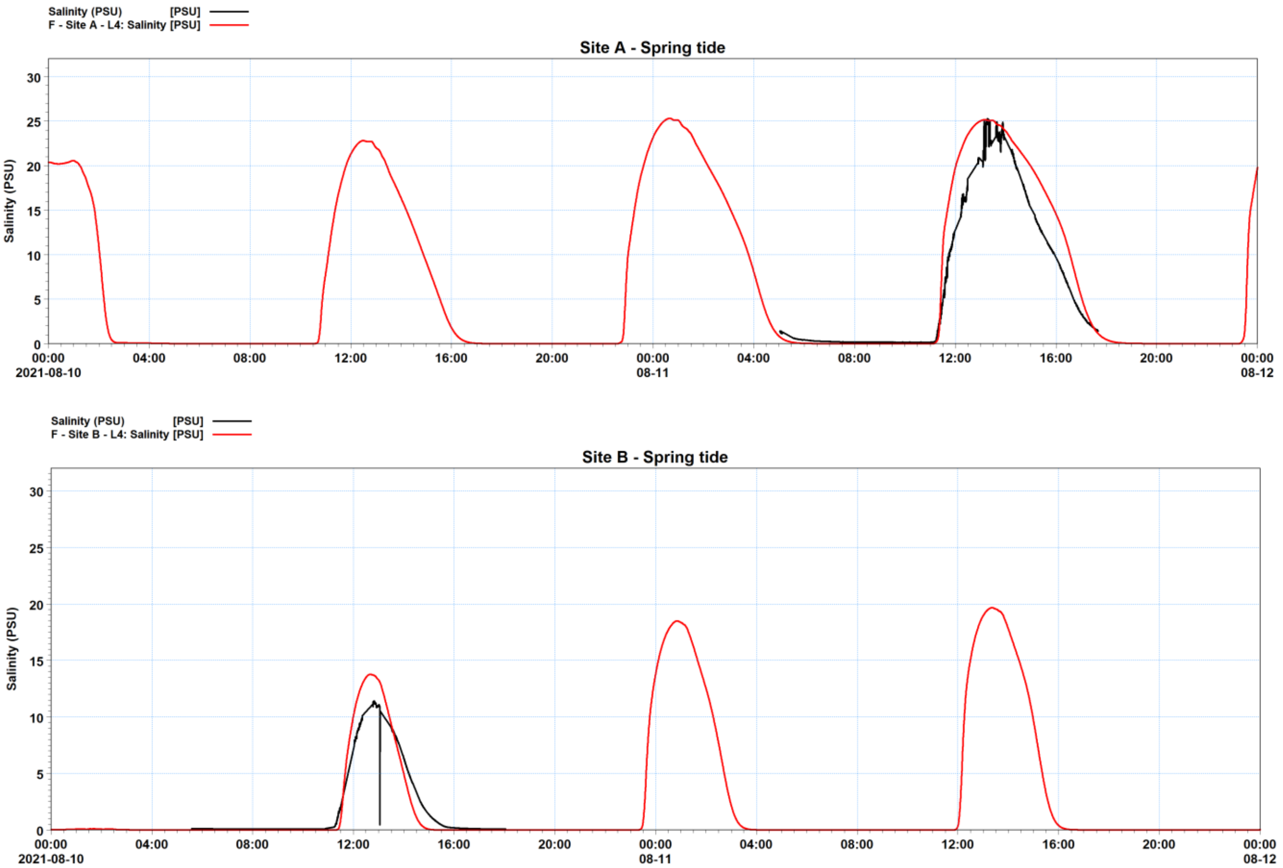
Station		RMSE (m/s)	Bias (m/s)	STD (m/s)	R^2	SI
Site A		0.19	0.08	0.17	0.90	0.97
Alternative locations	A_1	0.16	0.04	0.16	0.91	0.98
	A_2	0.17	0.05	0.16	0.91	0.97
	A_4	0.15	0.00	0.15	0.92	0.98
Site B		0.16	0.02	0.16	0.92	0.97
Alternative locations	B_1	0.16	0.02	0.16	0.92	0.97
	B_2	0.16	-0.03	0.16	0.92	0.97
	B_5	0.18	-0.08	0.16	0.91	0.96

Source: Mott MacDonald, 2021.

Salinity

The final part of the HD model calibration considered salinity. Figure 1-35 shows the measured salinity at 1 m below the surface (black line) and the near-surface modelled salinity (red line) at site A and site B. Based on a visual comparison, the model reproduces the correct magnitude and salinity patterns at site A. At site B, the model overestimates the salinity values by around 3 PSU. At both sites, the model performance is deemed to be acceptable.

Figure 1-35 Comparison between observed (black line) and simulated (red line) Spring salinity values at sites A and B. Please note that the observed data corresponds to 1 m depth, while the model data is extracted from the surface layer.



Source: Mott MacDonald, 2021. Contains Partrac data, 2021

Model validation

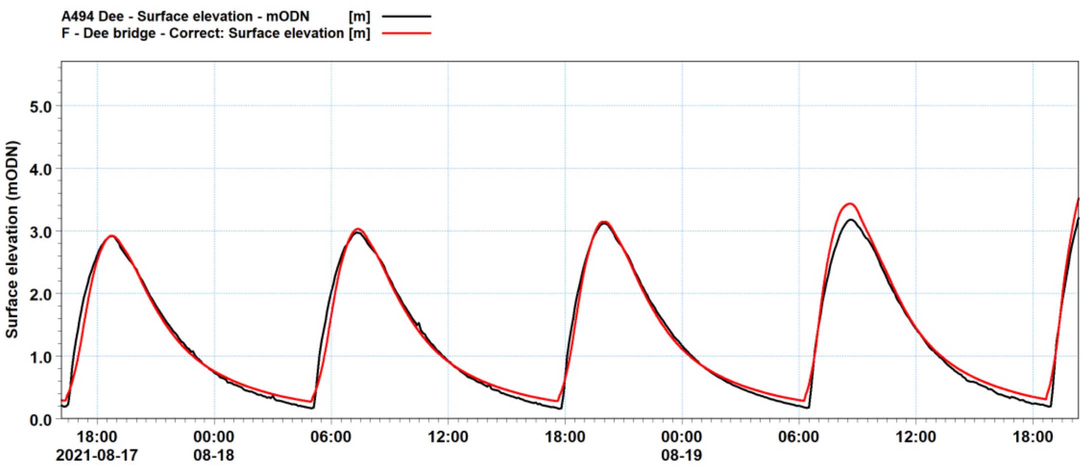
Model validation is usually undertaken after calibration using either observed data from a different date or a different location within the model domain and is used to test if the model still predicts water levels and/or tidal currents correctly. In the present study, validation was undertaken during a 2.5 day (five tides) neap tide period between the 17th and 19th August 2021.

Water levels

For the model validation, simulated water levels during the selected neap tide period were compared to the measured data at the site (Figure 1-36). The error statistics expressing agreement between the observed and simulated water levels are shown in Table 1-11 .

The water level validation is considered good. Although slightly overestimating the last high water, the model correctly represents the tide's shape. The statistics and visual results show very good levels of agreement with a small RMSE value, 4.1 % (0.13 m) of the spring tide tidal range (3.02 m), and an R2=0.98. Therefore, the model performance metrics are within the requirements set by the guidance in Table 1-8 (RMS <10%, R2>0.95).

Figure 1-36 The observed (black line) and simulated water levels (red line) for the neap tide at the A494 Bridge on 17th and 19th August 2021.



Source: Mott MacDonald, 2021. Contains Partrac data, 2021

Table 1-11 Summary of model validation statistics for the neap surface elevation at the A459 Bridge on 17th and 19th August 2021.

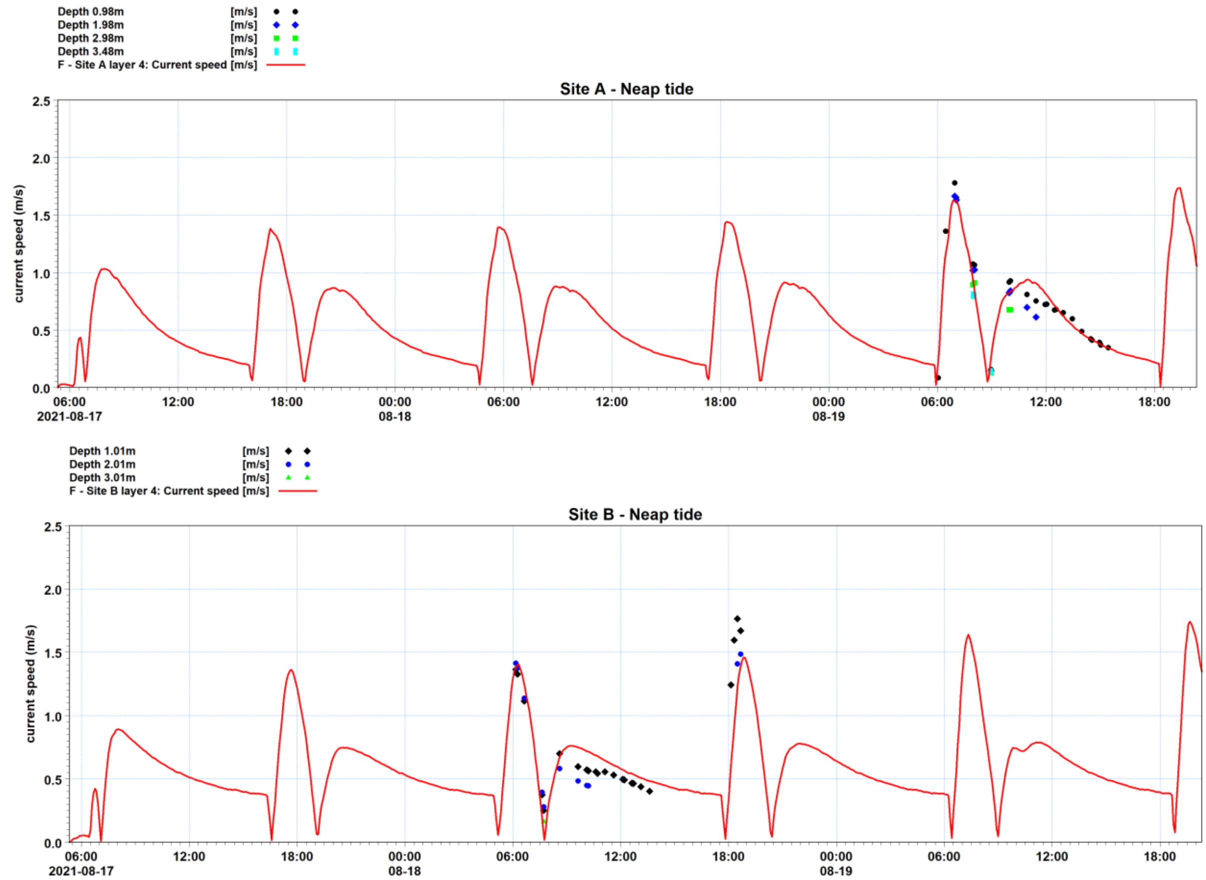
Station		RMSE (m)	Bias (m)	STD (m)	R^2	SI
A459 Bridge		0.13	-0.03	0.12	0.98	0.99

Source: Mott MacDonald, 2021.

Current speeds

Current speed data obtained between 17th and 19th August 2021 were used to validate the MIKE3 FM HD model. These data were compared with the surface current speed from the model at the same location. Figure 1-37 shows that the model represents the current speed at both sites compared to the measured data. The results show that the model surface layer (red line) tends to slightly underpredict the current speed, mainly during the flood tide, by around 0.2 m/s, compared to the most superficial current measurement (black points) at both sites.

Figure 1-37 Comparison between observed (point) and simulated (red line) neap current speed at sites A and B. The observed data are plotted at different depths, while the model data is extracted from the surface layer.

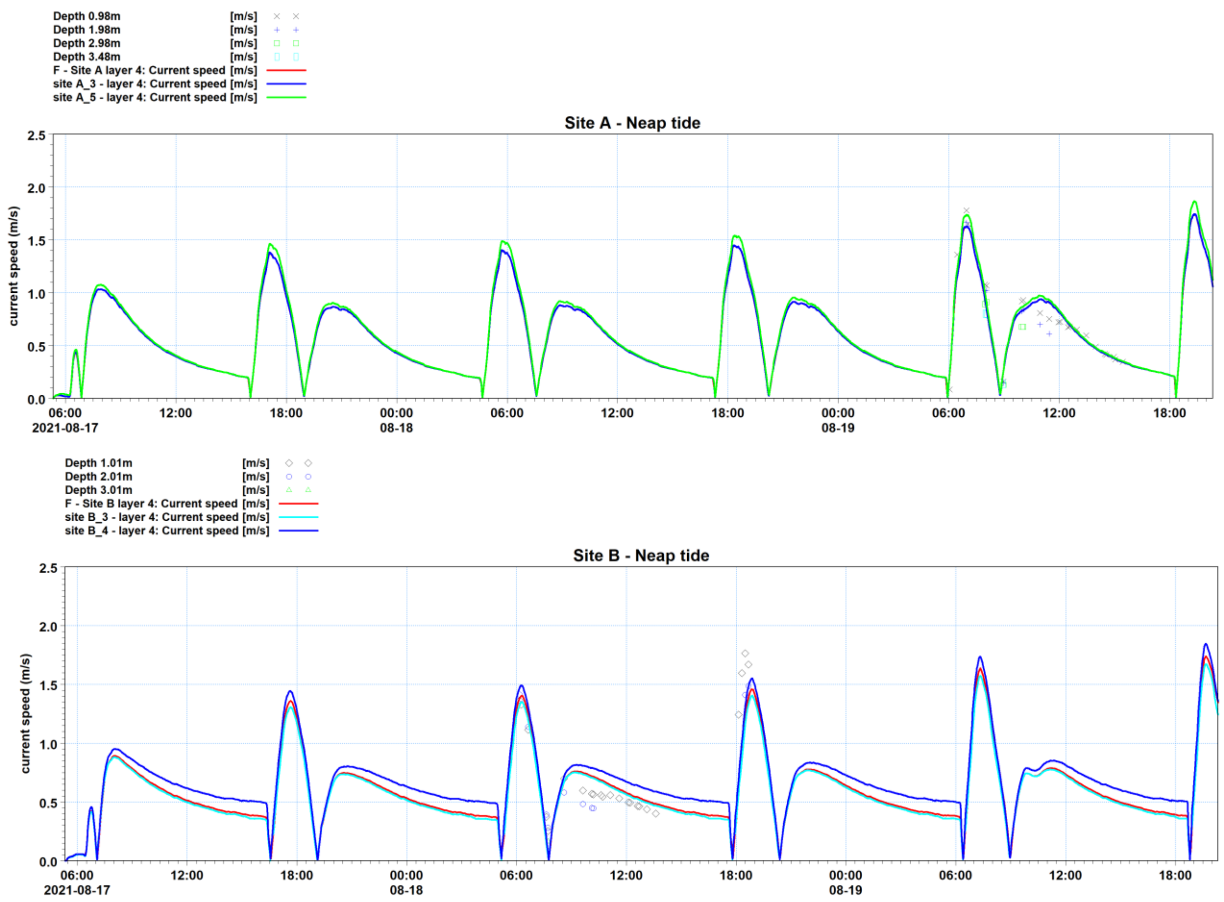


Source: Mott MacDonald, 2021. Contains Partrac data, 2021

On the spring tide, alternative locations were selected to extract neap current speeds to consider the boat movement (see previous section Figure 1-33). The model validation results for the neap tide are shown in Figure 1-38 .

Table 1-11 summarises the model performance statistics for the validation period at both sites. According to Table 1-12 at all locations, except for the alternative locations for Site B, the RMSE is relatively small and of the order of 0.16 to 0.19 m/s. These RMS values correspond to the 8.8 to 10.5% of neap peak speeds of 1.8 m/s. In common with the spring tide results, and as per model performance guidance in Table 1-8 , RMSE of peak current speeds <0.2 m/s are considered moderately good. The rest of the statistical parameters also meet the guidance requirements, except for the alternative locations of Site B.

Figure 1-38 Comparison between observed (point) and simulated (red line) neap current speed at Sites A and B, including alternative extraction locations. The observed data are plotted at different depths, while the model data is extracted from the surface layer



Source: Mott MacDonald, 2021. Contains Partrac data, 2021

Table 1-12 Summary of model calibration statistics for surface neap current at Sites A and B.

Station		RMSE (m/s)	Bias (m/s)	STD (m/s)	R^2	SI
Site A		0.129	-0.010	0.129	0.942	0.9751
	A_3	0.128	-0.008	0.128	0.940	0.976

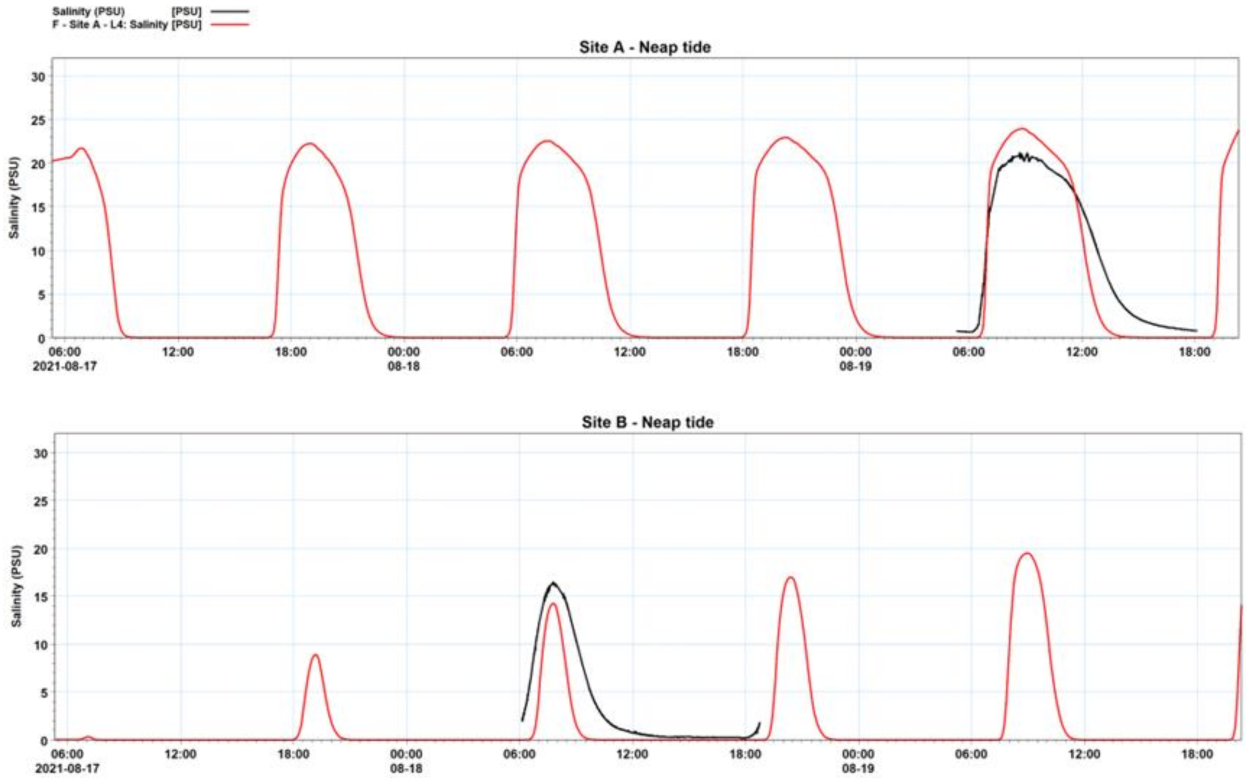
Station		RMSE (m/s)	Bias (m/s)	STD (m/s)	R^2	SI
Alternative locations Medium	A_5	0.118	-0.035	0.116	0.945	0.981
Site B		0.160	0.023	0.159	0.918	0.968
Alternative locations	B_3	0.327	-0.056	0.323	0.757	0.857
	B_4	0.363	-0.171	0.321	0.744	0.835

Source: Mott MacDonald, 2021.

Salinity

Figure 1-39 shows the salinity measured at 1 m depth (black line) and the modelled surface salinity (red line) at sites A and B during the neap tide. The salinity calibration is considered acceptable. The model reproduces the correct magnitudes and salinity patterns, overestimating salinity for the neap tide at site A and underpredicting for site B. The salinity model results are acceptable since the sites are considered well-mixed.

Figure 1-39 Comparison between observed (black line) and simulated (red line) neap salinity values at sites A and B. Please note that the observed data corresponds to 1m depth, whilst the model data is extracted from the surface layer.



Source: Mott MacDonald, 2021. Contains Partrac data, 2021

1.5 Local hydrodynamic model

Introduction

As part of this study, a local hydrodynamic model has been developed to assess the potential impacts of the proposed Bridge construction on flow patterns and sediment transport in the River Dee. The model has been configured and run for three different scenarios:

- **Scenario 1 (Existing Bridge only)** – this scenario represents the current conditions, with the existing Bridge in place and no construction activities. It serves as the baseline against which changes due to construction and the new Bridge can be assessed.

- **Scenario 2 (Existing Bridge with the new Bridge in place)** – this scenario includes the existing Bridge along with the proposed new Bridge.

- **Scenario 3 (New Bridge only)** – this scenario represents the final configuration, where the new proposed Bridge is in place and the existing Bridge piles are removed.

To study in detail, the area immediately upstream and downstream of the A494 Bridge, a local MIKE3 FM HD model with a smaller and more detailed domain able to resolve individually the existing piles of the Bridge was set up. This model is described below and was driven using boundary conditions derived from the calibrated regional model described in Chapter 1.4. The primary objective of this model was to provide the hydrodynamics required to drive the MIKE Sand Transport (ST) model used in this study to determine the non-cohesive sediment (sand) regime and the potential changes to the local bathymetry, tidal flows and sediment regime attributable to the Bridge piers (Section 1.9).

Model setup

The local model setup follows almost the same process as the one described in Section 1.4 for the regional model. However, several changes were necessary, these are described below. For the parameters that remain the same as per the regional model, please refer to Section 1.4.

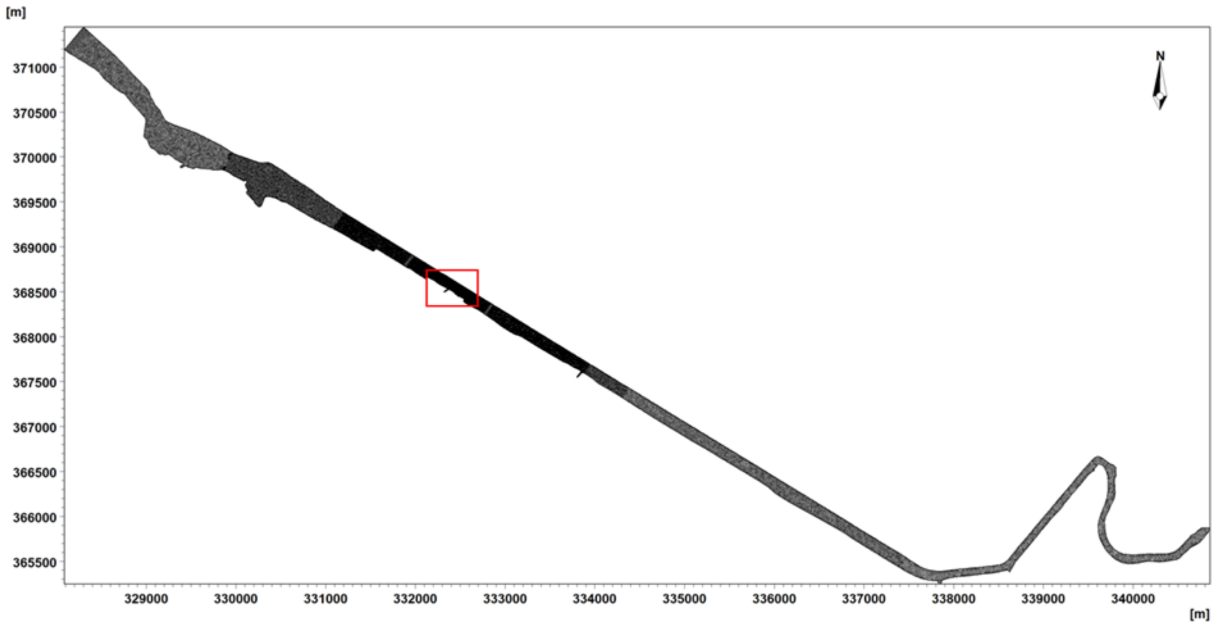
Horizontal and vertical references

In common with the regional model, the local model was set up using ‘British National Grid’ (BNG), based on the OSGB36 horizontal datum. The vertical reference datum used was ODN, defined as being +4.93 m above CD at Hilbre Island.

Local model mesh and extent

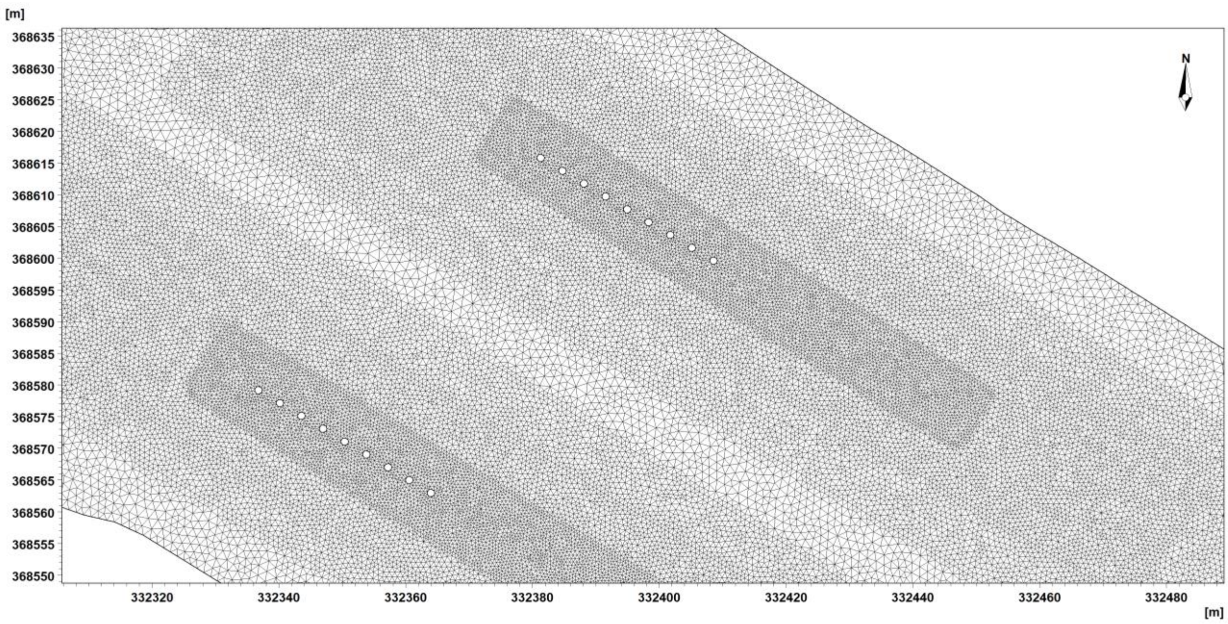
The local MIKE3 FM HD model mesh extends from the Dee training wall to the weir in Chester. Figure 1-40 and Figure 1-41 show the overall model mesh and details of the high resolution around the Project site, respectively. The local model mesh is generally fine, with a resolution of approximately 15 m at the training wall to 0.5 m at the A494 Bridge sufficient to resolve the existing and proposed piles of the Bridge adequately.

Figure 1-40 Local MIKE3 FMHD model domain and mesh



Source.: Mott MacDonald, 2025

Figure 1-41 Refined local MIKE3 FMHD model mesh near the A494 Bridge showing the existing Bridge piles.



Source: Mott MacDonald, 2025

Model vertical layers

The local model has three different vertical layers and the depth of each one is shown in Table 1-13 .

Table 1-13 Model vertical sigma layers for the simulations of the local model calibration.

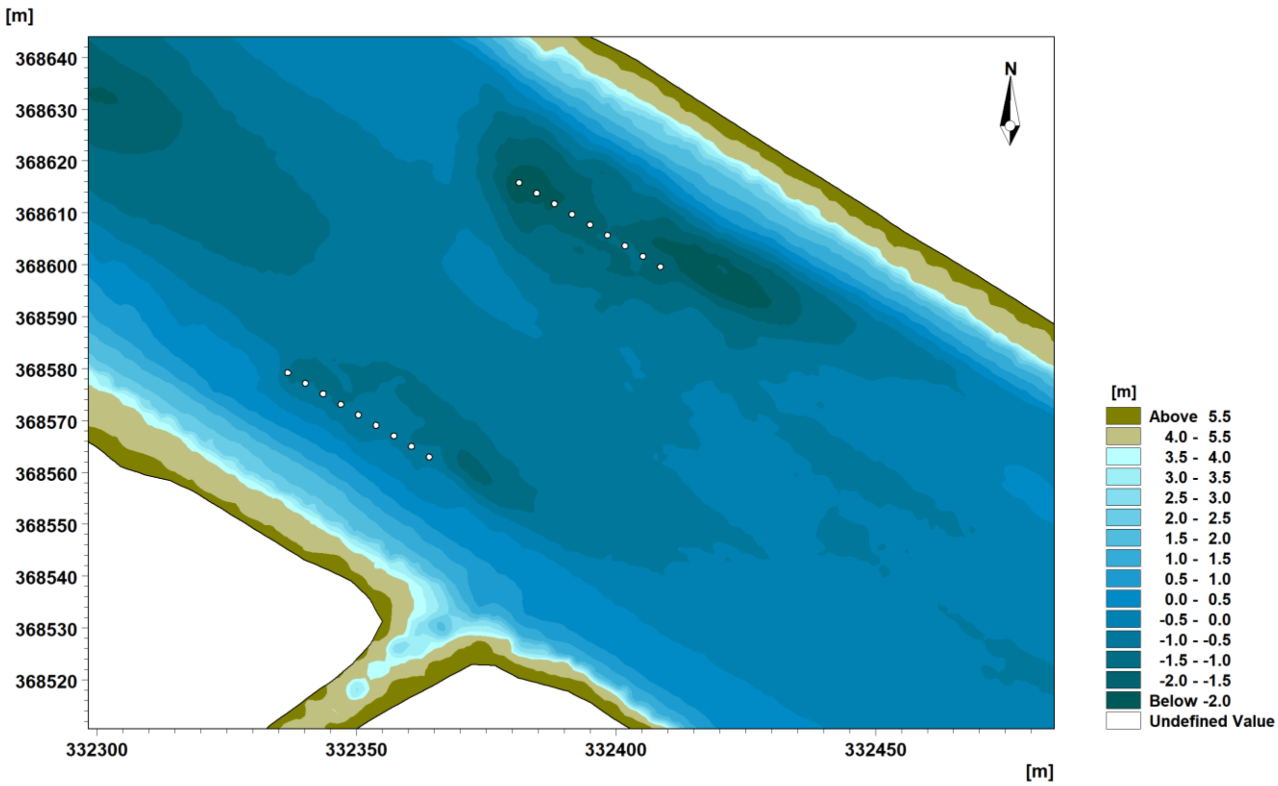
Layer	Sigma layer thickness (% of depth)
Layer 1 (bottom)	10
Layer 2	80
Layer 3 (top)	10

Source: Mott MacDonald, 2021

Model bathymetry

The local model bathymetry used the same dataset described in the Bathymetric data section and the regional model setup. The data were interpolated onto the local model mesh to define the bathymetry across the local model domain. Figure 1-42 shows the detailed bathymetry around the pile structures in the study area.

Figure 1-42 Detailed model bathymetry in the study area, derived from August 2021 survey data. Please note the scour hole around the pile structures.



Source: Mott MacDonald, 2021

Model boundary conditions

To ensure that the tidal flows and water levels are correctly represented in the local model, two boundary conditions were applied:

- An offshore boundary at the River Dee Training Wall obtained from the regional model; and
- An upstream boundary at Chester Weir, defined by the daily NRFA mean river flows for Station 67027 (Ironbridge, River flows).

Bed roughness and eddy viscosity

Both parameters were kept the same as those used in the regional model setup (Sections Bed roughness and Eddy viscosity, respectively).

Temperature and salinity module

The salinity boundaries and initial conditions are derived from the regional model and applied to the local model domain and boundaries.

Structures

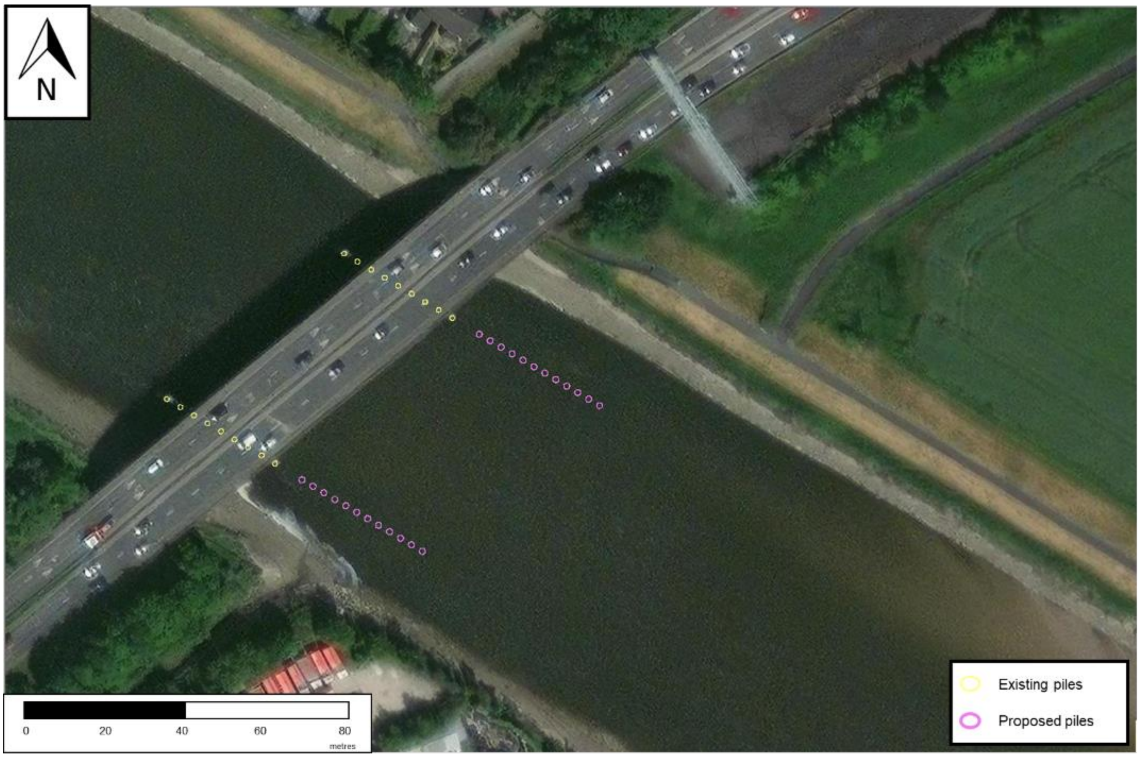
Baseline ("existing")

The existing Bridge, which includes 9 piles with a diameter of 1.2 m, and the Jubilee Bridge piles located approximately 150 m to the west (downstream) of the A494 Bridge, were included in the local mesh (Figure 1-41).

Proposed

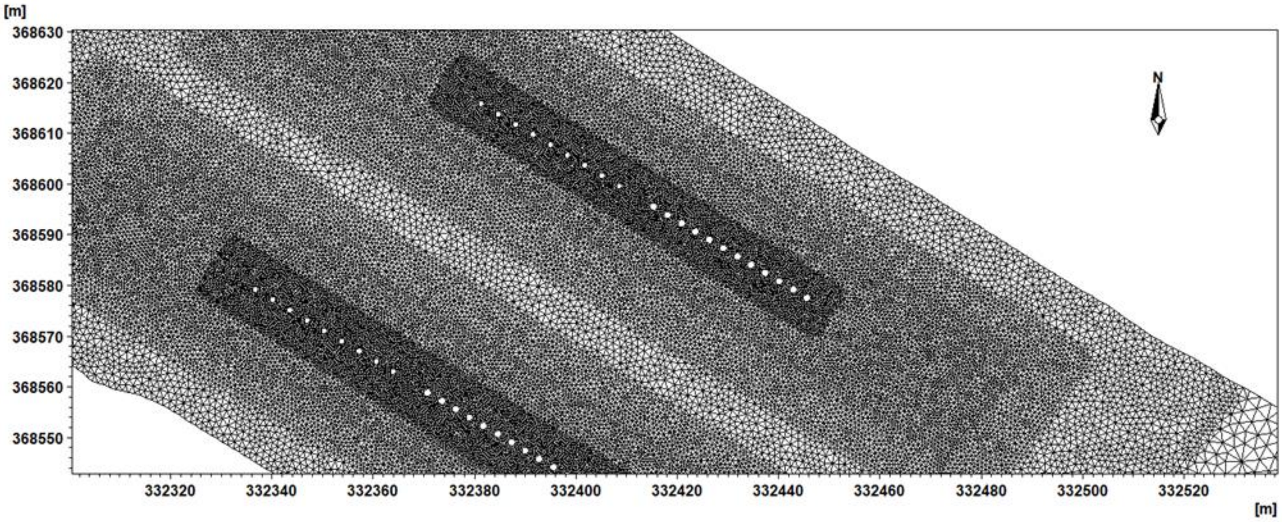
The proposed Bridge layout includes 12 piles with a diameter of 1.5 m. These new piles (pink circles in Figure 1-43) are included in the local model mesh (Figure 1-44).

Figure 1-43 Existing (yellow) and proposed (pink) A494 Bridge piles.



Source.: Mott MacDonald, 2025

Figure 1-44 Refined local MIKE3 FM model mesh with existing and proposed Bridge piles.



Source: Mott MacDonald, 2025

Please note that the design includes not only piles but also concrete capping, located above the piles and submerged for part of the tidal cycle. Due to the model limitations, both the piles and the concrete capping cannot be included in the model simultaneously. However, since this part of the structure is not in contact with the bed and only affects the upper part of the water column, it can be excluded without affecting the key sediment transport processes simulated by the model.

The validity of this modelling simplification was examined in a series of sensitivity tests showing that the piles cause more disruption to the flow than a solid structure aligned with the flow. Therefore, implementing only, the piles in the local model represents the worst-case regarding sediment transport.

Hydrodynamic model calibration and validation

Model calibration

Calibration of the local model was undertaken using water level, current and salinity data, described in Section Data, for the spring tide period between August and September 2021:

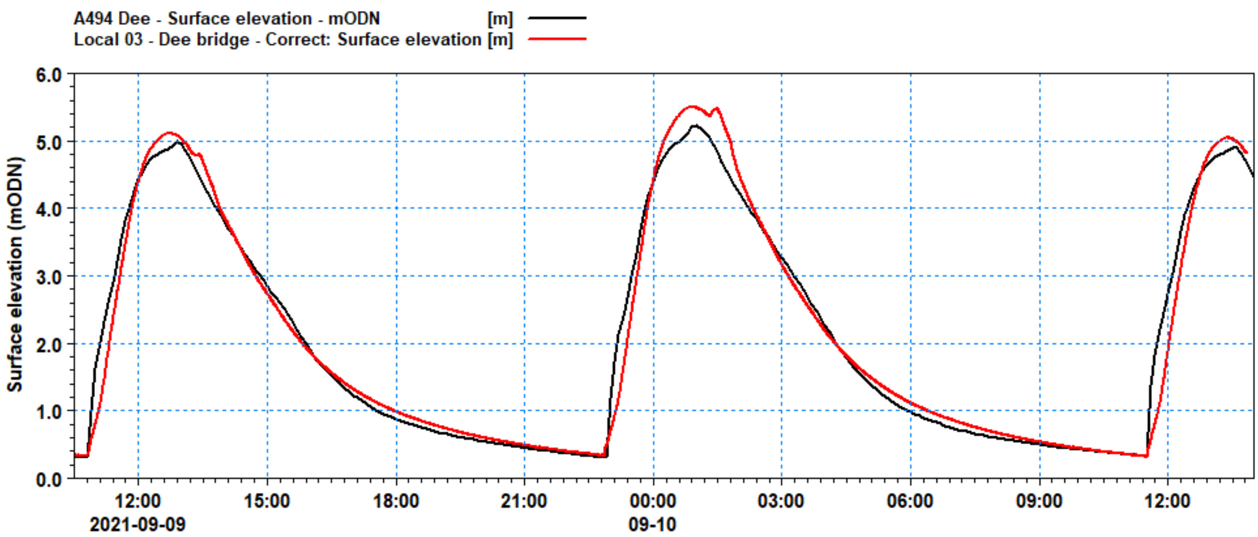
- Water level calibration: 08/09/2021 23:50 to 10/09/2021 23:50; and
- Current speed and salinity calibration: 10/08/2021 00:00 to 11/08/2021 14:00.

The calibration period covered 1.5 days (three tides). During the calibration process, bed roughness, eddy viscosity, bathymetry and boundary conditions were adjusted iteratively to obtain the best model performance.

Water level

The water level calibration of the local model was very similar to the one obtained for the regional model. The calibrated local model represents the shape of the tide correctly, with only a slight overestimation of the second high water level (Figure 1-45). The error statistics expressing agreement between the observed and simulated water levels are shown in Table 1-14 . The statistics and visual results show excellent levels of agreement with a small RMSE value, 5.4 % (0.27 m) of the spring tide tidal range (4.9m), and R^2 = 0.976. As per the model performance guidance (Table 1-8), the modelled water levels in an estuary are expected to have 10% RMSE and R^2 > 0.95, and therefore, the model calibration is considered good.

Figure 1-45 Comparison between observed (black line) and simulated water levels (red line) for the spring tide at the A494 Bridge with the local model.



Source: Mott MacDonald, 2021. Contains Partrac data, 2021

Table 1-14 Summary of model calibration statistics for surface elevation at the A494 Bridge

Station	RMSE (m)	Bias (m)	STD (m)	R^2	SI
A494 Bridge	0.27	0.00	0.27	0.98	0.99

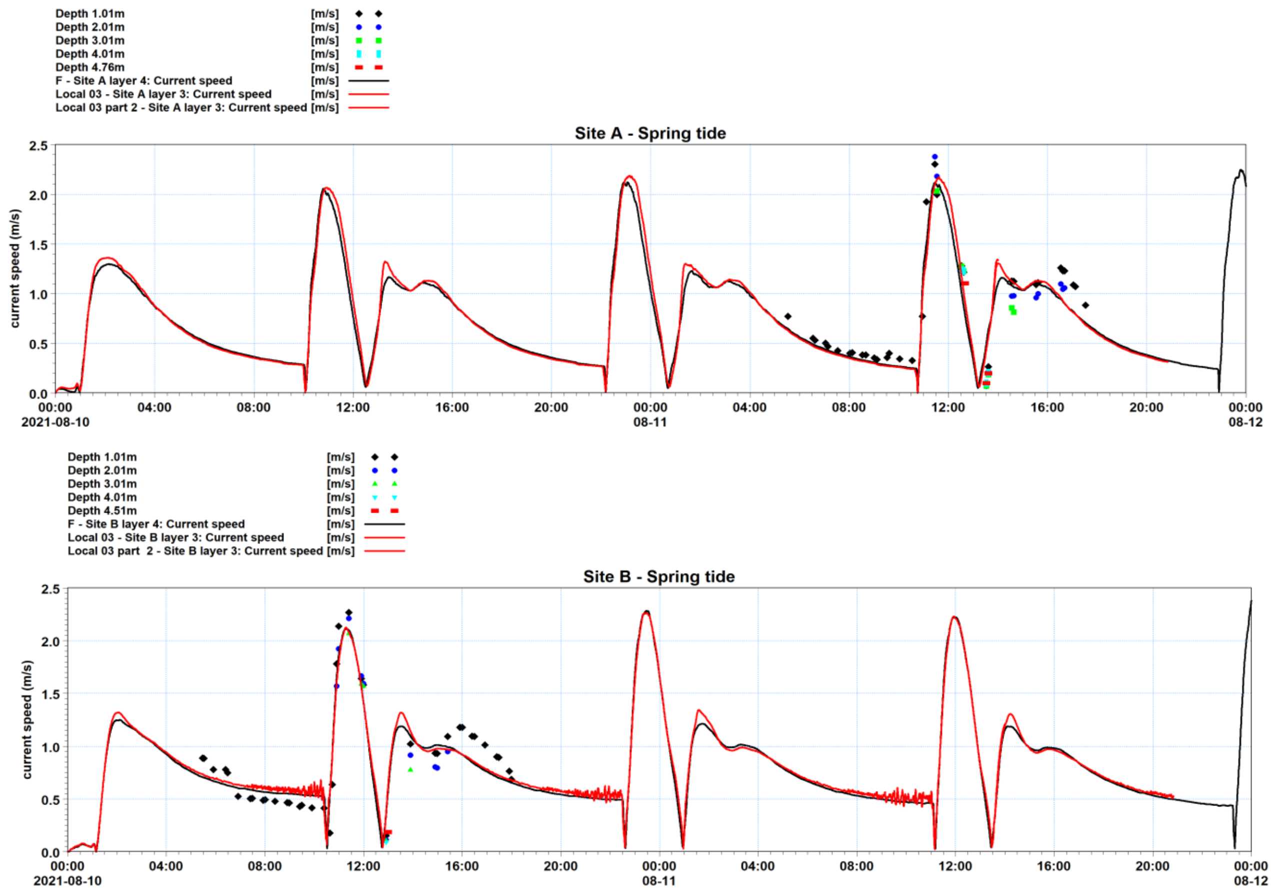
Source: Mott MacDonald, 2021.

Current speeds

The current speed calibration for the local model was very similar to the regional model. Figure 1-46 shows that the model reproduces the current speed at both sites compared to the measured data. The regional model calibration, in black, is also included in the plot for comparison. The results show that the surface layer of the model (red line) tends to slightly underpredict the current speed by around 0.2 m/s, mainly during the flood tide, compared to the most surficial current measurement (black points) at both sites.

In Figure 1-46 , small oscillations towards the end of the ebb phase, close to low water, can be observed in the model simulation. These small oscillations result from the interaction between the ebb flow and the piles and only occur in the model close to low water and for this specific point. If the point is moved, as per Figure 1-47 , the oscillations are no longer present. It is noted that this phenomenon is not recorded in the measured data due to the movement of the survey vessel.

Figure 1-46 Comparison between observed (point) and simulated (red line) Spring current speed at sites A and B. The black line represents the regional model calibration, and it is here only for comparative purposes. The observed data are plotted at different depths, while the model data is extracted from the surface layer.



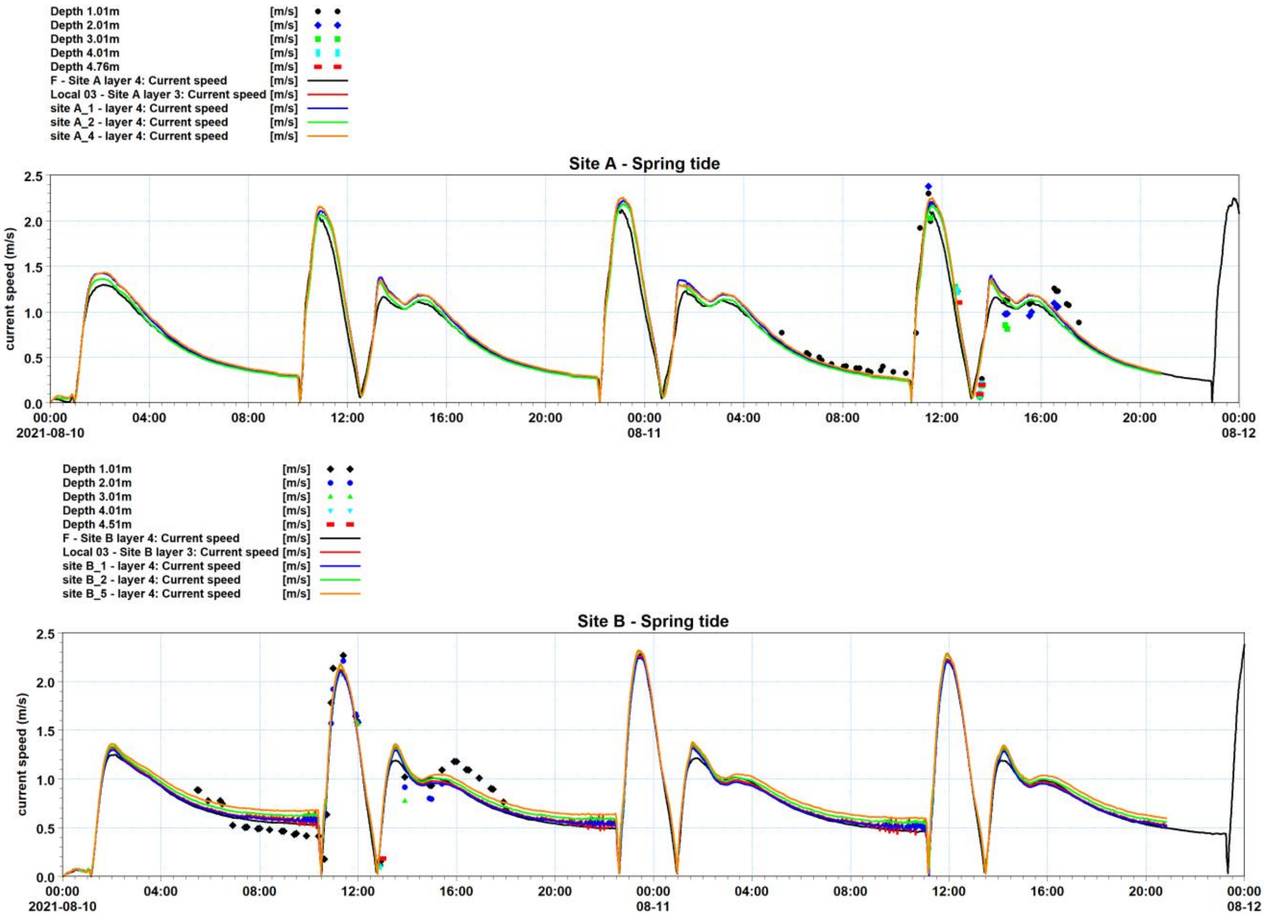
Source: Mott MacDonald, 2021. Contains Partrac data, 2021

In common with the regional model calibration, a better current speed calibration is achieved when the boat's movement is considered. Additional locations were extracted from the model results to represent the boat's movement as described in Section Current speeds and the regional model calibration (Section Hydrodynamic model calibration and validation).

The result of this analysis is shown in Figure 1-47 . Table 1-15 summarises the statistics of all results for the local model calibration period at both sites. From the figure and the table, some of the alternative model data extraction locations better represent the surface current speeds compared to the measured data (e.g. A_4 and B_2). The results in the table are similar to the regional model results, indicating that the finer mesh did not significantly improve the current speed calibration. However, this effort was not wasted since the finer resolution of the local model is required to resolve the sediment transport.

According to Table 1-15 , the RMSE is small and of the order of 0.15 to 0.19 m/s, which corresponds to the 6.5 to 8.7% of peak speeds of 2.3 m/s. According to the guidance (Table 1-8), peak currents RMSE within <0.2 m/s is considered moderately good, with R^2 > 0.90. The model results for some alternative locations compare better with the guidance of model performance.

Figure 1-47 Comparison between observed (point) and simulated (red line) Spring current speed at Sites A and B, including alternative extraction locations. The observed data are plotted at different depths, while the model data is extracted from the surface layer.



Source: Mott MacDonald, 2021. Contains Partrac data, 2021

Table 1-15 Summary of model calibration statistics for surface spring current at Sites A and B. The highlighted green shows the best statistics results.

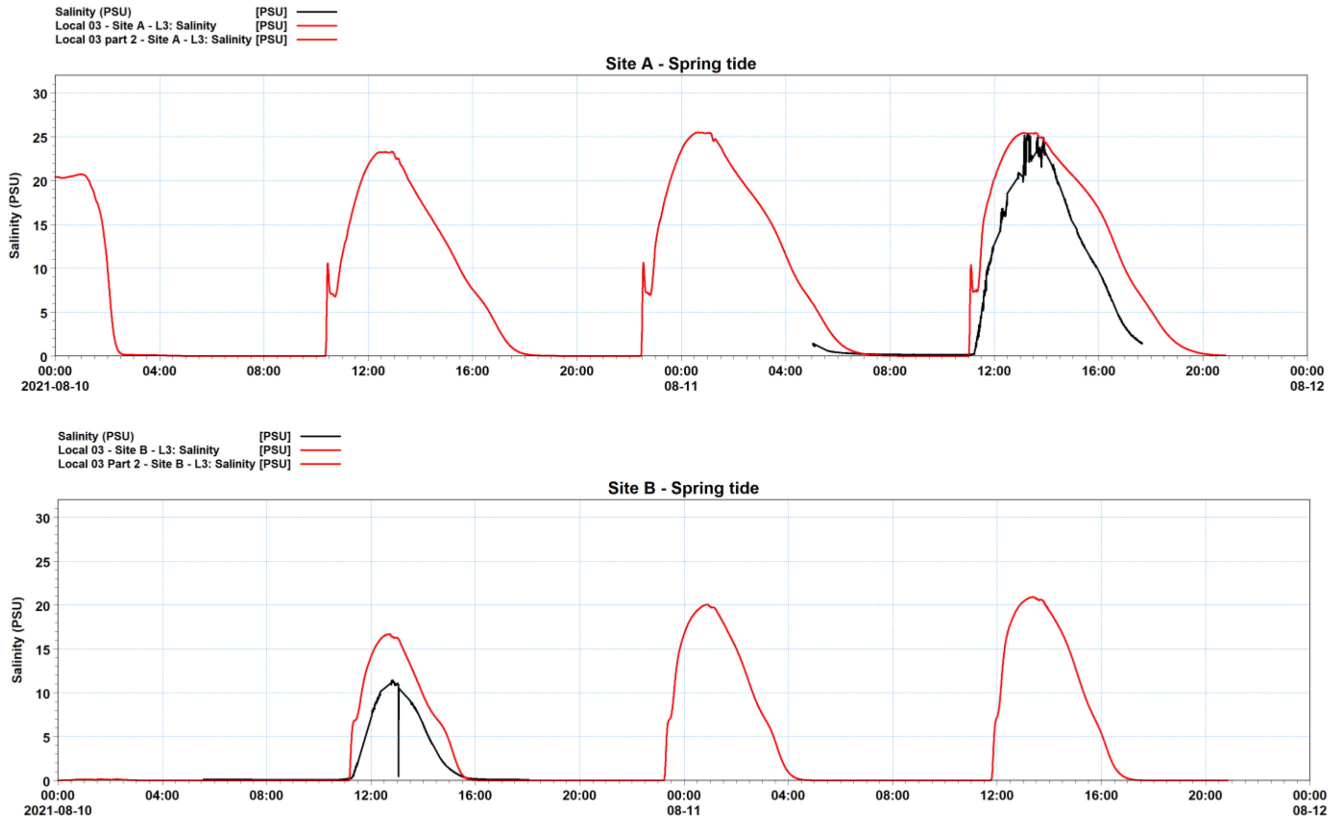
Station		RMSE (m/s)	Bias (m/s)	STD (m/s)	R^2	SI
Site A		0.19	0.09	0.16	0.91	0.97
Alternative locations	A_1	0.17	0.06	0.16	0.91	0.97
	A_2	0.19	0.09	0.16	0.91	0.97
	A_4	0.16	0.04	0.15	0.92	0.98
Site B		0.17	0.01	0.16	0.92	0.97
Alternative locations	B_1	0.17	0.02	0.17	0.92	0.97
	B_2	0.17	-0.02	0.17	0.92	0.97
	B_5	0.18	-0.06	0.17	0.92	0.96

Source: Mott MacDonald, 2021.

Salinity

Figure 1-48 shows salinity measured at 1m depth (black line) and the modelled surface salinity (red line) at Sites A and B. The salinity calibration is considered acceptable for this stage, and it is like the regional model. The model reproduces the correct magnitudes and salinity patterns. At Site B, the model overestimates the salinity values by 5 PSU.

Figure 1-48 Comparison between observed (black line) and simulated (red line) Spring salinity values at Sites A and B. The observed data correspond to 1 m depth, while the model data are extracted from the surface layer.



Source: Mott MacDonald, 2021. Contains Partrac data, 2021

Model validation

Since the parameter settings required to calibrate the local model were very similar to the regional model, it was considered safe to assume that the validation of the local model would be equal to the regional model. Thus, no validation of the local model was considered necessary.

Sediment transport modelling

To predict and understand sand transport at the site and the potential changes to the sediment regime the proposed scheme might cause, a MIKE3 Sand Transport (ST) model was set up. The local MIKE3 FMHD model provided the hydrodynamics required to drive the MIKE3 ST model.

MIKE3 ST requires information on the physical characteristics of the bed sediments. However, only limited information on the sediment properties was available for the river Dee and the site (Section Sediment processes). The sand transport model was, therefore, set up with the grain size map shown in Figure 1-49 and with the following assumptions:

a) A median grain size (D_{50}) of 0.2 mm was selected for the main channel, with the intertidal areas defined by D_{50} = 0.1 mm (Figure 1-49). A grading of 1.7 corresponding to medium sand was selected;

b) The sediment was assumed to be silica sand with a density of 2650 kg/m^3. The sand depth is unlimited and available throughout the whole model domain except for the structures in the river, such as groynes, revetments and training walls;

c) Morphological development of the seabed (e.g. erosion/accretion or bedforms) and subsequent feedback to the hydrodynamics and sand transport calculations are included; and

d) The sediment flux gradient at the model boundaries is zero.

Figure 1-49 Grain size map used as part of the local MIKE3 ST sand transport model setup

Source.: Mott MacDonald, 2025

1.6 Analysis of bathymetric survey data

Introduction

As part of the detail design for the A494 Bridge, several bathymetric surveys were undertaken to quantify changes in bed levels (Section 1.3). The surveys were limited to the area shown in Figure 1-50 and were undertaken on 9th and 28th September 2021, 3rd December 2021, 25th January 2022, 31st March 2022 and 26th May 2022. The results of all the surveys are considered and analysed in this report.

Figure 1-50 Approximate area of the bathymetric surveys around the A494 Bridge.

Source.: Mott MacDonald, 2022

This analysis provides an envelope defining the range of bed level changes over approximately four months and indicates bed level changes that might be expected during the Bridge's construction. To determine any trends, changes in the bed levels between surveys were obtained (Table 1-16) together with river flow data and tides. In addition, minimum and maximum bed levels were also calculated based on the collected data.

Table 1-16 Summary of model calibration statistics for surface elevation at the A494 Bridge

Period	Survey compared	No. of days between surveys
Period 1	9th September 2021 & 28th September 2021	19
Period 2	28th September 2021 & 3rd December 2021	66
Period 3	3rd December 2021 & 25th January 2022	53
Period 4	25th January 2022& 31st March 2022	65
Period 5	31st March 2022 & 26th May 2022	56
Total analysis	9th September 2021 & 26th May 2022	259

Source: Mott MacDonald, 2021.

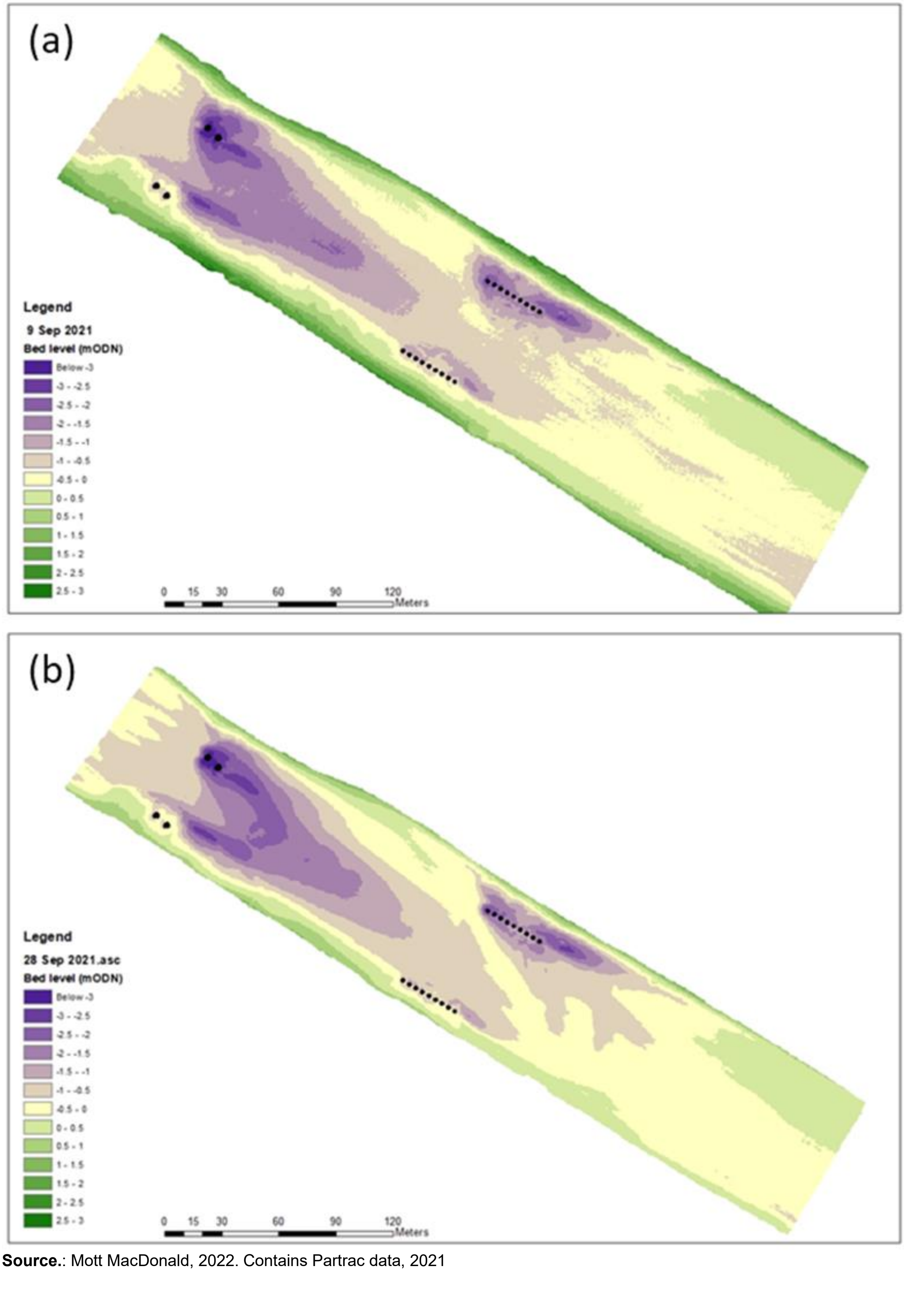
Period 1: 9th to 28th September 2021

Surveyed bed levels at the site on 9th and 28th of September 2021 are shown in Figure 1-51 . It is noted that even in the relatively short 19-day period between the two bathymetric surveys, significant changes in the bed levels occurred in the area in between the existing piles.

Figure 1-52 shows the bed level changes between where all positive values (red colours) indicate an increase in the bed level (accretion). Accretion is observed downstream of the piles of the existing Dee Crossing and the piles of the Jubilee Bridge. The development of a sedimentary feature is noted, with material accumulating downstream of north bank piles and moving towards the centre of the channel.

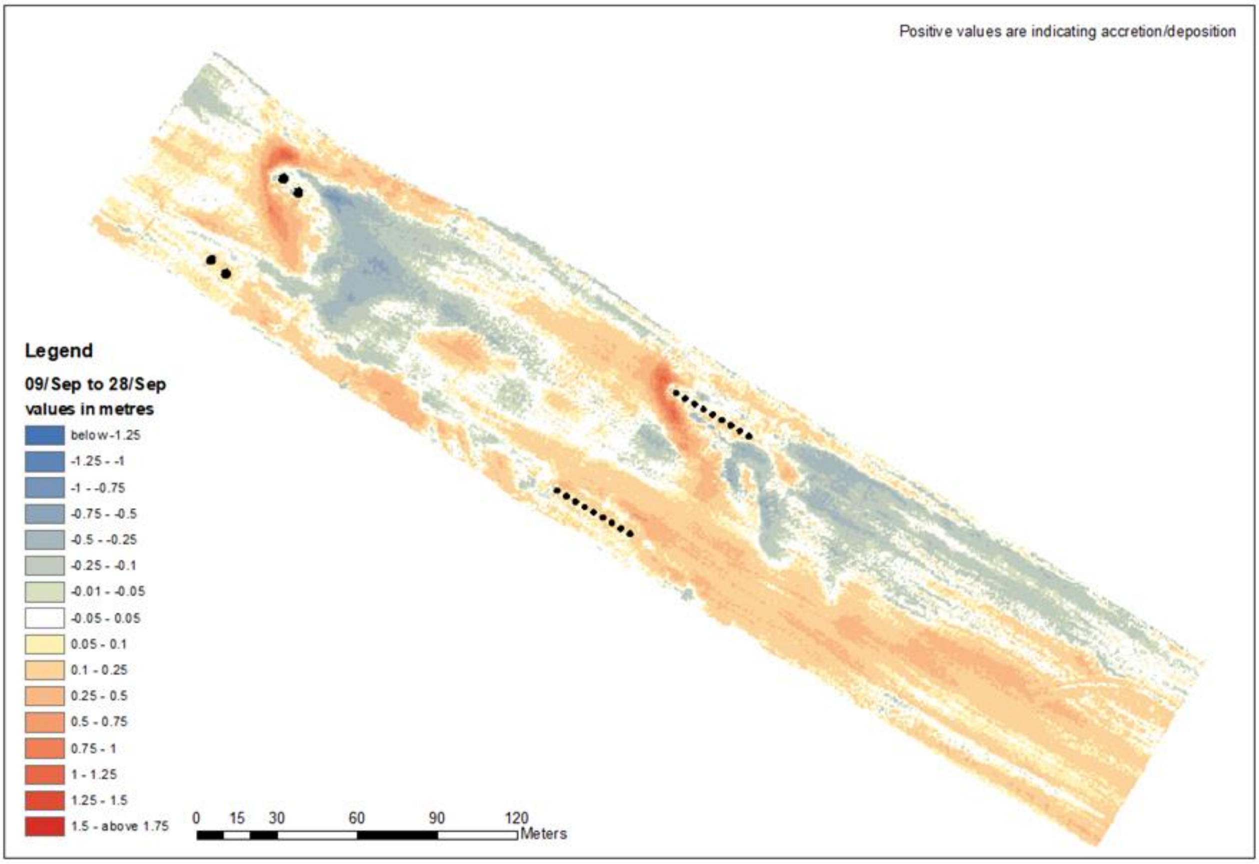
The increase in bed levels in front of the piles adjacent to the north bank extends upstream and is around 1 m near the piles and around 0.5 m towards the centre of the channel. On the south bank, bed levels change in the range 0.3 to 0.5 m is observed around and upstream of the existing piles.

Figure 1-51 Surveyed bathymetry on: (a) 9th September 2021; and (b) 28th September 2021. The black circles show the location of the existing piles and the Queensferry Bridge downstream.



Source.: Mott MacDonald, 2022. Contains Partrac data, 2021

Figure 1-52 Bed level change between the 9th and 28th September 2021 surveys. Positive values (red colours) show areas of accretion. The black circles show the location of the existing piles and the Queensferry Bridge downstream.

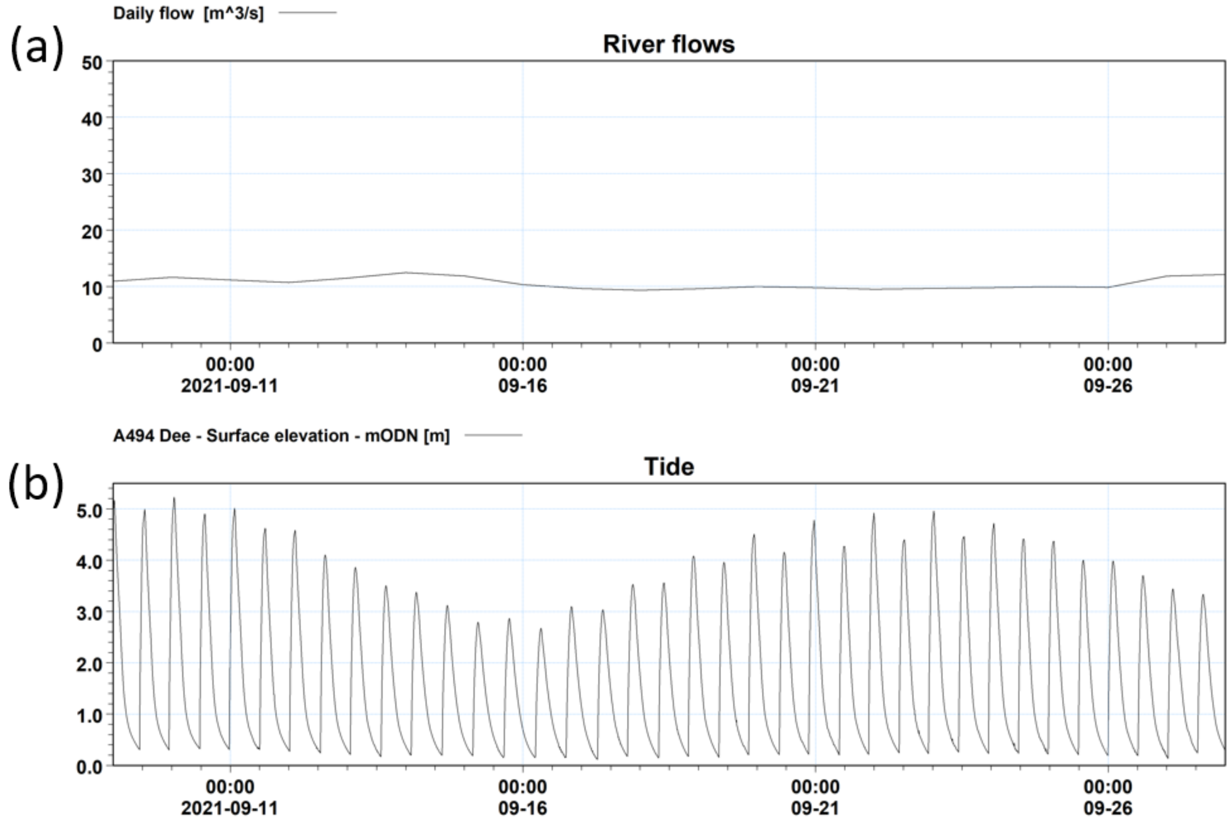


Source.: Mott MacDonald, 2022. Contains Partrac data, 2021

River discharge and tidal conditions between the 9th and 28th September 2021 are shown in Figure 1-53 This period was characterised by a low River Dee flow discharge of 10m^3/s. This value is four times less than the mean daily mean flow rate of 38m^3/s reported by NRFA data at Ironbridge. During this period, the site hydrodynamics was dominated by tidal flows. The bathymetric changes in Figure 1-52 shown accumulation of sediments, especially in the front of the piles and towards the centre of the channel.

With the low river discharge during this period, this behaviour is considered to result from the importation of sediments from the estuary to the site by the dominant flood tidal flows. Figure 1-52 also shows erosion upstream of the piles, especially on the north bank. This erosion also reflects the stronger flood tidal flows that interact with the structures and result in a localised scour of -0.5 m.

Figure 1-53 (a) Daily flow rates for Station 67027 (Dee at Ironbridge); and (b) tide levels at the site between 9th and the 28th of September 2021.



Source.: Mott MacDonald, 2022. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

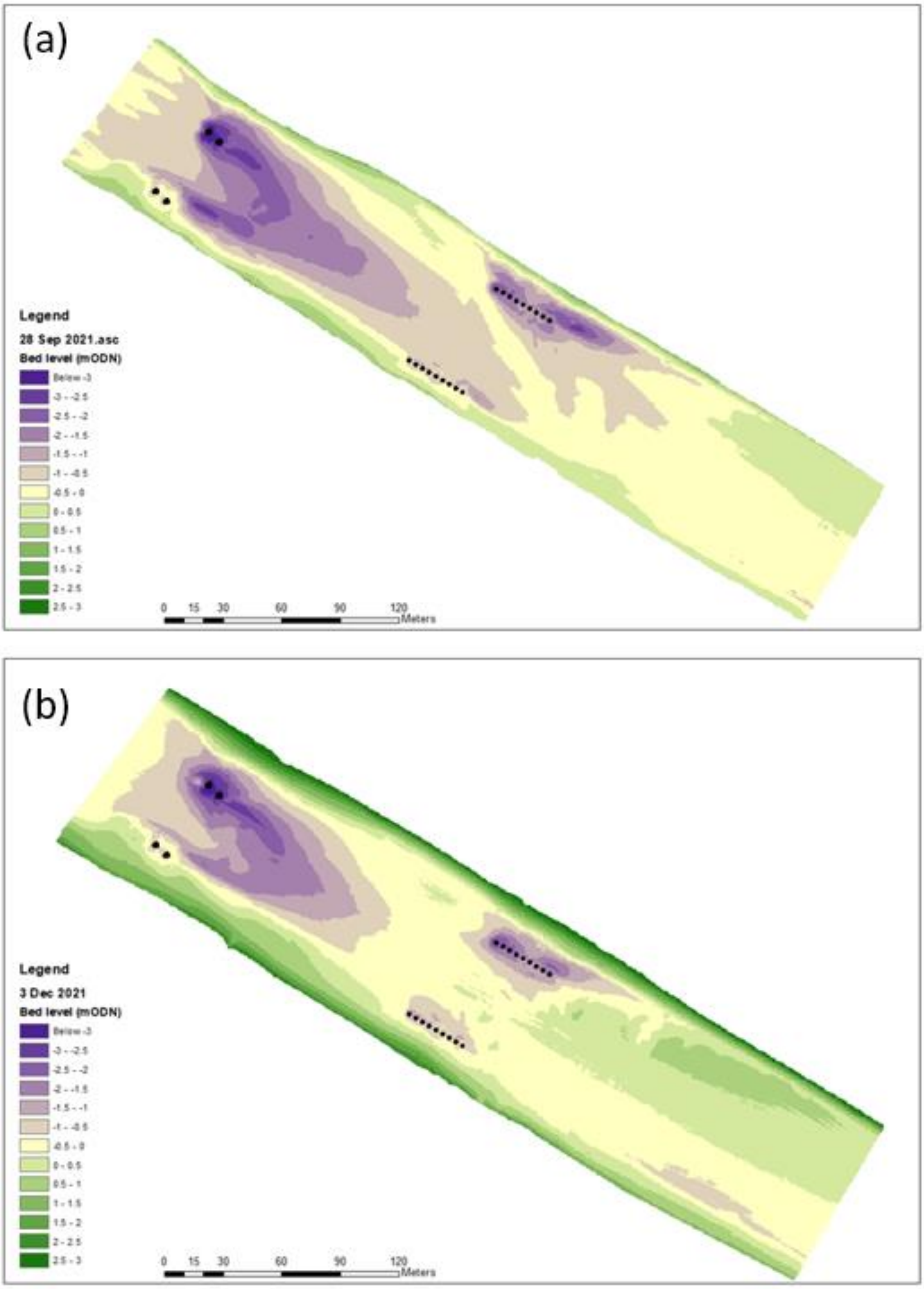
Period 2: 28th September 2021 to 3rd December 2021

Figure 1-54 shows the surveyed bed levels at the site on 28th September and 3rd December 2021. In the 66 days between the two surveys, an increase in bed levels around the Jubilee Bridge and A494 Bridge piles is evident. The bar formed downstream of the existing A494 Bridge piles and infilling the centre of the channel increases in elevation and extent.

Figure 1-55 shows the bed level changes between the two surveys. All positive values (red colours) indicate an increase in the bed level (accretion). Figure 1-55 shows evidence of widespread accretion at the site. Typical bed levels changes of the order of 0.8 m are observed in the centre of the channel, with a maximum accretion of 1.6 m observed upstream of the existing piles on the north bank.

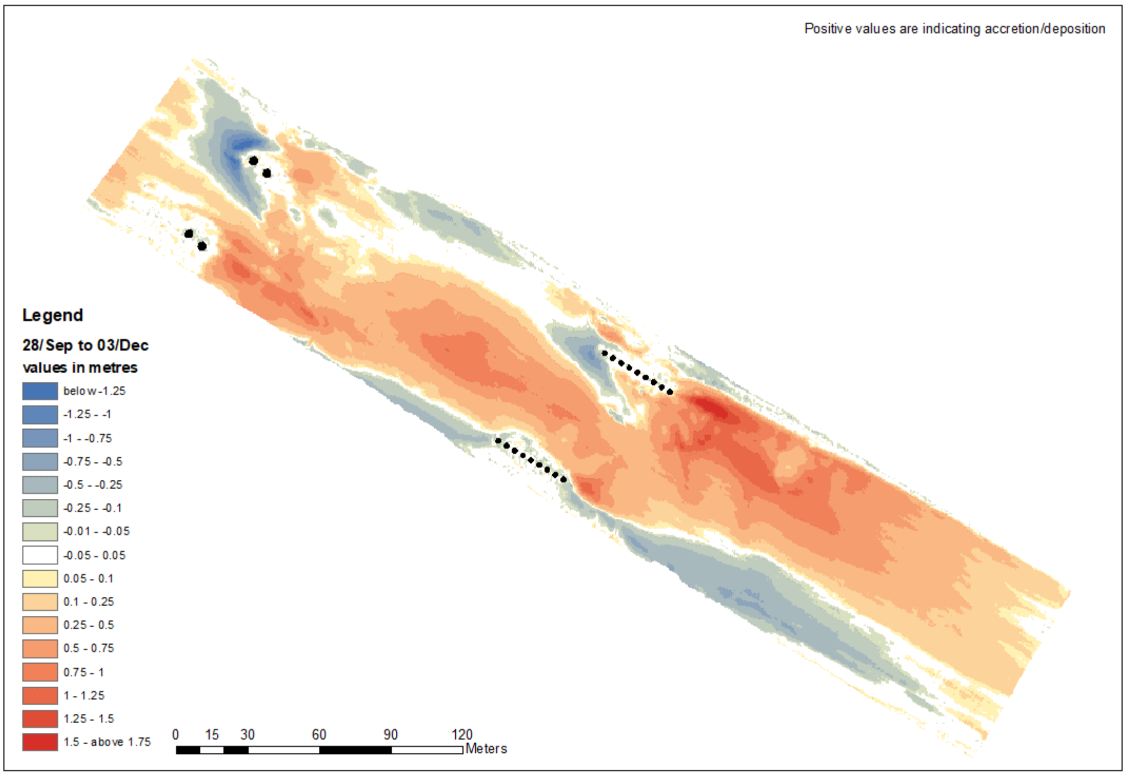
Areas of erosion are shown in front and downstream of the A494 Bridge piles and around the Jubilee Bridge piles, especially on the north bank. An erosion area around all the existing piles extending upstream is also noted on the south bank. Figure 1-55 shows erosion is between -0.3 and -0.6 m across the site, with the larger values of approximately -0.8 m in the area downstream of the existing piles on the north bank.

Figure 1-54 Bathymetry levels surveyed on: (a) 28th September; and (b) 3rd December 2021. The black circles show the location of the existing piles and the Queensferry Bridge downstream.



Source.: Mott MacDonald, 2022. Contains Partrac data, 2021

Figure 1-55 Surveyed bed level change between 28th September and 3rd December 2021. Please note that positive values (red colours) show areas of accretion. The black circles show the location of the existing piles and the Queensferry Bridge downstream.



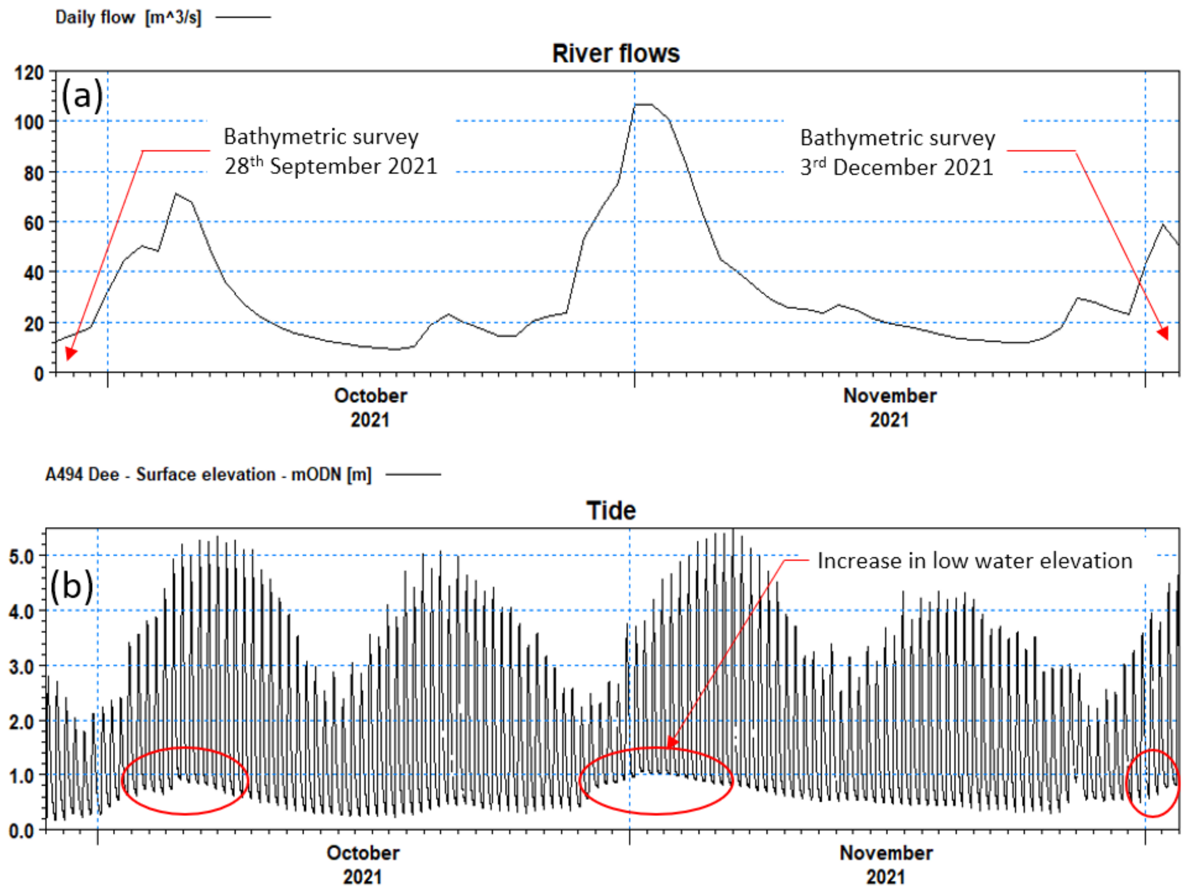
Source.: Mott MacDonald, 2022. Contains Partrac data, 2021

Figure 1-56 shows the measured river discharge and tidal elevations between the end of September and the beginning of December 2021. This figure shows two high river discharge events, with a third smaller one of around 60 m^3/s occurring just before the second bathymetric survey. The first river discharge event, in early October, reaches a maximum daily flow of around 70 m^3/s. The second event also in early November reached a maximum daily flow up almost 110 m^3/s. This event has a probability of exceedance larger than 0.1% (1 in 10 years event), Table 1-6 .

The high river discharges are also evident in the tidal signal, with low water levels increasing by almost 1 m during the high river discharge events (Figure 1-56 a and b). The hydrodynamics at the site during the period between the two bathymetric surveys tend to be more dominated by the river discharge events. Consequently, the importation of sediment from the estuary by the previously dominant flood tide is superseded by the higher river currents, and the sediment is transported in the opposite direction downstream.

This interpretation of the hydrodynamic data is supported by the evidence showing bed level changes in Figure 1-55 . This figure shows an accumulation of sediment upstream of the piles that extend towards the centre of the channel in the downstream direction. Erosion is observed downstream of the piles and is most probably related to the higher currents and turbulence generated by the river flows in the downstream/ebbing direction.

Figure 1-56 Measured river discharge at Station 67027 (Ironbridge) and tide levels at the site between 28th September 2021 (survey 1) and the 3rd December 2021.



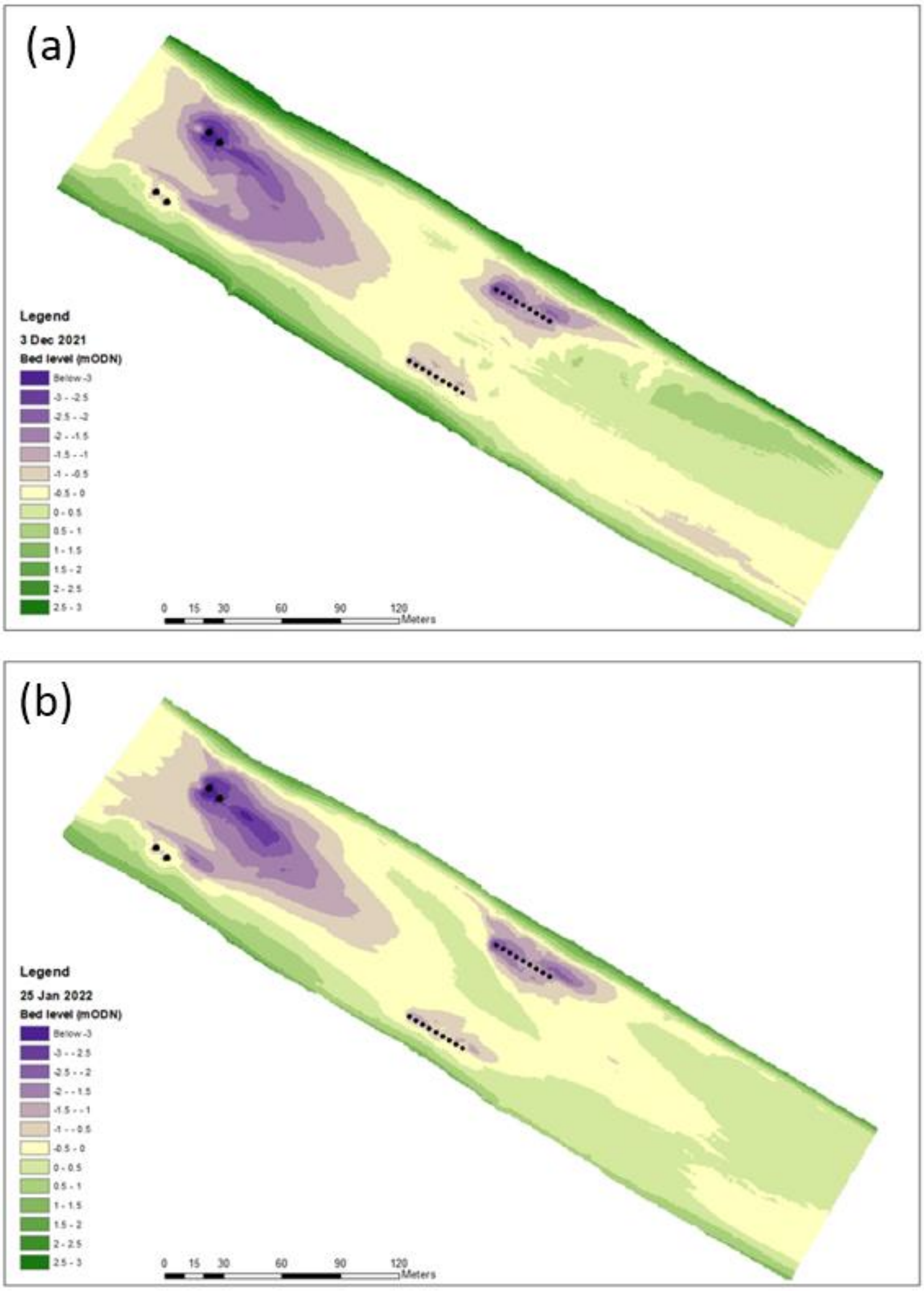
Source.: Mott MacDonald, 2022. Contains Natural Resources Wales information © Natural Resources Wales and database right.

Period 3: 3rd December 2021 to 25th January 2022

Figure 1-57 shows the surveyed bed levels at the site on 3rd December 2021 and 25th January 2022. During the 53 days between surveys, several changes to the bed levels occurred, especially in between and upstream of the A494 Bridge piles. These changes are shown more clearly in Figure 1-58 where the changes in bed level between the two surveys are shown. All positive values (red colours) indicate an increase in the surveys' bed level (accretion).

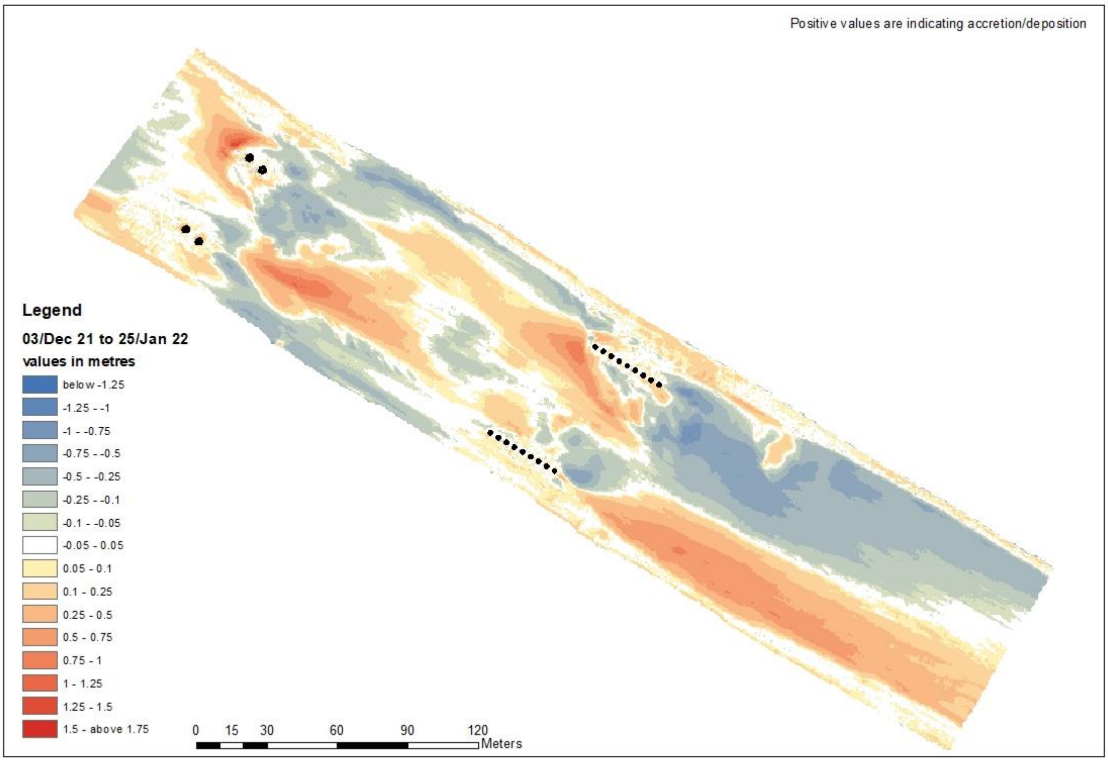
Figure 1-58 shows that upstream of the A494 Bridge piles, the south bank accreted by up to 0.7 m, while the erosion of the north bank results in a decrease in bed level of around -0.9 m. The figure shows an increase in bed levels up to 1 to 1.5 m downstream in front of the Jubilee and A494 Bridge piles, with the largest changes evident on the north bank. The area between the two bridges shows a mix of increasing and decreasing bed level trends of the order of +/-1m.

Figure 1-57 Bathymetry levels surveyed on: (a) 3rd December 2021; and (b) 25th January 2022. The black circles show the location of the existing piles and the Queensferry Bridge downstream.



Source.: Mott MacDonald, 2022. Contains Partrac data, 2021

Figure 1-58 Bed level changes between 3rd December 2021 and 25th January 2022. Please note that positive values (red colours) indicate areas of accretion. The black circles show the location of the existing piles and the Queensferry Bridge downstream.

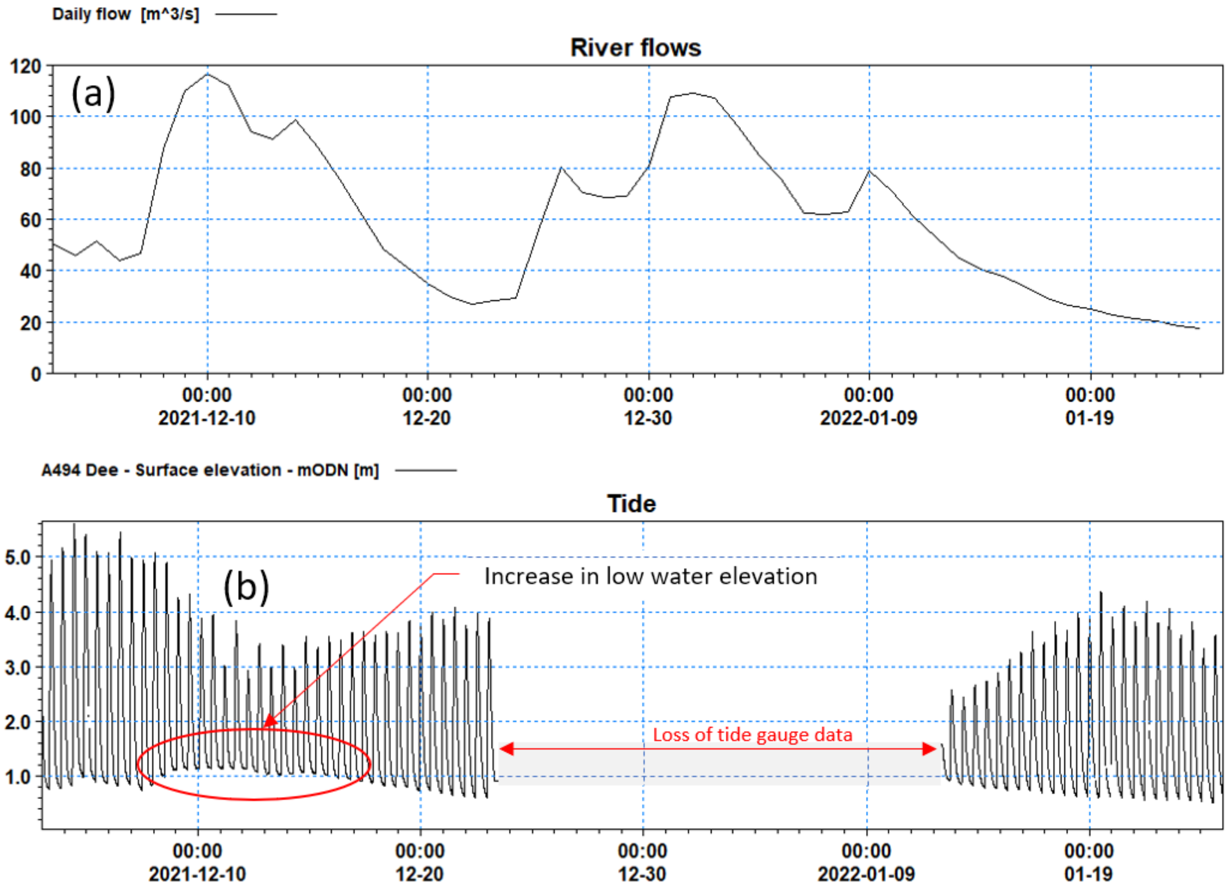


Source.: Mott MacDonald, 2022. Contains Partrac data, 2021

Figure 1-59 shows the daily river discharge and tidal elevation between the beginning of December 2021 and the end of January 2022. The river discharge during this winter period was higher than during the preceding three months (40 m^3/s for over 15 days), with two large and lengthy events peaking at almost 120 m^3/s. Figure 1-59 shows that from the middle of January 2022, river discharges started to decrease and went below 20 m^3/s on the 25th January 2022 bathymetric survey.

