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Ein cyf/Our ref MB/CS/0047/12

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 January 2012



Last year, I undertook to provide you with a copy of the Pont ar Dyfi options report after it had been passed to CADW for comment.

I now attach a copy of the report for your information, and apologise for the delay.

Given that the Dyfi Bridge is a Scheduled Ancient Monument and a Grade 2 Listed Structure, CADW see their role as having the conservation of the historic bridge as the primary objective and argue that it is the bridge's historic importance that should have a predominant consideration.

As a result we have decided not to pursue the option recommended in the report, i.e. the strengthening/widening of the existing bridge. We are therefore considering other options including a new bridge and approach roads. The next stage is to appraise options to address the flooding and closure problems at the bridge using the Welsh Transport Planning Appraisal Guidance (WeITAG).

The aim of this study is to identify the problems, opportunities and constraints in the area before identifying possible solutions. Traffic Surveys have already been completed which will be used as part of the WeITAG study.

In the short term, we have commissioned Powys County Council to consider options for improving signage in the area, including the possibility of installing a CCTV camera near the Eco Park Centre on the approach to Machynlleth. They are investigating options to resolve the flooding problems under the railway bridge in Machynlleth.

A handwritten signature in black ink, appearing to read 'Carl Sargeant', written in a cursive style.

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Minister for Local Government and Communities

*Asiantaeth Cefnffyrdd Canolbarth Cymru*  
Mid Wales Trunk Road Agency



**A487 FISHGUARD TO BANGOR TRUNK ROAD  
PONT AR DYFI IMPROVEMENT  
MACHYNLLETH**

**Options Development Report**

February 2011

**Report Prepared By: Powys County Council**



**Report Ref: 0396C/02/DC,SK Rev D**



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**A487 FISHGUARD TO BANGOR TRUNK ROAD**

**PONT AR DYFI IMPROVEMENT  
MACHYNLLETH**

February 2011

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## **EXECUTIVE SUMMARY**

It is recognised that there are a number of issues relating to the existing route of the A487 at Pont ar Dyfi (Dyfi Bridge) that affect network resilience, these generally relate to flood severance and the layout and condition of the existing bridge.

The route is the principal south to north coastal route in Wales and links communities along the west coast and is also a popular tourist route.

The Afon Dyfi frequently floods between the ECO Park and the bridge and the section of the A487 traversing the floodplain is periodically inundated, thus severing this south/north link between Powys and Gwynedd for periods of up to three days several times a year, however, the bridge itself is not subject to inundation.

The existing crossing of the Afon Dyfi has its own unique problems. In order to provide a solution to the flood severance issue a major scheme, such as a viaduct, costing in the region of £15-£20m will be required which is outside the scope of this report.

The bridge is narrow, has no footways, substandard height parapets and substandard visibility due to poor geometry of the junction on the northern side. This poor geometry results in continual damage to the parapets and spandrel walls. The bridge has also recently been assessed and the results indicate that the bridge does not have the capacity to accommodate larger vehicles and the capacity reduces further during severe flood conditions as the structure becomes saturated.

The structure is currently subject to significant annual maintenance costs, primarily for parapet damage repairs. It is considered that as the bridge continues to deteriorate these costs will increase significantly as will the delays.

A number of options have been considered at the bridge including Do Nothing, the installation of traffic signals, Do Minimum and widening and strengthening.

The existing bridge is classified as a Grade II Listed Structure and a Scheduled Ancient Monument and therefore approval must be obtained from CADW for any changes to the existing structure. The Afon Dyfi is a Statutory Main River, and falls under the jurisdiction of the Environment Agency (EA). Flood Defence Consent must therefore be obtained for any proposed works.

The widening and strengthening option is recommended as it would provide a carriageway width of 9.3m and footways 2m wide. It will ensure the long term future use of the structure, reduce the maintenance liability caused by collision damage and improve the junction layout with the A493. This option can be constructed while the route is operational, albeit single lane. It has the advantages of making the bridge fit for purpose and ensuring the preservation of the historic structure. It will remove current unsightly repairs and support bracing to leave the bridge in a condition which, though changed, will be in keeping with the design and aesthetics of the original structure. Once completed the structure's long term viability will be secured with relatively low maintenance costs.

