South Wales Trunk Road Agency

Managing and Improving Motorways and Trunk Roads through South Wales

Asiantaeth Cefnffyrdd De Cymru

Rheoli a Gwella'r Traffyrdd a'r Cefnffyrdd yn Ne Cymru

Preliminary Design and Options Report

New Footbridge at Lower Town, Fishguard

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

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Prelim Design and Options Report for New Footbridge

Lower Town Fishguard

Service Provider/Consultant Name: Atkins

Service Provider/Consultant Project Number: 5153418/601/RPT01

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Contents

Tables

Figures

Executive Summary

Lower Town is located to the east of the main town of Fishguard at the mouth of the Afon Gwaun. Situated on the eastern side of the river, the TRA487 road bridge provides the only vehicular and pedestrian access point from the west. There is no footpath provision on the bridge. Pedestrians walk along the carriageway, thus sharing road space with vehicular traffic, to cross the bridge.

With a projected increase in footfall through Lower Town and pedestrian demand at the existing road bridge, without improvement there is an increased risk both in terms of pedestrian safety and reduced footfall along this section of the path.

Constructing a new footbridge would provide an opportunity to maximise the attractiveness of the route through Lower Town, whilst also mitigating the existing safety and severance problems.

The proposed location of the bridge has been agreed as the most optimum position taking into account the various competing constraints. These constraints include but are not limited to:

- Flood Impact Requirements
- Planning and Aesthetics
- Conservation and Heritage
- Statutory Undertakers Operational Requirements
- Public Realm Issues

Due to the proximity to the coastline (marine environment with high corrosive potential) the preferred option is a glass fibre polymer (GRP) bridge. The predominant reasons for selecting this material are highlighted below:

1. Lightweight structure thereby minimum foundation requirements
2. Minimal effects on flood issues and overland flow paths
3. Durable material which is well suited to marine environment (non-corrosive),
4. Comparable costs when compared against traditional alternatives
5. Low maintenance costs hence lower Whole Life Costs

Further details and visualisations are included within the report.

1 Introduction

The South Wales Trunk Road Agent (SWTRA) commissioned Atkins to undertake a design review for a new footbridge at Lower Town Fishguard downstream of the existing A487 structure.

The emphasis of this study is on the viability of a new proposed site with a review of the access requirements and land take to allow a solution to be developed in sufficient detail with key parties consulted to ensure all constraints are understood, permitting a solution to be developed to sympathetically blend into the existing environment.

1.1 Context

Lower Town is located to the east of the main town of Fishguard at the mouth of the Afon Gwaun. Situated on the eastern side of the river, the TRA487 road bridge provides the only vehicular and pedestrian access point from the west. There is no footpath provision on the bridge. Pedestrians walk along the carriageway, thus sharing road space with vehicular traffic, to cross the bridge.

With a projected increase in footfall through Lower Town and pedestrian demand at the existing road bridge, without improvement it presents an increased risk both in terms of pedestrian safety and reduced footfall along this section of the Wales Coastal Path. This represents a significant safety concern and is a barrier to walking between Lower Town and Goodwick – Fishguard.

This report builds on previous studies and following additional consultation in 2015 with both Pembrokeshire County Council (PCC) and South Wales Trunk Road Agency (SWTRA), a new revised location was agreed as a viable location which proposed moving the bridge closer to the existing road bridge, whilst not impacting on the visual appearance of the existing bridge which is a Grade II listed structure.

This report highlights the key aspects and issues related to this proposed location and builds upon the previous work undertaken which has reviewed pedestrian behaviour in Lower Town Fishguard during 2012 and feasibility studies undertaken by Atkins in 2002, 2006 and 2015. The detail of these subsequent studies is briefly highlighted within this report for completeness.

1.2 Location Challenges

In developing the footbridge concept there are a number of competing constraints impacting on the chosen solution, these are listed below and briefly discussed:

- **Heritage / Conservation** – maintain and limit the impact on the view of the Grade II listed trunk road structure (masonry arch bridge),

- **Flooding** – maintain and/or increase current channel widths (conveyance) to ensure flooding issues are adequately addressed. By constructing downstream of the existing bridge the bridge is located in the tidal flood plain hence its footprint should not impact local flooding,
- **Aesthetics** - develop a solution to compliment the local built environment and is not overpowering,
- **Disability Access** – need to maintain DDA access therefore provide ramps and ensure structure accessibility is considered in design,
- **Planning** – trade-off between visual impact of ramp construction versus land take, aesthetics and flood consequences,
- **Ownership/Operational Maintenance** – working in tidal flood plain hence a low maintenance solution is required. If the bridge is located adjacent to the trunk road it will most likely be owned and operated by SWTRA however if the bridge moves away from the trunk road the ownership of the asset would most likely be that of PCC.
- **Linkages** – need to consider how to link the structure with the coastal path and highway footpaths together with the desired foot and cycle routes within Lower Town.

Hence, constructing a new footbridge along the desire line of the coastal path would provide an opportunity to maximise the attractiveness of the route through Lower Town, whilst also mitigating the existing safety and severance problems. This will help to promote Active Travel in the vicinity.

As agreed with SWTRA and PCC this review assumes a new footbridge would be located downstream of the existing road bridge with the offset to the existing bridge reduced to the location promoted during the 2013 study. The footbridge would connect the coastal path on the western side of the river with the harbour car park in Lower Town. From the car park the coastal path continues up towards Fishguard Fort initially alongside the A487 to the east of the town.

1.3 Location Plan

Figure 1. Location Plan

2 Previous Study Observations

2.1 Context

A number of previous studies have been undertaken reviewing the feasibility of a new replacement bridge and/or highway improvements to improve pedestrian safety. Hence this chapter summarises the work done to date and highlights the subsequent findings with an emphasis placed on some of the conclusion drawn to highlight key design inputs to understand the context and history of the problem and permit the viability of a new footbridge to be assessed accordingly.

2.2 2002 Bridge Feasibility Report

In 2002 an outline review of options was undertaken reviewing different bridge forms upstream and downstream of the existing trunk road structure. Six solutions were identified with an emphasis placed on the form of construction and structural location together with outline costs which ranged from £98K to £154K.

Some key observation made during the study and in subsequent meetings noted that a new structure would need to be independent of the existing to avoid having to apply for listed building consent due to the close proximity of the existing Grade II listed structure (masonry arch) forming part of the A465 Trunk Road.

Pembrokeshire County Council also noted they would be happy with either a traditional or modern solution as long as it complemented the conservation area. PCC also noted that the provision of a new footbridge would act as a catalyst for general enhancement of the area with planting and improved car parking provisions likely.

The possibility of moving the alignment of the bridge into a more downstream position was discussed however at that time it was considered relocating the new footbridge too far downstream would result in pedestrian not using this area and hence alternative footway arrangements would have to be provided. An upstream option was also considered however the requirement to purchase land and property quickly discounted any further development of this solution.

2.3 2005 Public Consultation

In 2005 PCC carried out a public consultation exercise into the provision of a pedestrian crossing over the Afon Gwaun.

The results showed clear support for a pedestrian crossing, with 89% of those expressing an interest supporting the idea. However, many of the comments received conveyed a strong feeling that the character of the area should not be changed.

2.4 2006 Highway Improvements Study

The provision of a 1.5m (maximum width) footway across the existing bridge by correspondingly reducing the width of carriageway to 3.5m was considered. A review of the vehicle swept path analysis showed that vehicles will still over-run the 1.5m footway at the western end of the bridge. This would create ongoing maintenance issues for the kerbed options and the removable bollard option unless the footway is further locally reduced to 1.2m in this location.

Hence an alternative option investigated the provision of an edge line to delineate the footway. This provided several advantages over the other options but it did not provide a physical separation between pedestrians and vehicles; and if the footpath is not locally reduced to 1.2m, it could give pedestrians a false sense of security.

2.5 2012 Pedestrian Movements Report

With the development of the Wales Coastal Path a further study assessed pedestrian movement in the locality. The pedestrian movement report undertaken in 2012 has re-evaluated the need for a new footbridge albeit at a position downstream to connect the existing coastal path on the western side of the river to the harbour car park in Lower Town.

Hence the focus of the pedestrian provision has changed in recent years where significant economic benefits have been recognised through tourism and the coastal path is without doubt a key contributing factor.

The report concludes that there is a forecasted increase in pedestrian traffic, this is currently estimated at 100,000 per year in Pembrokeshire with circa 10,000 potentially using this structure. Hence without improvement it presents an increased risk both in terms of pedestrian safety and reduced footfall along this section of the path.

Constructing a footbridge along the desire line of the coastal path would therefore provide an opportunity to maximise the attractiveness of the route through Lower Town, whilst also mitigating the existing safety and severance problems.

2.6 2013 Feasibility Review

A new downstream location was assessed spanning from the car/boat parking area adjacent to the Skirmisher building across to the main lower town car park near the slipway location.

The assessment also looked at the hydrological impact reviewing the tidal and fluvial flooding constraints whilst also assessing the likely geology and anticipated bearing strata to understand the likely bearing capacity of the underlying material.

The review assessed a number of structural forms with the preferred solution being a Fibre Reinforced Polymer (FRP) deck which presented significant durability and weight benefits. The span was increased to ensure the new structure provided a larger conveyance area than that of the existing bridge however one of the main challenges was the requirements for ramp structures which if located in the centre of the car park was quite imposing. The estimated cost of the bridge was circa £300k to £400k.