The effect of the high river discharges is also evident in the tidal signal, with low water levels increasing by almost 1 m during the first high river discharge event (Figure 1-59). Unfortunately, there was an issue with the tide gauge from the middle of December to the 10th of January, and tide data are not available for the second river discharge event. Based on the bathymetric changes observed at the site (Figure 1-58 and the measured hydrodynamic conditions (Figure 1-59), it can be concluded that the site was ebb dominant for most of Period 3, with a large amount of sediment moved downstream by the strong river flows. However, these conditions changed towards the end of January, when the river discharge was reduced and the normal flood tide dominance at the site was restored. In common with Period 1, accumulation of sediments in front of the piles is observed, indicating that the importation of sediments probably occurred during the last two weeks of January before the bathymetry survey.

Figure 1-59 Daily river discharge at Station 67027 (Ironbridge) and tide levels at the site between 3rd December 2021 and 25th January 2022.



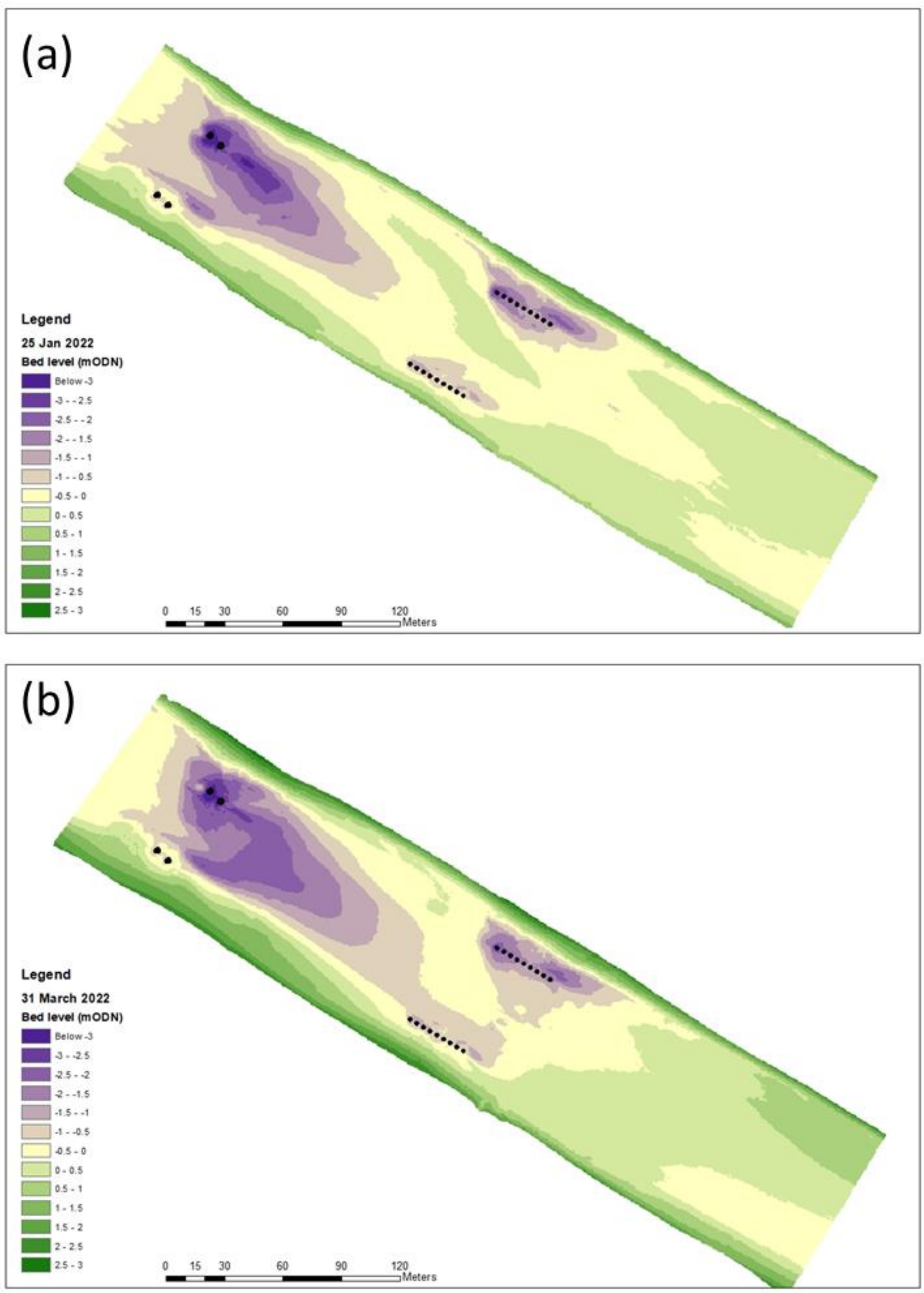
Source.: Mott MacDonald, 2022. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

Period 4: 25th January to 31st March 2022

Figure 1-60 shows the surveyed bed levels at the site on 25th January and 31st March 2022. During the 65 days between surveys, a general decrease in bed levels can be noticed, especially in the areas towards the centre of the channel, between both bridges. These changes are shown more clearly in Figure 1-61 where the changes in bed level between the two surveys are plotted. As in the previous sections, all positive values (red colours) indicate an increase in the surveys' bed level (accretion).

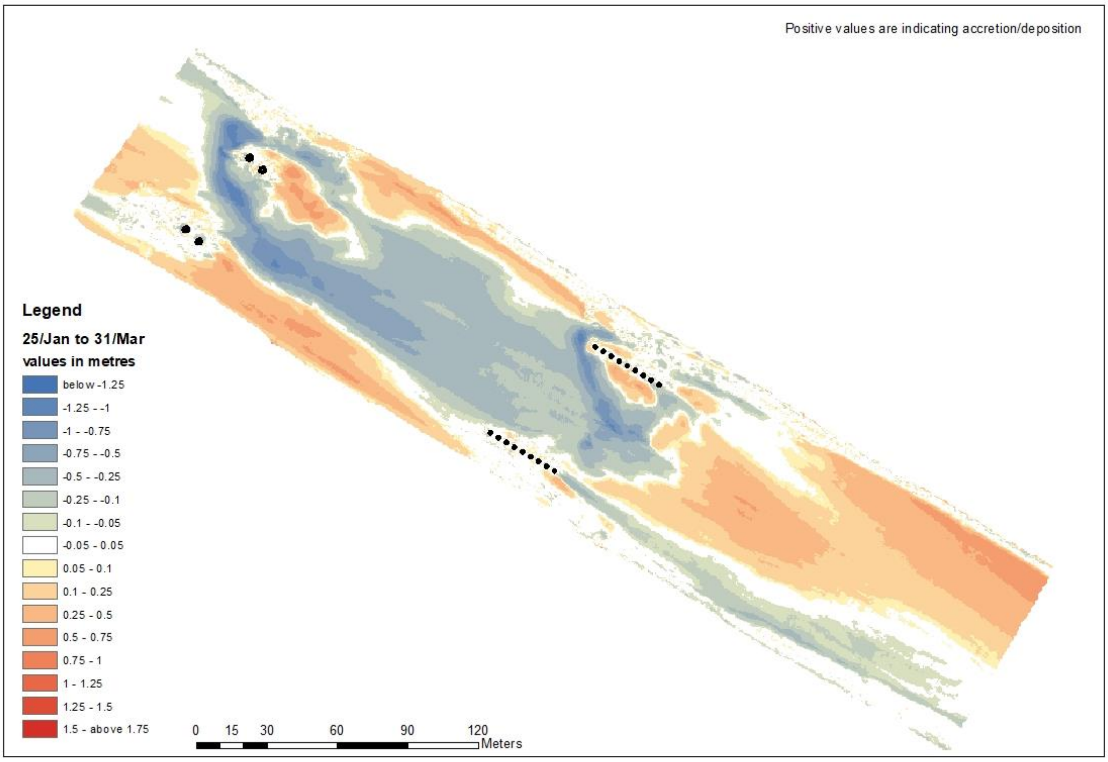
Figure 1-61 shows that upstream of the A494 Bridge piles, the centre and north bank of the channel accreted by up to 0.6 m, while the erosion of the south bank resulted in a decrease in bed levels of around -0.25 m. The figure shows a considerable decrease in bed levels between -1 to -1.2 m downstream in front of the Jubilee and A494 Bridge piles, with the largest changes evident on the north bank. The area between the two bridges also shows a decreasing bed level trend of the order of -0.3 to -1 m.

Figure 1-60 Bathymetry levels surveyed on: (a) 25th January 2022; and (b) 31st March 2022. The black circles show the location of the existing piles and the Queensferry Bridge downstream.



Source.: Mott MacDonald, 2022. Contains Partrac data, 2022

Figure 1-61 Bed level changes between 25th January and the 31st March 2022. Please note that positive values (red colours) indicate areas of accretion. The black circles show the location of the existing piles and the Queensferry Bridge downstream.



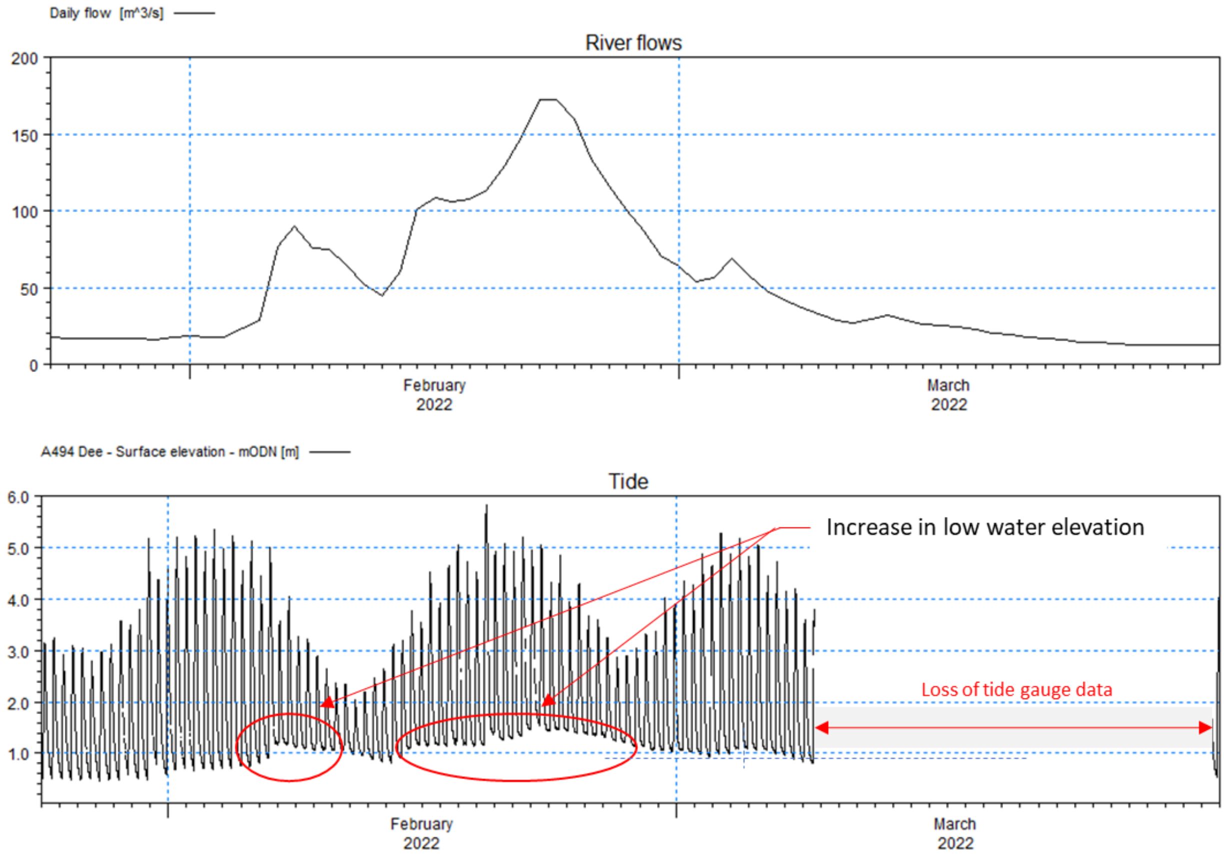
Source.: Mott MacDonald, 2022. Contains Partrac data, 2022

Figure 1-62 shows the daily river discharge and tidal elevation between the end of January and March 2022. The river discharge during this winter period was similar to the observed between December 2021 and January 2022 (Period 3), with a large and lengthy event peaking at flows larger than 150 m^3/s. Figure 1-62 shows that, however, from the beginning of March 2022, river discharges started to decrease and were below 20 m^3/s at the end of the month, when the bathymetric survey was undertaken.

The effect of the high river discharges is also evident in the tidal signal, with low water levels increasing by almost 1 m during the high river discharge event (Figure 1-62). Unfortunately, there was an issue with the tide gauge for most of March, and tide data are not available.

Based on the bathymetric changes observed at the site (Figure 1-61) and the measured hydrodynamic conditions (Figure 1-62), it can be concluded that the site was ebb dominant for most of Period 4, with a large amount of sediment moved downstream by the strong river flows. However, these conditions changed towards the middle of March, when the river discharge was reduced and the normal flood time dominance at the site was potentially restored. However, the results indicate erosion downstream of the piles and towards the centre of the channel, probably related to the higher currents and turbulence generated by the river flows in the downstream/ebbing direction, similar to the results of Period 3.

Figure 1-62 Daily river discharge at Station 67027 (Ironbridge) and tide levels at the site between 25th January and the 31st March 2022.



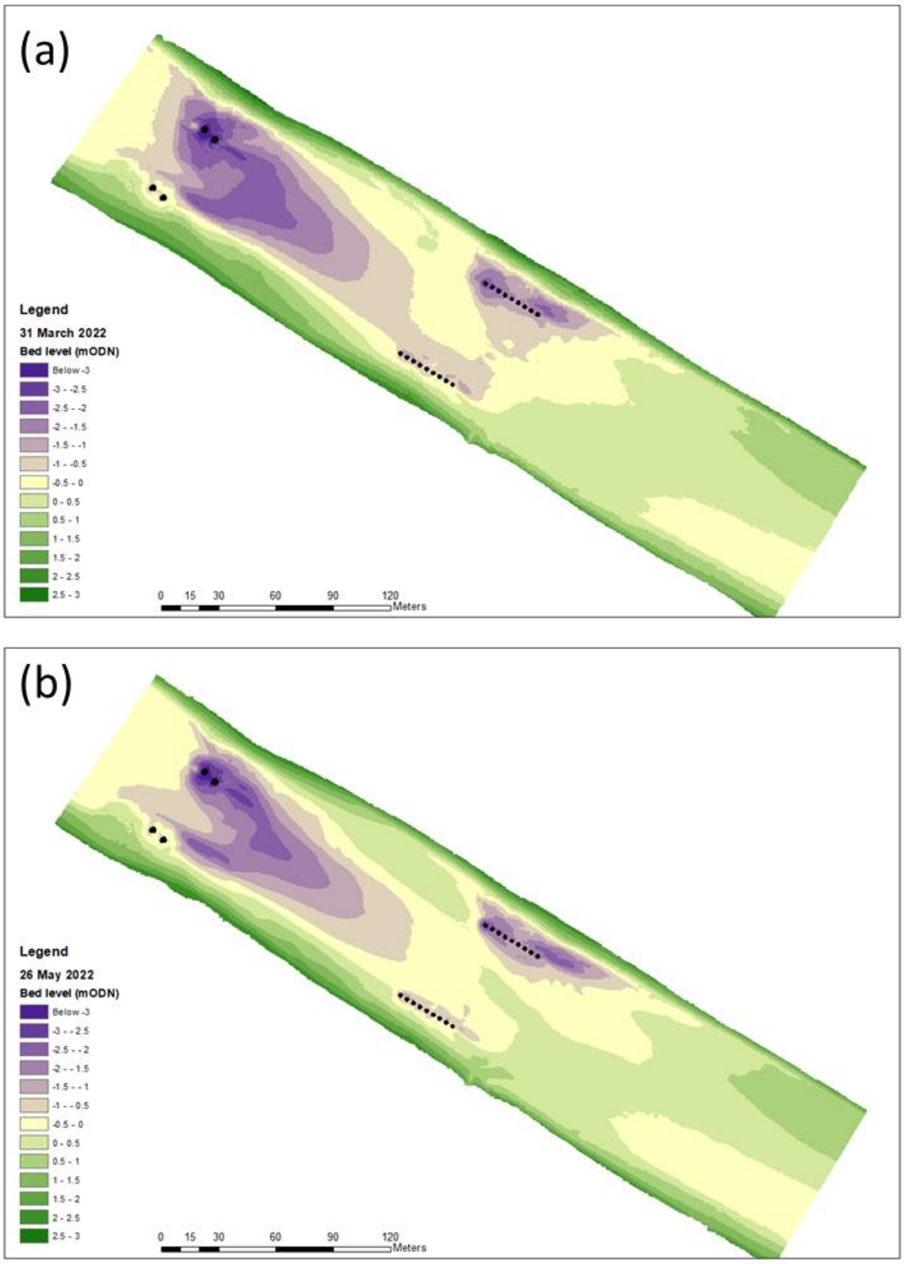
Source.: Mott MacDonald, 2022. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

Period 5: 31st March to 26th May 2022

Figure 1-63 shows the surveyed bed levels at the site on 31st March and 26th May 2022. In the 56 days between the two surveys, an increase in bed levels around the Jubilee Bridge and A494 Bridge piles is evident. The bar formed downstream of the existing A494 Bridge piles and infilling the centre of the channel increases in elevation and extent.

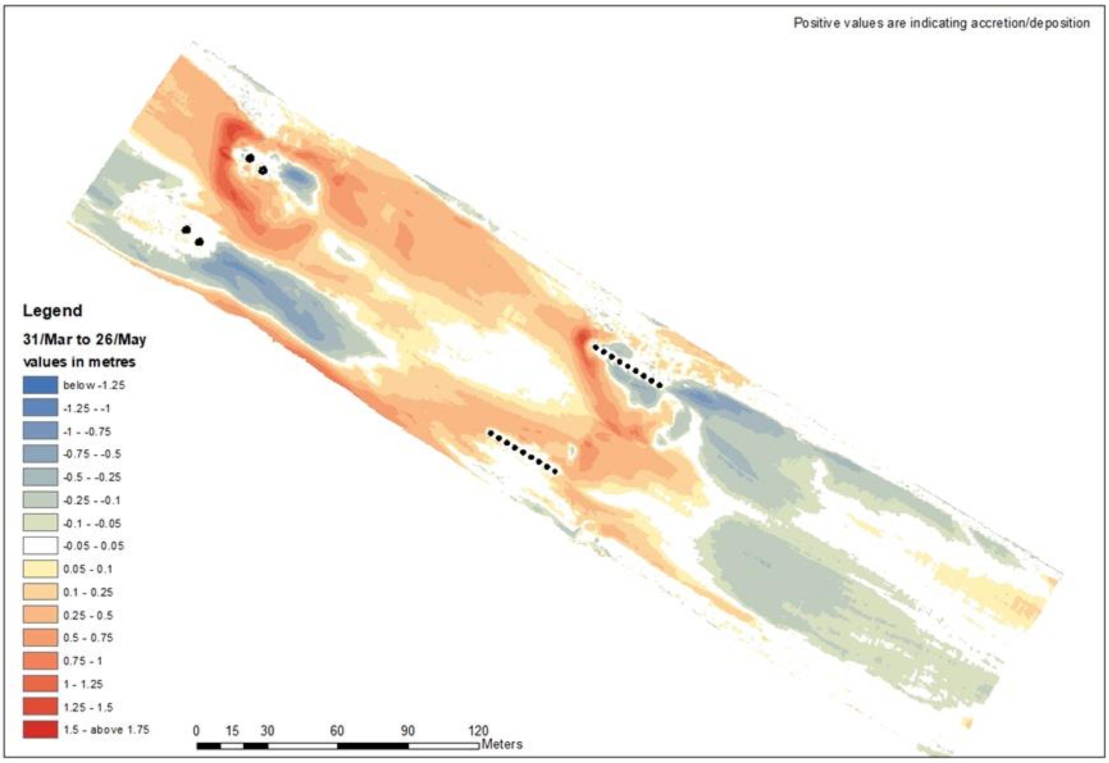
Figure 1-64 shows the bed level changes between the two surveys. All positive values (red colours) indicate an increase in the bed level (accretion) and reflect widespread accretion. Typical bed level changes of the order of 0.4 m occurred in the centre of the channel between the A494 Bridge piles and on the north bank between the two bridges. A maximum accretion of 1.3 m is observed downstream of both bridges on the north bank. Areas of erosion are evident behind and upstream of the A494 Bridge north piles and the Jubilee Bridge south piles, with bed levels reduced by -0.8 m. An erosion area upstream of the A494 Bridge is noted, with bed levels decreased by -0.2 m.

Figure 1-63 Bathymetric survey data: (a) 31st March 2022; and (b) 26th May 2022. The black circles show the location of the existing Bridge piles and the Queensferry Bridge downstream.



Source.: Mott MacDonald, 2022. Contains Partrac data, 2022

Figure 1-64 Bed level changes between 31st March 2022 and 26th May 2022. Positive values (red colours) indicate areas of accretion, and black circles show the location of the existing Bridge piles and the Queensferry Bridge downstream.

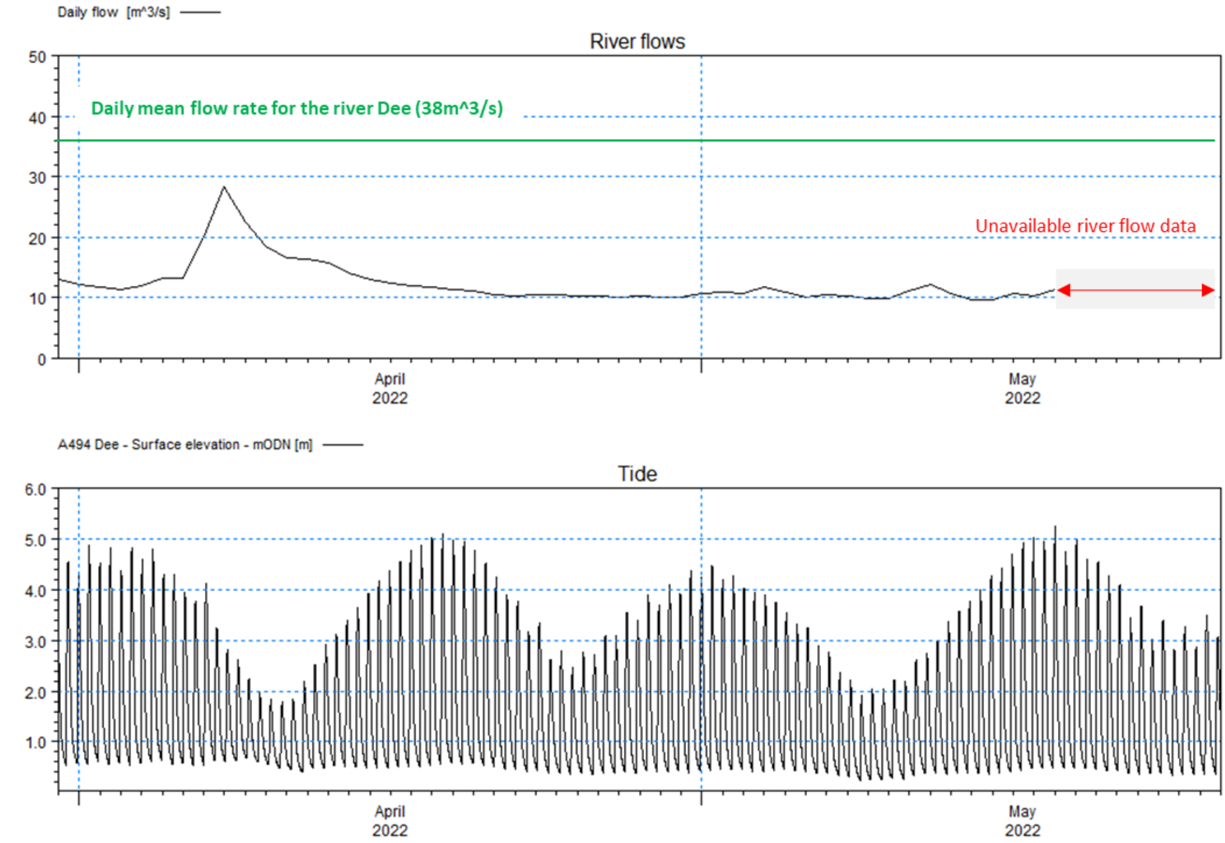


Source.: Mott MacDonald, 2022. Contains Partrac data, 2022

River Dee discharge and tidal conditions between the end of March and the end of May 2022 are shown in Figure 1-65 . This period was characterised by a low discharge between 10 to 20 m^3/s. This value is around 40% less than the mean daily flow rate of 38 m^3/s reported by NRFA data at Ironbridge. Tidal flows, therefore, dominated the site hydrodynamics during this time.

Figure 1-64 shows sediment deposition in the front of the piles and in the centre of the channel of the order of 1.3 m (maximum). This deposition reflects the importation of sediments from the lower estuary by the dominant flood tidal flows. Figure 1-64 also shows erosion upstream of the piles, especially on the north bank of the A494 Bridge. The erosion results from the stronger flood tidal flows that interact with the structures and result in localised scour of around -0.8 m.

Figure 1-65 Daily river discharge at Station 67027 (Ironbridge) and tide levels at the site between 31st March 2022 and 26th May 2022.

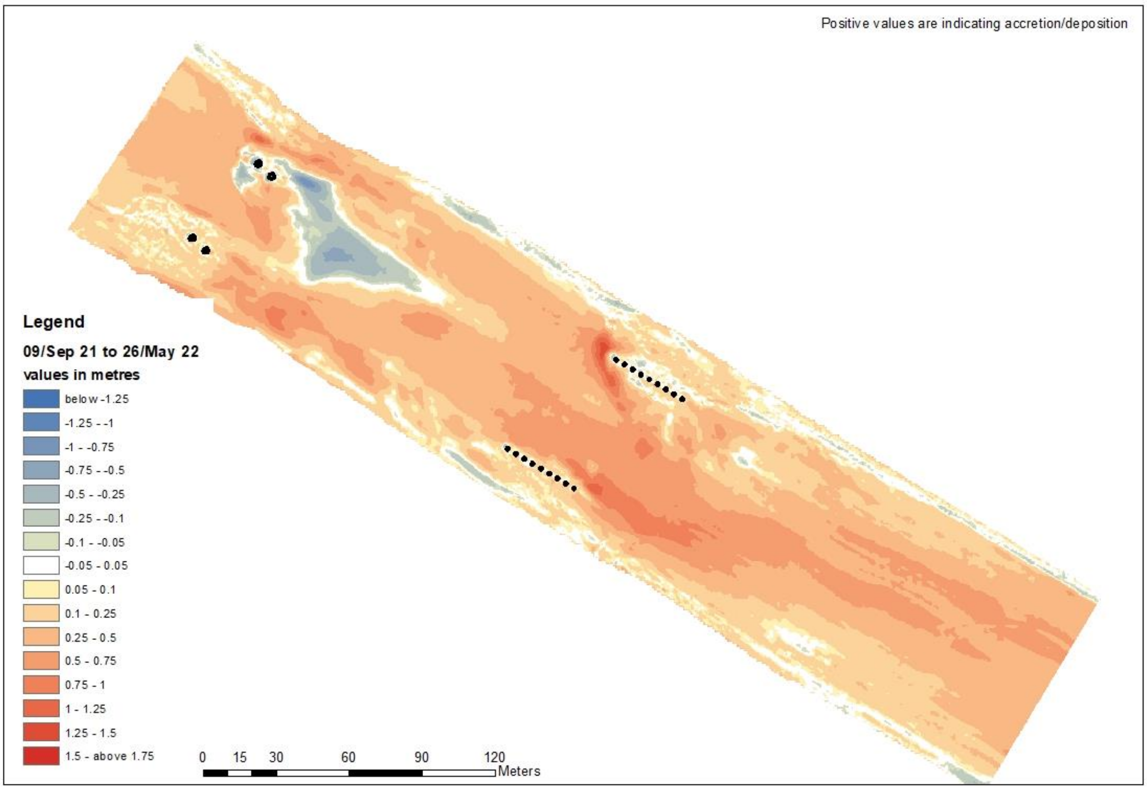


Source.: Mott MacDonald, 2022. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

Total bathymetric change: 9th September 2021 to 26th May 2022

Figure 1-66 shows the overall change in bed levels over approximately seven months between 9th September 2021 and 26th May 2022. All positive values (red colours) indicate an increase in the bed level (accretion). Bed levels have increased between 0.3 and 1.3 m, with the maximum change in front (downstream) of the piles of the A494 Bridge on the north bank. The only erosion area is located upstream of the Jubilee Bridge piles on the north bank, where bed levels erosion reaches a maximum value of -0.7 m. The clear evidence of widespread accretion at the site reflects the flood tide dominance that results in net sediment importation from the lower estuary.

Figure 1-66 Bed level changes between 9th September 2021 and the 26th May 2022. Please note that positive values (red colours) indicate areas of accretion. The black circles show the location of the existing piles and the Queensferry Bridge downstream.



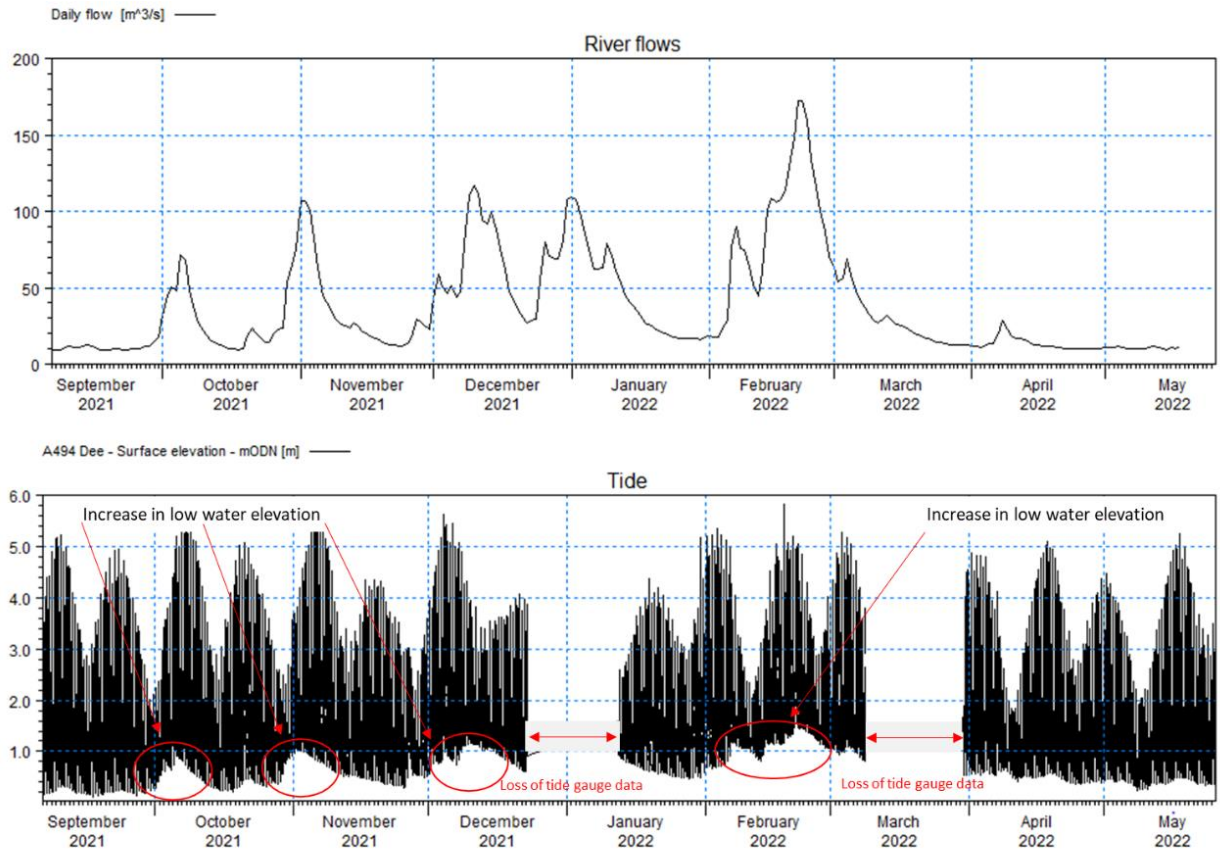
Source.: Mott MacDonald, 2022. Contains Partrac data, 2022

Figure 1-67 shows the daily river discharge and tidal elevation between September 2021 and May 2022. River discharge increased during the winter. The highest flow rates occurred during January and February when the discharge reached over 120 m^3/s. From the middle of March 2022, river discharge decreased, reaching less than 20 m^3/s at the last bathymetric survey. Increases in low water levels during the winter of around 1 m reflect the high river discharge at that time (Figure 1-67).

Measured hydrodynamic conditions (Figure 1-67) and bathymetric changes (Figure 1-66) provide evidence to show that the site was flood tide-dominated. This hydrodynamic regime resulted in a large quantity of sediment being moved upstream during periods of low river discharge.

As seen in the bathymetry analysis undertaken during the winter, when strong river flows are observed (period 4 and 5), the site conditions can be easily temporally changed to ebb dominated, and therefore, the movement of sediments is in the downstream direction, with a general erosion over the site. However, over the period surveyed the site was largely dominated by the import of sediments from the estuary, as shown in Figure 1-66 .

Figure 1-67 Daily river discharge at Station 67027 (Ironbridge) and tide levels at the site between 9th September 2021 and the 26th May 2022.



Source.: Mott MacDonald, 2022. Contains Natural Resources Wales information © Natural Resources Wales and database right.

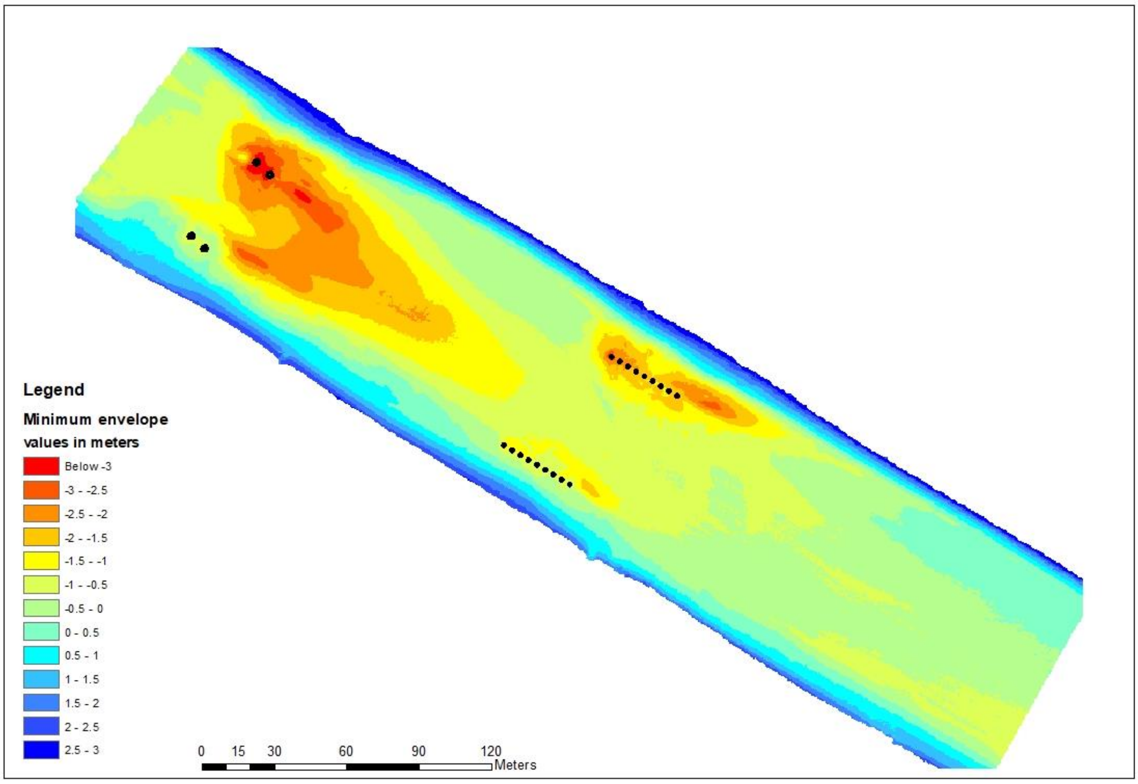
Bed level envelope of change

Bathymetric survey data from 9th and 26th September 2021, 3rd December 2021, 25th January 2022, 31st March 2022 and 26th May 2022 have been analysed to determine the minimum (see Figure 1-68) and maximum (see Figure 1-69) bed levels during those seven months. By subtracting the minimum levels from the maximum levels (see Figure 1-70), it is then possible to define areas of minimum and maximum bed elevation changes.

Figure 1-70 shows that most bed elevation changes occur at either end of the piles and in the centre of the channel. There is less bed elevation change towards the channel banks. In the deeper areas around the piles, where scour holes can be up to 3 m below the surrounding bed levels, bed elevation variations are constrained, and the scour holes generally remain intact.

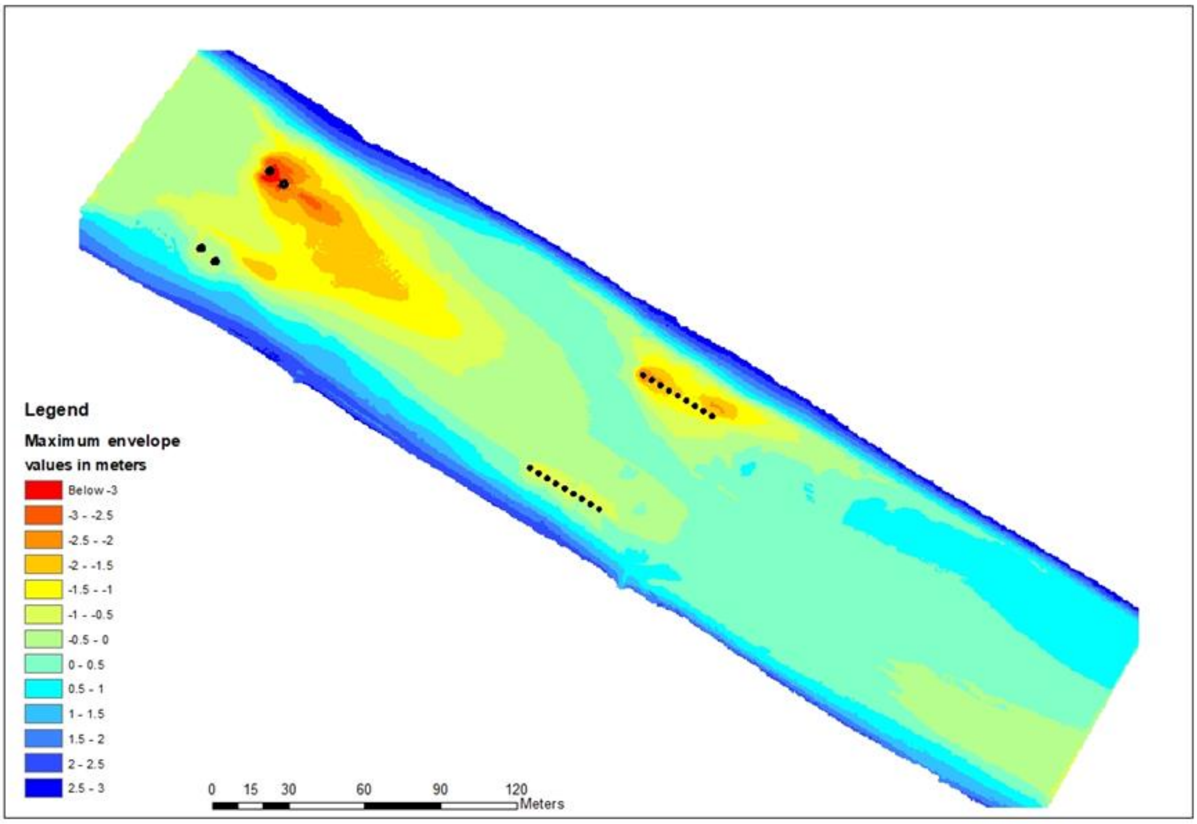
It should be noted, however, that the bathymetric surveys only reflect the conditions at the time of the survey and may not capture the actual maximum and minimum bed levels between 9th September 2021 and 26th May 2022. Nevertheless, it is considered that the present data provide a reliable indication of where most bed elevation changes are likely to occur and a reasonable estimate of the magnitude of change that could be expected.

Figure 1-68 Minimum bed levels from the bathymetric surveys (9th and 26th September 2021, 3rd December 2021, 25th January 2022, 31st March 2022 and 26th May 2022)



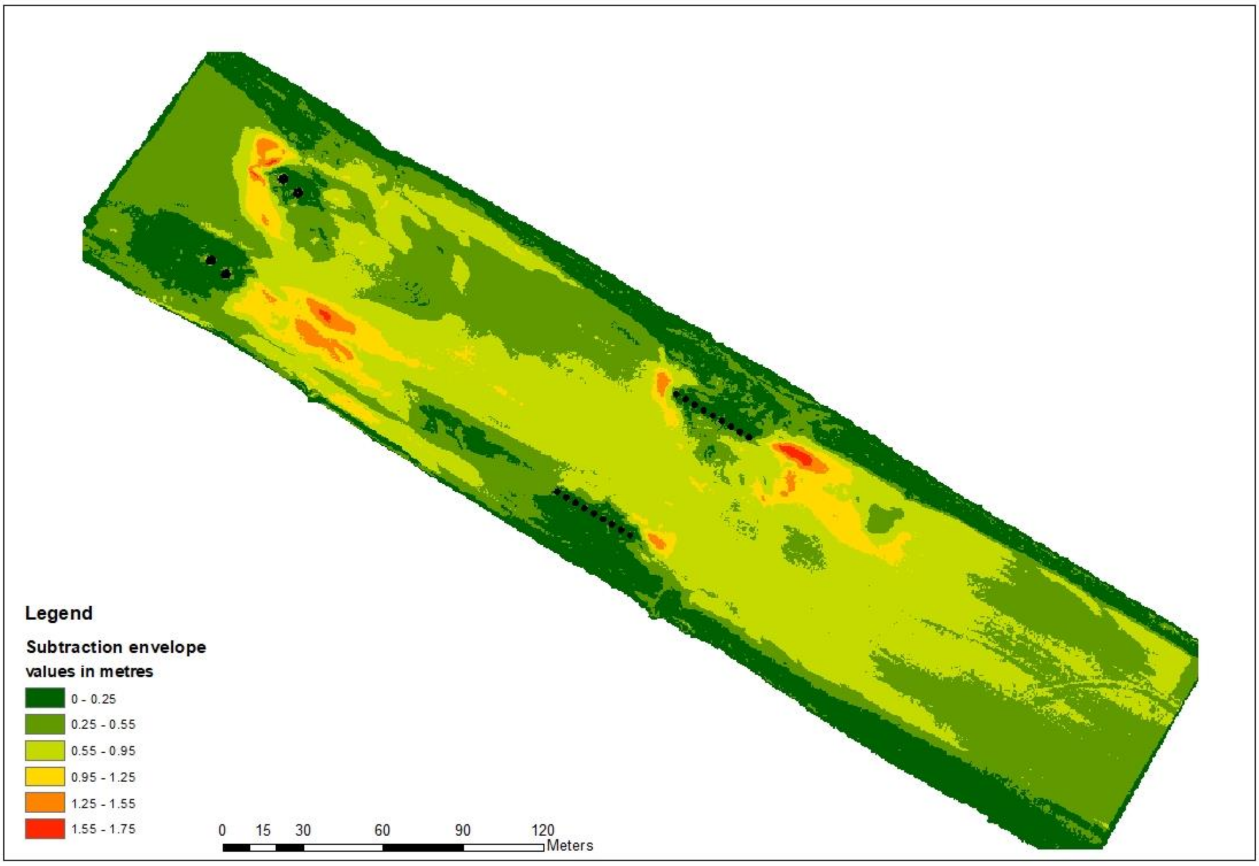
Source: Mott MacDonald, 2022

Figure 1-69 Maximum bed levels from the bathymetric surveys (9th and 26th September 2021, 3rd December 2021, 25th January 2022, 31st March 2022 and 26th May 2022).



Source.: Mott MacDonald, 2022

Figure 1-70 Bed level variability throughout the four bathymetry surveys (Maximum - minimum bed levels).



Source.: Mott MacDonald, 2022

Summary

The bed of the River Dee downstream from the weir at Chester is exposed to varying river discharge, tidal flows and extreme storm-related events that lead to temporal changes in bed level elevation at the project site. By correlating measured bed elevation changes with the hydrodynamic conditions, it has been possible to quantify temporal and spatial variability in the local bathymetry around the existing structures. The following results from the analyses may assist the design and construction of the new Bridge piles:

- The upstream transport of sediments by the flood tide dominates when river discharge is low, resulting in net upstream sediment transport accretion over the wider project site;

- The flood tide dominance is reversed when the river discharge is high, leading to net downstream sediment transport and erosion over the wider project site;
- Existing scour holes can be up to 3 m below the bed level in the main channel;
- Around the existing piles localised bed elevation changes of +/-1.8 m are observed over a relatively short period;
- During low river discharge conditions (< c. 20 m^3/s), the flood tide flow speeds reach a maximum value, and sediments tend to accumulate in front of and downstream of the A494 and Jubilee Bridge piles and towards the middle of the channel. At the same time, upstream of the piles, bed levels tend to decrease due to the high flow speeds and flow interactions with the structures. It is considered that the turbulence and related high bed shear stresses generated by these interactions result in the erosion observed upstream of the structures;
- During high river discharge conditions (> c. 70 m^3/s), the net sediment transport direction is dominated by the river flow and is directed downstream. In this regime, the sediments accumulate upstream of the A494 and Jubilee Bridge piles and towards the centre of the channel. Erosion occurs downstream of the piles due to turbulence generated by flow interactions with the structures. Under these conditions, the importation of sediment from the outer estuary is probably insignificant;
- The survey results show that the bed elevation at the site is very dynamic, with bed levels changing by up to +1.5 m over a relatively short period;
- It is noted that the surveys may not have captured the full dynamic range of bed elevation variations, and the temporal variability in bed elevation may have been even greater than that measured; and
- Similar results to those reported here were presented in the previous Dee Crossing study (Mott MacDonald, 2019). In common with the present study, this earlier study concluded that changes in bed elevation of up to +2 m occur upstream of the Bridge and that these changes are broadly correlated with high river discharge events.

1.7 Regional hydrodynamic model results

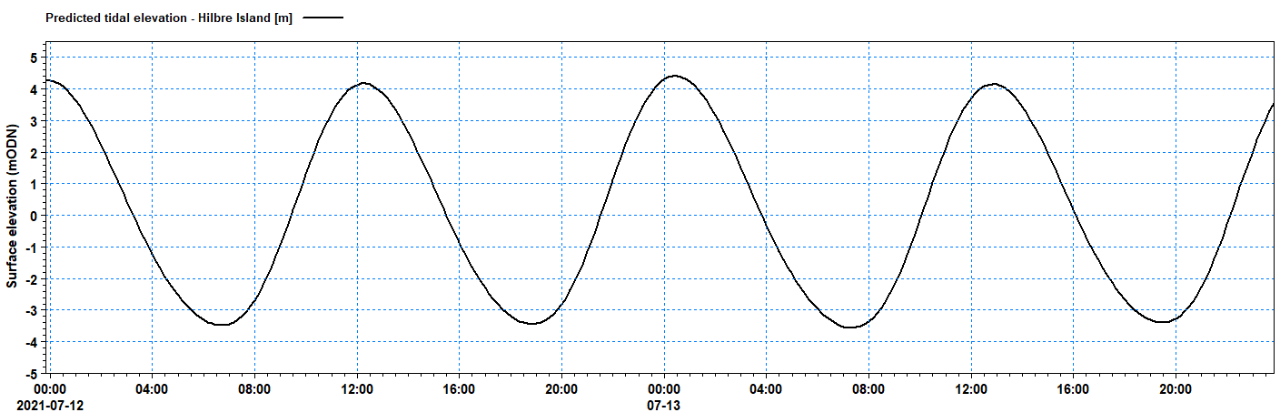
Introduction

The regional MIKE3 FM HD model (Chapter Approach) has provided the boundary conditions for the detailed local MIKE3 FM HD model. Following the model calibration and validation process, simulation of the mean spring tide, high river discharge, surge, and the spring neap cycle were undertaken with the regional model.

Mean spring tide simulation

The simulation of the mean spring tide was undertaken to: (a) support the navigational study (not reported here); and (b) provide data on the water levels and currents speeds at the site. The model was set up to simulate conditions between 12th and 14th July 2021. The offshore boundary was defined by the predicted tide at Hilbre Island in the mouth of the Dee Estuary (Figure 1-71) and measured daily river discharges from NRFA were used to define the upstream boundary. These were almost constant at about 11 m^3/s throughout the simulation.

Figure 1-71 Predicted tide at Hilbre Island used to define the offshore boundary water level for the mean spring simulation for the MIKE3 FM HD regional model.



Source.: Mott MacDonald, 2022

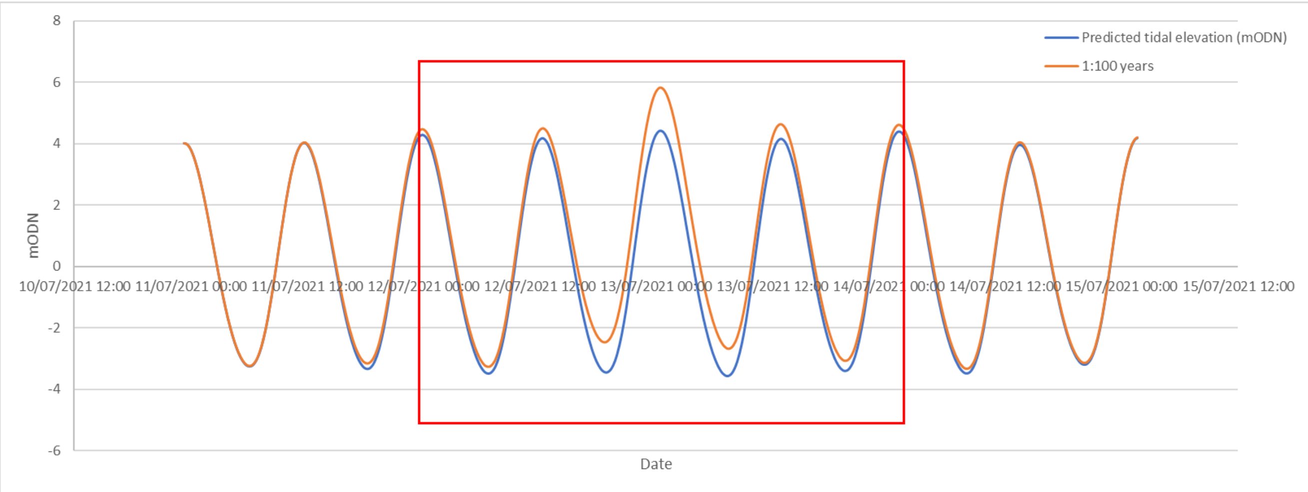
High river discharge simulation

The high river discharge simulation combined the mean spring tide and a 1:100 year river discharge event (187m^3/s, Table 1-6 , Section River flows).

Tidal surge simulation

The tidal surge simulation combines the mean spring tide and the 1:100 year water level (5.82 m ODN), with the surge aligned with high water to represent the worst-case scenario. The extreme water level was obtained from the CFB database for the mouth of the Dee (Section Water levels), together with the corresponding surge shape (Profile 29 – Liverpool). Figure 1-72 shows the MHWS tide (blue) and the scaled 1:100 year water level with the applied surge. The red box shows the model simulation period.

Figure 1-72 Offshore boundary conditions for the tidal surge simulation (orange line) using the regional MIKE3 FM HD model. The red box shows the model simulation period.

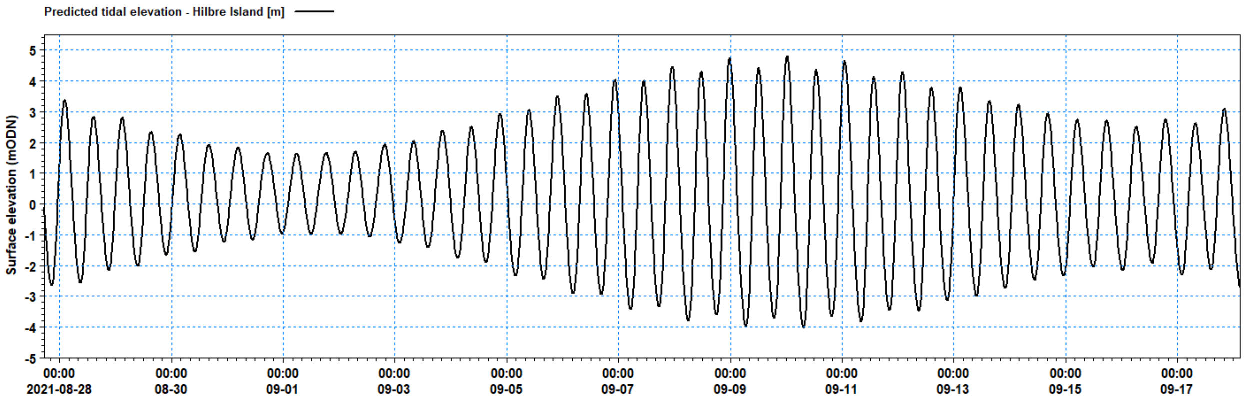


Source.: Mott MacDonald, 2022

Spring-neap cycle simulation

The predicted tide defined a 20-day spring-neap cycle at Hilbre Island in the mouth of the Dee estuary for the period 28th August 2021 to 16th September 2021 (Figure 1-73). During the simulation, the river discharge was held constant at a low value of 10 m^3/s.

Figure 1-73 Offshore boundary conditions for the spring-neap cycle simulation using the regional MIKE3 FMHD model.



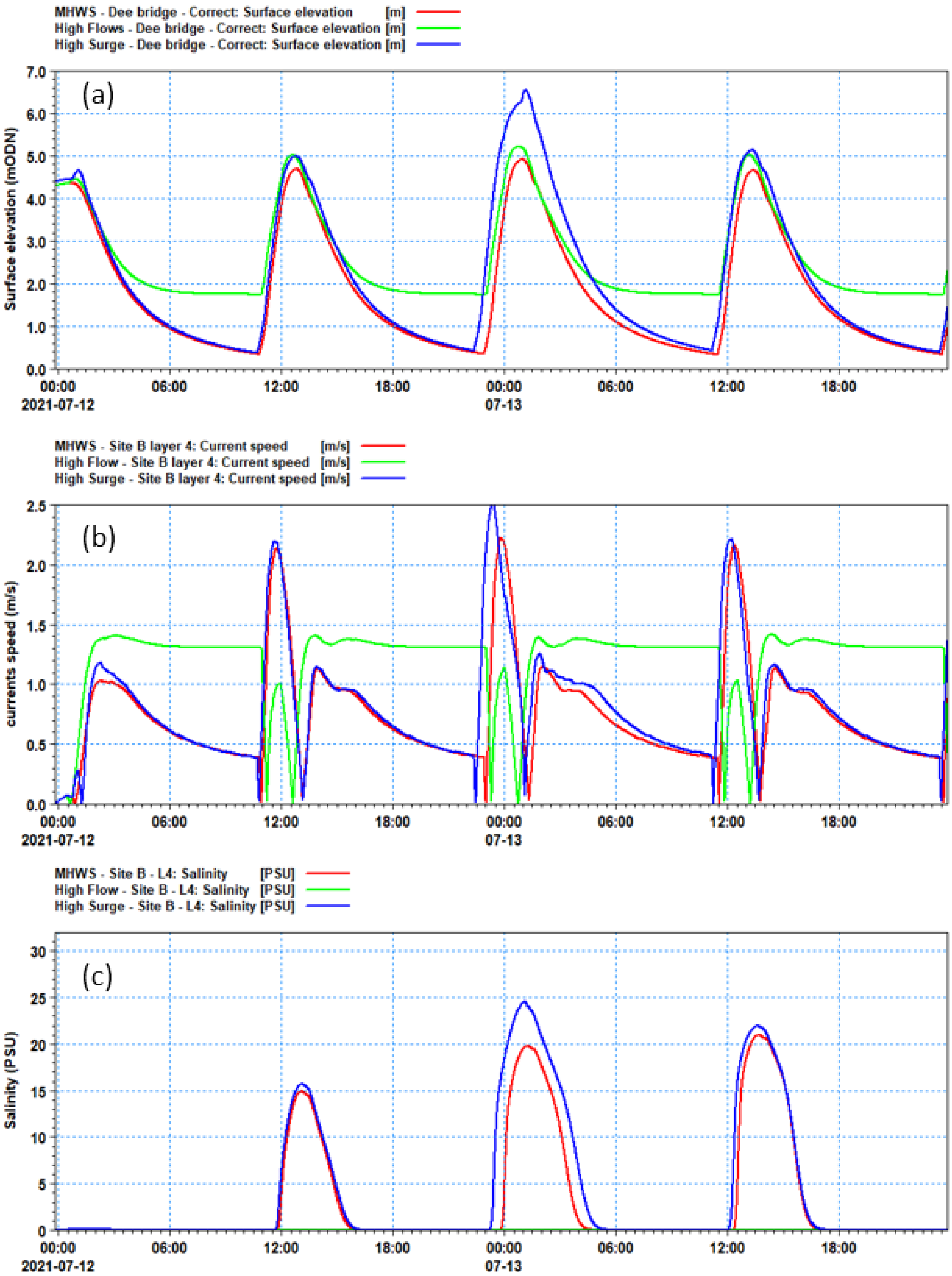
Source.: Mott MacDonald, 2022

Regional hydrodynamic model results

Since the regional MIKE3 FM HD model is mainly used to provide the boundary conditions for the local MIKE3 FM HD model, only a few selected results from the regional model are discussed here. Figure 1-74 shows water levels, current speeds and salinity at the site during the mean spring tide (Section Mean spring tide simulation), high river discharge (Section High river discharge simulation) and tidal surge (Section Tidal surge simulation) MIKE3 FM HD simulations.

This figure shows that the site's highest water levels and current speeds are associated with the tidal surge case (1:100 years water level). Figure 1-74 also shows that the high river discharge increases the low water elevation at the site by more than 1 m. The high river discharge also changes the characteristics of the currents during the tidal cycle so that the flood currents are reduced, and the site is dominated by higher ebb currents that are almost constant at 1.4 m/s. The site is dominated by freshwater when the river discharge is high, and the highest salinity values are associated with the tidal surge.

Figure 1-74 Results from the regional MIKE3 FM HD model showing: (a) surface elevation; (b) current speed; and (c) salinity for MHWS (red line), high river discharge (green line) and tidal surge (blue line) conditions.



Source.: Mott MacDonald, 2022

1.8 Local hydrodynamic model results

Introduction

The regional MIKE3 FM HD model provided boundary conditions for the local MIKE3 FM HD model. This model was used to simulate the existing conditions, and the scheme under the following scenarios:

- Scenario 1: **Existing Bridge piers only** – Represents the current conditions with the existing Bridge in place a no construction activities.

- Scenario 2 – **Existing Bridge and new Bridge piers** – includes both the existing Bridge and the new proposed Bridge.

- Scenario 3 – **New Bridge piers only** – represents the final configuration with the existing Bridge removed.

These scenarios were assessed for:

- The mean spring tide (see Section Mean spring tide simulation); and

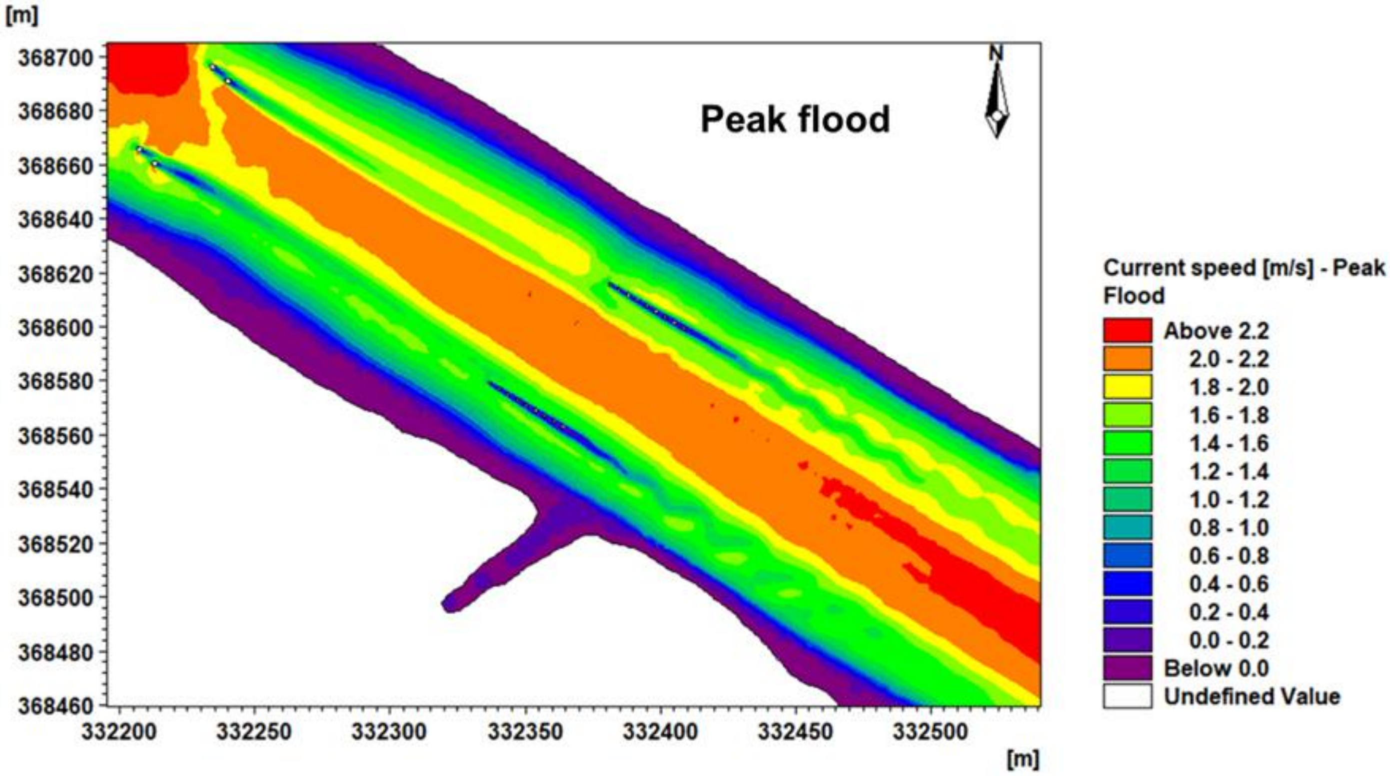
- A 1:100-year river discharge event (see Section High river discharge simulation).

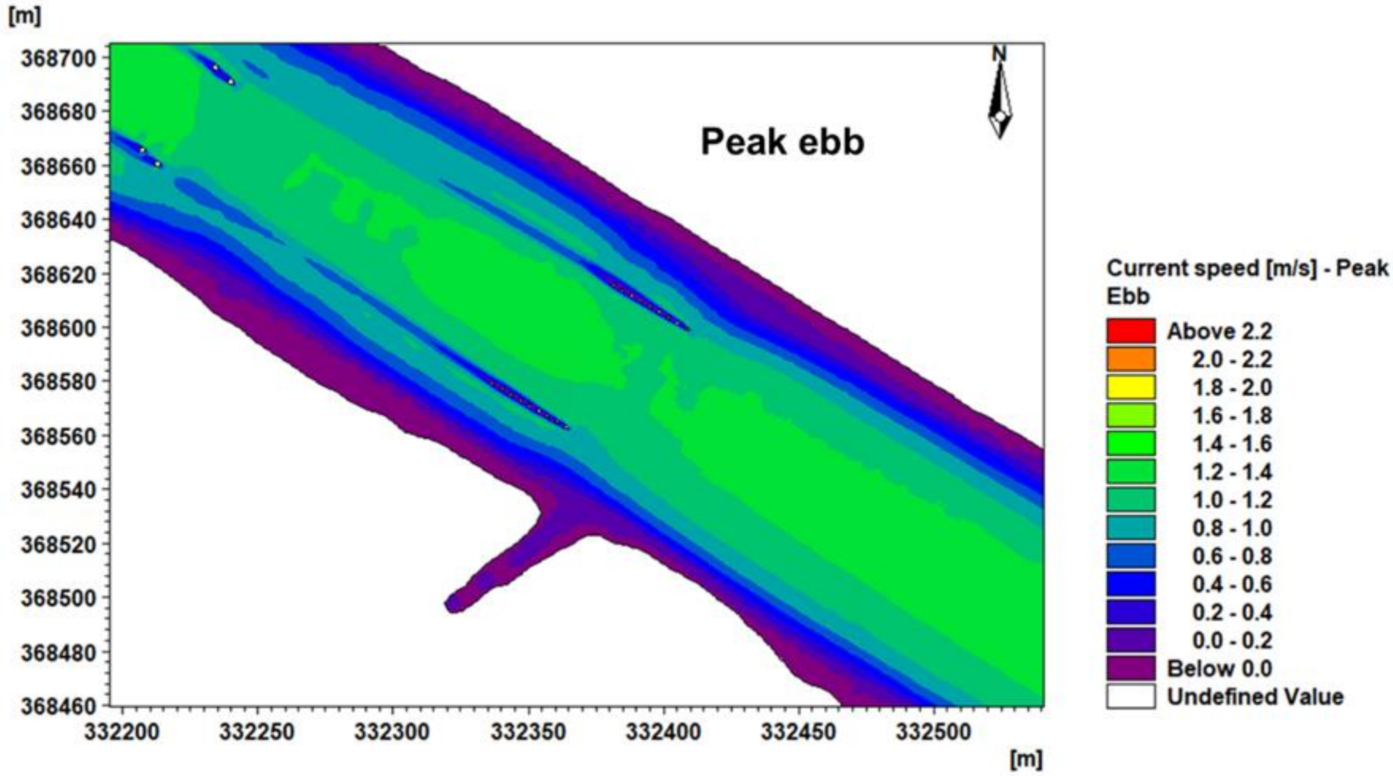
Scenario 1: Existing Bridge

Figure 1-75 shows the spatial distribution of current speeds at the site for peak ebb and flood flows during the mean spring tide simulation. Peak flood current speeds are considerably higher than ebb peak speeds demonstrating the flood tide dominance at the site. Figure 1-75 shows that current speeds in the middle of the channel are around 2.2 m/s during the flood tide, while during the ebb phase, peak currents are less than 1.4 m/s.

During the mean spring tide simulation flood, a series of eddies are observed in the lee of the structures. These features, also known as a Von Kármán vortex street (Figure 1-76), resulting from flow separation around the individual Bridge piles. This process is a natural phenomenon observed when fluid (air or water) flows past objects.

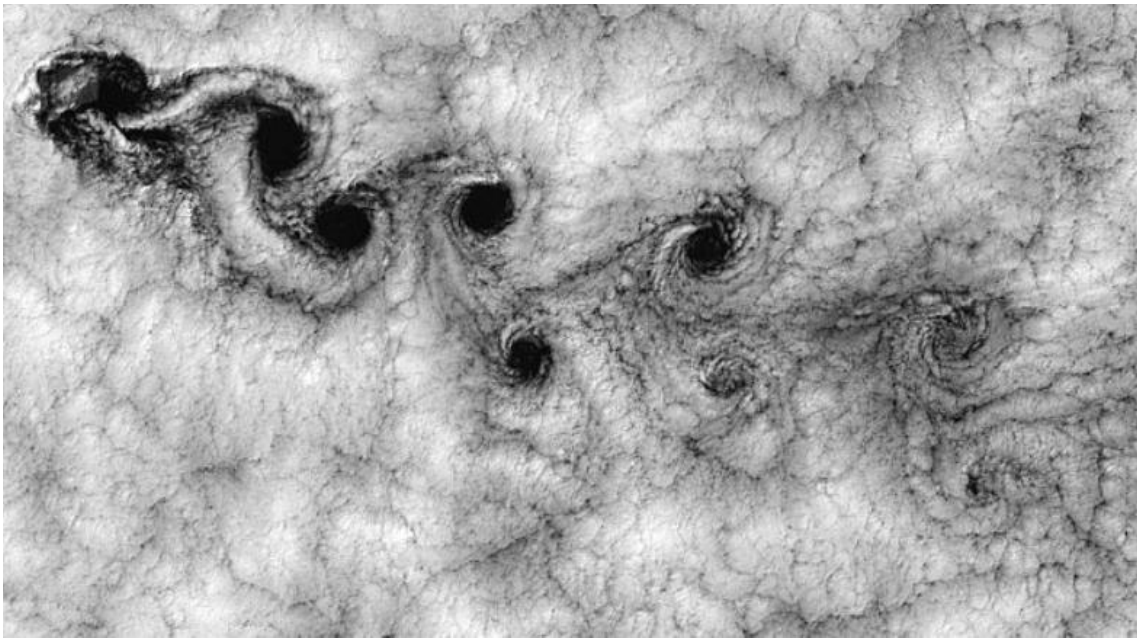
Figure 1-75 Peak flood and peak ebb depth-averaged current speeds under mean spring tide conditions at the A494 Bridge.





Source.: Mott MacDonald, 2025

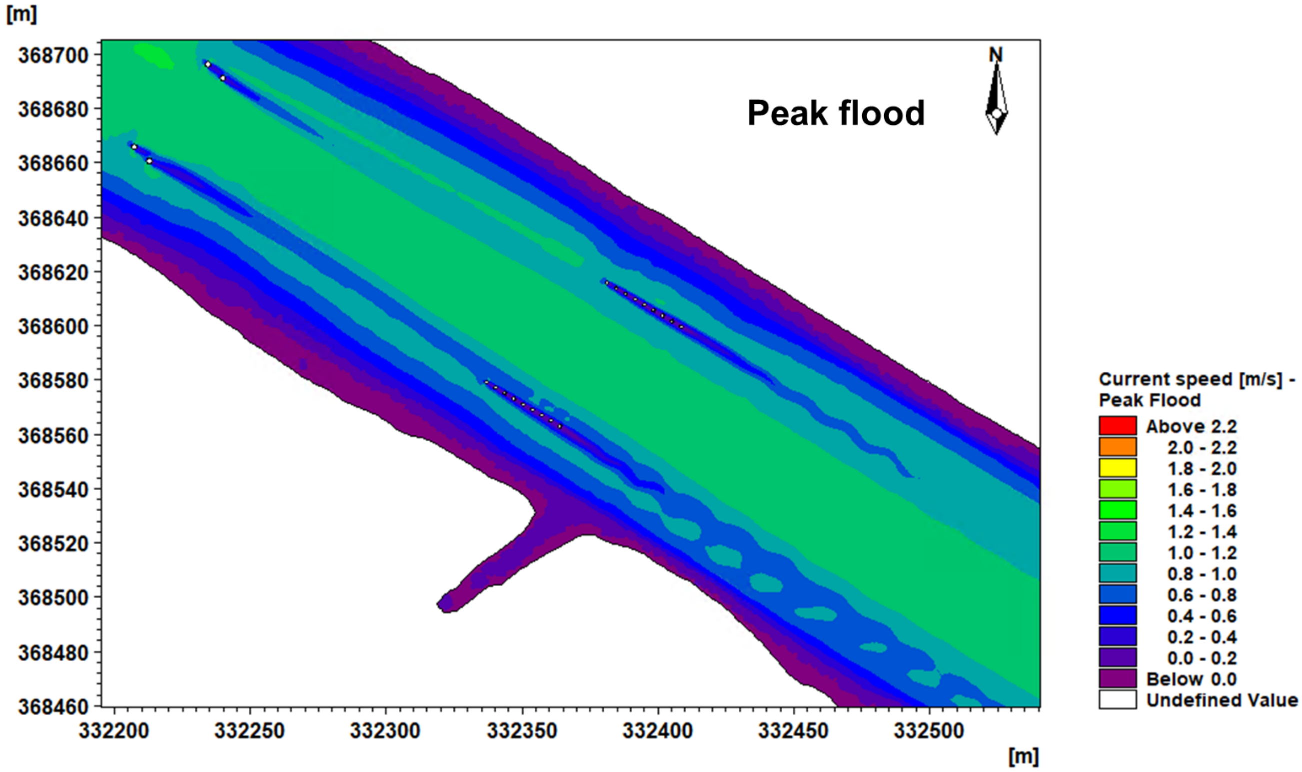
Figure 1-76 Vortices generated in the atmosphere by the Juan Fernandez Islands off the Chilean coast.

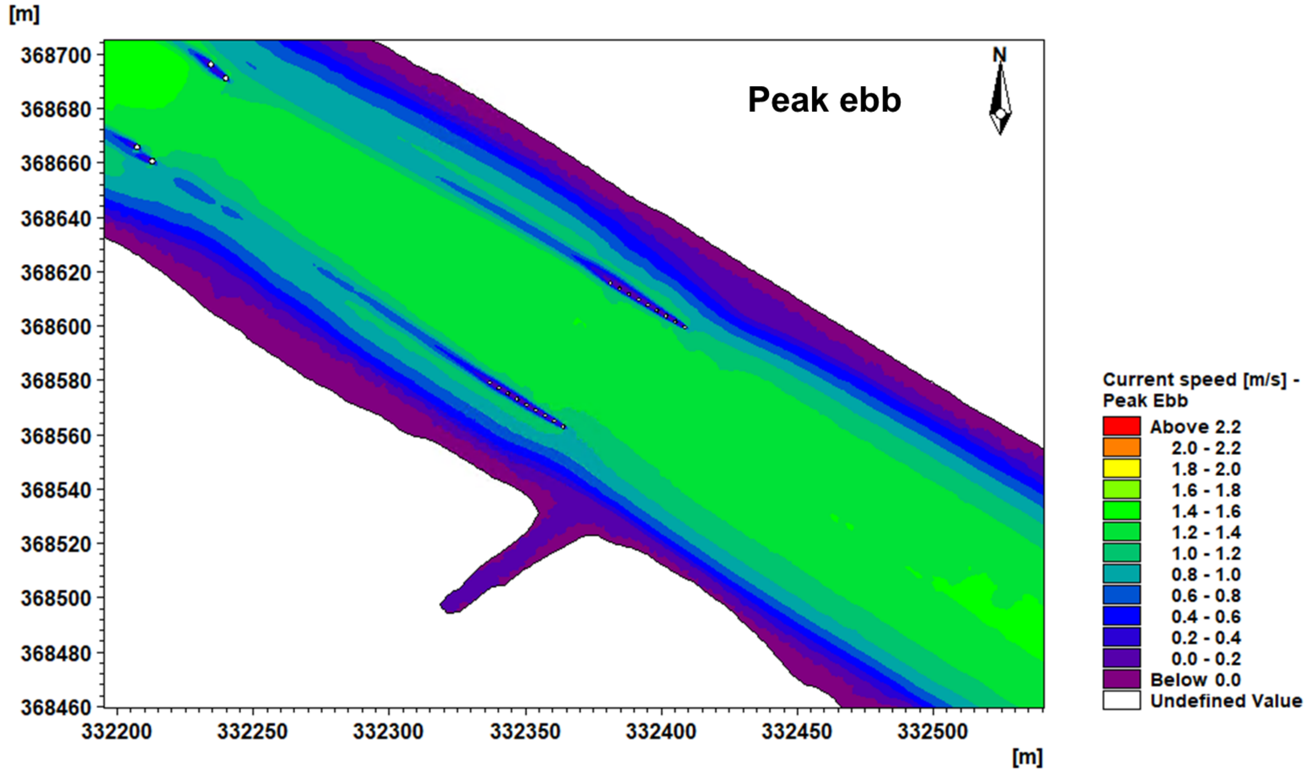


Source: Image by Landsat [Public domain]

When the river discharge is high, the hydrodynamic conditions at the site are dominated by higher velocity ebb flows that reach the order of 1.4 to 1.6 m/s in the centre of the channel as seen in Figure 1-77 Figure 1-77 . At the same time, the peak flood speeds are reduced to less than 1.0 to 1.2 m/s. In this simulation, a train of eddies is evident during the flood tide and less so during the ebb phase. Due to the lower water levels during the peak ebb, the flow is more confined to the centre of the channel, and the eddies associated with the deeper flood tide are not seen in the results.

Figure 1-77 Peak flood and peak ebb depth-averaged current speeds under high river discharge conditions (1:100- year event) at the A494 Bridge.





Source: Mott MacDonald, 2025

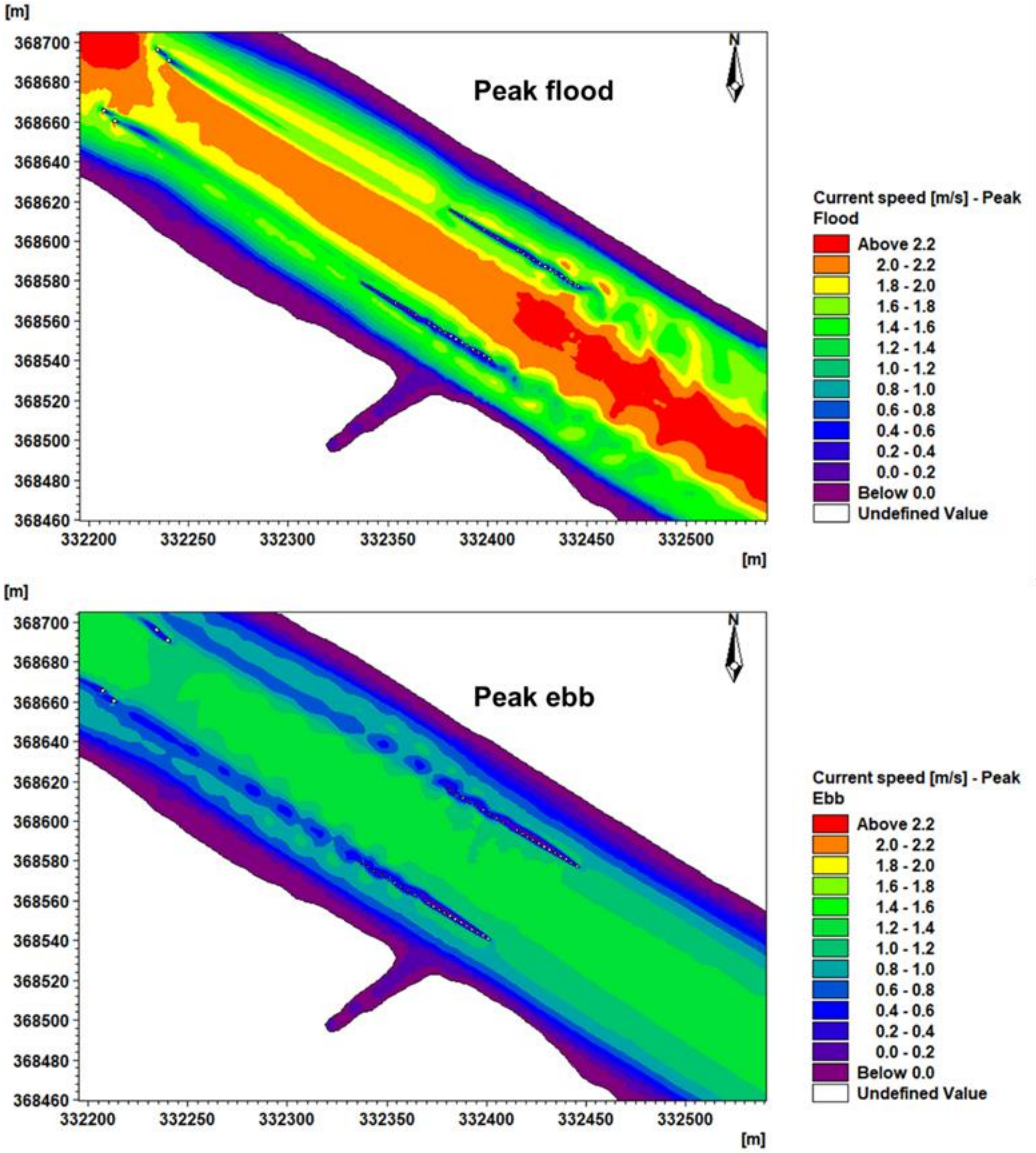
Scenario 2: Existing Bridge with the new Bridge

Figure 1-78 shows the current speeds at the site with the existing and proposed new A494 Bridge piles for peak flood and ebb flows during the mean spring tide simulation. In the middle of the channel, current speeds remain around 2.2 m/s during the flood tide. However, slightly higher currents of up to 2.3 m/s are observed between and upstream of the new Bridge section.

During the ebb phase, peak current speeds are of the order of 1.3 m/s in the centre of the channel between the proposed and existing A494 Bridge piles. The current speeds between the A494 Bridge piles and the Jubilee Bridge, located 150 m downstream of the site (Figure 1-78 are also around 1.3 m/s.

The train of eddies, previously observed in the baseline results during the flood tide, is now evident during peak flow conditions for both the flood and the ebb directions. It is considered that having both Bridge piles (existing and proposed at the same time) creates a more significant blockage to both ebb and flood flows and the generation of eddies by flow separation around the individual Bridge piles that extend upstream and downstream for 100 to 150 m (Figure 1-78).

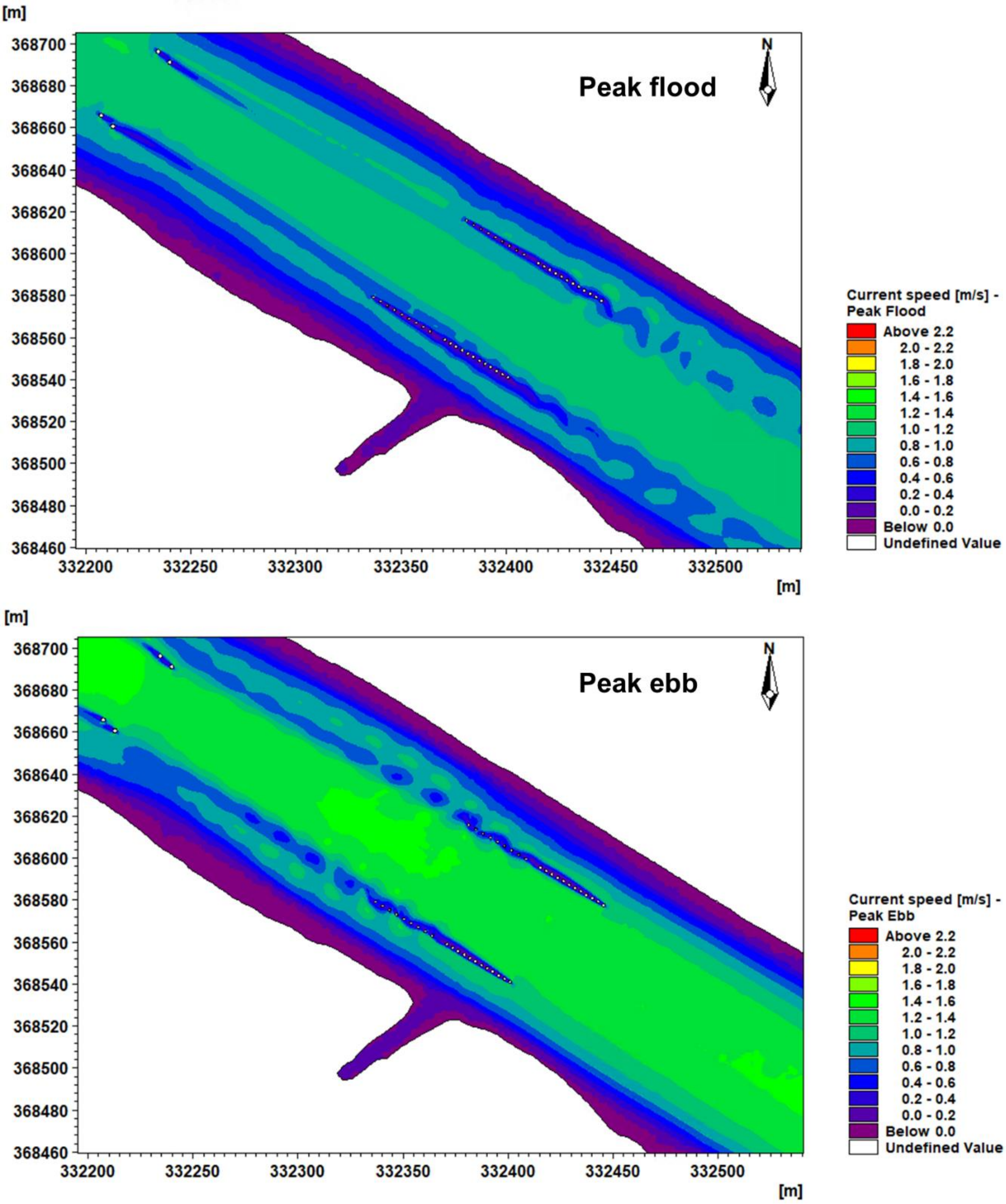
Figure 1-78 Peak flood and peak ebb depth-averaged current speeds under mean spring tide conditions at the A494 Bridge, including the proposed new A494 Bridge piles (existing and proposed piles scenario).



Source.: Mott MacDonald, 2025

During high river discharge conditions, the hydrodynamics are modified significantly. The simulation indicates that Scenario 2 (existing Bridge with proposed new A494) disrupts the flow more than Scenario 1 (existing Bridge only) creating larger and more extended eddies (Figure 1-79). In this case, the ebb flow speeds reach around 1.4 to 1.6 m/s in the centre of the channel, and peak flood speeds are reduced to around 1.0 to 1.2 m/s. Also, in Figure 1-79 , a train of eddies extending more than 100m upstream and downstream of the site is observed for peak flood and ebb conditions.

Figure 1-79 Peak flood and peak ebb depth-averaged current speeds under high river discharge conditions (1:100- year event) at the A494 Bridge, including the proposed new A494 Bridge piles (existing and proposed piles scenario).



Source.: Mott MacDonald, 2025

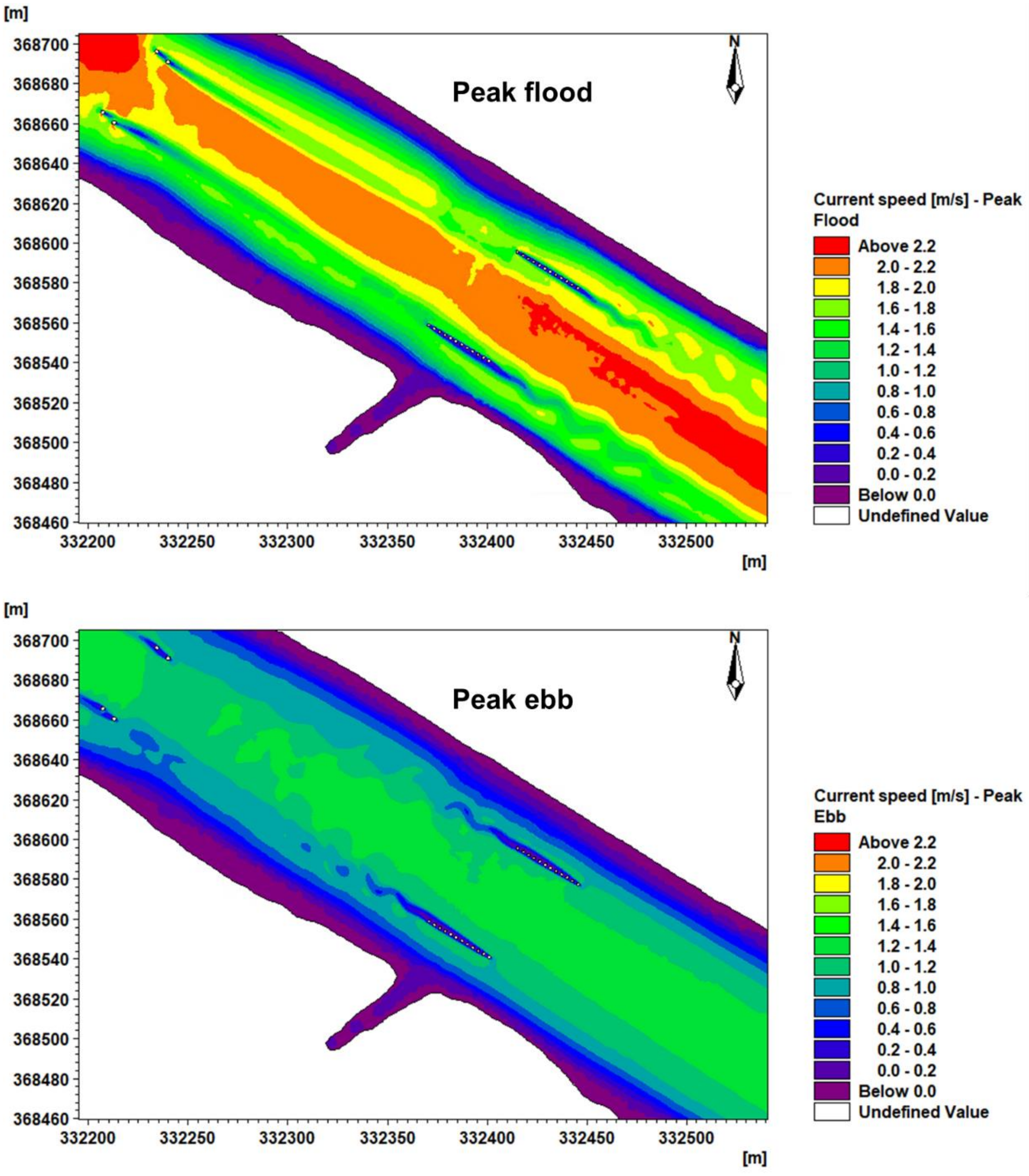
Scenario 3: New Bridge only

In the final configuration, the existing Bridge is assumed to be removed, and the new A494 Bridge is fully operational.

Overall, the results for this scenario under mean spring tide conditions (Figure 1-80) are like those observed under Scenario 1 (Existing Bridge only). Peak flood current speeds in the middle of the channel remain around 2.2 m/s, while during the ebb phase, maximum currents do not exceed 1.4 m/s. The spatial distribution of flow patterns is also largely unchanged, with current speeds between the new A494 Bridge and Jubilee Bridge (150 m downstream) remaining consistent with the baseline conditions.

The key difference between this scenario and the baseline is the more pronounced formation of eddies. The increased number of slightly larger piles introduces a greater obstruction to tidal flows, enhancing flow separation and resulting in more distinct and longer lasting eddy structures. While in Scenario 1, the train of eddies was primarily observed during the flood tide, under Scenario 3, these vortices are more evident and persist during both flood and ebb conditions. The intensified eddy formation extends between 100 and 150 m upstream and downstream of the site (Figure 1-80).

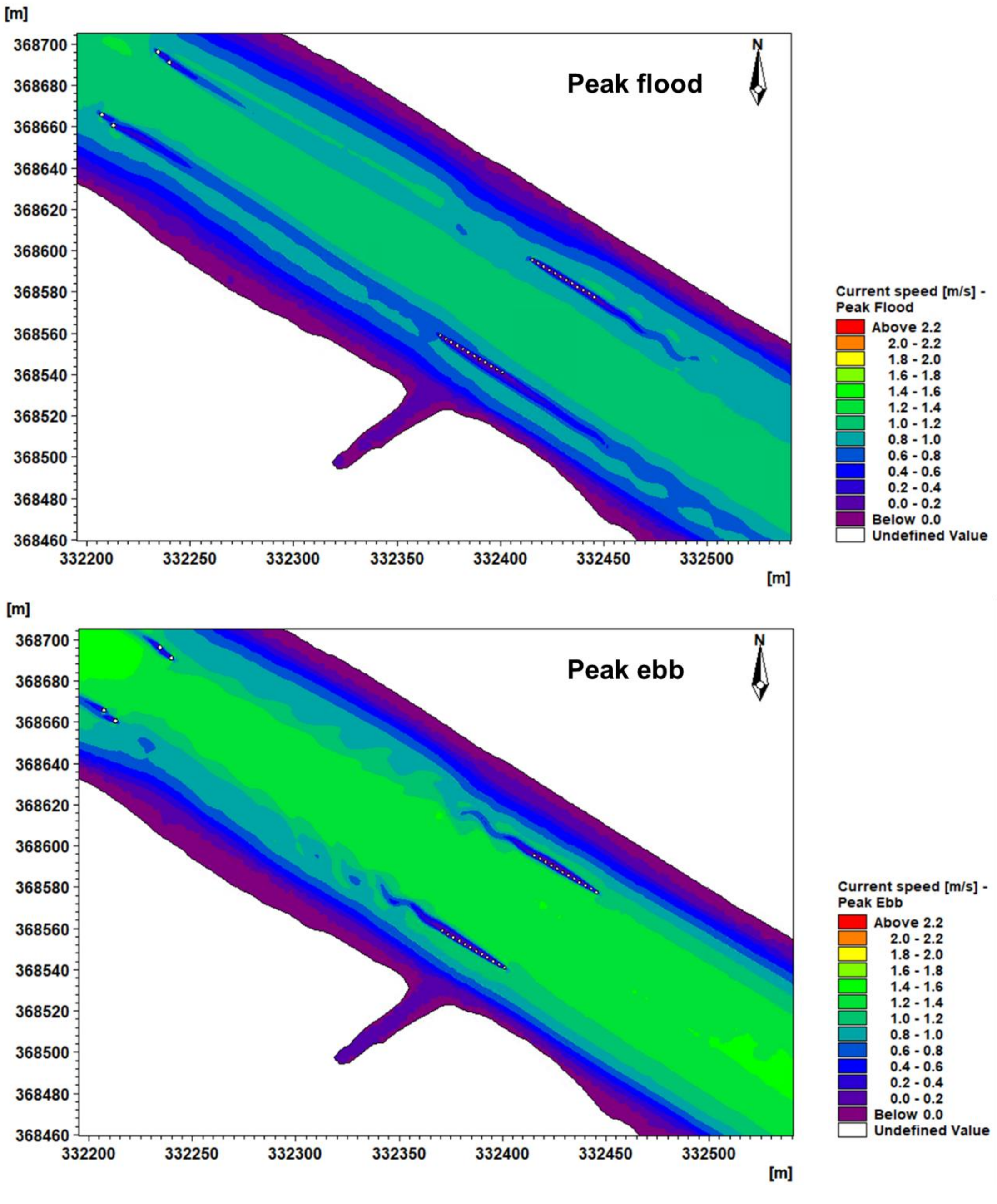
Figure 1-80 Peak flood and peak ebb depth-averaged current speeds under mean spring tide conditions for the proposed new A494. Bridge piles (proposed piles scenario).



