

Stephenson Street Flood Scheme

safeguarding properties and business with sustainable and innovative interventions

by Jared Gethin, David Gareth, Robin Campbell, Jamie Lancaster & Jak Canham

Stephenson Street is Natural Resources Wales (NRW)'s largest and most complex flood scheme, which runs along the eastern bank of the River Usk in South Wales, from the Newport Transporter Bridge in the north to Nash in the south. The existing flood embankment was narrow and in poor condition with low spots presenting a risk of breach and in 2015, NRW classified the embankment as a failing asset due to subsidence and a varying low crest level. More than 190 homes and 620 businesses were at risk to a tidal breach from the River Usk in the present day, increasing to 1,120 homes and 1,020 businesses by 2070 due to climate change. The nature of the flooding is particularly hazardous due to the speed and depth of inundation, extending up to 2.5km inland.



Flood scheme nearing completion, looking south from Stephenson Street
Courtesy of Natural Resources Wales



Flood wall protecting Newport from January 2024 tidal surge
Courtesy of Natural Resources Wales

Project scope

The Stephenson Street Scheme comprises approximately 2km of raised defences (flood bund, sheet pile wall and reinforced concrete stem walls). Additional defences address outflanking, including a 9m-wide floodgate where Corporation Road passes beneath a railway. This required the construction of 0.7km of new highway to provide alternative access and emergency egress when the flood gate needs to be closed.

Planning & design

The design overcame significant constraints including challenging mudflat settlement, access/landowner access requirements and a plethora of congested existing utilities.

The project vision supports the area becoming a visitor destination in its own right. A 'hidden' flood defence wall integrates the scheme into its industrial setting. For the trail section, views out to the River Usk from sections of the iconic Wales Coast Path (WCP) were maintained and accessibility improvements delivered.

The scheme also improved community green spaces. Enhancements to Coronation Park comprised new accessible footpaths with regular resting and seating areas to offer views across the River Usk and to the restored Newport Transporter Bridge in a circular route. 1,600 trees were planted to form an area of urban forest, as well as shrubs, wildflower, grassland, and reedbed areas. In response to suggestions during community engagement, a linear seating feature was incorporated into the design to support the adjacent community football team pitch.

De-risking soft ground

Ground conditions at the site are dominated by around 14m of very soft tidal flat deposits. The soft material is highly compressible and exhibits long-term secondary creep behaviour.

In Coronation Park, the historical embankment was raised by about 1m and widened, maximising reuse of site-won material, then capped with imported clay, with allowance for the bund crest to settle a predicted 0.4m over 50 years.

The highway runs up and over the flood wall on an embankment. Innovatively for a flood defence scheme, Arup designed a prefabricated vertical band drain facilitated surcharge solution to drive out the predicted 0.9m settlement within the construction phase rather than over decades.

Surcharge was required to expedite the consolidation process and mitigate against secondary component of consolidation known as creep. This protects the highway pavement and flood walls from excessive settlement post-construction, whilst saving significant cost and carbon over traditional piled methods.

Continuous monitoring and various instrumentation interpretation allowed site team to update actuals vs prediction for effective forward planning of subsequent highway construction. The scheme has gained national interest and featured in *Ground Engineering*.

Environmental performance

With SAC watercourses in proximity and earthwork activities during inclement weather, silt mitigation was a key consideration. Through attenuation ponds, well considered pre-earthworks drainage and silt busters, construction avoided silt-related issues. The scheme was developed in consultation with the Sustainable Drainage Approval Body (SAB) and the Highways Authority, prior to adoption.

The River Usk at this location is a Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI) - extending from the river to the crest of the embankment. Parts of the embankment are also Sites of Importance to Nature Conservation (SINC) for their habitats. Shad, a species of fish, are a feature of the SAC and are sensitive to vibration.

Proactive, extensive ecological surveys and consultation with regulators over several years, managed risk with protected and invasive species. Surveys identified potential habitats for water vole, dormouse, badger and great-crested newt but confirmed these are not likely to be found or breeding within the affected works area.

Construction minimised the impact on any sensitive species and habitats to ensure no loss to protected habitats. Techniques such as innovative GIKEN reaction-based piling system minimised noise and vibration, avoiding consenting delays and challenges.

GIKEN silent piler and reaction-based zero footprint solution

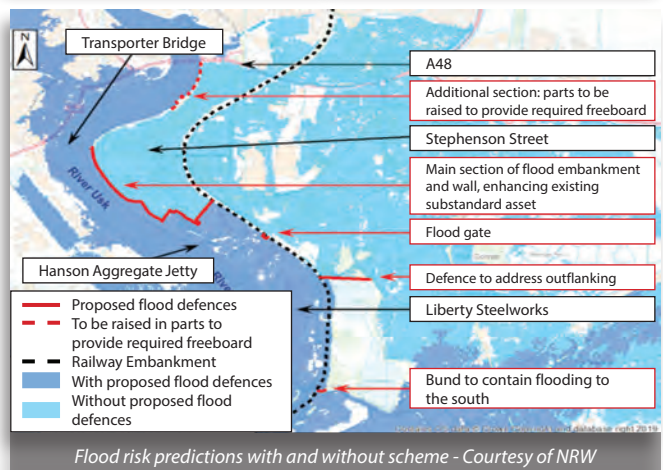
Between Coronation Park and the Felnex Industrial Estate, the existing bund was sandwiched between sensitive saltmarsh and businesses. Early engagement and collaborative design workshops with NRW environmental advisors and ECI partners led to the selection of silent press-piling systems to install 700m length of sheet pile wall; undertaken by Ivor King (CEC) Ltd.