Within the 2013 report equestrian use was also raised. It is further noted that there are a number of nearby bridleways following the Cwm Gwaun Valley and surrounding area. A local bridle path terminates at the upper North East district of Lower Town. At this location it is believed that equestrian users will either following the A487 trunk road or travel down Old Newport Road leading to Quay Street before crossing the existing A487 trunk road bridge. Equestrian use therefore will need to be raised during PCC consultations as their inclusion will significantly impact the bridge geometry such that cross section width and parapet heights/strengths will need to be increased.

2.7 2015 Stakeholder Meeting

A further meeting discussing the scheme was undertaken with representatives from Atkins, PCC and SWTRA in attendance. Three possible options were discussed with some of the key points and observations made are highlighted in the below text:

Location 1 - Upstream of Road Bridge

- Poor access to one side,
- Requires you to cross the main road for access,
- Need land take/purchase
- Negative fluvial flood impact.

➢ *Discounted as an option due to access and flood requirements.*

Location 2 - Downstream of Road Bridge

(Connecting the middle of Skirmisher and Lower Town Car Parks).

- On pedestrian desire line for coast path users,
- Setback for pedestrians using the trunk road footpath, hence some pedestrians may not take the detour and still use the road bridge,
- The footbridge itself is not considered appropriate. However, because of 2m difference in level between the two car parks and need to keep soffit at a high enough level to accommodate some boats, large ramp structures will be required to make route DDA compliable. These ramps are considered an inappropriate visual feature (intrusion) within the conservation area,
- Lower town car park is regularly flooded (tidal flooding on very high tides), thus there are operational issues when directing pedestrians to a

flooded car park. In these instances the footbridge should be closed and pedestrians diverted to the road bridge,

- There will be clearance issues for boat masts (even smallish dinghies) rendering existing slip unworkable thus a new slipway structure may be required, or an alternative used,
- A route away from the bridge would probably not be considered to be part of the trunk road network, hence come under the ownership of PCC rather than SWTRA.

➢ *Hence there were a number of negatives related to this location.*

Location 3 - Independent Footbridge Adjacent to the Road Bridge
(not connected to existing bridge and located a few metres downstream)

- Footbridge to be built separate from the listed road bridge, so not affecting the fabric.
- Reasonable connectivity available either side
- Need to consult with Welsh Water regarding access to pumping station
- Potential to blend design into the stonework construction for the pumping station hence reducing its current visual impact.
- A small separation between the bridges would enable the road bridge to be viewed from a new footbridge.
- Bridge at this location can be promoted as a trunk road structure.

➢ *The conclusion of the meeting was to agree to promote this location as the preferred option.*

2.8 Summary

The previous studies have indicated there is the need for improved pedestrian provisions in Lower Town. This is further supported by the future growth predicted arising from the coastal footpaths provision. Hence the economic benefit of an improved link is now greater than ever.

The revised proposed downstream location will link to both the existing highways footpaths along the A487 and the Wales Coastal Path. This will enhance safety and remove the conflicts over the existing narrow Grade II listed bridge crossing the Afon Gwaun in Lower Town Fishguard.

The new proposed location, with a smaller offset to the existing bridge (compared to the proposals highlighted in the 2013 report), will improve the safety and connectivity in this area and will facilitate and encourage walking and active travel.

3 Proposed Design Input Criteria

Within this section design information and constraints are listed to primarily highlight the proposed criteria and constraints and to also highlight the key governing principles.

3.1 Design Guidance: Active Travel (Wales) Act 2013

Guiding Principles

Recent research has suggested that the 'biggest barrier' to walking and cycling is concern for their safety. These concerns relate mainly to existing infrastructure, such as difficult road junctions and narrow sections of highway.

Thus the existing configuration at Lower Town Fishguard can easily be shown to be a route with safety concerns thereby creating a barrier for Active Travel.

Hence this report reviews the potential options with reference to the Active Travel Design Guidance and particular emphasis has been made in the development of this report to align the key guiding principles with other local factors permitting some effective discussions during key consultations.

These guiding principles are listed below and briefly discussed:

Principle	Considerations
Coherent	The new structure should be easily accessed and connected
Direct	It should as reasonably practicable provide a direct route using natural lines/paths
Safe	The route should minimise the collision risk via separating vehicles and pedestrians, it should be well-lit and secure/safe
Attractive	The route should be attractive encouraging use
Comfortable	The widths should be adequate taking into account the relevant user needs including the presence of ramps, rest areas and landings where appropriate

Table 1. Active Travel Guiding Principles

Guidance for Key Design Considerations

Within the Design Guidance there are a number of geometric requirements that should form the basis of the design for new routes. These are highlighted below for information relating to the new footbridge proposal:

Design Aspect	Requirement
Gradient	1 in 20 (desirable) 1 in 12 (maximum) 1 in 10 (very short lengths only)
Cross Falls	1 in 40 (desirable)
Widths	*Pedestrian Only* 2.0m (desirable minimum) *Pedestrian and Cycle* 3.0m (unsegregated paths with low flows) 3.5m (desirable for unsegregated pedestrian/cycle paths) 2.0m to 3.5m (segregated paths) *Equestrian Use* 3.5m minimum (from BD29/04)
Surfacing	Use of contrasting surfacing colours to distinguish different routes
Handrails (height)	Pedestrian use only – 1.15m Pedestrian and cycle use - 1.40m Pedestrian, cycle and equestrian use - 1.80m
Landings	Landing lengths to be 1.2m (min) to 1.5m (desirable) for every 10m of ramp
Steps	At stairs landing lengths to be 1.2m (min) to 1.8m (desirable) Riser dimension (R) between 100mm* to 170mm Tread dimension (G) between 250mm to 300mm Max number of stairs in one flight to be 12 *(*Note: BS 5395-1:2010 refers to a minimum riser of 150mm)*

Table 2. Design Input Criteria

3.2 Location

Further to recent discussion with both PCC and SWTRA in 2015 it was agreed that the preferred alignment would be for the new footbridge structure

to be offset a small distance downstream thereby not impacting on the Grade 2 listed trunk road structure.

This alignment was originally reviewed in 2002 (Alignment 2 – see below), however at that time 'Alignment 1' was preferred as a more feasible solution due to its smaller footprint. However, later discussions discounted 'Alignment 1' due to its impact on the existing bridge.

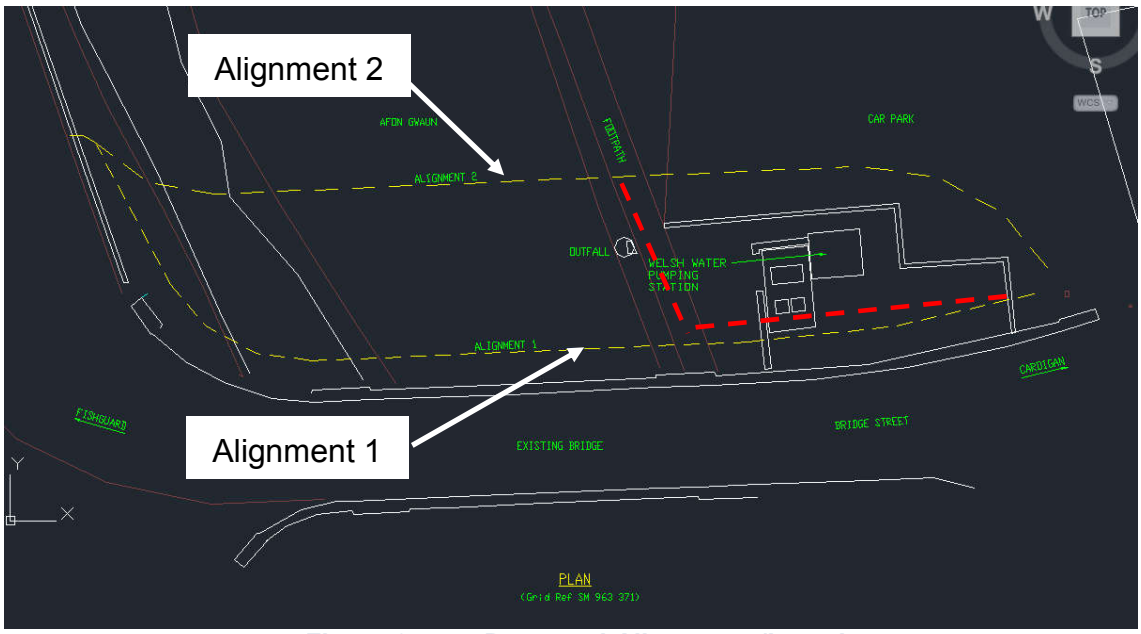


Figure 2. Proposed Alignments/Location

Thus the current proposed alignment will closely follow Alignment 2 illustrated above. However, discussion should also occur with the PCC conservation officer to see if the ramp structure could be dog-legged (see red dashed line above) with the ramp located adjacent to the highway wall. This will reduce the visual impact and land take and permit the footpaths to tie into the exiting routes which are located outside of the areas subject to regular tidal flooding in the existing car park.