Source.: Mott MacDonald, 2025

During high river discharge conditions (Figure 1-81), similar to those observed under mean spring tide conditions, the results for peak flood resemble those of Scenario 1. However, while in Scenario 1 the train of eddies was primarily observed during the flood tide, under Scenario 3, these vortices are more pronounced and persist during both flood and ebb phases. The intensified eddy formation extents 100 to 150 m upstream and downstream of the site. In this scenario with high river conditions, ebb flow speeds in the centre of the channel range between 1.2 to 1.4 m/s, while peak flood speeds are reduced to approximately 1.0 to 1.2 m/s as seen in Figure 1-81 .

Figure 1-81 Peak flood and peak ebb depth-averaged current speeds under high river discharge conditions (1:100-year event) for the proposed new A494. Bridge piles (proposed piles scenario).



Source.: Mott MacDonald, 2025

Changes to hydrodynamic conditions

To better understand the hydrodynamic changes caused by the new A494 Bridge, time series for water levels and current speeds have been extracted from the local MIKE3 FM HD model at locations both upstream and downstream of the site for the mean spring tide simulation. The data extraction locations are shown in Figure 1-82 . Figure 1-83 and Figure 1-84 present time series of water levels and current speed time series for Scenario 1 (black line), Scenario 2 (red line) and Scenario 3 (green line) upstream of the A494 Bridge site.

Figure 1-82 Location of water levels and current speed extraction points.

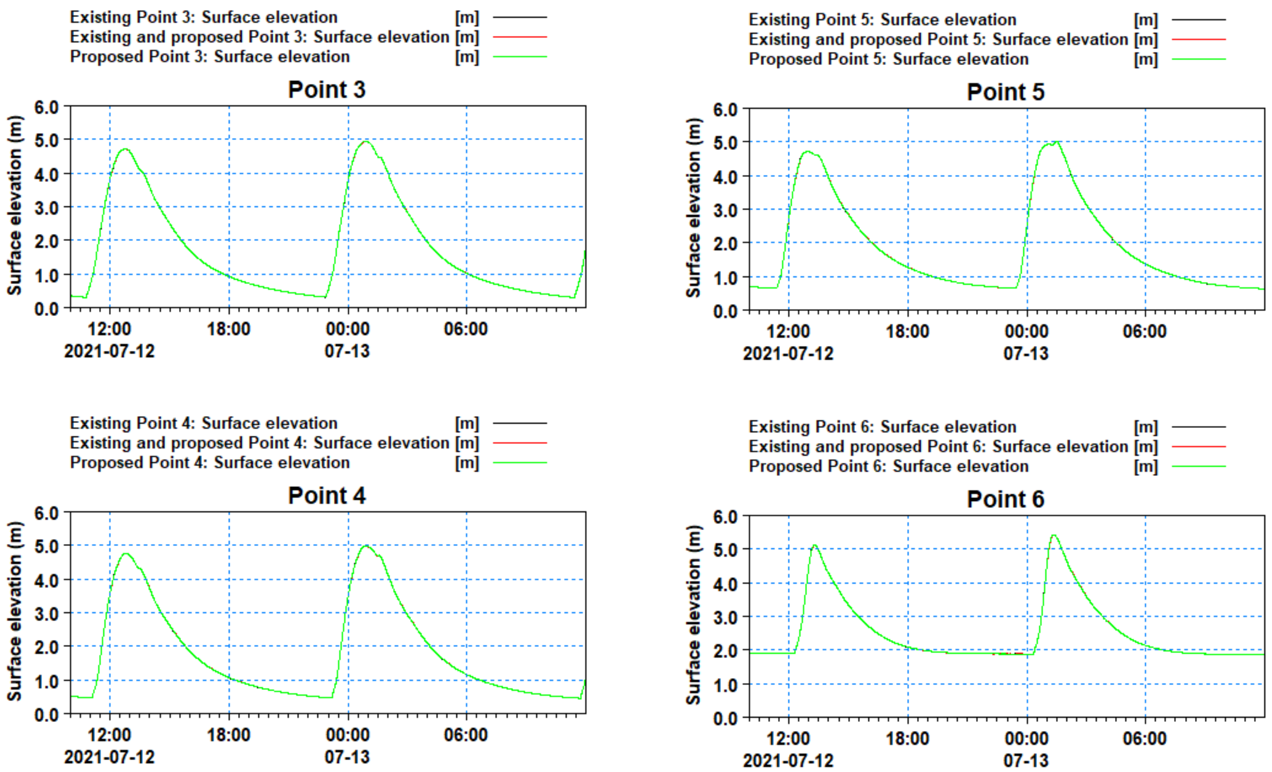
Source.: Mott MacDonald, 2021

At the scale of the plots in Figure 1-83 the model shows that Scenario 2 and Scenario 3 have no detectable effect on the water level upstream of the site. Indeed, the changes in the water levels are small (less than +1 cm) for all the upstream points.

These minor changes, illustrated with an enlarged vertical scale in Figure 1-84 , suggest that the new Bridge does not significantly alter tidal elevation or phase.

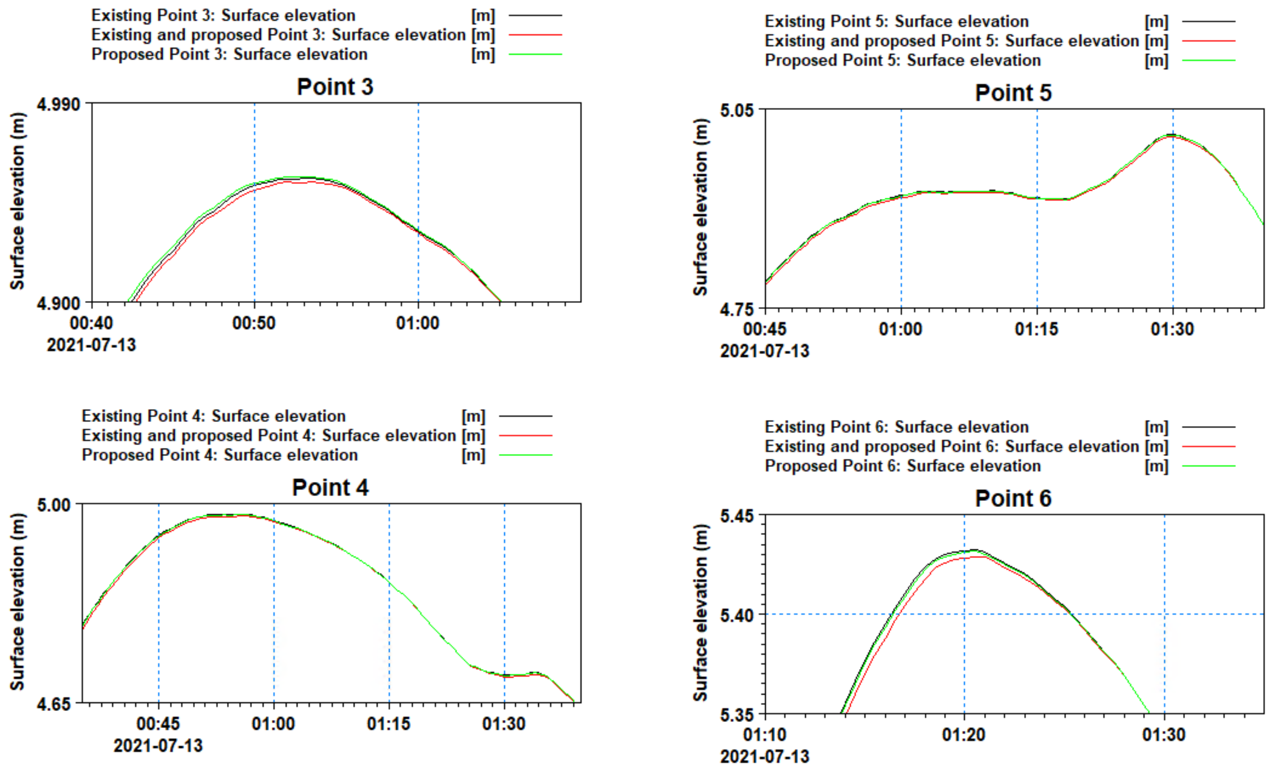
The most noticeable hydrodynamic effect is the change in tidal current speeds, primarily influenced by the increased number of Bridge piles under Scenario 2. This additional obstruction (original 9 piles plus 12 from the new Bridge) affects localised flow patterns but does not produce significant large-scale impacts. Figure 1-85 illustrates the changes in current speeds for the three scenarios. At Point 3 (the site), peak ebb and flood speeds increase by 3 and 4 cm/s, respectively, compared to Scenario 1 and Scenario 3. Further upstream, at Points 4, 5 and 6, peak flood and ebb current speeds have no significant changes.

Figure 1-83 Water level for the existing (black line), existing and proposed (red line) and proposed scenario (green line) for locations upstream of the project site.



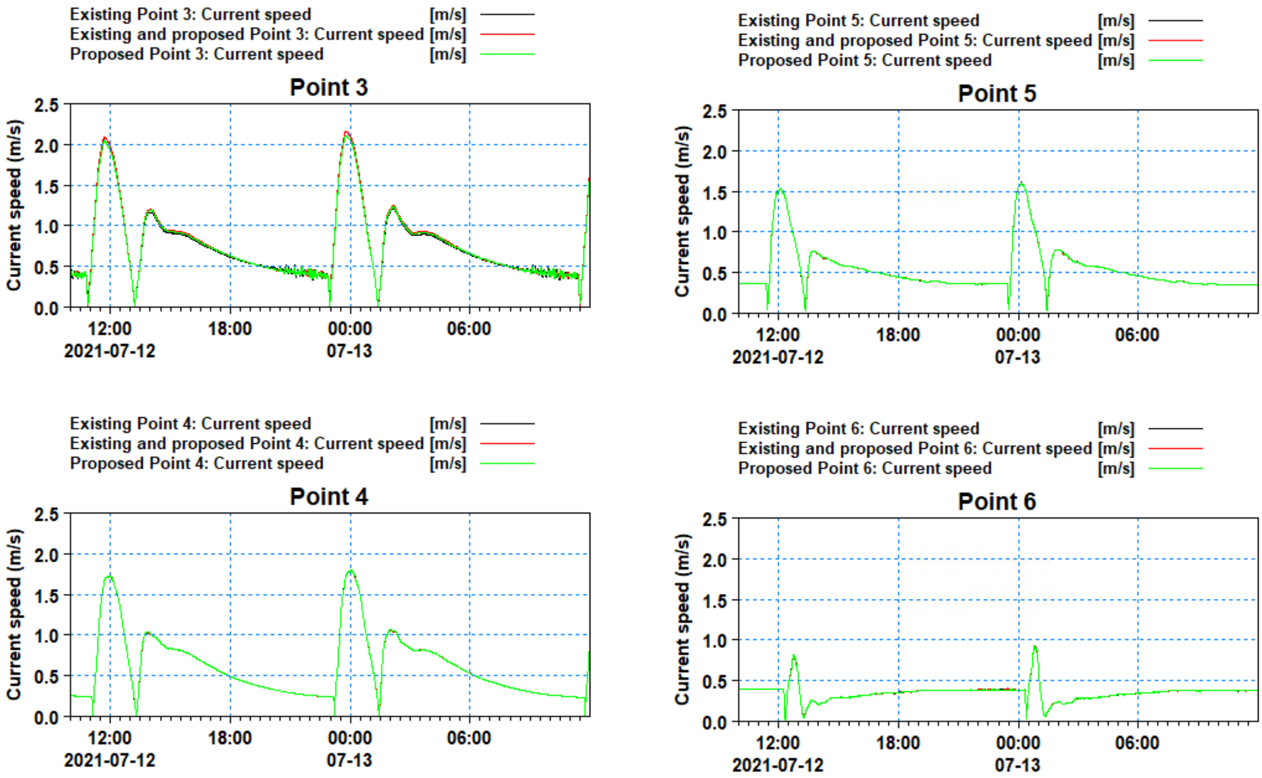
Source.: Mott MacDonald, 2025

Figure 1-84 Enlargement of the second high water of the water level plot (Figure 1-83) to show the small changes in water levels for the existing (black line), existing and proposed (red line) and the proposed scenario (green line) for locations upstream of the project site.



Source.: Mott MacDonald, 2025

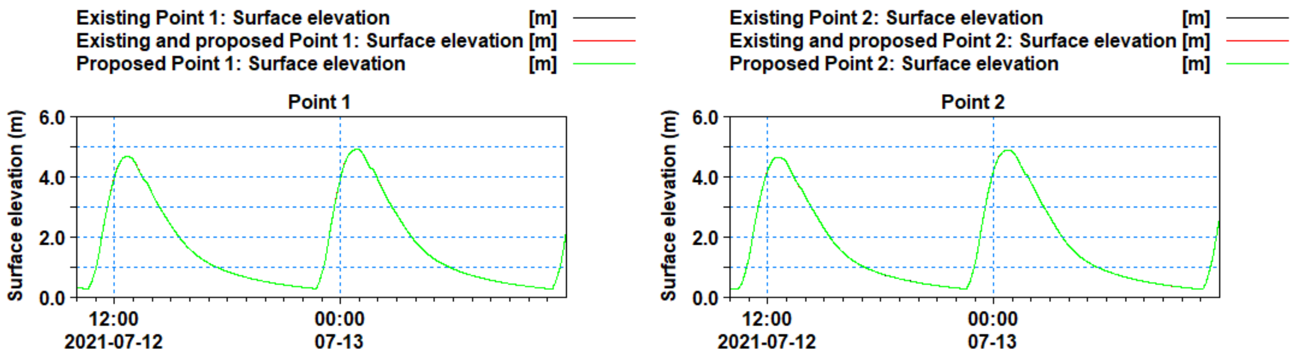
Figure 1-85 Current speed for the existing (black line), existing and proposed (red line) and the proposed scenario (green line) for locations upstream of the project site.



Source.: Mott MacDonald, 2025

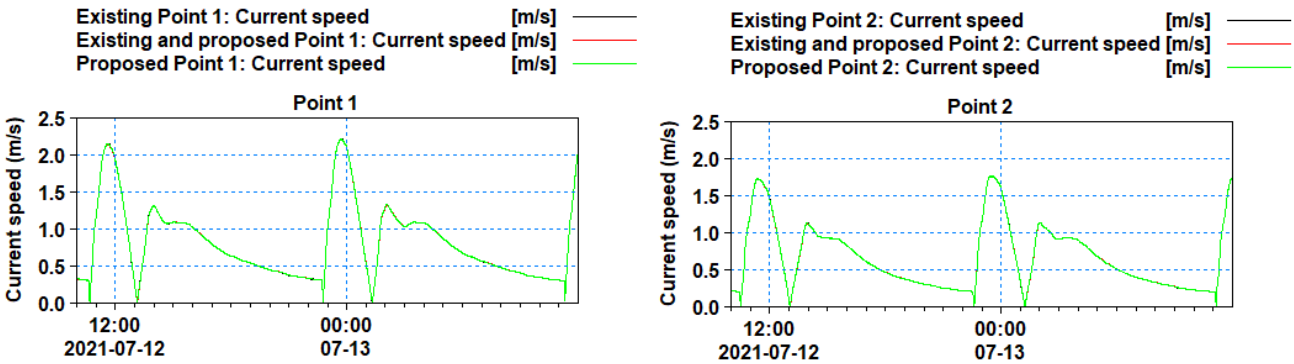
Downstream in Figure 1-86 and Figure 1-87 differences in water levels and currents speeds are not significant between the three different scenarios.

Figure 1-86 Water level for the existing (black line), existing and proposed (red line) and proposed scenario (green line) for locations downstream of the project site.



Source.: Mott MacDonald, 2025

Figure 1-87 Current speeds for the existing (black line), existing and proposed (red line) and proposed scenario (green line) for locations downstream of the project site.



Source.: Mott MacDonald, 2025

Mean spring conditions

Figure 1-88 to Figure 1-93 illustrate the changes in current speeds under mean spring tide conditions during peak flood flow conditions. Positive values (yellow to red) indicate increased current speeds relative to the existing Bridge configuration (Scenario 1), blue to purple indicate a reduction in current speed.

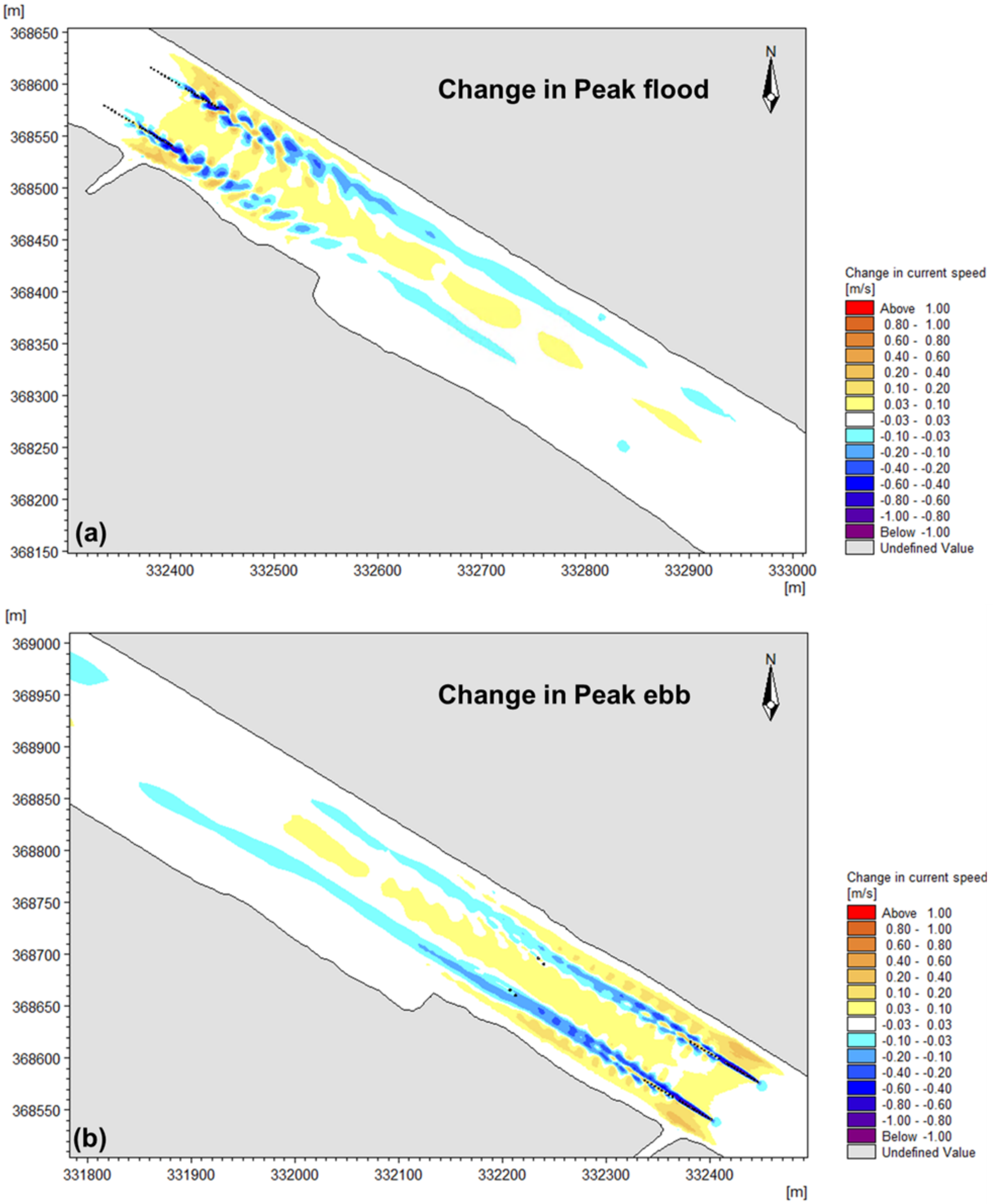
For Scenario 2, Figure 1-88 , Figure 1-90 and Figure 1-92 , show that peak flood currents generally decrease around the piles due to flow blocking. However, localised increases of 0.4 to 0.6 m/s occur between some existing and proposed piles as the effects of eddies are realised. In the middle of the channel, current speeds increase by up to 0.1 m/s, due to compression of the flow into the centre of the channel and towards the banks, either side of the structures. Approximately 300 m upstream on the flood tide, current speeds rise by less than 0.1 m/s, while localised increases of up to 0.4 m/s occur along the channel edges. Additionally, an upstream shadow effect results in reduced flow speeds (less than -0.1 m/s), more pronounced on the north side of the channel.

For Scenario 3, Figure 1-89 , Figure 1-91 and Figure 1-93 show increases of up to 1 m/s around the existing A494 Bridge piles during peak flood tidal conditions. The removal of the existing Bridge structure eliminates previous flow obstructions, allowing water to move more freely. Higher current speeds are observed in areas previously occupied by the old piles, and in the centre of the channel and bank areas adjacent to where the existing piles used to be. The new Bridge configuration, with 12 piles instead of 9, reduces the flow area and causes velocity increases between the piles. Compression of the flow, from the proposed piles, into the centre of the channel and towards the banks, increases current speeds at the time of peak flood, by up to 0.1 and 0.4 m/s, respectively. Figure 1-94 and Figure 1-95 illustrates the hydrodynamic changes during peak ebb flow conditions.

For Scenario 2, Figure 1-94 shows that current speeds generally decrease around the piles due to flow blocking. However, localised increases of up to 0.2 m/s occur downstream between the piles and the banks, where flow is constricted by the structures and the eddies that are formed. In the middle of the channel, ebb currents are increased by up to 0.1 m/s but remain up to 0.1 m/s lower than during the flood tide, indicating a less pronounced impact compared to peak flood conditions.

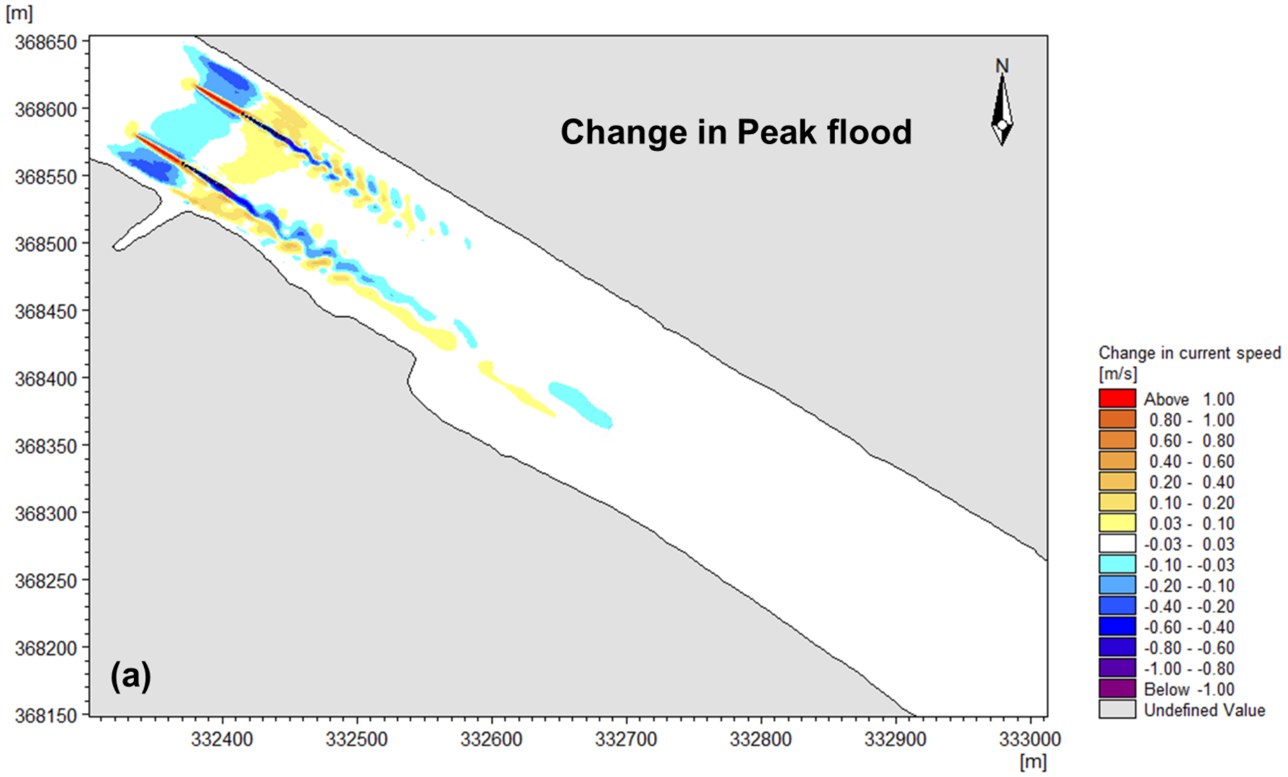
For Scenario 3, Figure 1-95 suggests a redistribution of flow energy during peak ebb. Current speeds increase by up to 0.8 m/s where the old Bridge piles have been removed, while localised reductions of up to -0.6 m/s occur due to the additional obstruction of the new Bridge piles. Overall, ebb flow modifications are smaller in magnitude and extent compared to peak flood flows. This is likely due to the naturally lower current speeds and reduced turbulence during the ebb phase, limiting the extent of flow alterations. The influence of the new Bridge structure on ebb flows extends approximately 150 m downstream towards the Jubilee Bridge, whereas flood flow effects extend further.

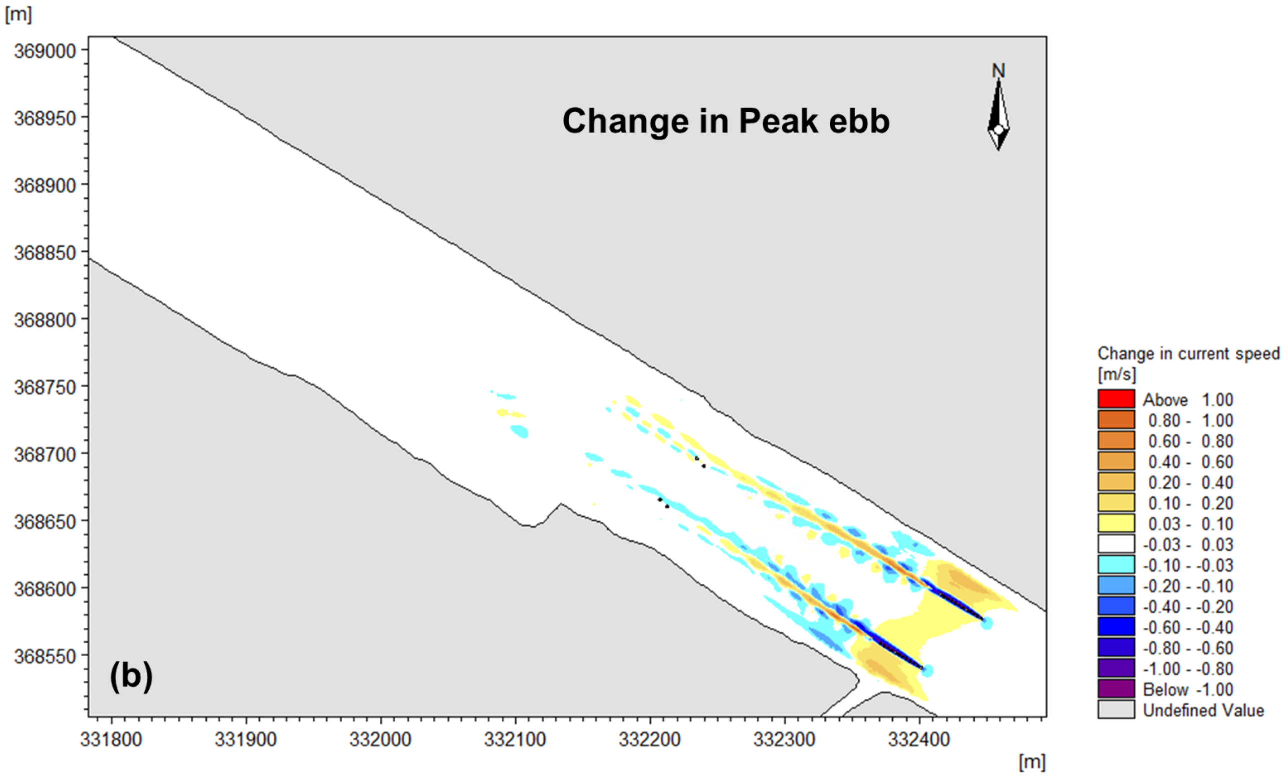
Figure 1-88 Differences in speed between the existing and the existing and proposed scenario for mean spring tide conditions during: (a) peak flood; and (b) peak ebb currents.



Source.: Mott MacDonald, 2025

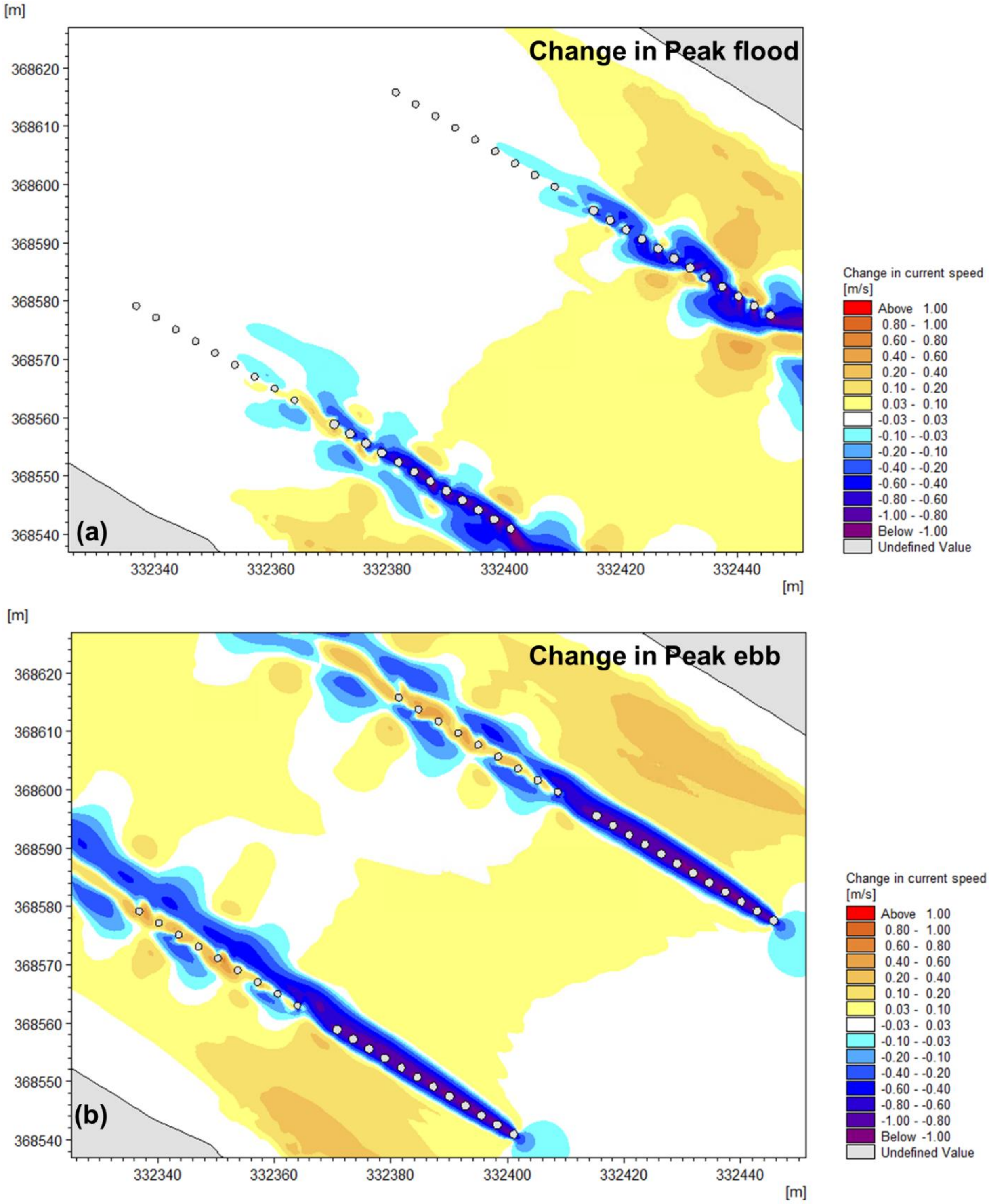
Figure 1-89 Differences in speed between the existing and the proposed scenario for mean spring tide conditions during: (a) peak flood; and (b) peak ebb currents.





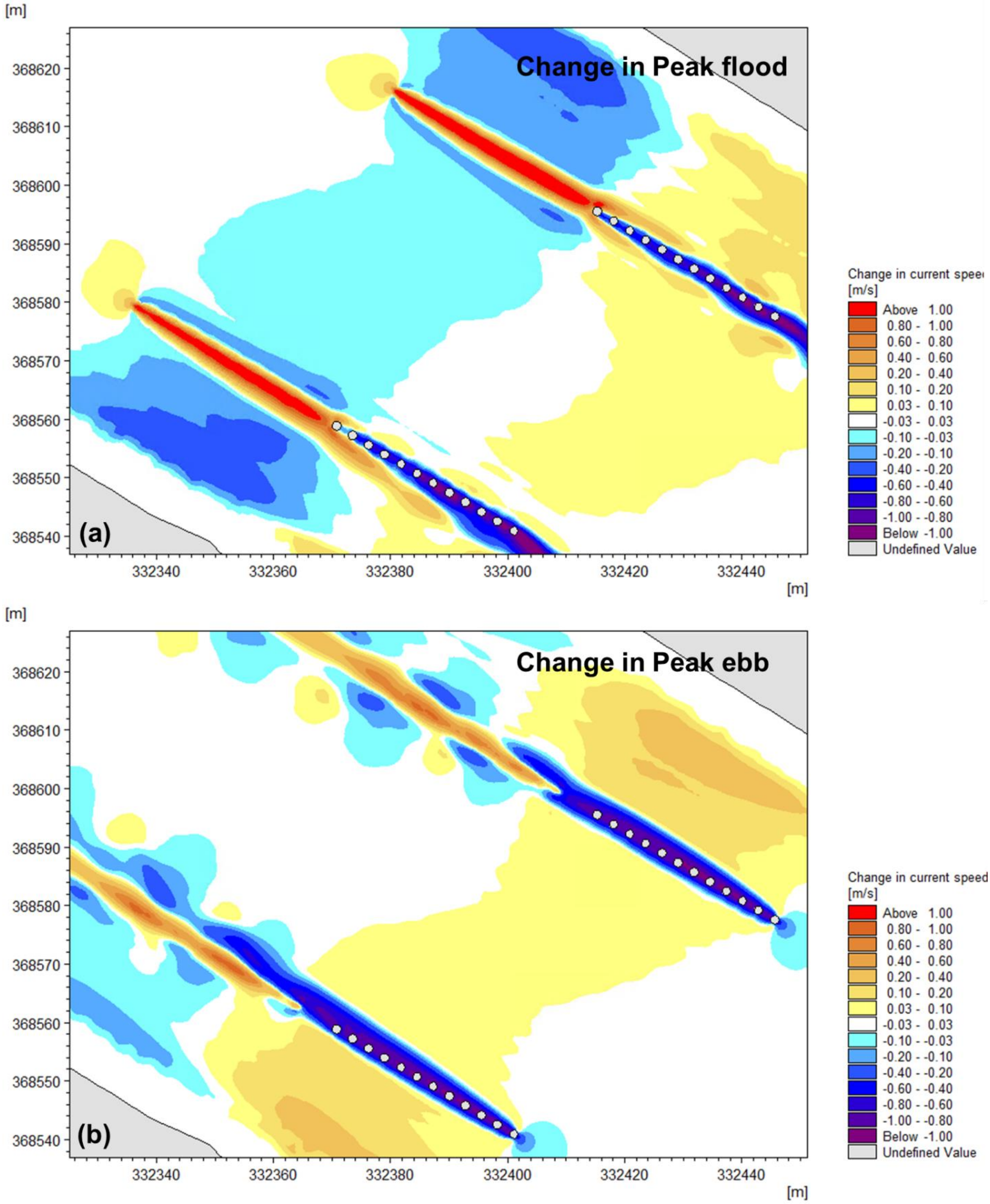
Source.: Mott MacDonald, 2025

Figure 1-90 Enlarged view of the differences in speed between the existing and the existing and proposed scenario for mean spring tide conditions during: (a) peak flood; and (b) peak ebb currents.



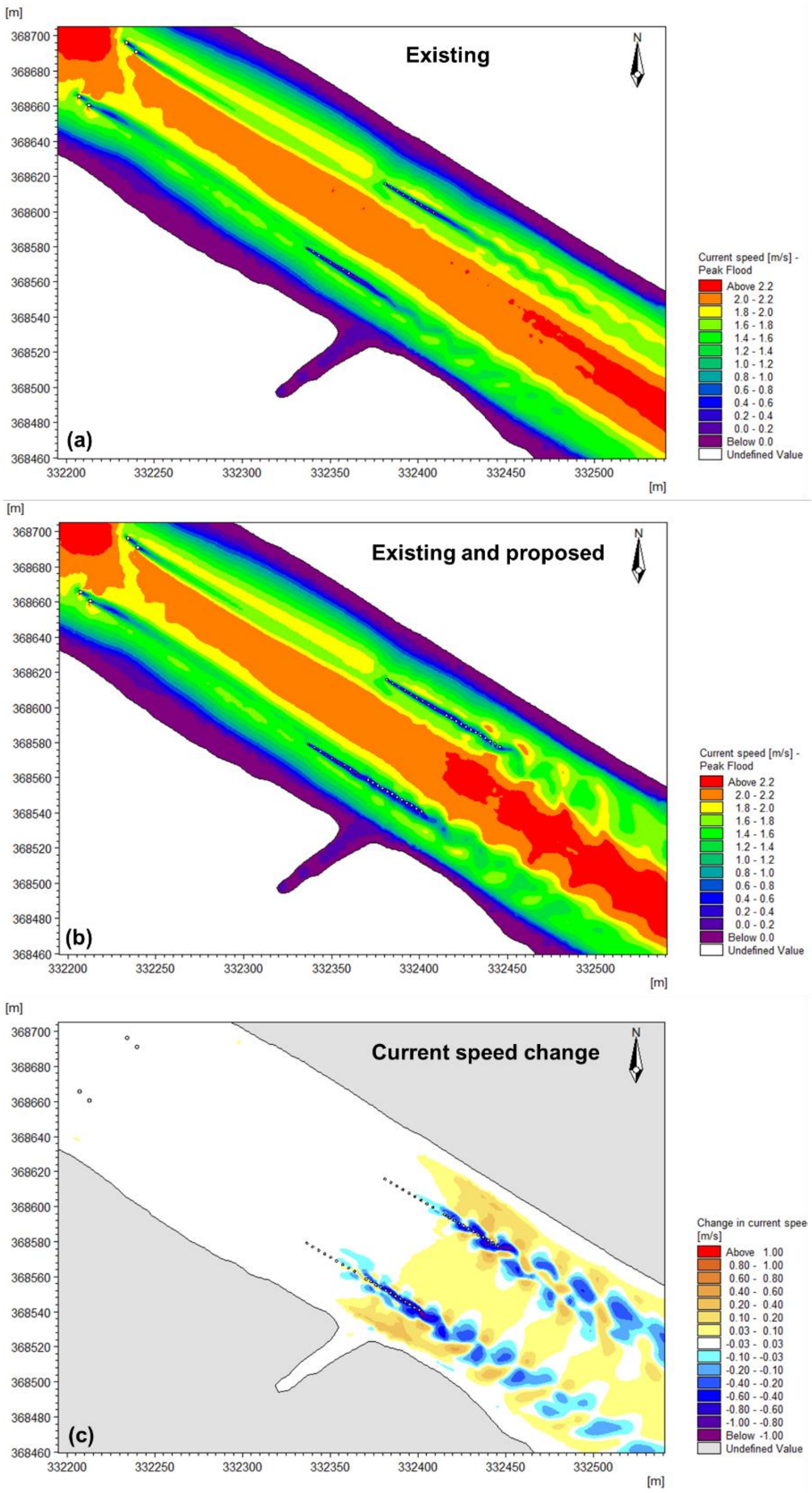
Source.: Mott MacDonald, 2025

Figure 1-91 Enlarged view of the differences in speed between the existing and the existing and proposed scenario for mean spring tide conditions during: (a) peak flood; and (b) peak ebb currents.



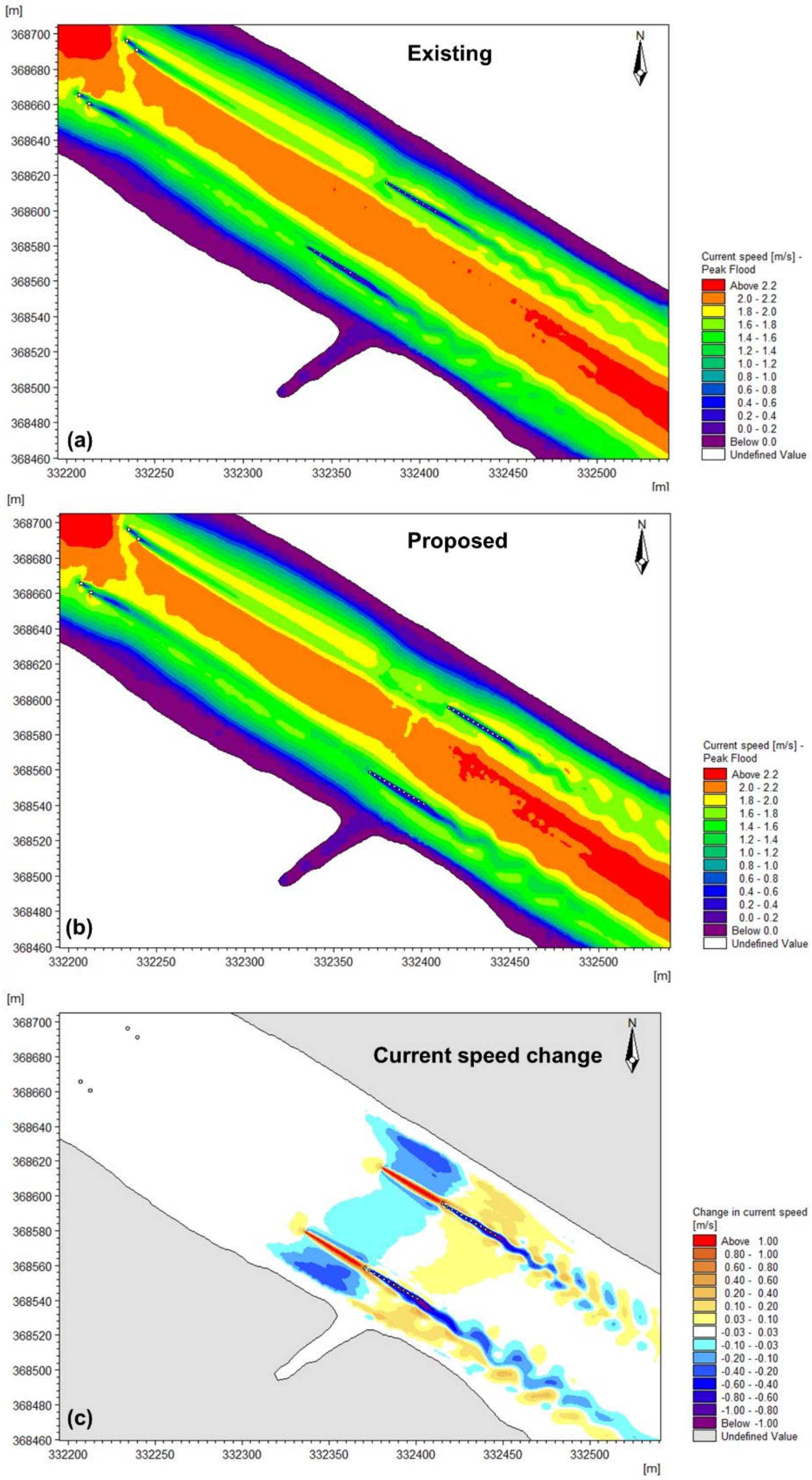
Source.: Mott MacDonald, 2025

Figure 1-92 Change in peak flood depth-averaged current speeds for the mean spring tide conditions due to the existing and proposed scenario: (a) existing scenario; (b) existing and proposed scenario; and (c) changes in current speed between the existing and existing and proposed scenario.



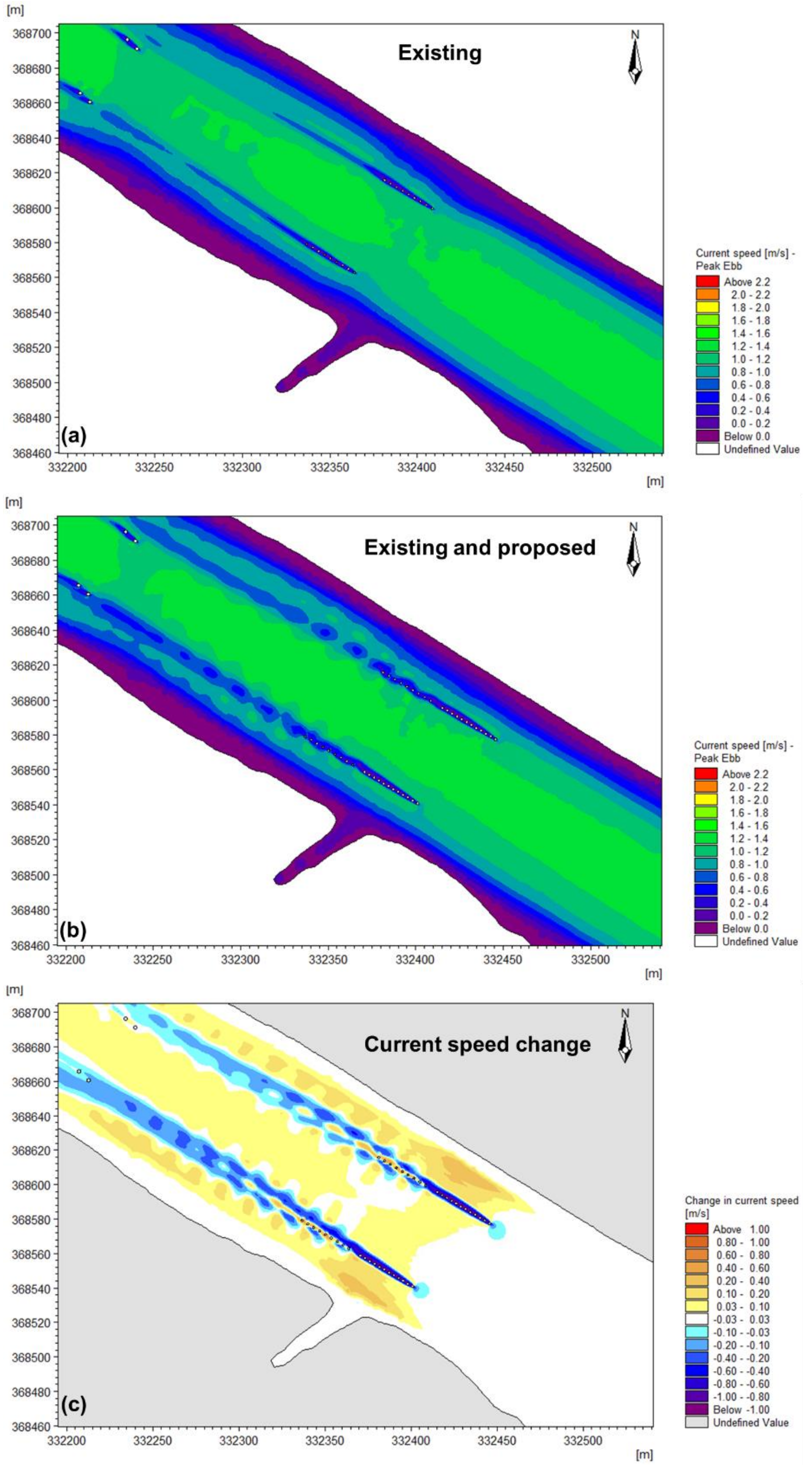
Source.: Mott MacDonald, 2025

Figure 1-93 Change in peak flood depth-averaged current speeds for the mean spring tide conditions due to the proposed scenario: (a) existing scenario; (b) proposed scenario; and (c) changes in current speed between the existing and the proposed scenario.



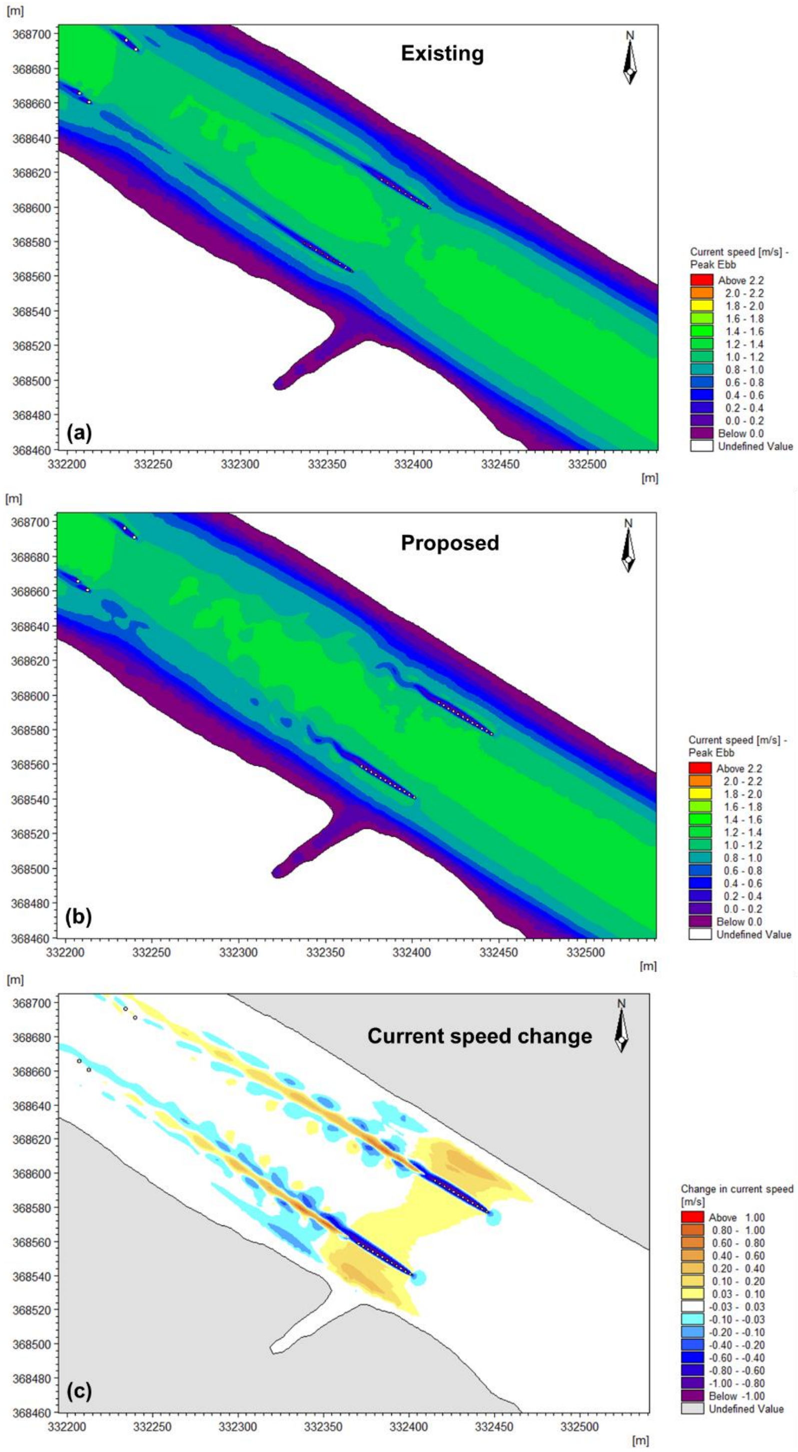
Source.: Mott MacDonald, 2025

Figure 1-94 Enlargement showing the changes in peak ebb depth-averaged current speeds for the mean spring tide conditions due to the existing and proposed scenario: (a) existing scenario; (b) existing and proposed scenario; and (c) changes in current speed between the existing and the existing and proposed scenario.



Source.: Mott MacDonald, 2025

Figure 1-95 Enlargement showing the changes in peak ebb depth-averaged current speeds for the mean spring tide conditions due to the proposed scenario: (a) existing scenario; (b) proposed scenario; and (c) changes in current speed between the existing and the proposed scenario.



Source.: Mott MacDonald, 2025

High river discharge conditions

Figure 1-96 to Figure 1-101 illustrate the changes in current speeds under high river discharge conditions during peak flow. Positive values (yellow to red) indicate an increase in current speeds relative to the existing Bridge configuration (Scenario 1), blue to purple indicate a reduction in current speeds.

In Scenario 2, Figure 1-96 Figure 1-98 and Figure 1-100 show that peak flood currents decrease around the piles due to flow blockage. However, localised increases of 0.2 to 0.4 m/s occur between some of the existing and proposed piles as eddies form. In the middle of the channel, current speeds increase by up to 0.1 m/s, driven by flow compression towards the channel centre and banks on either side of the structures. Near both channel margins, localised increases of up to 0.1m/s are observed, while a shadow effect on the north side of the channel results in reduced flow speeds (less than -0.1 m/s) over a 600 m stretch.

This indicates that Scenario 2 has a limited impact on the overall flow dynamics during peak flood, but a larger impact during the ebb phase where the higher river flows are constrained in the centre portion of the channel.

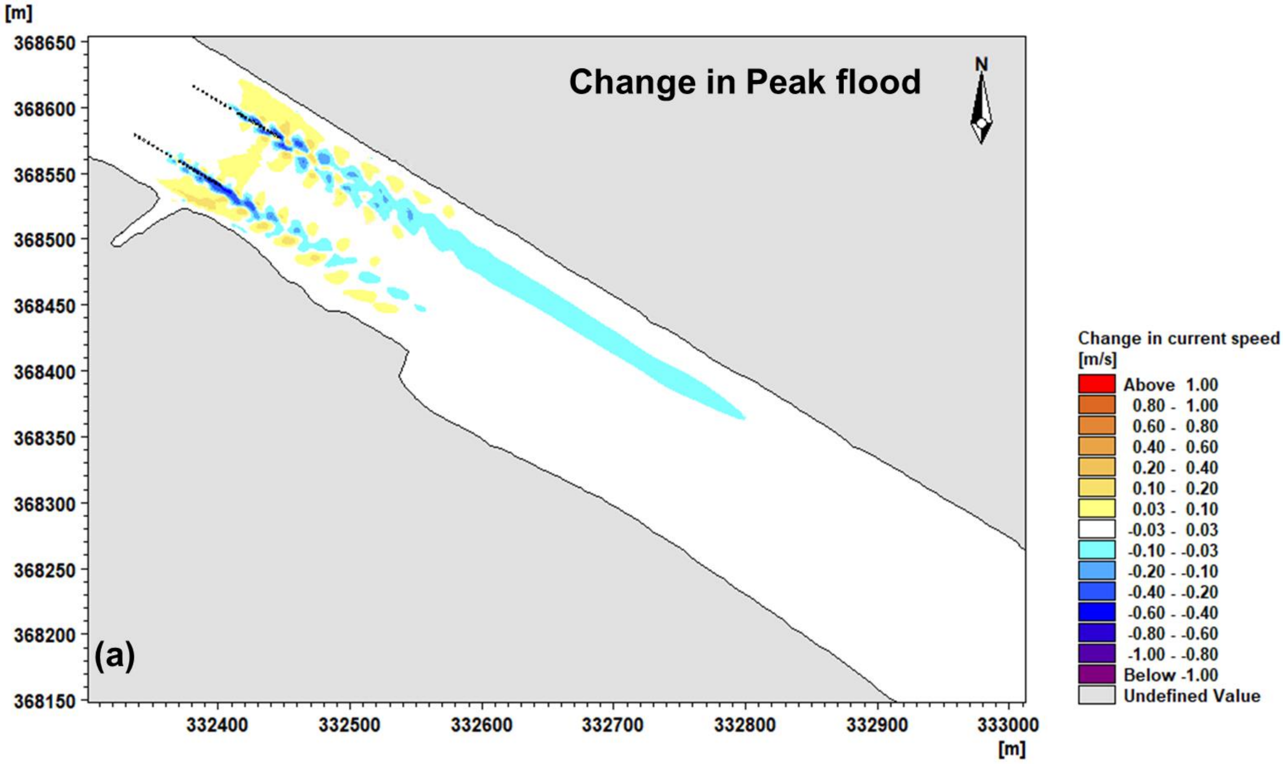
For Scenario 3, Figure 1-97 , Figure 1-99 and Figure 1-101 show increases of up to 0.8 m/s around the existing A494 Bridge piles during peak flood tidal conditions. The removal of the existing Bridge structure eliminates previous flow obstructions, allowing water to move more freely. Higher current speeds are observed in areas previously occupied by the old piles. The new Bridge configuration, with 12 piles instead of 9, reduces the flow area and causes velocity decreases between the piles.

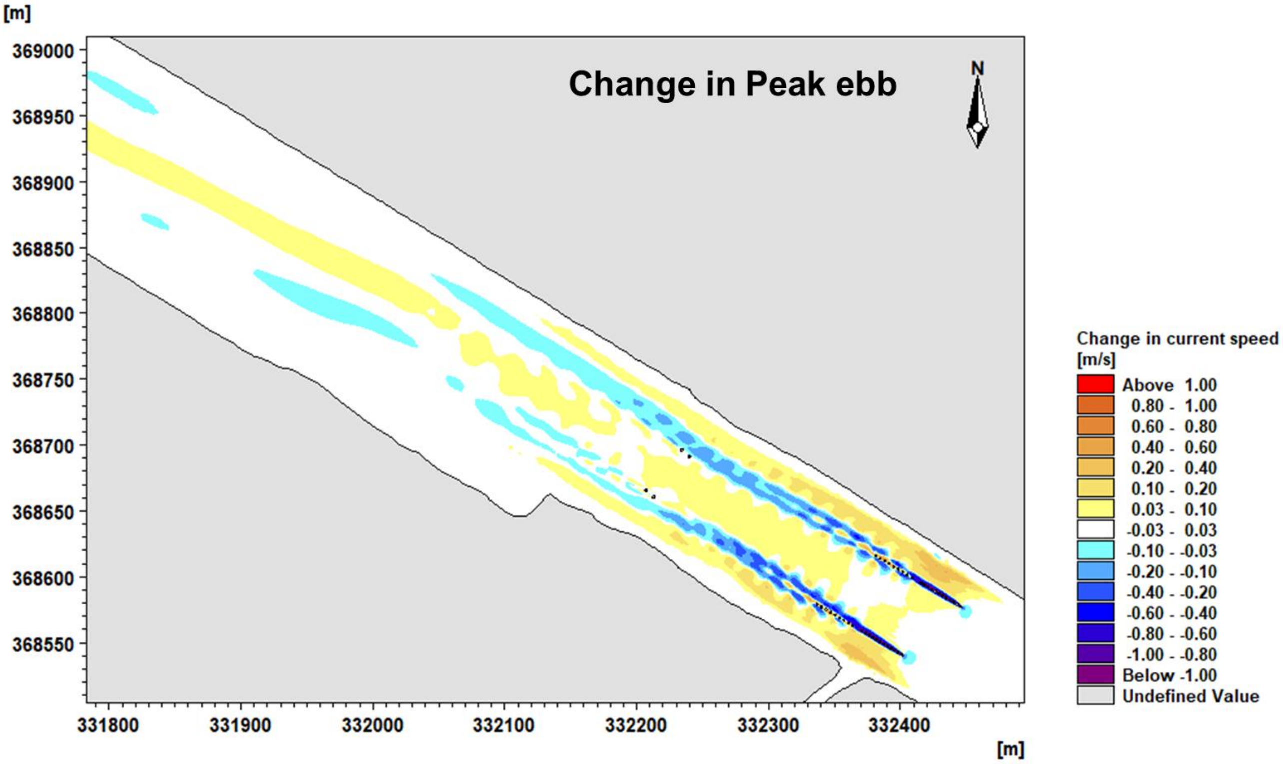
Figure 1-102 and Figure 1-103 illustrates the hydrodynamic changes during peak ebb flow conditions under high river discharge conditions.

For Scenario 2, Figure 1-102 shows that current speeds decrease around the piles due to flow blocking and an increase downstream of up to 0.2 m/s between the piles and the banks, where flow is constricted by the structures. Like the mean spring conditions, in the middle of the channel ebb currents increase by up to 0.1 m/s, suggesting that Scenario 2 has a minimal impact on the broader ebb flow dynamics.

For Scenario 3 during peak ebb (Figure 1-103) the most significant variations in current speeds occur around the Bridge piles, where localise increases of up to 0.8m/s are observed downstream due to reduced flow obstruction, while strong decreases occur immediately around the piles (up to -1 m/s), indicating intensified flow separation. Increased velocity near the banks of up to 0.6 m/s, likely due to the redirection of flow around the new pile configuration.

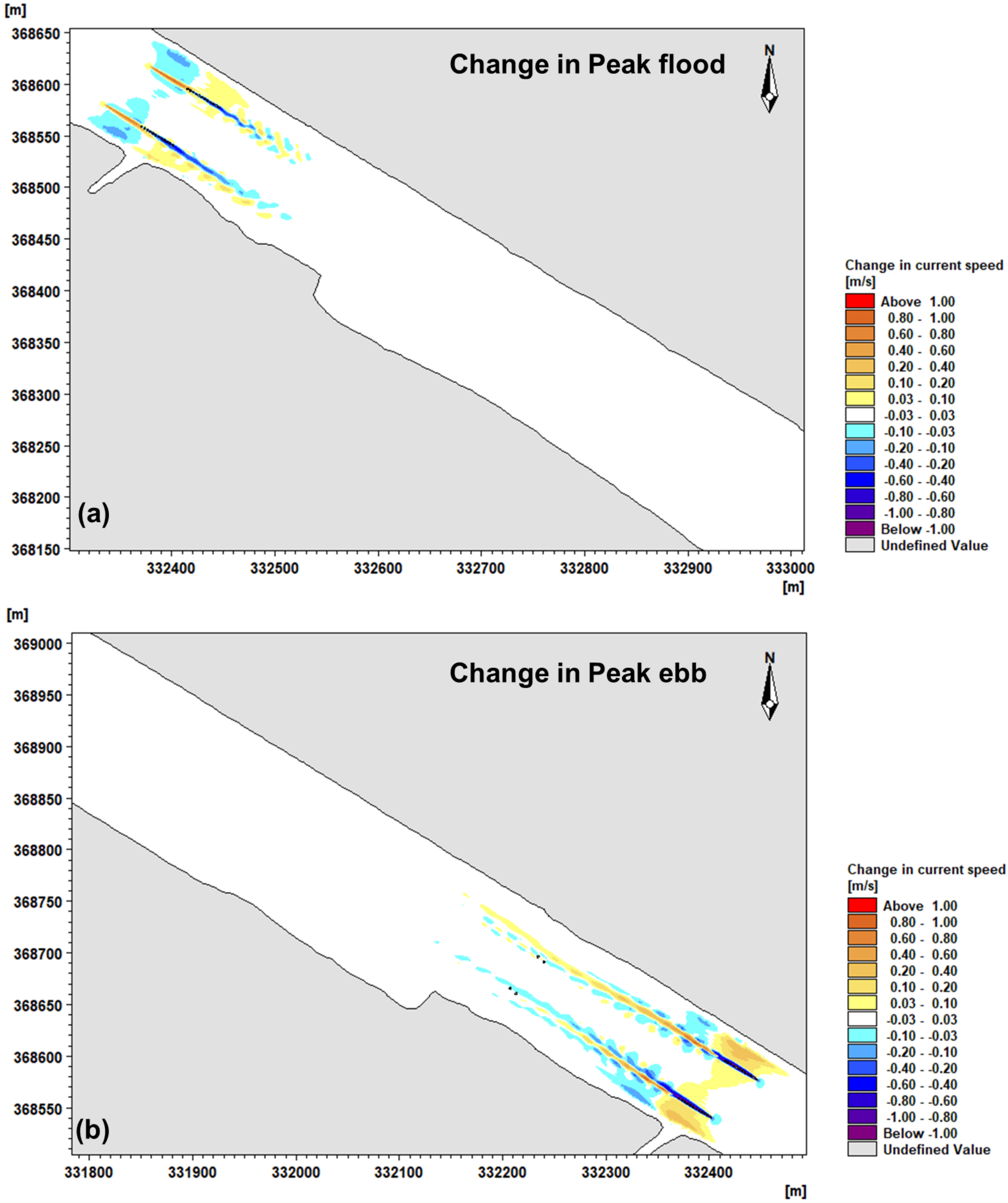
Figure 1-96 Differences in speed between the existing and the existing and proposed scenario for high river discharge conditions (1:100- year event) during: (a) peak flood; and (b) peak ebb currents.





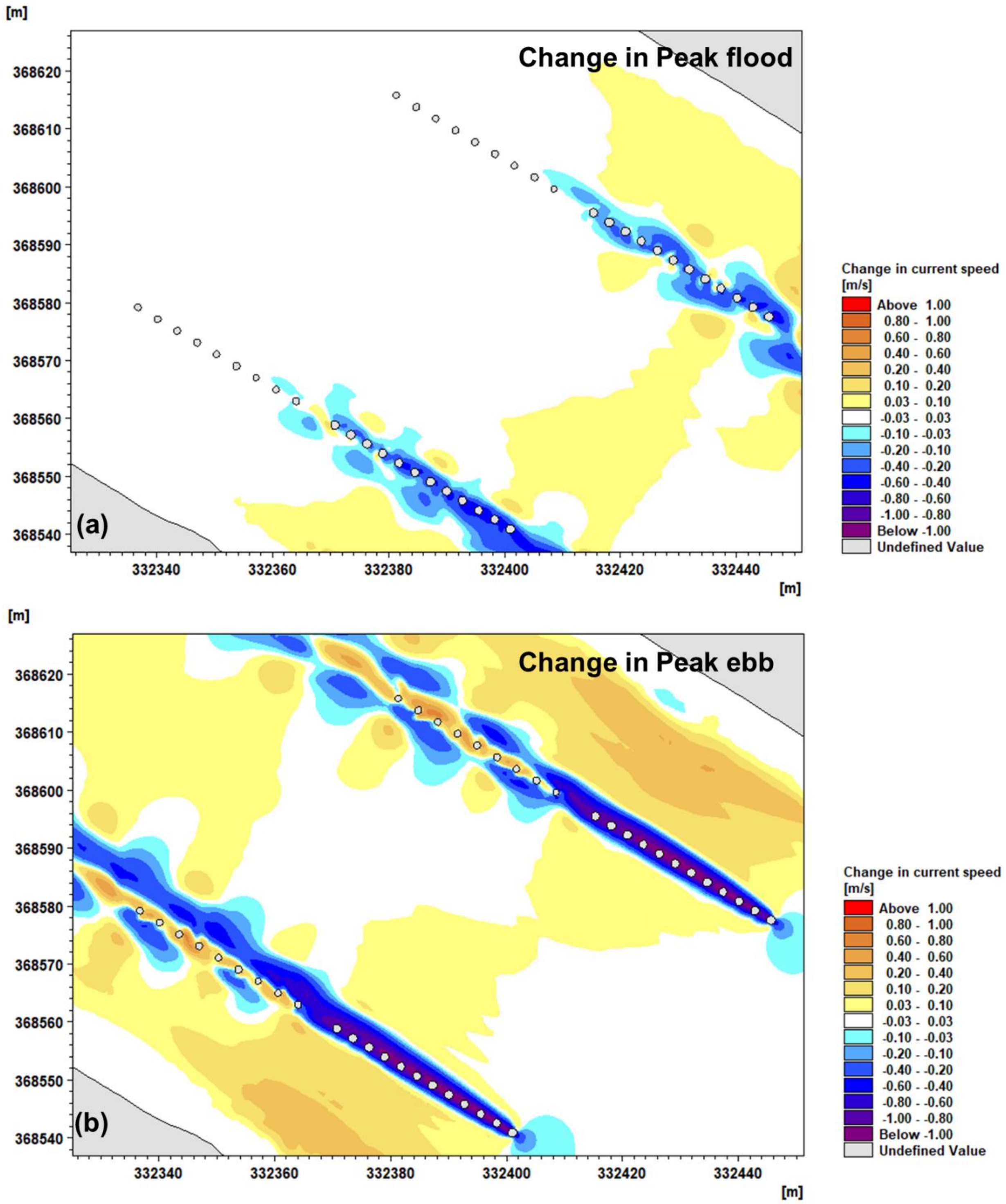
Source.: Mott MacDonald, 2025

Figure 1-97 Differences in speed between the existing and the proposed scenario for high river discharge conditions (1:100- year event) during: (a) peak flood; and (b) peak ebb currents.



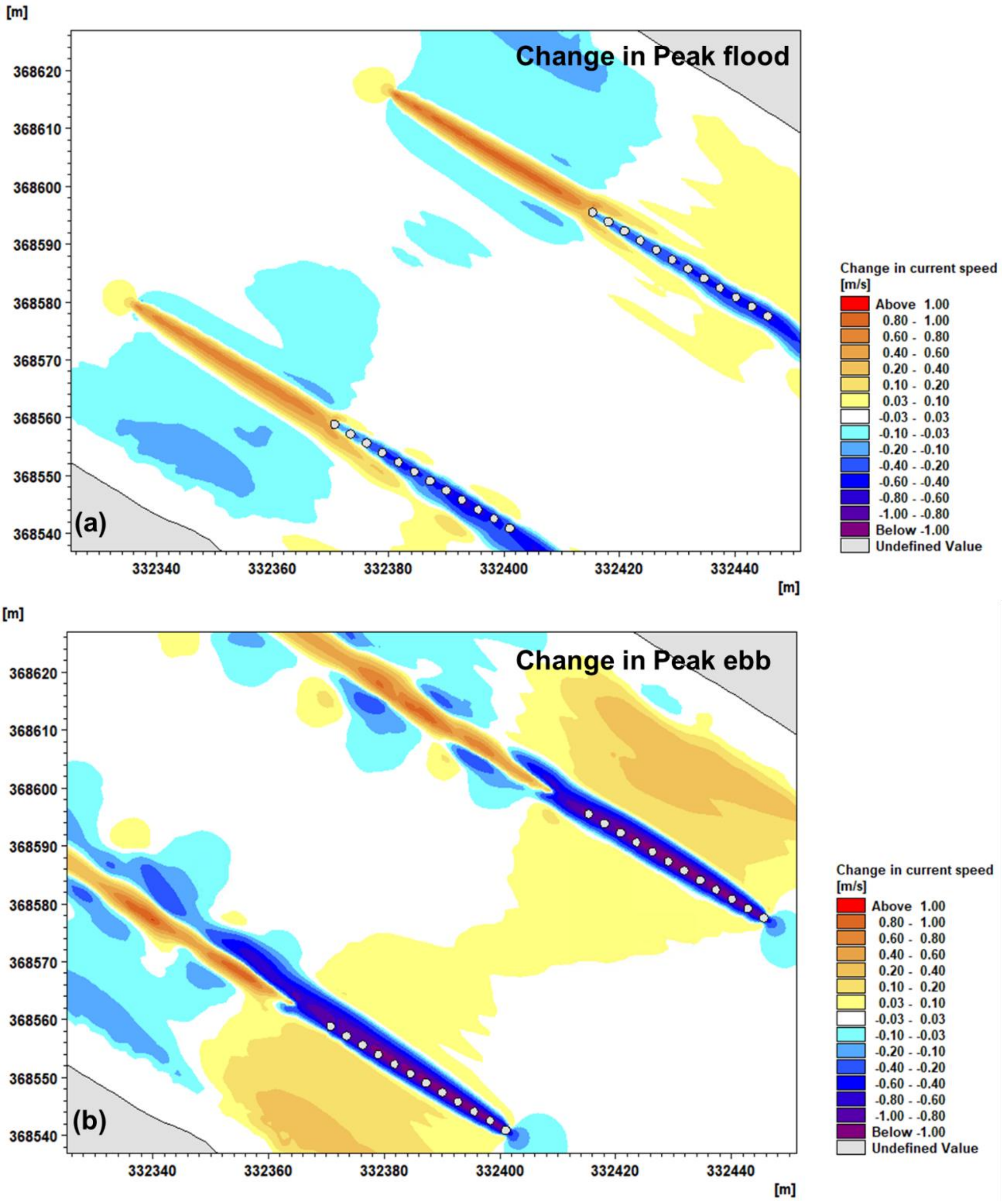
Source.: Mott MacDonald, 2025

Figure 1-98 Enlarged view of the differences in speed between the existing and the existing and proposed scenario for high river discharge conditions (1:100-year event) during: (a) peak flood; and (b) peak ebb currents.



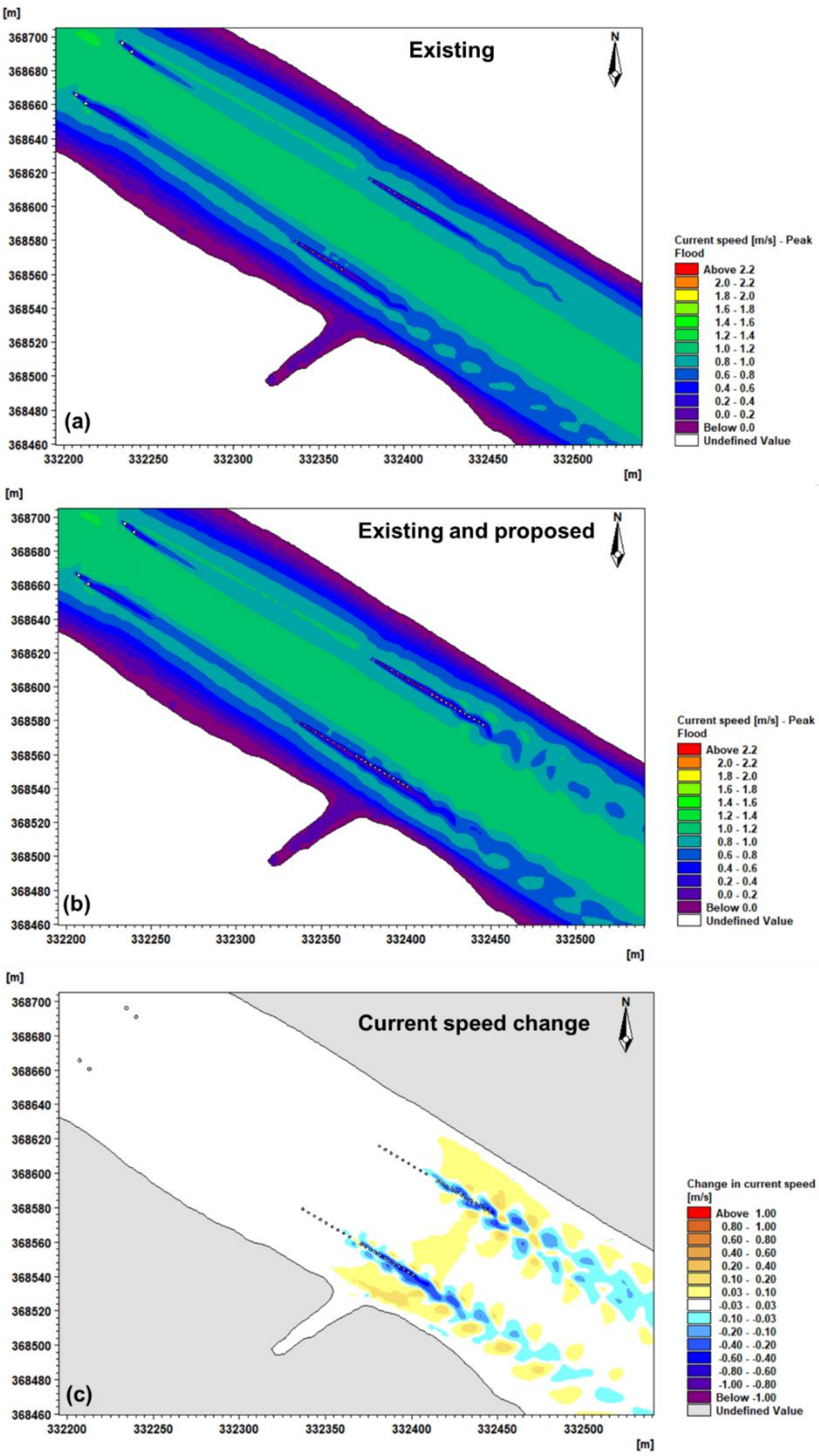
Source.: Mott MacDonald, 2025

Figure 1-99 Enlarged view of the differences in speed between the existing and the proposed scenario for high river discharge conditions (1:100-year event) during: (a) peak flood; and (b) peak ebb currents.



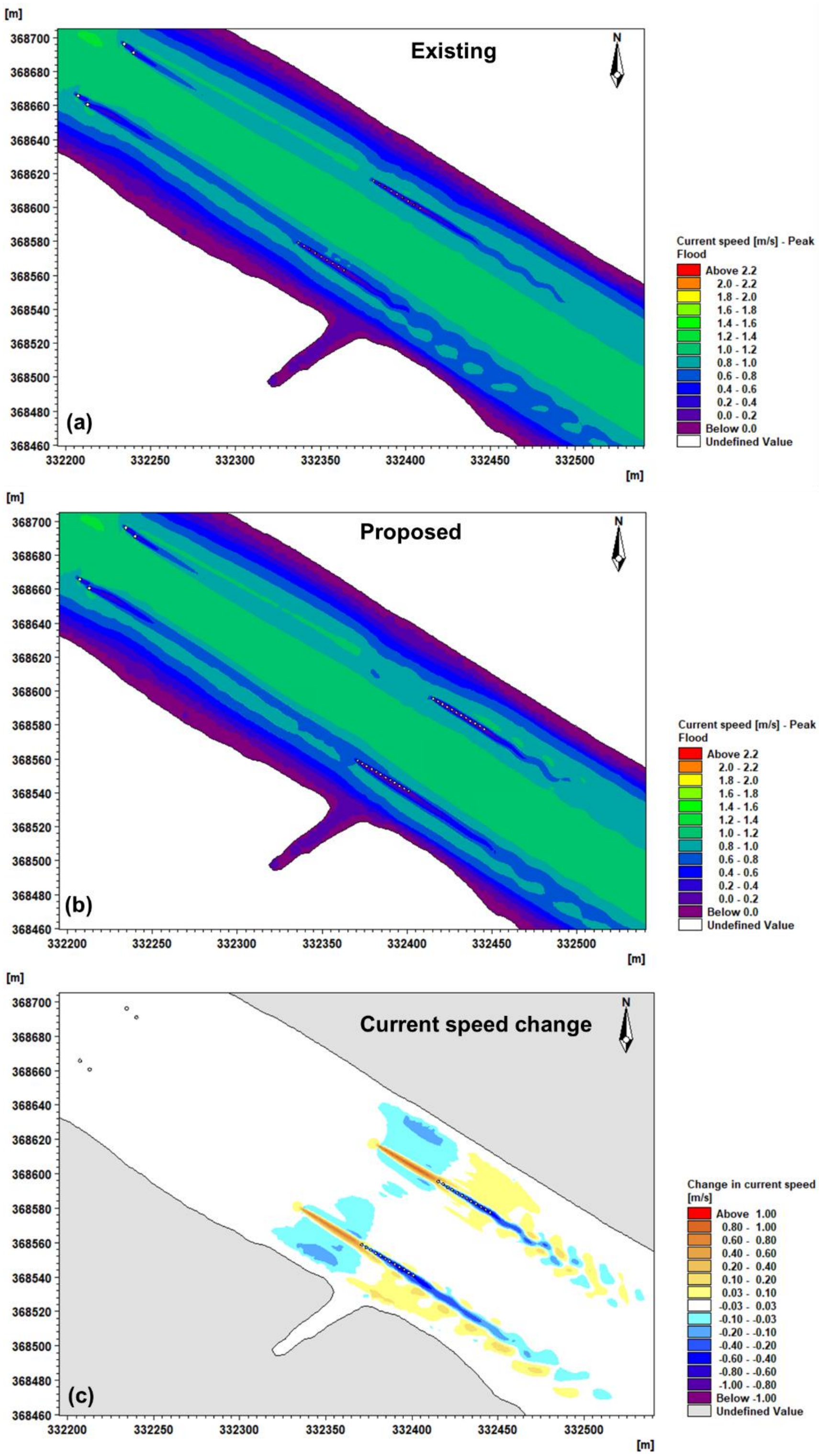
Source.: Mott MacDonald, 2025

Figure 1-100 Change in peak flood depth-averaged current speeds for high river discharge conditions (1:100-year event) due to the existing and proposed scenario: (a) existing scenario; (b) existing and proposed scenario; and (c) changes in current speed between the existing and existing and proposed scenario.



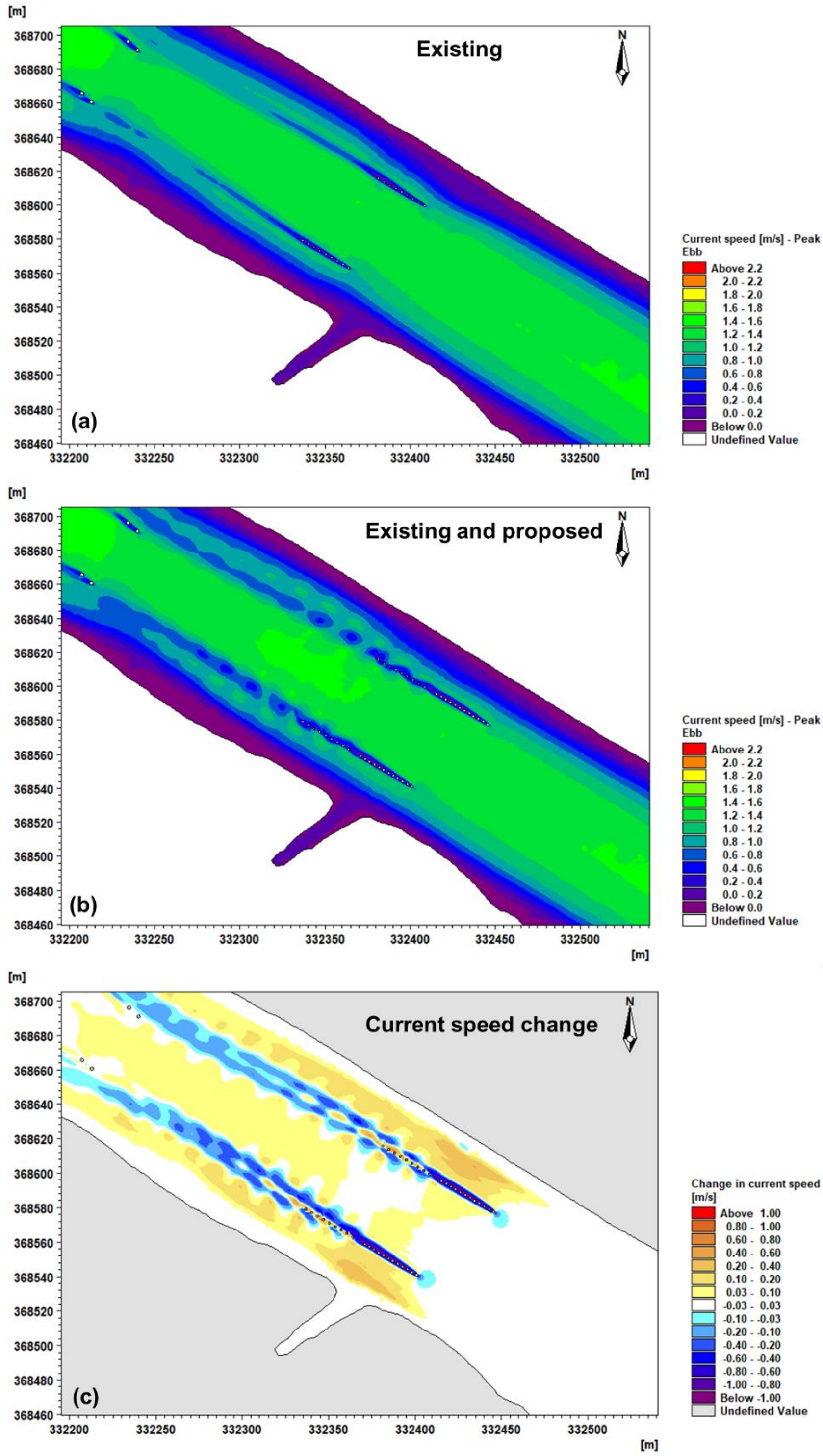
Source.: Mott MacDonald, 2025

Figure 1-101 Change in peak flood depth-averaged current speeds for high river discharge conditions (1:100-year event) due to the proposed scenario: (a) existing scenario; (b) proposed scenario; and (c) changes in current speed between the existing and the proposed scenario.



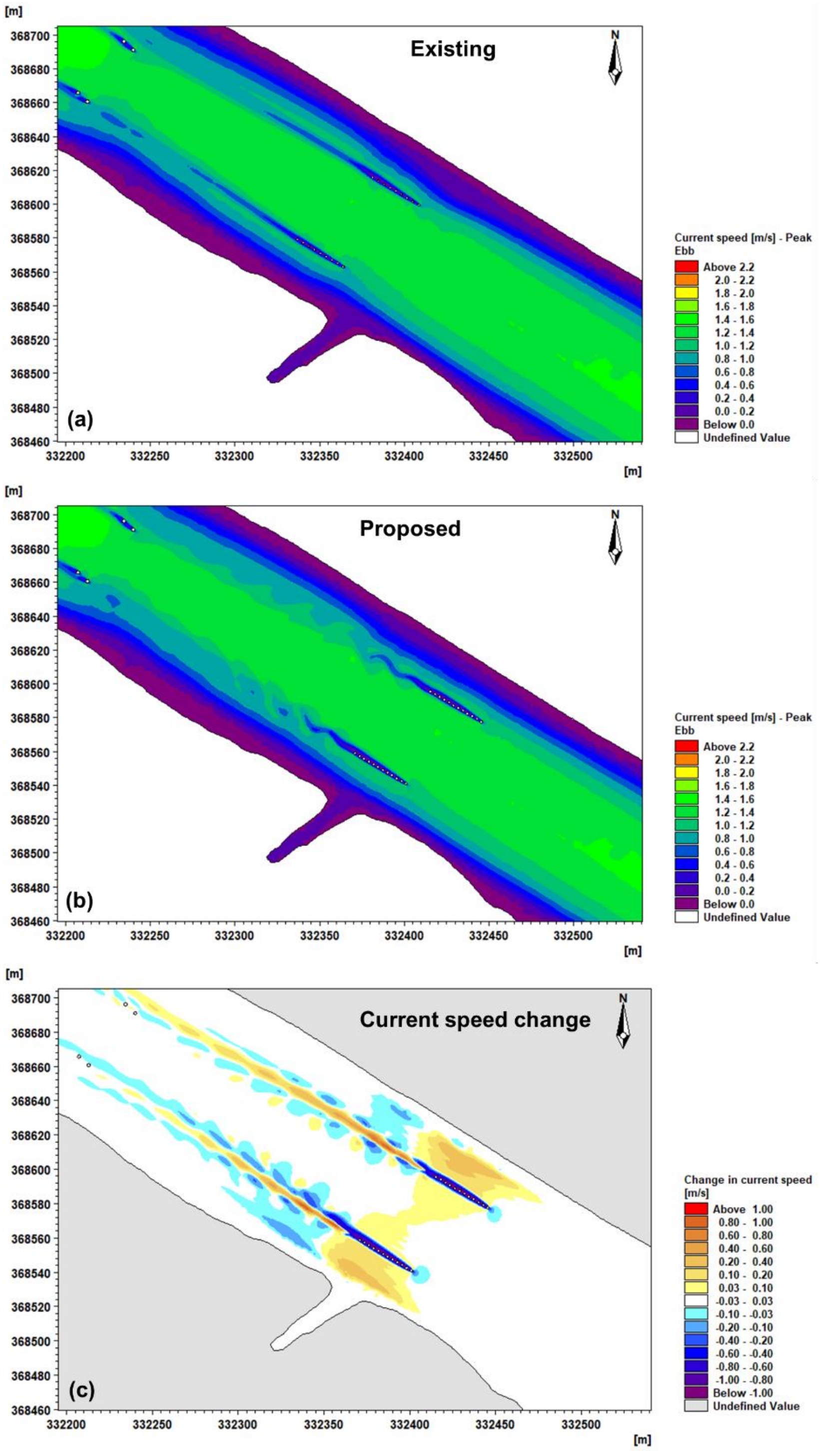
Source.: Mott MacDonald, 2025

Figure 1-102 Enlargement showing the changes in peak ebb depth-averaged current speeds for high river discharge conditions (1:100-year event) due to the existing and proposed scenario: (a) existing scenario; (b) existing and proposed scenario; and (c) changes in current speed between the existing and the existing and proposed scenario.



Source.: Mott MacDonald, 2025

Figure 1-103 Enlargement showing the changes in peak ebb depth-averaged current speeds for high river discharge conditions (1:100-year event) due to the proposed scenario: (a) existing scenario; (b) proposed scenario; and (c) changes in current speed between the existing and the proposed scenario.



Source.: Mott MacDonald, 2025

1.9 Results of the sediment transport and bed morphology modelling

Introduction

The local MIKE3 FM HD hydrodynamic model was coupled with the Sand Transport (ST) module and was run morphologically (Section Sediment transport modelling) for the mean spring tide. In morphological mode, the seabed evolves through the simulation period in response to the hydrodynamic conditions. Changes in the bed morphology also provide feedback to the hydrodynamic conditions and sediment transport calculations. The results presented in this section have been interpreted carefully, considering the sediment model setup, assumptions and limitations (Section Sediment transport modelling).

Scenario 1

Mean spring tide simulation

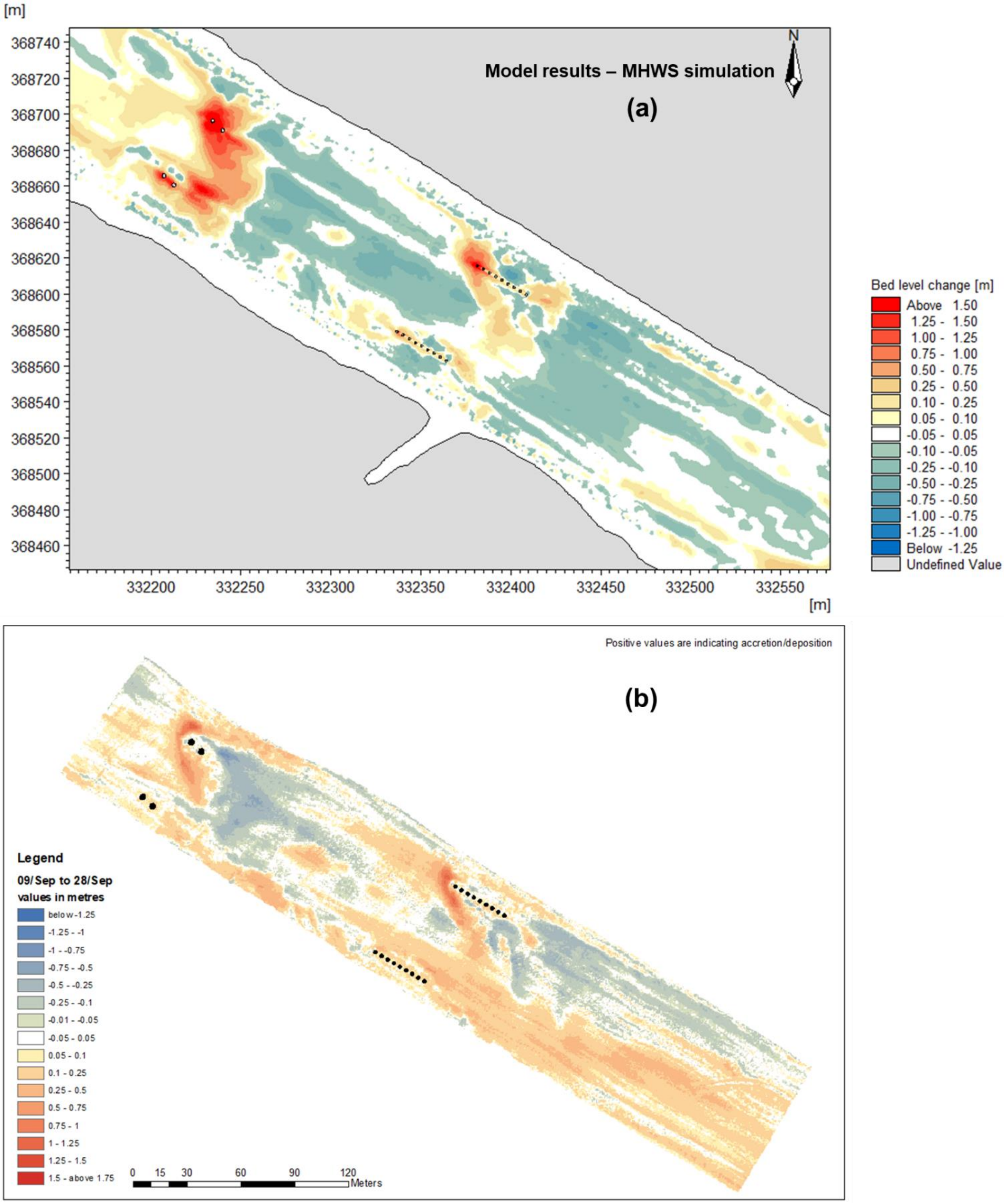
Figure 1-104 (a) shows the predicted changes in bed level during the mean spring tide simulation, which spans two tides. To simulate as closely as possible, the conditions of the bathymetric surveys of the 9th and 28th September 2021 (Figure 1-51) was assumed that the flood tide dominated the site with a small river discharge (10 m^3/s). Figure 1-104 (b) shows the actual changes in bed level measured on the 9th and 28th of September 2021.

Figure 1-104 shows that the model and observations indicate that during mean spring tidal conditions, with a low river discharge (c. 10 m^3/s), the site is flood dominated with sediment importation in the upstream direction. This is expressed by the accretion in front of the Bridge pile structures and infilling towards the centre of the channel. Since the measured and predicted bathymetric changes are in good agreement (Figure 1-104), it is argued that the MIKE3 FM HD ST model is correctly simulating sediment transport and the associated morphological changes at the site.

Although due to the extended model run times, the model only considered two peak spring tides, the measured changes in bed levels correspond to a more extended period. The bed evolution is likely related only to the peak tidal flows during the period between the surveys, with the neap tides having little or no morphological impact (refer to Figure 1-105). Here the critical result is the demonstration by the model that the observed magnitudes and patterns of erosion and accretion are reproduced well in the simulation.

Figure 1-104 demonstrates that the model simulations of bed elevation changes agree well with the observed changes in the bathymetric survey. Although the predicted and observed bed level changes are not directly comparable, both show that the site is subject to large and relatively rapid changes in bed level that reflect the dynamic nature of the site.