Pile transportation, pitching and installation itself are carried out from on top of previously installed piles. This footprint-free method had multiple benefits:

- Eliminated the risk of vibrations impacting on neighbouring industrial properties.
- Eliminated the risk of vibrations impacting migratory fish (shad) in the River Usk.
- Eliminated the need for temporary platforms and workspaces for cranes.

Corporation Road flood gate

The 1.7m high and 9m span sliding flood gate across the Corporation Road highway prevents a flow path for flood water beneath a railway overbridge. As the access to industrial premises, the design considered the road is subject to a high volume of Heavy Goods Vehicles and also abnormal vehicles, and the gate was design for deployment in high winds by a single operative. The gate was manufactured by local Port Talbot-based firm MM Engineering.



Stephenson St Flood Scheme: Supply chain: key participants

Designer & ECC Services: Arup
Cost & project management: Arcadis
Principal contractor: Griffiths Ltd
Design support to Griffiths: Burroughs | Richter Consulting
Research & archaeology: Black Mountain Archaeology
Property & estates surveys: Bruton Knowles
Legal counsel: Gelbards
S185 management: DCWW Developer Services
Temporary works/shoring: MGF Ltd
FRC works: A&S Formwork Ltd
Piling: Ivor King - The Piling People
Access ramps/walkways design: Asset International Structures Ltd
Over pumping: Selwood
Works to rail culverts: Kaymac Marine & Civil Engineering Ltd
Floodgate design & manufacture: MM Engineering
Floodgate design assistance: Pebble Engineering Ltd

CCTV & jetting: GD Environmental
Traffic management: Quantum Traffic Management
Joint sealant to walls & bases: Sealability
Concrete & building products: Tarmac
S185 works: Velta
Material Supplies: Marshalls
Material supplies: Keyline Civils Specialist Ltd
Material Supplies: SDS Limited
Concrete & building products: Heidelberg Materials
Street lighting: PS Lighting
Reinforcement: BRC Reinforcement
Material supplies: Burdens
Concrete & building products: Cemex
Vertical 'wick' drains: COFRA
VRS: Littlewood Fencing
Soft landscaping: Eco Vigour | Landcraft Projects

There are a high number of existing statutory and non-statutory utilities in the carriageway. Construction was delivered through close collaboration with every statutory undertaker without impacts on project programme, minimising construction risk.

Carbon savings

Minimising embedded carbon was a key performance indicator for the scheme. An initial baseline embodied carbon assessment by the design team in advance of construction highlighted key areas for potential savings.

The team selected 'Eco' sheet piles, produced using recycled steel and 100% renewable energy, delivering a 40% reduction in sheet pile embodied carbon.

The concrete specification strongly promoted carbon reduction with cement replacement materials. Indeed, ordinary Portland cement was not permitted for use.

Sustainable earthworks balance

Creating an earthworks balance was challenging. The nature of the scheme and site constraints offered limited areas of fill. Also, the engineering and chemical parameters of most soils excavated were unfavourable. Facilitated by site-specific risk assessments to derive appropriate re-use criteria, the project team found a use for materials won in the highway construction within the formation of the Coronation Park flood bund. This allowed re-use of 3,500m³ of site-won material otherwise needing off-site disposal.

Educating the next generation

Educating the next generation of engineers and environmental specialists was an important aspect that was incorporated into the delivery model. Two engineering and one QA apprentices were employed on site. Trips with around 200 site visitors were organised and supported through organisations such as ICE, CIWEM and University of South Wales. The scheme was also an important part of Cardiff University's Civil Engineer Degree Year 4 module with fifty students attending each year for a site visit and presentation given by the site team.

Summary

Stephenson Street represents NRW's largest capital investment in a singular flood risk management project in Wales. The collaborative engagement between client, designer and contractor throughout development and delivery demonstrates inherent value; particularly through the incorporation of innovative, low-carbon engineering solutions and the early identification and utilisation of a local supply chain. Not only does the project provide improved resilience against tidal flooding, it also represents a scheme delivering wider benefits for people and the environment.

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Installation of band drains beneath the carousel embankment to expedite consolidation settlements - Courtesy of NRW



(top) Construction of the carousel and (bottom) completed embankment with reinforced concrete flood wall interfaces - Courtesy of NRW