Therefore key areas for discussion will relate to:

- Operational access requirements for Welsh Water – to determine the access constraints which will impact the desired ramp and stairs configuration to be adopted
- Ramp location – as alignment 2 or dog-legged to alignment 1 (see red dashed line)

3.3 Geology

The ground conditions comprise 'alluvium' comprising sand, gravel and cobbles overlying 'boulder clay' of similar description overlying shale bedrock. From review of the borehole information obtained in the 2013 study, the high incidence of cobbles and boulders would seem to preclude the use of driven

piling and also the use of small diameter bored piles, (up to 750mm), because the pitch of the auger is not sufficiently large to bring up the large grain size material.

SPT N values recorded at 1.5mbgl are in the range 7 – 48 with an average of 27 and those at 3.0m BGL are in the range 29 – 60 with an average of 42. Hence, based on the information available we would suggest an allowable bearing pressure of 125kN/m^2 would limit settlement under load to less than 25mm. This tends to lead to the adoption of spread foundations.

Higher values may be possible or alternatively a spread granular base installed below foundations to provide an improved bearing stratum. Further Ground Investigation should be carried out during the commencement of the detailed design phase.

3.4 Flood Risk

3.4.1 General

The proposed footbridge is located within an area which is considered to be at risk of flooding. This area of Lower Town Fishguard has a long history of flooding, historically, the area upstream of the A487 Road Bridge has been affected by fluvial flooding and the area downstream which includes the car park and Quay Street has been affected by tidal flood events.

3.4.2 Tidal Effects

The table below provides estimates of the current extreme tides at Fishguard using the recommendations contained within a Joint Defra & Environment Agency Research Project: SC060064: Coastal flood boundary conditions for UK mainland and islands; Published in Feb 2011.

From the available topographic information, it is apparent that the ground level on the left bank adjacent to the footbridge is in the order of 4.4mAOD, whilst the right bank is significantly lower at approximately 2.5mAOD. The Mean High Water Spring Tide (MHWS) at Fishguard is 2.4mAOD. We can expect the car park to be at risk from frequent tidal flooding. Thus although the car park is subject to tidal flooding, the installation of the footbridge presents no further risk, however careful consideration of the level and location of the ramp/pedestrian route should look to minimise this impact.

Also proposals would also need to consider climate change and the implications of higher sea levels in the future. Current guidance indicates that average sea levels can be expected to rise by 1.05m over the next 100 years. These levels if/when realised would have a significant impact on Lower Town.

3.4.3 Fluvial Effects

The area is also considered at risk from flooding from the River Gwaun. Historically properties have been flooded to the east, (upstream), of the A487

Road Bridge. Flood water backs up behind the bridge flooding properties on Glyn-Y-Mel Road.

During extreme events it is possible that overland flow paths could develop down Glyn-Y-Mel Road, along Bridge Street, returning to the main channel through the car park. Downstream of the A487 Road Bridge, the car park area on the right bank could also be at risk of direct flooding from the main river channel.

It will be necessary to prove that the new footbridge does not increase the risk to properties/infrastructure in the Lower Town area. Potential impacts include reduced main channel conveyance in the area of the new foot bridge and the ramps within the car park preventing overland flow paths returning to the main river channel. This could impact properties on Quay Street.

3.4.4 Summary of Flood / Hydrology Considerations

Potential impacts include reduced conveyance in the area of the new foot bridge and the ramps within the car park preventing overland flow paths returning to the main river channel.

The type of construction utilized for the new footbridge will have an impact on the flood consequences. An open structure supported on pillars will have significantly less impact than a Masonry structure with 'solid' approach ramps.

A Flood Consequence Assessment (FCA) will be required to inform the planning process for the proposed footbridge. The FCA would need to demonstrate that there is no detriment to the local community as a result of the proposed footbridge. A 2D hydraulic river model would be required to inform the FCA. Key areas for discussion will relate to:

1. Ensure conveyance area of new bridge does not impact flooding,
2. Consider use of open ramps to aid overland water flows
3. Consider location of abutments and use relief arches if needed to improve overland flows
4. Consider the soffit level and span requirements – trade-off between soffit height and resulting ramps due to DDA access requirements (need the most appropriate blend of requirements to ensure the impact in the conservation area is minimal whilst providing a new asset to improve pedestrian safety)

3.5 Aesthetics

Pembrokeshire County Council has noted that any proposed structure should complement the conservation area. PCC are open to traditional and modern style structures as long as they are seen to be complementary to the surrounding environment.

4 Consultation on Key Design Criteria

4.1 Context

Within the proposed locality there are numerous competing constraints impacting on the choice of construction and location. To ensure the most appropriate solution is proposed we have listed a number of factors to be discussed with the key consultees. These are listed below with a short description included:

In reviewing these options the relevant criteria for Cycle, Disabled and Equestrian Access will be consulted on with a view to understanding the impacts on the aesthetics of a proposed structure. Hence a balance is needed between what is desirable and what is practicable within a conservation area.

Disabled Access	**Ramps –** Is 1:10 acceptable, if 1:12 is not possible. **Seating -** Discuss and agree the best location? Do we need to avoid change of direction landings to avoid clash with cycles (assuming cycles are permitted). **Landings –** Are landings required for short ramps which are only marginally over 10m (i.e. 13m ramp with no landing). **Steps –** location, requirement for landings? Widths? **Tie–in Locations** – Most appropriate location (need to consider conservation and planning requirements).
Equestrian Access	**Use New Footbridge –** wider structure with larger parapets is undesirable. **Use Existing Road Bridge –** desirable however users still at risk, consider mitigations/traffic calming if appropriate.
Cycle Use	**Cycle use or Pedestrian only -** a low cycle traffic volume is envisaged, hence there is a case for pedestrian only structure (with lower parapets) with cyclist still urged to use the existing bridge alternatively an unsegregated path could be adopted. **Segregated/Unsegregated –** impact on widths/layouts, a low cycle traffic volume is envisaged hence preferred solution would be unsegregated. **Mount/Dismount** – impact on parapet heights raising them from 1.1m to 1.4m, a cycle gate could reduce this risk although its inclusion may deter cyclists and discourage use hence moving them onto the existing road bridge. The volume of cyclist is very low hence this risk is deemed low.

Ramp/Stairs Locations	The most optimum solution needs to address stakeholder requirements getting the best-fit. This will require a consultation with planning and conservation officers. A number of solutions are possible for the ramps and stairs locations.
Aesthetics	PCC previously confirmed that they would be open to all forms of structure from traditional to modern as long as it complemented the conservation area, consider pallet of materials to be proposed in preferred solution. **Main Structural Material** - FRP Composites (required for durability and weight). **Deck Finishes** – timber clad, painted, high gloss (gel coat). **Parapets –** conventional steel, conventional aluminium, stainless steel posts and wire, stainless posts and glass panels, solid FRP. **Substructures -** depending on ramp locations the use of solid or open ramps will be possible (depends on overland flood paths). Main abutments clad in local stone with lime pointing finish. Steel or composite crossheads and piers for intermediate landings for ramps if required.

Table 3. Consultation Criteria

4.2 Consultations

4.2.1 PCC Planning and Conservation Officers

PCC Highways planning officer (Stephen Benger) and Conservation officer (Matt Pyart) were consulted over the location and current proposals (as indicated herein).

One of the key constraints discussed was the ability to reduce the impact on the adjacent existing Grade II structure thereby offsetting the structure was a consideration discussed.

In addition to this when considering the flood impact and visual intrusion within the car park the proposal to ‘hide’ the ramp structure by locating in an area of existing landscaping adjacent to the highway boundary was agreed to be a beneficial solution.

Hence a solution with a footbridge offset at a skew angle to the existing with the ramp structure located (adjacent to the highway) in the landscaping area

next to the pumping station was agreed as the most suitable location to meet all requirements.

4.2.2 PCC Access Officer

Initial consultations with the PCC Access Officer (Alan Hunt) focussed on the requirements for disabled access and in particular the need for access ramps within the Lower Town Car Park.

The key aspects discussed was the impact of ramps for disabled access and in particular the associated impact of flood risk plus the visual impact (planning requirements). Mr Hunt noted he understood it was a difficult challenge to implement and meet all requirements in this area which is subject to regular flooding.

During the discussions Mr Hunt suggested some deviations from standards may be possible to ensure the solution fits within the local environment (conservation area) however it was noted a disabled person does live adjacent to the bridge hence deviating away from standard and only providing stepped access was not an option and is something that would likely be challenged.

Thus it was suggested that ramps will be required however it may be possible reduced the length of these ramps by using a gradient of 1:10 if there was insufficient room available. However if possible a 1:12 ramp would be preferred.

4.2.3 Welsh Water

In developing an option located close to the existing road bridge the interaction with the adjacent Welsh Water pumping station is of prime importance to:

- Ensure the operational aspects are clearly unaffected,
- Develop a complimentary solution that does not impinge on the assets,
- Where appropriate, identify and implement control measures to protect the existing assets and ensure if appropriate, diversion routes are feasible and clearly identified.

The below figures highlight the service location and easements for access. A site meeting with Welsh Water has occurred to discuss the operational requirements. This is further highlighted below.