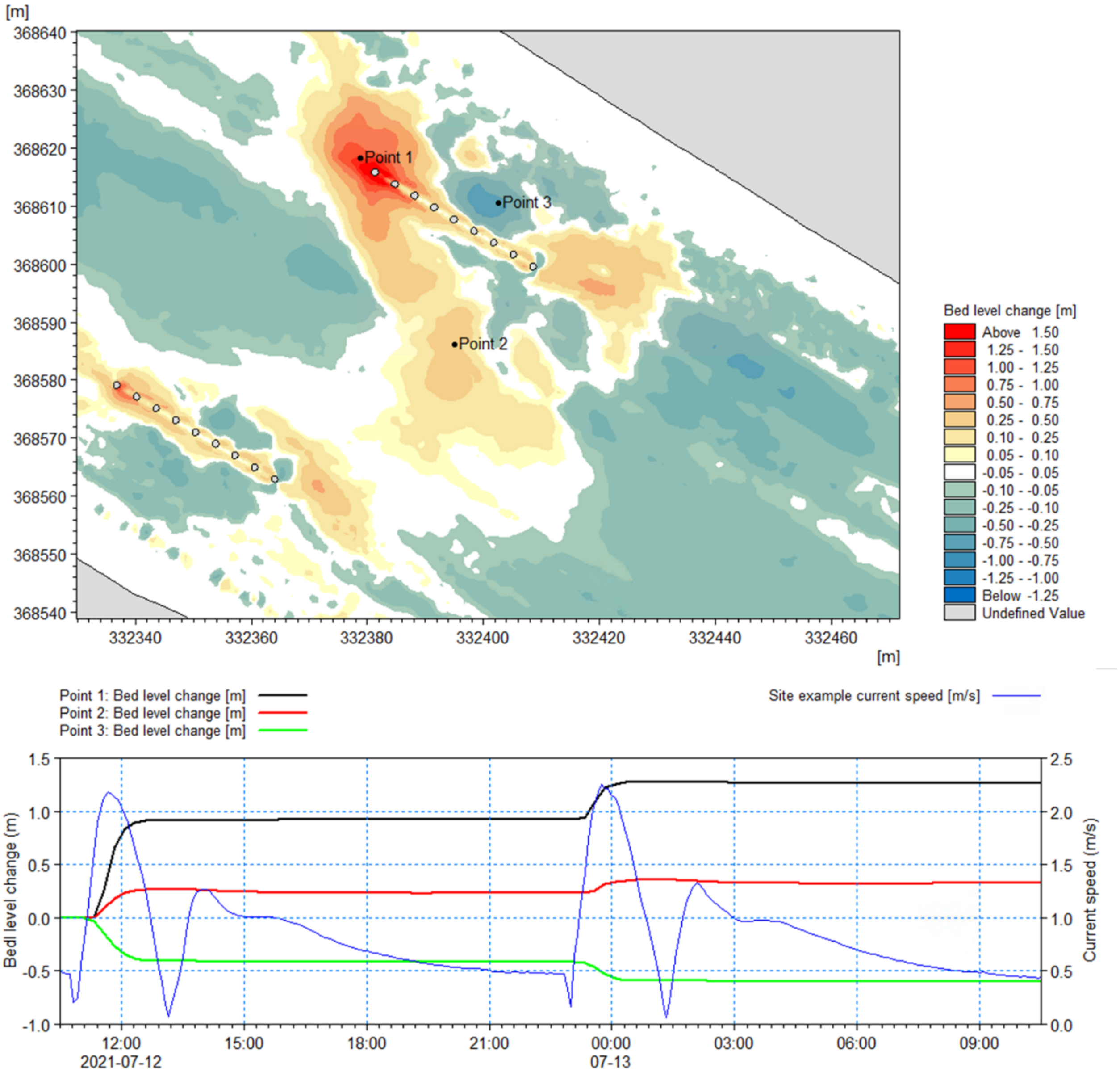
Figure 1-104 Bed level change (m) between 9th and 28th of September 2021 from: (a) the mean spring model simulation with low river discharge; and (b) the measured data.



Source.: Mott MacDonald, 2022. Contains Partrac data, 2021

To demonstrate that bed level change only occurs during strong flood currents and that for the rest of the time, the bed is stable, Figure 1-105 shows the predicted bed level change at three locations around the A494 Bridge. This figure shows that changes in bed elevation only occur once the current speed exceeds a threshold value of approximately 1 m/s.

Figure 1-105 Example of bed level change, plotted with current speed, during the mean spring tide simulation for three points at the site.



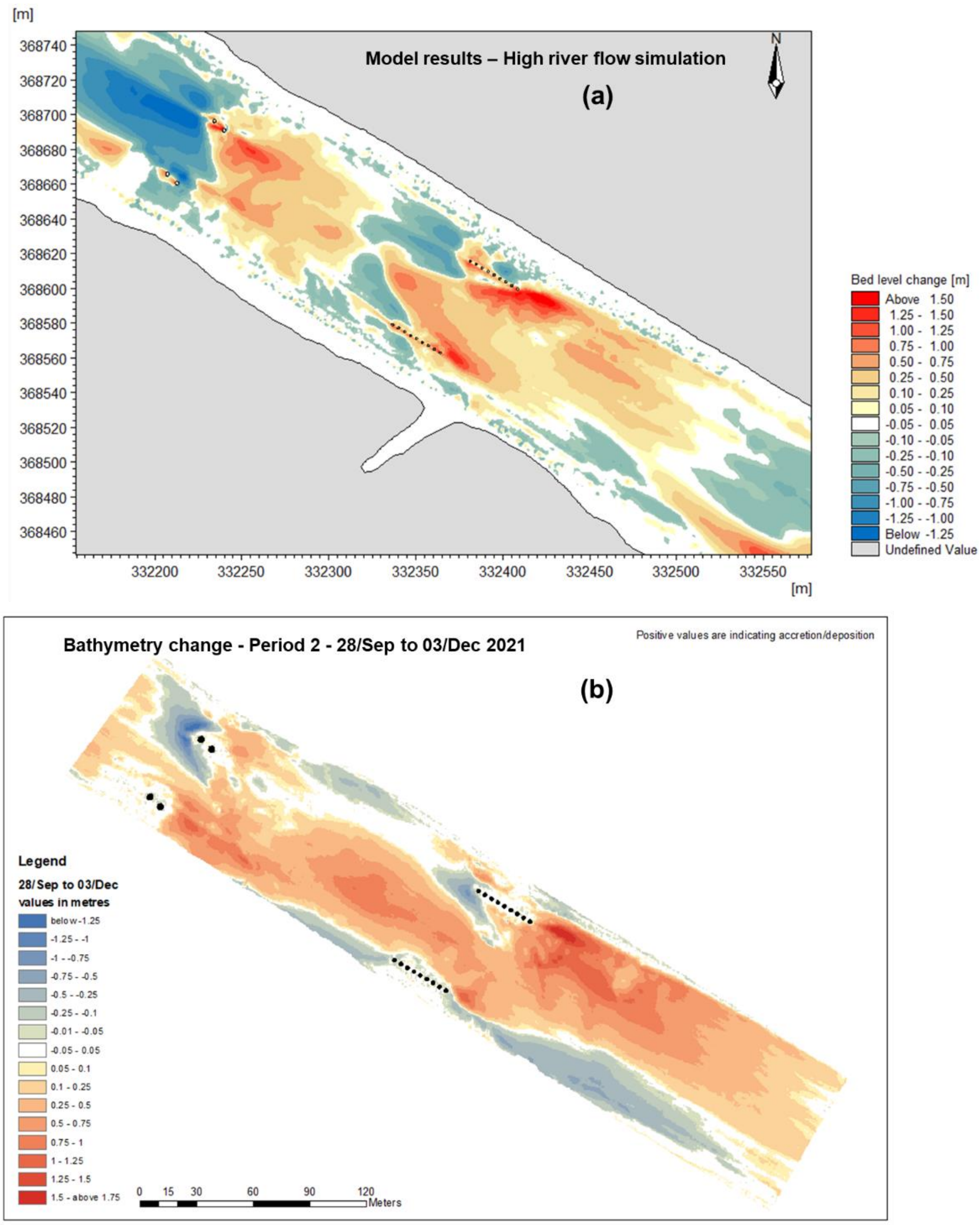
Source.: Mott MacDonald, 2025.

High river flow discharge simulation

Figure 1-106 (a) shows bed level changes predicted by the model during mean spring tidal conditions with the large river discharge of the 1:100-year event (196 m^3/s). The measured bathymetric changes between 28th September and 3rd December are shown in Figure 1-106 (b). During the period between surveys, several large river discharges were recorded. The analysis in section 1.6 showed the site to be more ebb dominated as a result, with an accumulation of sediments upstream of the structures and sandbars moving downstream and infilling the centre of the channel. The model results in Figure 1-106 (a) show approximately the same erosion and accretion patterns as measured bathymetric changes in Figure 1-106 (b).

Figure 1-106 demonstrate that the model simulations of bed elevation changes agree well with the observed changes between the bathymetric surveys. Although the predicted and observed bed level changes are not directly comparable, both show that the site is subject to large and relatively rapid changes in bed level that reflect the dynamic nature of the site.

Figure 1-106 Bed level change (m) between 9th and 28th of September 2021 from: (a) the mean spring model simulation with high river discharge; and (b) the measured data.



Source.: Mott MacDonald, 2025.

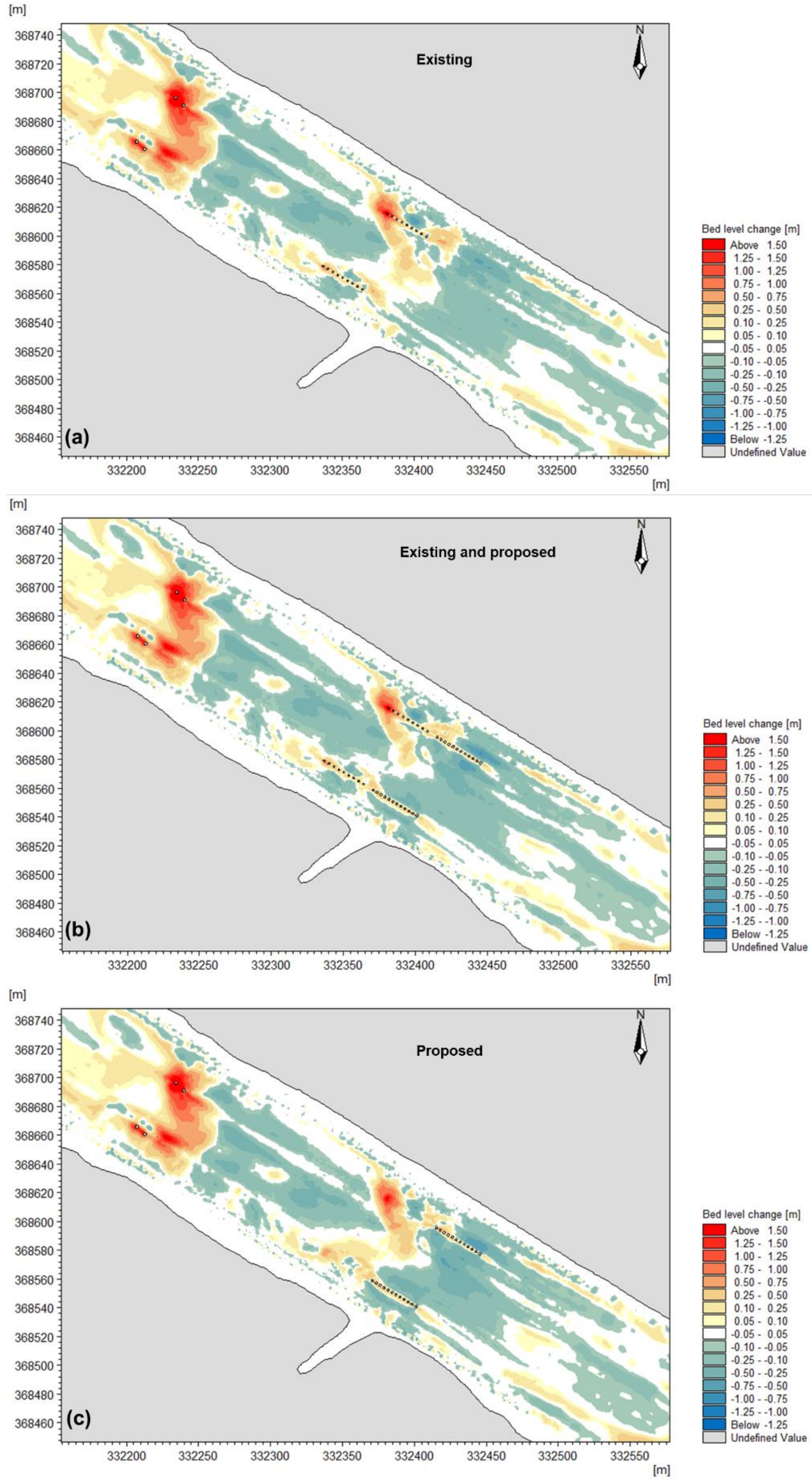
Scenario 2 and Scenario 3

Mean spring tide simulation

The sediment transport model was also run for Scenario 2 and Scenario 3. The predicted bed level changes for the mean spring tide with low river discharge conditions are shown in

Figure 1-107 for the three scenarios. While increased sedimentation and erosion attributable to the Bridge piles are observed in several areas in Figure 1-107 , the general sediment patterns are not changed greatly by the new proposed Bridge structures. The complex sediment transport processes at the site are primarily governed by the hydrodynamic conditions rather than structural modifications. The relative changes to the bed levels attributable to the different scenarios are considered in the next section.

Figure 1-107 Bed level change (m) for (a) existing, (b) existing and proposed, and (c) proposed scenario under mean spring tide conditions.

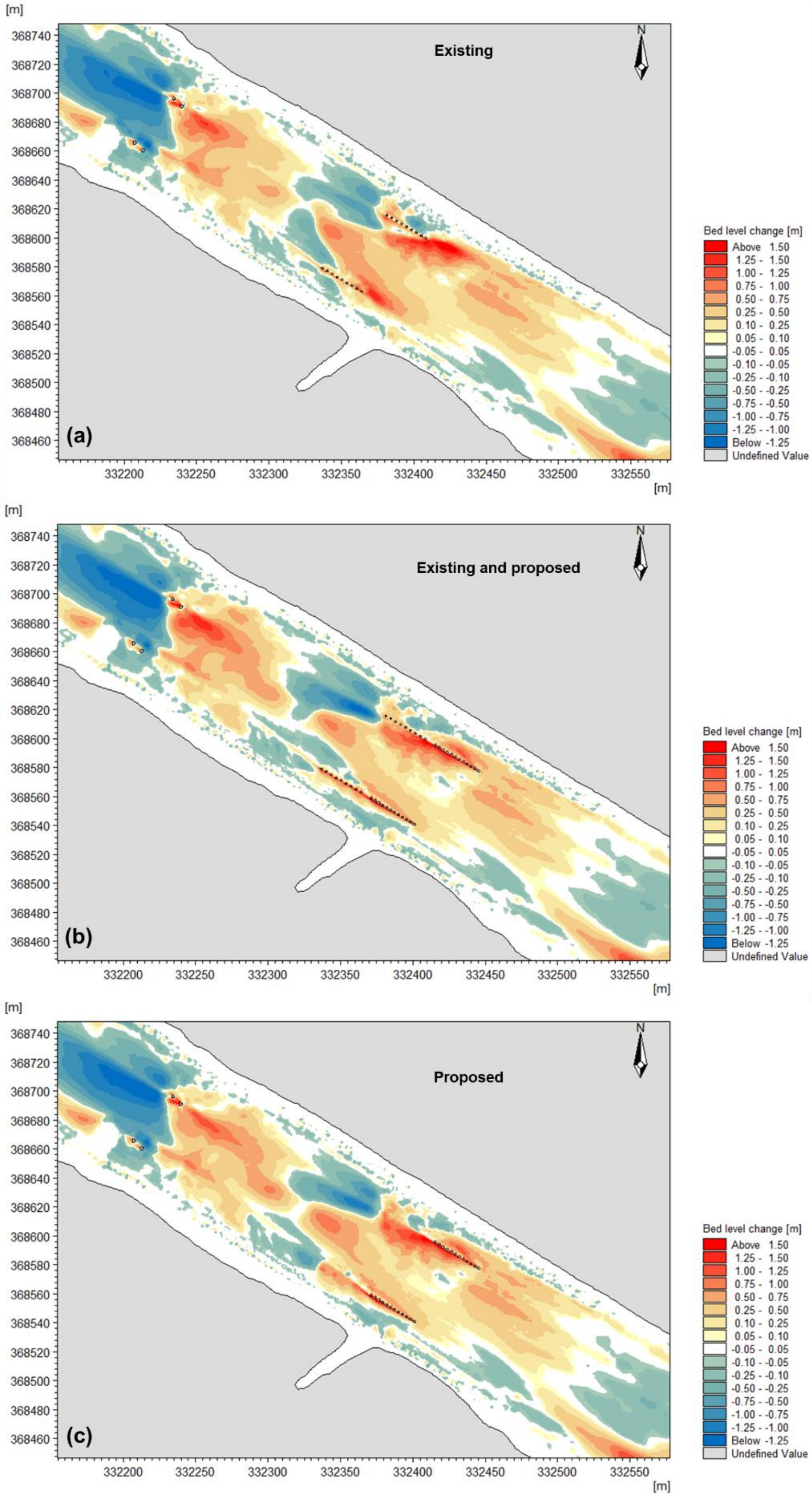


Source.: Mott MacDonald, 2025

High river flow discharge simulation

The sediment transport model was also run for Scenario 2 and Scenario 3 under high river flow discharge conditions. The predicted bed level changes for the mean spring tide with high river discharge conditions are shown in Figure 1-108 for the three scenarios. While increased sedimentation and erosion attributable to the Bridge piles is observed in several areas in Figure 1-108 , the general sediment patterns are not changed greatly by the new proposed Bridge structures. The complex sediment transport processes at the site are primarily governed by the hydrodynamic conditions rather than structural modifications. The relative changes to the bed levels attributable to the different scenarios are considered in the next section.

Figure 1-108 Bed level change (m) for (a) existing, (b) existing and proposed, and (c) proposed scenario under high river discharge conditions.



Source.: Mott MacDonald, 2025

Changes to bed levels

Figure 1-109 and Figure 1-110 illustrates the observed changes in bed levels for the mean spring tide simulation under two different river discharge conditions: low river discharge (Figure 1-109) and high river discharge (Figure 1-110). Across all scenarios, localised areas of erosion and sedimentation are evident, yet the overall sediment transport patterns remain largely consistent.

Comparing Scenario 2 (existing and proposed Bridge) to Scenario 1 (existing Bridge only) under low river discharge conditions (Figure 1-109 (a)), sediment deposition is predicted around the new and existing Bridge piles, with bed levels increasing by up to +0.5m in these areas. The extent of deposition diminishes gradually upstream reducing to 0.1m or less within 100 m. Erosion is primarily observed in the centre of the channel between the proposed Bridge piles and adjacent to the banks, where peak current speeds are predicted to increase, resulting in erosion in these regions, by up to 0.25 m. However, the overall extent of sedimentation and erosion remains limited to the site, indicating that the hydrodynamic modifications induced by the additional Bridge piles in Scenario 2 do not significantly alter the broader sediment dynamics.

Under high river discharge conditions (Figure 1-110 (a)), the general patterns of erosion and deposition remain similar, although the magnitude of bed level changes is more pronounced. Deposition around and upstream of the new piles can reach 0.5 to 1.0 m suggesting the formation of depositional features due to flow separation and reduced velocities in these regions. Increased flow velocities through constricted sections of the channel result in scouring of up to 0.75m in localised areas. Despite these more noticeable changes, the modifications remain focused within the vicinity of the Bridge, and no significant alterations in sediment transport are observed.

When Scenario 3 (proposed Bridge) is compared to Scenario 1 (existing Bridge only) under low river discharge conditions (Figure 1-109 (b)) a more pronounced redistribution of sediments is evident, especially downstream of the new proposed Bridge structures. The removal of the existing piles reduces the localised constriction in flow caused by the existing Bridge piles, thus decreasing current speeds, leading to additional deposition of the order of up to 0.25 m. The presence of the new proposed Bridge piles result in slightly increased current speeds in the adjacent channel and towards the banks, this is the reason why the bed levels can be seen to have decreased slightly in these regions, by up to 0.25 to 0.5 m. There are some small increases in bed level of 0.1 m up to 100 m upstream of the proposed structure, but beyond this there are no major deviations from the existing sediment transport regime.

Under high river discharge conditions (Figure 1-110 (b)), the trends observed in the low flow conditions are accentuated. Larger zones of both deposition and erosion emerge with sedimentation exceeding 0.5 to 1.0 m in areas where flow velocities decrease due to the removal of the existing Bridge piles. In contrast, stronger currents in the newly formed constricted flow paths caused erosion reaching depths of -0.5 to -1.0 m, particularly around the new piles, with erosion of -0.5m in the centre of the channel. These changes remain concentrated near the Bridge site, with no evidence of broader scale sediment transport disruption.

Overall, localised areas of erosion and deposition are evident across all scenarios and sediment transport patterns remain consistent, with no large scale disruption. Under high river discharge conditions, bed level changes are more pronounced.

Low river discharge:

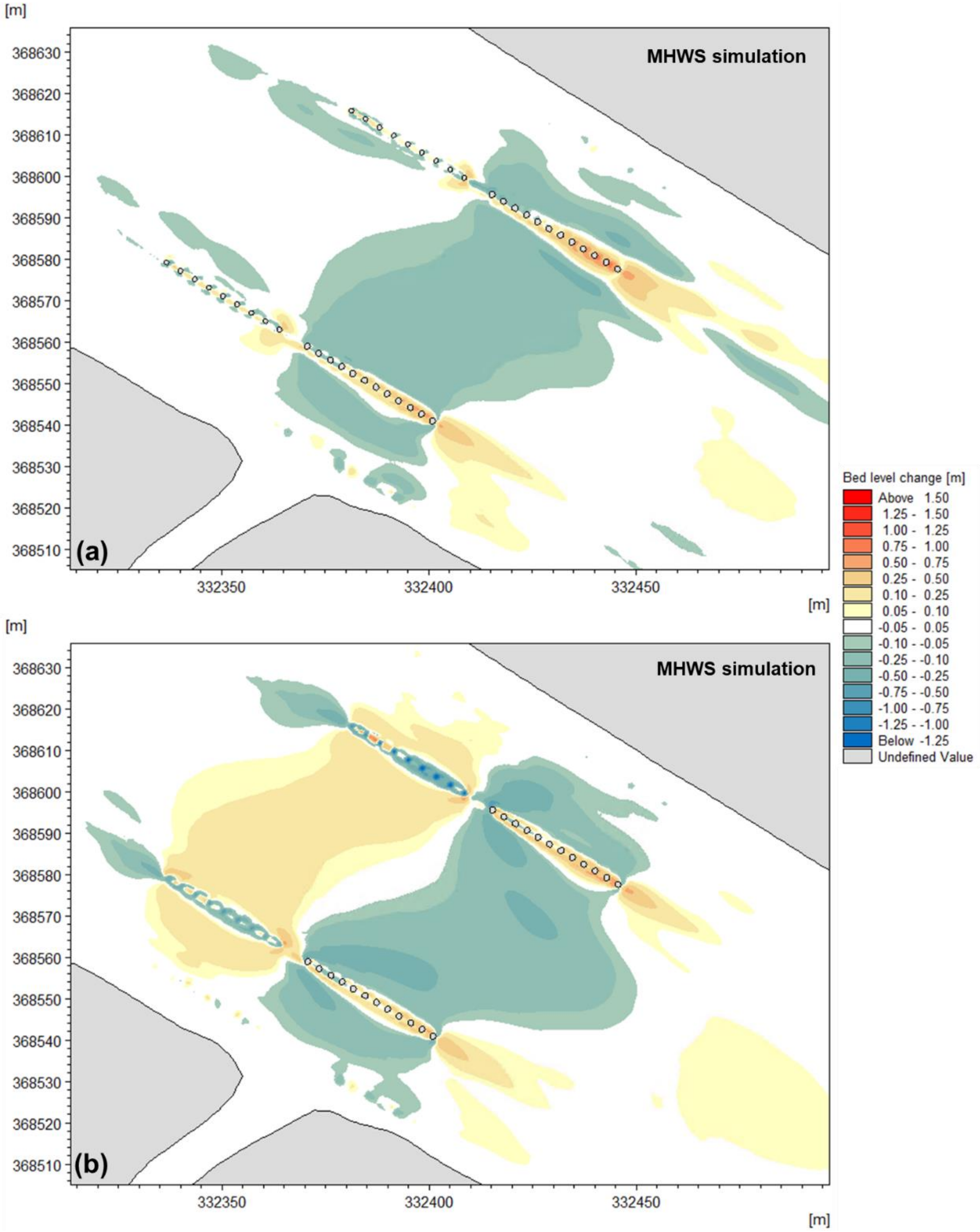
- Deposition around the new and existing Bridge piles with bed levels increasing by up to +0.5 m for Scenario 2.
- For Scenario 3, the removal of existing Bridge piles reduces flow constriction, decreasing current speeds and enhancing deposition of up to +0.25 m.
- Under Scenario 2, deposition decreases upstream, reducing to 0.1 m or less within 100 m.
- The new Bridge piles slightly increase current speeds near the banks and channel edges, eroding around -0.25 to -0.5 m.
- Minor sediment accumulation of 0.1 m up to 100 m under Scenario 3 with no major changes beyond this point.

High river discharge:

- Deposition near the Bridge piles and the area where the existing Bridge is removed, reaching 0.5 to 1.0 m.

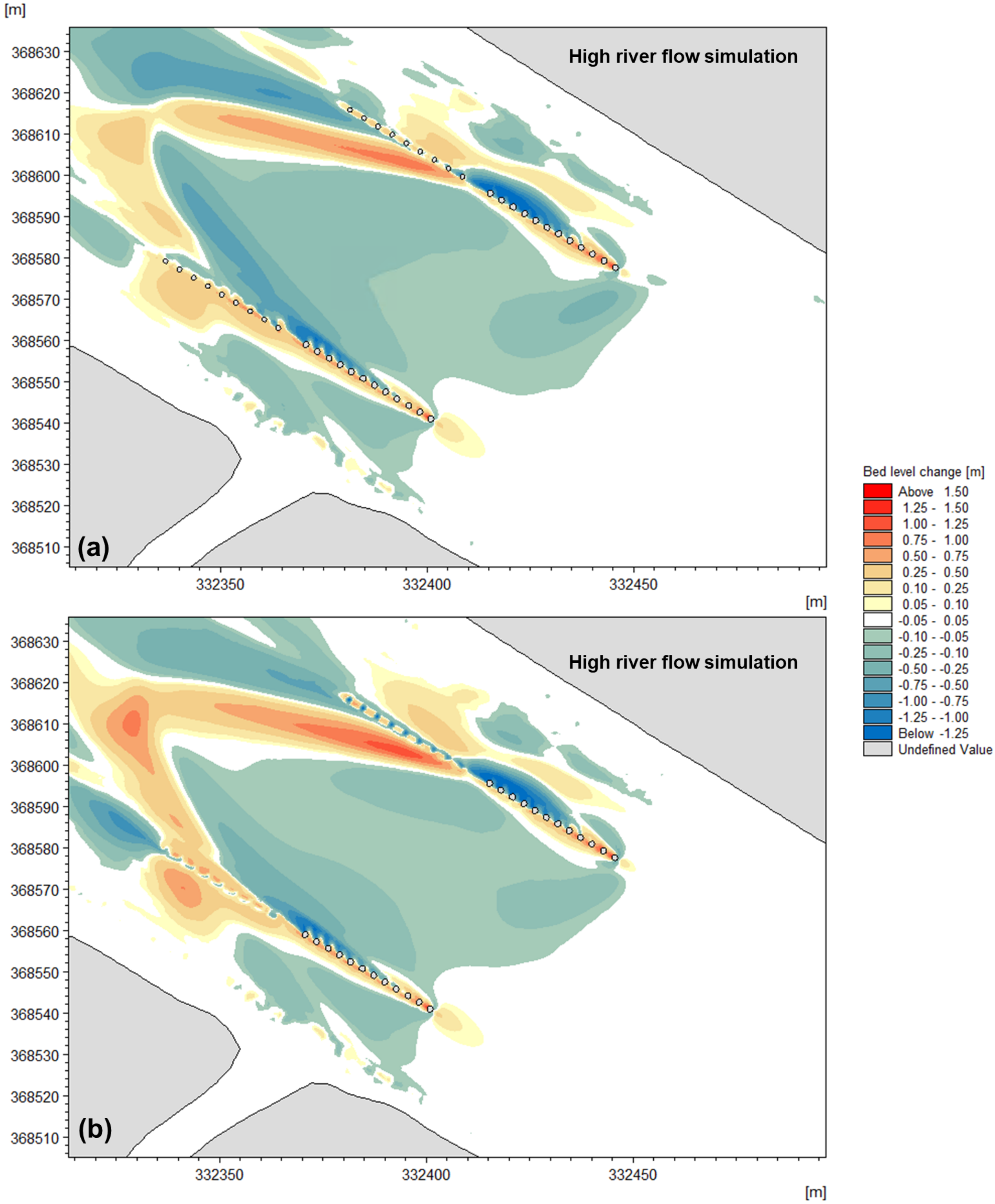
- Increased velocities in constricted channel sections caused localised erosion of up to -0.5m and around the new Bridge piles due to stronger currents.

Figure 1-109 Change in bed levels between (a) Scenario 1 (existing) and Scenario 2 (existing and proposed), and (b) Scenario 1 (existing) and Scenario 3 (proposed) results for the MHWS.



Source.: Mott MacDonald, 2025

Figure 1-110 Change in bed levels between (a) Scenario 1 (existing) and Scenario 2 (existing and proposed), and (b) Scenario 1 (existing) and Scenario 3 (proposed) results for the high river flow.



Source.: Mott MacDonald, 2025

1.10 Summary and conclusions

A hydrodynamic and sediment transport study was conducted to assess the impact of the proposed new A494 Dee Crossing Bridge at Queensferry. Using the MIKE3 HD FM model, three scenarios were simulated under mean spring tide with low and high river discharge conditions:

- Scenario 1 – Existing Bridge only;
- Scenario 2 – Existing and proposed Bridge together; and
- Scenario 3 – New Bridge only (existing Bridge removed).

The results demonstrated that:

Current speeds

Low river discharge

- Flood tide dominance is evident across all scenarios, with peak flood currents (~2.2 m/s) being higher than ebb currents (~1.4 m/s).
- Scenario 2 shows minor increases in current speeds (~0.1 to 0.6 m/s) due to flow acceleration between and upstream of the new Bridge piles.
- Scenario 3 results in a redistribution of flow, increasing speeds in some areas (by up to 0.4 m/s) while reducing them in others by a similar amount.

High river discharge

- Site becomes ebb dominated, with peak ebb speeds increasing to 1.4 to 1.6 m/s
- Scenario 3 results in a more pronounced flow distribution, with current speed variation extending 100-150 m upstream and downstream of the site.

Eddy formation and flow separation

Low river discharge

- Scenario 1, eddies (Von Karman vortex street) are primarily observed during flood tides.
- Scenario 2 the presence of both bridges intensifies eddy formation, persisting during both flood and ebb tides.
- Scenario 3, eddies become more pronounced and extend 100 -150 upstream and downstream due to the increased number and size of the new Bridge piles.

High river discharge

- The presence of both bridges (Scenario 2) creates larger and more persistent eddies due to greater flow obstruction.

Water levels

- Across all scenarios and conditions, water level changes remain minimal (<1 cm), indicating that the new Bridge does not significantly alter tidal elevations.

Tidal flow

Low river discharge

- Scenario 2, increased blockage effects cause increases in peak current speeds close to the piles of between 0.4 to 0.6 m/s. In the centre of the channel current speeds are increased by up to 0.1 m/s, whilst between the piles and the banks, speeds are increased by up to 0.4 m/s.
- Scenario 3, flow redistribution occurs, with peak flood speeds increasing locally due to the removal of the old piles and introduction of new ones. Adjacent to where the existing piles were located, current speeds increase in the centre of the channel by up to 0.1 m/s, whilst at the margins, then increase by up to 0.4 m/s. Adjacent to the new proposed piles, speeds in the centre of the channel are predicted to increase by up to 0.1m/s.

High river discharge

- Scenario 2, localise increase in current speeds of 0.2 to 0.4 m/s between some existing and proposed piles due to eddies. In the centre of the channel, current speeds increased by up to 0.1 m/s due to flow compression. There is a shadow effect on the north bank causing current speeds to reduce up to -0.1m/s over 600 m.
- Scenario 3 results in increased current speeds of up to 0.8 m/s around the existing Bridge piles.

Sediment transport and bed mobility

Low river discharge

- The site is flood dominated, leading to a net sediment transport in an upstream direction during mean high water spring tides.
- Bed level changes are primarily driven by strong flood currents (>1 m/s)
- When comparing Scenario 2 against Scenario 1, minor sedimentation (0.5 m) near the new Bridge piles, and slight erosion (~0.25 m) in the centre of the channel due to increased current speeds.

- When comparing Scenario 3 against Scenario 1, more noticeable sediment redistribution, particularly downstream (~0.25 m deposition) and adjacent to the piles in the centre of the channel (~0.5 m erosion). Erosion (~1 m) occurs at the location of the removed existing piles where previously accreted sediment, is eroded.

High river discharge

- The site becomes ebb dominated, with sediment deposition upstream and sandbar migration downstream.

The study concludes that the construction of the new A494 Bridge will not significantly alter water levels but will lead to localised changes in current speeds and flow patterns. The presence of additional Bridge piles in Scenario 2, increases eddy formation and slightly modifies current speeds, though these changes do not result in large-scale hydrodynamic impacts. In Scenario 3, the removal of the existing Bridge allows for flow redistribution, leading to minor increases in flood current speeds and more pronounced eddy formation.

While sediment transport patterns remain largely consistent across scenarios, localised areas of erosion and deposition occur particularly near the Bridge piles, without significantly disrupting overall sediment dynamics. Overall, while the new Bridge influences localised flow conditions, its broader impact on tidal regime and sediment transport remains limited.

1.11 References

Environment Agency, 2018. Coastal flood boundary conditions for the UK: update 2018. Technical Summary Report SC060064/TR6, 116pp.

Fugro, 2019. Report on Ground Investigation without Geotechnical Evaluation - A494 River Dee Bridge Improvement – Overwater Ground Investigation Fugro Document No.: G190001U (02)

Halcrow Group, 2011. Cell Eleven Tide and Sediment Study (CETaSS). North West & North Wales Coastal Group. North West England and North Wales Shoreline Management Plan SMP2. 126pp

Halcrow Group, 2013. North West Estuaries Processes Reports - Dee Estuary. 63pp

Moore, R. D, Wolf, J., Souza A. J. & Flint S. S., 2009 Morphological evolution of the Dee Estuary, Eastern Irish Sea asymmetry approach. Geomorphology 103 (2009) 588–596.

Mott MacDonald, 2019. A494 River Dee Improvements Key Stage 3-4 - Hydrodynamic Modelling Study.

Mott MacDonald, 2022. A494 River Dee Improvements Scheme- Hydrodynamic and Sediment Transport Modelling of Bridge Pier Impacts – Modelling Report.

Partrac, 2021. A494 Dee Survey Data Report. M5006.05.03.D01.V01. 60pp

Soil Mechanics. (2007). Drome Corner to Ewloe Particle Distribution Analysis.

Williams, J.J. & Esteves, L. S., 2017. Guidance on Setup, Calibration, and Validation of Hydrodynamic, Wave, and Sediment Models for Shelf Seas and Estuaries, Volume 2017, Article ID 5251902, 25 pages, https://doi.org/10.1155/2017/5251902.

A494 River Dee Improvement Scheme

River Dee Hydraulic Modelling Report
Proposed Development Assessment

September 2025

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A494 River Dee Improvement Scheme

River Dee Hydraulic Modelling Report Proposed Development Assessment

September 2025

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	05/09/2025	JB	MN	NH	First Issue

Document reference: 100395318 | 0010 | A | 395318-MMD-00-XX-RP-D-0010

The consultant will follow accepted procedure in providing the services but given the residual risk associated with any prediction and the variability which can be experienced in flood conditions, the consultant takes no liability for and gives no warranty against actual flooding of any property (client's or third party) or the consequences of flooding in relation to the performance of the service. This report has been prepared for the purposes of informing an FCA for planning application only.

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Figures – Appendices

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, nor do they indicate an increase in flood risk elsewhere.

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 effect 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.

Sensitivity testing has shown that the hydraulic model is sensitive to minor changes in the embankment crests (by 10mm) and these changes can significantly impact the resulting flood extents and depths in overtopping scenarios.

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.

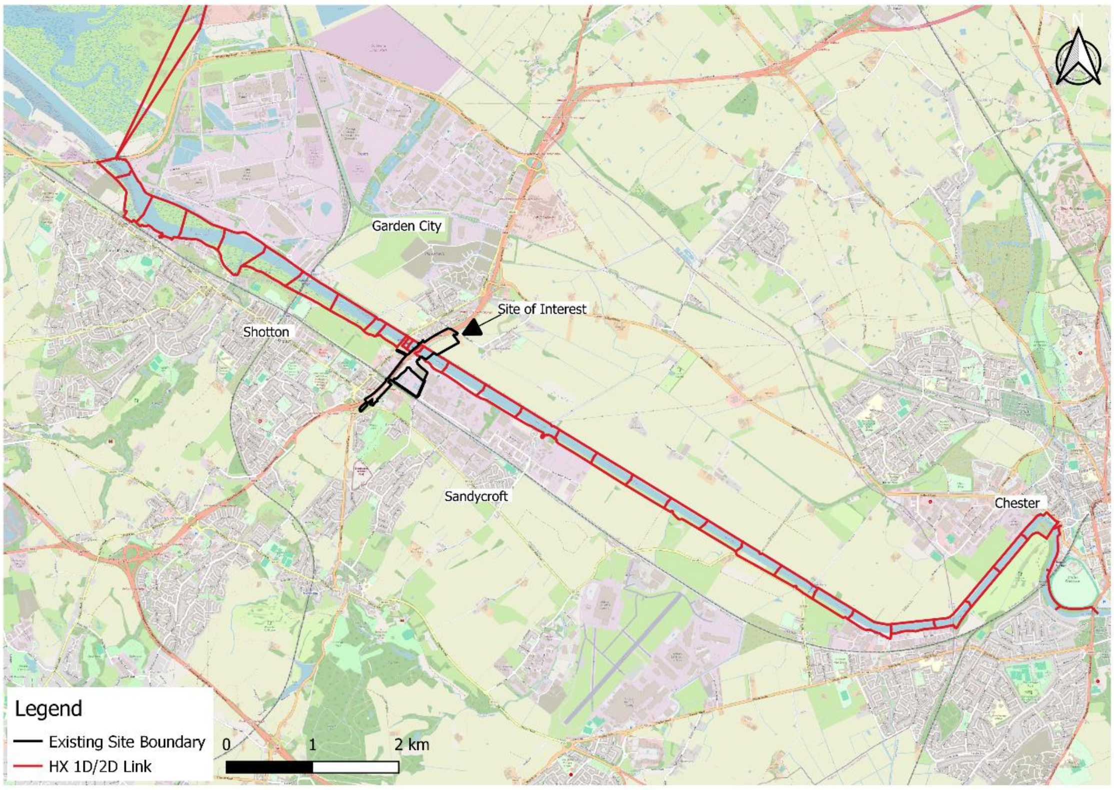
A hydraulic model is required to assess both the existing flood risk at the Scheme and the impact of the Proposed Option. Figure 1.2 shows the location plan and area of interest.

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 (2025)

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[2] 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.

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.

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.

The Lidar data under 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 5.16m AOD (2d_zsh_Makro_store_001_R.shp).

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.

Additionally, 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.

[2] 395318-1015 – A494 River Dee Bridge Replacement Scheme – River Dee Model, Emerging Preferred Option Modelling Scoping Report, by Mott MacDonald, Oct 2024

2.4 Roughness Updates

The roughness material layer has been updated using the values provided by the NRW which have been defined using OSMasterMapping data to detail the entire model area.

2.5 Boundary Conditions Updates

The fluvial inflows have been updated in line with the latest hydrological analysis recorded in the hydrological Performa GN008[3] from March 2025.

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.

No change has been made to the location of fluvial or tidal boundaries in the model from the previous A494 development modelling.

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

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. Otherwise, no further 1d river cross sections have been updated.

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.

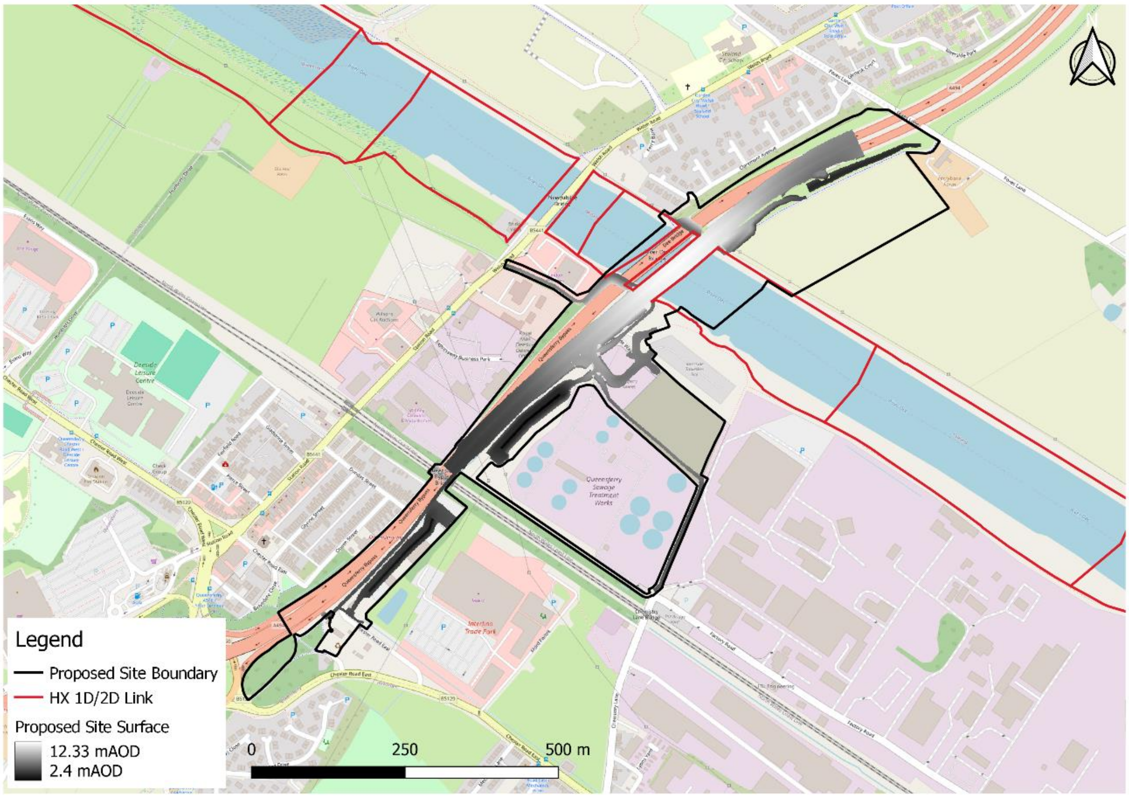
No other 1D structural updates have been made compared to the Existing (pre-development) scenario model.

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 5.16m (2d_zsh_Makro_store_001_R.shp).

3.3 Roughness Updates

The OSMasterMap was used to define the roughness. 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.

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[4].

The breaches modelled for this study have been given a width of 50m to adhere to NRW breach modelling guidelines[5] 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.

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[6]). 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.

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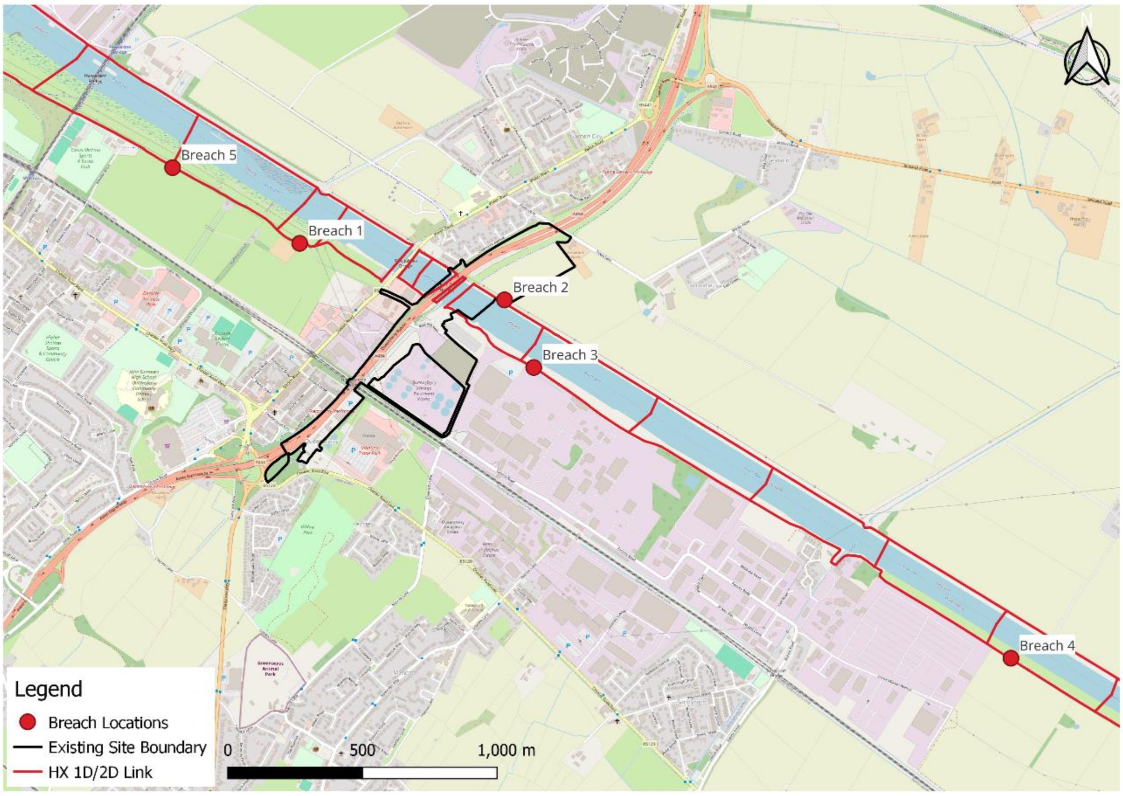
[4] A494 Bridge Improvements River Dee FCA Modelling Report_REV_F.pdf

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

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

Figure 3.2: Tidal Breach Location



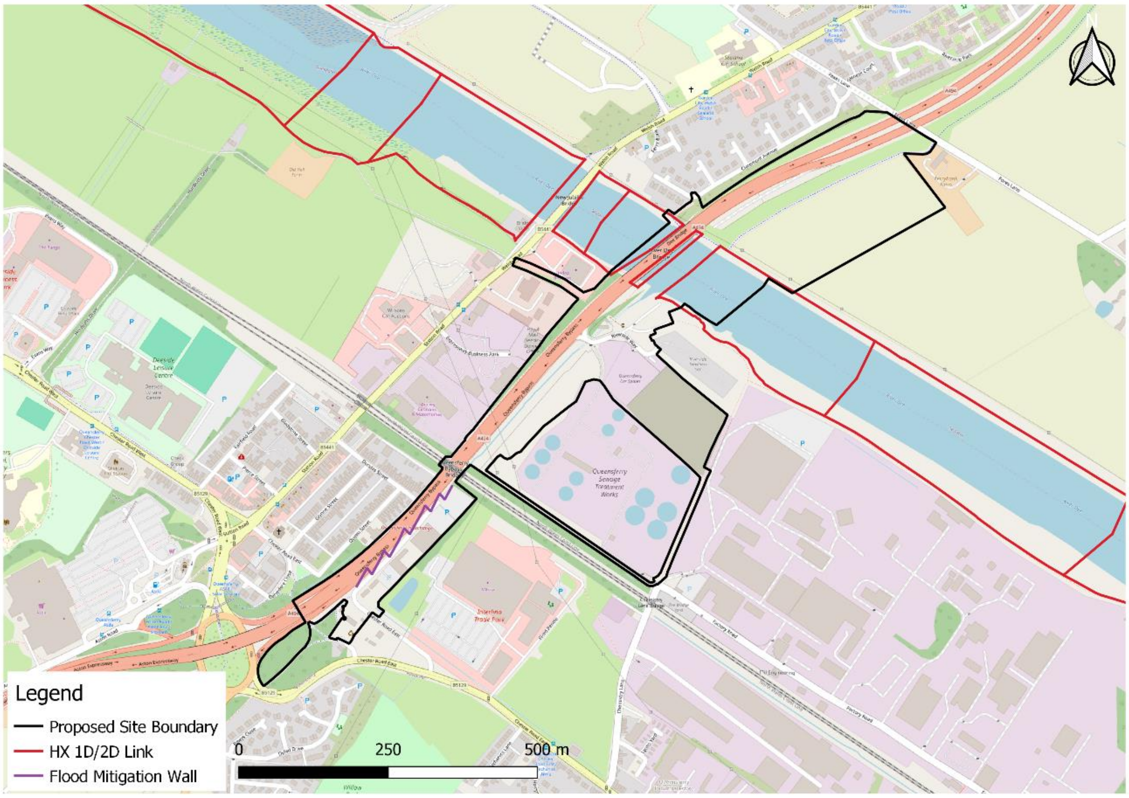
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

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_001.tmf and decreased by 20% using model file TidalDee_SEN_002.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 have 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 A 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 B.

All fluvial models have been designed in line with the NRW's guidance for climate change consideration[7]. 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.

[7] Flood Consequences Assessments: Climate change

An additional sensitivity run with the 0.1% AEP 2100 fluvial flood event has also been assessed, 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 A Existing (Pre-Development) Flood Risk Assessment contains the pre-development model results including depth maps.
- Appendix B 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 A and Appendix B 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. The only changes are 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 uplift) however these are minor and fall within the tolerable allowances (Figure B.1). At Chester there is a minor increase in flood extent within this defined watercourse (outside the urban areas) when comparing the Existing and Proposed scenarios.

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 B (see Figure B.2).

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 B (see Figure B.3).

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 2 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 1 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 3 and 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 0.005m.

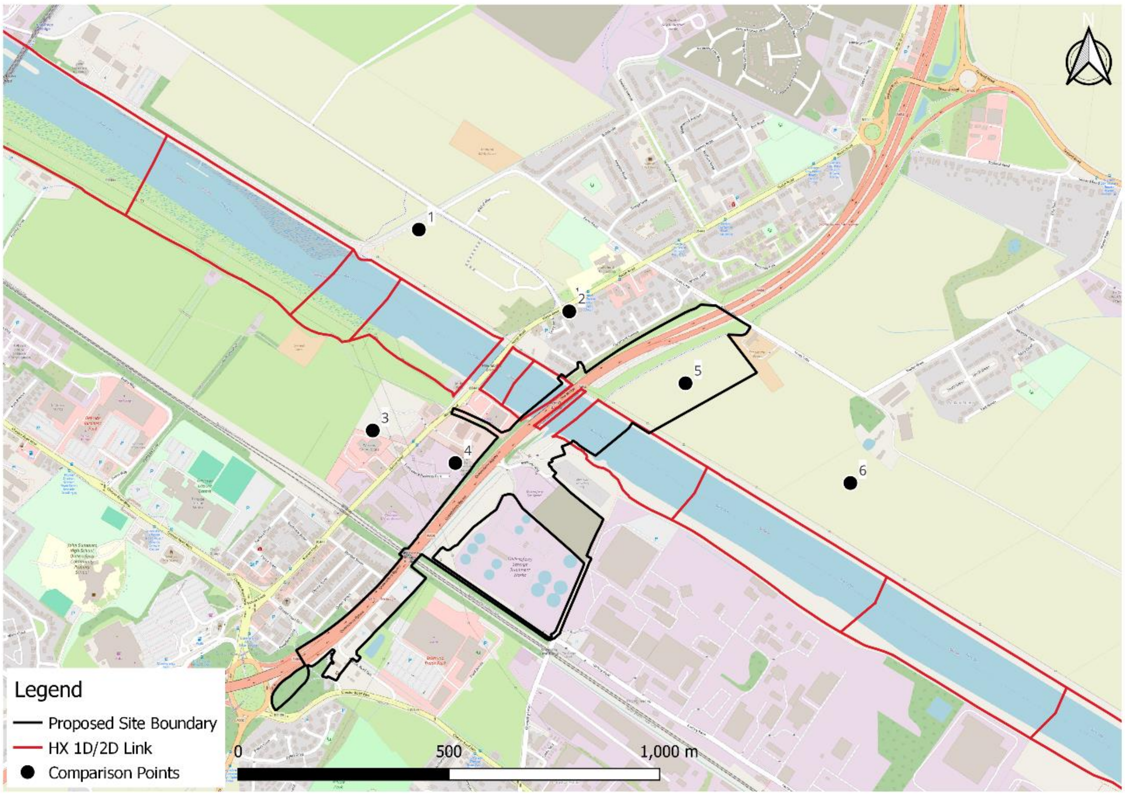
The changes in flood depth between the Existing (pre-development) scenario and the Proposed (post-development) scenario are primarily attributed to the movement of the new A494 bridge crossing upstream compared to the existing bridge. The raised embankments and ground modifications in this area are higher 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	0.027	0.060	0.033
2	0.077	0.089	0.012
3	0.106	0.114	0.008
4	0.041	0.050	0.009
5	0.297	0.095	-0.202
6	**0.186**	**0.096**	**-0.090**

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)

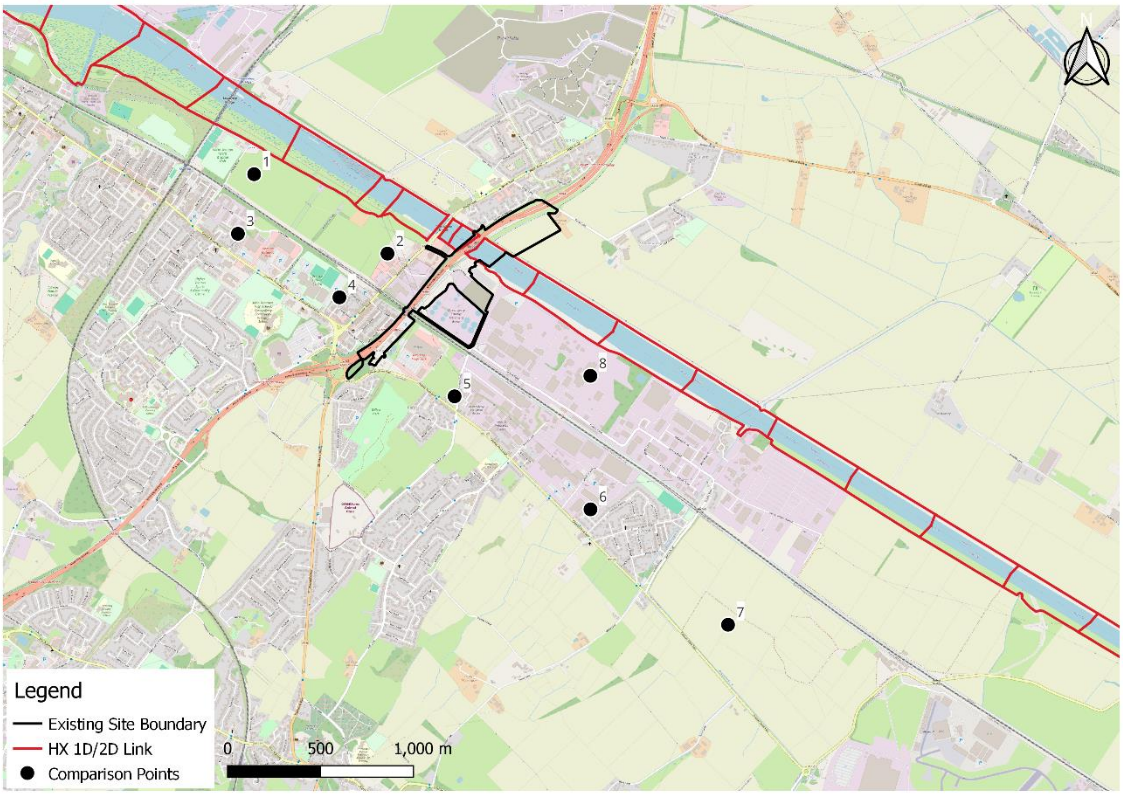
5.3.1 Tidal Breach Assessment Process

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 change 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 B. 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 B.12 and Figure B.13 in Appendix B 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	1.183	1.172	-0.011
	2	1.409	1.396	-0.013
	3	0.710	0.664	-0.046
	4	0.888	0.840	-0.048
Sandycroft	5	0.383	0.503	0.120
	6	0.166	0.253	0.087
	7	0.800	0.900	0.100
	8	No Data	No Data	No Data
0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.309	1.296	-0.013
	2	1.529	1.514	-0.015
	3	0.824	0.780	-0.044
	4	1.000	0.954	-0.046
Sandycroft	5	0.440	0.553	0.113
	6	0.188	0.303	0.115
	7	0.843	0.945	0.102
	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 B.32 and Figure B.33 in Appendix B 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	0.114	0.122	-0.008
	2	0.473	0.479	0.006
	3	No Data	No Data	No Data
	4	0.303	0.279	-0.024

Sandycroft	5	0.565	0.553	-0.012
	6	0.453	0.443	-0.010
	7	1.053	1.055	0.002
	8	0.379	0.376	-0.003
0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	0.163	0.242	0.079
	2	0.516	0.539	0.023
	3	No Data	No Data	No Data
	4	0.339	0.326	-0.013
Sandycroft	5	0.736	0.713	-0.023
	6	0.648	0.649	0.001
	7	1.173	1.170	-0.003
	8	0.471	0.468	-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 B.42 and Figure B.43 in Appendix B 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	1.471	1.467	-0.004
	2	1.565	1.553	-0.012
	3	0.913	0.887	-0.026
	4	1.097	1.065	-0.032
Sandycroft	5	0.444	0.546	0.102
	6	0.193	0.307	0.114
	7	0.861	0.964	0.103
	8	No Data	No Data	No Data

0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.638	1.631	-0.007
	2	1.735	1.719	-0.016
	3	1.150	1.119	-0.031
	4	1.331	1.291	-0.040
Sandycroft	5	0.509	0.623	0.114
	6	0.253	0.402	0.149
	7	0.944	1.060	0.116
	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 B 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	1.183	1.189	0.006
	2	1.409	1.415	0.006
	3	0.710	0.738	0.028
	4	0.888	0.915	0.027
Sandycroft	5	0.383	No Data	-0.383
	6	0.166	No Data	-0.166
	7	0.800	No Data	-0.800
	8	No Data	No Data	No Data
0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.309	1.319	0.010
	2	1.529	1.540	0.011
	3	0.824	0.855	0.031
	4	1.000	1.031	0.031
Sandycroft	5	0.440	No Data	-0.440
	6	0.188	No Data	-0.188
	7	0.843	No Data	-0.843
	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	0.114	0.076	-0.038
	2	0.473	0.458	-0.015
	3	No Data	No Data	No Data
	4	0.303	0.311	0.008
Sandycroft	5	0.565	0.564	-0.001
	6	0.453	0.447	-0.006
	7	1.053	1.050	-0.003
	8	0.379	0.376	-0.003
0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	0.163	0.126	-0.037
	2	0.516	0.520	0.004
	3	No Data	No Data	No Data
	4	0.339	0.351	0.012
Sandycroft	5	0.736	0.738	0.002
	6	0.648	0.641	-0.007
	7	1.173	1.170	-0.003
	8	0.471	0.468	-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	1.471	1.472	0.001
	2	1.565	1.574	0.009
	3	0.913	0.929	0.016
	4	1.097	1.113	0.016
Sandycroft	5	0.444	No Data	-0.444
	6	0.193	No Data	-0.193
	7	0.861	0.454	-0.407
	8	No Data	No Data	No Data
0.1% AEP 2100 Flood Event				
Location	**Comparison Site No**	**Existing**	**Proposed**	**Depth Difference (m)**
Shotton	1	1.638	1.643	0.005
	2	1.735	1.742	0.007
	3	1.150	1.158	0.008
	4	1.331	1.334	0.003
Sandycroft	5	0.509	0.396	-0.113
	6	0.253	0.177	-0.076
	7	0.944	0.924	-0.020
	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 B.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 suitable and sufficient for modelling.

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 causes the Proposed (post-development) scenario model to predict significant changes in flood extent and depth along the right bank. Flooding under this scenario is predicted significantly decreased compared to the unmodified Proposed scenario and compared to the Existing scenario model as well for the 0.1% AEP 2100 event. Flood depths are also decreased in areas where flooding persists. On the left bank flooding is not significantly changed as flooding occurs outside of the modified areas and travels through the 2d floodplain to reach the affected area.

5.5.2.1 Summary

The hydraulic model is sensitive to the minor changes in the embankment crests (by 10mm) and these changes can 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 5m and is likely due to the 10m modelling grid cell sized used in the model. 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[8] 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[9]. 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 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.

[8] 395318-0195 A494 River Dee Bridge Improvement - Hydraulic Modelling of Options

[9] 395318-1015 - A494 River Dee Scoping Report

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 only fluvial flood risk identified occurs upstream of the Scheme, in Chester. Under the 1% AEP 2100 event with Upper climate change allowance, flooding becomes more extensive affecting a mix of residential and commercial areas.

For both the Central and Upper climate change allowances, there is no change to the existing flood risk from the Proposed Development under the 1% AEP (or 1 in 100 year) 2100 scenario.

Under the 0.1% AEP (or 1 in 1000 year) 2025 fluvial event, no differences in flood risk are observed between the Existing and Proposed development scenarios. 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.

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 0.012m) 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 0.09m).

Under the c2 conditions[10] 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.

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 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 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.

[10] 97.5% confidence interval for extreme sea levels

- 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 is predicted to significantly reduce the 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 modelling is sensitive to embankment heights; and the study shows that a small increase in embankment height could potentially mitigate these affected areas.

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

A. Existing (Pre-Development) Flood Risk Assessment

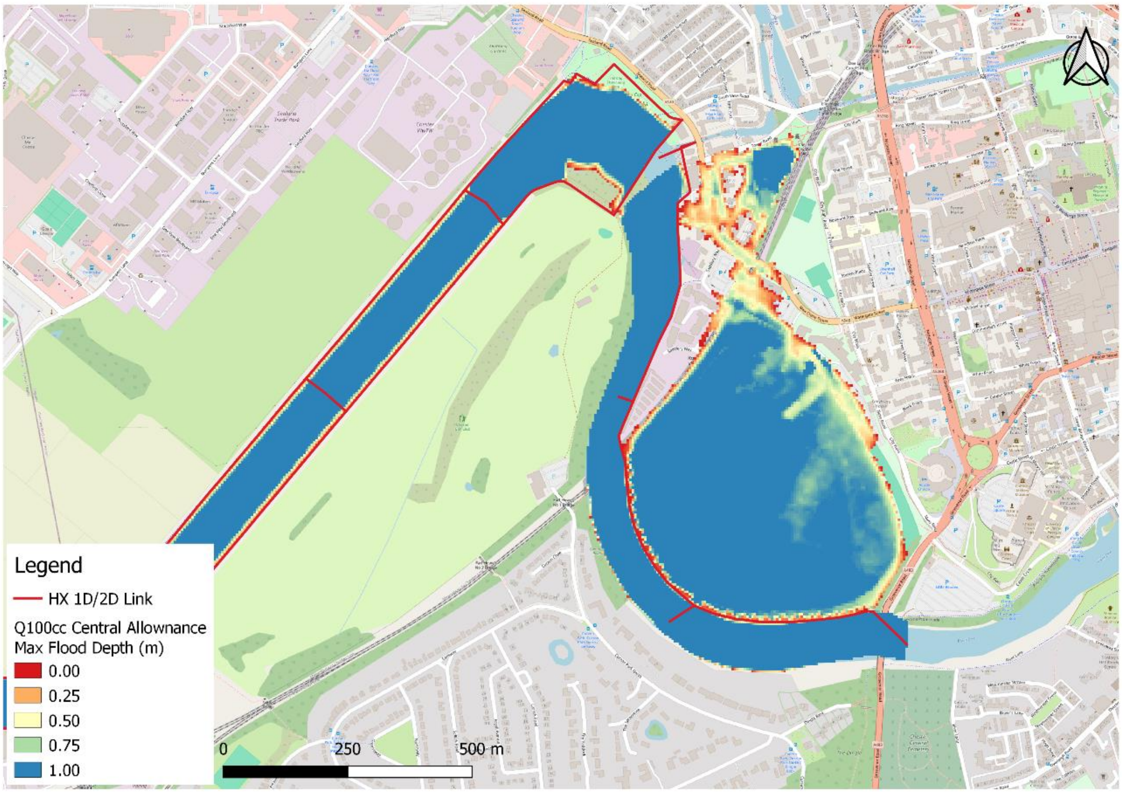
This section outlines the predicted existing flood risk to the A494 crossing Scheme and the surrounding floodplain, based on the current modelling outputs.

A.1 Fluvial Overtopping

A.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 A.1). Flood depths exceed 1m for much of the area around Chester racecourse as well as across Towergate.

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

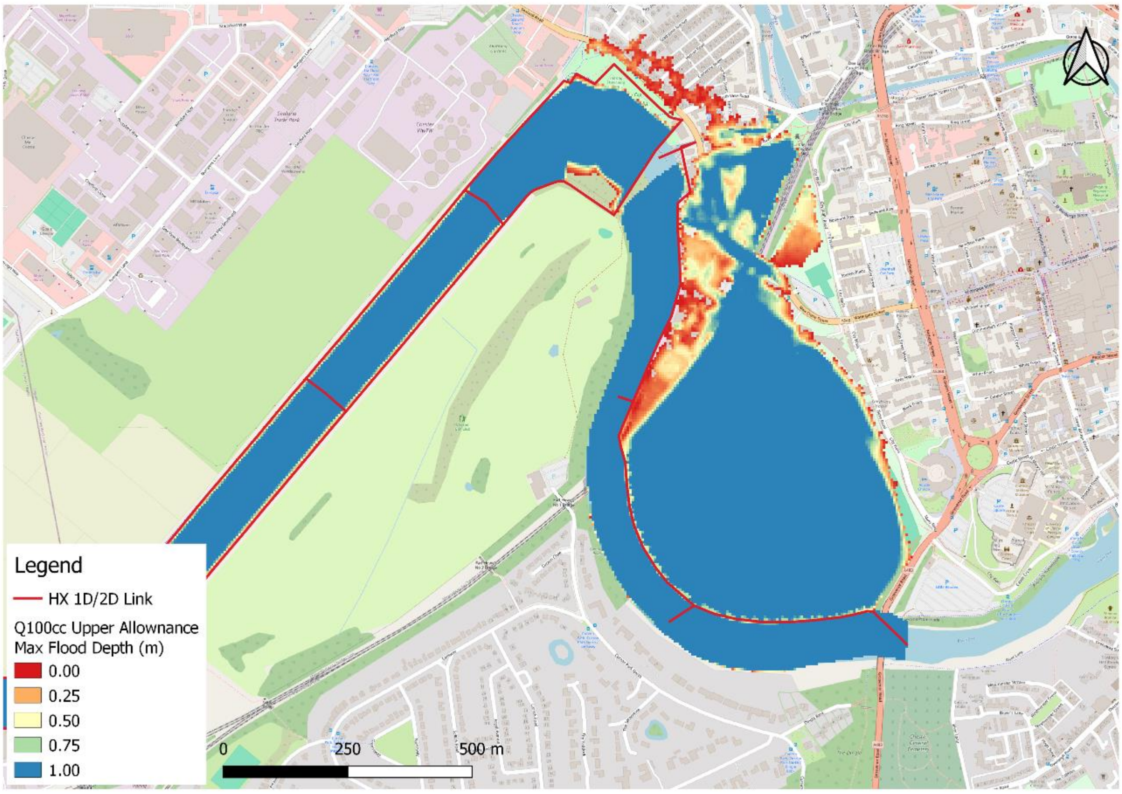


Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

A.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 A.2). Flood depths are predicted to be above 1m for most of the area in Towergate under this scenario.

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

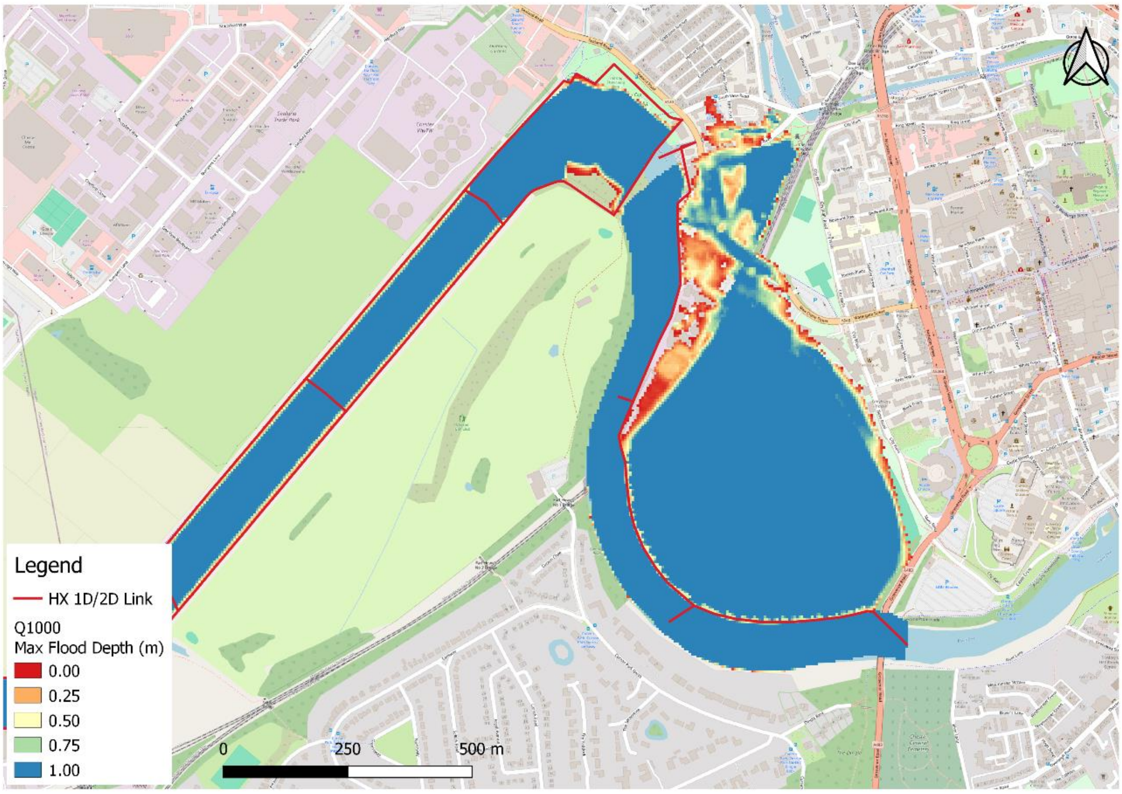


Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

A.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 A.3).

Figure A.3: 0.1% AEP 2025 Fluvial

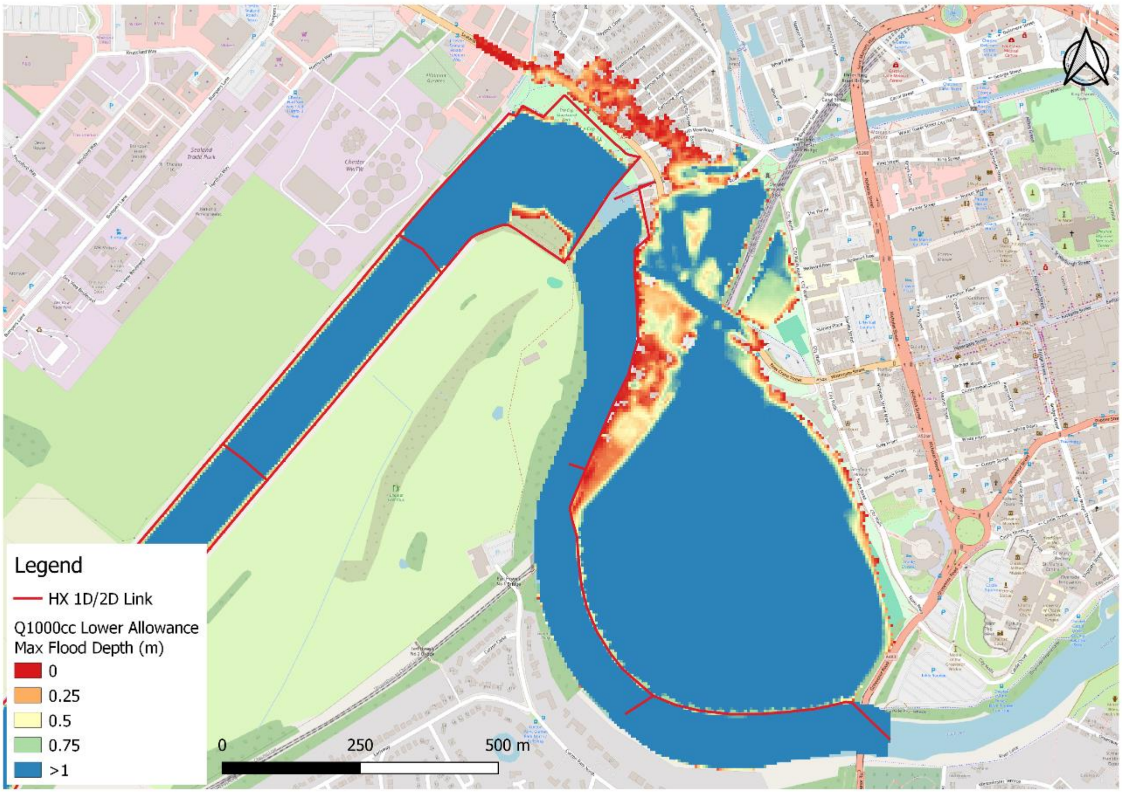


Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

A.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 A.4).

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



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A.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).

A.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 A.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 A.6).

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

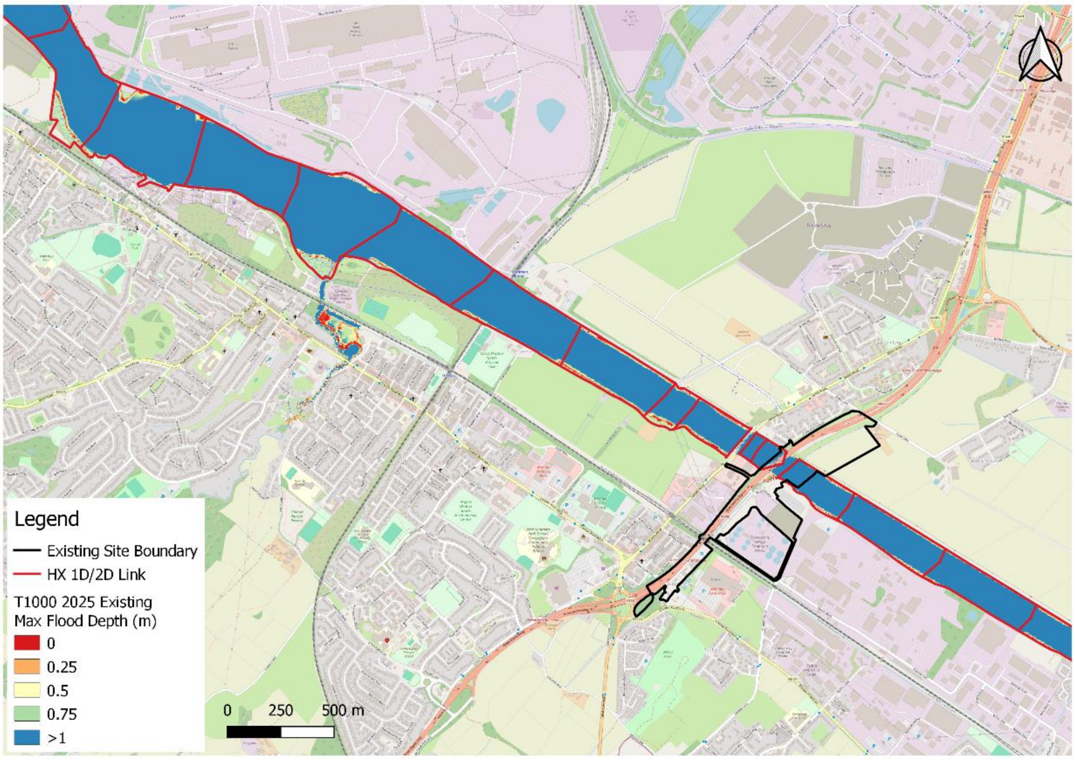

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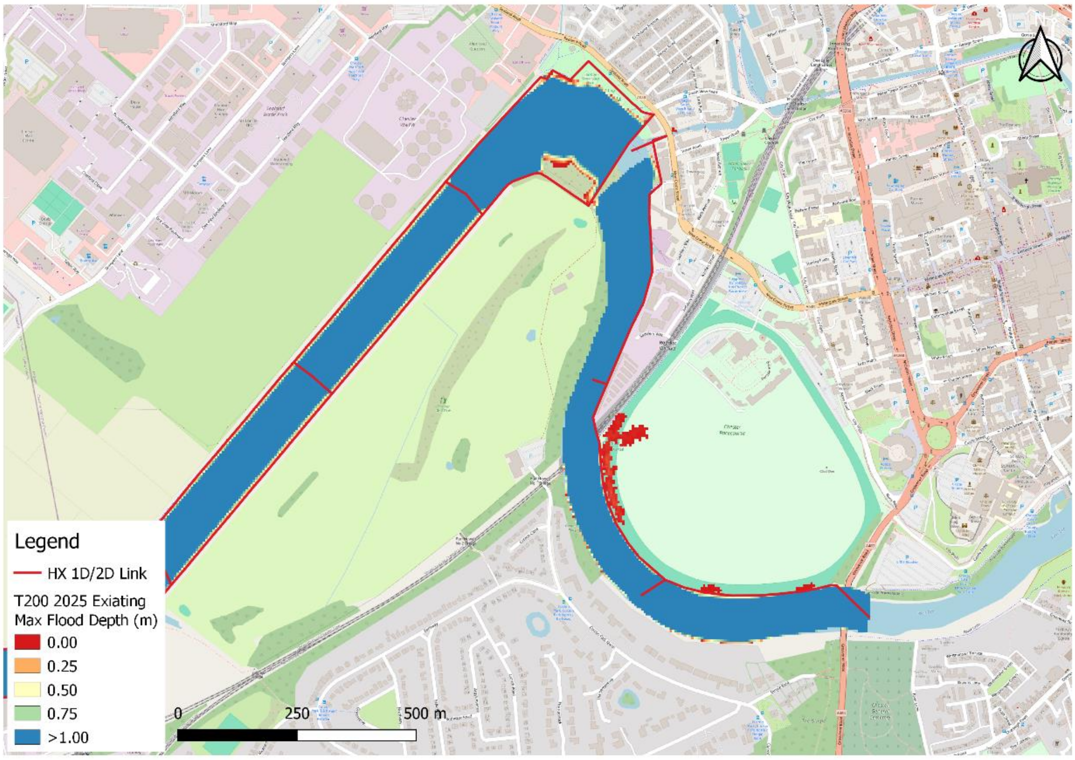
Figure A.6: 0.5% AEP 2025 Tidal Existing Scenario Flood Depth at Chester



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A.2.2 0.1% AEP 2025 Tidal

In the 0.1% AEP 2025 flood scenario (see Figure A.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 A.8).

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

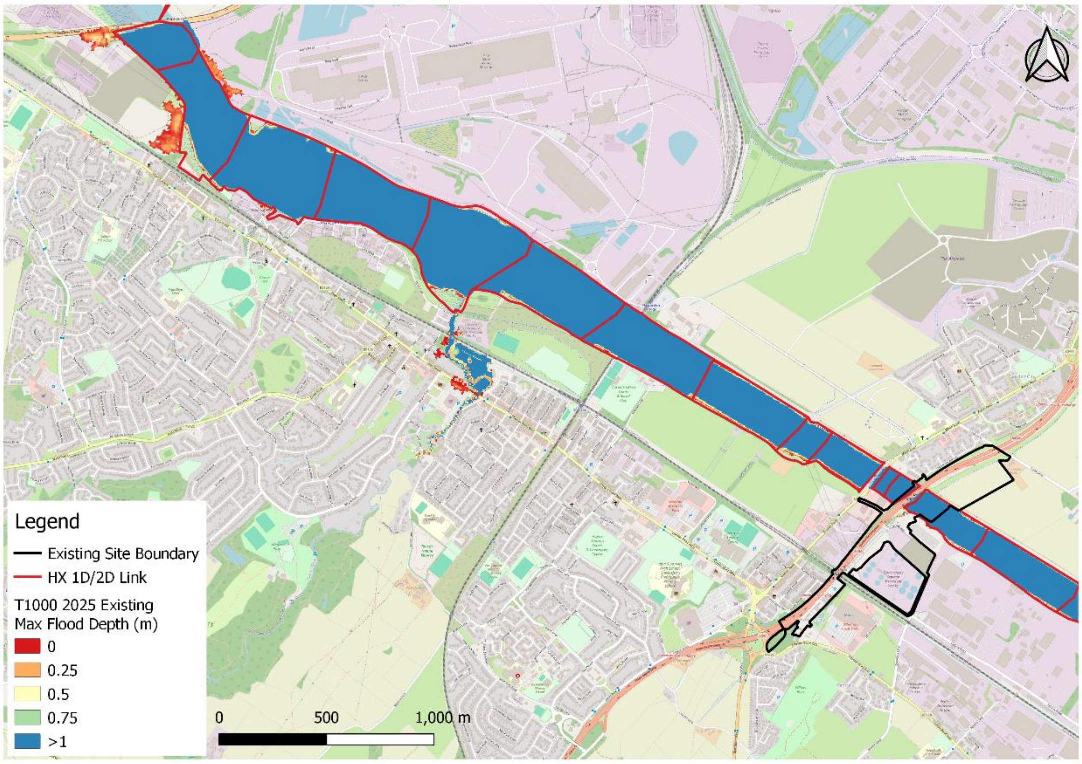

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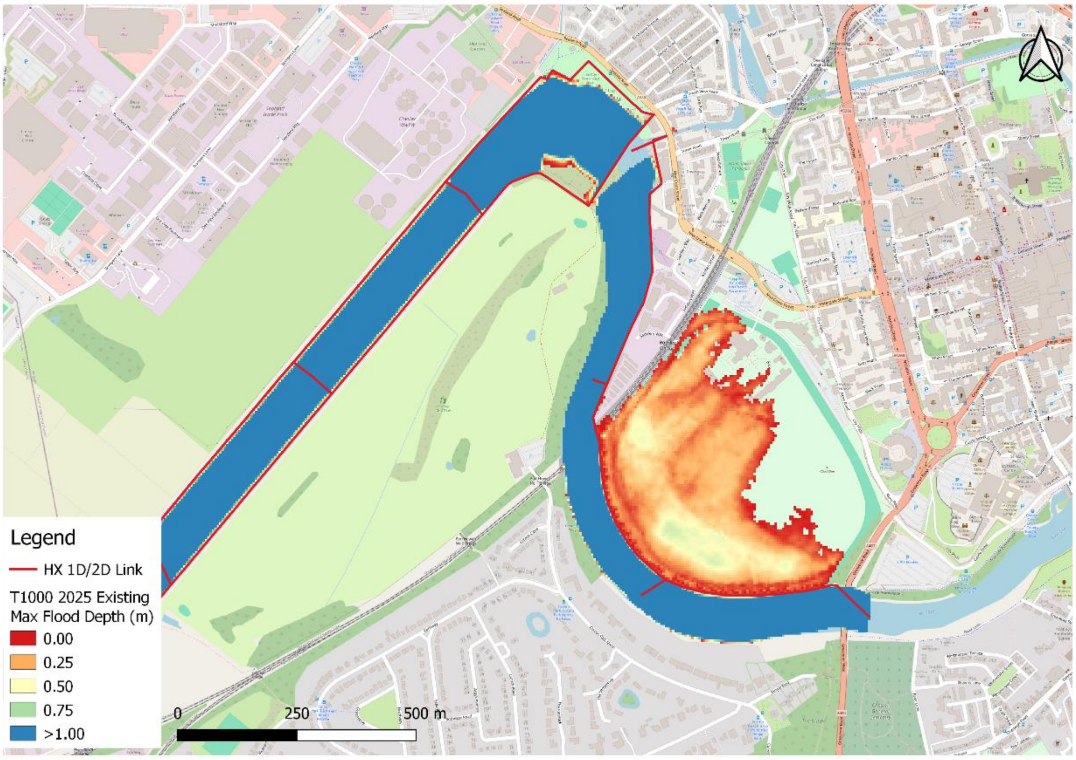
Figure A.8: 0.1% AEP 2025 Tidal Existing Scenario Flood Depth at Chester



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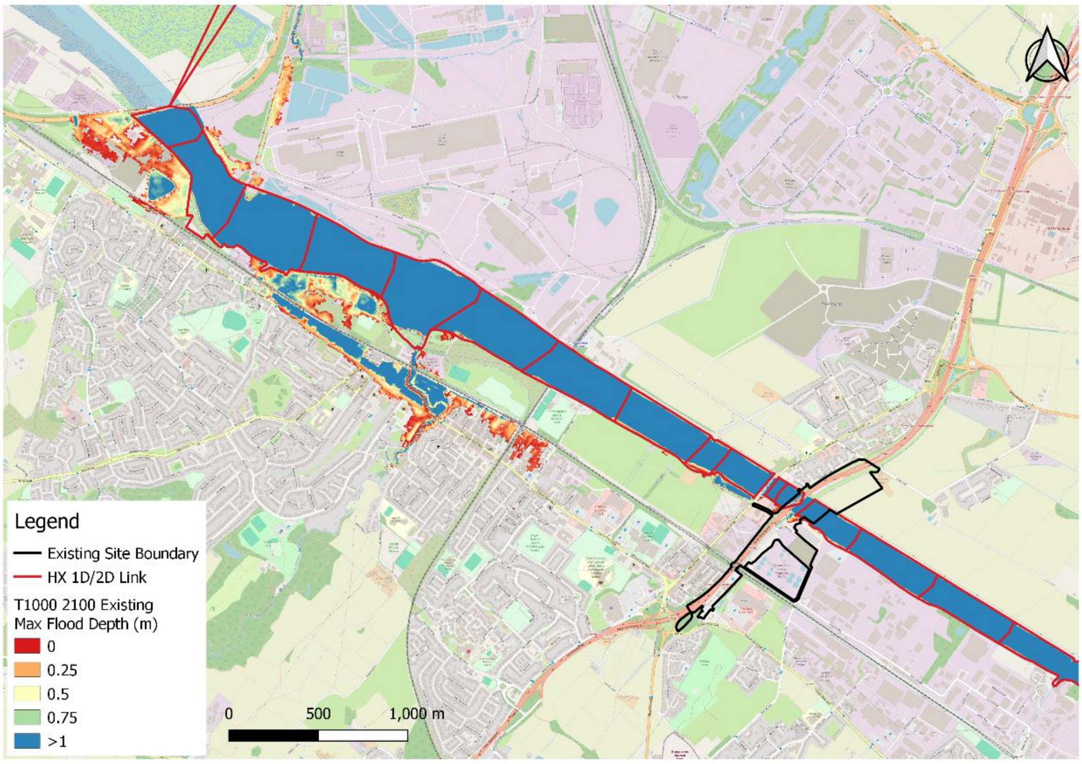
A.2.3 0.5% AEP 2100 Tidal

In the 0.5% AEP 2100 event (see Figure A.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 A.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 (see Figure A.11).

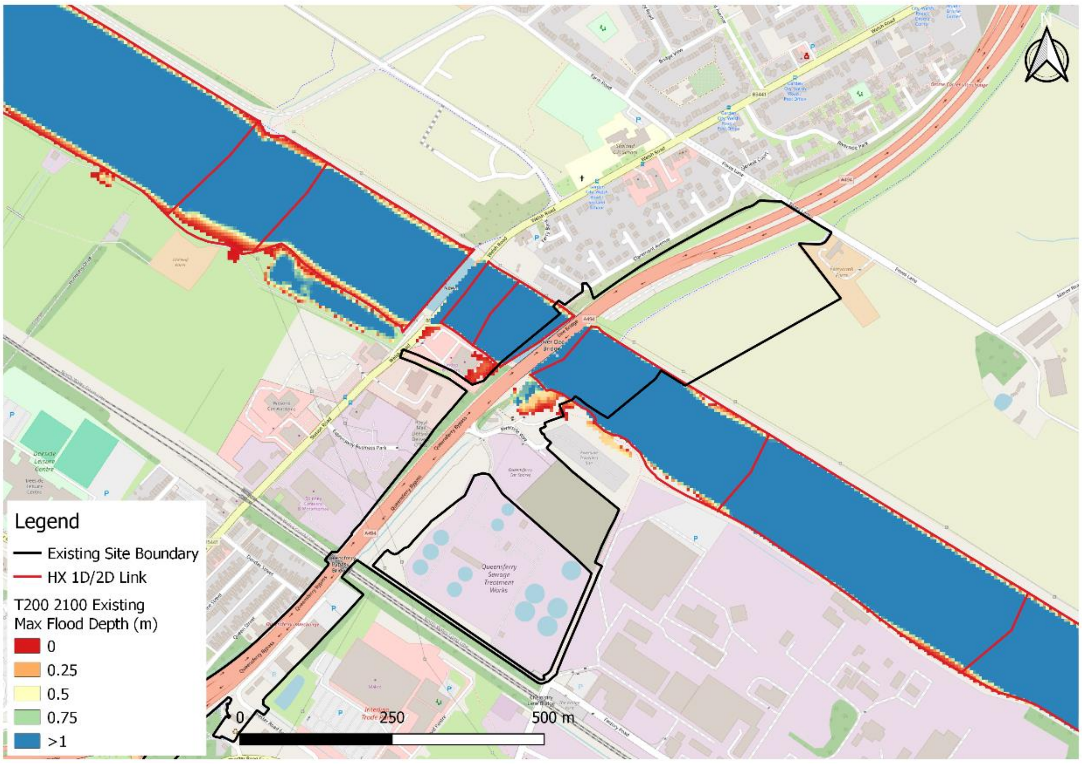
A sensitivity test using the 97.5% confidence bound (or C2 level – upper limit of the likely sea level for a given return period) from the CFB Dataset has been applied to the 2100 scenario. This scenario shows additional out of bank flooding along both banks of the River Dee including immediately up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

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



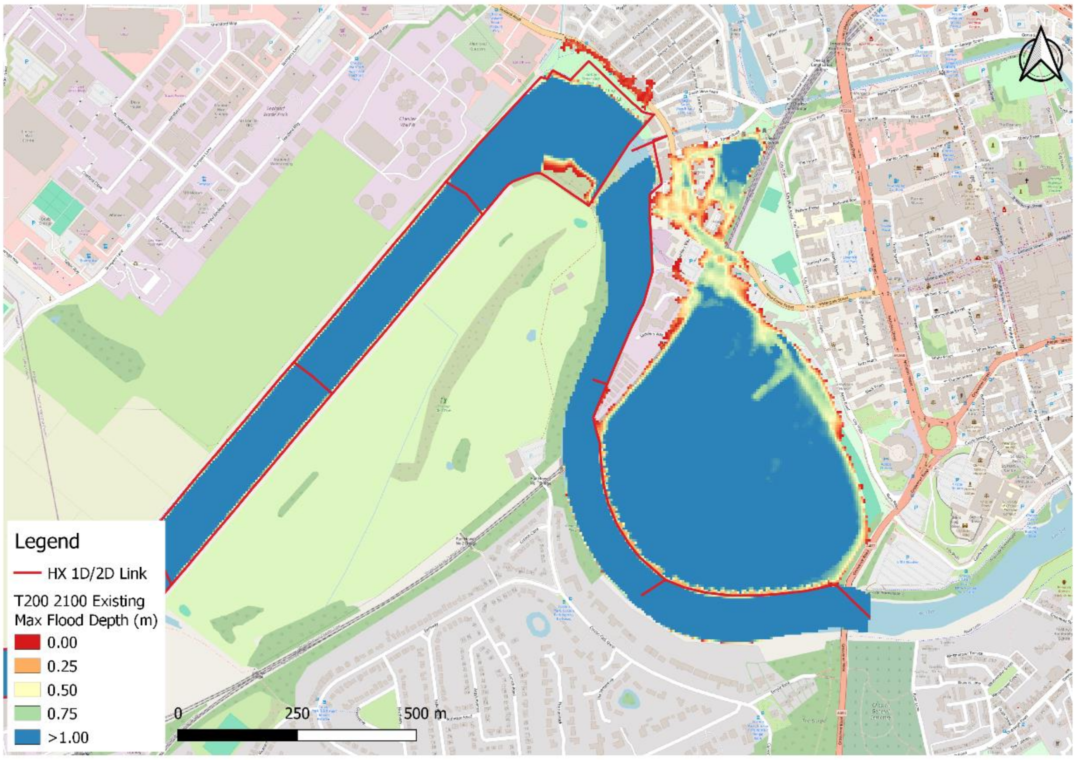
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

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



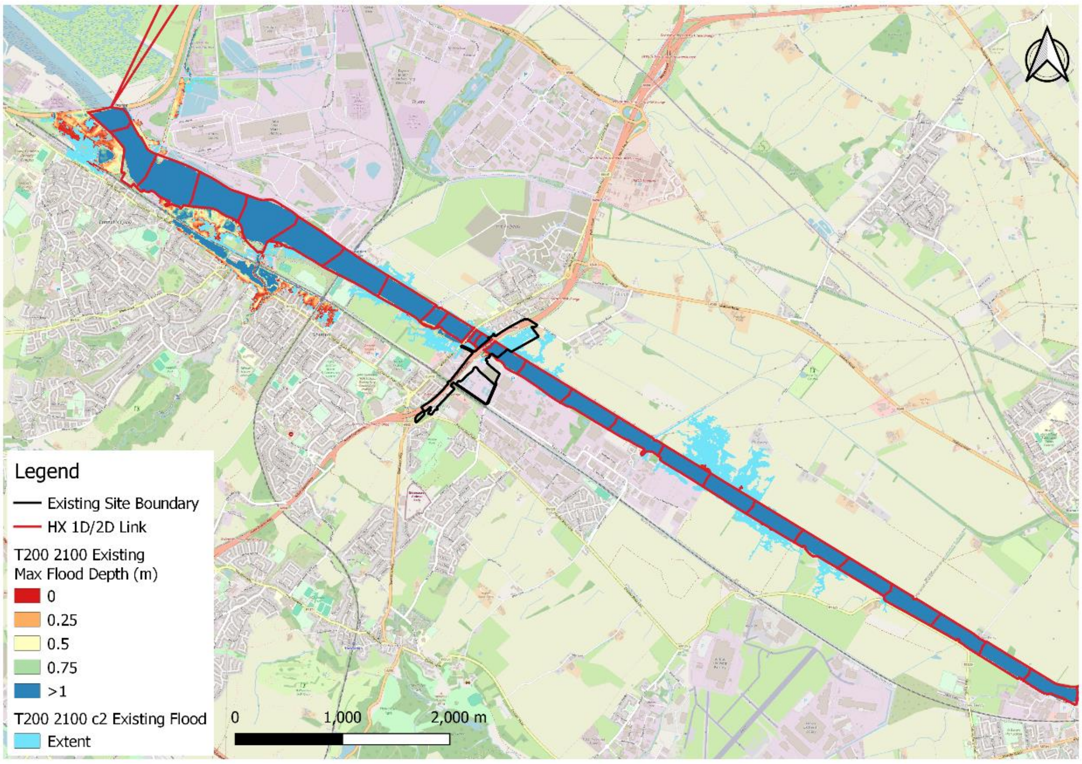
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

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



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

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



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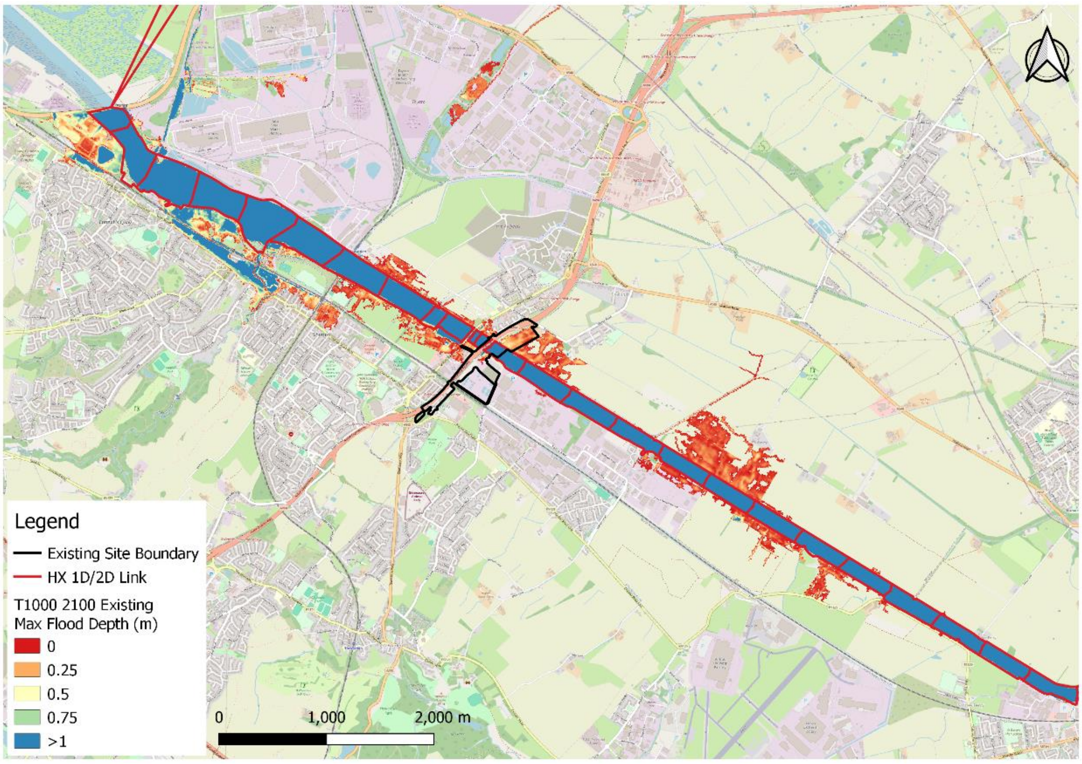
A.2.4 0.1% AEP 2100 Tidal

In the 0.1% AEP 2100 event (see Figure A.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 A.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.