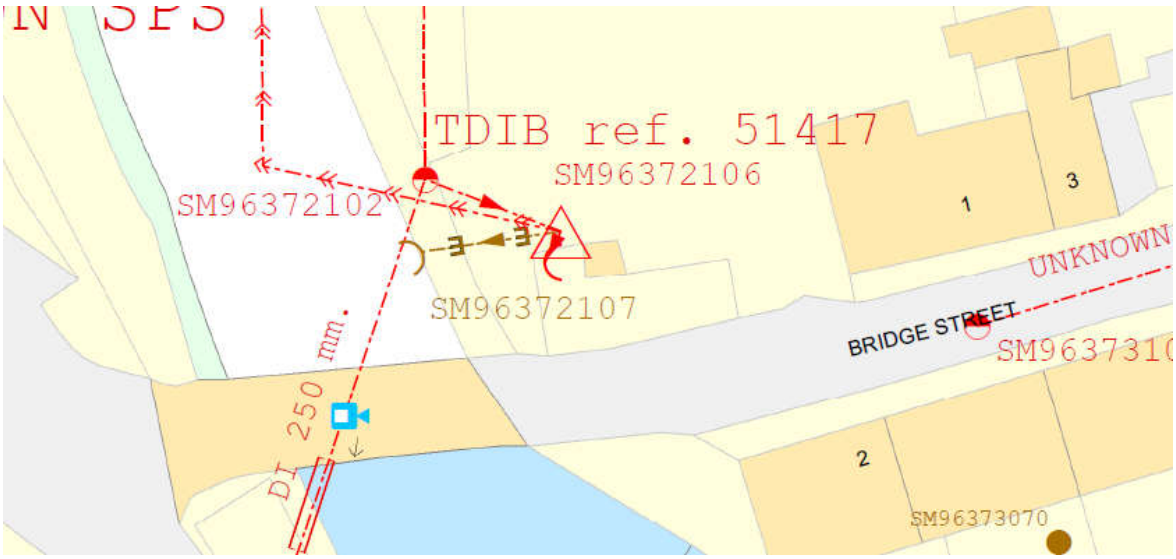


Figure 3. Welsh Water Stats Location Plan

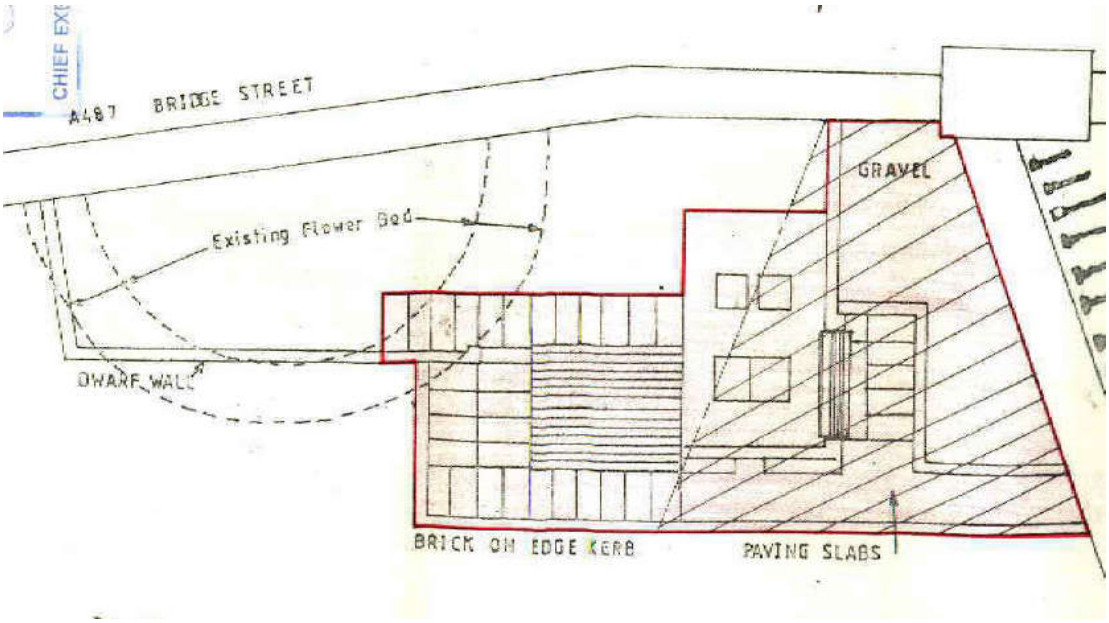


Figure 4. Location Plan of Pumping Station with Easement Zone Identified

Welsh Water Site Meeting

A site meeting with Atkins and Welsh Water occurred on 19th January 2017. The purpose of the meeting was to understand the operational constraints and requirements at the pumping station. This was deemed a necessary aspect to consult on as any structures built adjacent to the pumping station could impact on the operational management of the WW asset. A summary of the meeting is highlighted below and figures are used to highlight any specific requirements.

Access Requirements (refer to figure 5 – areas are indicative and not to scale):

- **Area A** - General access required to the main building (front doors) to access control and telemetry equipment,

- **Area B** - Access to the manholes for pumping. A tanker is used and located adjacent to the pumping station hence any ramps or structures located to the north of the pumping station could hinder access,
- **Area C** – at the manhole positions occasionally the pumps may need to be removed. Thus lifting equipment is used within the compound, therefore this are should not be spanned over as this could impact on any lifting operations.
- **Area D** – Area D no access requirements other than a path around the pumping station building. The landscaped area was thus suitable to build over.

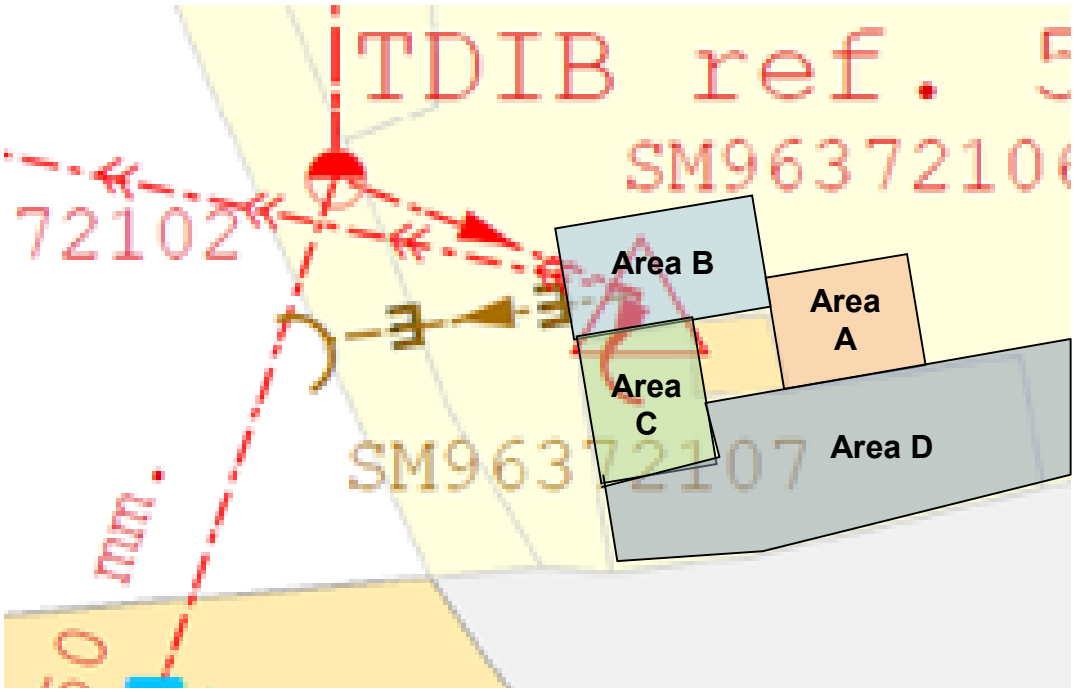


Figure 5. Operational Access Areas

4.3 Preferred Option Layout and Configuration

When proposing a layout for this structure there are a number of competing influencing factors that are affecting the choice of location in this sensitive site location. Some of the key generic factors are listed below:

- Improved User Safety
- Improved Accessibility
- Promote Active Travel
- Promote Footfall (complimenting Wales Coastal Path)
- Close to trunk road structure
- Acceptable impact in local environment

The proposed solution (location) aims to address these factors in a manner that is mutually beneficial to all parties minimising the impact on each. These requirements are briefly summarised below:

Welsh Water

A local pumping main/station is positioned within the area of interest. The pumping station pumps waste to the nearby treatment plant in Goodwick/Fishguard. The main is live and in continual use. Diversion of any apparatus would be a challenge and if possible should be avoided.

The pumping station is offset from the main wall at a distance of approximately 4.5m. This zone (4.5m) currently comprises a paved access path around the pumping station and an adjacent area of landscaping. Access is required to and around the pumping station plus a clear area is required adjacent to the pumping station within the car park to permit the passage of tankers adjacent to the station who access chambers to the rear of the pumping station.

Outcome – The installation of a ramp directly between the pumping station and existing highway wall (above the area of landscaping) would be preferred to minimise the impact on future access (tankers) within the car park adjacent to the pumping stations. Access riverside of the pumping station is not required hence an abutment could be founded in this region, however some minor accommodation works may be required to existing boundary walls to maintain access. There are existing services (foul sewer) located nearby, thus the location of the abutment needs to be chosen to limit the impact on these services.

Flood Alleviation Requirements

The bridge is located in the flood plain however its location downstream of the existing traffic bridge is such that its location is deemed to be more associated with tidal flooding.

The area associated with fluvial flooding relates to the area upstream of the existing road bridge where back water effects are observed due to the constricting nature of the existing structure. Extensive flooding has been observed in the area and climate change will in the future increase the flood impact in Lower Town.

Outcome - The main criteria to be addressed in the development of new asset relates to the structure not adversely impacting the flow of flood water (tidal and fluvial) and in particular the return of these flood waters back to the main channel. Thus any abutments and ramps must not affect the overland flow paths. Hence the new bridge should have an increased conveyance to that of the existing road bridge and any ramps structures must consider flood conveyance and overland flow paths.

Hence in light of this, a new footbridge with a span and clearance greater than existing should be sufficient and any ramps located in the car park would need to be open in nature. This would have a significant cost implications as additional independent spans for ramps would have a significantly higher cost than traditional masonry/fill structures.

Thus to minimise impact a solid ramp could be installed above the existing landscaping next to existing bridge (as noted above). The footprint at site would be minimal and by inspection this solution would have least impact on the local environment. Hence this solution would not add to the problem and have neutral impact

Planning Requirements

As noted above the key issues concerning the structures location are:

- Visual impact and intrusion within the car park
- Impact of the visibility of the Grade II listed highway structure
- New structure should have minimal footprint and be slender to ensure it does not overpower the adjacent listed structure.

Outcome - The preferred solution is a new bridge skewed from the existing road bridge with the ramps located above an existing region currently used for landscaping as discussed above.

5 Outline Design

5.1 Proposed Location

The preferred location of the bridge is slightly offset at a skew angle to the adjacent grade II listed highway structure. The chosen offset and skew is a result of blending together the main stakeholder needs where specific attention is paid to the impact on flooding and associated visual impact on the adjacent listed structure.

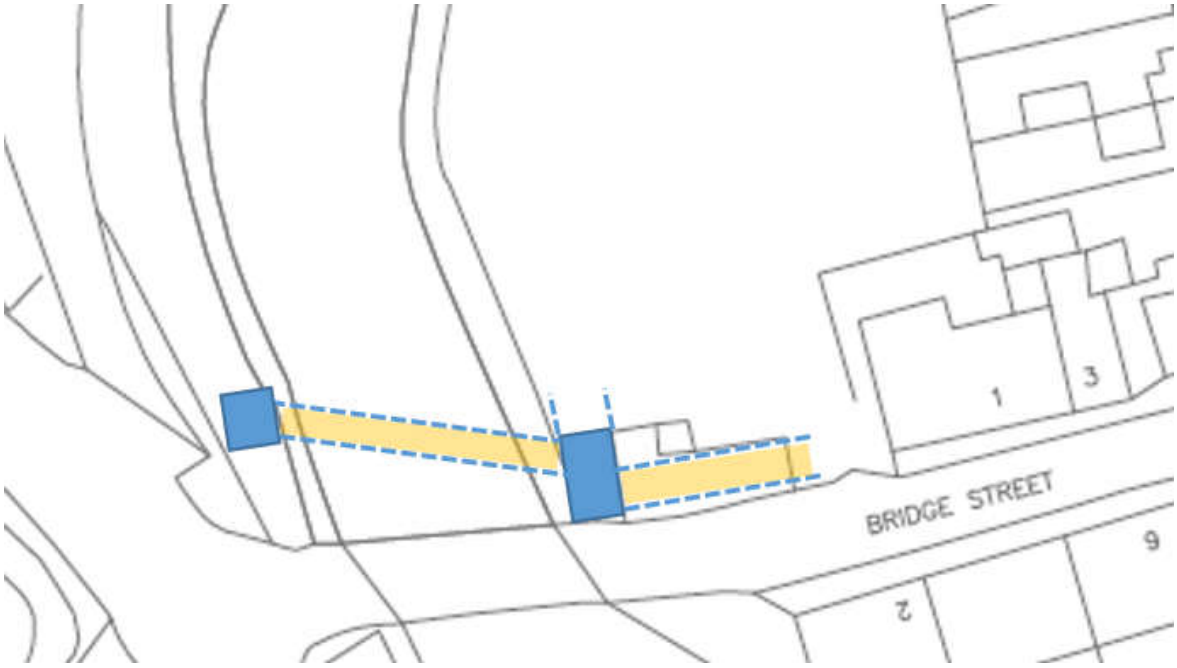


Figure 6. Proposed Location

Hence the proposed location is highlighted above. There are a number of key benefits in locating the structure at this position. These are highlighted below:

1. Minimal intrusion into the car park
2. Not affecting overland flood flow paths
3. Ramp structures are utilising the existing footprint used for some minor landscaping
4. Footbridge is offset from the main road bridge thereby minimising the visual impact
5. Footbridge meets with the key 'Active Travel' guidance (see below for further information
6. Avoids services and the need for diversions,
7. Footbridges ties into the existing pedestrian routes along A487 and Coastal Path(s),
8. Preferred tie in levels (thereby this can impact the footprint of the ramp and/or permit a more desirable ramp gradient to be adopted.

5.2 Proposed Geometric Information

Following a review of the existing survey information and the relevant local requirements the proposed geometry is listed below:

Design Aspect	Requirement
Span	Approximately 20 – 23m (TBC at detailed design)
Gradient	1 in 20 (desirable) 1 in 12 (maximum)
Cross Falls	1 in 40 (desirable)
Widths	Pedestrian Only 2.0m clear widths
Surfacing	Single colour (TBA) for unsegregated use.
Handrails	Pedestrian use - 1.15m
Landings	Landing lengths to be 1.2m (min) to 1.5m (desirable) for every 10m of ramp (marginal relaxations may be possible)
Steps	Riser dimension (R) between 100mm* to 170mm Tread dimension (G) between 250mm to 300mm Max number of stairs in one flight to be 12 (*Note: BS 5395-1:2010 refers to a minimum riser of 150mm)

Table 4. Proposed Geometry

5.3 Proposed Materials and Finishes

Bridge Superstructure

Fibre Reinforced Polymer (FRP) Composites are proposed for use on this structure. These materials provide some important characteristics that are suited to this project, (within a tidal flood plain with sub-prime ground conditions).

Hence the durability of the solution is a key consideration together with its high strength to weight ratio and lower dead load than that of traditional construction materials thereby reducing the cost of the supporting foundations.

West Abutment

The levels at the west abutment permit the use of a smaller bank seat type of structure. This will utilise either reinforced concrete or mass concrete construction. Much of the structure will be buried with any exposed surfaces clad in local stone. The intention would be to use pennant sandstone with cement mortar for strength, however the joints could be pointed using a natural hydraulic lime mortar (NHL 3.5) in keeping with the finish of the adjacent Skirmisher Building.

East Abutment

The eastern abutment will be located adjacent to the pumping station. Its' form of construction could vary (i.e. mass concrete / reinforced concrete and concrete block work or steel frame faced with stonework).

The preferred solution would be to use mass concrete as this will not deteriorate in this marine environment, however the excessive weight may be a concern. A strengthened earthworks solution may be possible however whatever solution is adopted it is likely that the geotechnical constraints of the underlying ground will govern the choice of solution.

Although not preferred due to durability concerns a steel solution may be the most efficient permitting increased conveyance adjacent to the existing bridge and although maintenance painting will be regularly required, access is good and readily available hence this operation would be able to be undertaken with relative ease.

Thus at present, a mass concrete solution is assumed with stonework facing to match existing. This may be amended during the planning phase once more detailed ground investigation information is received.

The eastern abutment will also be extended and access stairs installed to one elevation using materials similar to that used for the main abutment. These stairs could be made integral with the abutment.

East Ramp

The ramp is located adjacent to the stone wall abutting the highway and positioned above an area of landscaping. We anticipated that this area could be constructed using concrete block work faced with stone and traditional fill materials. This form of construction will be the most cost effective for this location.

The wall will be capped using stone flags with an asphalt surfacing together with a parapet system similar to that used on the main bridge.

Parapets

There are a number of parapet systems that can be used from traditional post and rail to glass or solid stonework. In this instance we would recommend the use of a stainless steel post with either a tensioned wire horizontals or glass insert panels.

Glass is an attractive solution however due to its close proximity to the coast it may need regular cleaning therefore has the potential to become a maintenance concern. Thus it is believed that the use of tensioned stainless steel wire may be more suitable and will provide the best aesthetical solution.

Surfacing

The main bridge will most likely use a methyl methacrylate (MMA) resin with 2 to 5mm chippings in a shallow thickness construction (10mm). This solution blends well with the FRP structure. The landing and adjacent ramps will use a traditional 6mm bitumen surfacing over traditional construction lay up (sub base / base course / wearing course).

5.4 Outline Design

Design Review

At the preferred location the level at the tie in is approx. 3.1m, this is slightly advantageous location as it is marginally higher than the remaining car park which is generally at a level of 2.6m. Therefore the lengths of ramps required will be less and the proposed location also links well to the existing footpaths and footfall in Lower Town (hence large footpath diversions are not required).

The critical dimension in the development of these proposals is the soffit level of the new footbridge. At present the existing bridge is proving to be the throttle impacting the fluvial flooding upstream in Lower Town. Our proposed structure is located a short distance down stream of this structure (on a skew to the existing structure with an offset of between 3m to 6m). Thus the new proposed structure will have a span significantly higher than that of the existing bridge. The existing bridges' span (masonry arch) is circa 13m, the new footbridge will be between 16m to 23m depending on the location. Hence the overall conveyance will be much higher than the existing bridge. This is critical as a larger conveyance is required to ensure the new bridge does not have an adverse impact on flooding.