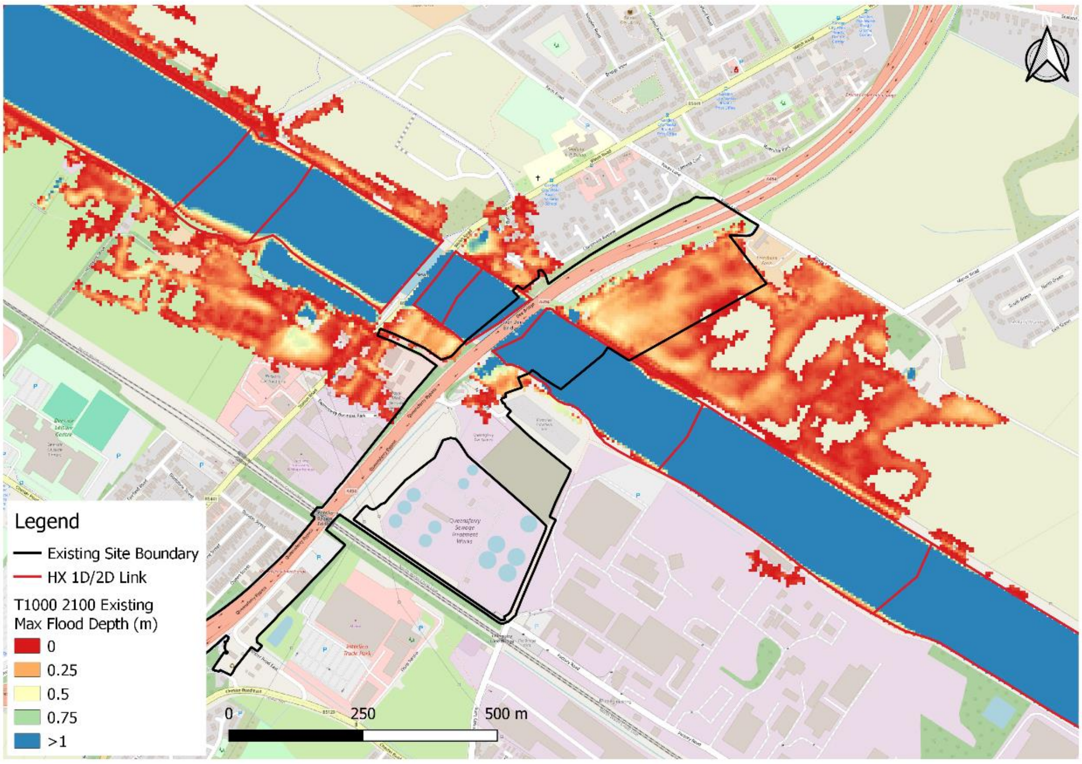
An additional sensitivity test using the 97.5% confidence bound (or C2 level – upper limit of the likely sea level for a given return period) from the CFB Dataset has been applied to the 2100 scenario. Under this scenario there is a significant increase in the extent of flooding for the 0.1% AEP 2100 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 A.16).

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



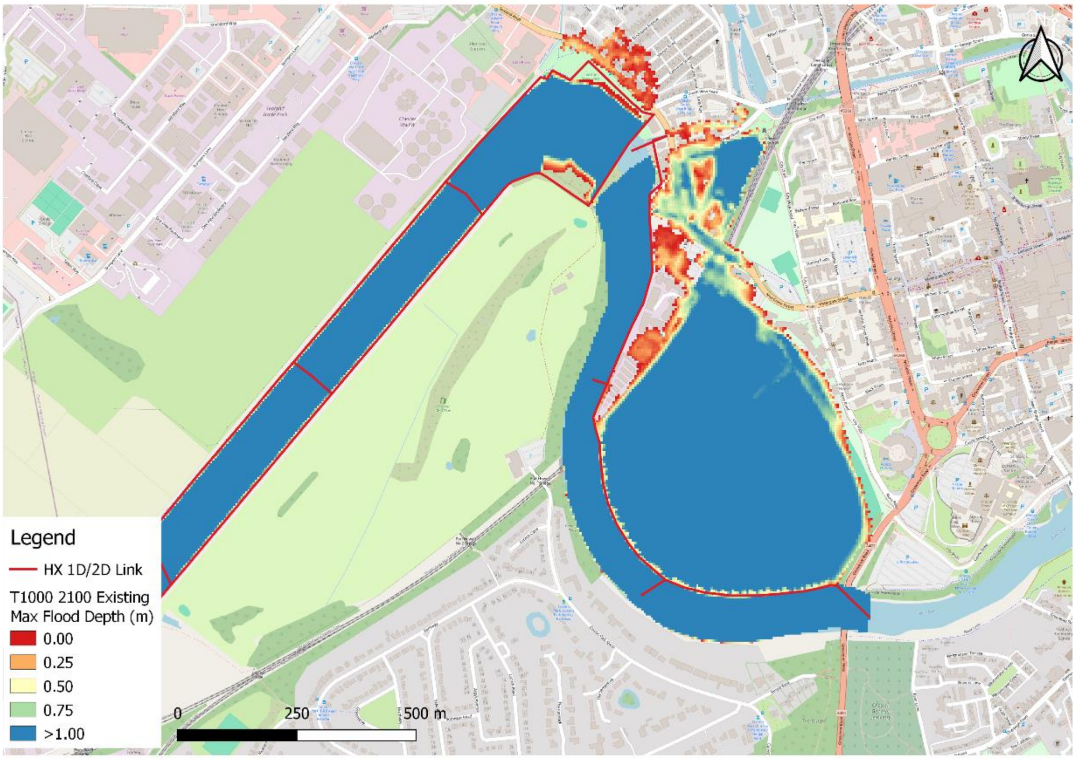
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

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



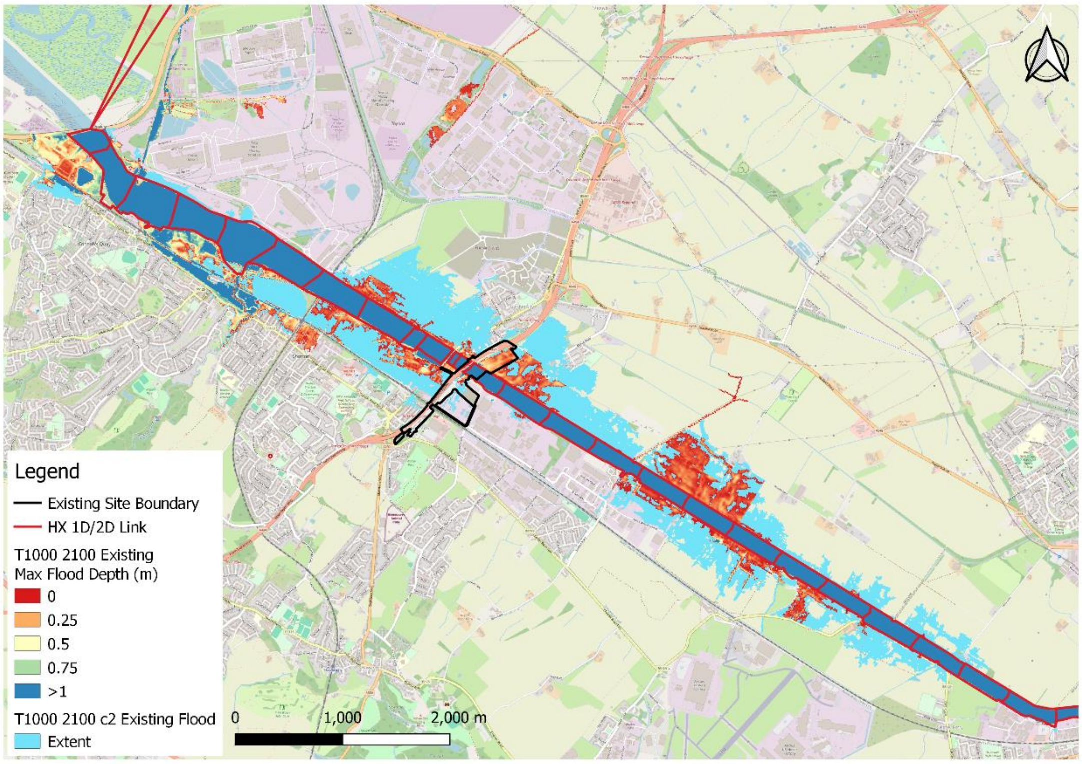
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

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



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

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



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A.3 Tidal Breach

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

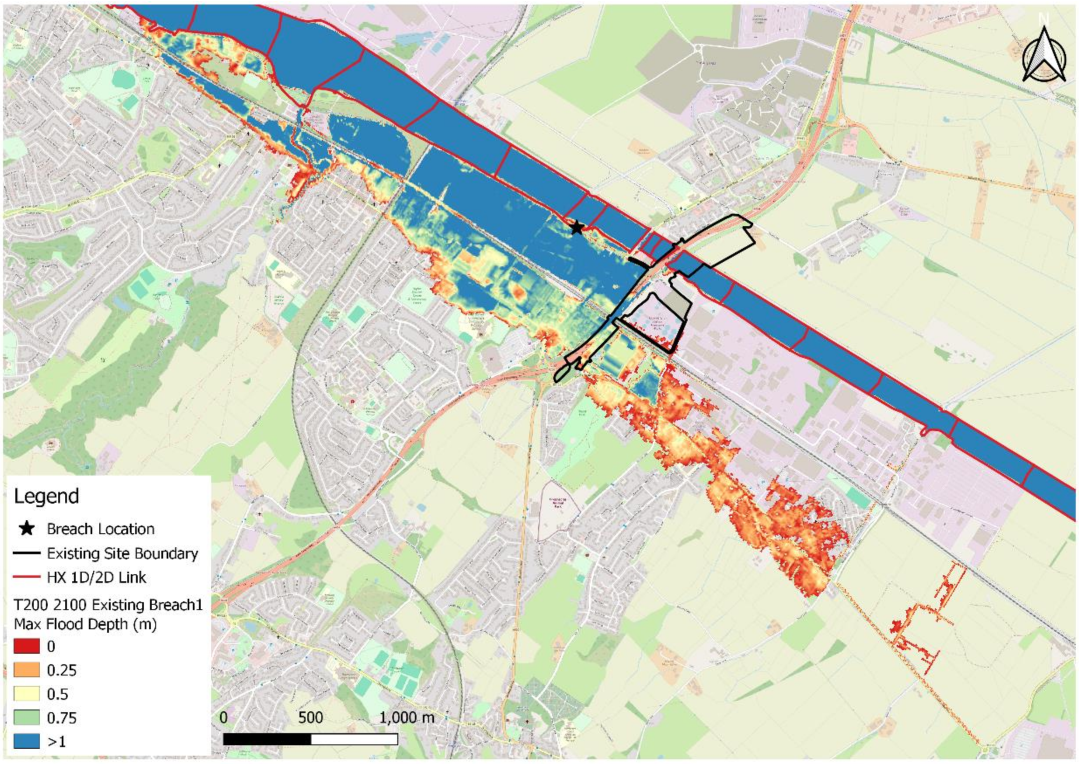

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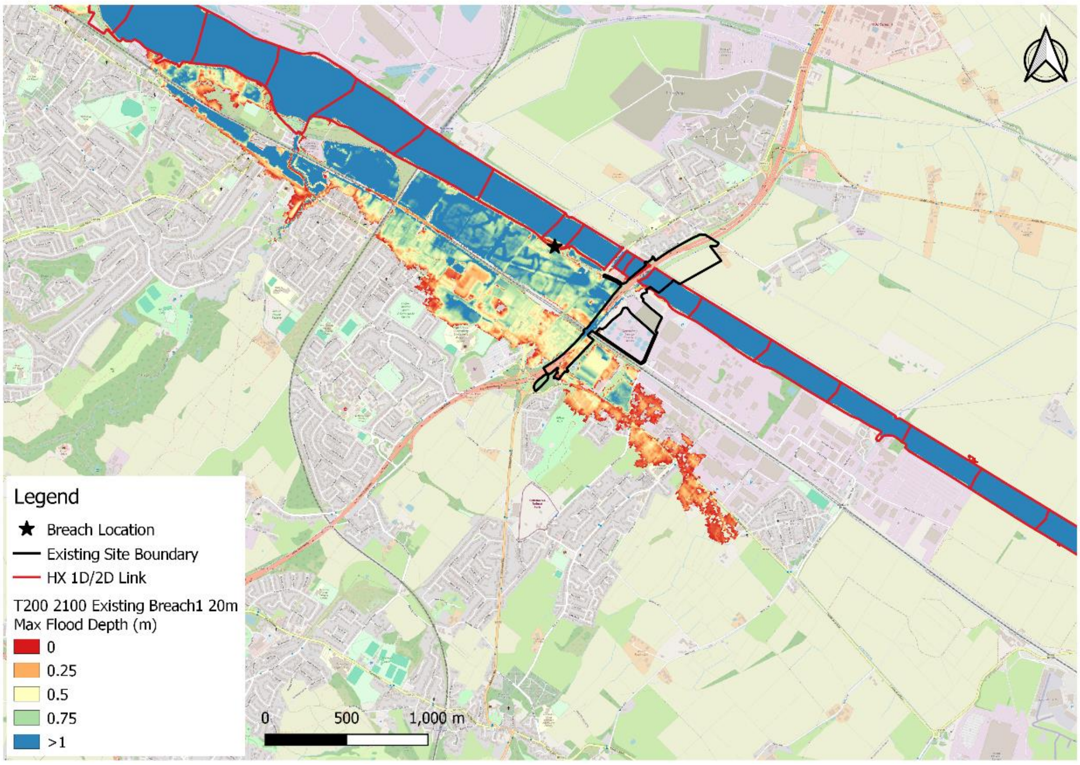
Figure A.18: 0.5% AEP 2100 Tidal Breach One 20m Existing Scenario Flood Depth



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A.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 A.19.Floodwater also extends onto the High Street in Shotton under this scenario.

The results of the 20m sensitivity test are shown in Figure A.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 A.19: 0.1% AEP 2100 Tidal Breach One Existing Scenario Flood Depth

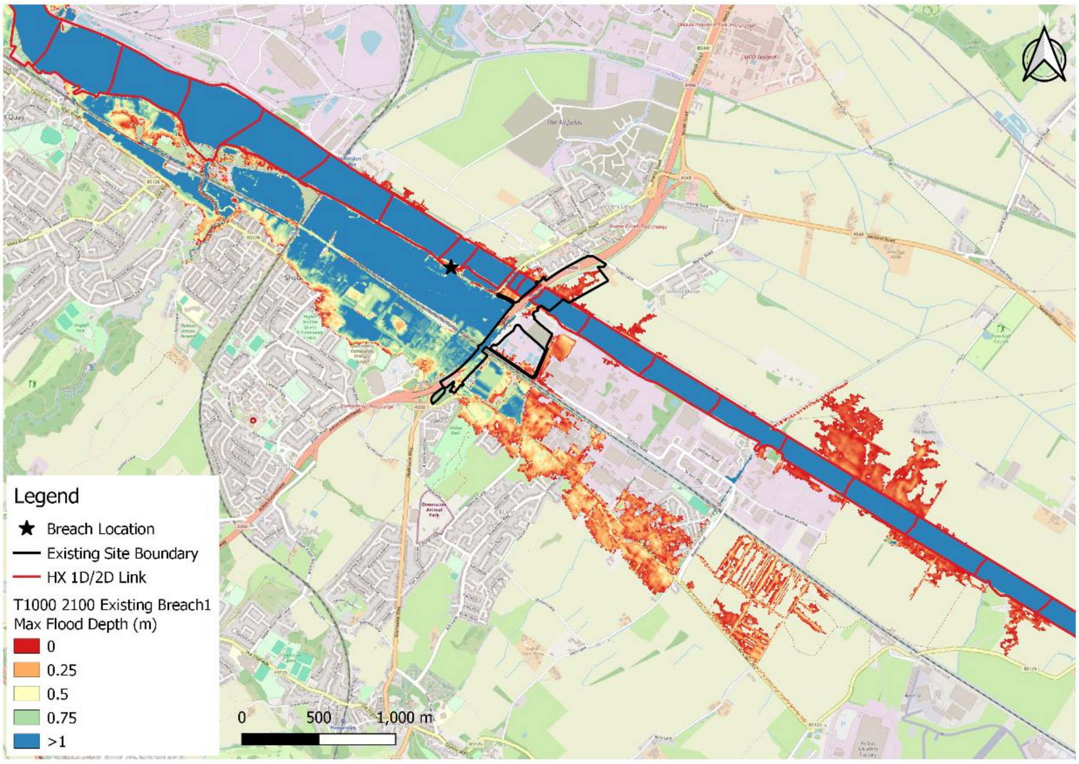

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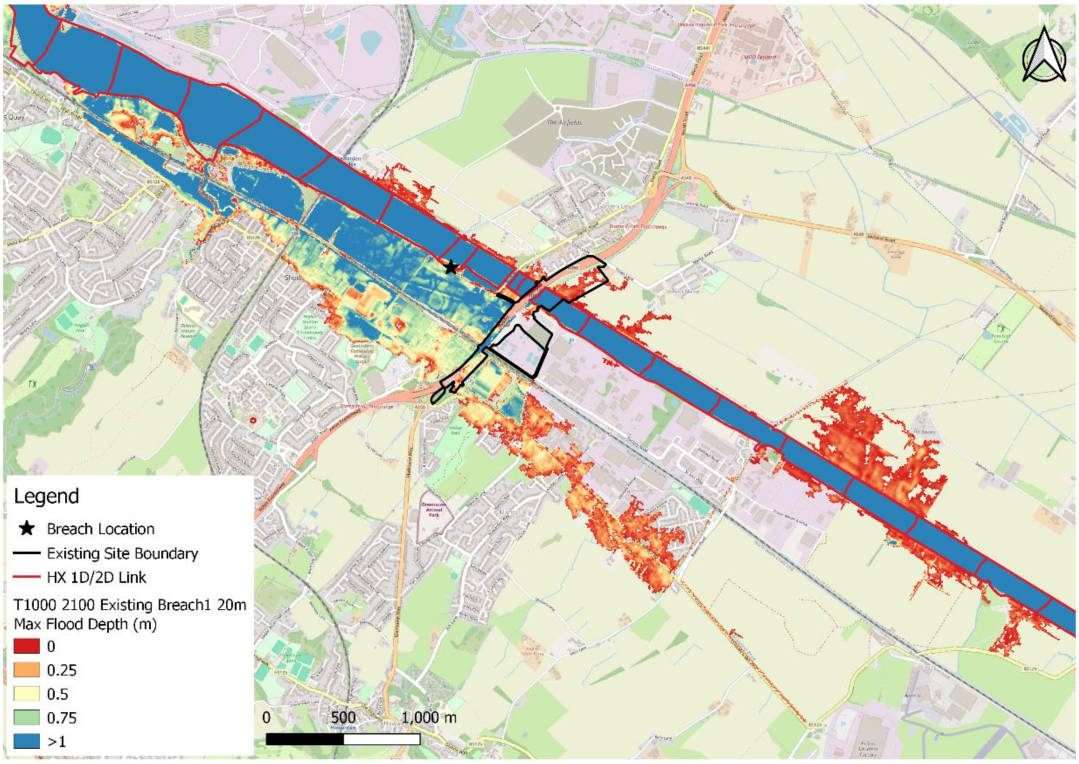
Figure A.20: 0.1% AEP 2100 Tidal Breach One 20m Existing Scenario Flood Depth



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

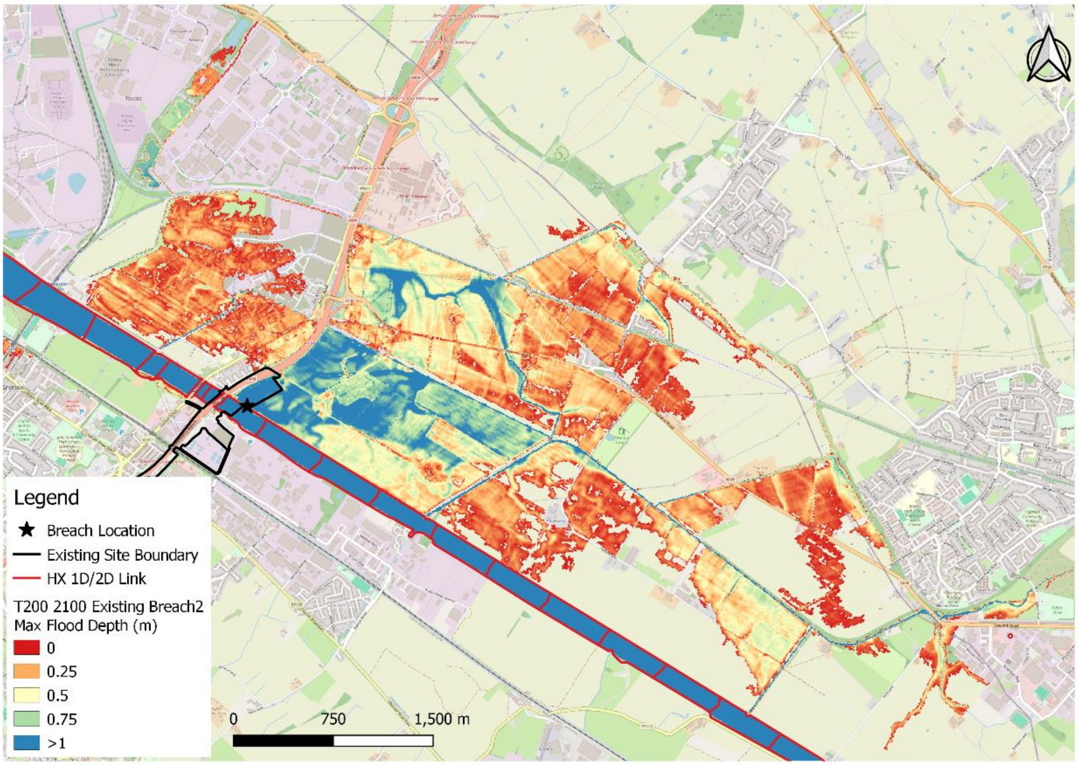

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Figure A.22: 0.5% AEP 2100 Tidal Breach Two 20m Existing Scenario Flood Depth

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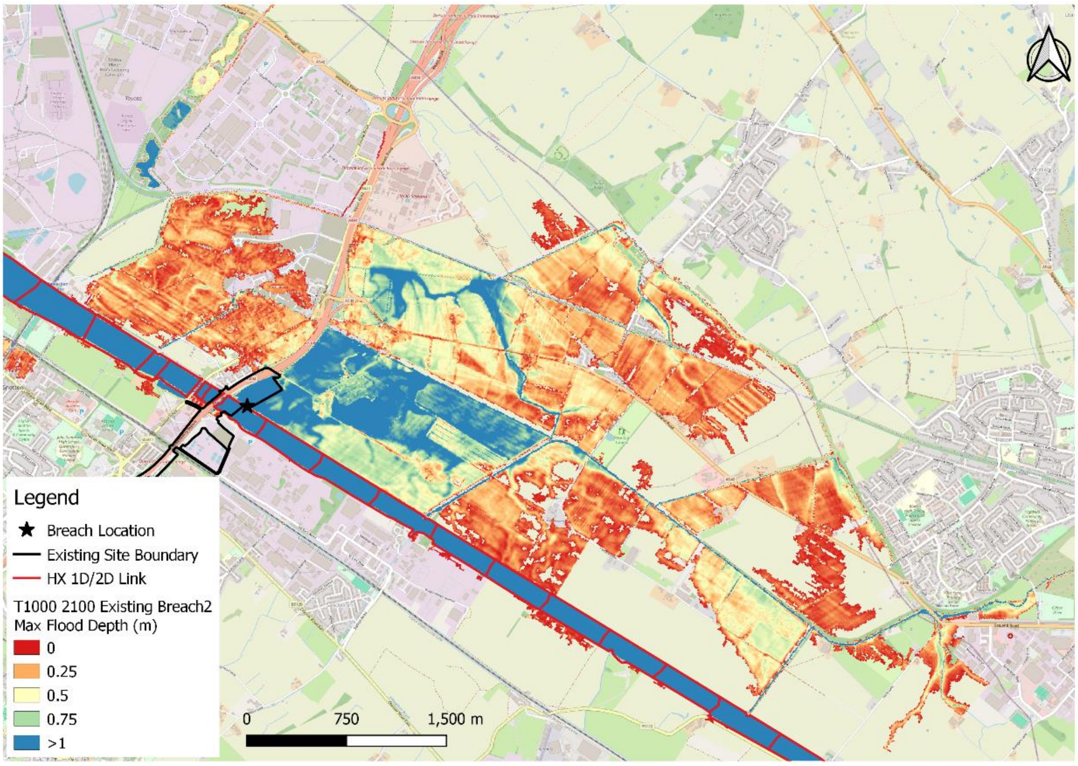
A.3.4 Tidal Breach Two – 0.1% AEP 2100 Tidal

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 A.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.

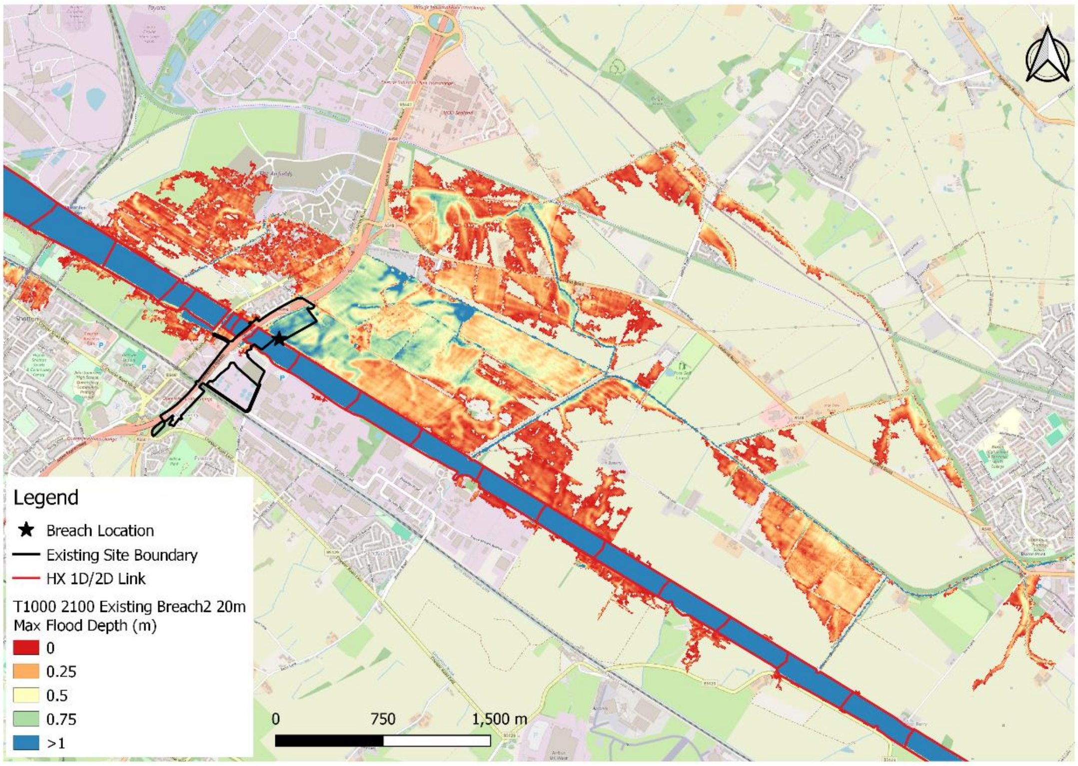
The results of the 20m sensitivity test are shown in Figure A.24. There are reductions in both flood extent and depth compared to the 20m scenario including reductions across The Airways to the east of the breach. There are also significant reductions in flooding to the northwest of the breach where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

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



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

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



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

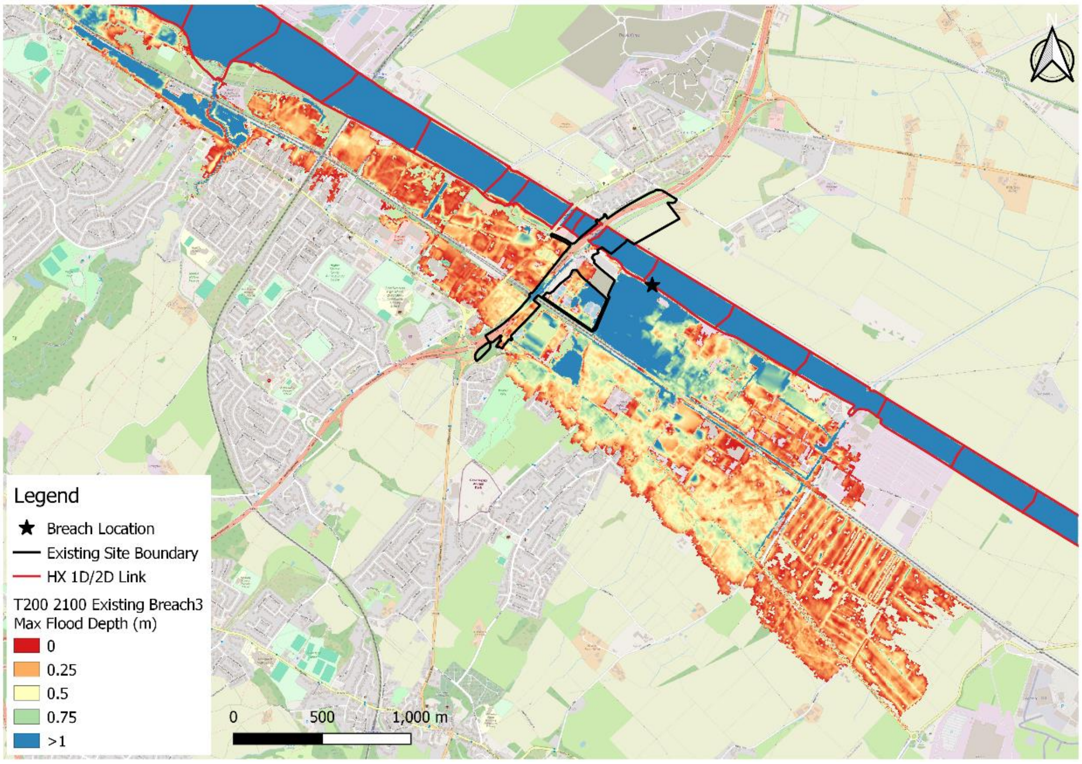

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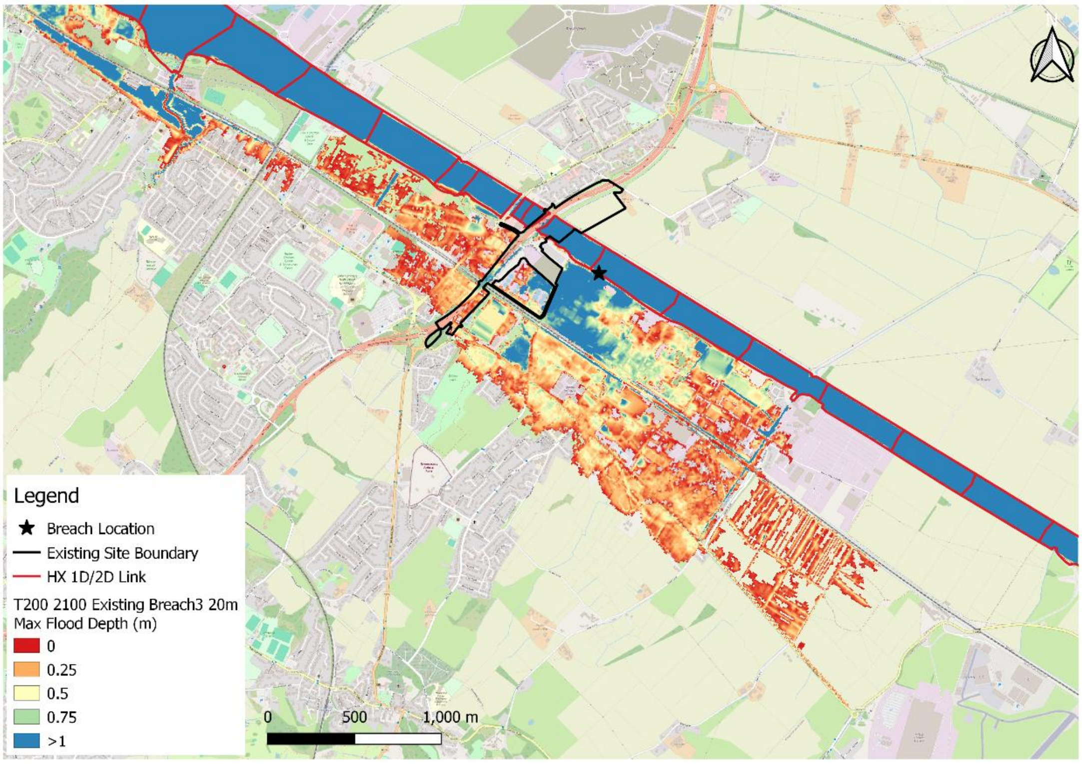
Figure A.26: 0.5% AEP 2100 Tidal Breach Three 20m Existing Scenario Flood Depth



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

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

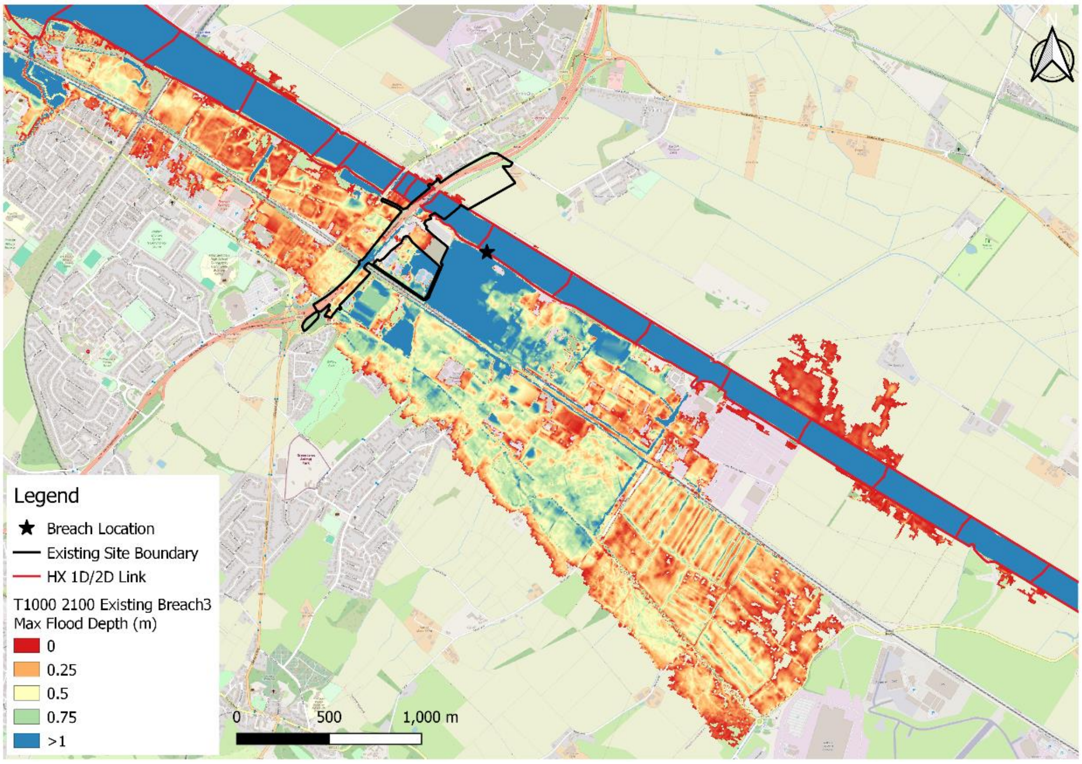

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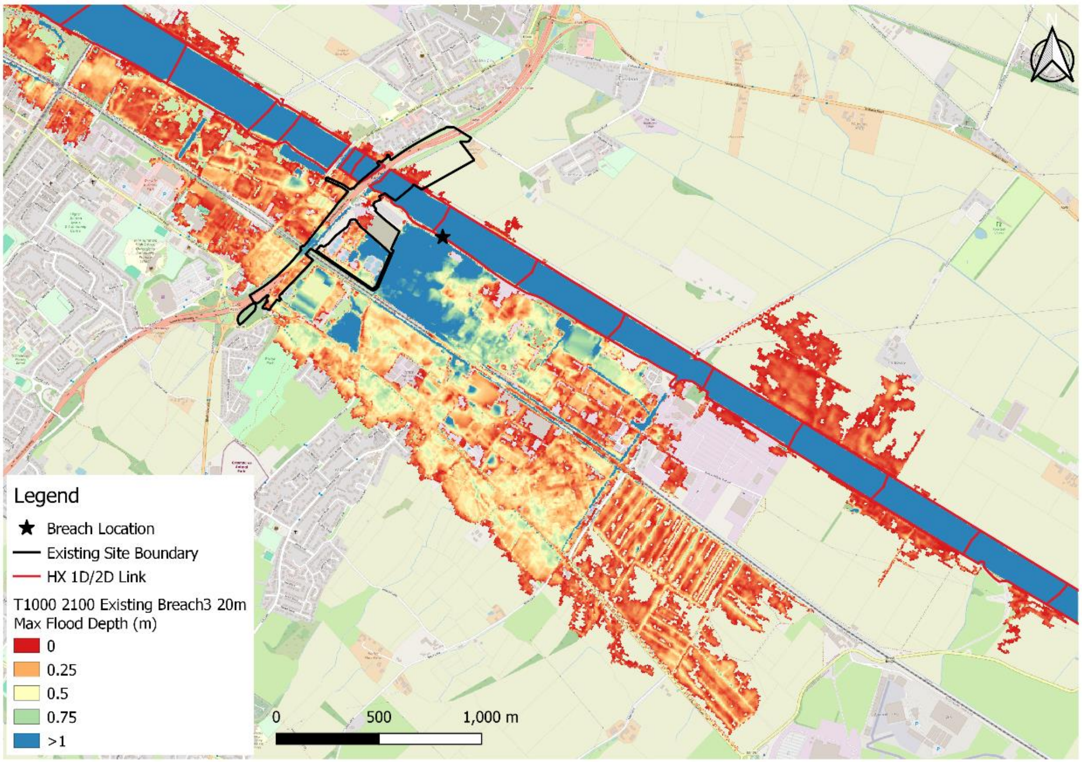
Figure A.28: 0.1% AEP 2100 Tidal Breach Three 20m Existing Scenario Flood Depth



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

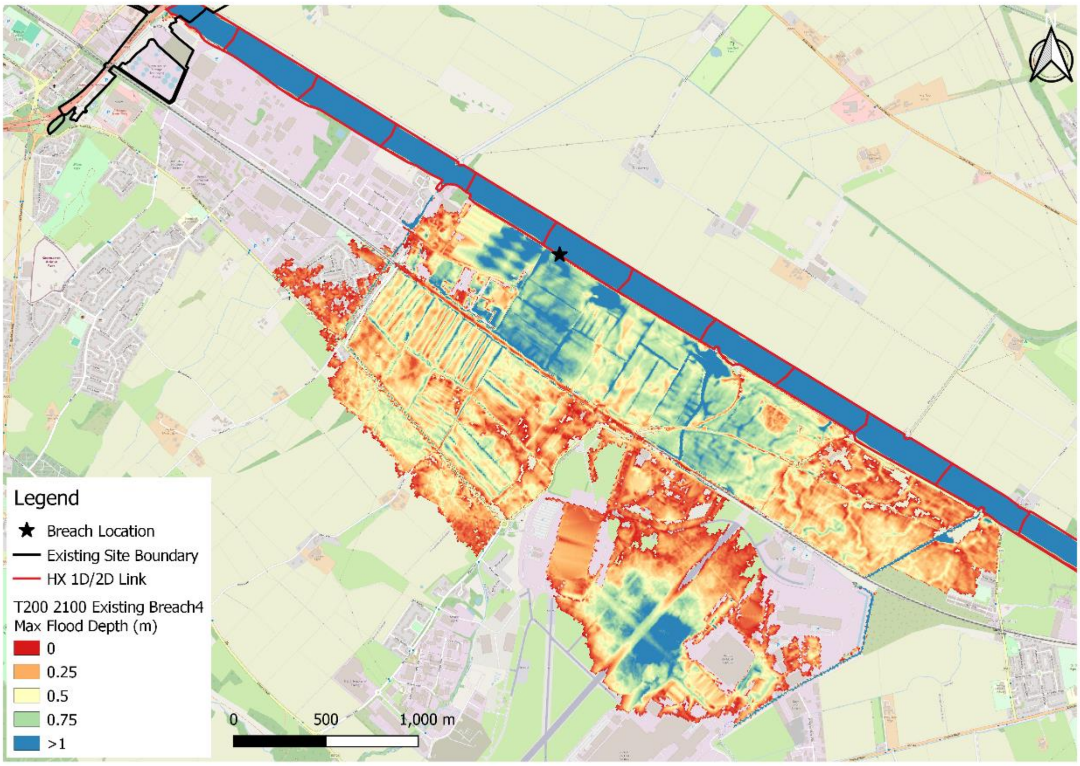

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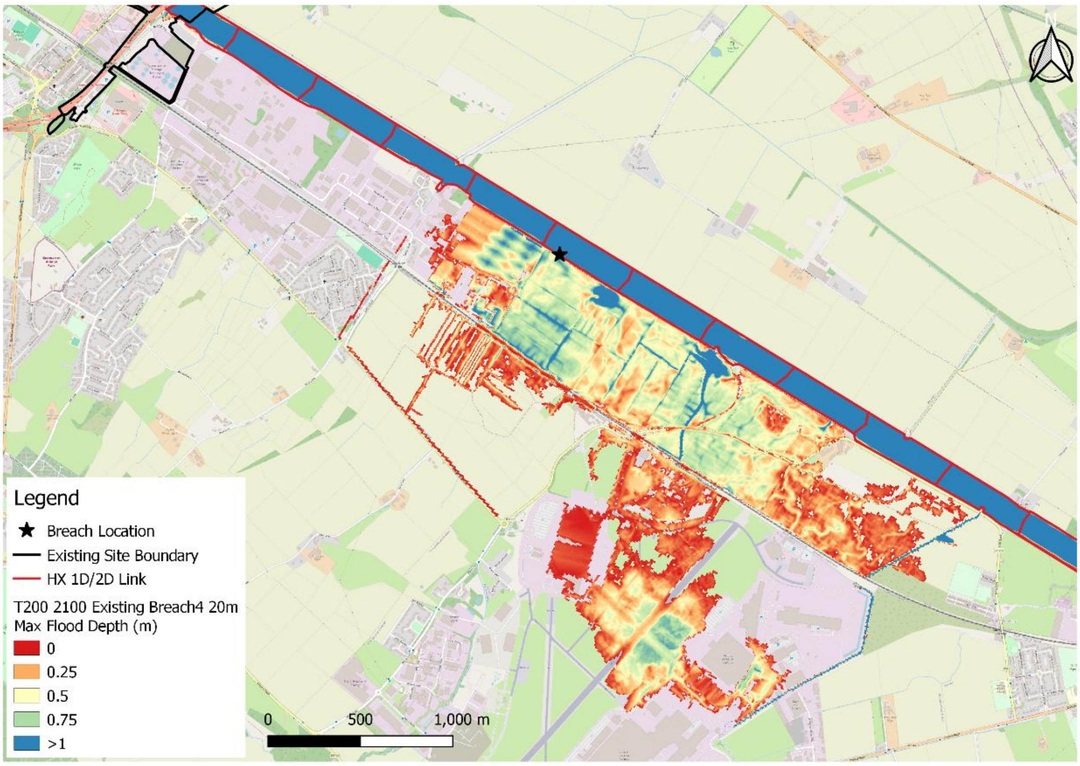
Figure A.30: 0.5% AEP 2100 Tidal Breach Four 20m Existing Scenario Flood Depth



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

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

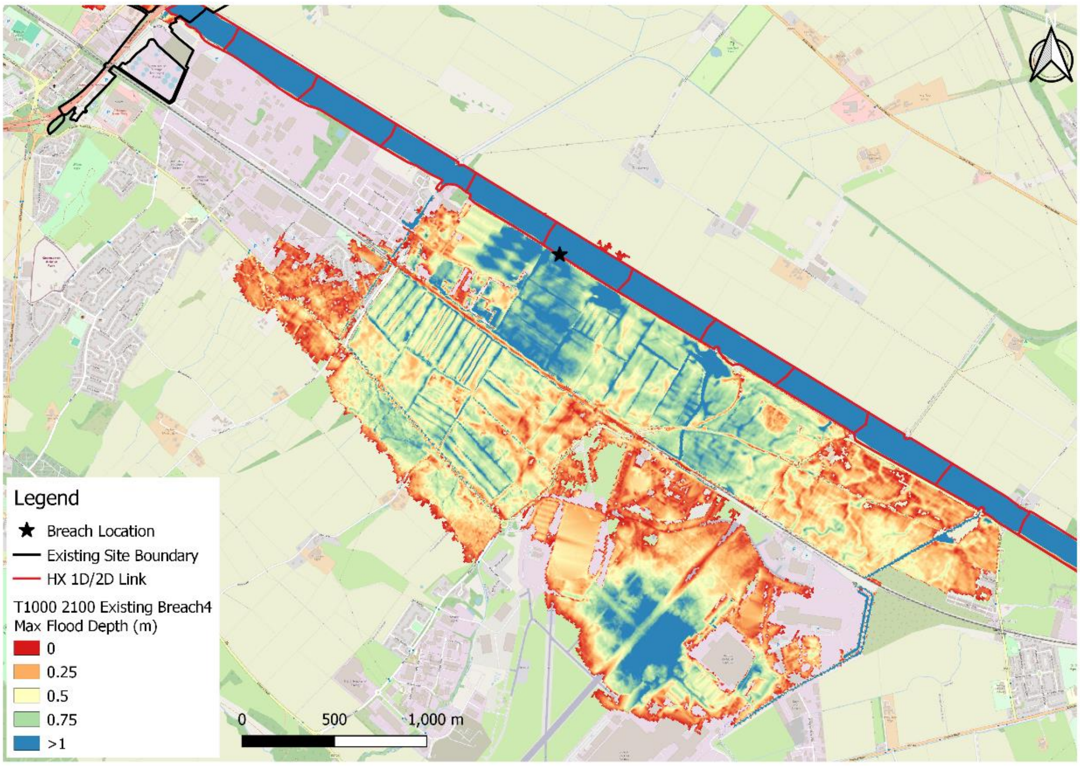

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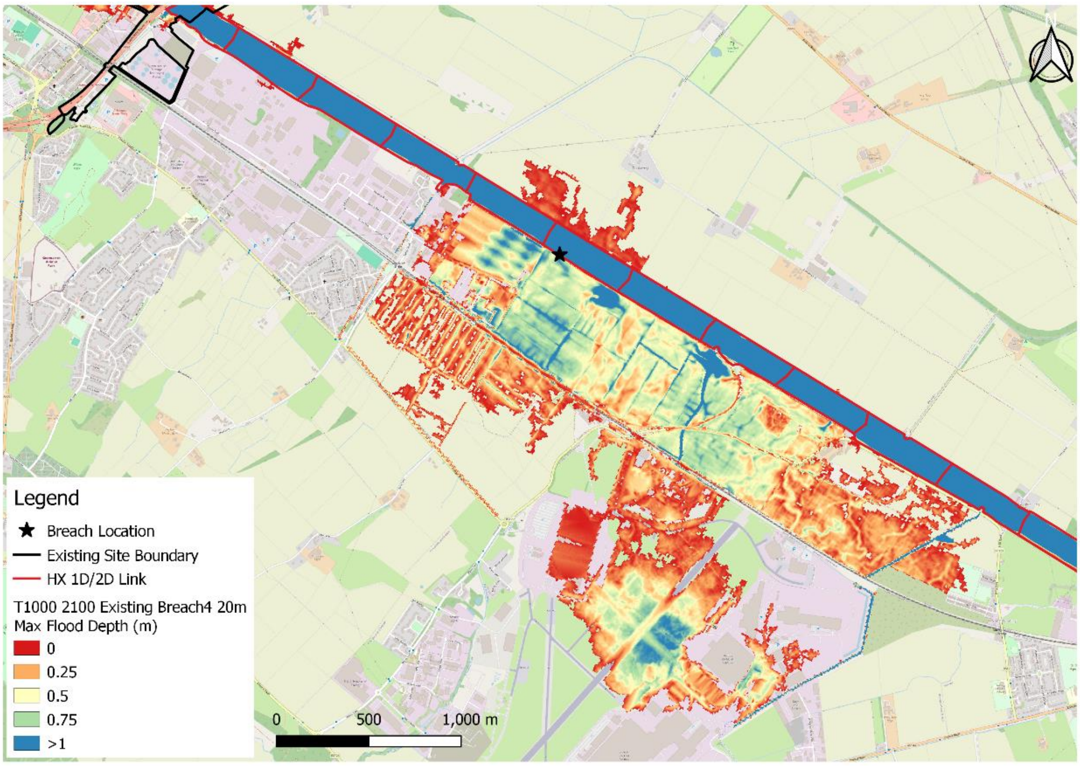
Figure A.32: 0.1% AEP 2100 Tidal Breach Four 20m Existing Scenario Flood Depth



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

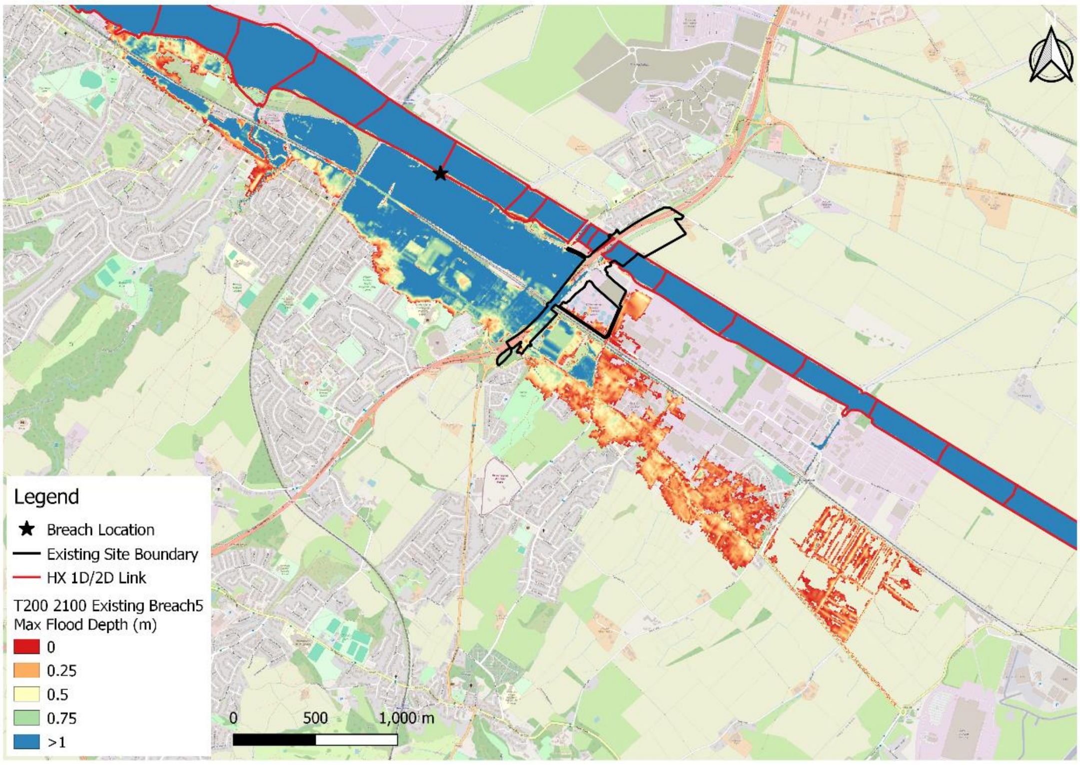

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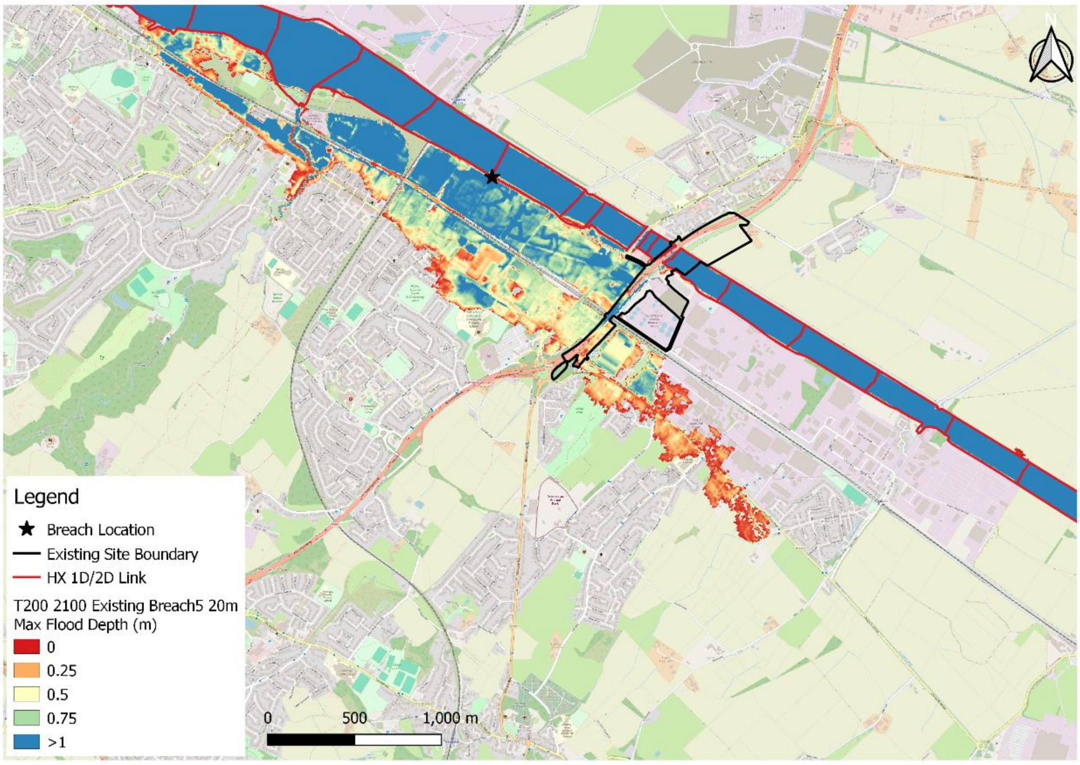
Figure A.34: 0.5% AEP 2100 Tidal Breach Five 20m Existing Scenario Flood Depth



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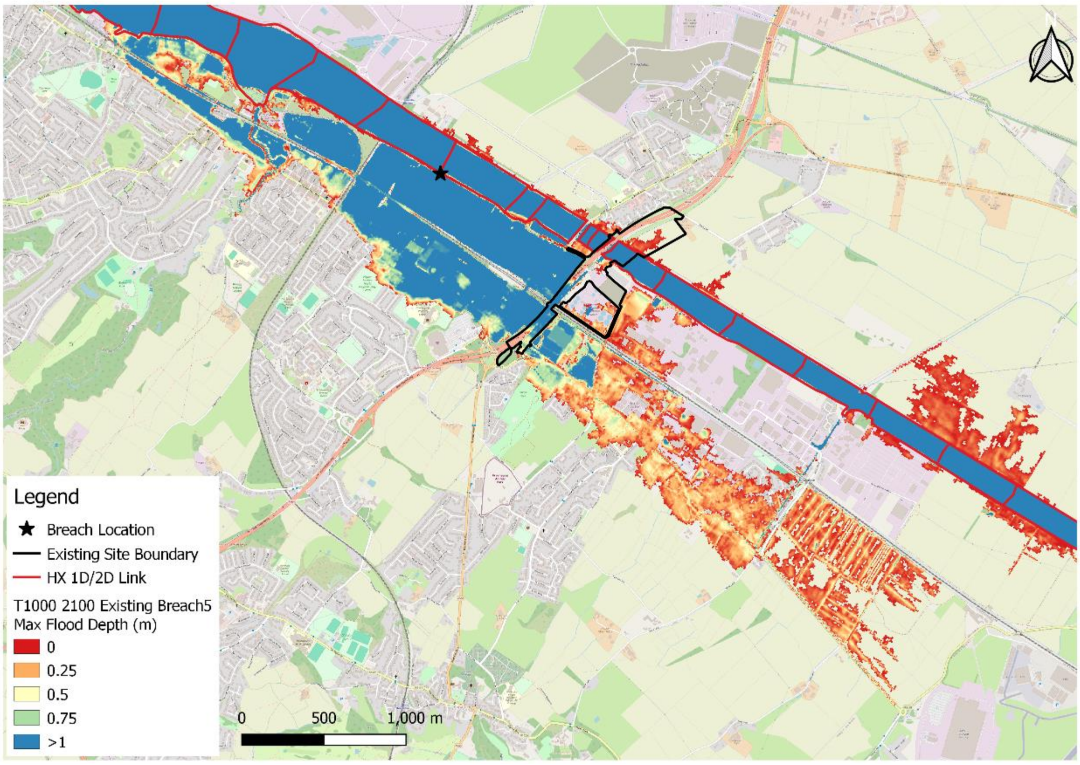
A.3.10 Tidal Breach Five – 0.1% AEP 2100 Tidal

As shown in Figure A.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.

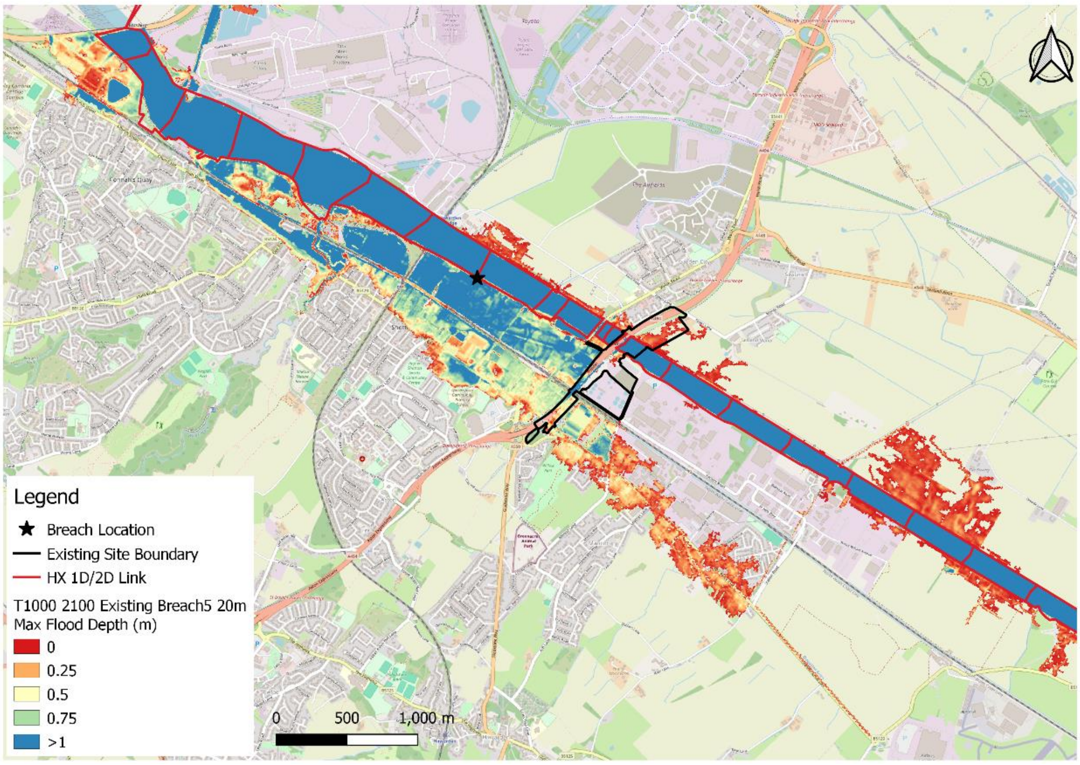
Figure A.36 shows the results of the 20m sensitivity test on Tidal Breach Five. Under the 20m scenario there are reductions in flood depth and extent around Sandycroft with flooding not predicted past Station Road. Additionally, there is a significant decrease in flood depth to Shotton especially in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

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



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

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



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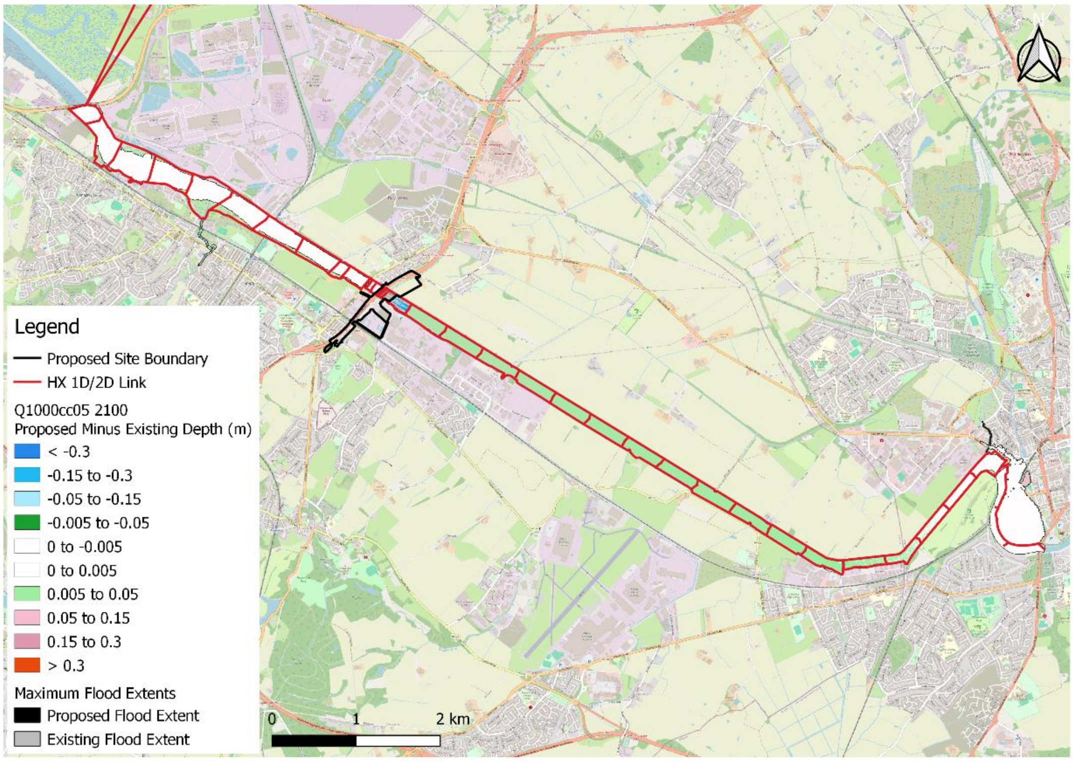
B. Proposed (Post-Development) Flood Risk Assessment

B.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. Upstream at Chester there is a slight increase in the flood extent. This increase is caused by the flood water in the 2d floodplain flowing into a defined watercourse which sits at a lower elevation compared to the flooded road. The additional flood extent is located within this defined watercourse not the urban areas of Chester. These differences are detailed in Figure B.1.

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



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B.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 A.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.

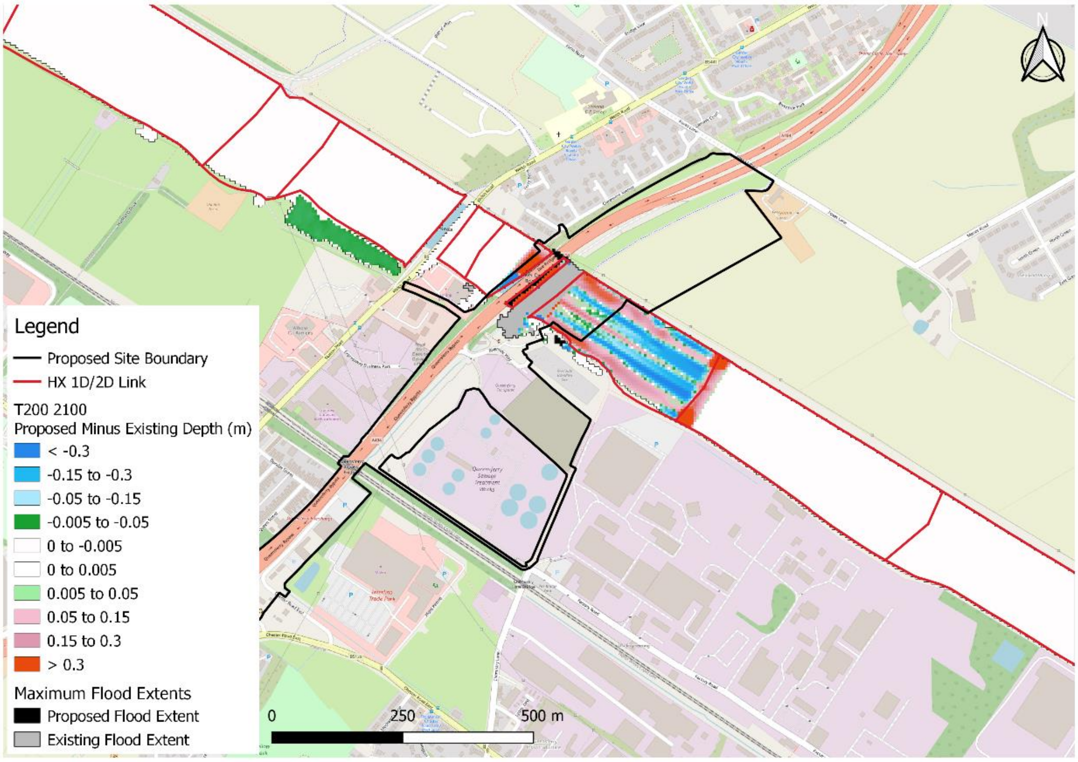
B.2.1 Future Scenario (2100)

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 B.2).

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 B.3. 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:

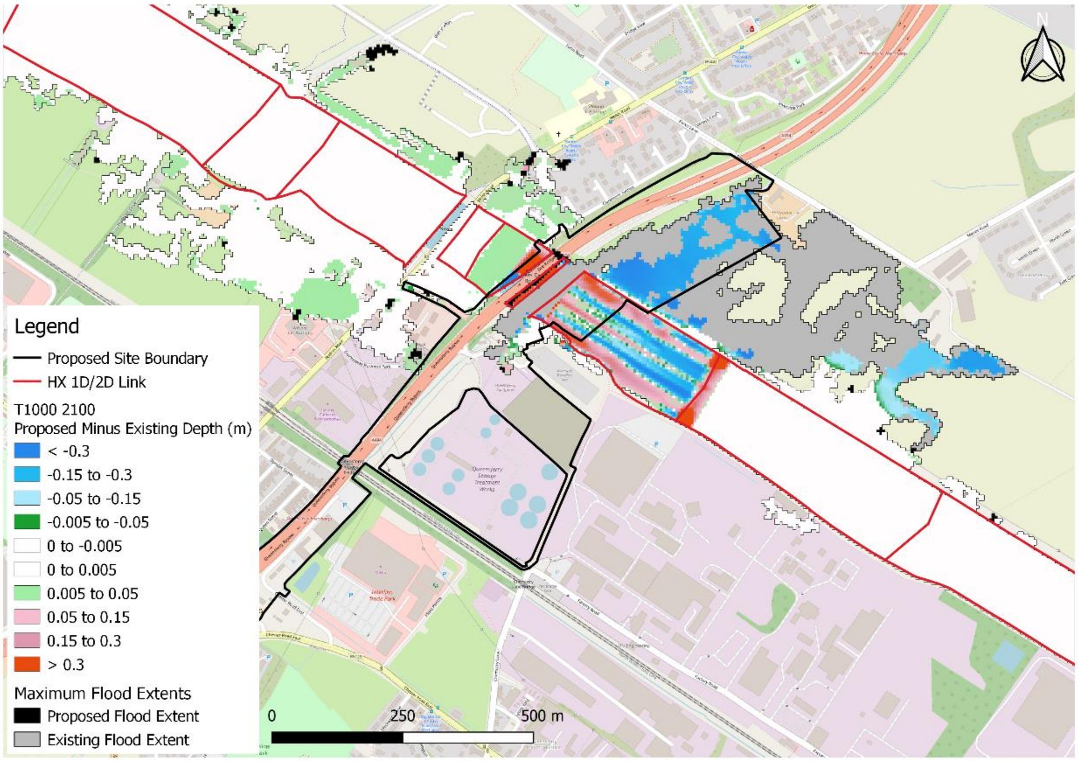
- A small area of Garden City close to the River Dee sees a small increase in the number of residential areas affected.
- Additional increases in flood extent are observed in rural areas along the right bank.
- On the left bank, flood extent increases are most notable in the commercial area within the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

Figure B.2: 0.5% AEP 2100 Tidal Existing vs Proposed Depth Difference



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

Figure B.3: 0.1% AEP 2100 Tidal Existing vs Proposed Depth Difference



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

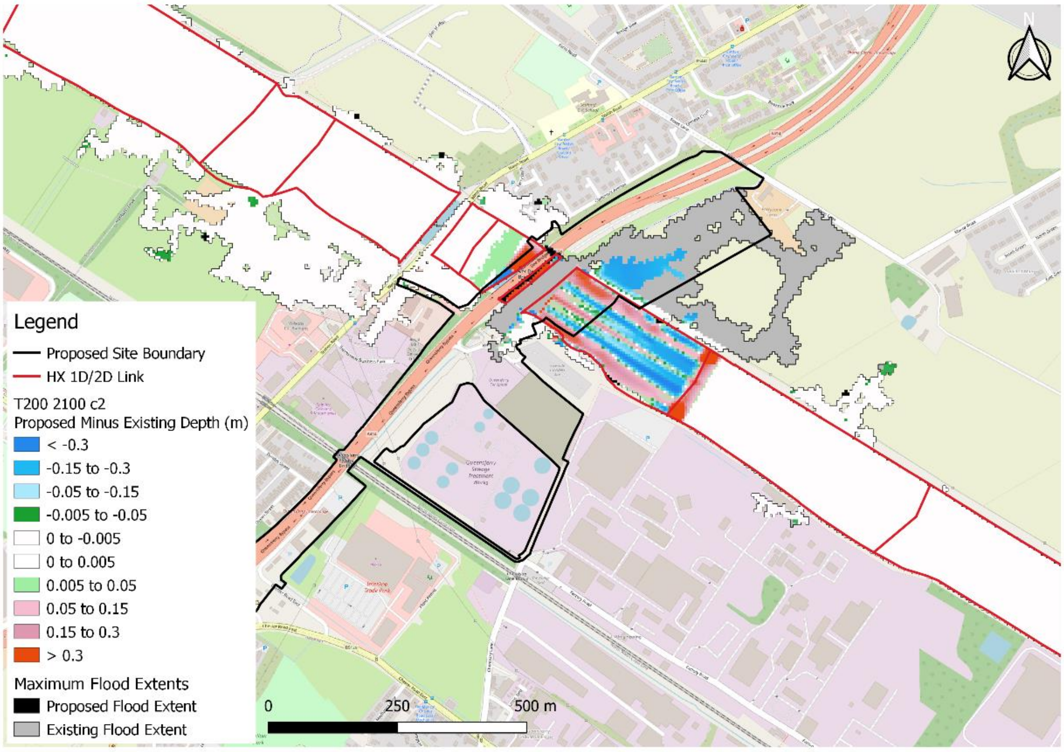
B.2.2 Future Scenario Under Upper Confidence Limit (2100)

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 B.4 and Figure B.5.

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.

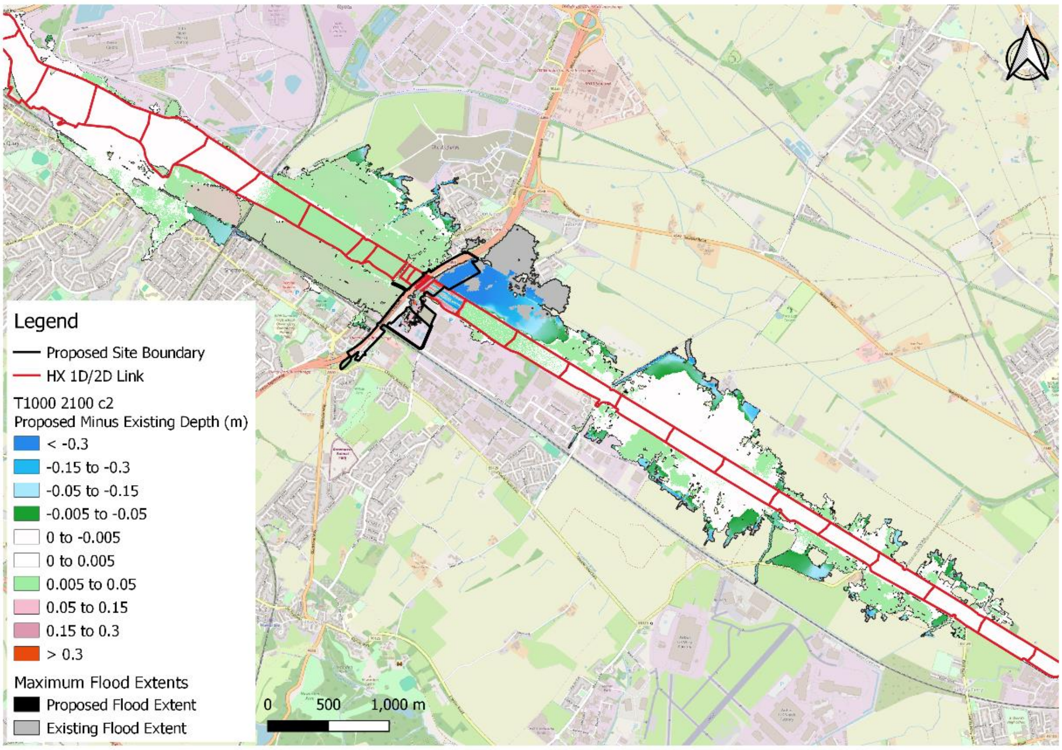
The 0.1% AEP 2100 under c2 conditions the post-development model predicts a significant reduction in flood extent across the Scheme and upstream along the right bank compared to the pre-development scenario. Flood depths are also reduced in these areas. Downstream of the development, flood extents fluctuate 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 B.4: 0.5% AEP 2100 Tidal Under c2 Conditions Existing vs Proposed Depth Difference



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

Figure B.5: 0.1% AEP 2100 Tidal Under c2 Conditions Existing vs Proposed Depth Difference



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

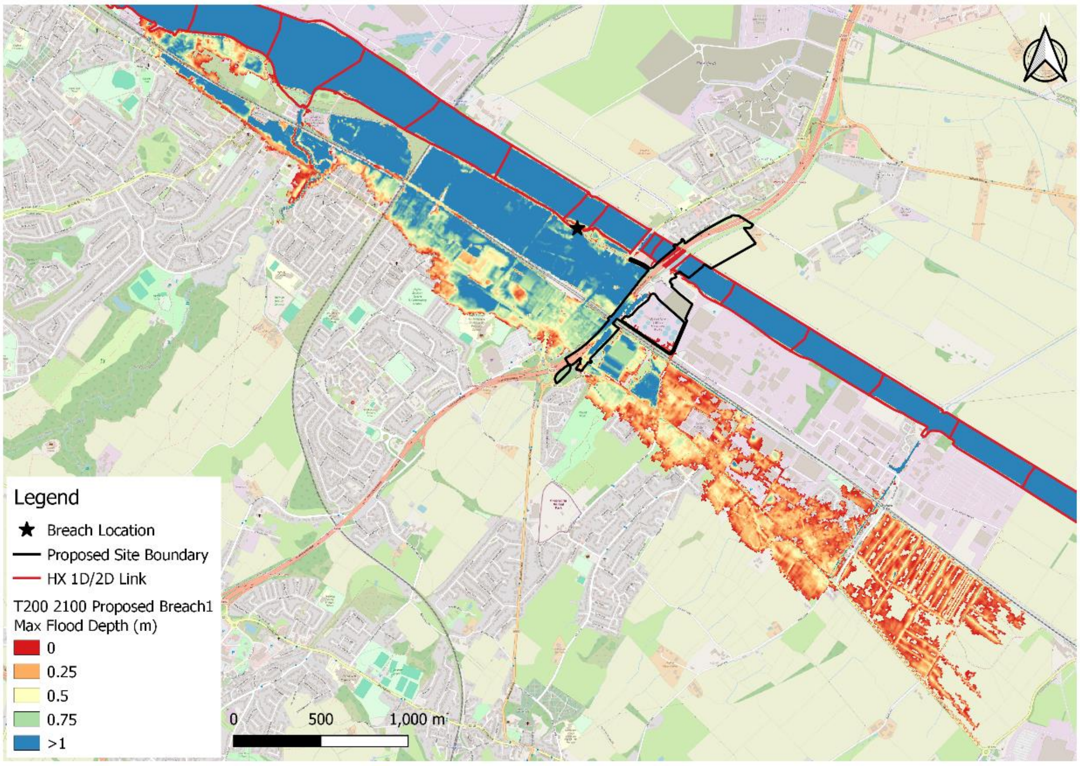
B.3 Tidal Breach (No Mitigations)

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

B.3.1 Tidal Breach One

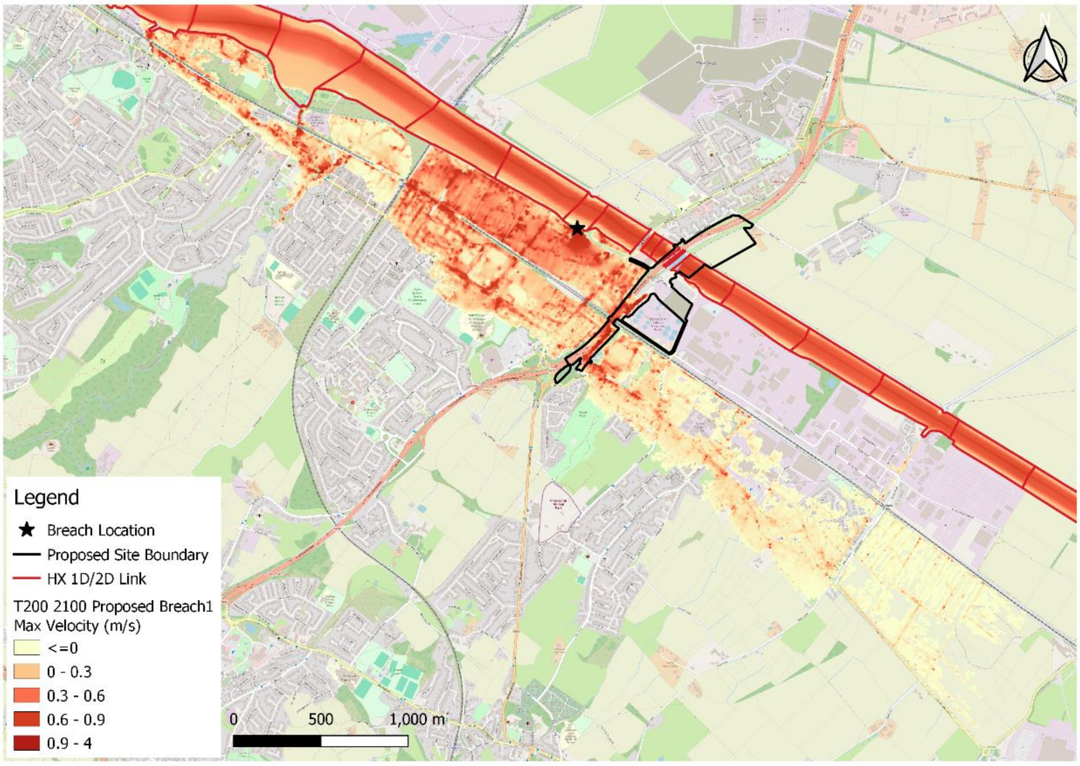
Figure B.6 to Figure B.11 show the predicted flood extent, depth and velocities caused by Tidal Breach One under the post-development scenario as well as the flood extent and depth of the 20m sensitivity breach scenario. Tidal Breach One poses a significant flood risk to the Shotton, Queensferry, Pentre 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 B.6: 0.5% AEP 2100 Tidal Breach One Flood Depth



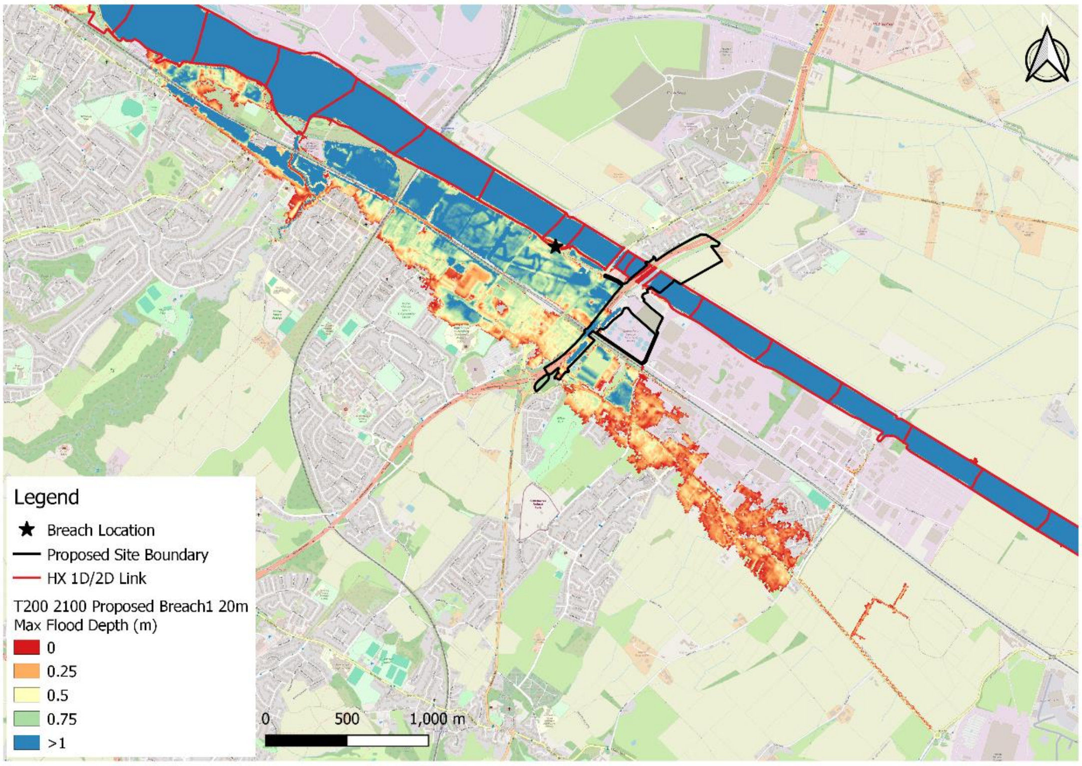
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.7: 0.5% AEP 2100 Tidal Breach One Flood Velocity



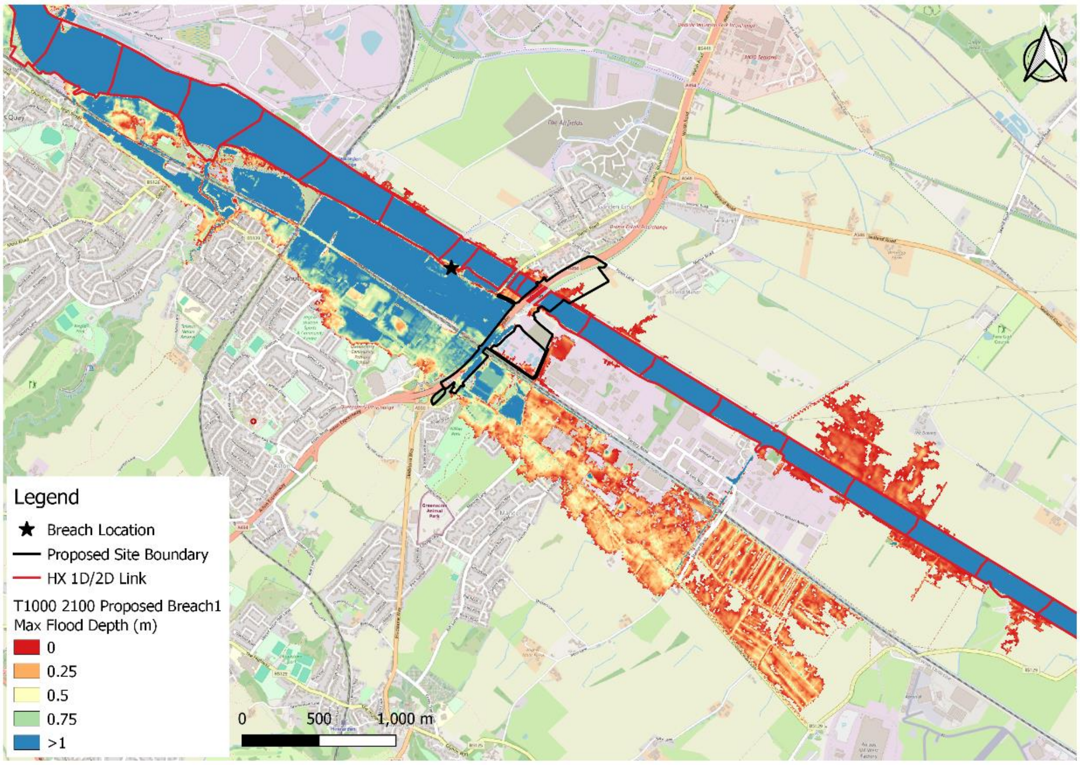
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.8: 0.5% AEP 2100 Tidal Breach One 20m Flood Depth



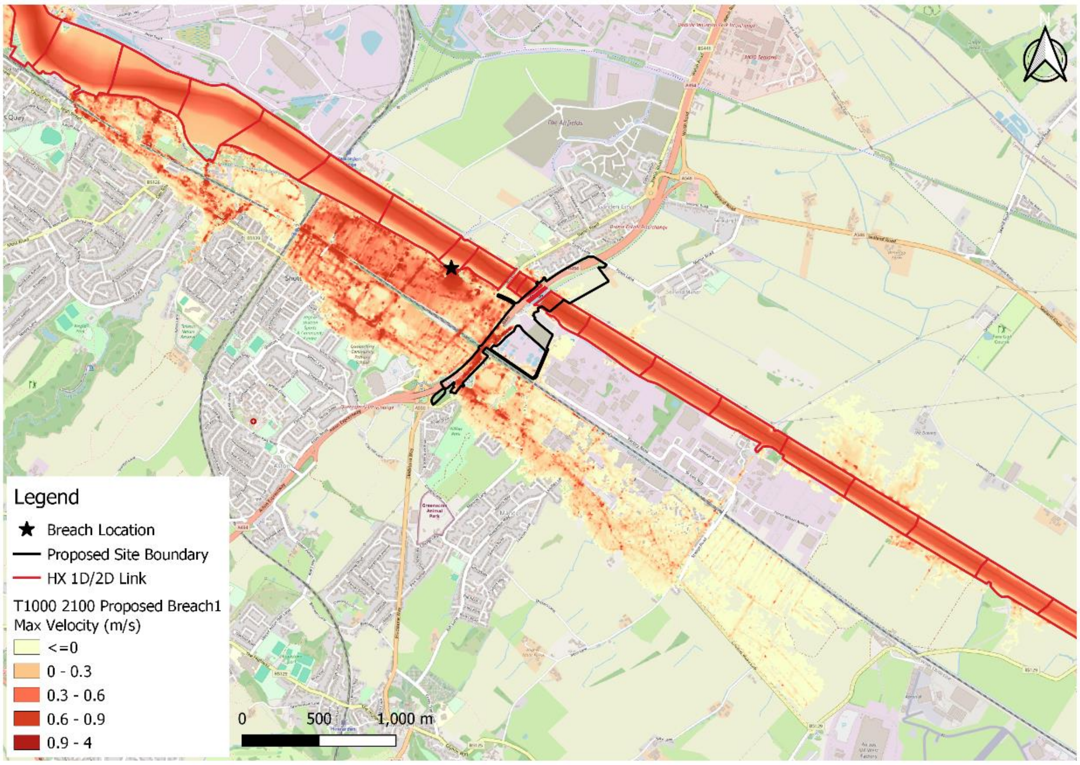
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.9: 0.1% AEP 2100 Tidal Breach One Flood Depth



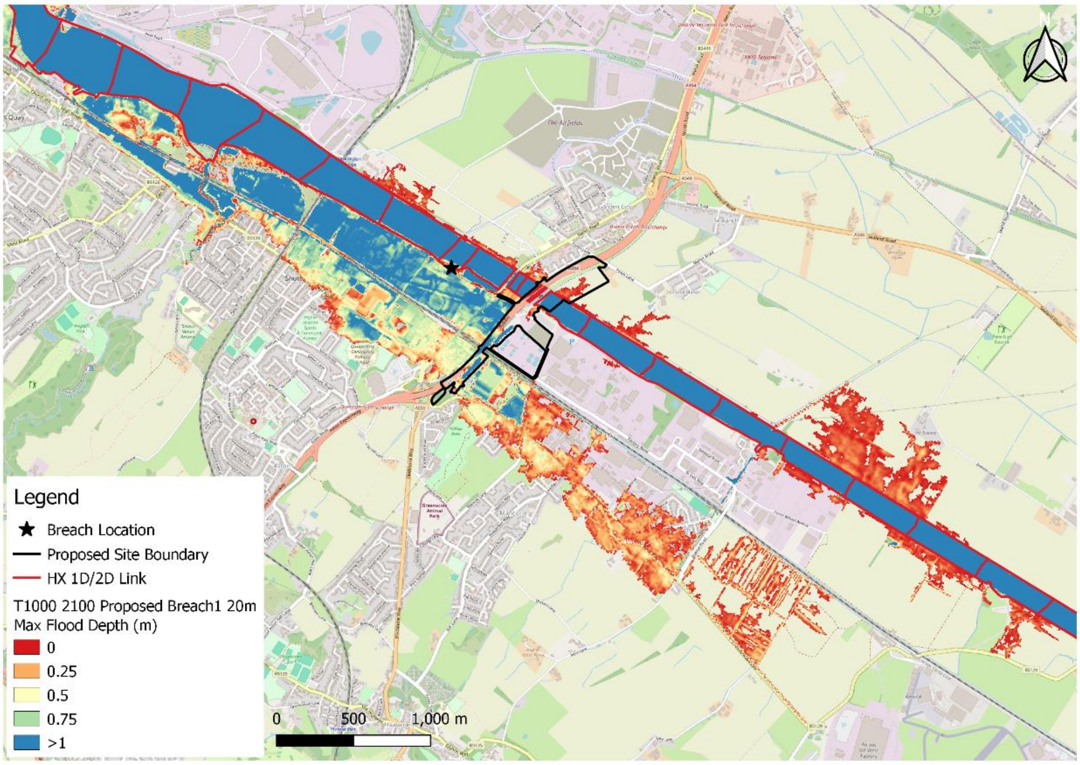
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.10: 0.1% AEP 2100 Tidal Breach One Flood Velocity



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

Figure B.11: 0.1% AEP 2100 Tidal Breach One 20m Flood Depth



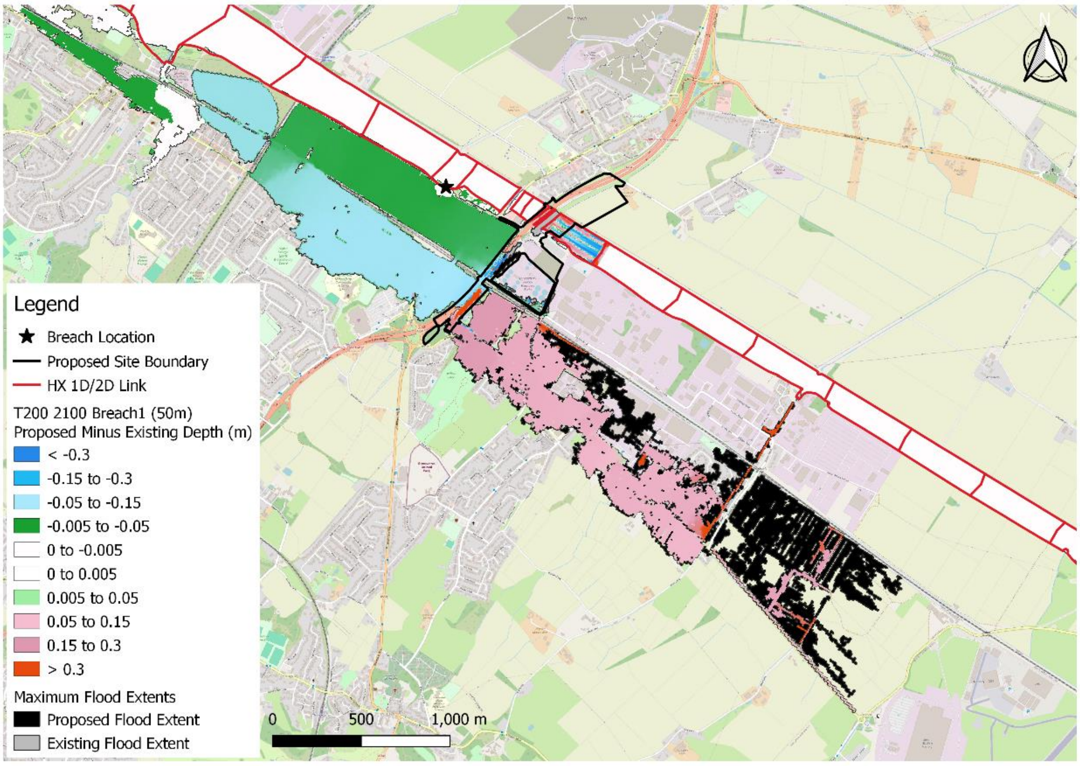
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

B.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 B.12 and Figure B.13. 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.