Also when assessing the conveyance effects at both bridges and in particular the drop in water (flood) level from the throttling existing bridge to the new bridge (with significantly larger conveyance as noted above) it may be possible to reduce the soffit level of the new structure accordingly. This will have a large impact on the size and length of the proposed ramp, for instance a drop in level of 0.5m can reduce the ramp length by 6 to 10m. The possibility of reducing this soffit level of the new bridge will need to be reviewed at detailed design stage in association with the flood impact

assessment to understand how critical the soffit level is to the surrounding flood consequences.

It is however noted at this time we have assumed the soffit level of the existing bridge (at centre) will be the same as the existing masonry arch, thus some reduction may be possible however we believe for this study this is a conservative assumption used in the development of the solution at this time.

Thus for a span of 16m, preliminary design calculations have suggested the design could take the form illustrated below:

- Span = between 16m to 23m (depending on founding position at West Abutment)
- Deck Thickness = 550mm at centre increasing to 900mm at supports (for a 16m span)
- Assumed Construction = Resin Infused FRP Deck
- Materials = Vinylester resin, glass fibre reinforcement
- Stiffness (E modulus) = 27,000 N/mm2
- Deck Composition = FRP sandwich construction
- Lay ups = 30mm top and bottom flanges, 10mm shear webs and 70mm foam core
- Core material = 3D bridging Saer Foam
- Soffit level (above crown) = 4.72m
- Footway level (" ") = 5.27m
- Tie in Level = 3.10m
- Variance = 2.17m
- Available Ramp Length = 15m
- Deck longitudinal camber (1:12) required to reduce subsequent ramp lengths

Proposed Cross Section

A typical (part) cross section detail highlighting the proposed cross section is shown below:

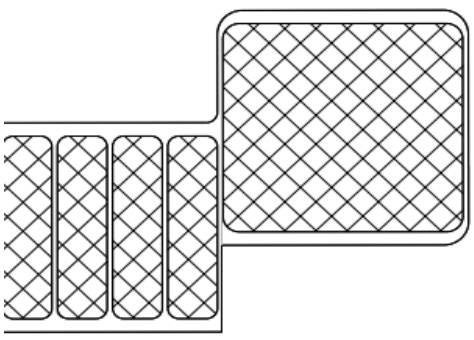


Figure 7. Proposed Cross Section Detail

Deck anchorages can also be moulded into the parapet beams to fix the parapet posts. There are no construction joints and the deck is cast as a single entity offsite and brought to site fully fabricated. This can include provisions for parapets and surfacing and any required finishes.

Hence if the supporting infrastructure/substructure is already in place the bridge can be operational within hours of installation.

Finishing Opportunities

A number of finishes are possible to the GRP deck such as timber, gloss gel coat (various colours) or Matt UV resistant paints. For this location and in keeping with the maritime theme, we believe a white/grey gloss finish (gel coat) is the most applicable finish which compliments the environment.

5.5 Active Travel Criteria Review

Principle	Considerations	How is this Implemented?
Coherent	The new structure should be easily accessed and connected	• Ties in well with the Wales Coastal Path, local routes and foreshore paths, existing footpaths along the A487 plus the pedestrian/car park area in Lower Town.
Direct	It should as reasonably practicable provide a direct route using natural lines/paths	• Located adjacent to the existing pedestrian route therefore is a natural line. • The route provides a safer passage for pedestrians moving them away from the narrow overbridge which has little provisions for safe pedestrian passage.
Safe	The route should minimise the collision risk via separating vehicles and pedestrians, it should be well-lit and secure/safe	• As above. New safe route separated from vehicle and traffic on the adjacent trunk road. • Issues of lighting to be discussed with planning during application stage (structure is within a conservation area)
Attractive	The route should be attractive encouraging use	• Provides safe platform for viewing the Lower Town

		Coastal Area. • Located outside of the areas subject to flooding – therefore has good connectivity during flood events. • Considering use of landscaping and/or seating to enhance user experiences, (to be developed in more detail during detailed design phase).
Comfortable	The widths should be adequate taking into account the relevant user needs including the presence of ramps, rest areas and landings where appropriate	• Widths in accordance with national design guides for an area/region where the pedestrian flows are relatively low in comparison to congested urban areas.

Table 5. Active Travel Review Criteria

6 Financial Estimate

To deliver this scheme, further to this study, we have estimated the likely outturn costs to be met taking a 'cradle to grave approach'. The cost highlighted are best estimates at the time of writing.

6.1 Design Costs

Outline indicative design costs including aspects such as planning approval, flood mitigation studies plus procurement and tender analysis are estimated below for future considerations. A 10% contingency is included to manage risk and escalation of duties as a result of any significant challenges raised during design such as flood mitigation constraints or planning issues:

Item	Description	Quantity	Rate	Total
Structural Design	Design of Bridge sub and superstructure including ground improvements and Dwg's	1 item	£30,000	£30,000
Ground Investigation	Site Investigation and Interpretation	1 item	£12,000	£12,000
Flood Consequence Assessment	Flood modelling / consents / liaison with NRW	1 item	£10,000	£10,000
Specification and BoQ	Design Outputs	1 item	£4,000	£4,000
Planning Application	Planning Application, Planning Meetings and Consultation	1 item	£2,500	£2,500
Procurement	Production of Tender Documents and Management of Tender Process	1 item	£1,000	£1,000
Tender Analysis	Tender Analysis and Financial Assessment	1 item	£2,000	£2,000
			Sub Total	£66,500
			Contingency (10%)	£6,650
			Total	£73,150

Table 6. Design Implementation Cost and Procurement

6.2 Construction Costs

For the proposed solution an estimate is made in relation to the overall construction costs. These costs include site setup, superstructure, substructure and site supervision. As noted above the costs are indicative and included for information only to aid future planning. A construction period of 8 weeks is anticipated (and costed for):

Item	Description	Quantity	Rate	Total
Preliminaries	Assume 10% of overall contract value	1 item	N/A	N/A
Traffic Management	Diversion signs, cones to close of skirmisher area, cones for footpath	1 item	£4,000	£4,000

Item	Description	Quantity	Rate	Total
Temporary Works	Temp sheet pile for excavation, scaffold access for stonework and formwork/RC fixing, flood protection measures (sandbags)	1 item	£15,000	£15,000
Ground Improvement	Over excavation to hard material / removal of boulders/cobbles, infill with suitable material	1 item	£6,000	£6,000
Substructure	Mass concrete, formwork …etc.	1 item	£6,500	£6,500
Substructure	Stonework cladding	40 sq m	£400	£16,000
Superstructure	Manufacturer Supply (Resin Infused Deck with surfacing)	1 item	£200,000	£200,000
Structural Health Monitoring	Fibre Optic Monitoring	Equipment Interpretation/ Load Test		£15,000 £5,000
Finishes	Parapets Seating Landscaping Lime Pointing	60m 2 No 1 Item 30 m2	£150 £1,500 £6,000 £200	£9,000 £3,000 £6,000 £6,000
Ancillary Works (Reinstate Surfaces)	Resurface / Reinstate Car Park	1 item	£5,000	£5,000
Misc (Accommodation works – Welsh Water/Other)	Service Diversions/Protection	1 item	£10,000	£10,000
Risk / Contingency	Assume 10% of overall contract value	1 item	N/A	N/A

Sub Total	£306,500
Prelim/Contingency (20%)	£61,300
Total	£367,800

Table 7. Construction Estimate

6.3 Lifecycle Costs (WLC)

Bridges are designed to have a 120 year design life. Thus during an assets lifespan the cost of maintenance can be high and the Institute of Asset Management report that the lifecycle cost of can be in the order of x8 construction cost.

Hence this can result in significant burden on Asset owners. Hence in this section we have highlighted a typical approach and included estimated lifecycle costs for this footbridge.

The key aspect proposed for this structure is the use of Fibre Reinforced Polymers in the construction of this structure. The key factors in proposing the use of FRP Composites relates to the lightweight nature and durability of this material. This is especially important as the structure will be located in coastal

environment subject to flooding supported on sand/alluvium layer with a low bearing capacity.

The below whole life cost estimate covers the 120 years lifespan. The WLC is based on current values with no Net Present Value (NPV) time framed adjustments undertaken.

Item	Description	Quantity	Rate	Total
Statutory Inspections - Handover	Post opening and transfer handover inspections	2 item	£1,500	£3,000
Statutory Inspections - General	General Inspection – every 2 years	60 items	£750	£45,000
Statutory Inspections - Principal	Assume PI every 10 years (assume £2000 per inspection)	11 items	£2,000	£22,000
Maintenance to Coatings	Minor repairs every 10 years	11 items	£300	£3,300
	Full recoating after 50 years	1 item	£10,000	£10,000
Minor Repairs	Minor blister repairs (every 30 years)	3 item	£1,500	£4,500
SHM Reviews	Assumed Fibre Optics Strain measurements @ 4 intervals	4 items	£2,000	£8,000
Surfacing	Every 15 years recoat using CICOL system or similar (coverage assume 40 sqm)	7 item	£10,000	£70,000
Cleaning	Water jetting / Surface cleaning (approx. every 5 years)	20 item	£500	£10,000
			Total (WLC)	£175,800

6.4 Summary of Costs

The estimated costs of Design, construction plus lifecycle costs are summarised below. A contingency sum is included for both Design and Construction to allow for unforeseen issues and events.