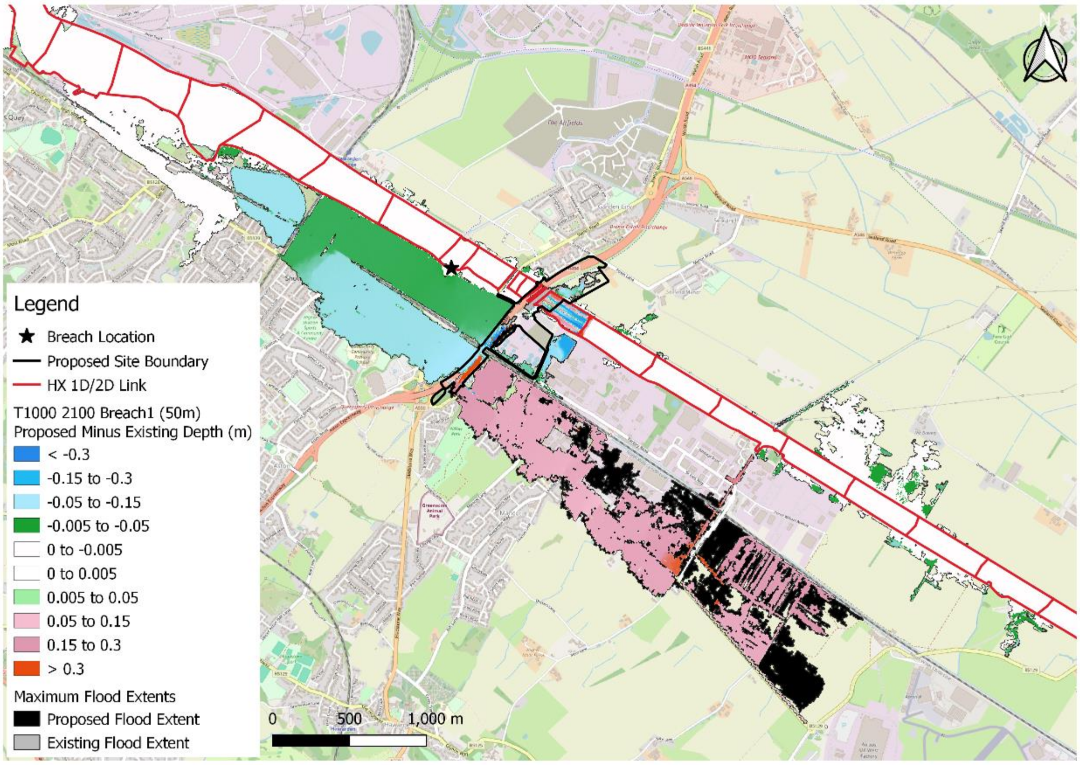
Figure B.14 and Figure B.15 detail the results of the Tidal Breach One 20m sensitivity runs. There are similar patterns of flood risk compared to the 50m breach scenarios with areas to the south of Shotton predicted to have reduced flood levels whilst area to the southeast of the development indicates an increase in water levels. Areas close to the breach appear to have similar flood levels to the Existing scenario.

Figure B.12: 0.5% AEP 2100 Tidal Breach One Flood Depth Difference



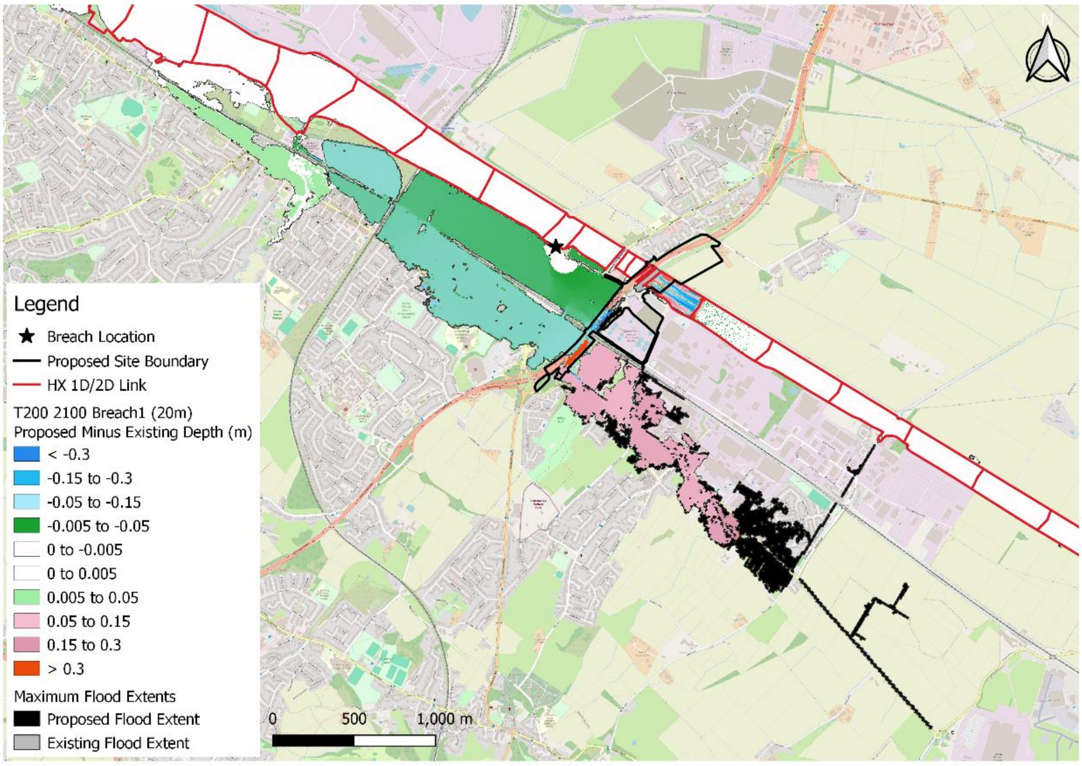
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.13: 0.1% AEP 2100 Tidal Breach One Flood Depth Difference



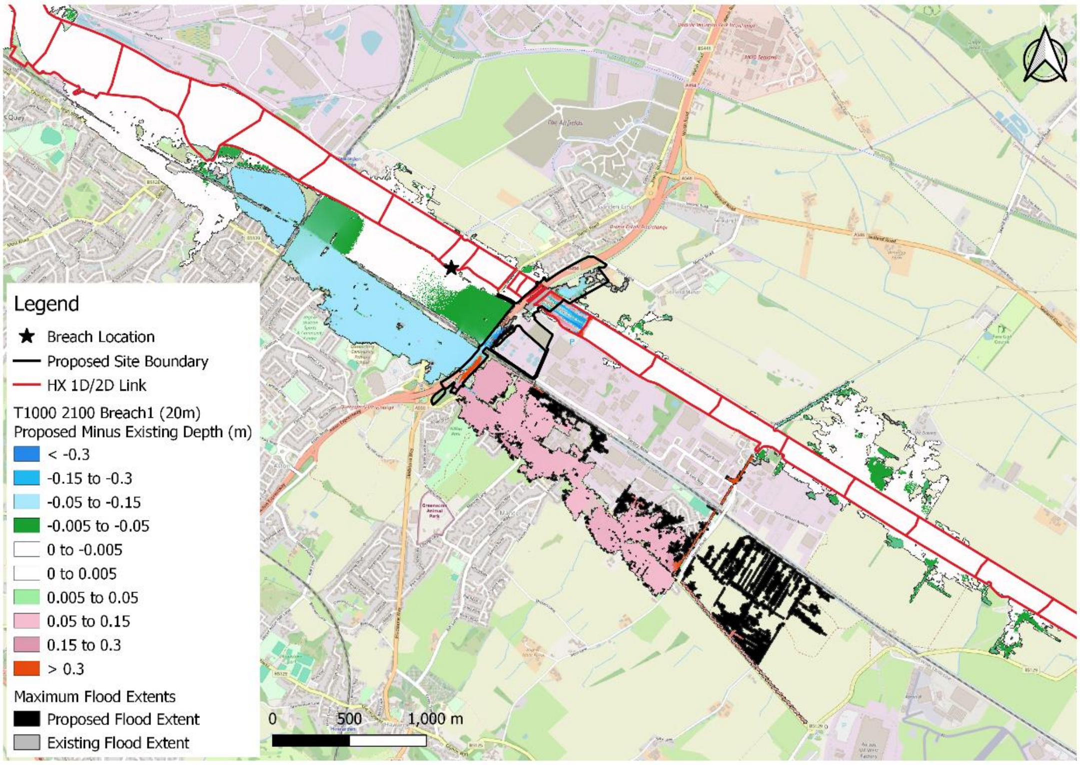
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.14: 0.5% AEP 2100 Tidal Breach One 20m Flood Depth Difference



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

Figure B.15: 0.1% AEP 2100 Tidal Breach One 20m Flood Depth Difference

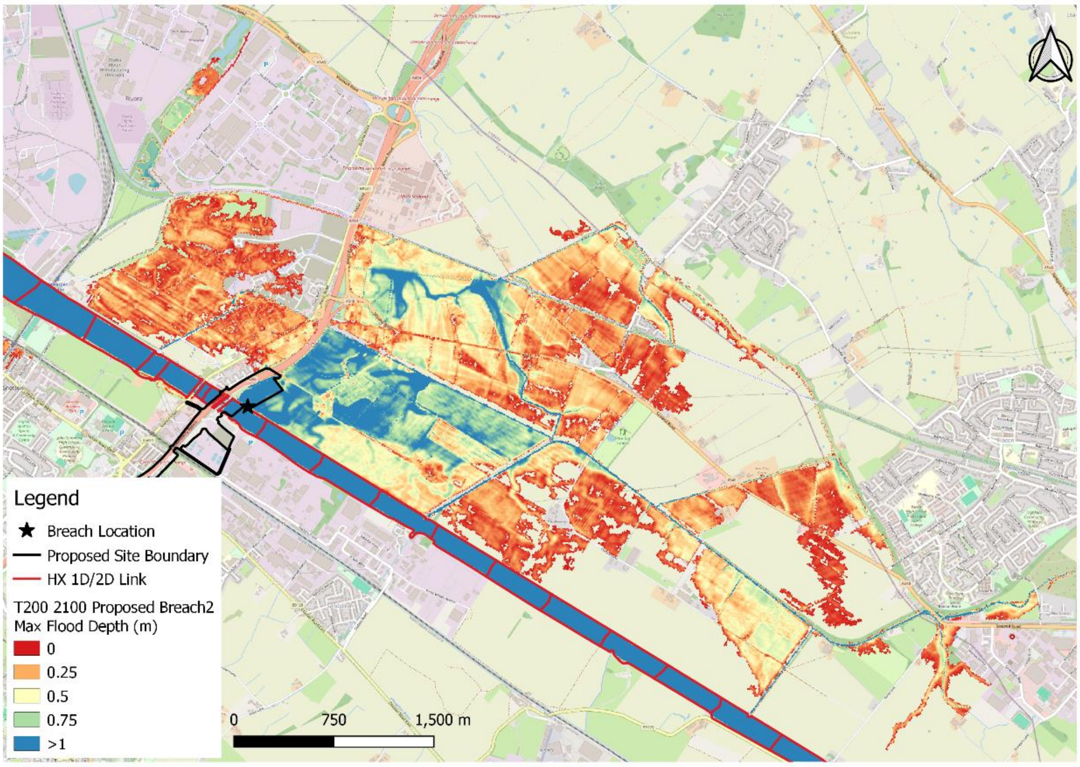


Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

B.3.2 Tidal Breach Two

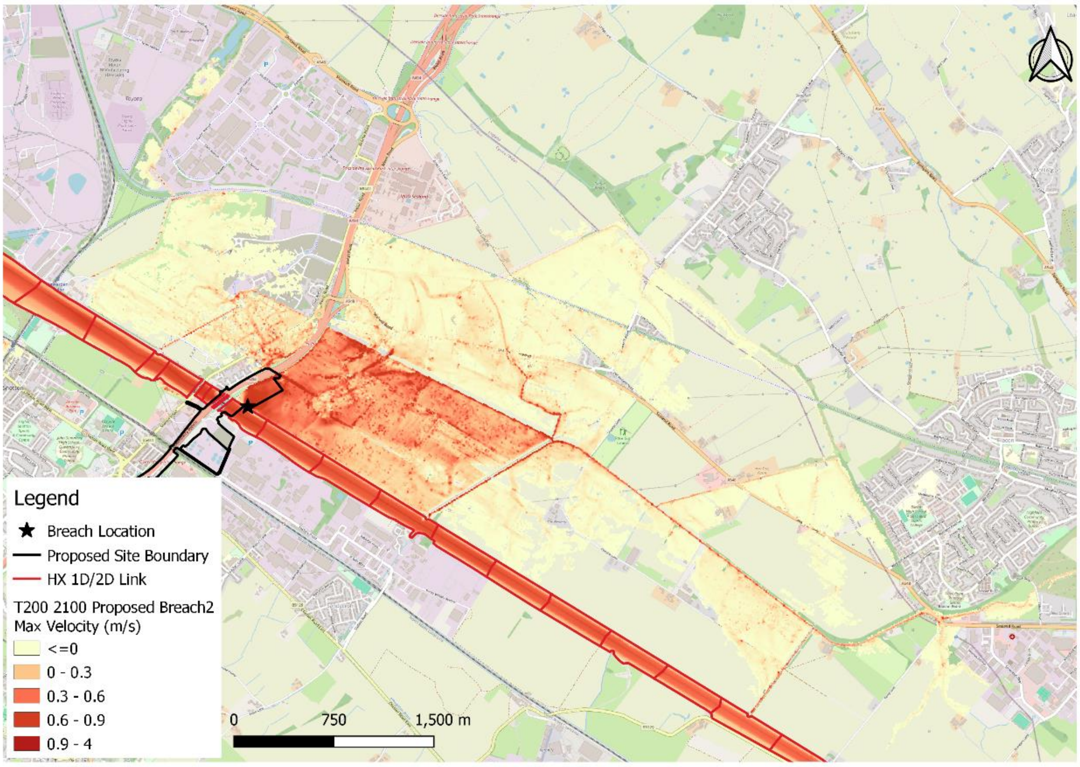
Figure B.16 to Figure B.21 show the predicted flood extent, depth and velocities caused by Tidal Breach Two under the post-development scenario as well as the flood extent and depth of the 20m sensitivity breach scenario. Flooding extents across residential areas of Garden City and Sealand as well as 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 B.16: 0.5% AEP 2100 Tidal Breach Two Flood Depth



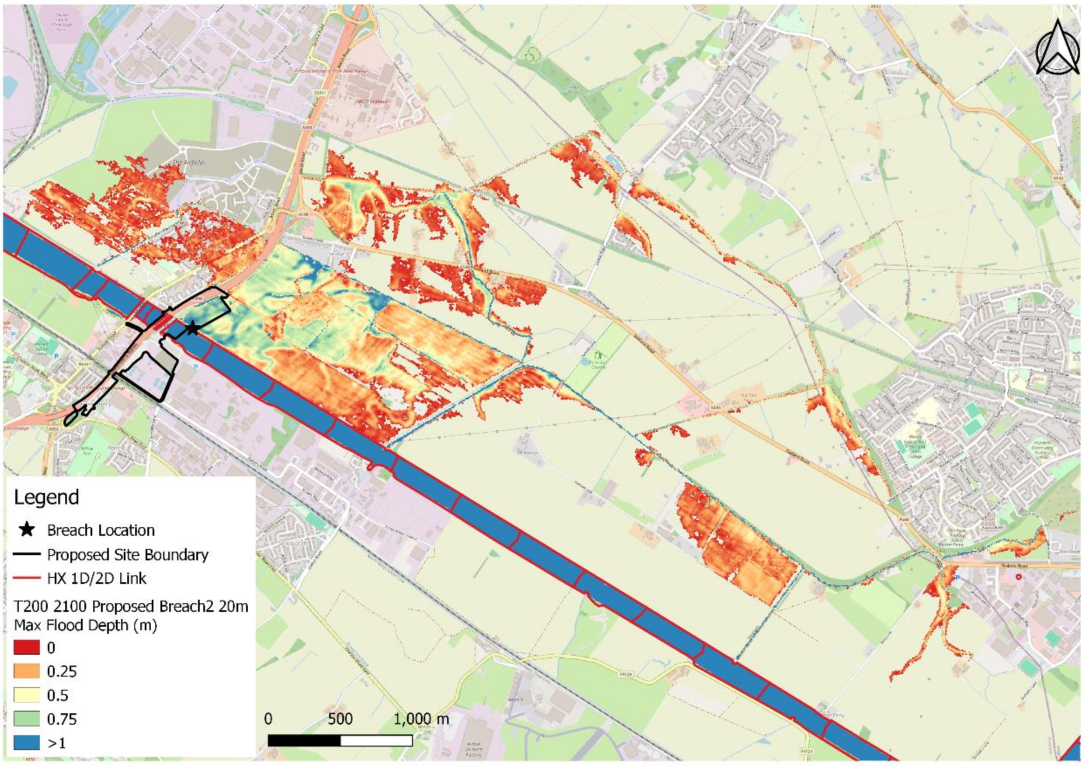
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.17: 0.5% AEP 2100 Tidal Breach Two Flood Velocity



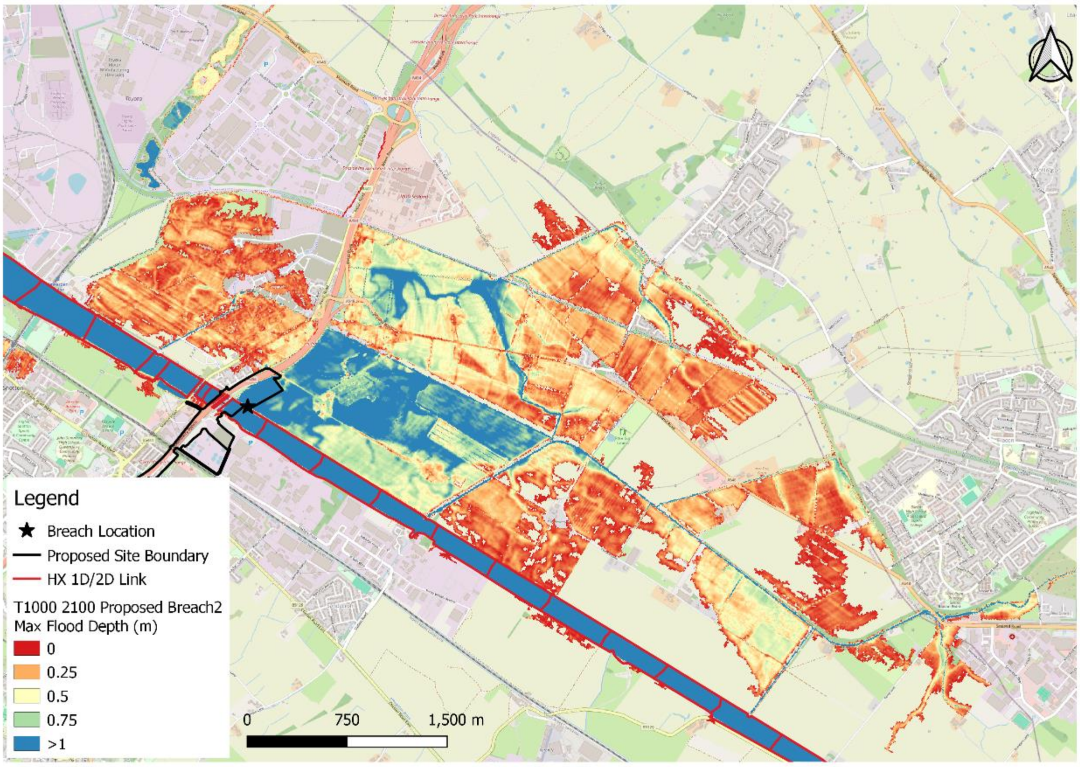
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.18: 0.5% AEP 2100 Tidal Breach Two 20m Flood Depth



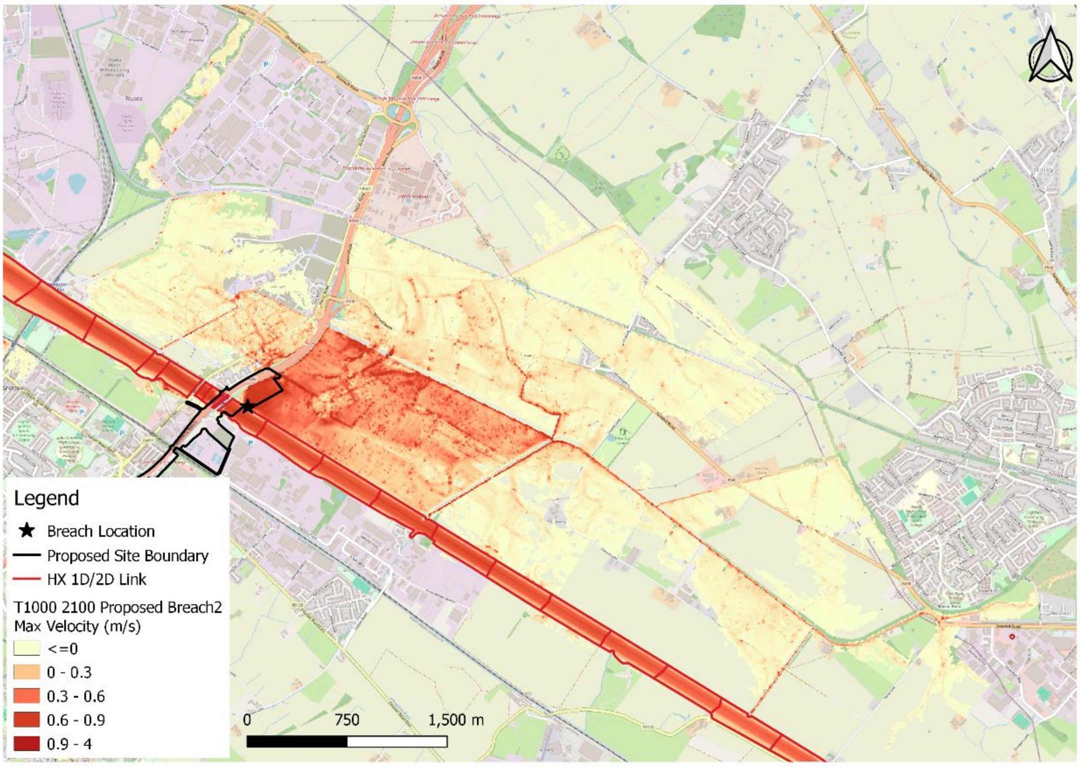
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.19: 0.1% AEP 2100 Tidal Breach Two Flood Depth



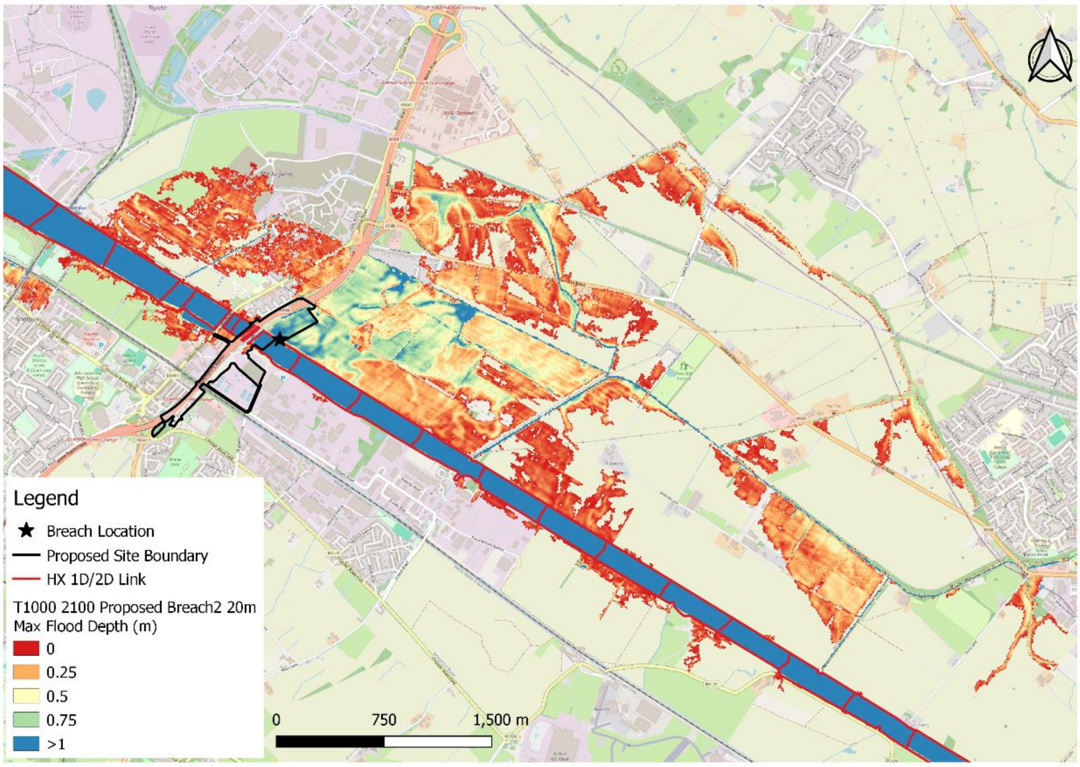
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.20: 0.1% AEP 2100 Tidal Breach Two Flood Velocity



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

Figure B.21: 0.1% AEP 2100 Tidal Breach Two 20m Flood Depth



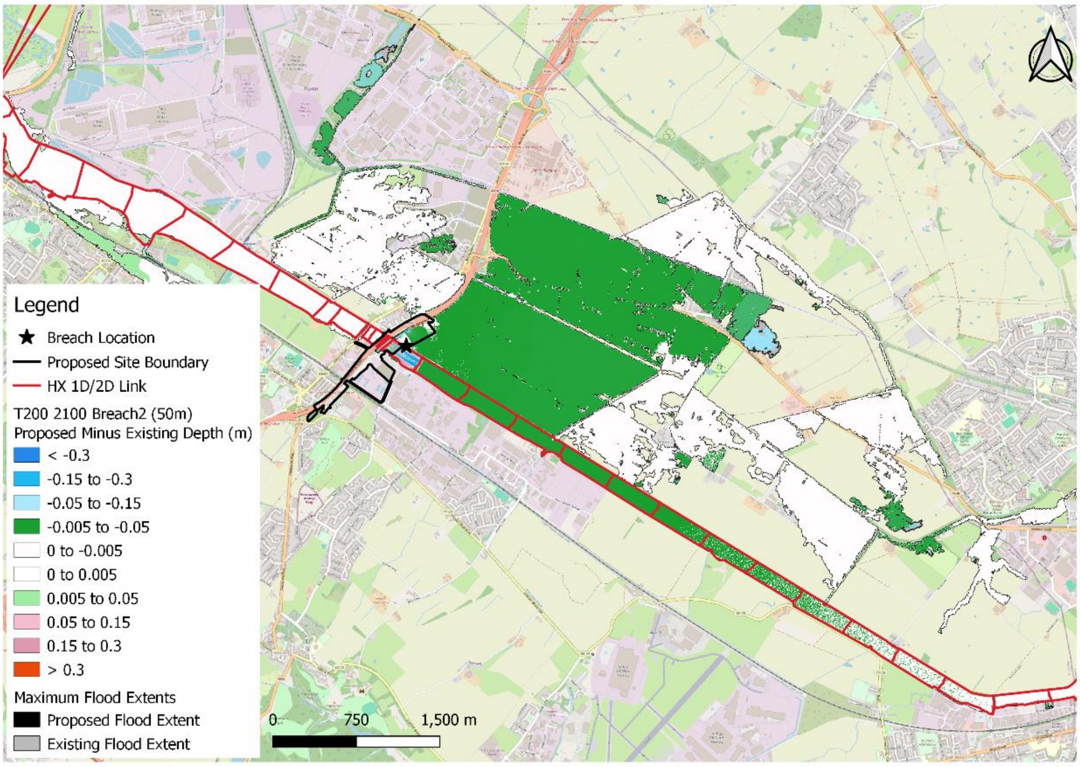
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

B.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 B.22 and Figure B.23. 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 some minor reductions in flood depth in the rural areas of the River Dee floodplain for the post-development scenario model. An average reduction of 0.008m.

Figure B.24 and Figure B.25 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 B.22: 0.5% AEP 2100 Tidal Breach Two Flood Depth Difference



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

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

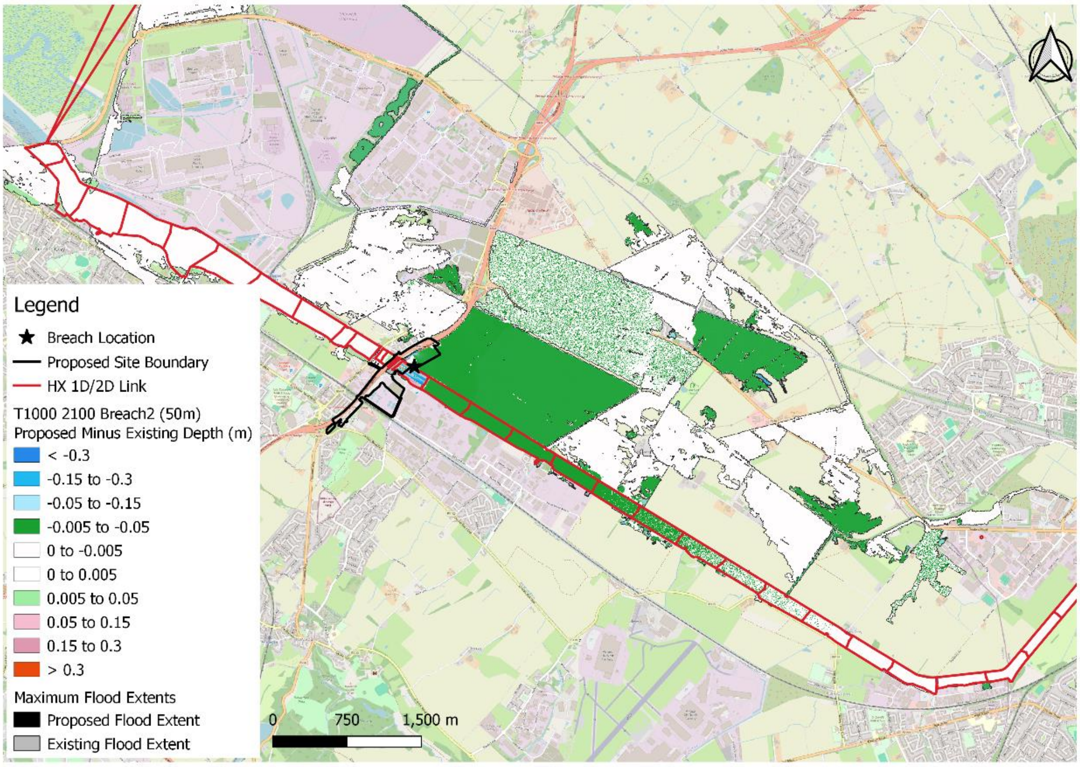


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Figure B.24: 0.5% AEP 2100 Tidal Breach Two 20m Flood Depth Difference

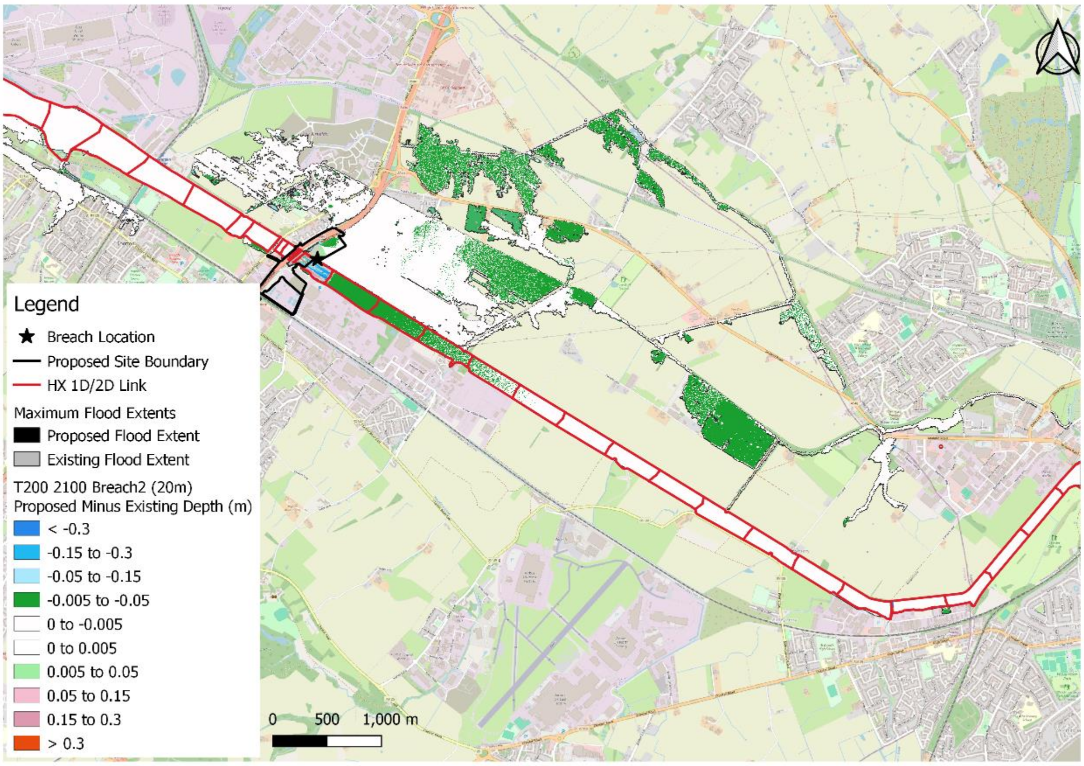

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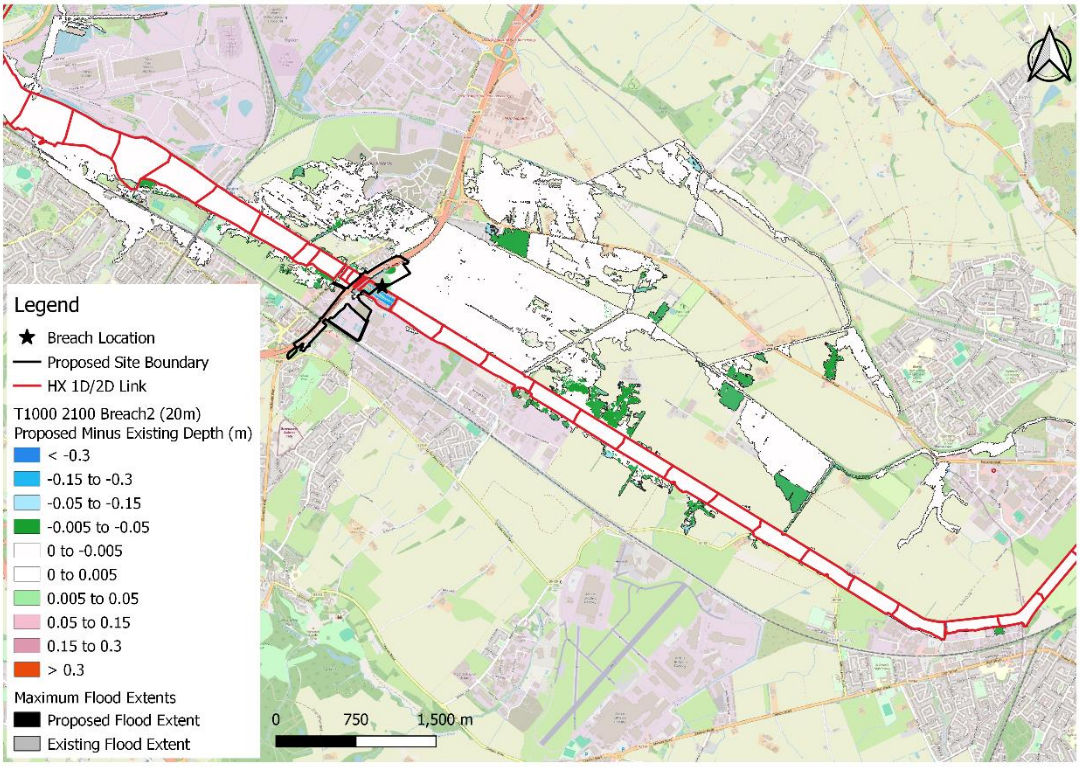
Figure B.25: 0.1% AEP 2100 Tidal Breach Two 20m Flood Depth Difference



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B.3.3 Tidal Breach Three

Figure B.26 to Figure B.31 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 B.26: 0.5% AEP 2100 Tidal Breach Three Flood Depth

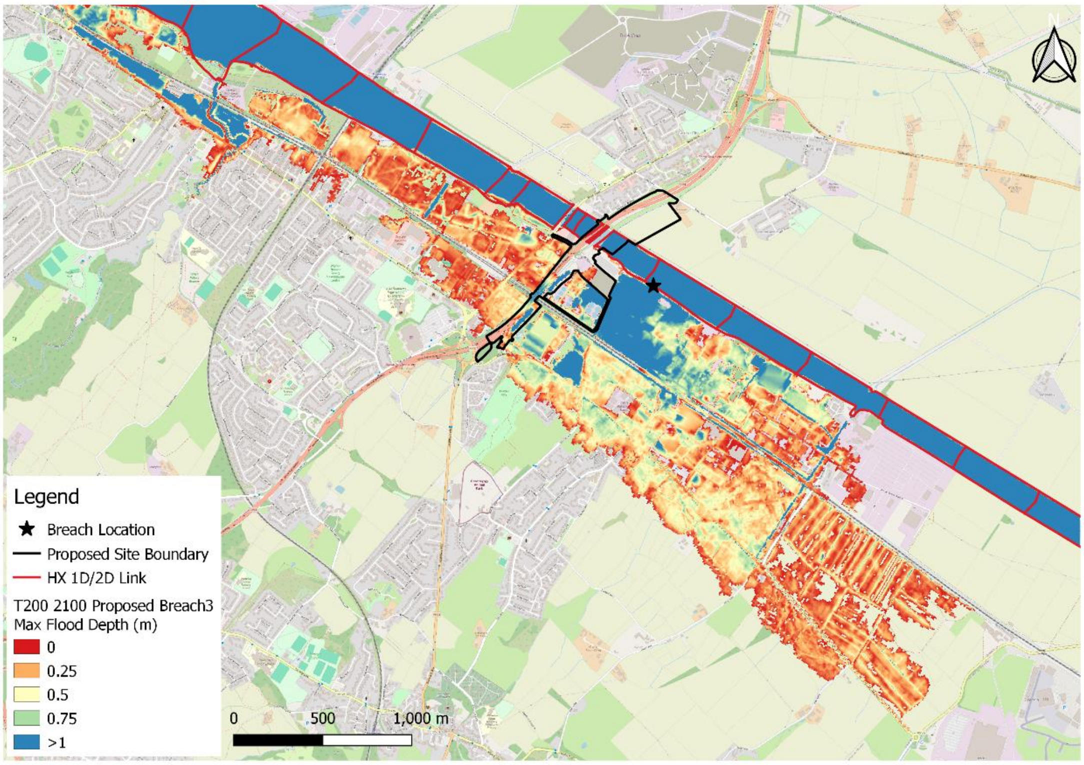

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Figure B.27: 0.5% AEP 2100 Tidal Breach Three Flood Velocity

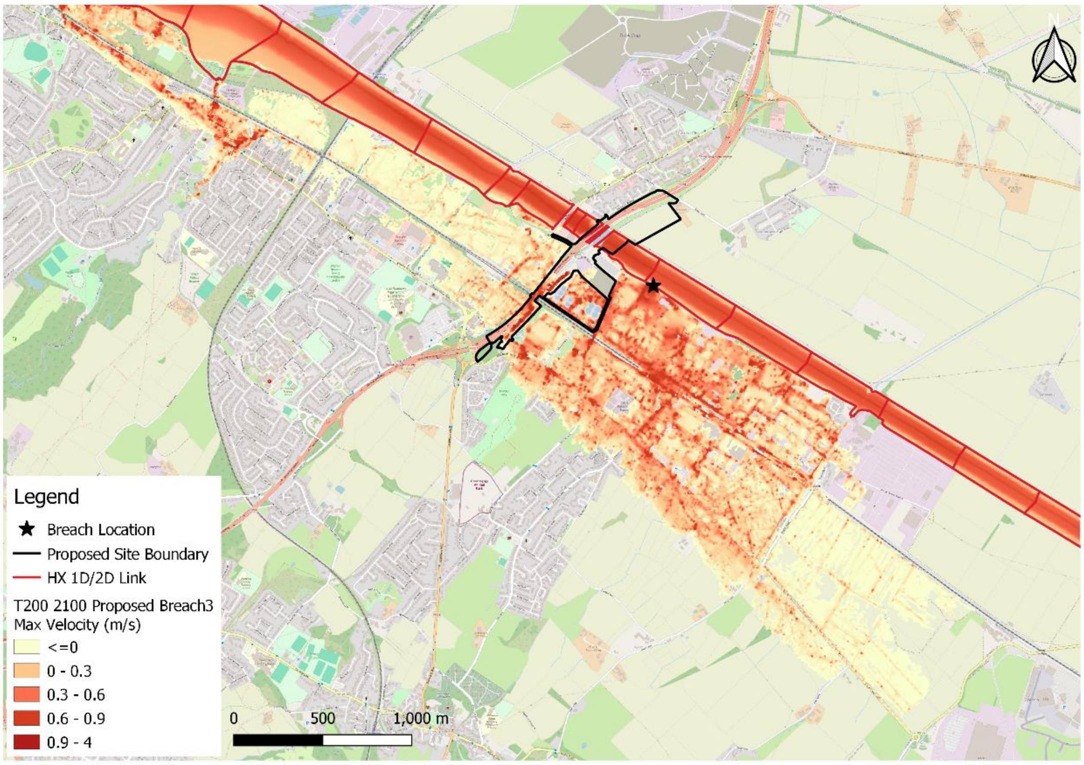

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Figure B.28: 0.5% AEP 2100 Tidal Breach Three 20m Flood Depth

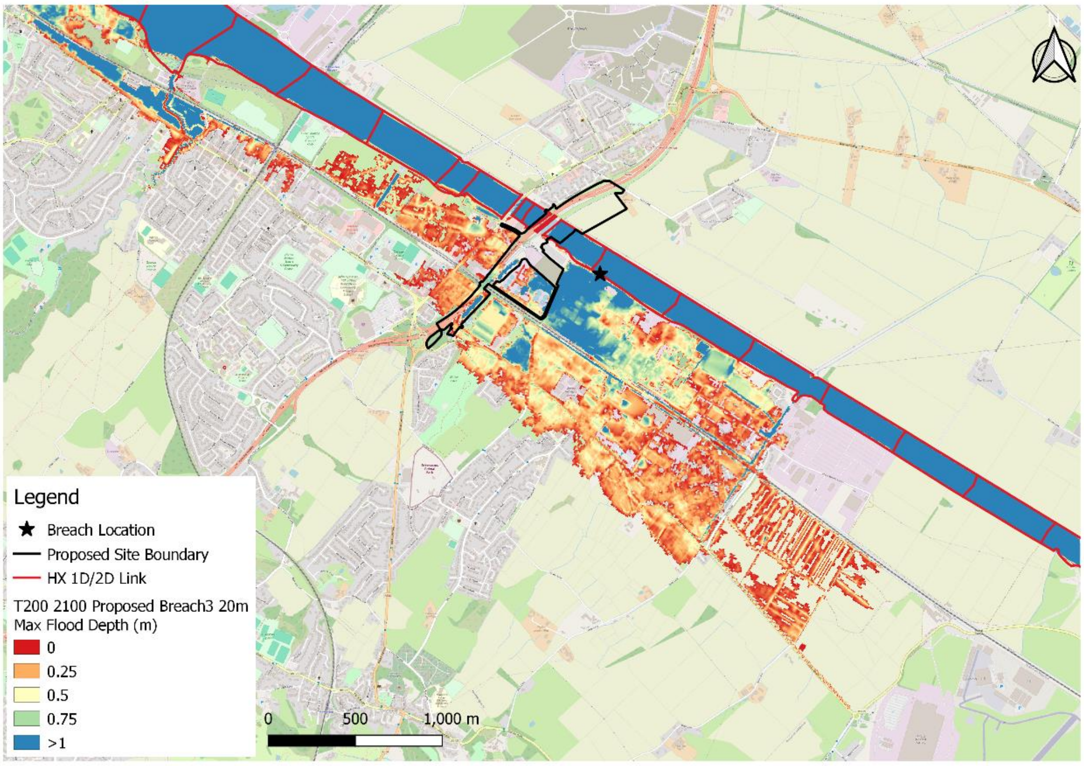

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Figure B.29: 0.1% AEP 2100 Tidal Breach Three Flood Depth

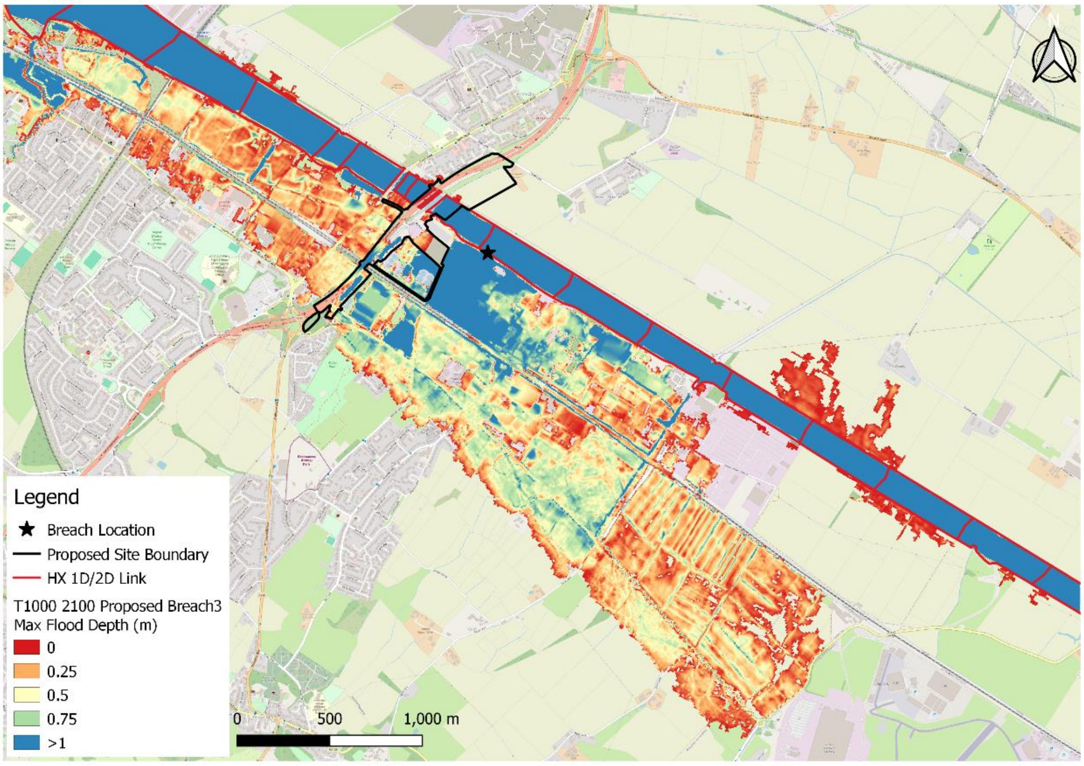

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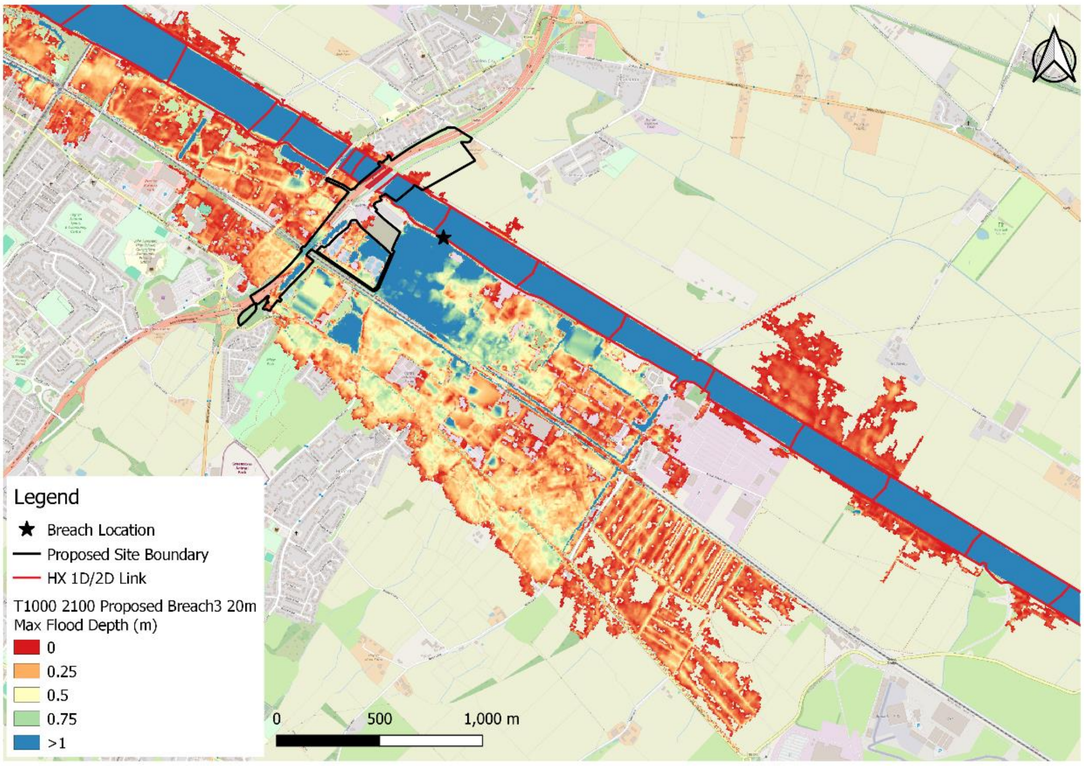
Figure B.30: 0.1% AEP 2100 Tidal Breach Three Flood Velocity

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

Figure B.31: 0.1% AEP 2100 Tidal Breach Three 20m Flood Depth



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B.3.3.1 Comparison Against Existing Scenario

Depth differences from Tidal Breach Three for the Proposed and the Existing scenario are detailed in Figure B.32 and Figure B.33. 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 B.34 and Figure B.35 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 B.32: 0.5% AEP 2100 Tidal Breach Three Flood Depth Difference

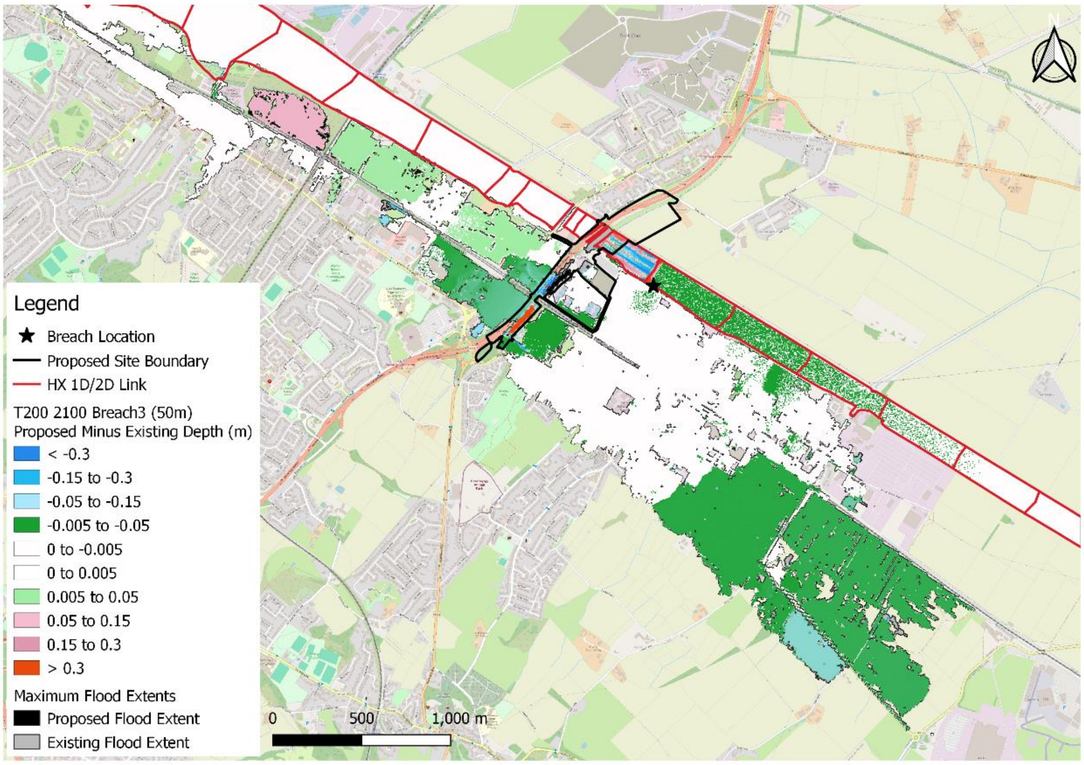

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Figure B.33: 0.1% AEP 2100 Tidal Breach Three Flood Depth Difference

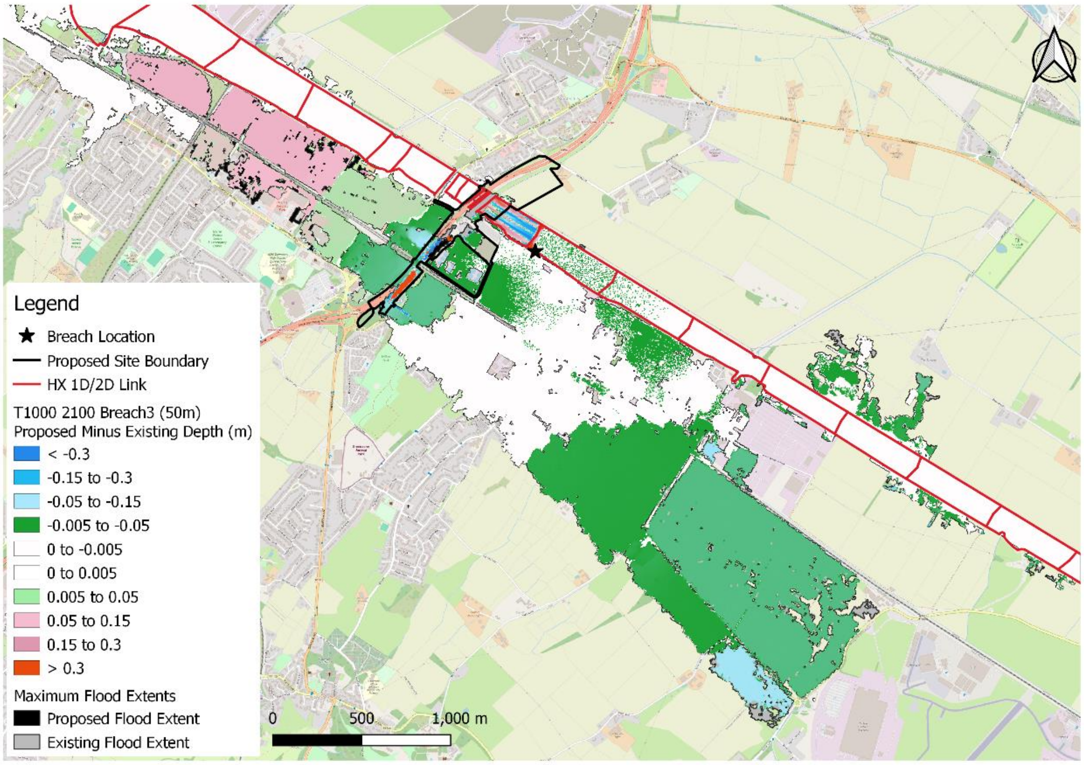

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Figure B.34: 0.5% AEP 2100 Tidal Breach Three 20m Flood Depth Difference

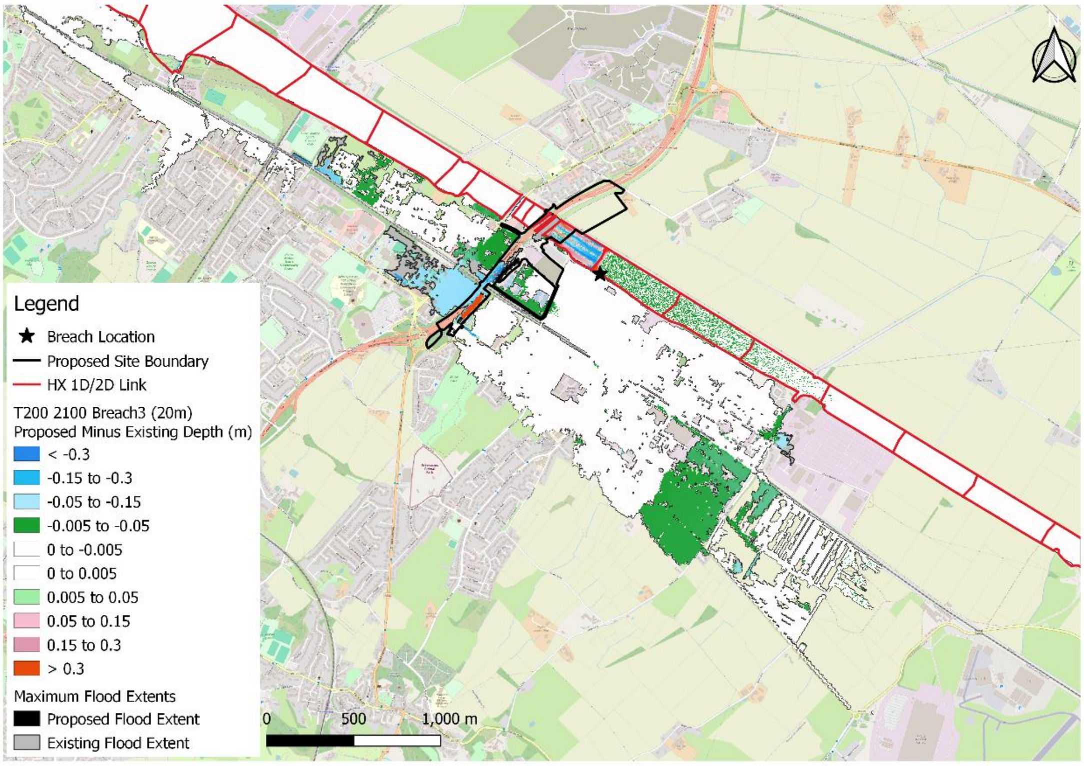

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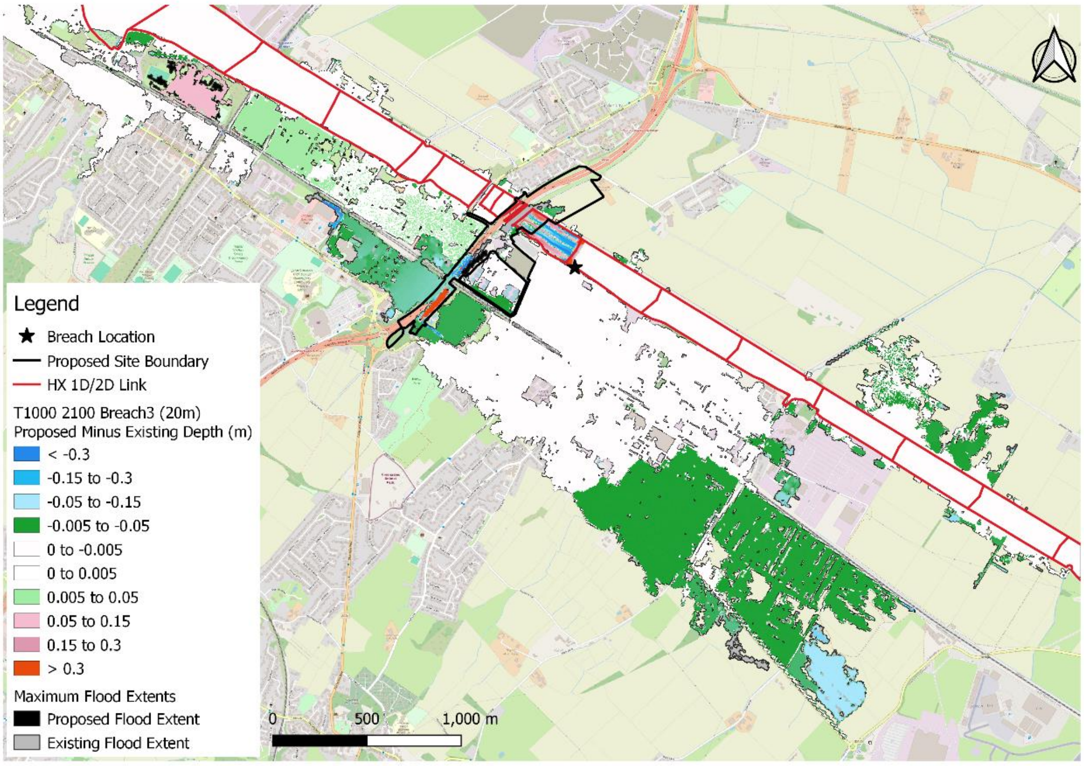
Figure B.35: 0.1% AEP 2100 Tidal Breach Three 20m Flood Depth Difference



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B.3.4 Tidal Breach Four

Figure B.36 to Figure B.41 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 B.36: 0.5% AEP 2100 Tidal Breach Four Flood Depth

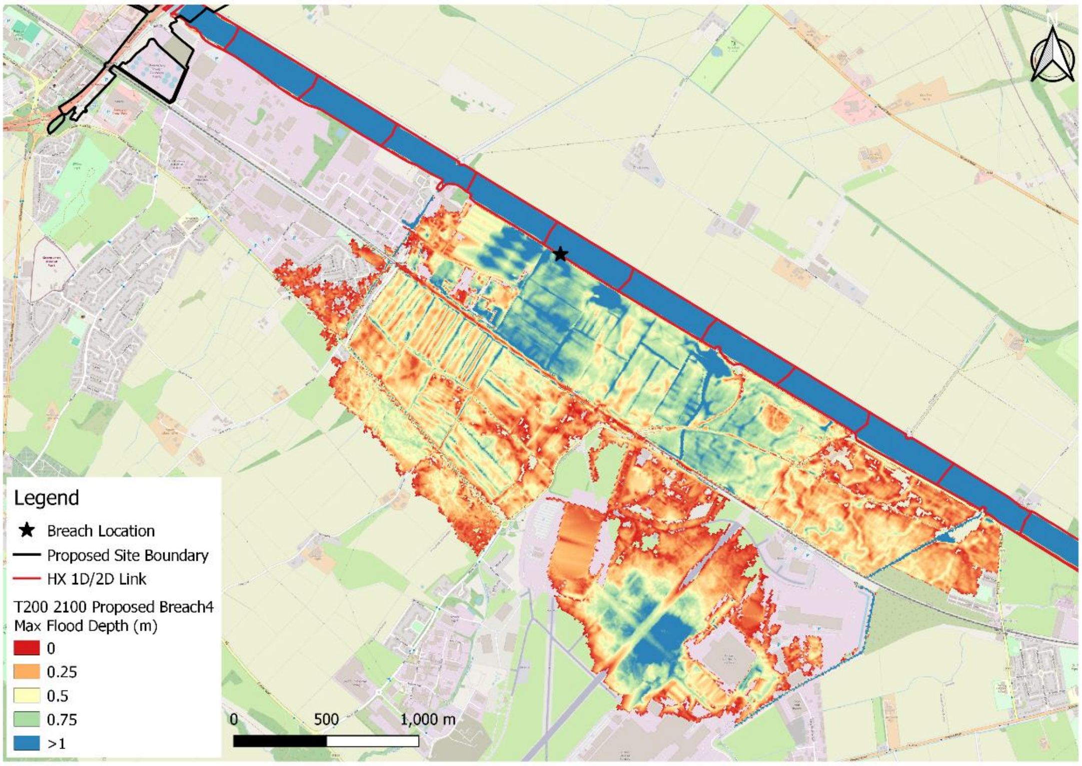

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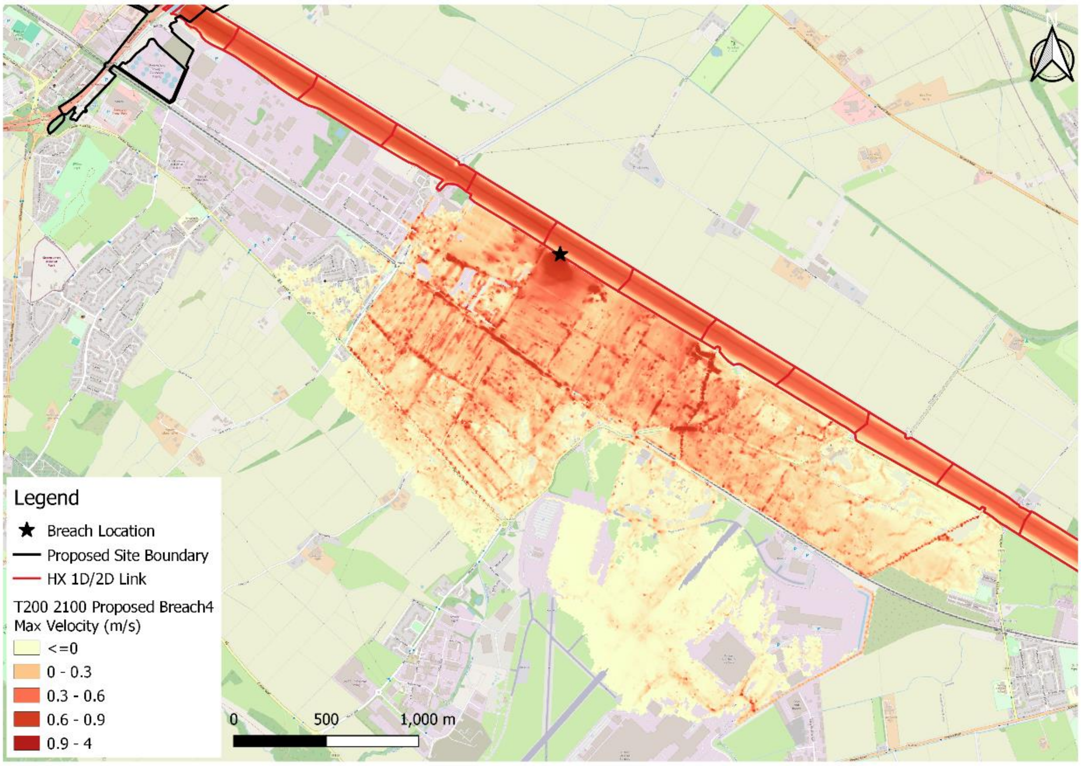
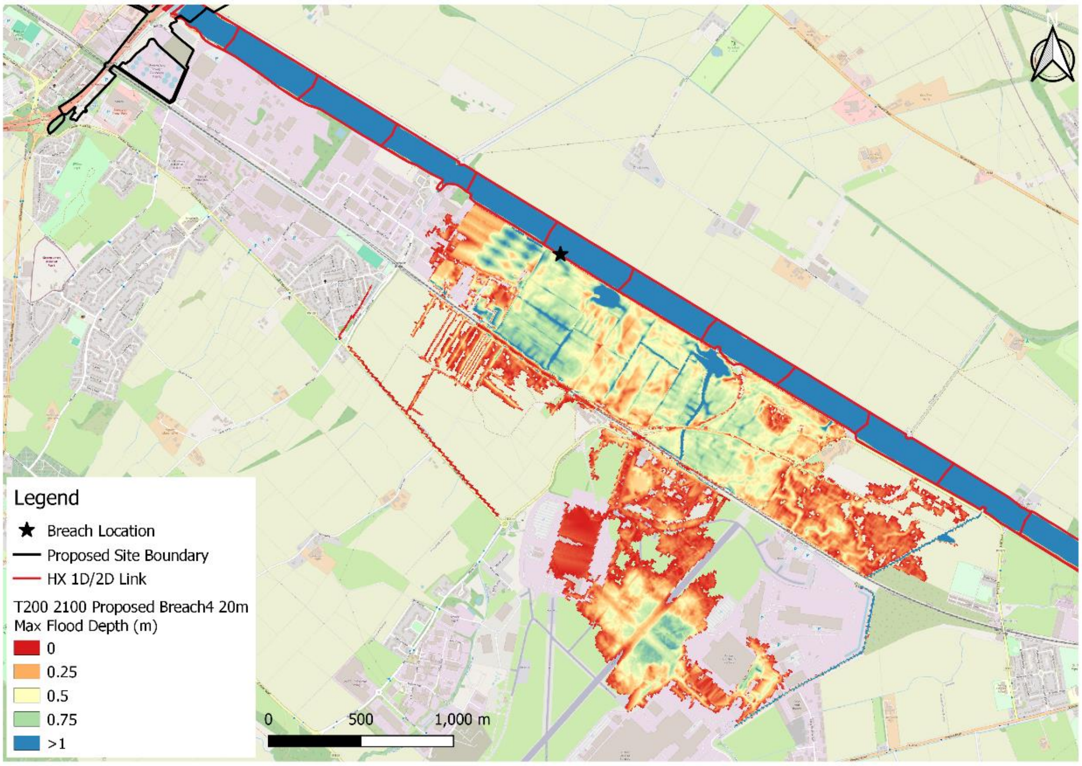
Figure B.37: 0.5% AEP 2100 Tidal Breach Four Flood Velocity



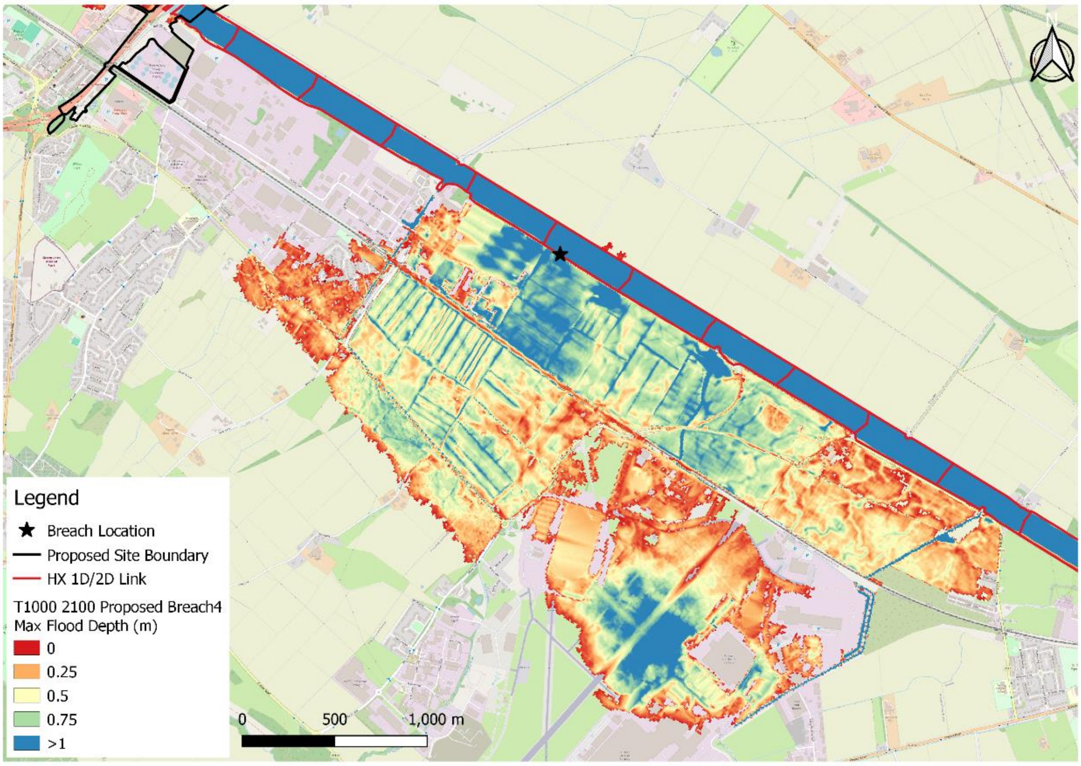
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.38: 0.5% AEP 2100 Tidal Breach Four 20m Flood Depth



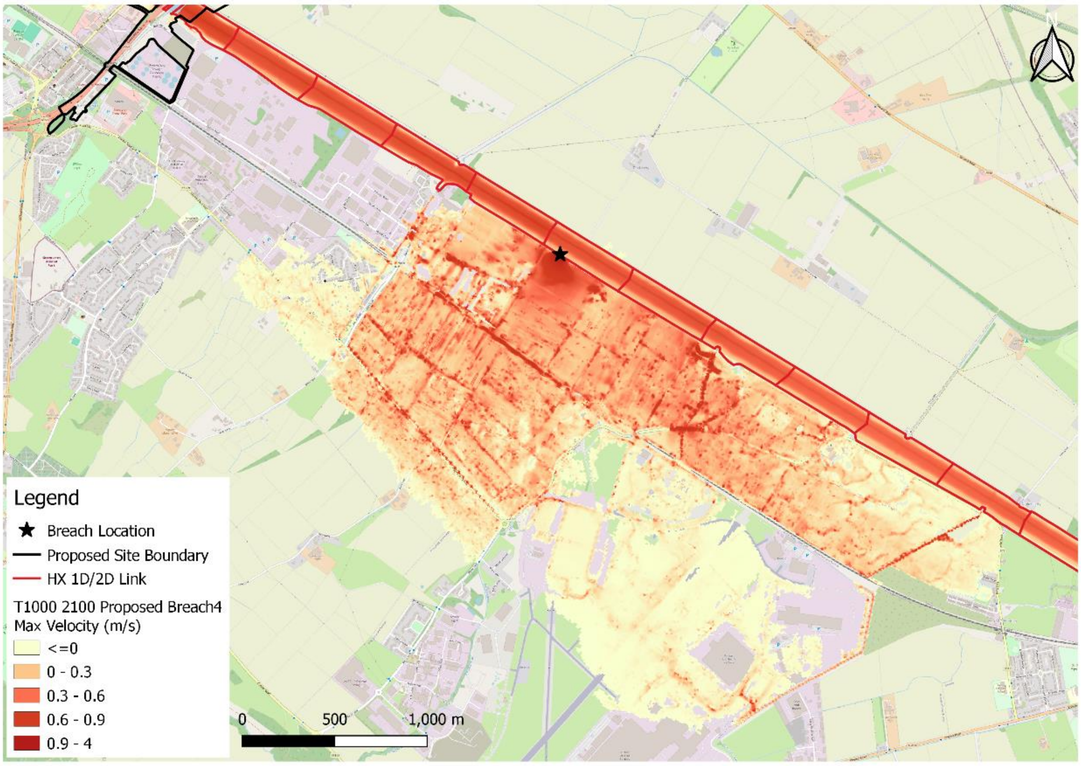
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.39: 0.1% AEP 2100 Tidal Breach Four Flood Depth



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

Figure B.40: 0.1% AEP 2100 Tidal Breach Four Flood Velocity



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

Figure B.41: 0.1% AEP 2100 Tidal Breach Four 20m Flood Depth

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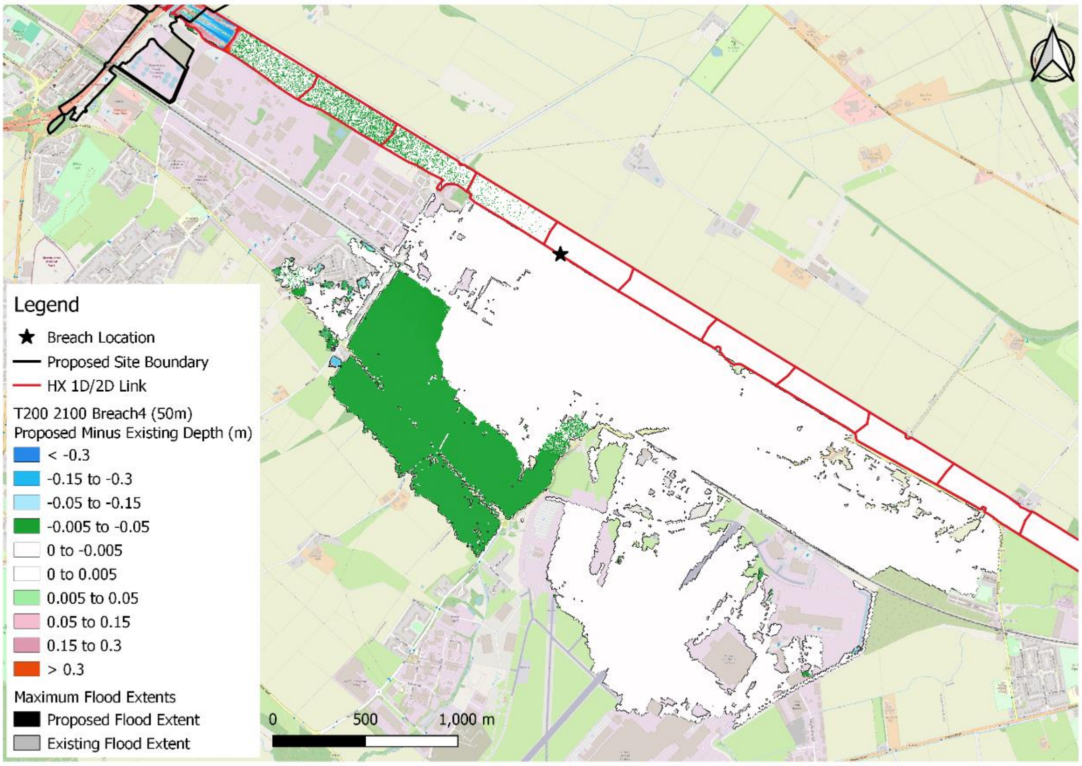
B.3.4.1 Comparison Against Existing Scenario

Depth differences from Tidal Breach Four for the Proposed and the Existing scenario are detailed in Figure B.42 and Figure B.43. 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 B.44 and Figure B.45 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 B.42: 0.5% AEP 2100 Tidal Breach Four Flood Depth Difference



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

Figure B.43: 0.1% AEP 2100 Tidal Breach Four Flood Depth Difference

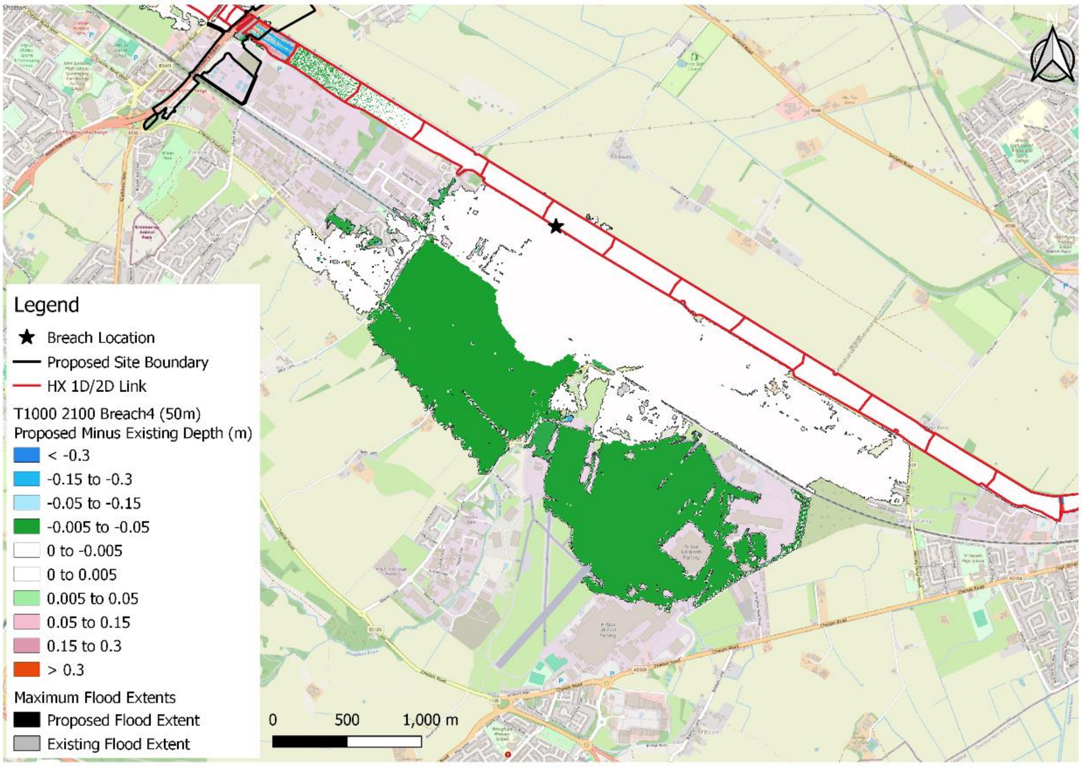


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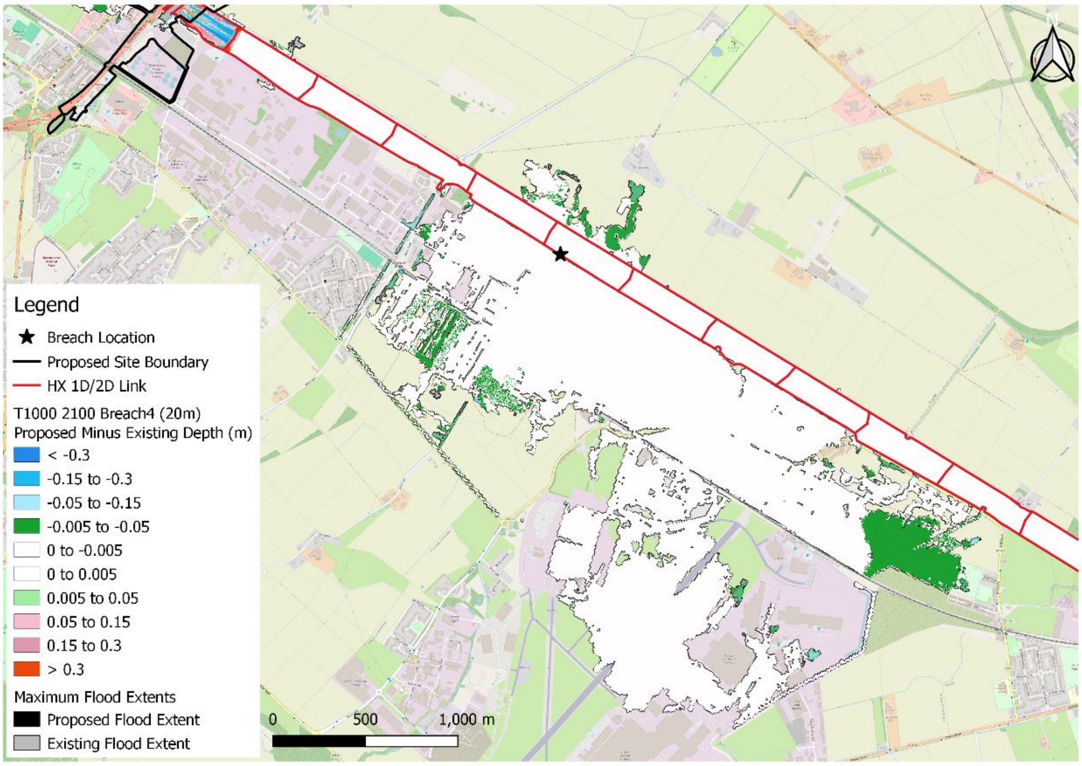
Figure B.44: 0.5% AEP 2100 Tidal Breach Four 20m Flood Depth Difference

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

Figure B.45: 0.1% AEP 2100 Tidal Breach Four 20m Flood Depth Difference



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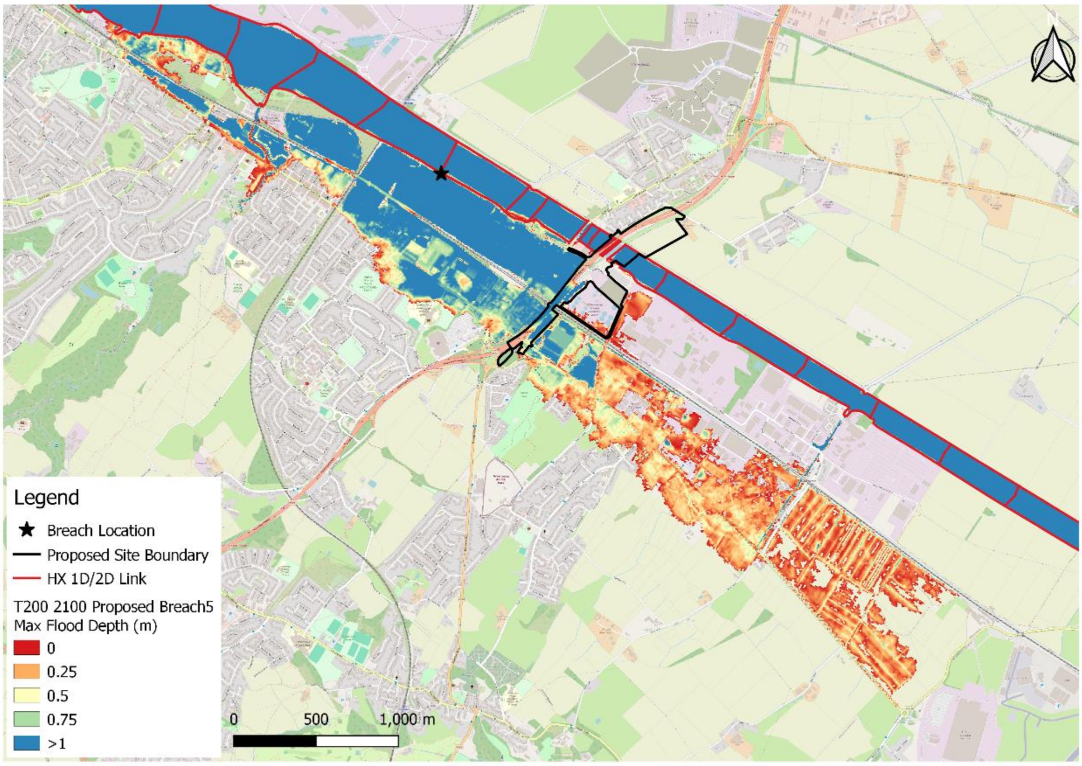
B.3.5 Tidal Breach Five

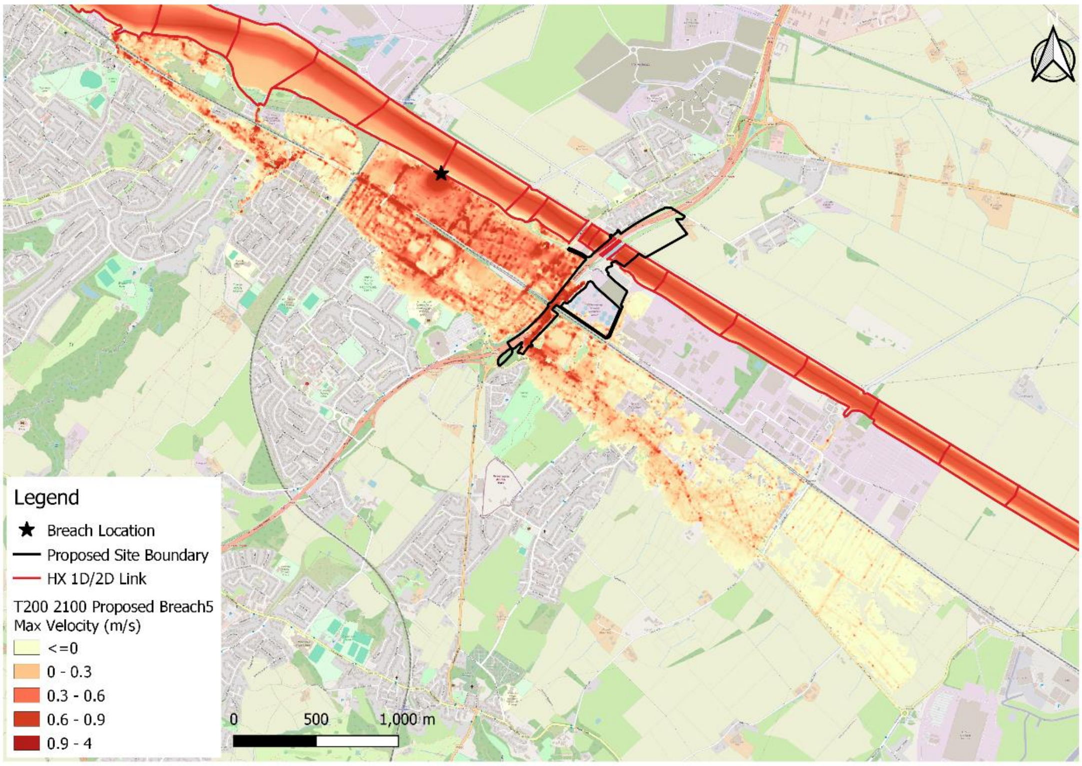
Figure B.46 to Figure B.51 show the predicted flood extent, depth and velocities caused by Tidal Breach Five under the post-development scenario as well as the flood extent and depth of the 20m sensitivity breach scenario. Tidal Breach Five causes significant flooding to the Shotton, Queensferry, Pentre 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 B.46: 0.5% AEP 2100 Tidal Breach Five Flood Depth



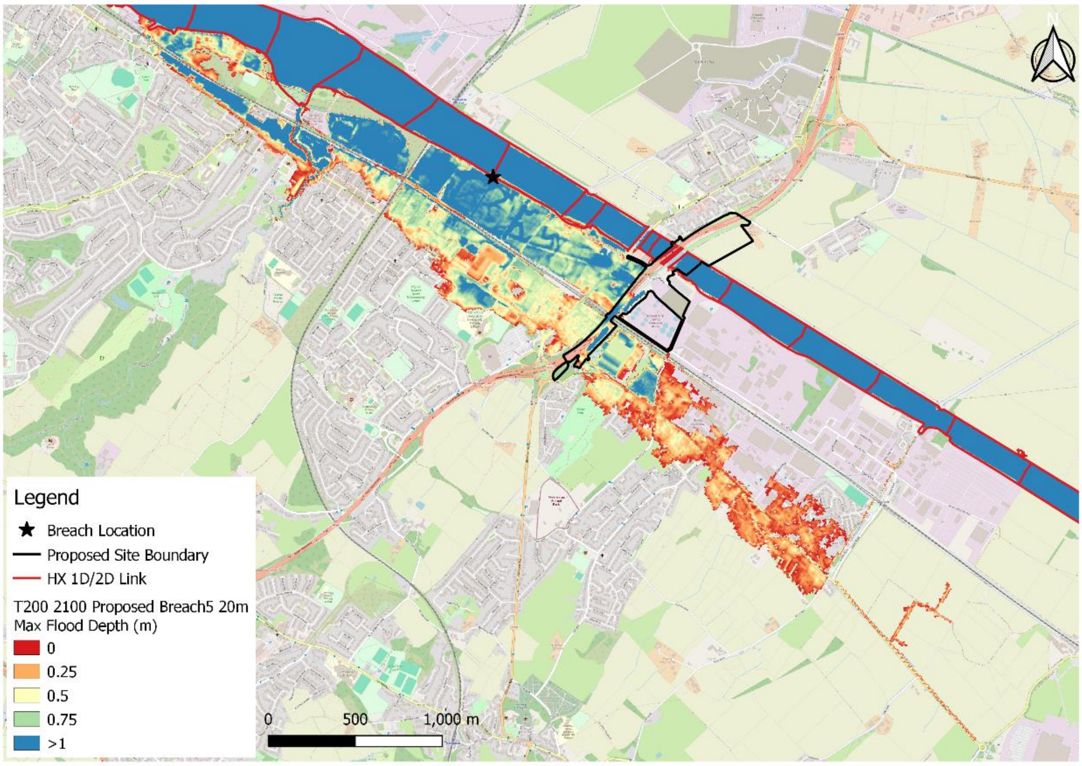
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.47: 0.5% AEP 2100 Tidal Breach Five Flood Velocity



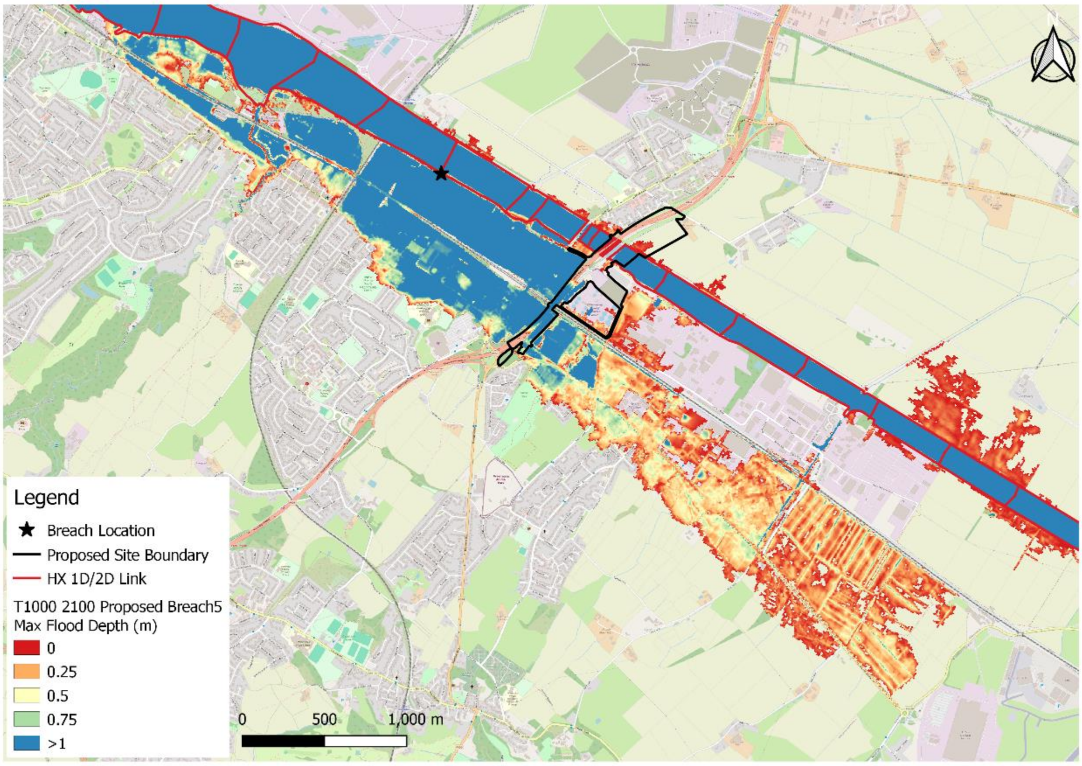
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.48: 0.5% AEP 2100 Tidal Breach Five 20m Flood Depth



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

Figure B.49: 0.1% AEP 2100 Tidal Breach Five Flood Depth

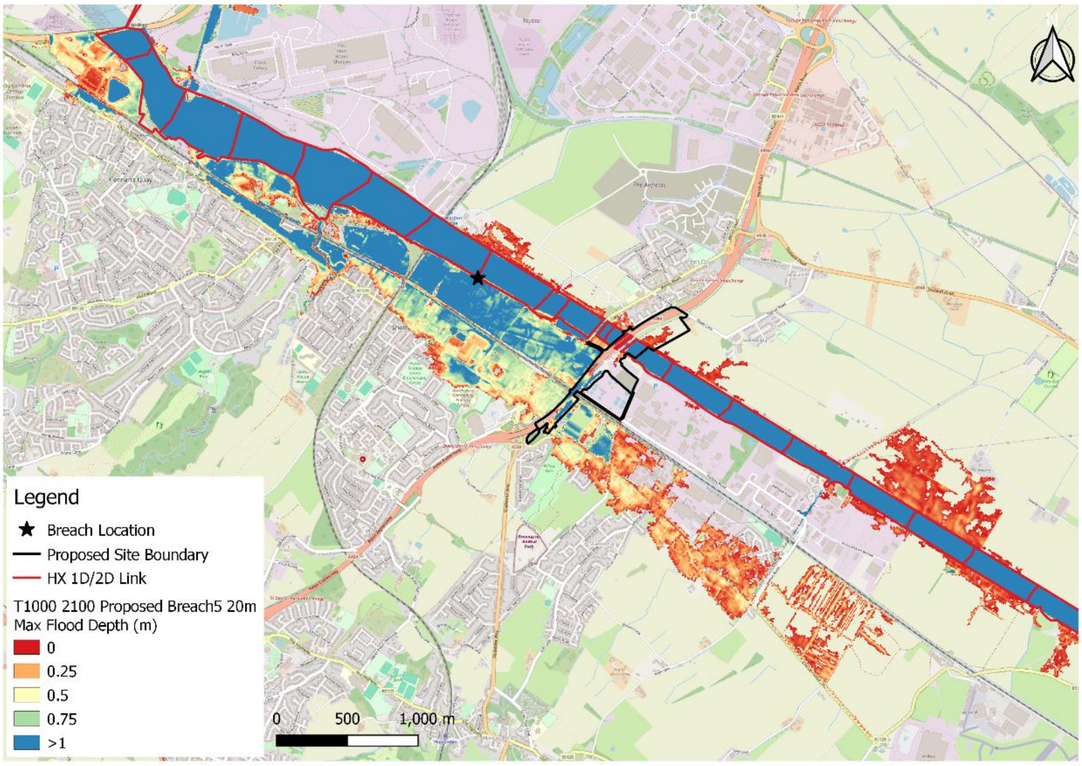


Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.50: 0.1% AEP 2100 Tidal Breach Five Flood Velocity

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

Figure B.51: 0.1% AEP 2100 Tidal Breach Five 20m Flood Depth



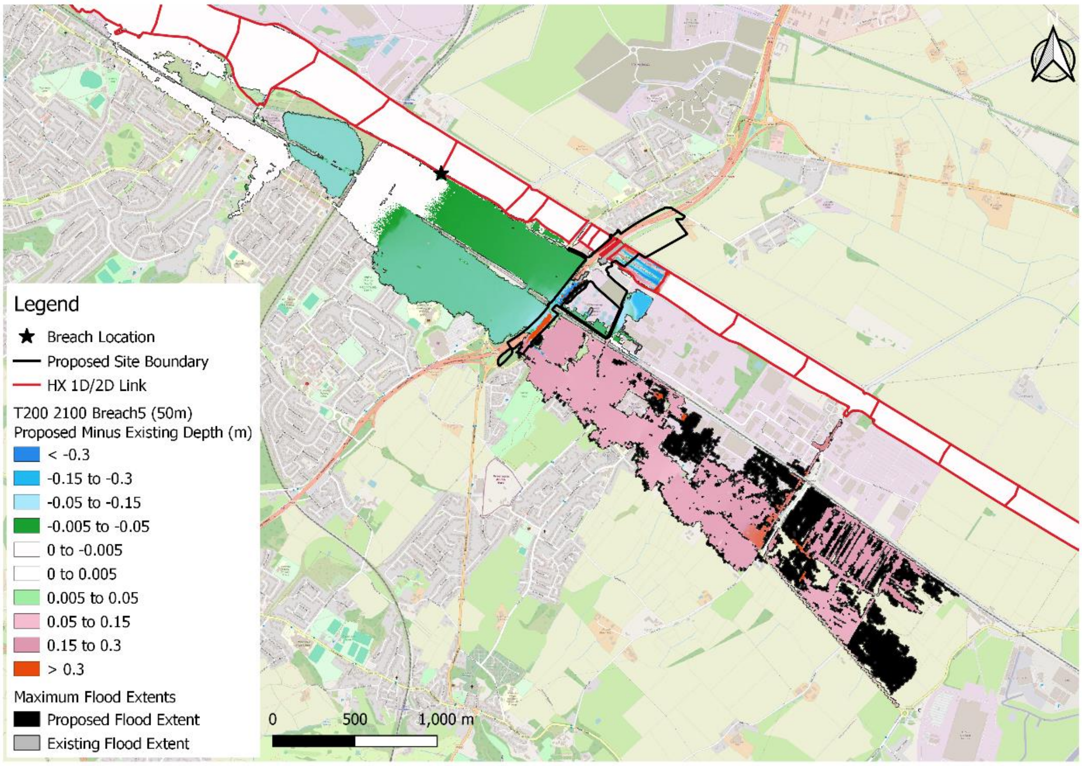
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

B.3.5.1 Comparison Against Existing Scenario

Depth differences from Tidal Breach Five for the Proposed and the Existing scenarios are detailed in Figure B.52 and Figure B.53. 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.