- Estimate Design/Planning Realisation Costs = £73,150
- Estimated Construction Costs = £367,800
- Life Cycle Costs = £175,800

The design realisation costs are approximately 20% of the Construction costs. This amount is somewhat higher than traditional design costs which are normally in the order of 5 to 10% however the complexity of the site (requiring detailed planning/conservation discussion plus studies on flood alleviation/mitigation) will be much more time consuming, plus additional work has been suggested such as upfront ground investigation and tender process/procurement costs are also allowed for.

More importantly the lifecycle costs are considered to be quite conservative, hence the actual cost may be less and can be seen to be significantly lower than that required for conventional concrete and steel construction. This is primarily due to the higher durability of the constituent materials. FRP Composites are much more resilient to corrosion effects from salt water (marine environment) therefore will far out perform any reinforced concrete and steel solutions deployed in this type of environment. Likewise the lower weight advantages of FRP composites are such that the likely substructure construction will be less than that required for a concrete deck which can be over 3 times the weight of FRP.

7 Preferred Option Development

7.1 Summary

The option will deploy the use of GRP deck elements with reinforced concrete stonework clad substructures. The use of resin infused monocoque deck structure has been assumed for the development of the outline design and costing. Foundation will be spread foundations and some ground improvements may be required to increase bearing capacity.

The out-turn cost estimate to design and construct this structure is in the order of £440K. However do to the nature of the materials (high durability) the whole life cost for this structure is somewhat significantly reduced for this structure compared to traditional alternatives. Thus the lifecycle cost is estimated at £176K.

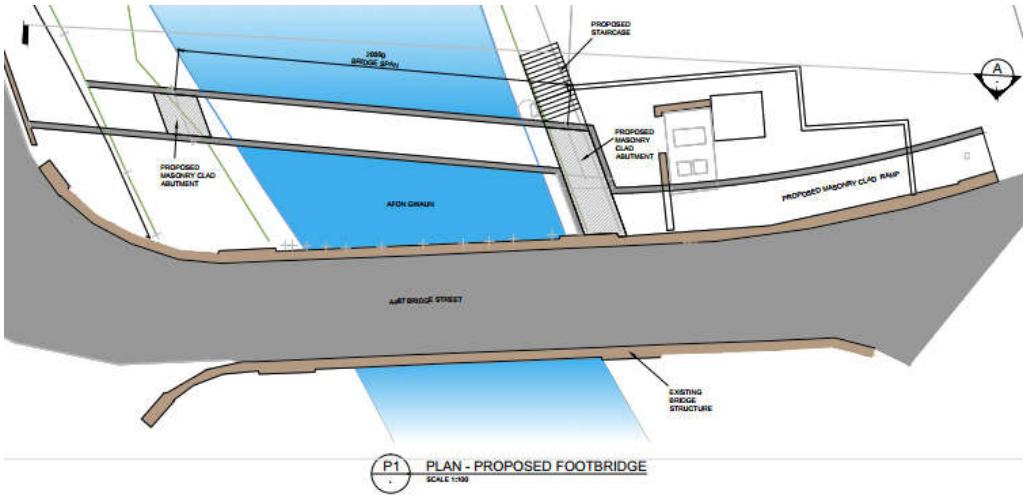
The sustainability of FRP composites is also a major factor in deciding on the solution. Previous studies have shown the embodied energy and environmental impact of glass fibre composites is approximately half that of traditional alternatives using steel and concrete, (refer to Paper: R A Daniel and G Nagtegaal, Pedestrian Bridge of Pultruded Sections as result of Ecological design, in Proc. EPTA Seminar, EPTA, 2001).

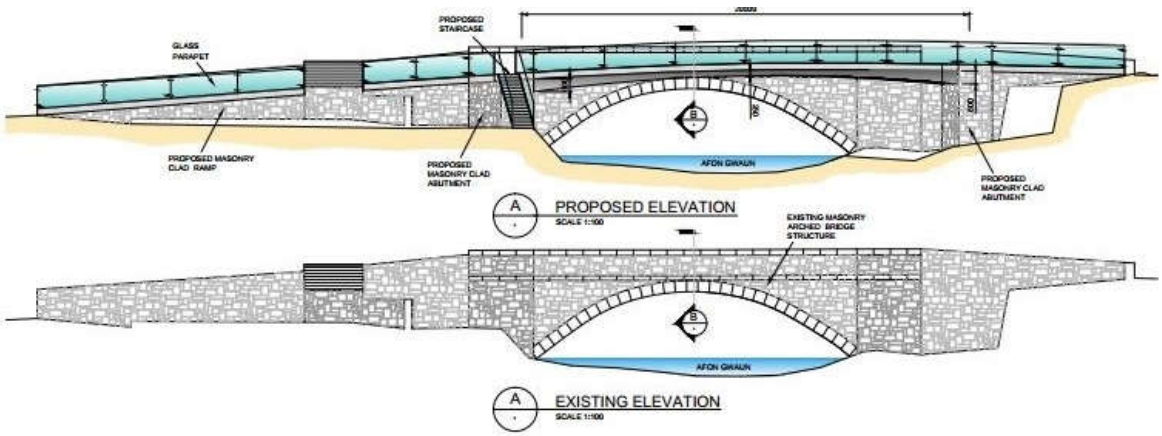
Hence, the use of FRP as a material to overcome the bridging problem in this constrained highly corrosive environment proves to be a solution with numerous merits.

7.2 Sketches and Visualisations

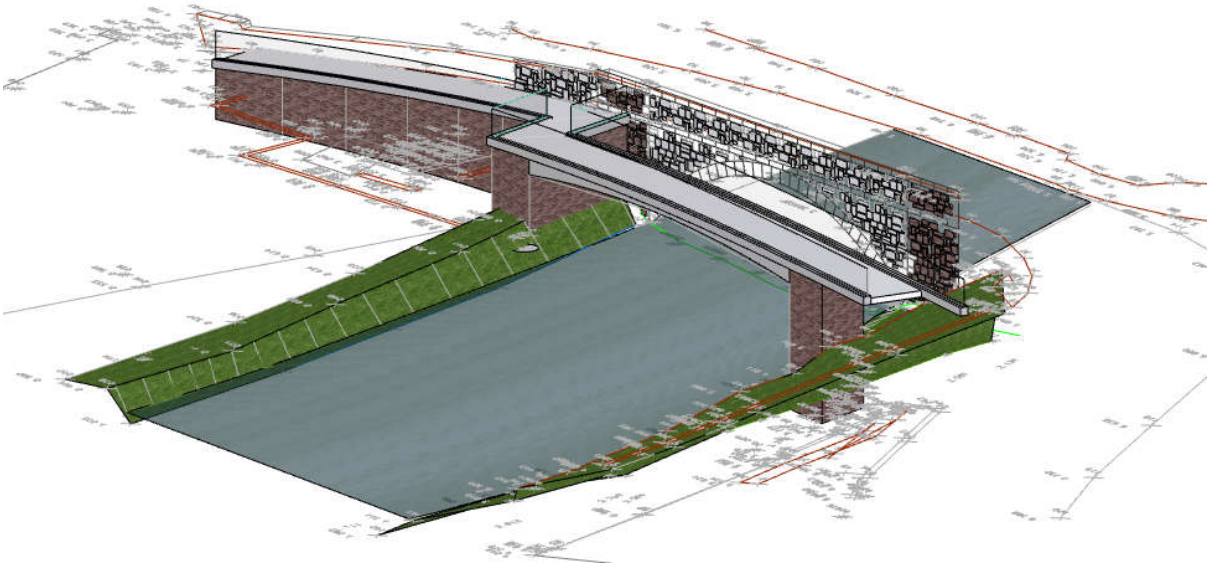
Extracts from our survey and 3D CAD models are highlighted below. Further illustrations and montages are included in the appendices.

2D Illustrations





3D CAD Models (incl. survey information)



7.3 Conclusion and Recommended Option

As noted above the recommended option is a lightweight GRP bridge deck with traditional stonework clad reinforced concrete abutment. The estimated outturn cost of the structure is circa £440,950. The predominant reasons for selecting this material are highlighted below:

1. Lightweight Structures thereby minimum foundation requirements
2. Minimal effects on flood issues including interruption of overland flow paths,
3. Durable material which is well suited to marine environment,
4. Comparable costs when compared against steel alternatives,
5. Ease of erection,
6. Can provide a visually appealing structure,
7. Low maintenance costs hence low whole life cost implications.