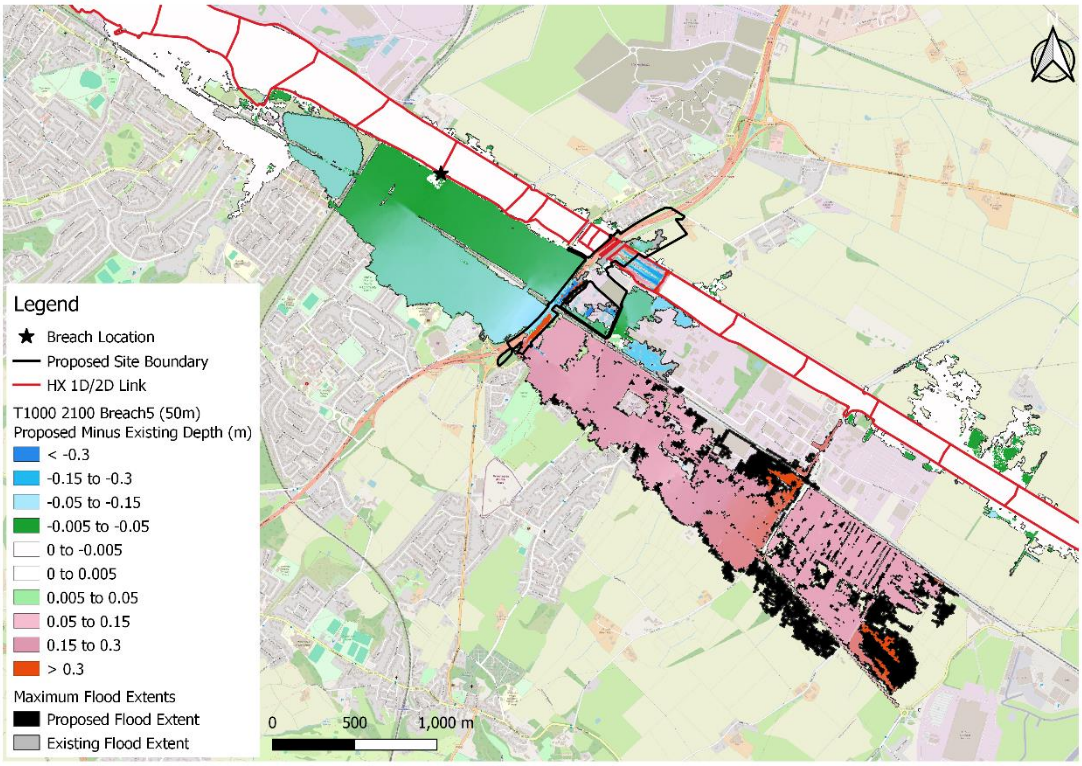
Figure B.54 and Figure B.55 detail the results of the Tidal Breach Five 20m sensitivity runs. The 0.5% AEP 2100 event has depth reduction in areas around Shotton with residential areas seeing a reduction of up to 0.15m. However, this is offset by increased flooding to the south of the project Scheme 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 0.3m in some areas as well as having a significant increase in flood depth compared to the Existing scenario extents.

Figure B.52: 0.5% AEP 2100 Tidal Breach Five Flood Depth Difference



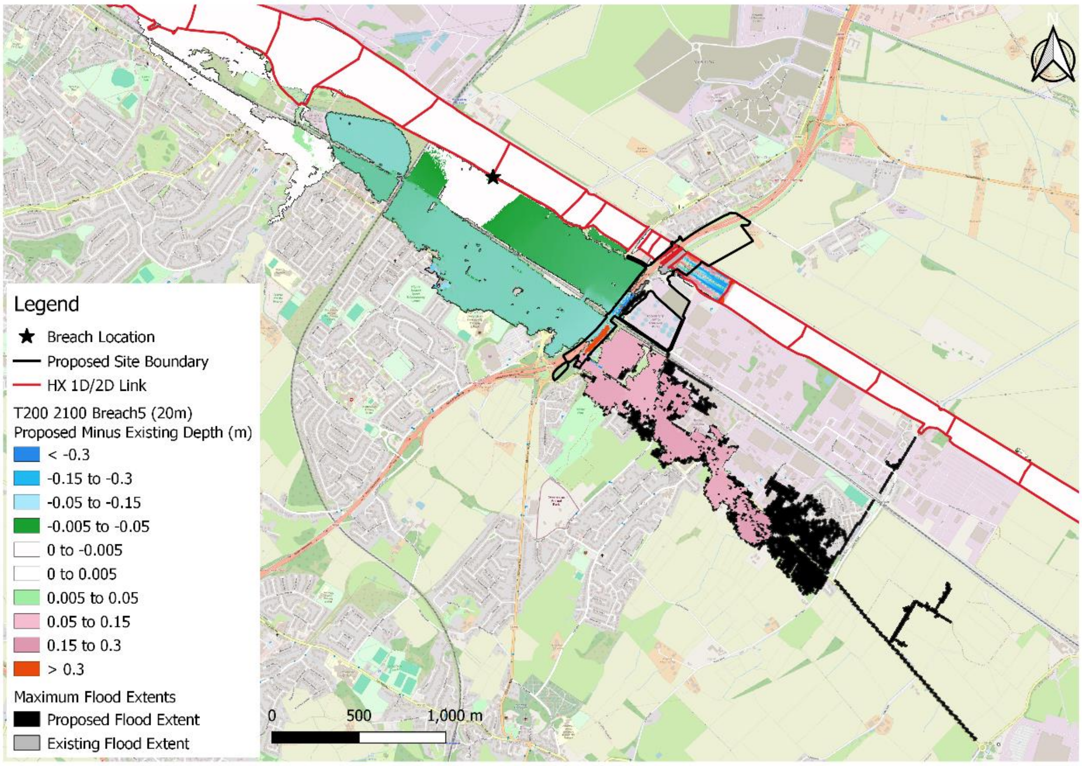
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.53: 0.1% AEP 2100 Tidal Breach Five Flood Depth Difference



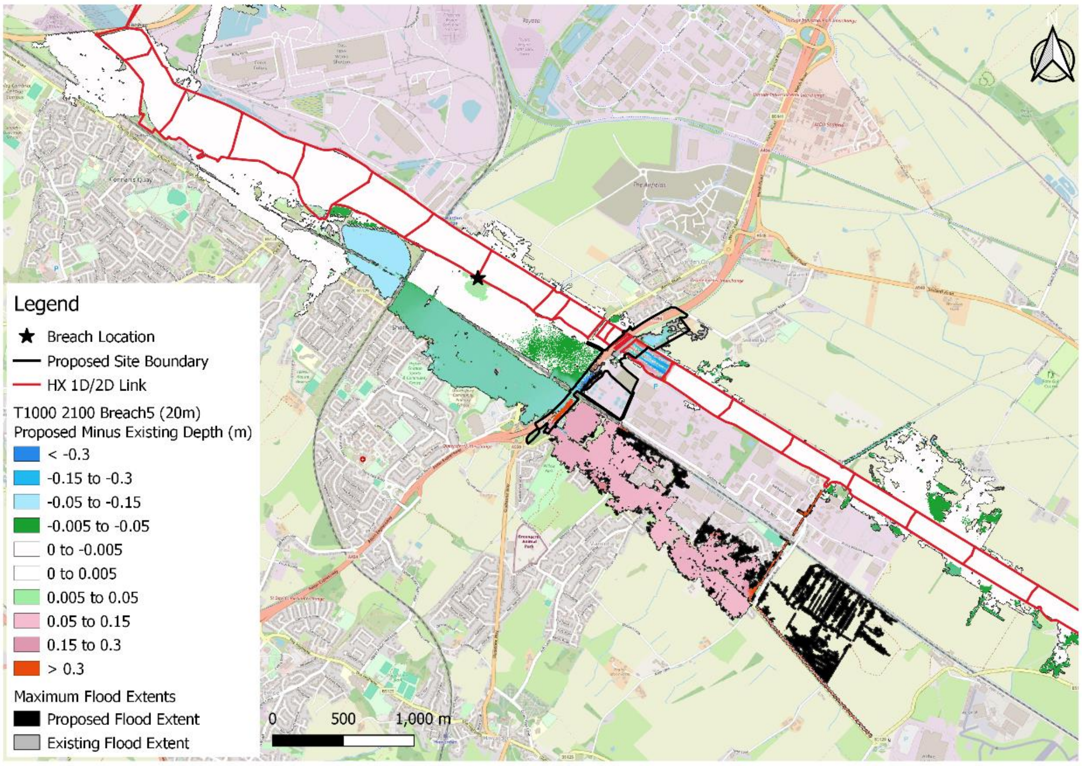
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

Figure B.54: 0.5% AEP 2100 Tidal Breach Five 20m Flood Depth Difference



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

Figure B.55: 0.1% AEP 2100 Tidal Breach Five 20m Flood Depth Difference



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

B.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.**

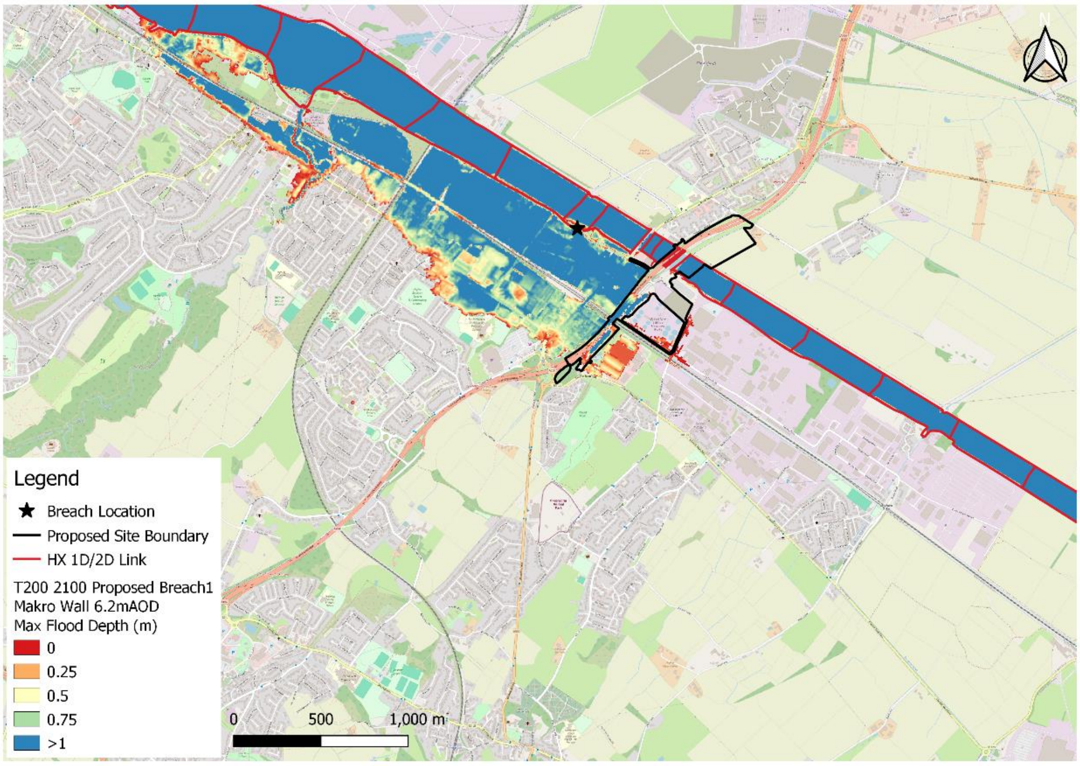
B.4.1 Makro Wall Flood Mitigation

B.4.1.1 Tidal Breach One

Figure B.56 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.

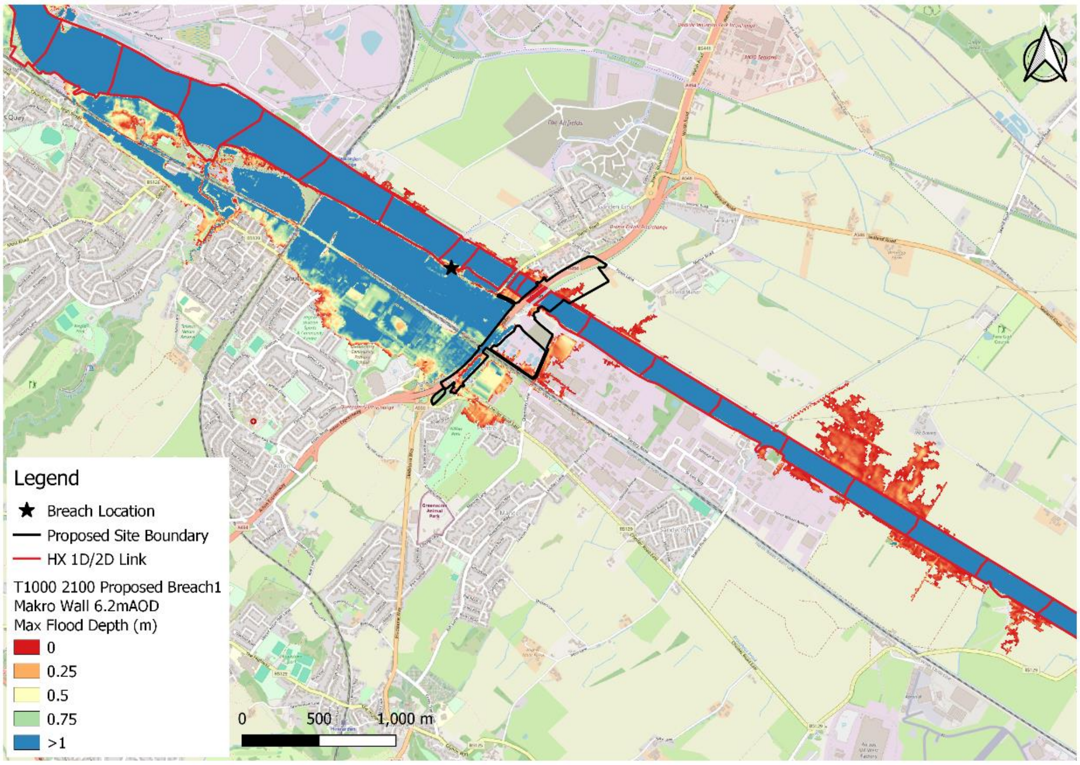
Figure B.57 details the flood depth for Tidal Breach One including the Makro Wall flood mitigation measure for the 0.1% AEP 2100 event. Under this scenario Tidal Breach One poses a significant flood risk to the Shotton and Queensferry as well as to the Scheme. Flood depths close to the breach location 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 B.56: 0.5% AEP 2100 Tidal Breach One Makro Wall Flood Depth



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

Figure B.57: 0.1% AEP 2100 Tidal Breach One Makro Wall Flood Depth



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

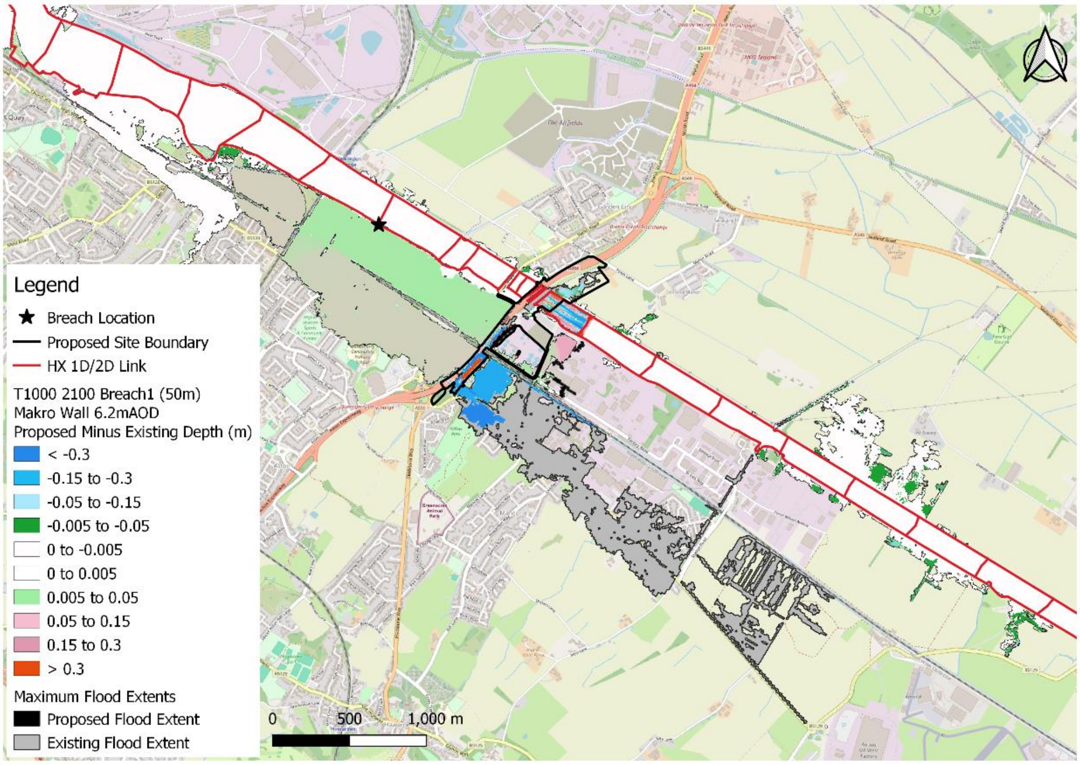
Figure B.58 details the impact of the Makro Wall on the 0.5% AEP 2100 event for Tidal Breach One. As detailed, there is a significant reduction in flood extent compared to the Existing scenario where flooding extended across the floodplain to Sandycroft. However, this reduction in flood extent is counterbalanced by water levels being raised around 0.006m on average across the open spaces to the north of Shotton and 0.029m across the urbanised areas.

Figure B.59 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 0.033m over the urbanised areas of Shotton and an average increase of 0.012m 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 B.58: 0.5% AEP 2100 Tidal Breach One Makro Wall Flood Depth Difference

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

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



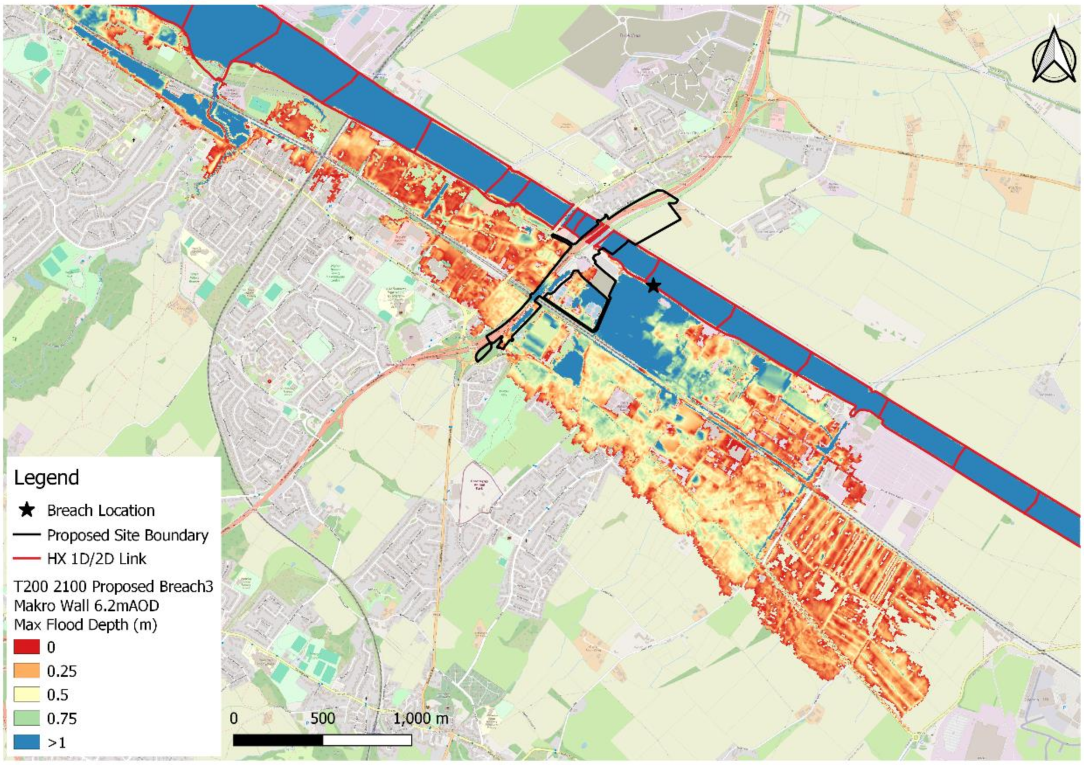
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

B.4.1.2 Tidal Breach Three

Figure B.60 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 B.61 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 B.60: 0.5% AEP 2100 Tidal Breach Three Makro Wall Flood Depth



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

Figure B.61: 0.1% AEP 2100 Tidal Breach Three Makro Wall Flood Depth

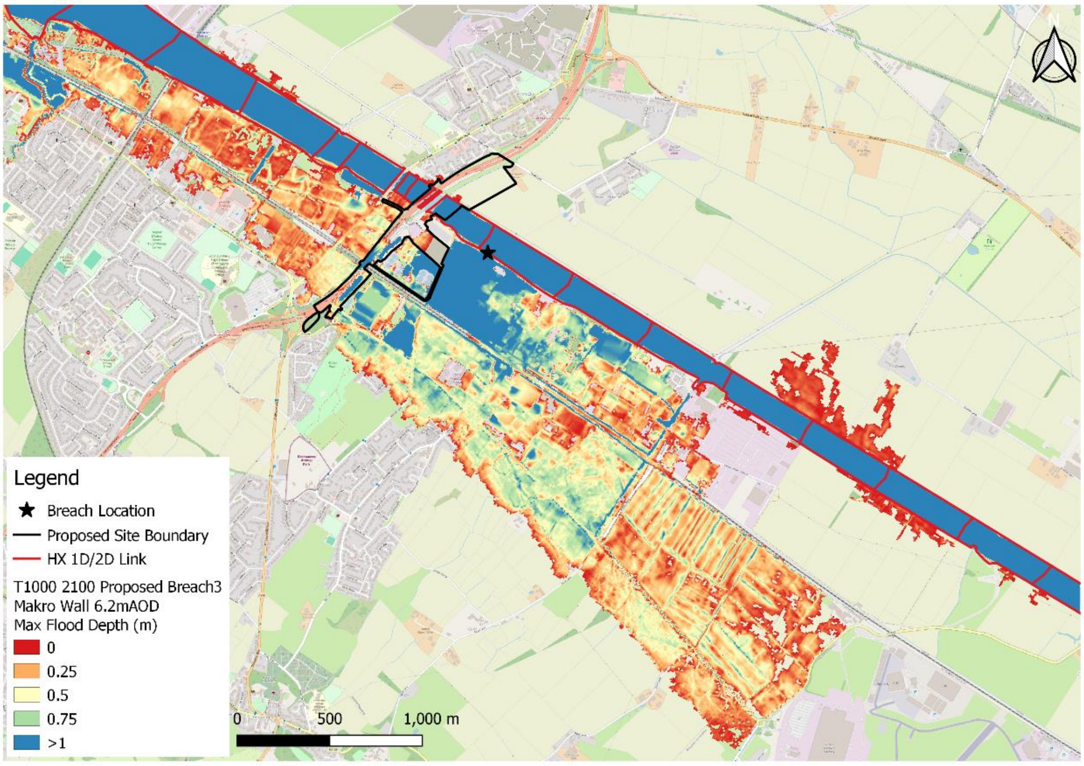


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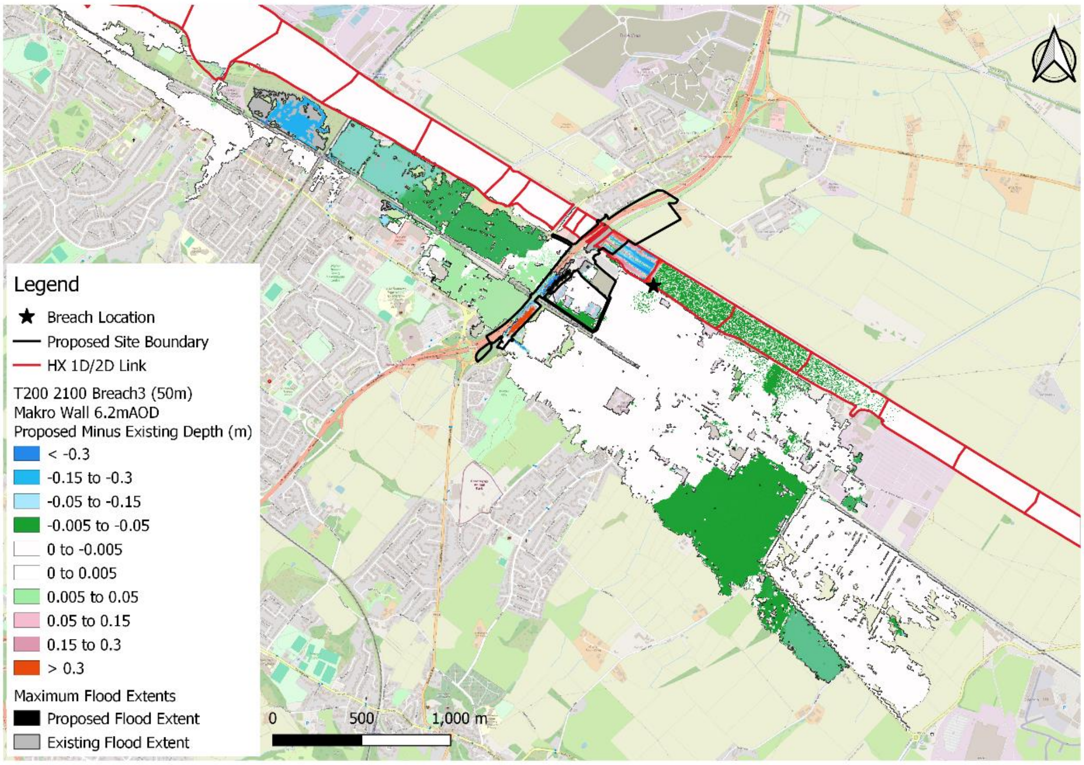
Figure B.62 details the impact of the Makro Wall on the 0.5% AEP 2100 event for Tidal Breach Three. Flood depths near and to the south of the breach location do not change within a noticeable range. Whilst areas to the north of the Scheme see a reduction in flood depth compared to the Existing scenario with flood depths reducing the further from the breach location the water flows.

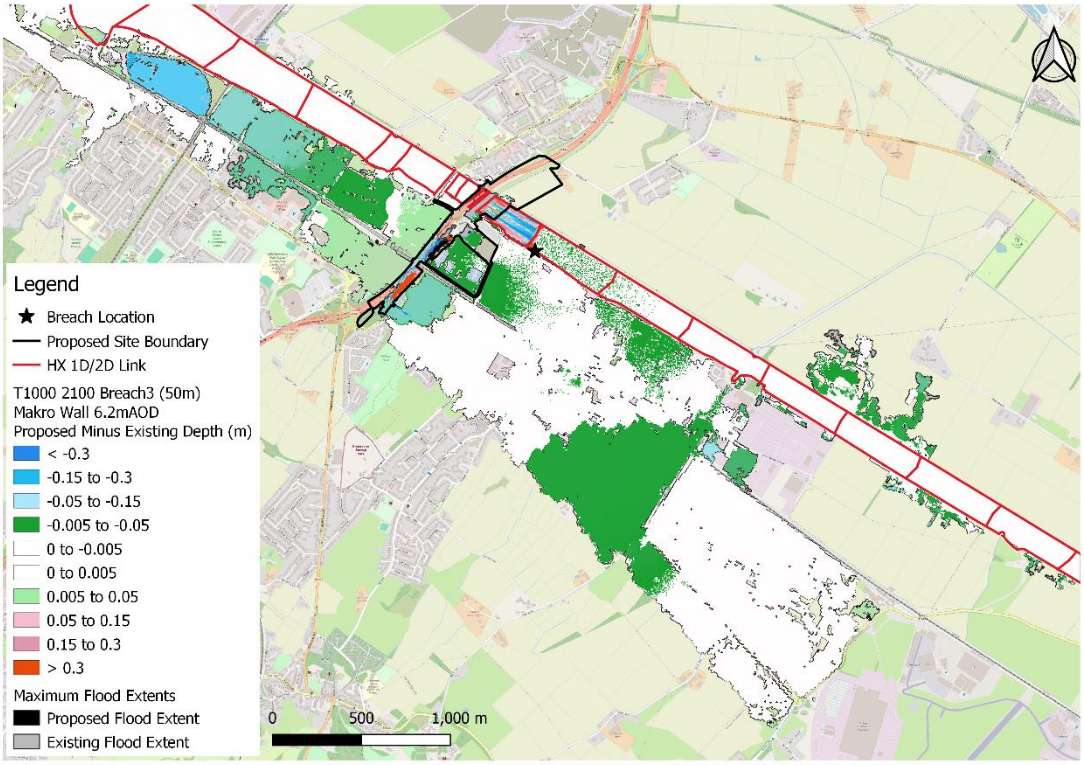
Figure B.63 details the flood depth difference between the Proposed scenario including mitigation measures and the Existing scenario for Tidal Breach Three. Flood depths near the breach location remain largely similar between the Existing scenario and the Proposed scenario including mitigation, there is a slight increase in flood depths to the south of Sandycroft however this area is rural. Flood depths increase slightly near the Deeside Leisure Centre and in areas of Shotton to the south of the railway line. To the north of the railway line flood depths can be seen reducing by up to 0.012m.

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



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

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



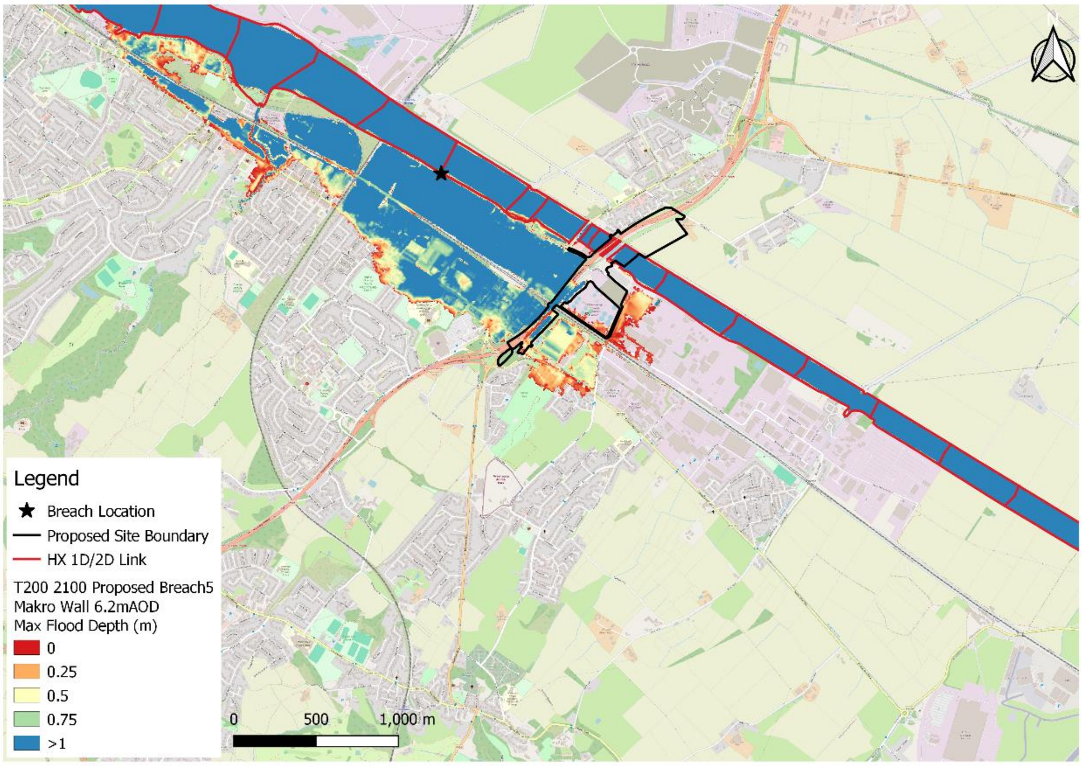
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

B.4.1.3 Tidal Breach Five

Figure B.64 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 then 1m of flood water. Flood depths are much lower in areas of Queensferry where flood water makes it past the Makro Wall mitigation.

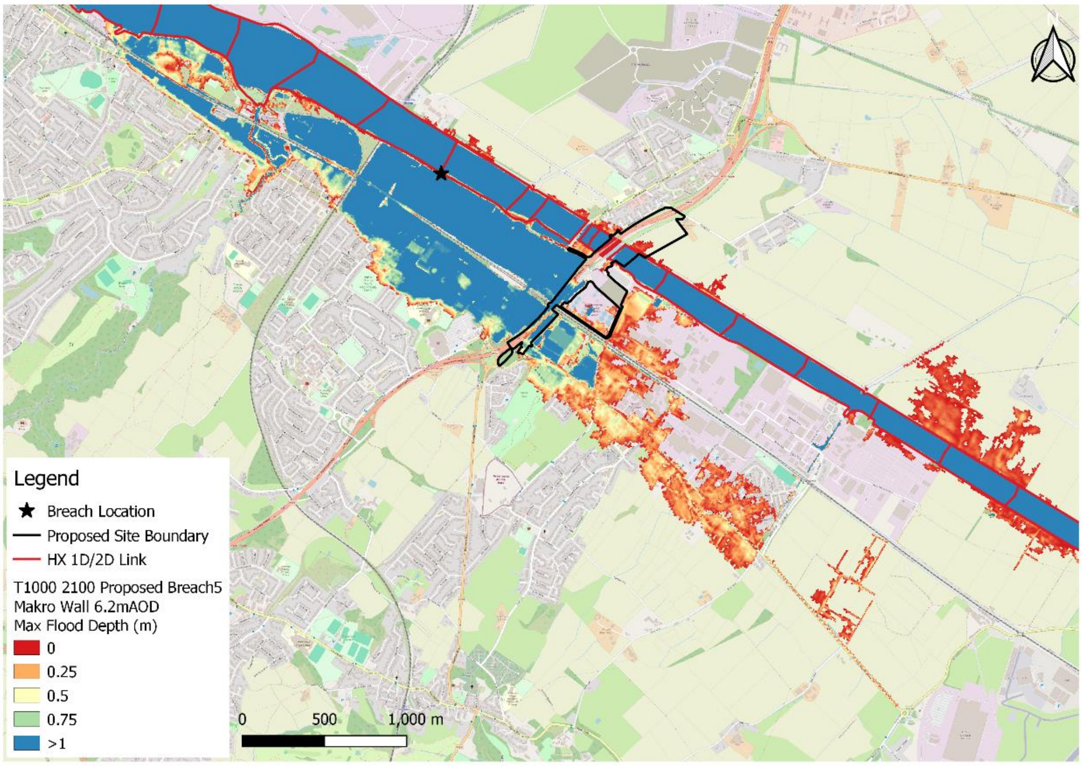
Figure B.65 details the flood depths from Tidal Breach Five including the Makro Wall flood mitigation measure in place under the 0.1% AEP 2100 event. Under this scenario Tidal Breach Five causes significant flooding to the Shotton, Queensferry, and Pentre areas with a significant area around the Tidal 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 B.64: 0.5% AEP 2100 Tidal Breach Five Makro Wall Flood Depth



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

Figure B.65: 0.1% AEP 2100 Tidal Breach Five Makro Wall Flood Depth



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

Figure B.66 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 and 0.018m in the urbanised areas. Water levels are expected to improve by an average of 0.246m in the areas of flooding around Queensferry.

Figure B.67 details the flood depth difference between the Proposed scenario including mitigation measures and the Existing scenario for Tidal Breach Five. Flooding can be seen to increase across Shotton with an average increase of 0.011m. Flood depth near Wepre Brook are increased further to around 0.027m on average in the area. To the south of the development area flood depths are decreased compared to the Existing scenario with flood depths decreasing more the further towards Sandycroft you get. Additionally, flood extents for Tidal Breach Five are reduced compared to the Existing scenario with some urban areas across Sandycroft no longer inundated by water with the inclusion of the Makro Wall along the A494.

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

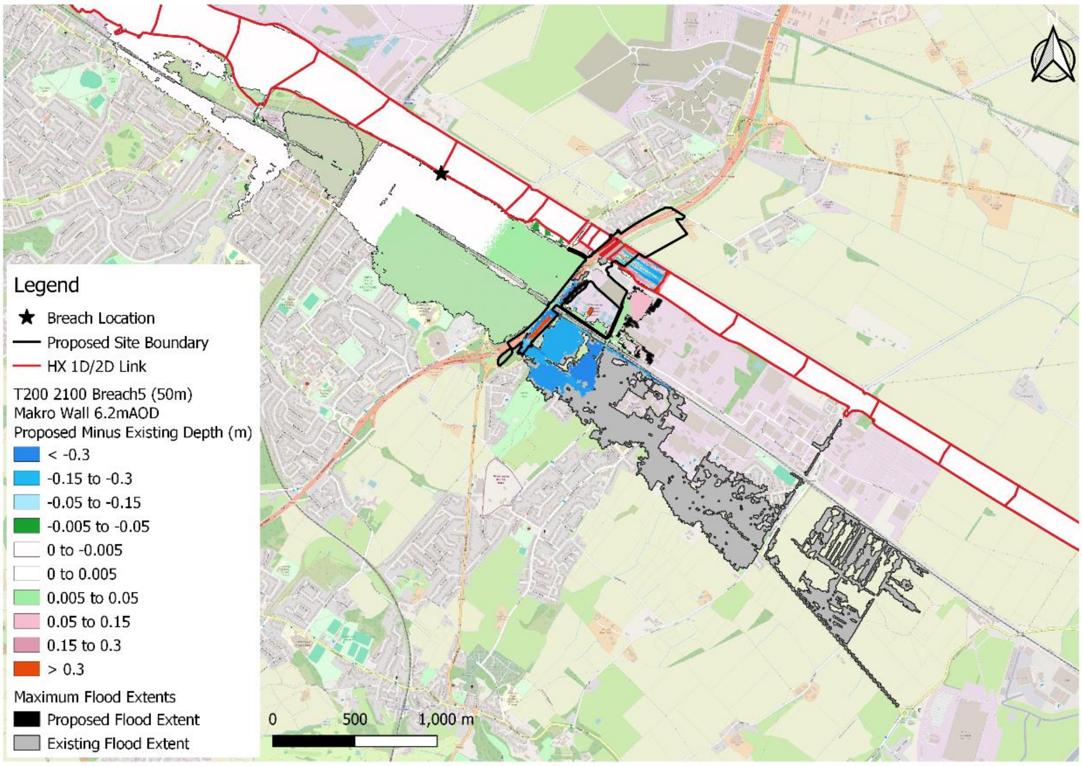


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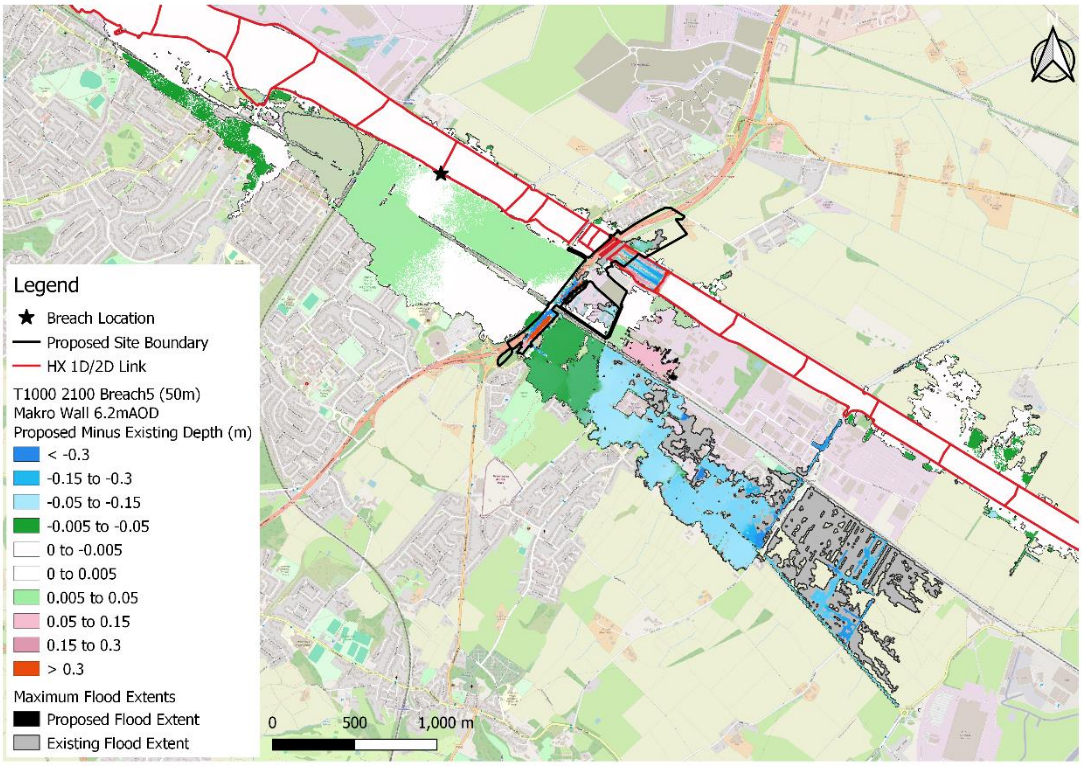
Figure B.67: 0.1% AEP 2100 Tidal Breach Five Makro Wall Flood Depth Difference



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B.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.**

B.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.

B.5.1.1 Roughness up 20%

Figure B.68 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 B.68: 0.1% AEP 2100 Tidal Roughness Up 20% Flood Depth

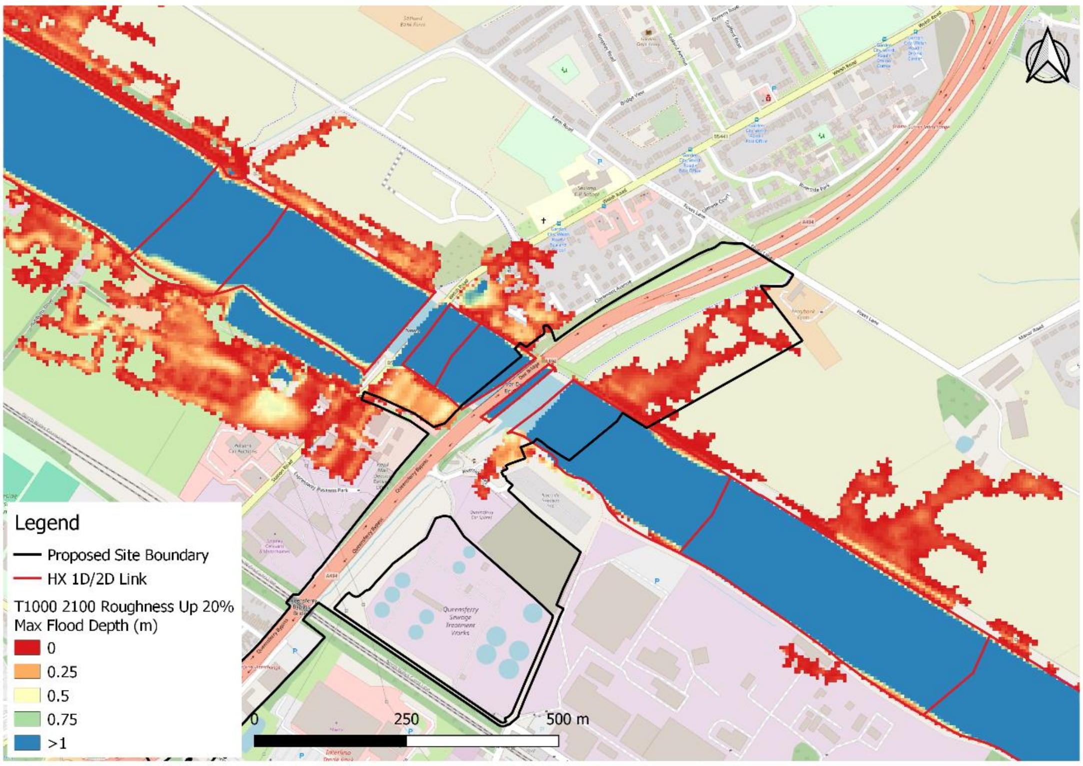

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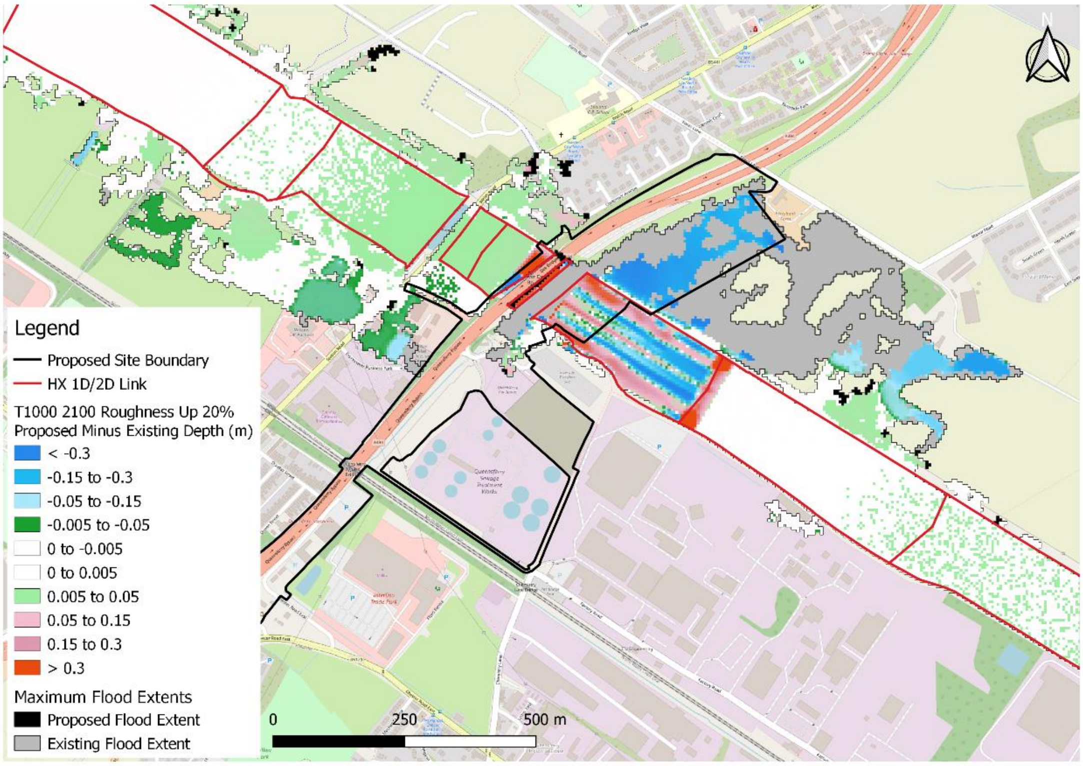
Figure B.69 details the flood depth difference between the increased roughness post-development scenario model results and the pre-development flood depths for the 0.1% AEP 2100 event. There are some small increases in flood depth in the channel and on the right bank downstream of the proposed bridge 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 B.69: 0.1% AEP 2100 Tidal Roughness Up 20% Flood Depth Difference



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B.5.1.2 Roughness down 20%

Figure B.70 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 B.70: 0.1% AEP 2100 Tidal Roughness Down 20% Flood Depth

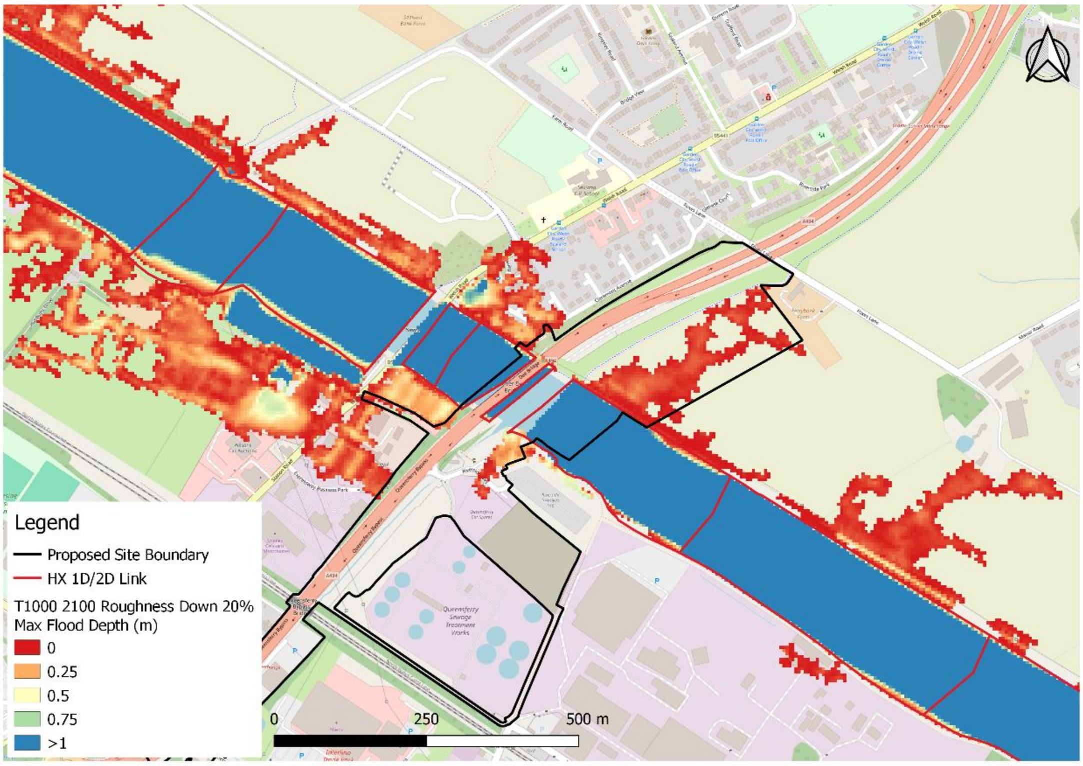

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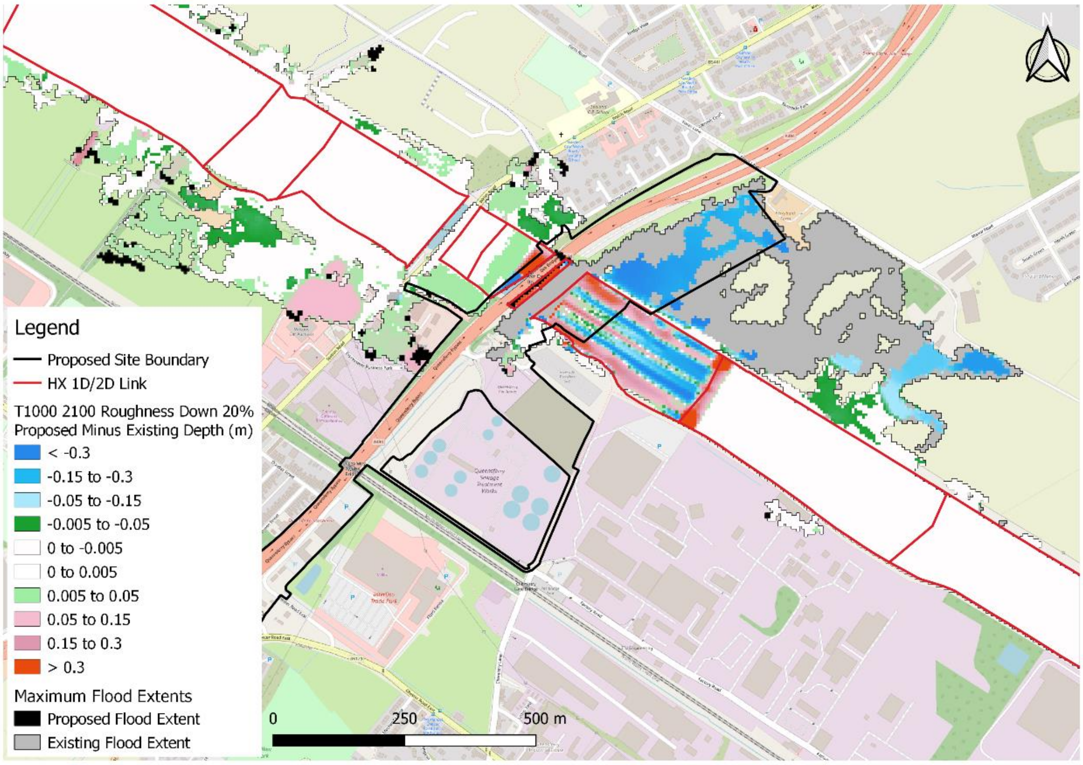
Figure B.71 details the flood depth difference between the decreased roughness Proposed scenario results and the Existing scenario flood depths for the 0.1% AEP 2100 event. There are some small increases in flood depth in the channel immediately downstream of the existing bridge piers. On the right bank 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 B.71: 0.1% AEP 2100 Tidal Roughness Down 20% Flood Depth Difference



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B.5.2 Embankment Mitigation

Figure B.72 details the flood depths for the results of the 0.1% AEP 2100 event including an embankment raise on both banks downstream of the proposed bridge location extending to the Jubilee bridge. 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. Flood extent on the right bank is reduced with flood water not predicted to extend past roads; Ferry Bank or Cleaveland Grove. Flooding on the left bank extends to the Queensferry Bypass.

Figure B.72: 0.1% AEP 2100 Tidal Embankment Mitigation Flood Depth

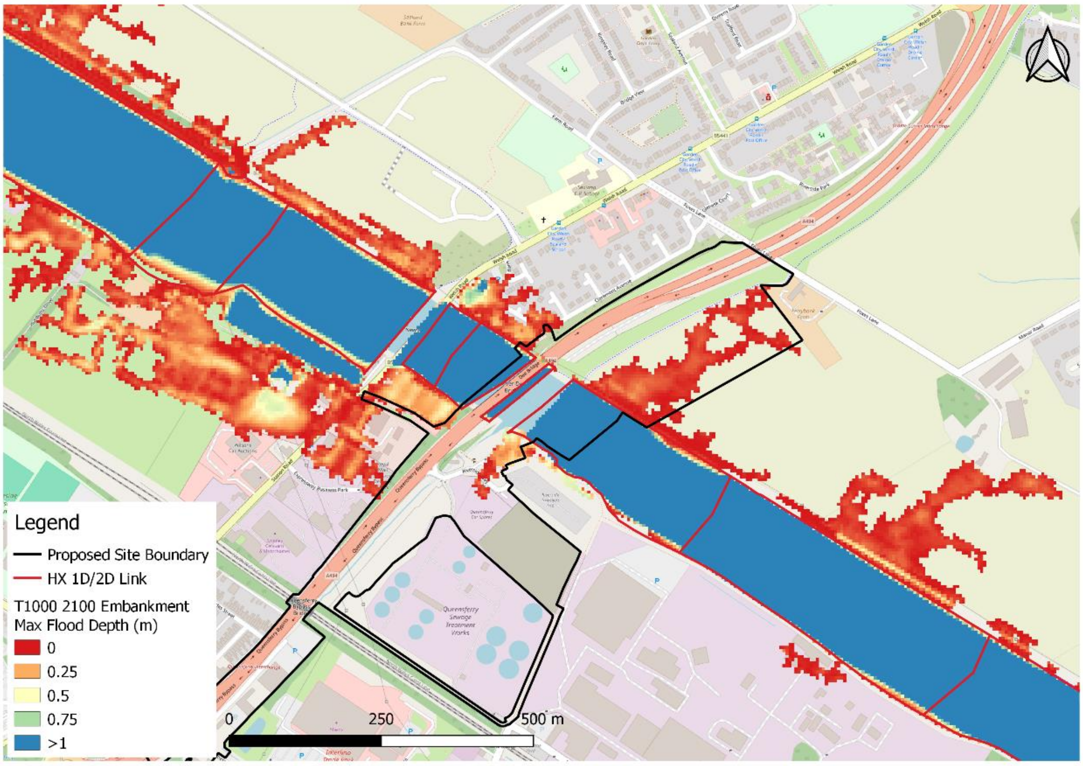

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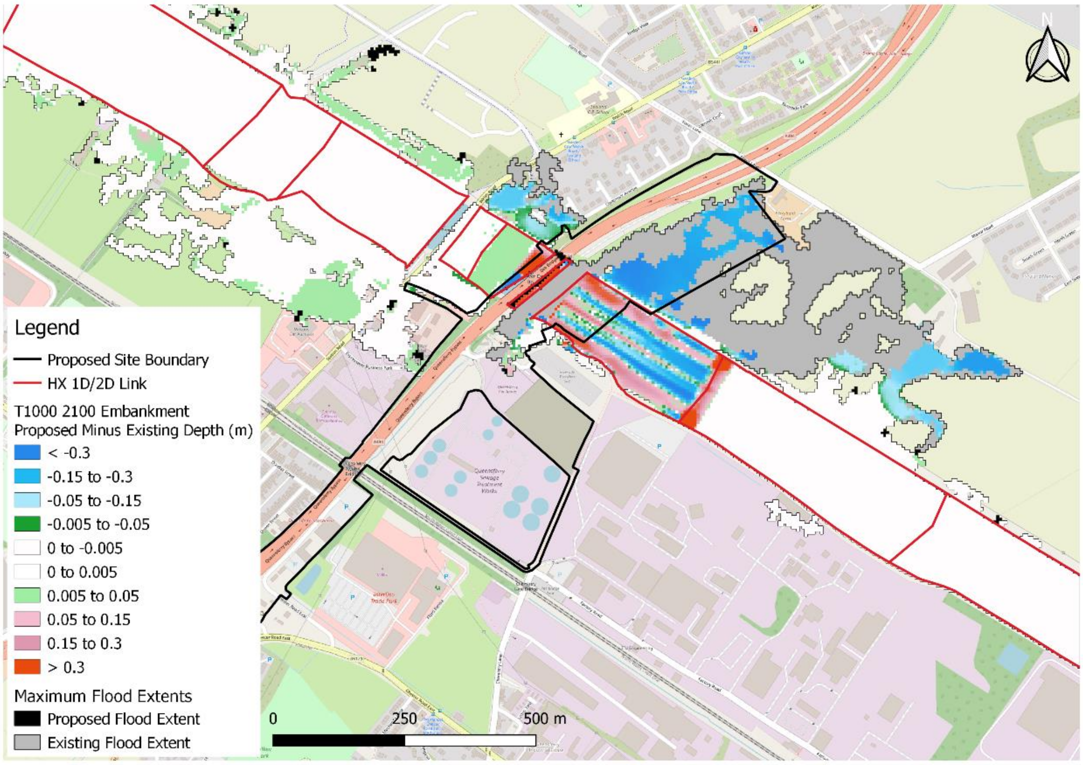
Figure B.73 details the difference in flood depth between the proposed bridge results including an embankment raise and the Existing scenario flood depths for the 0.1% AEP 2100 event. The right bank downstream of the development sees a significant reduction in flooding with flood extents reduced beyond the Existing scenario flood extent. Additionally flooding which does persist on this bank is significantly reduced compared to the predicted Existing scenario flood depths in this location. There are some small points of raised flood depths along the left bank which as an average increase of 0.01m. Flooding is reduced both in depth and extent significantly upstream of the Scheme along the right bank under this scenario.

Figure B.73: 0.1% AEP 2100 Tidal Embankment Mitigation Flood Depth Difference



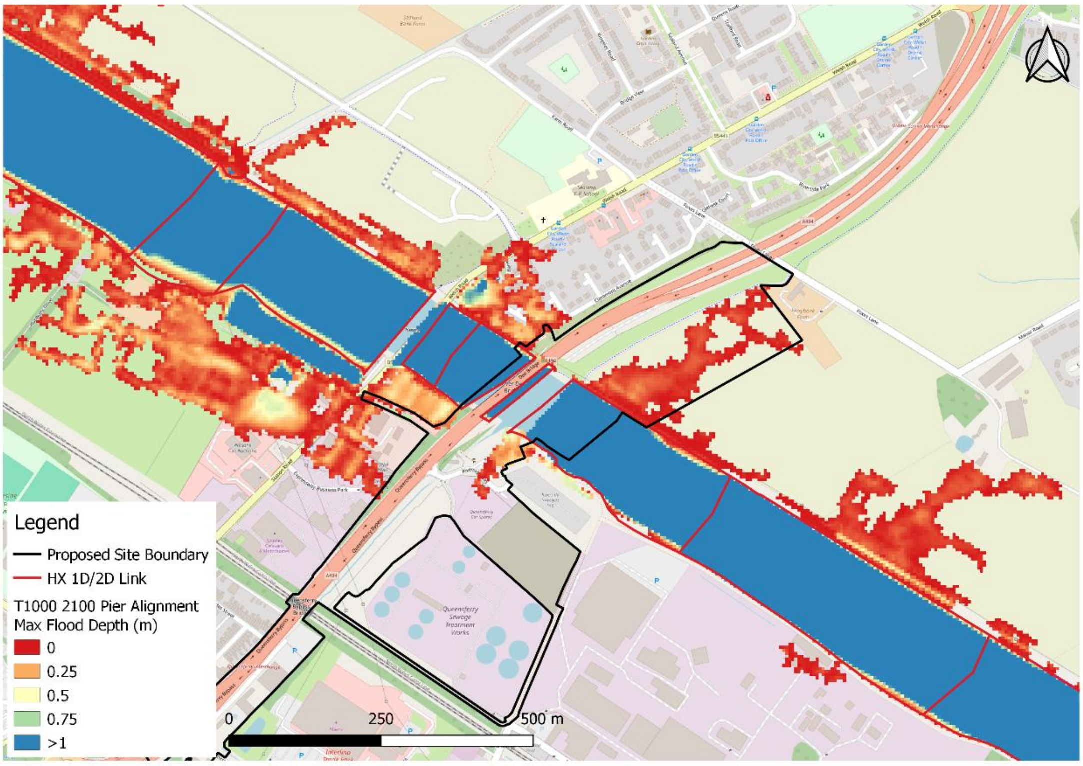
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

B.5.3 Pier Adjustments

B.5.3.1 Pier Alignment

Figure B.74 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.

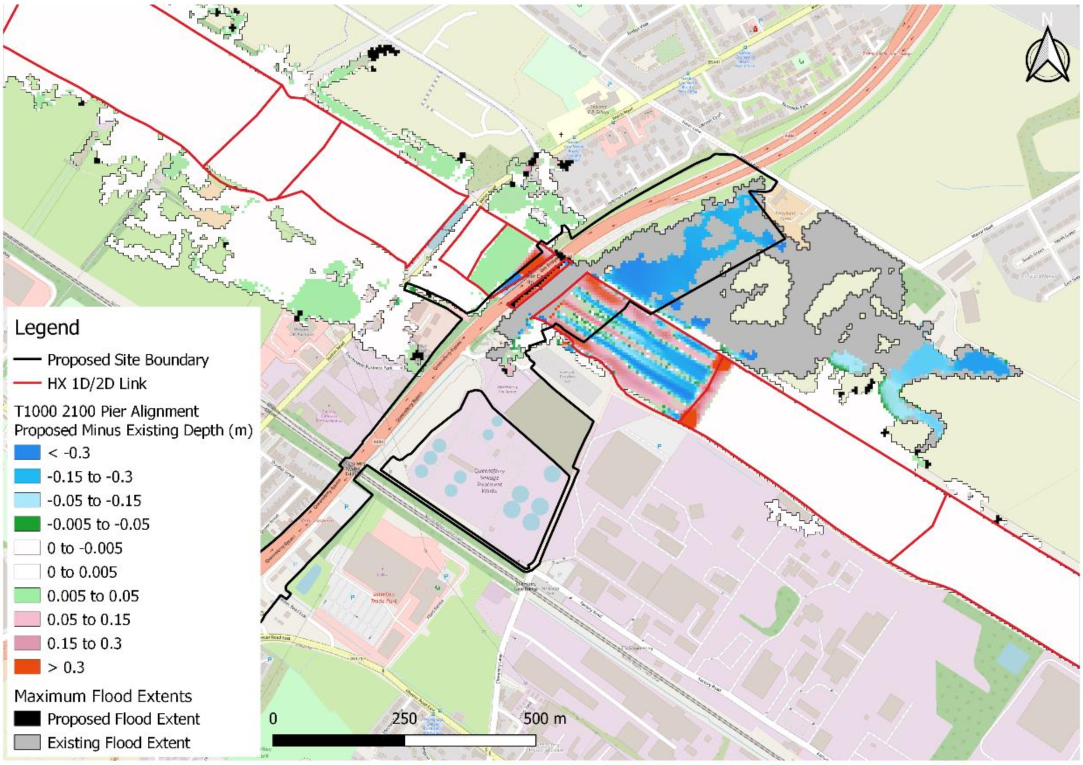
Figure B.74: 0.1% AEP 2100 Tidal Pier Alignment Flood Depth



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

Figure B.75 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 B.75: 0.1% AEP 2100 Tidal Pier Alignment Flood Depth Difference

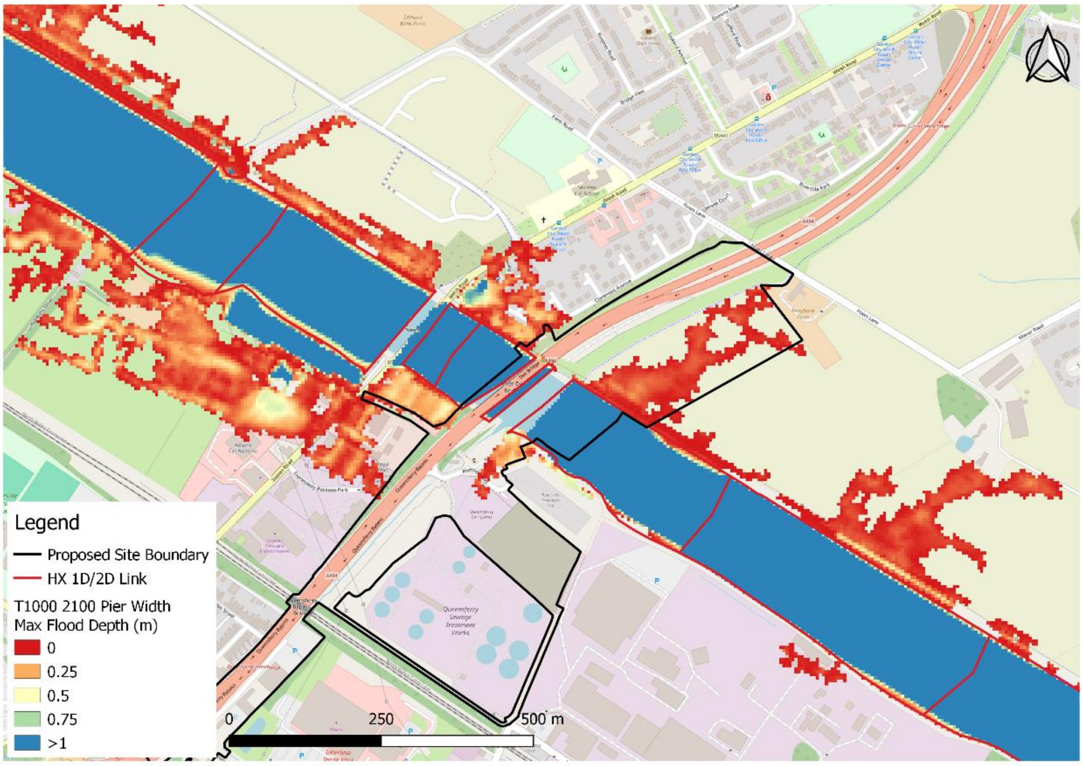


Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

B.5.3.2 Pier Widths

Figure B.76 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.

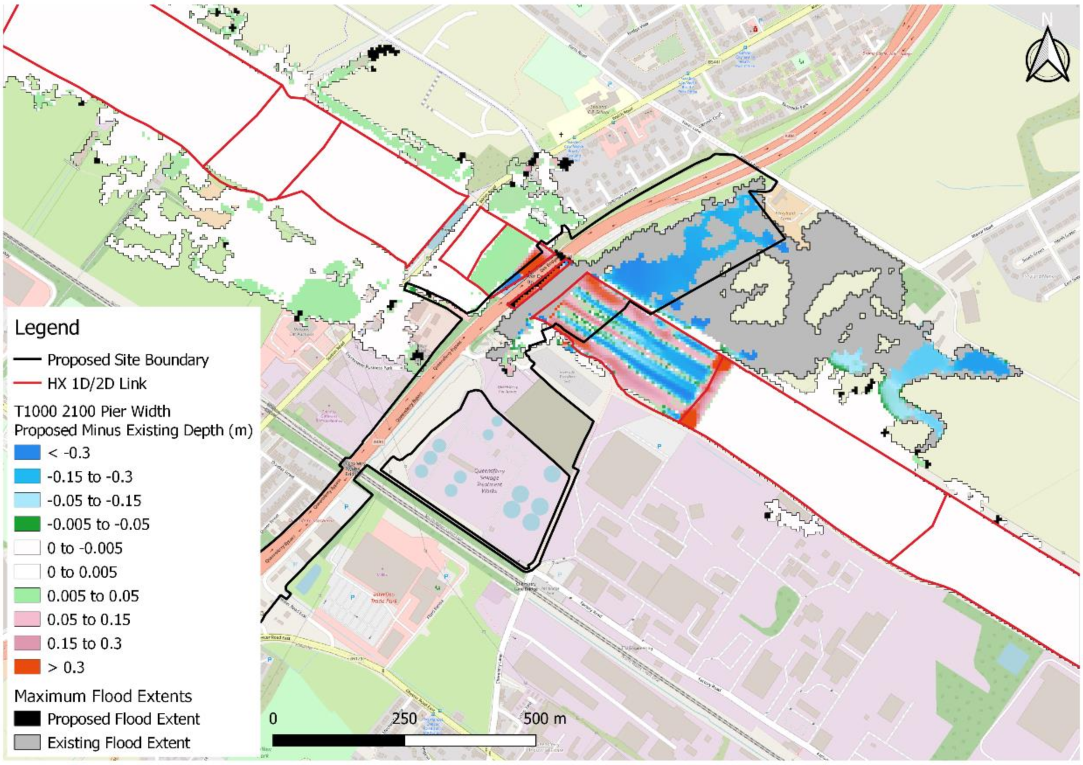
Figure B.76: 0.1% AEP 2100 Tidal Pier Width Flood Depth



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

Figure B.77 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 B.77: 0.1% AEP 2100 Tidal Pier Width Flood Depth Difference



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MOTT MACDONALD

A494 River Dee Improvement Scheme

Queensferry Drain Hydraulic Modelling Report Proposed Development Assessment

September 2025

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A494 River Dee Improvement Scheme

Queensferry Drain Hydraulic Modelling Report Proposed Development Assessment

September 2025

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The consultant will follow accepted procedure in providing the services but given the residual risk associated with any prediction and the variability which can be experienced in flood conditions, the consultant takes no liability for and gives no warranty against actual flooding of any property (client's or third party) or the consequences of flooding in relation to the performance of the service. This report has been prepared for the purposes of informing a FCA for planning application only.

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Executive summary

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

Mott MacDonald has been undertaking the hydraulic modelling for the A494 River Dee Bridge Improvement Scheme since 2019, most recently carrying out options appraisal modelling in 2024. An emerging Preferred Option (now referred to as the 'Proposed scenario') for the Scheme was identified during that stage and has been further developed by the design team in 2025 to support the 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.

In July 2024, Natural Resources Wales (NRW) provided Mott MacDonald with an updated hydraulic model for the Queensferry Drain. This model was an alternative to the existing A494 Scheme model used for option appraisal stage in 2024. The NRW provided model was reviewed and compared against existing A494 Scheme model in October 2024. As a result,, it was proposed to take the NRW model as a new baseline (with amendments) for the next stage of the project. The detailed comparison of the two models is presented in the 2024 Scoping Report[1].

The hydrological inputs to the hydraulic model have been updated following the recommendations from the NRW. The hydrology update is presented in a separate GN008 proforma document from November 2024. The findings of the hydrological analysis have been agreed with the NRW and the ReFH2 method has been selected as the leading hydrology estimate for the Queensferry catchment.

This study assessed both the existing flood risk at the site (Existing scenario model) and the impact of the Scheme on flood risk (Proposed scenario model).

The study concluded that overall the Proposed scenario may reduce the overall food risk in the area. The most prominent changes in flood extent and flood water levels are predicted downstream of Chemistry Lane. The Proposed scenario model has reduced maximum flood depths by 0.129m when compared to Existing scenario model results for 1% AEP 2100 flood event.

The improvements in flood risk are due to the increased capacity of the Queensferry Drain channel in the Proposed scenario. Two new open channels have been added in the downstream section (north and south of the railway line), additionally the existing culverts will be upsized.

Sensitivity test has shown that the Existing scenario model is sensitive to the blockages of structures, the roughness values and the buildings representation.

[1] A494 River Dee Bridge Replacement Scheme – Queensferry Drain Model, Emerging Preferred Option Modelling Scoping Report, October 2024

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 existing A494 River Dee crossing (in Figure 1.1) was constructed in 1960 and provides a vital connection between North Wales and the Northwest of England. The crossing carries approximately 61,000 vehicles per day connecting people, communities, and businesses. Due to the age of 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[2] developed in October 2022.

Figure 1.1: Existing A494 River Dee Bridge

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

The Queensferry Drain runs through the urbanised area on the southern floodplain of the River Dee and discharged into the River Dee immediately upstream of the proposed bridge crossing. Due to the Scheme, relocation of the existing Queensferry Drain (QD) is required.

1.2 Previous hydraulic modelling

The hydraulic model was previously developed by different consultancies as follows:

[2] 395318-TN-38-F-A494 Bridge Improvements River Dee FCA Modelling Report RevF, Mott MacDonald, October 2022

- Created in 2000 by JBA Consulting for a S105 flood risk mapping study,
- Updated in 2007 by Halcrow for pre-feasibility and viability studies on Broughton Brook, Sandycroft Drain and Pentre Drain (when the model was extended to include Queensferry Drain and Pentre Drain North and South)
- Further updated by Jacobs in 2010 to inform a PAR investigation to support a case for a Flood Alleviation Scheme in the districts of Broughton and Pentre

The NRW supplied the hydraulic model to Mott MacDonald in 2019 and the previous hydraulic models developed by Mott MacDonald in 2019, 2023 and 2024 were based on this model. The findings from the previous hydraulic modelling are presented in the following documents:

- 395318-TN-0037-REV3 ‑ A494 River Dee Bridge ‑ Queensferry Drain Hydraulic Modelling[3], Mott MacDonald, 18th October 2019;
- 395318-TN-111 A494 River Dee Bridge Improvement Scheme ‑ Trash Screen Updates[4], Mott MacDonald, 19th April 2024;
- 395318-0196 A494 River Dee Bridge Improvement – Queensferry Drain Hydraulic Modelling of Options[5], 27th September 2024;

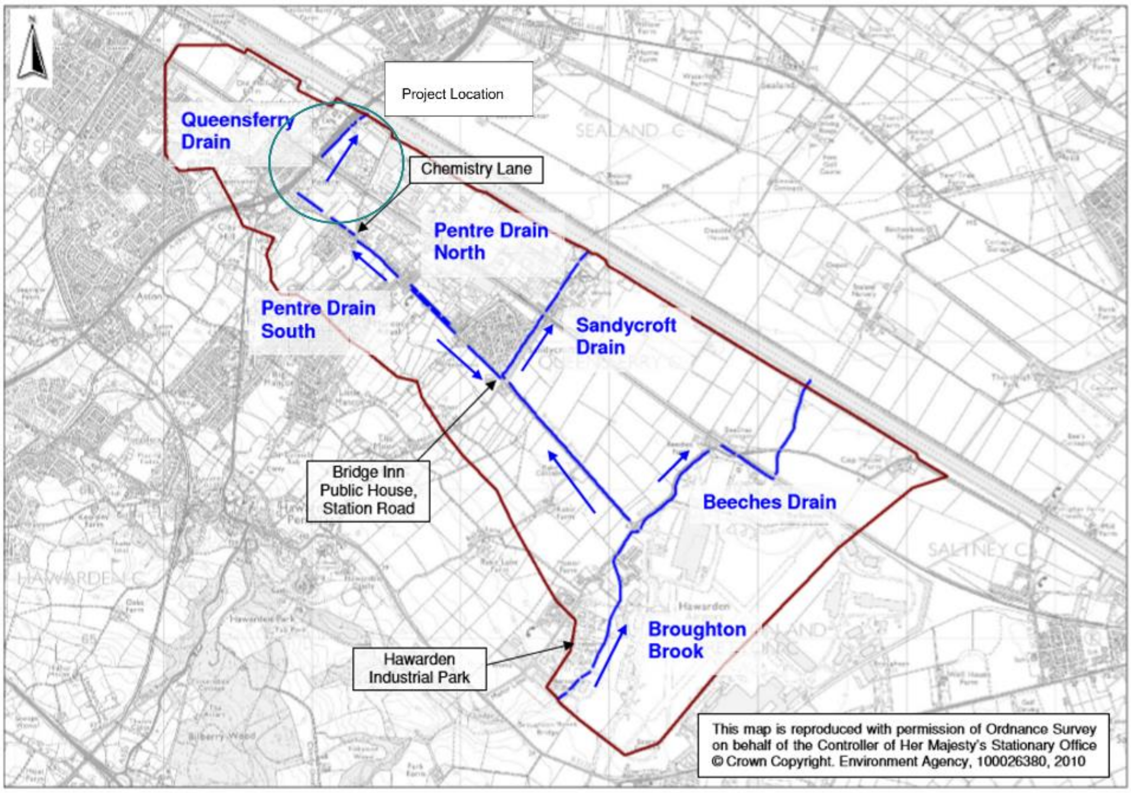
In July 2024 NRW provided Mott MacDonald with an updated hydraulic model for the Queensferry Drain. The updated model was reviewed and compared with the previous hydraulic model used in the A494 study. Upon the review it was decided that the updated NRW model will be adopted in the next stage of the A494 study and used to develop a new Existing scenario model. The details of the review are presented in the scoping report[6] from October 2024.

[3] A494_Queensferry_Drain_Hydraulic_Modelling_002 Final.docx, October 2019
[4] 395318-TN111 A494 FCA Addendum - Hydraulic Model Updates .pdf, April 2024
[5] A494 River Dee Bridge Improvement, Queensferry Drain Hydraulic Modelling Report, September 2024
[6] 395318-1016 A494 Queensferry Scoping Report.docx, October 2024

2 Existing Scenario Model Updates

For the purpose of this study, the latest Existing scenario model provided by NRW in June 2024 has been used as starting point and the Existing scenario model was further updated as mentioned in the scoping report. The updates to the Existing scenario model are explained in the following sections.

Figure 2.1: Modelled reaches in 1D and extent of 2D domain



Source: Boughton PAR - Jacobs

2.1 1D Structural Updates

The invert level of culvert outlet QD_0424c has been updated to 2.72mAOD to reflect drawing A494 380 drawing (T.R. No. MC/84/86/1)[7]. The existing culvert outlet QD_0066c into the River Dee has been set to flapped. An existing Chester Road East trash screen has been modelled at culvert inlet QD_0757cu. The details of trash screen are based on survey drawing created in December 2018 by PM Surveys[8] UK Ltd and in Table 2.1.

Table 2.1: Details of Existing Chester Road East Trash Screen

Table Label	Type	Screen Width (m)	Bar Proportion (%)	Screen Height (m)	Loss Coefficient
QD_0704cu	Trash Screen	1.310	7	2	1.5

[7] A494 380 - Drawing Details Of Headwall At Outlet Of Box Culvert.pdf

[8] PMS18258-03 – Surveyed Cross-section at Trash Screen

2.2 1D Cross-sectional Updates

The bed level of open channel section QD_0424d has been updated to 2.72mAOD to be in line with the culvert outlet QD_042c invert level.

2.3 2D Topographical Updates

The existing LiDAR data from 2017 in NRW model has been replaced by latest Lidar data (2022) downloaded from Home portal[9]. 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 5.16m AOD (2d_zsh_Makro_store_001_R.shp).

2.4 Boundary Condition Updates

No changes have been made to the locations of hydrological boundaries.

The fluvial boundaries have been updated to the new hydrographs presented in the hydrological Performa GN008[10]. The new hydrological analysis was submitted to the NRW in January 2025. The NRW provided their feedback on 6th March 2025 where they agreed with the proposed hydrology assessment and conclusions. The ReFH2 was selected the preferred method for the Queensferry Drain catchment.

The downstream boundary levels were extracted from latest River Dee model at the outflow locations. The River Dee model has used the Mean High-Water Spring tidal curve from the Coastal Flood Boundary Dataset[11] 2018 at the Hilbre Island (Chainage 1152) with a 30m^3/s fluvial flow rate in the River Dee. The peak timings of tidal levels extracted from River Dee have been matched with the fluvial peak of Queensferry Drain in line with the conservative assumptions.

2.5 Climate Change Allowances

The climate change allowances applied in this study are in line with the latest Welsh Government climate change guidelines from September 2021[12] and August 2022[13].

The climate change allowances have been chosen based on the lifetime of the proposed development (75-year, as was assumed in the previous stages of the project). The year 2025 has been defined as base year and 2100 horizon has been considered as future scenario. Therefore, the future scenarios have considered 2080s horizon (2070 to 2115) and the central estimate of the climate change allowance, i.e., a 20% uplift to the rainfall intensity was applied within ReFH2 software for all sub-catchments aside from BRO01 where the peak river flow was manually uplifted using the 20% uplift.

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[9] Home | DataMapWales (gov.wales), Accessed January 2025

[10] Flood estimation – calculation record, November 2024

[11] Coastal Design Sea Levels - Coastal Flood Boundary Extreme Sea Levels (2018), Environment Agency, Accessed January 2025

[12] Climate change allowances and flood consequences assessments (gov.wales), September 2021.

[13] Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales (gov.wales), August 2022.

Further details on the climate change allowances are presented in the hydrological Performa GN008[14].

[14] Flood estimation – calculation record, November 2024

3 Proposed Scenario Model Building

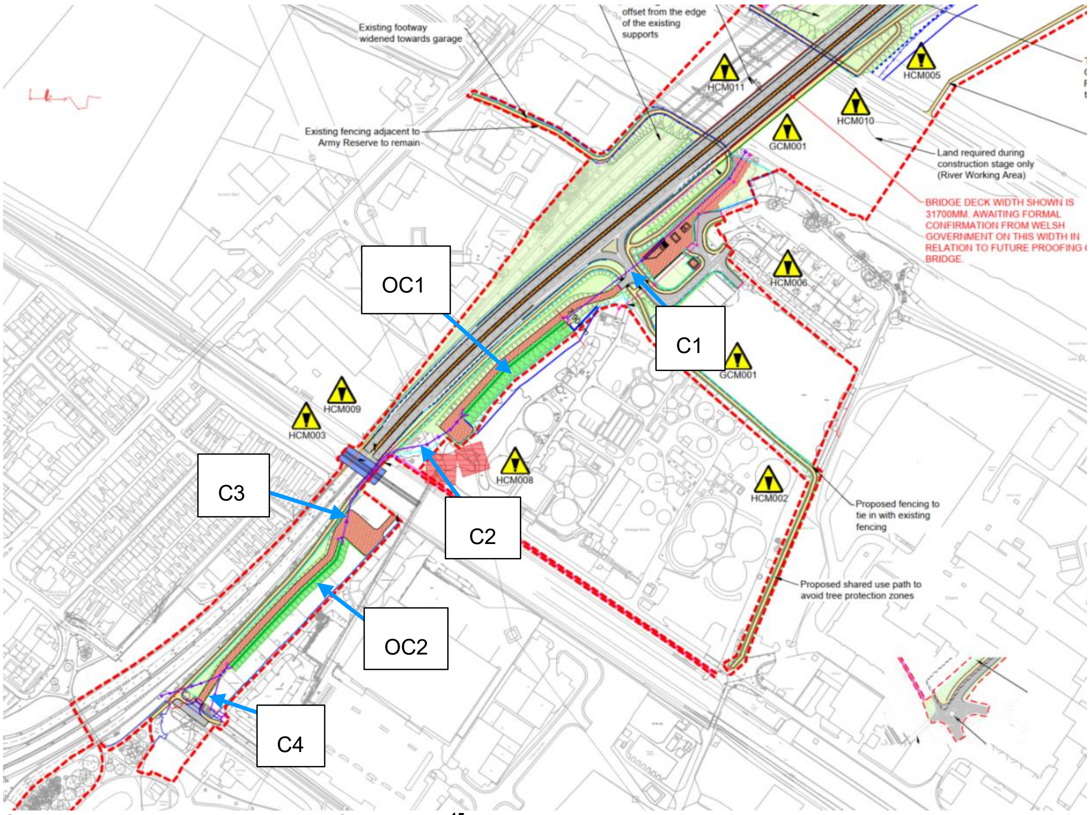
Mott Macdonald has previously undertaken hydraulic modelling for the options appraisal of the River Dee Bridge Replacement Scheme in September 2024. An emerging Preferred Option (previously referred to as Option 2) for the Scheme was identified during that stage.

In line with the latest design, the following amendments to the updated Existing scenario model (described in Section 2) have been made to build the Proposed scenario model:

3.1 1D Cross-Sectional Updates

Two open channel sections have been added. The open channel sections upstream and downstream of railway line have been called as Open Channel 1 (OC1) and Open Channel 2 (OC2) respectively as shown in Figure 3.1.

Figure 3.1: Proposed scenario Drawing Plan View



Source: 395318-MMD-00-XX-DR-C-0002-P02[15]

[15] 395318-MMD-00-XX-DR-C-0002-P02.pdf, March 2025

3.1.1 Open Channel 1 (OC1)

The invert levels for OC1 are based on design drawing 395318-MMD-00-XX-M2_D-0500[16]. The channel was built in 1D by adding the cross-sections at 20m centres with a total channel length of approximately 130m. A three-stage channel shape has been modelled.

The cross-sectional dimension for a typical section is shown in Figure 3.2. The design drawing showing the plan 395318-MMD-00-XX-DR-C-0004 has been used for the chainage values. The Modelled OC1 cross-sections are based on drawing named Section sheet 5 and Section sheet 6 between chainage 110 to chainage 240. The first cross-section QD_0330d represent section at chainage 110 in Section sheet 5 whereas the last section QD_0200u represents section at chainage 240 in Section sheet 6.

The first stage of channel consists of 1.7m wide bed and 1:1.5 side slopes. The second stage of channel consists of the maintenance track on left bank and the head grow on the right bank. The third stage of channel consists of slope embankment which ties up with the existing ground at both the banks.

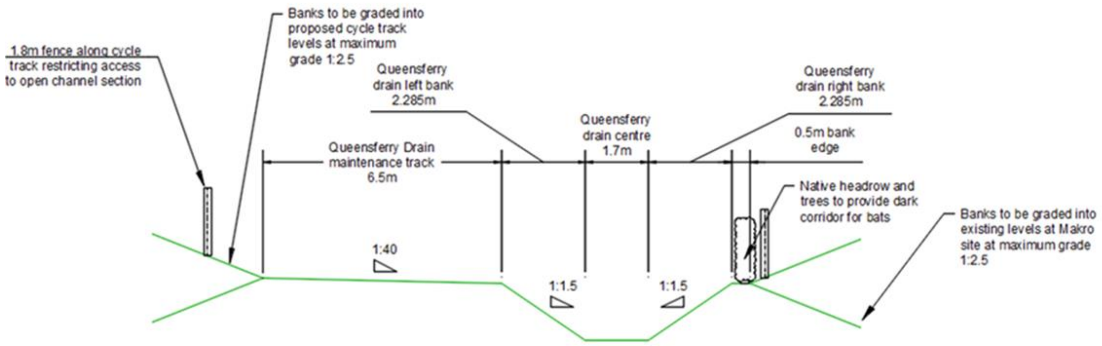
3.1.2 Open Channel 2 (OC2)

The invert levels for OC2 are based on design drawing 395318-MMD-00-XX-M2_D-0500.The channel was built in 1D by adding the cross-sections at 20m centres with a total channel length of approximately 150m. A three-stage channel shape has been modelled.

The cross-sectional dimension for a typical section is shown in Figure 3.2. The design drawing showing the plan 395318-MMD-00-XX-DR-C-0004[17] has been used for the chainage values. The Modelled OC2 cross-sections are based on section drawing sheets[18] named Section sheet 1 and Section sheet 2 between chainage 90 to chainage 240. The first cross-section QD_0650 represent section at chainage 90 in Section sheet 1 whereas the last section QD_0500u represents section at chainage 240 in Section sheet 2.

The stages of channel are the same as in OC1.

Figure 3.2: Cross-Sectional Dimensions of Typical Proposed Section



Source: Proposed scenario Design April, 2025

16 395318-MMD-00-XX-M2_D-0500.pdf, December 2024

17 395318-MMD-00-XX-DR-C-0004.pdf, February 2025

18 Queensferry Channel Section Drawings Sheets

3.2 1D Structural Updates

Four culvert sections have been proposed in the new Queensferry Drain watercourse, namely Culvert 1 (C1), Culvert 2 (C2), Culvert 3 (C3), and Culvert 4 (C4) as shown in Figure 3.1. The existing Chester Road East trash screen at inlet of C4 culvert has been retained. The dimensions of the proposed culverts are based on the design drawing 395318-MMD-00-XX-M2_D-0500.

Table 3.1: Details of Proposed scenario proposed culverts

Label	Type	Upstream Invert (mAOD)	Downstream Invert (mAOD)	Length (m)	Cross-sectional Dimensions
C1	Circular	2.27	1.716	227.64	1.5m
C2	Box	2.68	2.53	72.24	1.5m x 1.5m
C3	Box	3	2.81	41.61	1.5m x 1.5m
C4	Circular	3.41	3.3	50.15	1.5m

Source: Mott MacDonald, 2025

3.3 2D Topographical Updates

The proposed ground surface for the Proposed scenario has been added on top of the latest LiDAR data (mentioned in section 2.3). The proposed ground surface includes two open channels (mentioned in sections 3.1.1 and 3.1.2), shared use cycle track and carriageways as shown in Figure 3.1.

In the updated Existing scenario model, the buildings have been raised by 0.3m. The footprints of the buildings which are proposed to be demolished have been removed from the Proposed scenario model.

3.4 2D Roughness

A new material layer has been added on top of the existing OSMasterMap to represent the proposed features such as two channels, the shared use cycle track and the carriageways.

The footprints of buildings which are proposed to be demolished, and the general surface roughness has been applied at those building footprints.

4 Modelling Results

4.1 Summary of Modelled Scenarios

Table 4.1 and Table 4.2 provide a list of all modelled scenarios which have been completed for this assessment. This includes sensitivity runs on the culvert blockage, representation of buildings, structures parameters, downstream conditions and roughness values.

Table 4.1: Existing Scenarios

Model Run	Hydrological Event
QFD_BAS_DES_SD_10_25_0100_005	1% AEP Fluvial
QFD_BAS_DES_SD_10_25_0100_20CC_005	1% AEP 2100 Fluvial
QFD_BAS_DES_SD_10_25_01000_005	0.1% AEP Fluvial
QFD_BAS_DES_SD_10_25_01000_20CC_005	0.1% AEP 2100 Fluvial
Sensitivity Analysis Run	
QFD_BAS_SEN_B67P_SD_10_25_0100_20CC_005	1% AEP 2100 Fluvial + 67% blockage
QFD_BAS_SEN_B67P_SD_10_25_01000_20CC_005	0.1% AEP 2100 Fluvial + 67% blockage
QFD_BAS_SEN_BlockedBuildings_SD_10_25_0100_20CC_005	0.1% AEP 2100 Fluvial + blocked building polygons
QFD_BAS_SEN_HighSpillCoeff_SD_10_25_0100_20CC_005	0.1% AEP 2100 Fluvial + high spill Coeff
QFD_BAS_SEN_LowSpillCoeff_SD_10_25_0100_20CC_005	0.1% AEP 2100 Fluvial + low spill Coeff
QFD_BAS_SEN_HighTide_SD_10_25_0100_20CC_005	0.1% AEP 2100 Fluvial + High Tide
QFD_BAS_SEN_LowTide_SD_10_25_0100_20CC_005	0.1% AEP 2100 Fluvial + Low Tide
QFD_BAS_SEN_R20M_SD_10_25_0100_20CC_005	0.1% AEP 2100 Fluvial + 1d-2d roughness 20% increased
QFD_BAS_SEN_R20P_SD_10_25_0100_20CC_005	0.1% AEP 2100 Fluvial + 1d-2d roughness 20% decreased

Source: Mott MacDonald, 2025

Table 4.2: Proposed Scenarios

Model Run	Hydrological Event
QFD_SCH_DES_SD_10_25_0100_008	1% AEP Fluvial
QFD_SCH_DES_SD_10_25_0100_20CC_008	1% AEP 2100 Fluvial
QFD_SCH_DES_SD_10_25_01000_008	0.1% AEP Fluvial
QFD_SCH_DES_SD_10_25_01000_20CC_008	0.1% AEP 2100 Fluvial
Sensitivity Analysis Run	
QFD_SCH_SEN_B67P_SD_10_25_0100_20CC_008	1% AEP 2100 Fluvial + 67% blockage
QFD_SCH_SEN_B67P_SD_10_25_01000_20CC_008	0.1% AEP 2100 Fluvial + 67% blockage

Source: Mott MacDonald, 2025

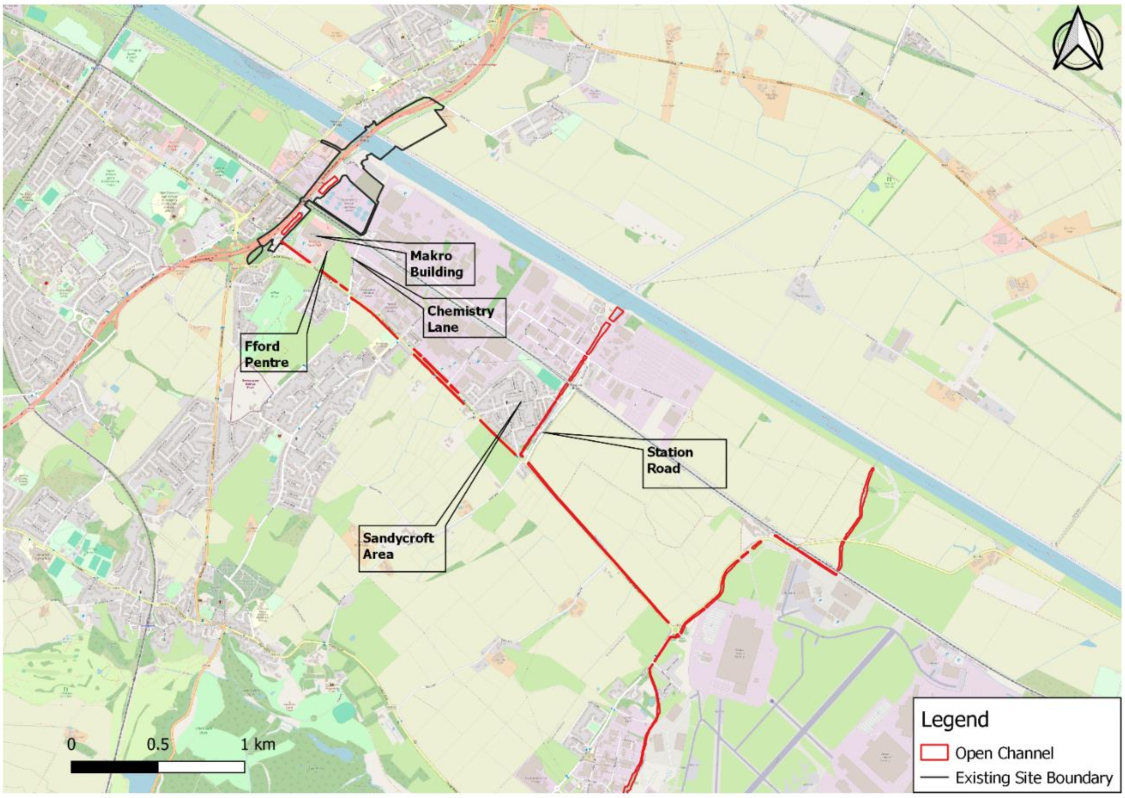
5 Results Comparison

5.1 Overview

The following sections compare the maximum flood extents and flood levels from the Existing scenario and Proposed scenario models for the 1% AEP, 1% AEP 2100, 0.1% AEP, and 0.1% AEP 2100 flood events

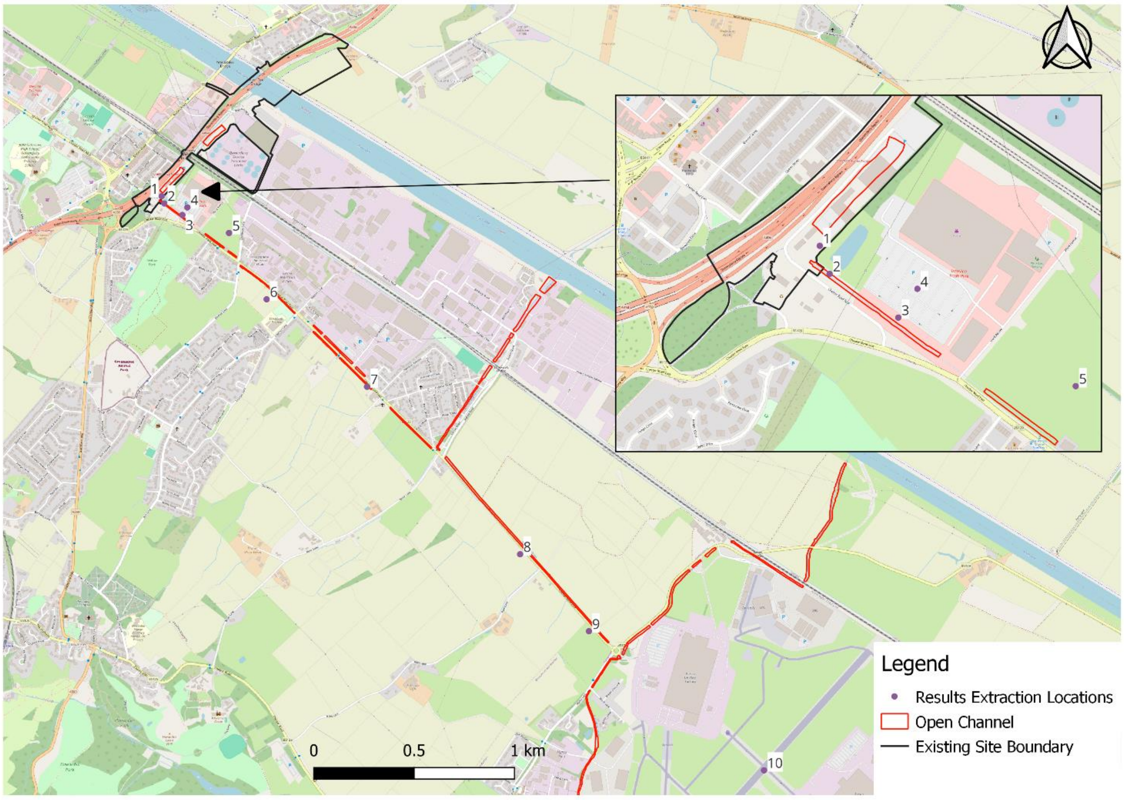
Figure 5.1 shows the location of the Scheme and the key areas of interest. Figure 5.2. shows the locations of 10 selected points used in the results comparison. The selected points represent nearby residential, commercial and open space receptors.

Figure 5.1: Areas of Interest



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

Figure 5.2: Results Extraction Locations



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

5.2 Existing scenario model Vs Proposed scenario model

This section represents the comparison of the maximum flood extents and flood levels for Existing scenario and Proposed scenario models. The maximum flood levels of the Proposed scenario Model have been subtracted from maximum flood levels of Existing scenario model. Therefore, the negative values show improvement whereas the positive values show increases in water levels.

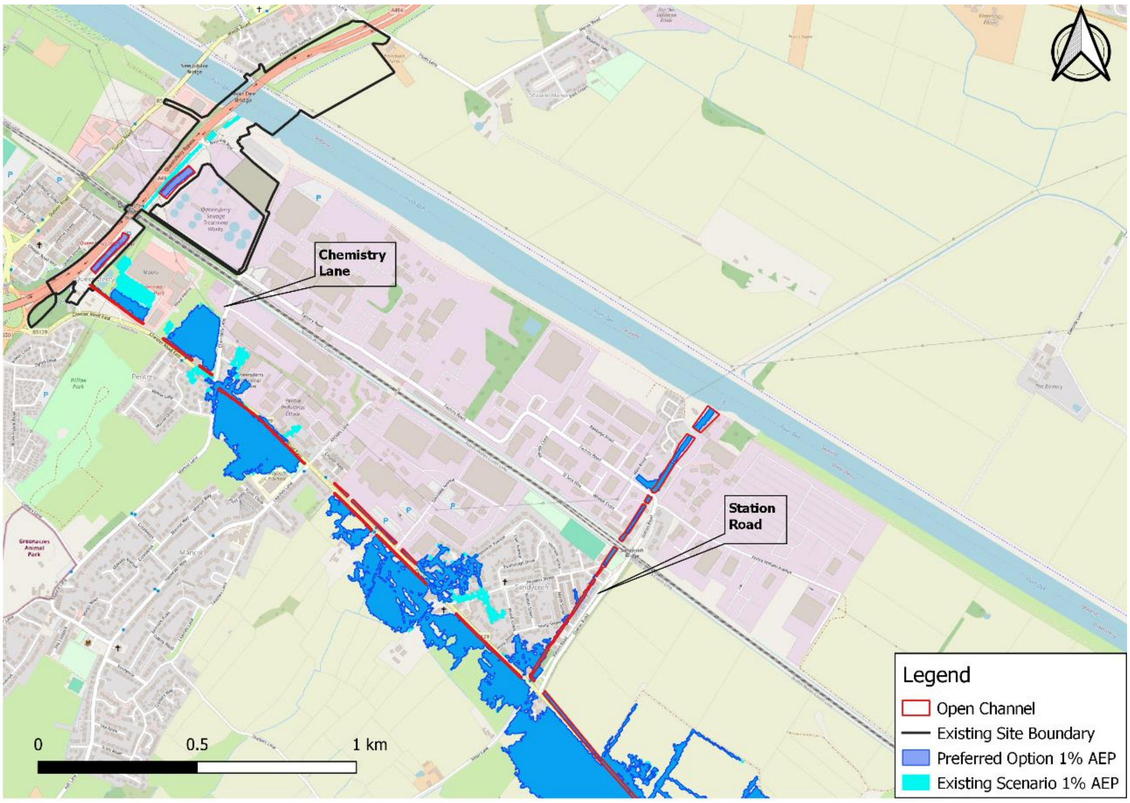
5.2.1 1% AEP Fluvial Event

Figure 5.3 and Table 5.1 show the comparison of maximum flood extent and flood water levels of Existing scenario and Proposed scenario models for the 1% AEP fluvial flood event. The Scheme has reduced the overall flooding when compared to existing flooding. The changes in flood risk are most significant downstream of Station Road. The Proposed scenario model has predicted smaller flood extent and lower flood levels in the area north of Station Road and in commercial areas of Queensferry, around Makro store. The maximum reduction is at Point 2, where the maximum flood levels are predicted to drop by 0.09m. This is because of the improved capacity of proposed culverts and open channels within the existing site boundary.

The changes in flood risk upstream of the Chemistry Lane are minor, with the predicted reduction of flood level in Pentre (Point 6) by 0.01m and no significant changes further upstream.

The flood extents comparison map is focused on the downstream areas of the Queensferry Drain catchment, with the full extent of modelled reach shown in appendix as Figure B.1

Figure 5.3: Existing scenario vs Proposed scenario Flood Extents for 1% AEP Flood Event



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

Table 5.1: Existing scenario vs Proposed scenario Flood Levels for 1% AEP Flood Event

Sample Point	Ground Level	Existing scenario	Proposed scenario	Change in depth (m)
1	5.380	no flooding	no flooding	N/A
2	4.230	5.124	5.035	-0.089
3	4.960	5.140	5.071	-0.069
4	4.930	5.066	no flooding	N/A
5	4.800	5.140	5.013	-0.127
6	5.280	5.563	5.556	-0.007
7	4.850	5.138	5.137	-0.001
8	4.810	5.422	5.422	0.000
9	5.095	5.436	5.436	0.000
10	4.255	no flooding	no flooding	N/A

Source: Mott MacDonald, 2025

Note: Sample Point locations are displayed in Figure 5.2

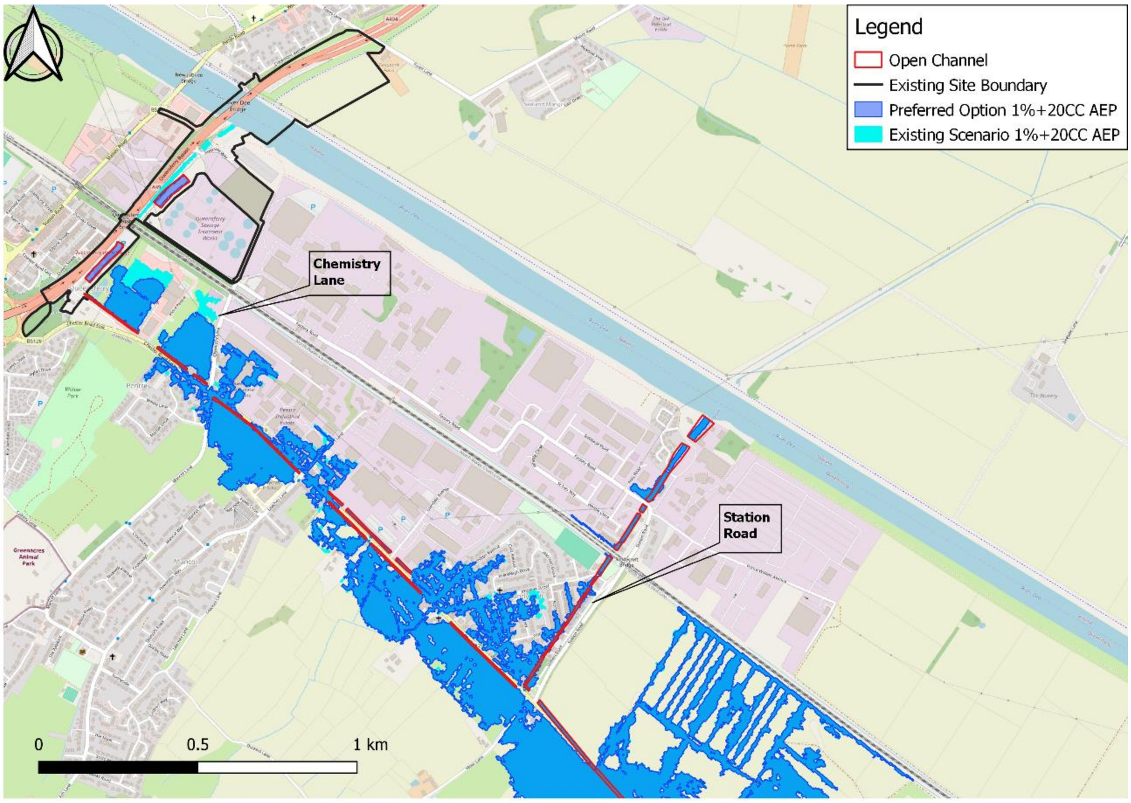
5.2.2 1% AEP 2100 Fluvial Event

Figure 5.4 and Table 5.2 show the comparison of maximum flood extent and flood water levels of Existing scenario and Proposed scenario models for 1% AEP 2100 flood event. The Scheme has reduced the overall flooding when compared to existing flooding. The Proposed scenario model has predicted smaller flood extent and lower flood levels in the area north of Station Road with the predicted maximum reduction in flood level by 0.07m immediately downstream of Chemistry Lane.

The predicted reduction in flood risk is due to the improved capacity of proposed culverts and open channels within the existing site boundary.

The flood extents comparison map is focused on the downstream areas of the Queensferry Drain catchment, with the full extent of modelled reach shown in appendix as Figure B.2

Figure 5.4: Existing scenario vs Proposed scenario Flood Extents for 1% AEP 2100 Flood Event



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

Table 5.2: Existing and Proposed scenario Flood Levels for 1% AEP 2100 Flood Event

Sample Point	Ground Level	Existing scenario	Proposed scenario	Change in depth (m)
1	5.380	no flooding	no flooding	N/A
2	4.230	5.222	5.175	-0.047
3	4.960	5.242	5.185	-0.057
4	4.930	5.242	5.185	-0.057

Sample Point	Ground Level	Existing scenario	Proposed scenario	Change in depth (m)
5	4.800	5.263	5.190	-0.073
6	5.280	5.600	5.599	-0.001
7	4.850	5.156	5.152	-0.004
8	4.810	5.447	5.447	0.000
9	5.095	5.470	5.470	0.000
10	4.255	4.288	4.288	0.000

Source: Mott MacDonald, 2025

Note: Sample Point locations are displayed in Figure 5.2

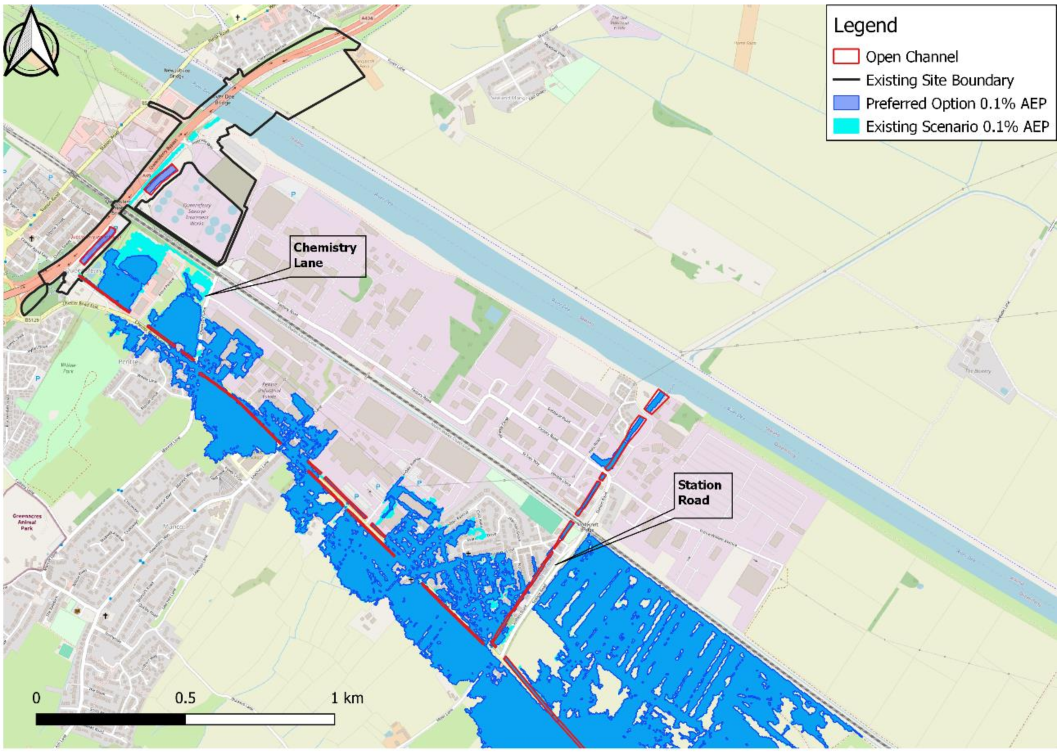
5.2.3 0.1% AEP Fluvial Event

Figure 5.5 and Table 5.3 show the comparison of maximum flood extent and flood water levels of Existing scenario and Proposed scenario models for 0.1% AEP flood event. The Scheme has reduced the overall flooding when compared to existing flooding. The Proposed scenario model has predicted smaller flood extent and lower flood levels in the area north of Station Road with the predicted maximum reduction in flood level by 0.189m immediately upstream of the proposed culvert C4.

The predicted reduction in flood risk is due to the improved capacity of proposed culverts and open channels within the existing site boundary.

The flood extents comparison map is focused on the downstream areas of the Queensferry Drain catchment, with the full extent of modelled reach shown in appendix as Figure B.3

Figure 5.5: Existing scenario vs Proposed scenario Flood Extents for 0.1% AEP Flood Event



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

Table 5.3: Existing scenario and Proposed scenario Flood Levels for 0.1% AEP Flood Event

Sample Point	Ground Level	Existing scenario	Proposed scenario	Change in depth (m)
1	5.380	no flooding	no flooding	N/A
2	4.230	5.356	5.170	-0.186
3	4.960	5.368	5.193	-0.175
4	4.930	5.367	5.193	-0.174
5	4.800	5.387	5.249	-0.138
6	5.280	5.622	5.620	-0.002
7	4.850	5.203	5.188	-0.015
8	4.810	5.462	5.462	0.000
9	5.095	5.492	5.491	-0.001
10	4.255	4.326	4.326	0.000

Source: Mott MacDonald, 2025

Note: Sample Point locations are displayed in Figure 5.2

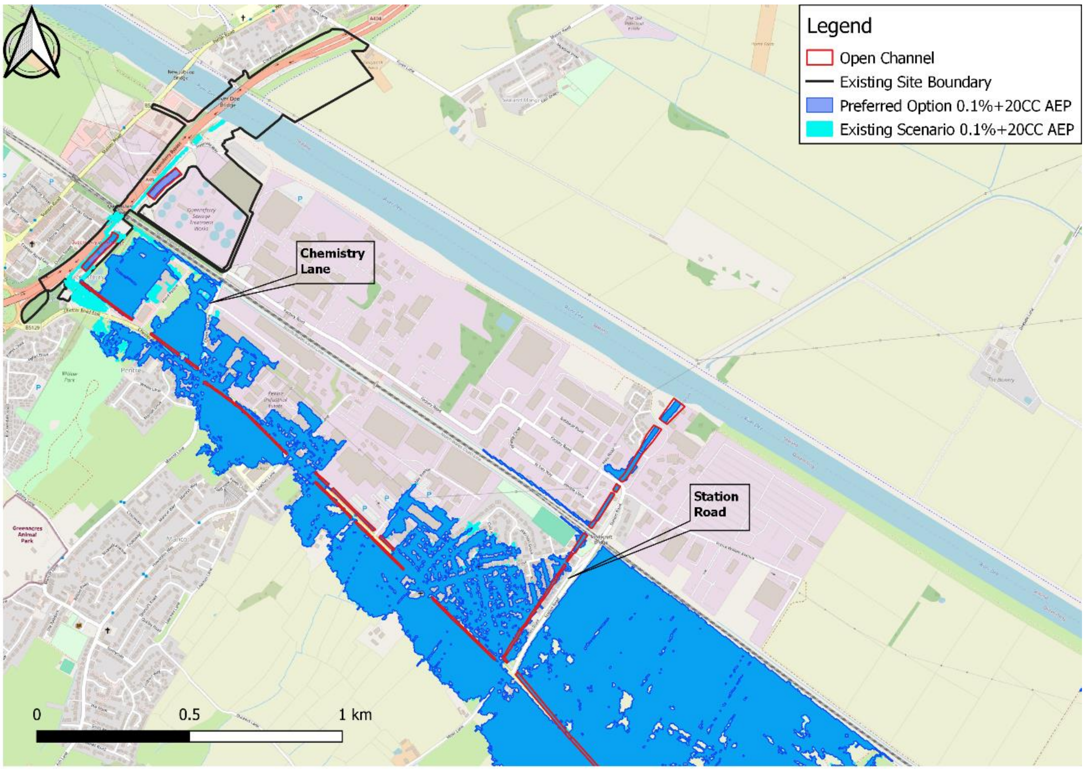
5.2.4 0.1% AEP 2100 Fluvial Event

Figure 5.6 and Table 5.4 show the comparison of maximum flood extent and flood water levels of Existing scenario and Proposed scenario models for 0.1% AEP 2100 flood event. The proposed Scheme has reduced the overall flooding when compared to existing flooding. The Proposed scenario model has predicted smaller flood extent and lower flood levels in the area north of Station Road with the predicted maximum reduction in flood level by 0.092m immediately upstream of the proposed culvert C4. The Proposed scenario model results show no overtopping of A494 highway embankment when compared to Existing scenario model results.

The predicted reduction in flood risk is due to the improved capacity of proposed culverts and open channels within the existing site boundary.

The flood extents comparison map is focused on the downstream areas of the Queensferry Drain catchment, with the full extent of modelled reach shown in appendix as Figure B.4

Figure 5.6: Existing scenario vs Proposed scenario Flood Extents for 0.1% AEP 2100 AEP Flood Event



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

Table 5.4: Existing scenario and Proposed scenario Flood Levels for 0.1% AEP 2100 Flood Event

Sample Point	Ground Level	Existing scenario	Proposed scenario	Change in depth (m)
1	5.380	5.475	no flooding	N/A
2	4.230	5.486	5.394	-0.092
3	4.960	5.495	5.407	-0.088
4	4.930	5.495	5.406	-0.089
5	4.800	5.509	5.440	-0.069
6	5.280	5.636	5.635	-0.001
7	4.850	5.255	5.245	-0.010
8	4.810	5.472	5.472	0.000
9	5.095	5.505	5.505	0.000
10	4.255	4.437	4.437	0.000

Source: Mott MacDonald, 2025

Note: Sample Point locations are displayed in Figure 5.2

6 Model Assumptions and Limitations

The key assumptions and limitations are as follows:

- The NRW model provided in June 2024 has been used to create the Existing scenario model and was further updated to build the Proposed scenario model for this study.
- The topographic data used in the NRW model is over 15 years old. To assess its accuracy, spot checks have been carried out to compare the NRW model data against the 2018 topographic data (obtained from NRW) and the latest available LiDAR. The comparison identified minor discrepancies in bank levels. The details of spot check are included in Appendix C.
- The roughness values used in NRW model are assumed to be correct and have not been further assessed.
- Topographic modifications for the Proposed scenario have been provided by the design team in April 2025 and are assumed to be the latest design. Any changes to the design may impact model results.
- A new Queensferry Drain Pumping Station facility is proposed to replace the existing pumping station. The operational rules of the pumping station are based on the previous Queensferry Drain model of the A494 Scheme from 2023 and it is assumed that the operational rules are unchanged and still represent the latest design.
- The existing Chester Road East trash screen has been modelled at the inlet of the long culvert upstream of railway in the Existing scenario model. The details of trash screen are based on survey drawing created in December 2018 by PM Surveys UK Ltd.
- The existing Chester Road East trash screen has been retained at inlet of C4 culvert in the Proposed scenario model. No trash screen is modelled at the railway culvert (C3 inlet).
- A new trash screen has been modelled at the inlet of pumping station as part of Proposed scenario design. The details of trash screen have been taken from the previous Scheme design submitted in September 2024.
- Based on the recorded flood outlines and assessment of vulnerability of receptors, eight structures were initially identified as critical to blockages. However, due to modelling instabilities, only five structures have been blocked and assessed in the blockage sensitivity analysis.
- Both the Existing scenario and Proposed scenario models use a dflood value of 6m in the simulation file (IEF). However, since both models are connected to the 2D floodplain via HX-CN links, which use water level rather than depth directly, the dflood value is unlikely to impact the model results.
- Tuflow double precision method has been used for both the Existing scenario and Proposed scenario models to improve stability. Double precision also provides greater numerical accuracy, particularly in simulations in urban environments or shallow flow conditions.
- A sensitivity analysis has been carried out to test the uncertainties of following modelling parameters. These are reported in Appendix A.
  - Blockage
  - Downstream boundary
  - Roughness coefficient
  - Structure coefficients
  - Building representation
  - Depth limit factor

– Automated Preissmann slot

7 Conclusions

Hydraulic modelling of the Queensferry Drain watercourse has been carried out to assess the impact of the proposed A494 River Dee Improvement Scheme. Hydraulic models for the Existing scenario and Proposed scenario have been constructed and run for the 1% AEP and 0.1% AEP fluvial flood events, including allowances for future climate change in 2100.

Based on the results comparison from the Existing scenario and Proposed scenario models, the study has concluded the following:

- An overall improvement in existing flood risk is predicted in the Proposed scenario model.
- The improvement in flood risk in the Proposed scenario is most prominent in the area downstream of Chemistry Lane. The improvement includes both the reduction in flood extent and decreased maximum flood levels.
- The maximum predicted reduction in flood depth is in the area downstream of Chemistry Lane (0.129m for the 1% AEP 2100 fluvial flood event).
- The changes upstream of Chemistry Lane are less significant, however, an improvement is still predicted.
- No significant change is predicted upstream of Station Road.
- The Existing scenario model is sensitive to the blockages of structures, the roughness values and the buildings representation.

Appendices

A. Sensitivity Analysis

Sensitivity analysis has been carried out on the following modelling parameters:

- Blockage
- Downstream boundary
- Roughness coefficient
- Structure coefficients
- Building representation

The blockage scenario runs have been undertaken for both 1% AEP 2100 and 0.1% AEP 2100 flood events and Existing scenario and Proposed scenario models.

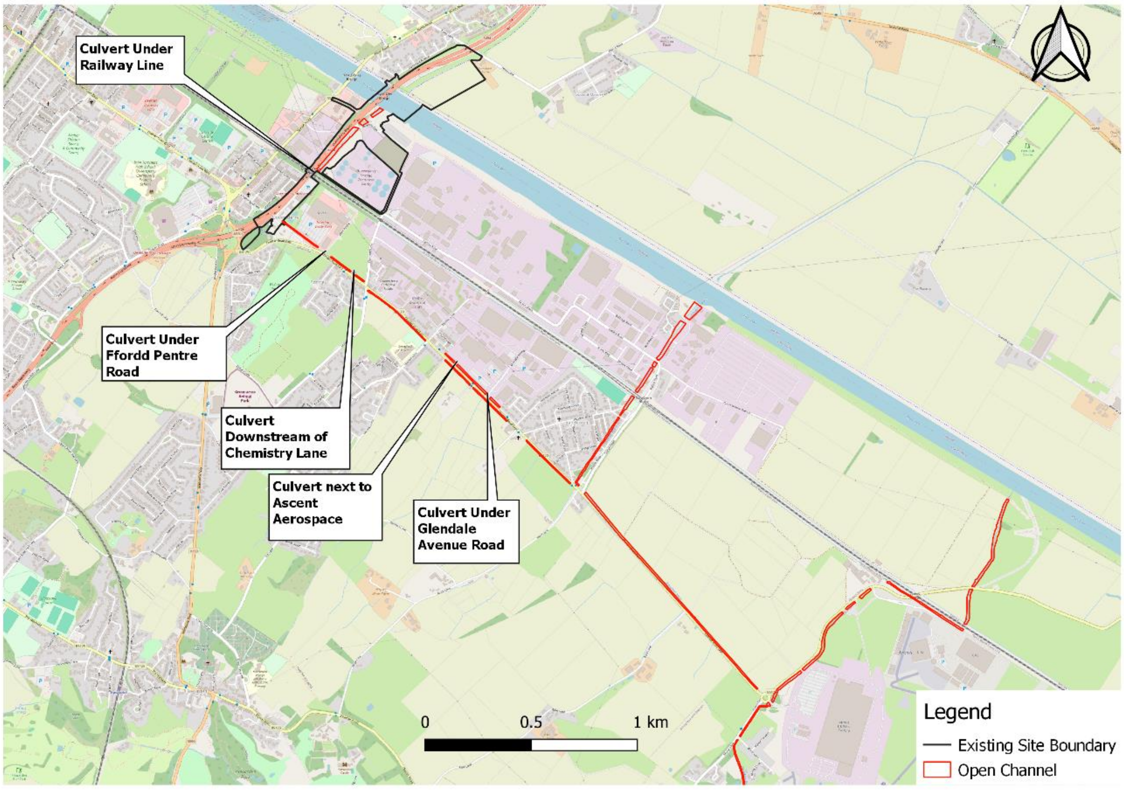
All other sensitivity runs have been undertaken for 1% AEP 2100 fluvial event and Existing scenario model only.

A.1 Blockage

Sensitivity analysis has been undertaken by blocking five critical structures shown in Figure A.1 by 67%. The blockage has been applied via blockage unit for each identified structure. The blockage units have been added as event file (IED) in the relevant simulation file (IEF). The blocked structures are listed below:

- Culvert Inlet (PD_0590cu) under Glendale Avenue Road
- Culvert Inlet (PD_0801CI) next to Ascent Aerospace
- Culvert Inlet (QD_1193cu) downstream of Chemistry Lane
- Culvert Inlet (QD_1039cu) under Fford Pentre Road
- Culvert Inlet (QD_0757cu) under Railway Line

Figure A.1: Blocked Structures



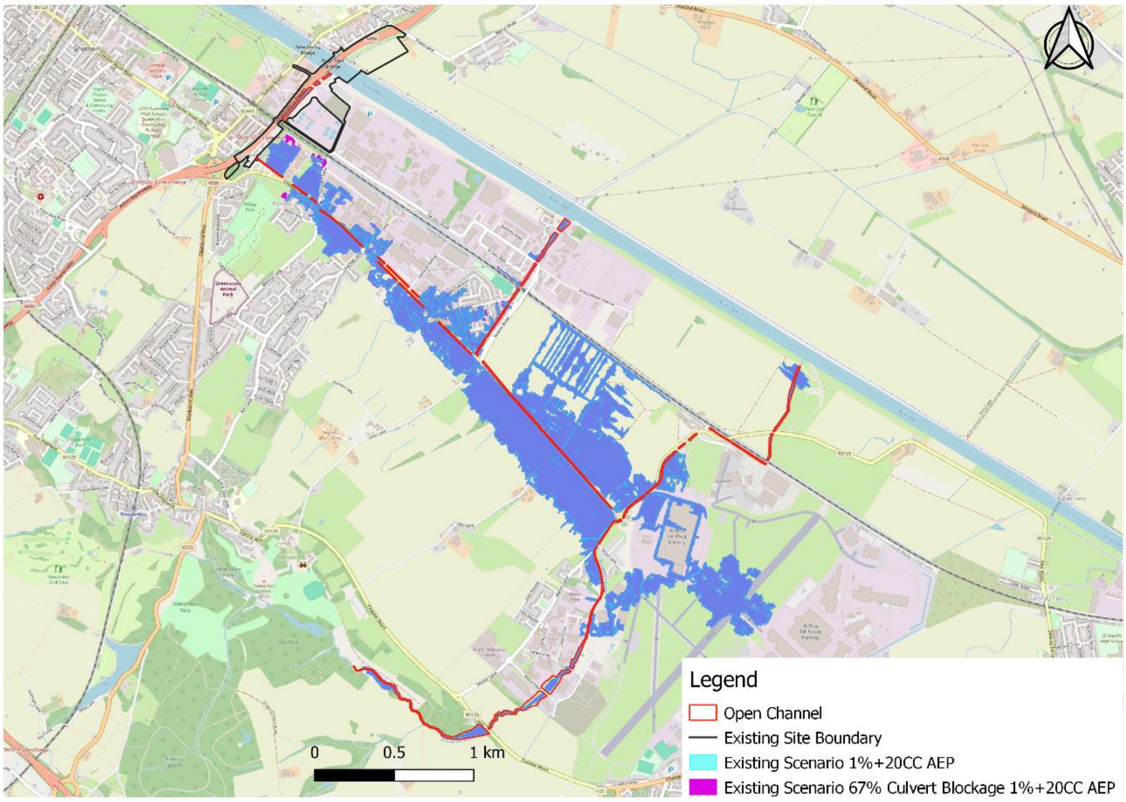
Source: © OpenStreetMap contributors; Contains OS data © Crown copyright and database rights (2025)

A.1.1 Existing scenario

Figure A.2 and Table A.1 show the comparison of maximum flood extent and flood water levels for Existing scenario and Existing scenario with 67% culvert blockage models, with the following conclusions:

- The Existing scenario model is sensitive to the blockages of the structures.
- The impact of blockage is limited to the area north-west of Station Road as shown in Figure A.2 and Table A.1.
- The blockage model has predicted larger flood extent in the Sandycroft area due to the blockage of the culverts in the downstream area.
- The blockage of culvert under Glendale Avenue Road has predicted larger flood extent in right floodplain in the residential area surrounded by Evansleigh Drive, Clair Avenue and Hamilton Avenue.
- The blockage of culvert under Fford Pentre Road has predicted larger flood extent in the commercial area between Ffordd Pentre Road and Chemistry Lane on the left right floodplain. There is also larger flood extent in the left flood plain due to the blockage of the culvert under Fford Pentre Road.
- The blockage of culvert under railway line has predicted larger flood extent in the Makro area in the right floodplain.

Figure A.2: Existing scenario vs Existing Scenario 67% Culvert Blockage Flood Extents for 1% AEP 2100 Flood Event



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

Table A.1: Existing Scenario vs Existing Scenario Blockage Sensitivity Flood Levels for 1% AEP 2100 Flood Event

Sample Point	Ground Level	Existing scenario (No Blockage)	Existing scenario (67% Blockage)	Change in depth (m)
1	5.380	no flooding	no flooding	N/A
2	4.230	5.222	5.246	0.024
3	4.960	5.242	5.261	0.019
4	4.930	5.242	5.261	0.019
5	4.800	5.263	5.287	0.024
6	5.280	5.600	5.601	0.001
7	4.850	5.156	5.158	0.002
8	4.810	5.447	5.447	0.000
9	5.095	5.470	5.470	0.000
10	4.255	4.288	4.288	0.000

Source: Mott MacDonald, 2025

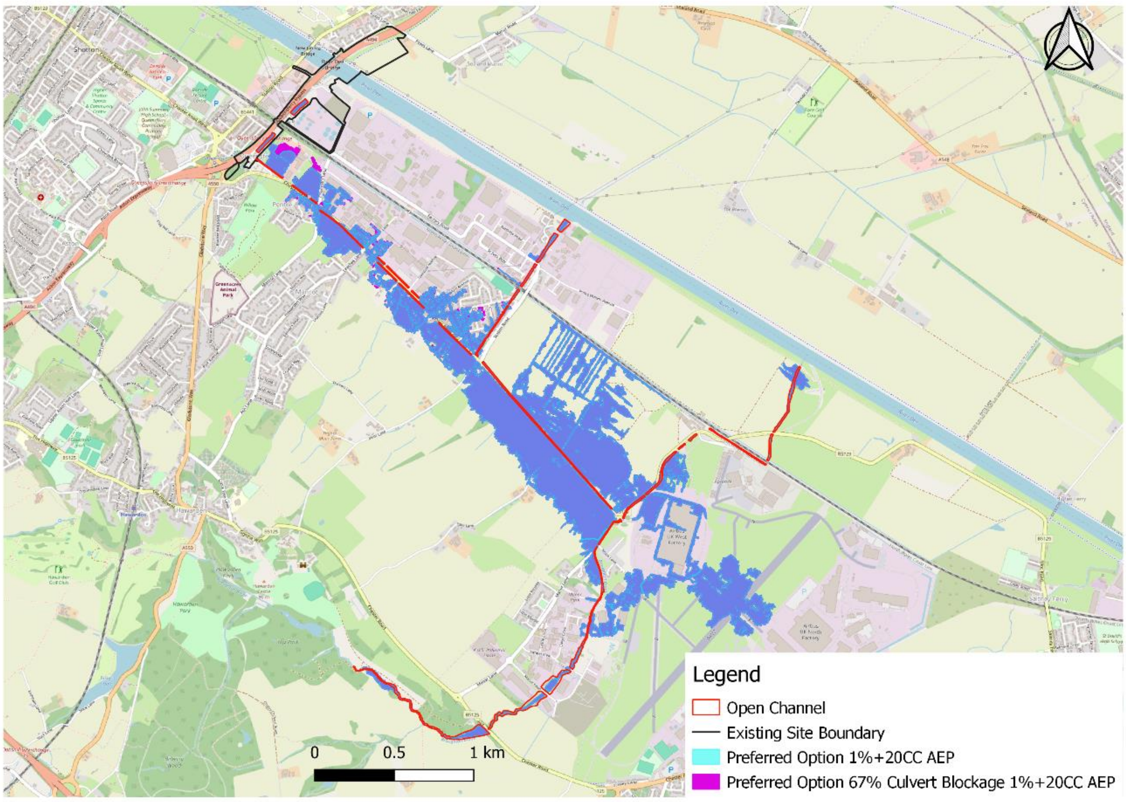
Note: Sample Point locations are displayed in Figure 5.2

A.1.2 Proposed scenario

Figure A.3 and Table A.2 show the comparison of maximum flood extent and flood levels for Proposed scenario and Proposed scenario with 67% culvert blockage models, with the following conclusions:

- The Proposed scenario model is sensitive to the blockages of the structures.
- The impact of blockage is limited to the area north-west of Station Road as shown in Figure A.2 and Table A.1.
- The blockage model has predicted larger flood extent in the Sandycroft area due to the blockage of the culverts in the downstream area.
- The blockage of culvert under Glendale Avenue Road has predicted larger flood extent in right floodplain in the residential area surrounded by Evansleigh Drive, Clair Avenue and Hamilton Avenue.
- The blockage of culvert under Fford Pentre Road has predicted larger flood extent in the commercial area between Ffordd Pentre Road and Chemistry Lane on the right floodplain. There is also larger flood extent in the left flood plain due to the blockage of this culvert.
- The blockage of culvert under railway line has predicted larger flood extent in the Makro area in the right floodplain.

Figure A.3: Proposed scenario vs Proposed scenario 67% Culvert Blockage Flood Extents for 1% AEP 2100 Flood Event



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

Table A.2: Proposed scenario vs Proposed scenario Blockage Sensitivity Flood Levels for 1% AEP 2100 Flood Event

Sample Point	Ground Level	Proposed scenario (No Blockage)	Proposed scenario (67% Blockage)	Change in depth (m)
1	5.380	no flooding	no flooding	N/A
2	4.230	5.175	5.201	0.026
3	4.960	5.185	5.212	0.027
4	4.930	5.185	5.212	0.027
5	4.800	5.190	5.258	0.068
6	5.280	5.599	5.601	0.002
7	4.850	5.152	5.155	0.003
8	4.810	5.447	5.447	0.000
9	5.095	5.470	5.470	0.000
10	4.255	4.288	4.288	0.000

Source: Mott MacDonald, 2025

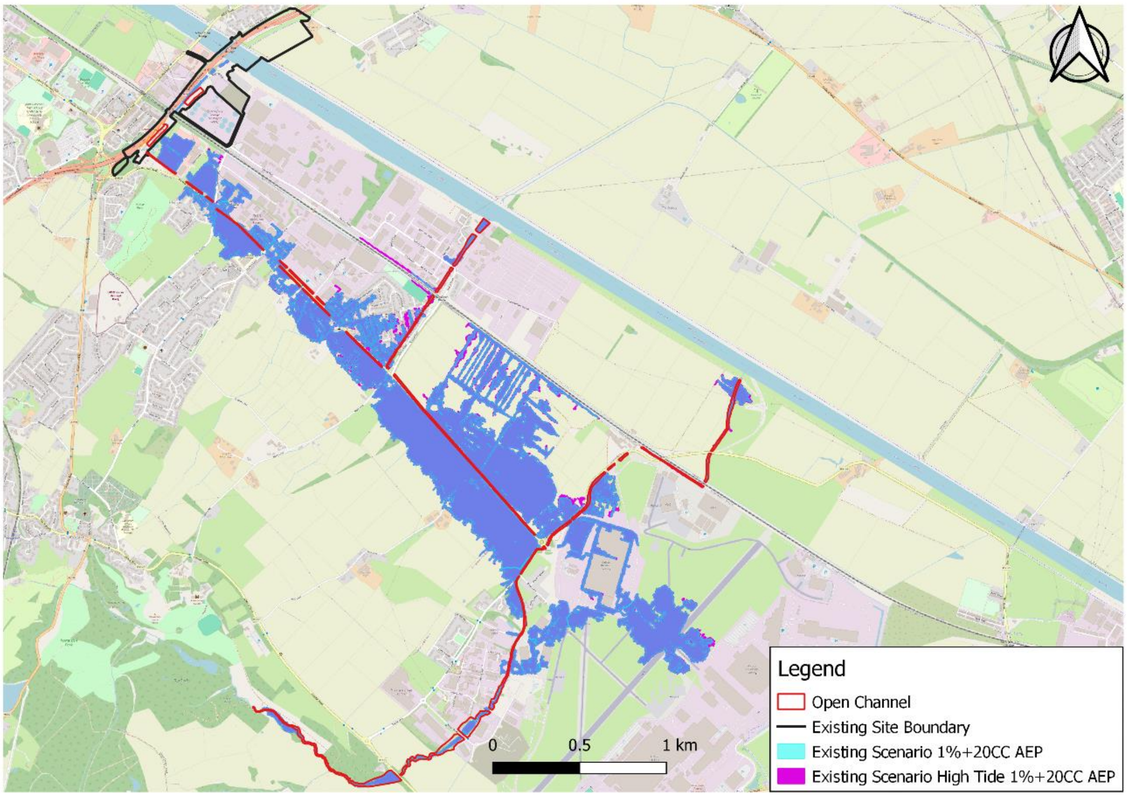
Note: Sample Point locations are displayed in Figure 5.2

A.2 Downstream Boundary

The downstream boundary sensitivity analysis has been undertaken by changing the future tidal levels by ±0.5m. The updated tidal levels (Low Tide and High Tide) were used as downstream boundary with the 1%AEP 2100 fluvial event for the sensitivity tests. Figure A.4 shows the comparison between Existing scenario and Existing scenario with high tide whereas the Figure A.5 shows the comparison between Existing scenario and Existing scenario with low tide. Table A.3 shows the comparison of maximum flood levels between Existing scenario and Existing scenario with high tide and low tide models.

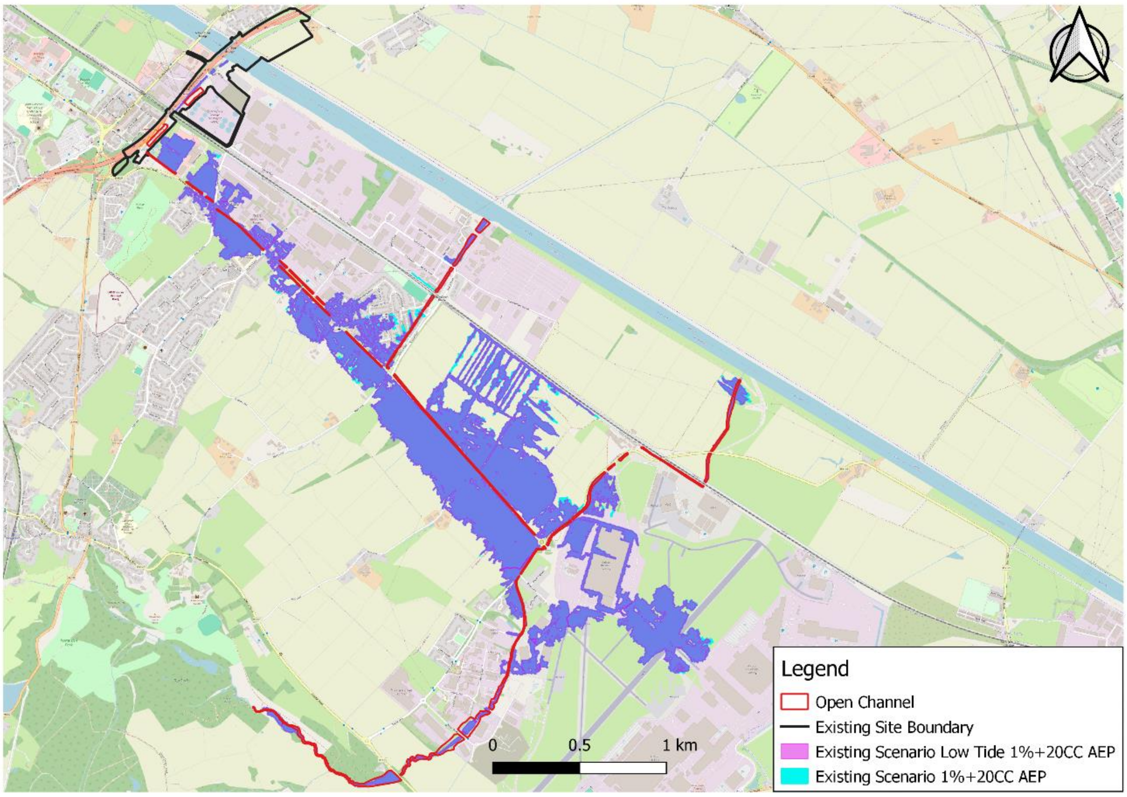
The impact of downstream boundary sensitivity is limited to 0.004m in the floodplain as shown in Table A.3. This is because the Queensferry Drain outlet has a flap valve and pumping system operation in parallel at its outlet. Therefore, the impact of the downstream conditions is minimal.

Figure A.4: Existing scenario vs Existing scenario High Tide Flood Extents for 1% AEP 2100 AEP Flood Event



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

Figure A.5: Existing scenario vs Existing scenario Low Tide Flood Extents for 1% AEP 2100 AEP Flood Event



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

Table A.3: Existing scenario vs Existing scenario Downstream Boundary Sensitivity Flood Levels for 1% AEP 2100 Flood Event

Sample Point	Ground Level	Existing scenario	Existing scenario (Low Tide)	Change in depth (m)	Existing scenario (High Tide)	Change in depth (m)
1	5.380	no flooding	no flooding	N/A	no flooding	N/A
2	4.230	5.222	5.217	-0.005	5.224	0.002
3	4.960	5.242	5.238	-0.004	5.245	0.003
4	4.930	5.242	5.238	-0.004	5.244	0.002
5	4.800	5.263	5.259	-0.004	5.265	0.002
6	5.280	5.600	5.600	0.000	5.600	0.000
7	4.850	5.156	5.154	-0.002	5.159	0.003
8	4.810	5.447	5.446	-0.001	5.448	0.001
9	5.095	5.470	5.469	-0.001	5.471	0.001
10	4.255	4.288	4.287	-0.001	4.288	0.000

Source: Mott MacDonald, 2025

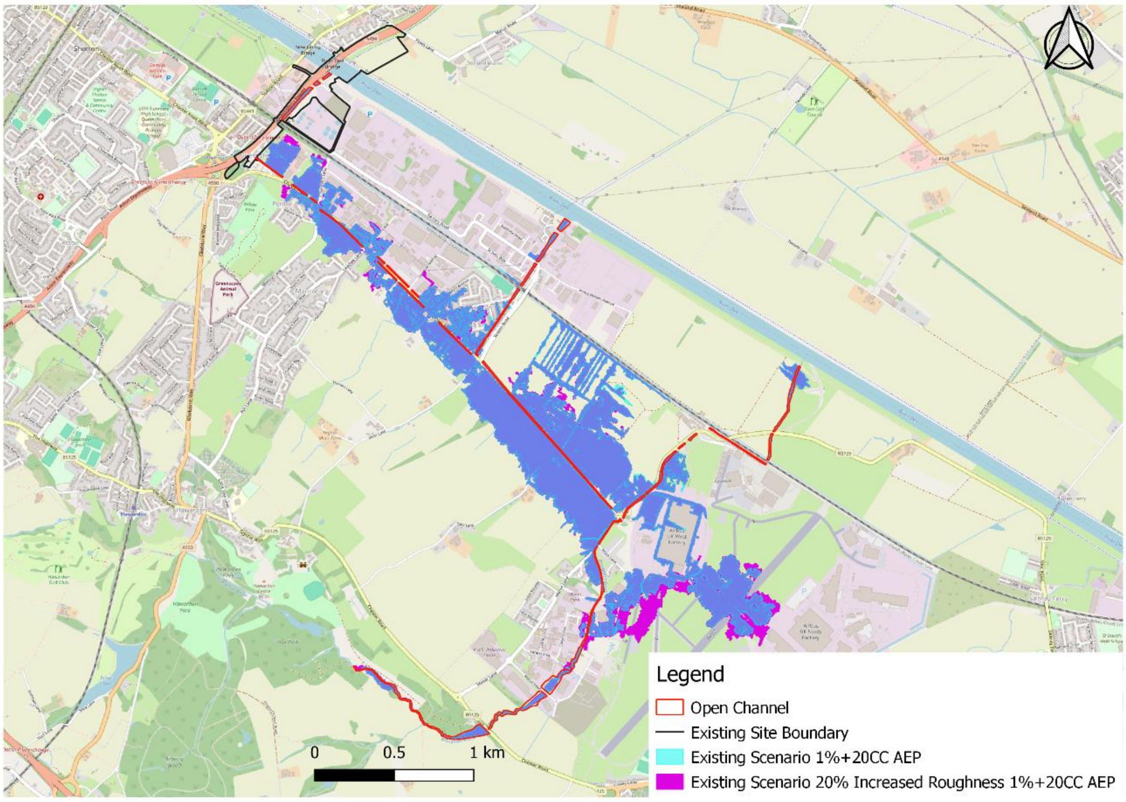
Note: Sample Point locations are displayed in Figure 5.2

A.3 Roughness Coefficient

The roughness coefficient sensitivity analysis has been undertaken by updating the existing 1d and 2d roughness values by ±20%. Figure A.6 shows the comparison between Existing scenario and Existing scenario with high roughness whereas the Figure A.7 shows the comparison between Existing scenario and Existing scenario with low roughness. Table A.4 shows the comparison of maximum flood levels between Existing scenario and Existing scenario with high and low roughness models.

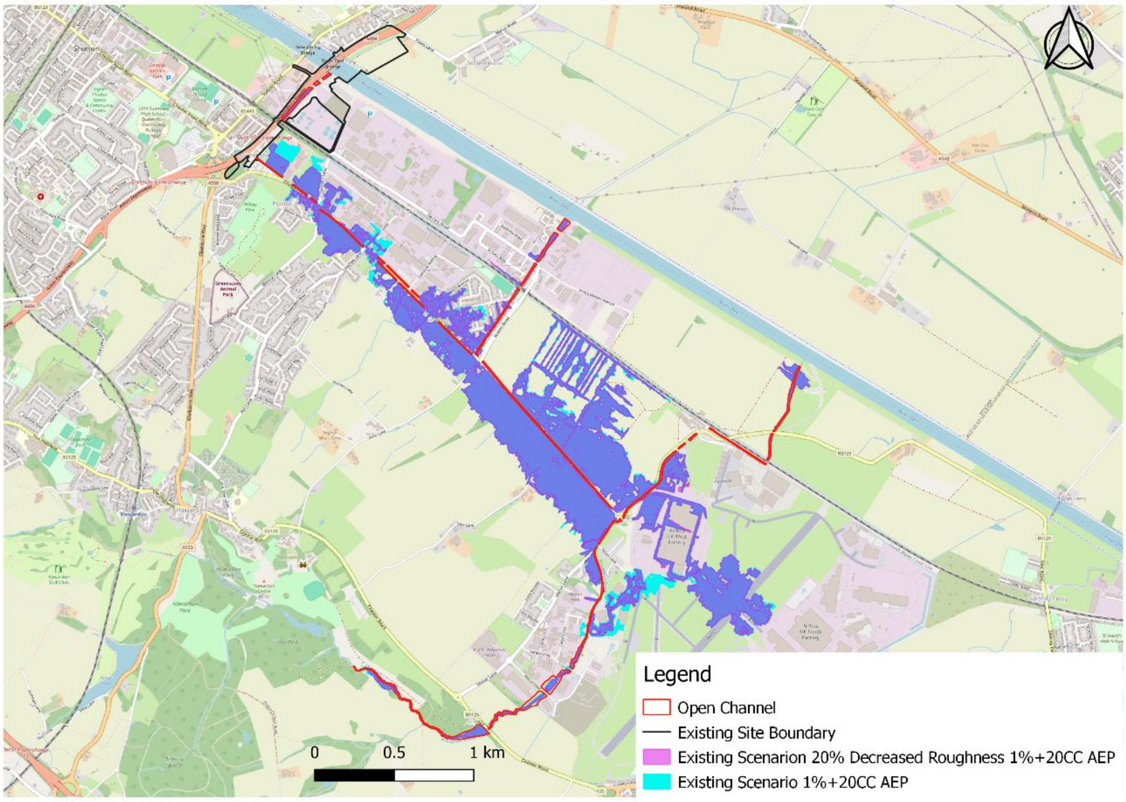
- The Existing scenario model is sensitive to the roughness values.
- The sensitivity to the roughness values has predicted larger and smaller flood extent throughout the modelled reach when compared with Existing scenario model for high and low roughness models respectively.
- The maximum impact of the roughness values change is downstream of the Fford Pentre Road.

Figure A.6: Existing scenario vs Existing scenario 20% High Roughness Flood Extents for 1% AEP 2100 Flood Event



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

Figure A.7: Existing scenario vs Existing scenario 20% Low Roughness Flood Extents for 1% AEP 2100 Flood Event



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

Table A.4: Existing scenario vs Existing scenario Roughness Sensitivity Flood Levels for 1% AEP 2100 Flood Event

Sample Point	Ground Level	Existing scenario	Existing scenario (20% Low Roughness)	Change in depth (m)	Existing scenario (20% High Roughness)	Change in depth (m)
1	5.380	no flooding	no flooding	N/A	no flooding	N/A
2	4.230	5.222	5.129	-0.093	5.275	0.053
3	4.960	5.242	5.154	-0.088	5.289	0.047
4	4.930	5.242	5.154	-0.088	5.289	0.047
5	4.800	5.263	5.197	-0.066	5.303	0.040
6	5.280	5.600	5.592	-0.008	5.607	0.007
7	4.850	5.156	5.154	-0.002	5.163	0.007
8	4.810	5.447	5.443	-0.004	5.448	0.001
9	5.095	5.470	5.460	-0.010	5.476	0.006
10	4.255	4.288	4.288	0.000	4.300	0.012

Source: Mott MacDonald, 2025

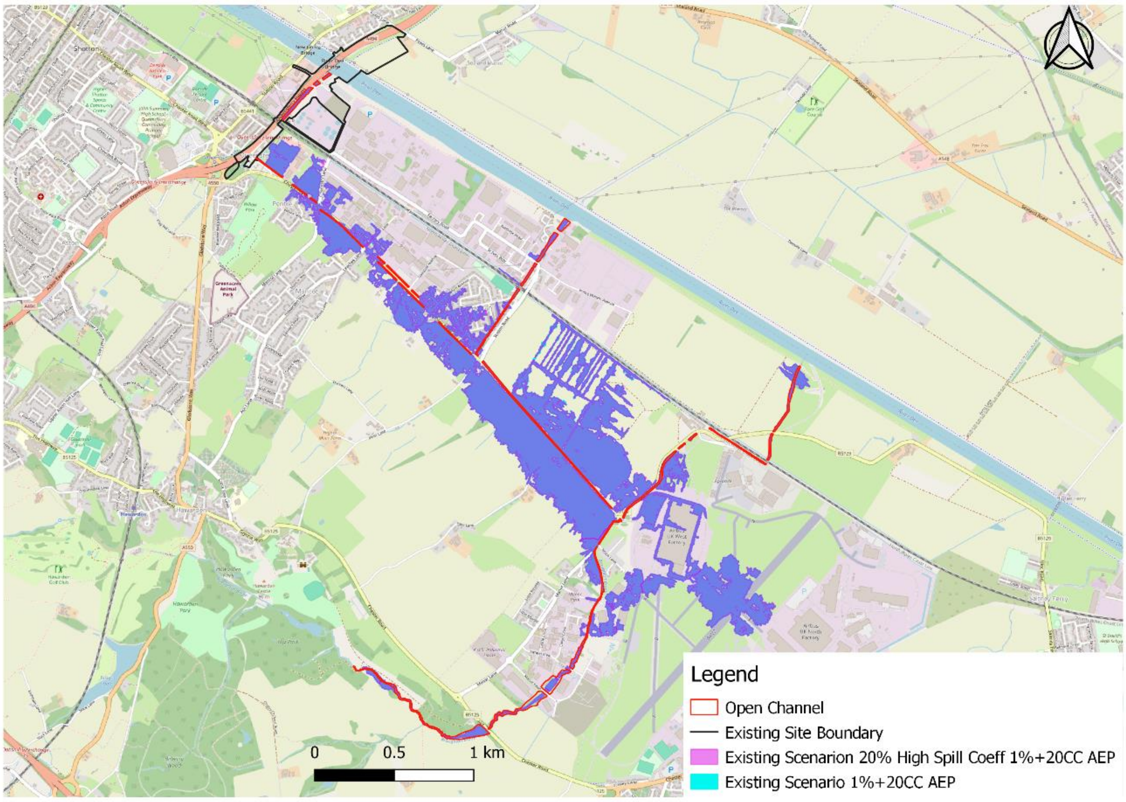
Note: Sample Point locations are displayed in Figure 5.2

A.4 Structure Coefficients

The structure coefficients sensitivity analysis has been undertaken by updating the existing spill coefficients by ±20%. The maximum spill coefficient has been maintained as 1.7. Figure A.8 shows the comparison between Existing scenario and Existing scenario with high spill coefficients whereas the Figure A.9 shows the comparison between Existing scenario and Existing scenario with low spill coefficients. Table A.5 shows the comparison of maximum flood levels between Existing scenario and Existing scenario with high and low spill coefficients models.

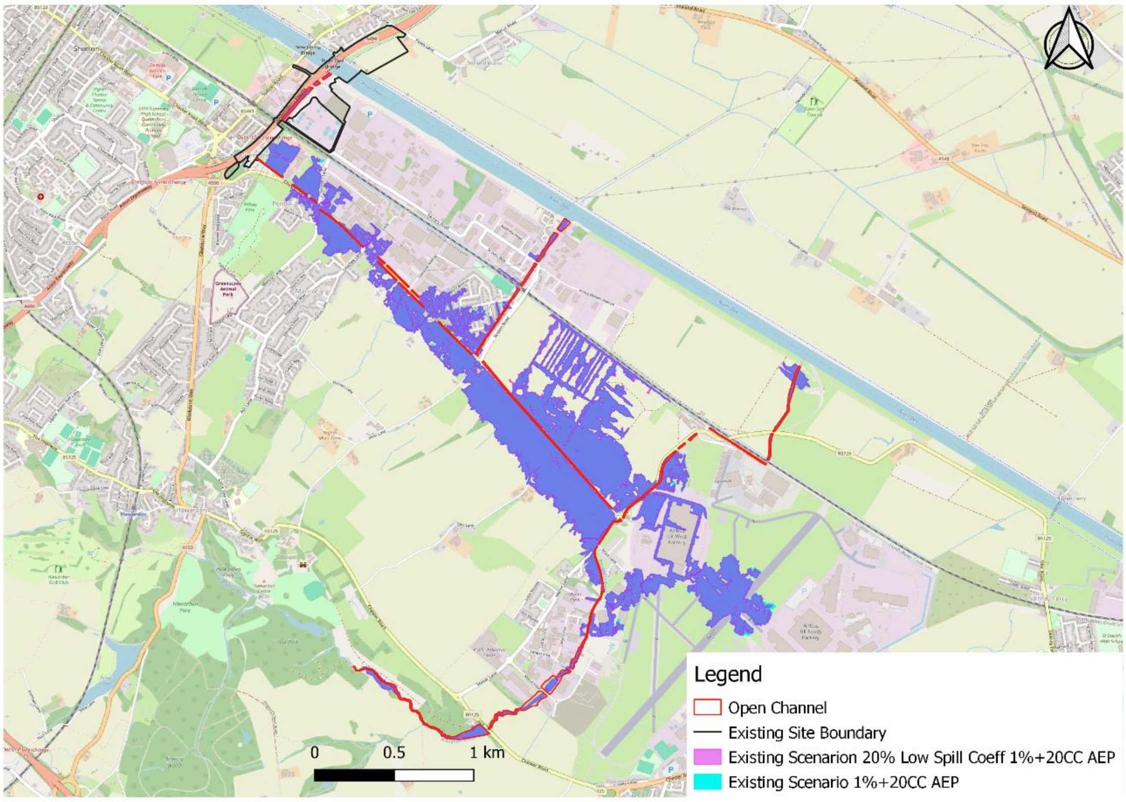
- The Existing scenario model is not highly sensitive to the structure(spill) coefficients. The impact of the spill coefficient sensitivity is limited within the channel.
- The impact of spill coefficients sensitivity is limited to 0.001m in the floodplain.

Figure A.8: Existing scenario vs Existing scenario 20% High Spill Coefficient Flood Extents for 1% AEP 2100 Flood Event



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

Figure A.9: Existing scenario Vs Existing scenario 20% Low Spill Coefficient Flood Extents for 1% AEP 2100 Flood Event



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

Table A.5: Existing scenario Vs Existing scenario Structure Coefficient Sensitivity Flood Levels for 1% AEP 2100 Flood Event

Sample Point	Ground Level	Existing scenario	Existing scenario (20% Low Coeff)	Change in depth (m)	Existing scenario (20% High Coeff)	Change in depth (m)
1	5.380	no flooding	no flooding	N/A	no flooding	N/A
2	4.230	5.222	5.219	-0.003	5.223	0.001
3	4.960	5.242	5.240	-0.002	5.243	0.001
4	4.930	5.242	5.240	-0.002	5.243	0.001
5	4.800	5.263	5.261	-0.002	5.263	0.000
6	5.280	5.600	5.601	0.001	5.600	0.000
7	4.850	5.156	5.162	0.006	5.157	0.001
8	4.810	5.447	5.448	0.001	5.447	0.000
9	5.095	5.470	5.471	0.001	5.469	-0.001
10	4.255	4.288	4.287	-0.001	4.288	0.000

Source: Mott MacDonald, 2025

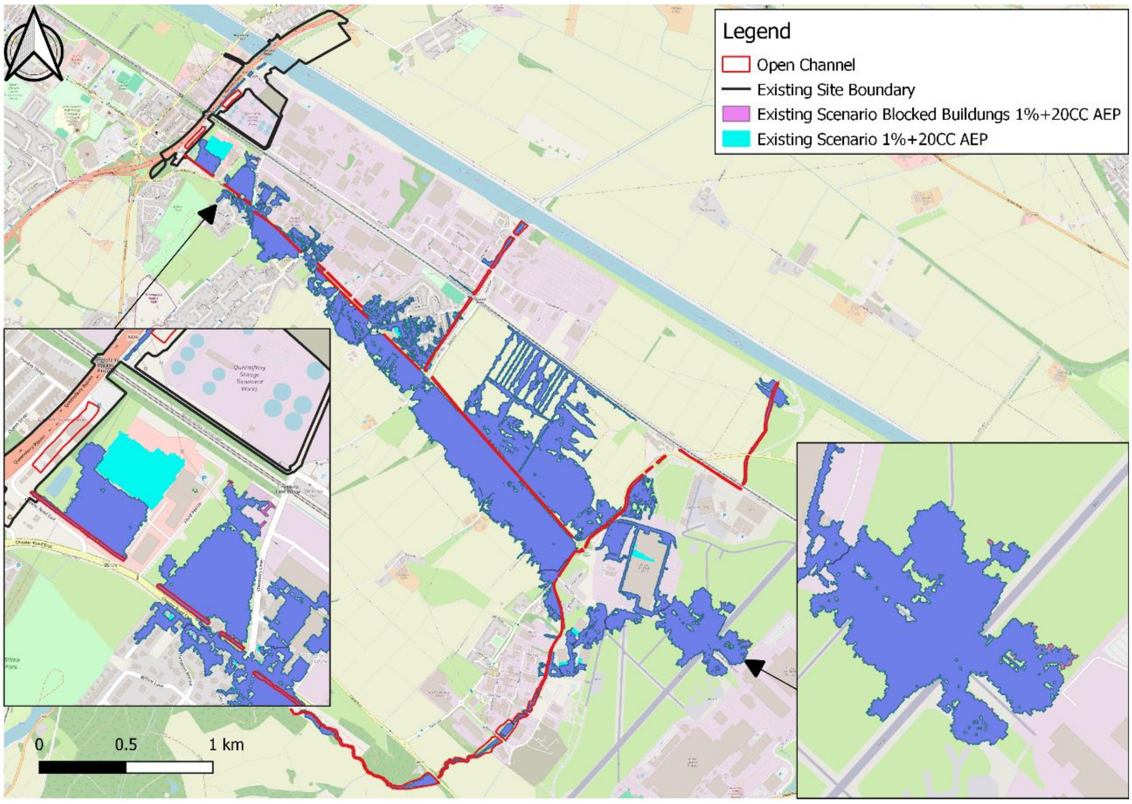
Note: Sample Point locations are displayed in Figure 5.2

A.5 Building Representation

The building representation sensitivity analysis has been undertaken by blocking the existing buildings 100%. This has been carried out by deactivating the buildings polygons from the active floodplain. Figure A.10 and Table A.6 show the comparison of flood extents and flood levels between Existing scenario and Existing scenario with blocked buildings models, respectively.

- The Existing scenario model is sensitive to the building representation.
- Blocking of the buildings from the active flood plain has removed the flooding at Airbus UK West factory and as a result, it has predicted slightly larger flood extent east of the Airbus UK West factory as shown in the focused map in Figure A.10
- The above change has also removed the flooding at Makro building and as a result, it has predicted slightly larger flood extent in the right flood plain between the Chemistry Lane and Fford Pentre Road as shown in focused map in Figure A.10

Figure A.10: Existing scenario vs Existing scenario Blocked Buildings Flood Extents for 1% AEP 2100 Flood Event



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

Table A.6: Existing scenario vs Existing scenario Building Representation Sensitivity Flood Levels for 1% AEP 2100 Flood Event

Sample Point	Ground Level	Existing scenario (No Blockage)	Existing scenario (Buildings Blocked)	Change in depth (m)
1	5.380	no flooding	no flooding	N/A
2	4.230	5.222	5.225	0.003
3	4.960	5.242	5.246	0.004
4	4.930	5.242	5.246	0.004
5	4.800	5.263	5.265	0.002
6	5.280	5.600	5.600	0.000
7	4.850	5.156	5.157	0.001
8	4.810	5.447	5.447	0.000
9	5.095	5.470	5.470	0.000
10	4.255	4.288	4.288	0.000

Source: Mott MacDonald, 2025

Note: Sample Point locations are displayed in Figure 5.2

A.6 Depth Limit Factor

The Existing scenario and Proposed scenario models use a depth limit factor of 20. A sensitivity test has been carried out to assess the impact of this modelling parameter by applying the default value of 10. The test was conducted for 1% AEP 2100 fluvial event using the Existing scenario model. The results showed no difference when compared with the original Existing scenario model. Therefore, the Existing scenario and Proposed scenario models are not sensitive to the depth limit factor used in the modelling.

A.7 Automated Preissmann Slot

The Existing scenario and Proposed scenario models use automated Preissmann slot option enabled in the simulation (IEF) file. A sensitivity test has been undertaken to assess the impact of this modelling parameter by disabling the automated Preissmann slot option. The test was conducted for 1% AEP 2100 fluvial event using the Existing scenario model. Table A.7 shows a comparison of maximum flood levels between the Existing scenario model with and without automated Preissmann slot. The predicted impact of automated Preissmann slot is minimal, with a difference of 0.001m.

Table A.7: Existing scenario vs Existing scenario without Automated Preissmann Slot Sensitivity Flood Levels for 1% AEP 2100 Flood Event

Sample Point	Ground Level	Existing scenario (Automated Preissmann Slot)	Existing scenario (No Automated Preissmann Slot)	Change in depth (m)
1	5.380	no flooding	no flooding	N/A
2	4.230	5.222	5.222	0.000
3	4.960	5.242	5.243	0.001
4	4.930	5.242	5.243	0.001
5	4.800	5.263	5.263	0.000

Sample Point	Ground Level	Existing scenario (Automated Preissmann Slot)	Existing scenario (No Automated Preissmann Slot)	Change in depth (m)
6	5.280	5.600	5.600	0.000
7	4.850	5.156	5.157	0.001
8	4.810	5.447	5.447	0.000
9	5.095	5.470	5.470	0.000
10	4.255	4.288	4.288	0.000

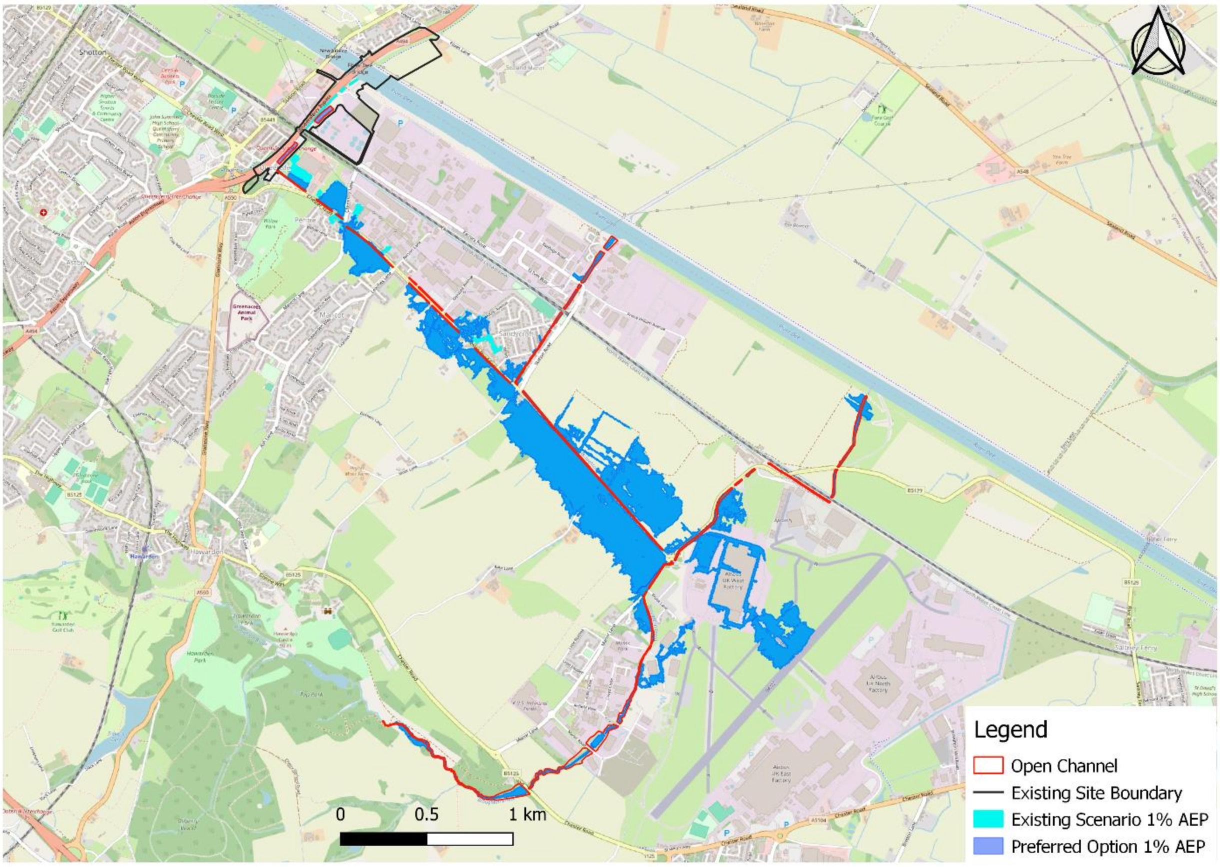
Source: Mott MacDonald, 2025

Note: Sample Point locations are displayed in Figure 5.2

B. Additional Figures

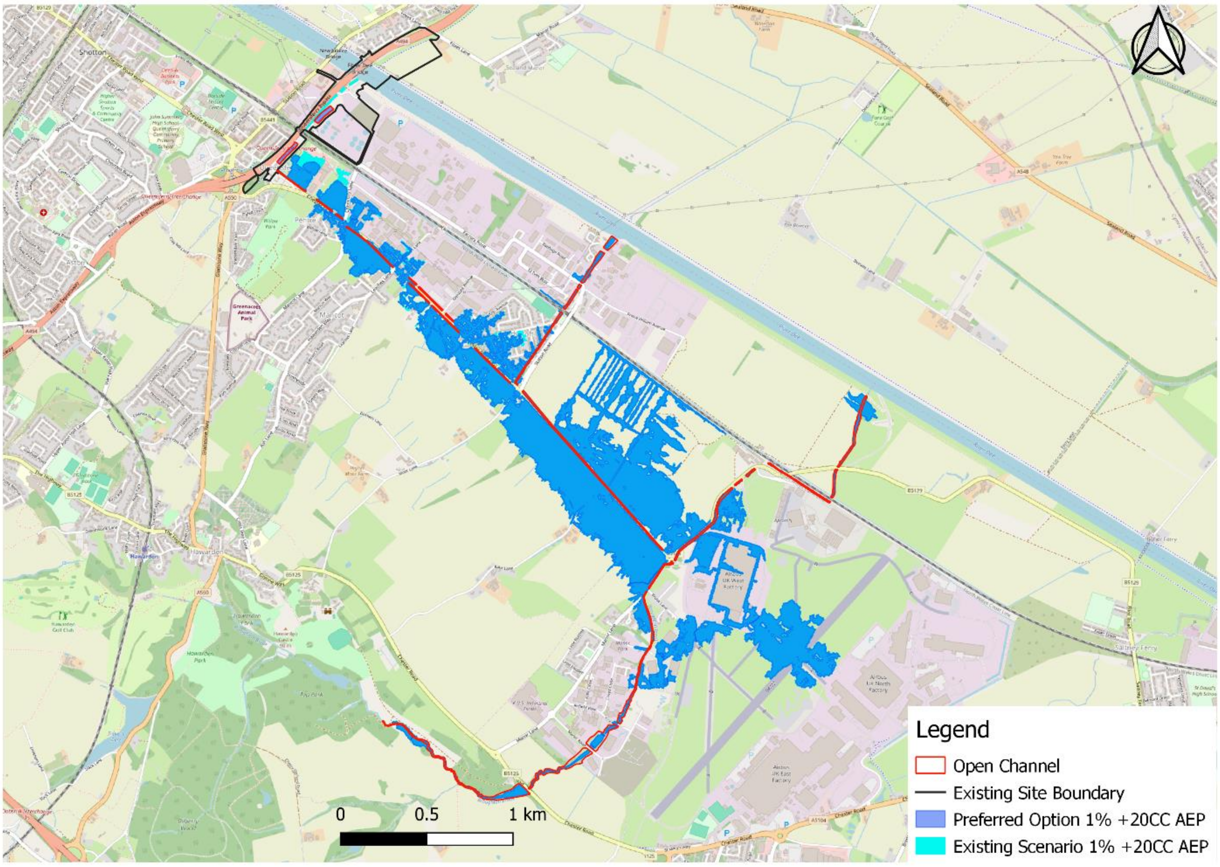
This section represents the additional figures of flood maps showing the full extent of modelled area comparing the flood extents for Existing scenario and Proposed scenario models for 1% AEP, 1% AEP 2100 AEP, 0.1% AEP and 0.1% AEP 2100 AEP flood events respectively.

Figure B.1: Existing scenario vs Proposed scenario Flood Extents for 1% AEP Flood Event



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

Figure B.2: Existing scenario vs Proposed scenario Flood Extents for 1% AEP 2100 Flood Event



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

Figure B.3: Existing scenario vs Proposed scenario Flood Extents for 0.1% AEP Flood Event

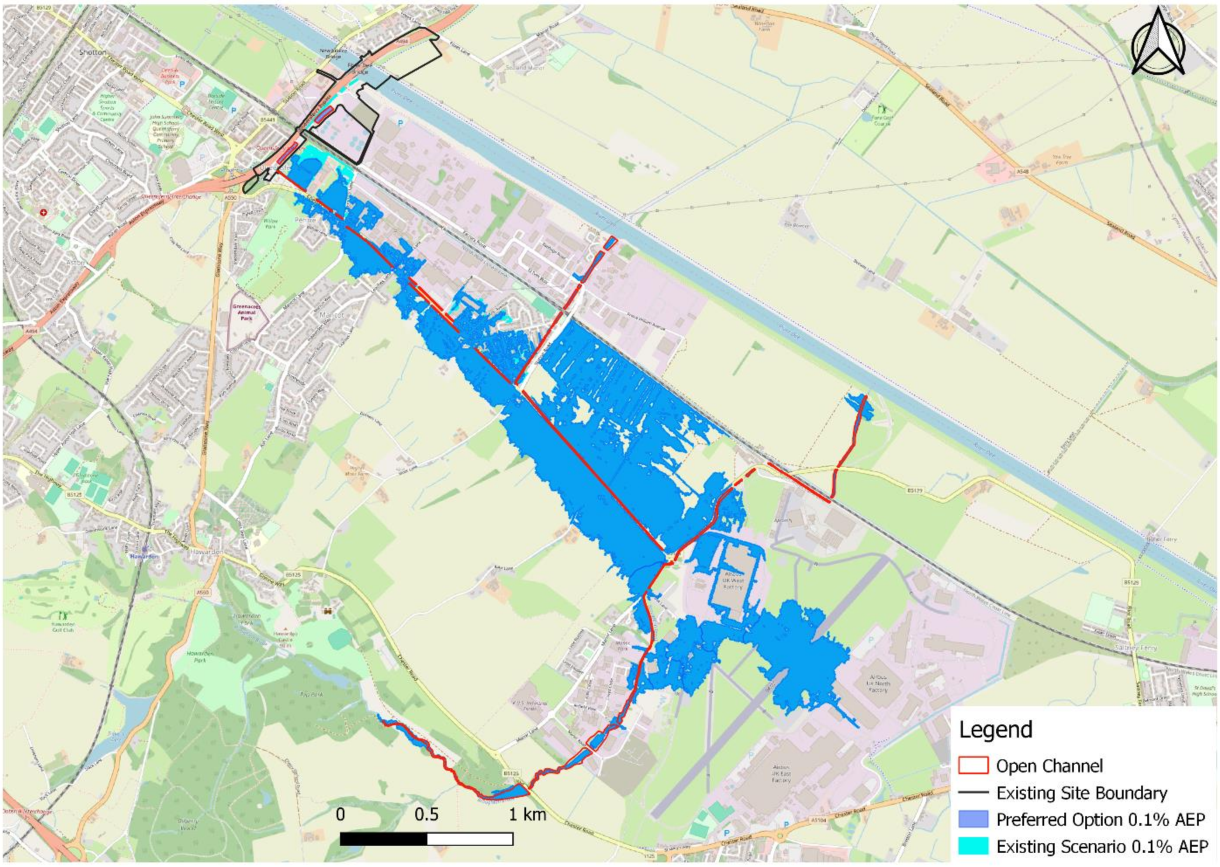


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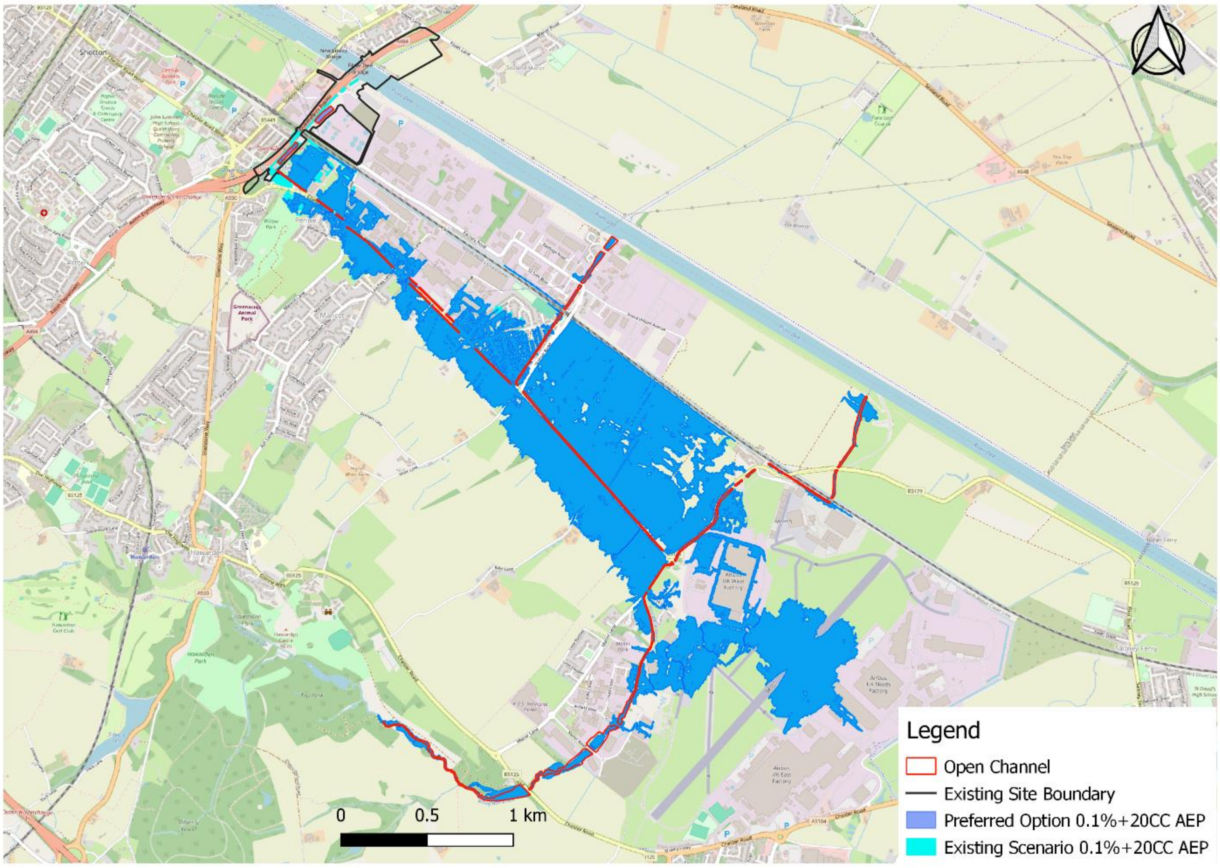
Figure B.4: Existing scenario vs Proposed scenario Flood Extents for 0.1% AEP 2100 Flood Event



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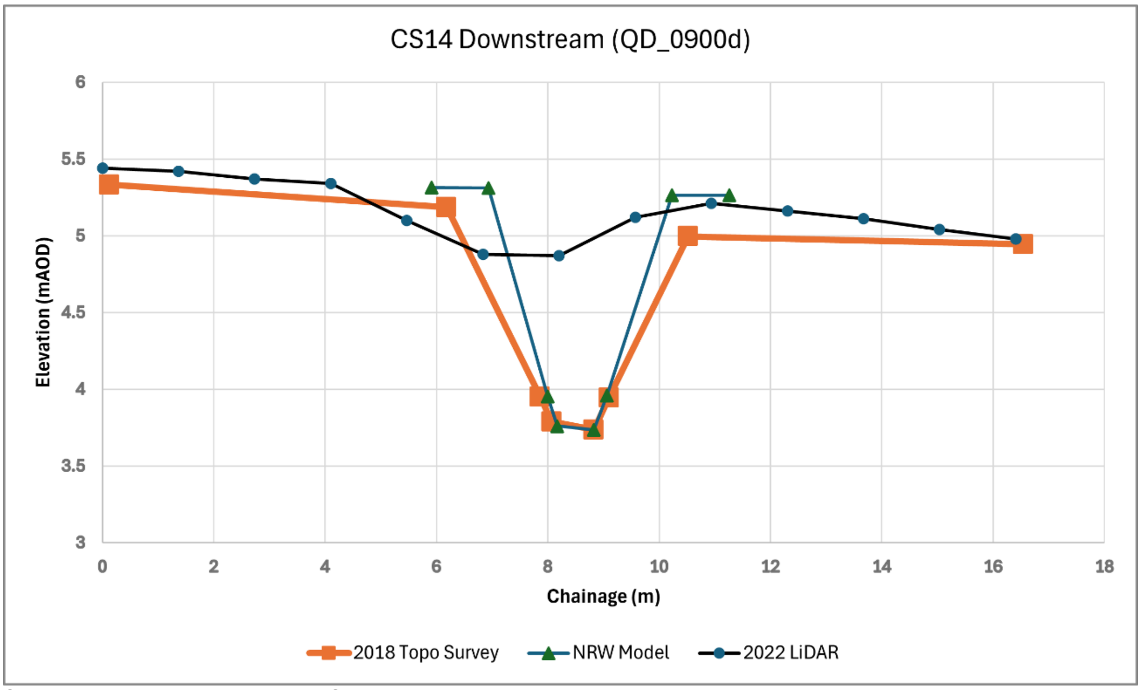
C. Cross-sectional Data Comparison

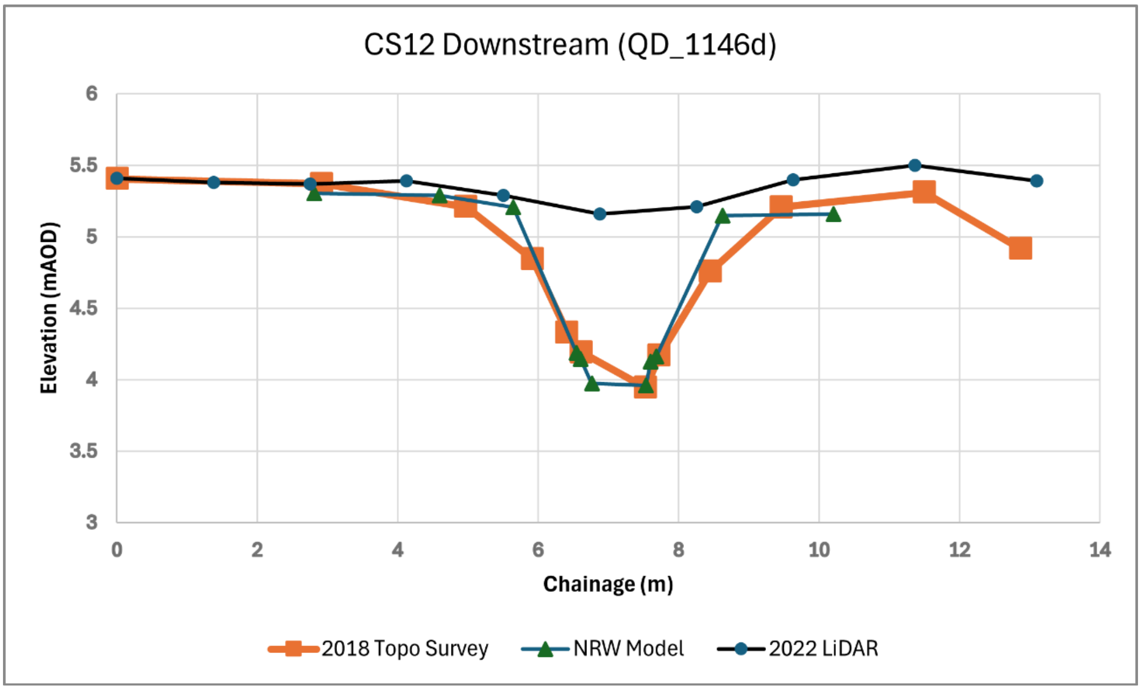
Figure C.1 and Figure C.2 compares the NRW model cross-sectional data with the 2018 topographical survey and the 2022 LiDAR data at sections QD_0900d and QD_1146d respectively. The NRW model data aligns well with the 2018 topographical survey, with minor differences observed in the bank levels. The 2022 LiDAR data also show slight variations in bank levels.

Figure C.1: Cross-sectional Data Comparison at QD_0900d



Source: NRW Model, 2018 Topo Survey and 2022 LiDAR

Figure C.2: Cross-sectional Data Comparison at QD_1146d



Source: NRW Model, 2018 Topo Survey and 2022 LiDAR

D. Photographs

Figure D.1: Broughton Brook

Source: Mott MacDonald, site visit

Figure D.2: Queensferry Drain channel

Source: Mott MacDonald, site visit

Figure D.3: Chester Road East - Trash Screen

Source: PM Surveys UK Ltd, December 2018

Figure D.4: Outfall to River Dee

Source: Mott MacDonald, site visit