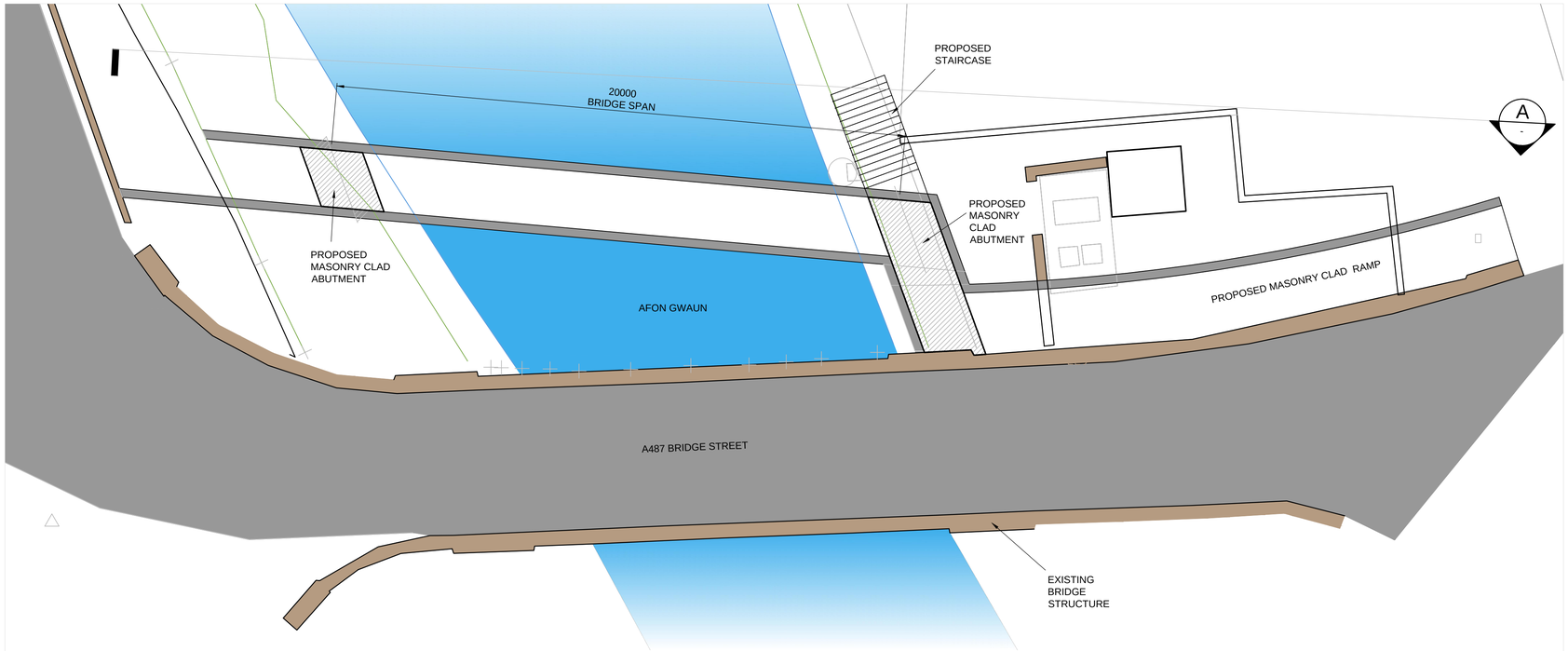
7.4 Further Considerations

To take this recommendation forward further consideration is to be given into:

- **Third Party Requirements** - A 2D flood consequence assessment will be required and further consultation will be required with the National Resources Wales (NRW),
- **Third Party Requirements –** need to consult in detail and obtain consents from Welsh Water regarding locating the ramp and abutment near their plant, some variations and amendments to WW easement and licenses may be required to be updated/reviewed as a result of the proposed scheme,
- **Site Information** - Site investigation and geotechnical interpretation of information,
- **Design** - a detailed design will need to be developed with a structural design specialist for fibre reinforced composites,
- **Construction** – employ suitable contractor.

Appendix A

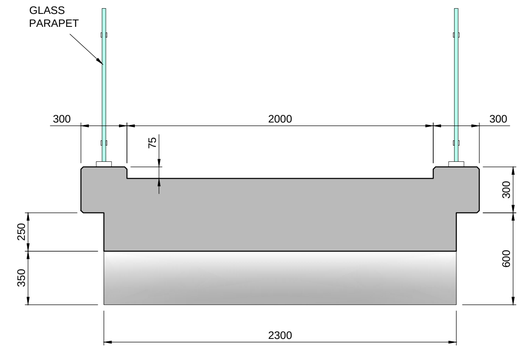
Drawings and Visualisations



P1 PLAN - PROPOSED FOOTBRIDGE

SCALE 1:100

L1 LOCATION PLAN



B TYPICAL SECTION

SCALE 1:20

A PROPOSED ELEVATION

SCALE 1:100

A EXISTING ELEVATION

SCALE 1:100

DRAFT

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTES OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following:

CONSTRUCTION

STATUTORY UTILITIES PLANT AND PROXIMITY TO HIGH SPEED TRAFFIC

MAINTENANCE/CLEANING

NONE

DECOMMISSIONING/DEMOLITION

NONE

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

Rev.	Date	Description	By	Chk'd	App'd
P1	07/04/17	FIRST ISSUE	D.A.S.	J.R.	D.B.

Drawing Status: FOR INFORMATION

Suitability: S2

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Project Title: A487 FISHGUARD

Drawing Title: FOOTBRIDGE LOWER TOWN FISHGUARD GENERAL ARRANGEMENT

Scale	Designed	Drawn	Checked	Authorised
1:250	JH	DAS	AT	JR
Original Size	**Date**	**Date**	**Date**	**Date**
A1	07/04/17	07/04/17	07/04/17	07/04/17

Drawing Number: JR16-601-ATK-HGN-SWTRA-DR-D-0001

Revision: P1


Existing


Proposed Footbridge

Existing

Proposed Footbridge

Proposed Footbridge

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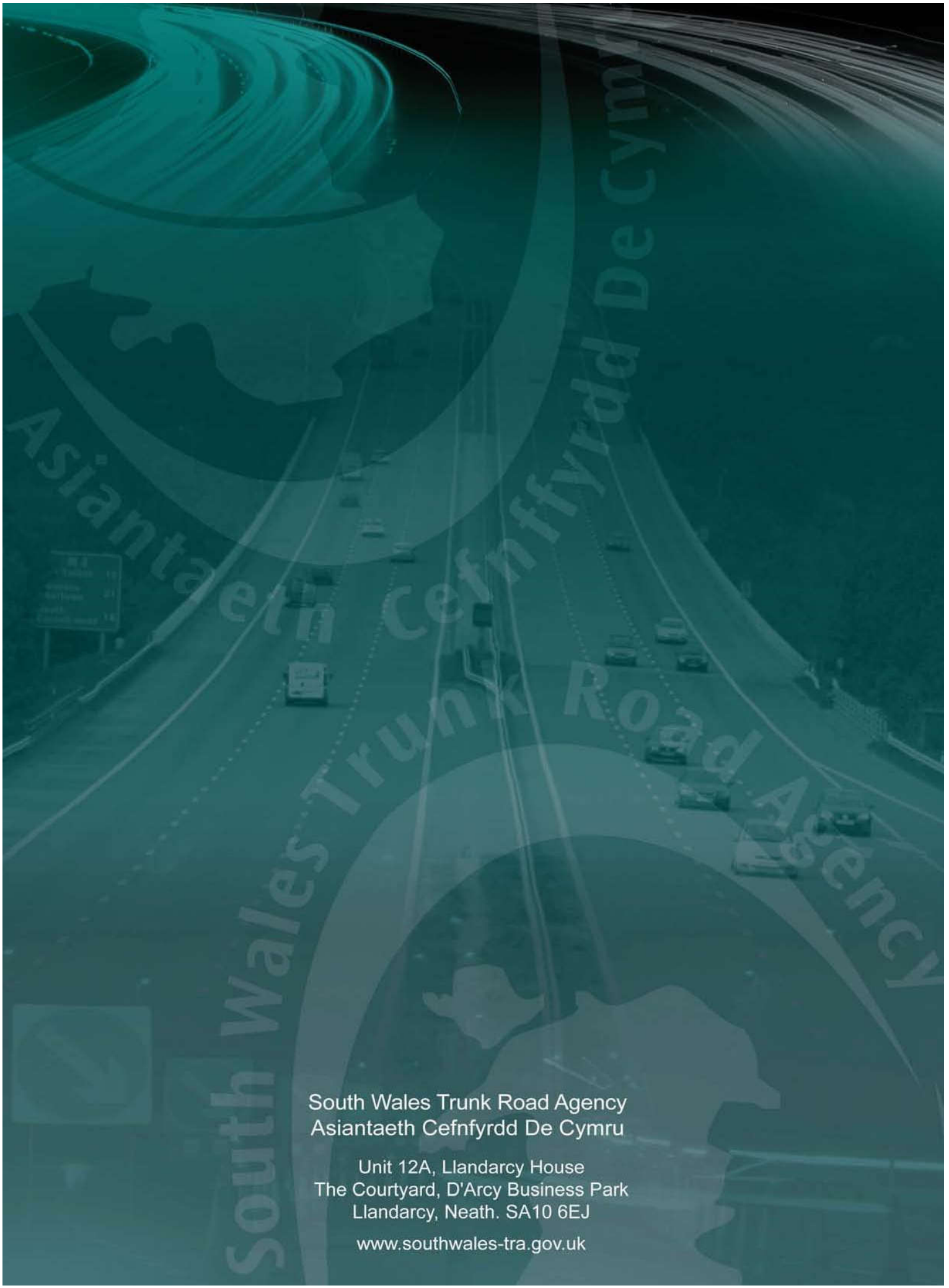

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