It should be noted that flood severance of the trunk road to the south of the bridge will continue, possibly up to four times a year and it is recommended that gates/bollards are installed to prevent access through the flooded area and therefore mitigate the risks to vehicles and their occupants crossing the estuary during flood conditions. A report has been prepared to consider this issue, however, this should be pursued as a matter of priority due to the inherent risks currently posed.

## 1. INTRODUCTION

The A487 Fishguard to Bangor Trunk Road is the principal south to north coastal route in Wales. The highway links communities along the west coast and is also a popular tourist route carrying traffic through Pembrokeshire, Ceredigion, Powys and Gwynedd. As well as local and business traffic the route carries the TrawsCambria bus service that links North and South Wales as well as a number of local bus services.

Pont ar Dyfi (Dyfi Bridge) is located immediately north of the market town of Machynlleth in north Powys, where the A487 crosses the Afon Dyfi and its associated floodplain.

The trunk road at Pont ar Dyfi has been the subject of a number of studies into the operation and serviceability of the existing route across the Afon Dyfi floodplain.

## 2. REPORT SCOPE

There are a number of issues relating to the existing route at this location, generally relating to flood severance and the layout and condition of the existing bridge, however, this report intends to concentrate on the existing crossing of the Afon Dyfi which has its own unique problems.

Other wider network issues, generally relating to flooding of the highway network in this area have been the subject of a number of separate studies and are not considered within this report.

In order to provide a solution to the flood severance problem a major scheme, such as a viaduct, costing in the region of £15-£20m will be required which is out of the scope of this report. In order to comply with Welsh Assembly Government policy it will also be necessary to undertake a transport appraisal in accordance with the Welsh Transport Planning and Appraisal Guidelines (WelTAG). This will assist in the development of proposals and to enable the most appropriate scheme to be identified using an objective led approach and to allow comparison of competing schemes on a like for like basis

## 3. NEED FOR SCHEME

It is considered that the principal factors determining the need for an improvement scheme are:-

- the existing bridge requires strengthening to accommodate 40/44 tonne vehicle loading;
- the existing bridge is too narrow, has sub-standard parapets, is without footways and has poor turning geometry and visibility on the north (Gwynedd) side;
- the substandard alignment results in collisions on a regular basis damaging the fabric of the bridge. This constant damage has resulted in ongoing, costly maintenance and deterioration to the structure;
- collisions at the bridge result in road closures for maintenance and repair work requiring diversions to be implemented;
- the A487 trunk road crosses the Afon Dyfi north of Machynlleth at the first upstream road crossing of the river 15km east from its estuary at Aberdyfi and is strategically important for communities on both side of the Dyfi;
- the nearest alternative road crossing of the river is 8km to the east using the 'Jubilee Bridge' (Powys CC ref no. CB2333) at Grofft, which involves an 18km detour along the B4404 and A489. However, this route is not suitable for larger vehicles and has also been closed due to flooding on a number of occasions; and

- to provide network resilience when the A470 diversion route is closed for any reason, such as the landslip near Bwlch y Drws in 2010.

#### **4. EXISTING CONDITIONS**

##### **4.1 Location**

Pont ar Dyfi is located north of Machynlleth on the boundary between Powys and Gwynedd where the A487 crosses the Afon Dyfi and is partly situated within the Snowdonia National Park. A location plan is shown below. Drawing No. 0396C/F/05 shows the general arrangement of the existing bridge and photographs are included in Appendix A

##### **4.2 Speed Limits**

The trunk road is subject to a 30mph speed limit through Machynlleth to a point 500m south of Pont ar Dyfi. The trunk and county roads north of this point are subject to the National Speed Limit.

##### **4.3 Traffic Flows**

The Average Annual Daily Traffic (AADT) flow on this section of the A487 Trunk Road is 6680. Records show that 2% of these are Heavy Goods Vehicles (HGV's). These figures were recorded in 2009 by the Department of Transport south of Pont ar Dyfi. However, records show that traffic volumes increase considerably during the summer months as a result of tourist traffic

##### **4.4 Layout, Alignment and Visibility**

From Machynlleth the A487 proceeds northwards passing below the Cambrian Line Railway (14'-0" headroom) emerging with the Dyfi Eco Park Industrial Estate on its eastern side.

The A487 continues northwards across the Afon Dyfi flood plain for 600m on a slightly raised embankment to the existing Pont ar Dyfi. The five span masonry arch bridge carries the trunk road across the river to the junction on the northern side with the A493, the Aberdyfi/Twyn road.

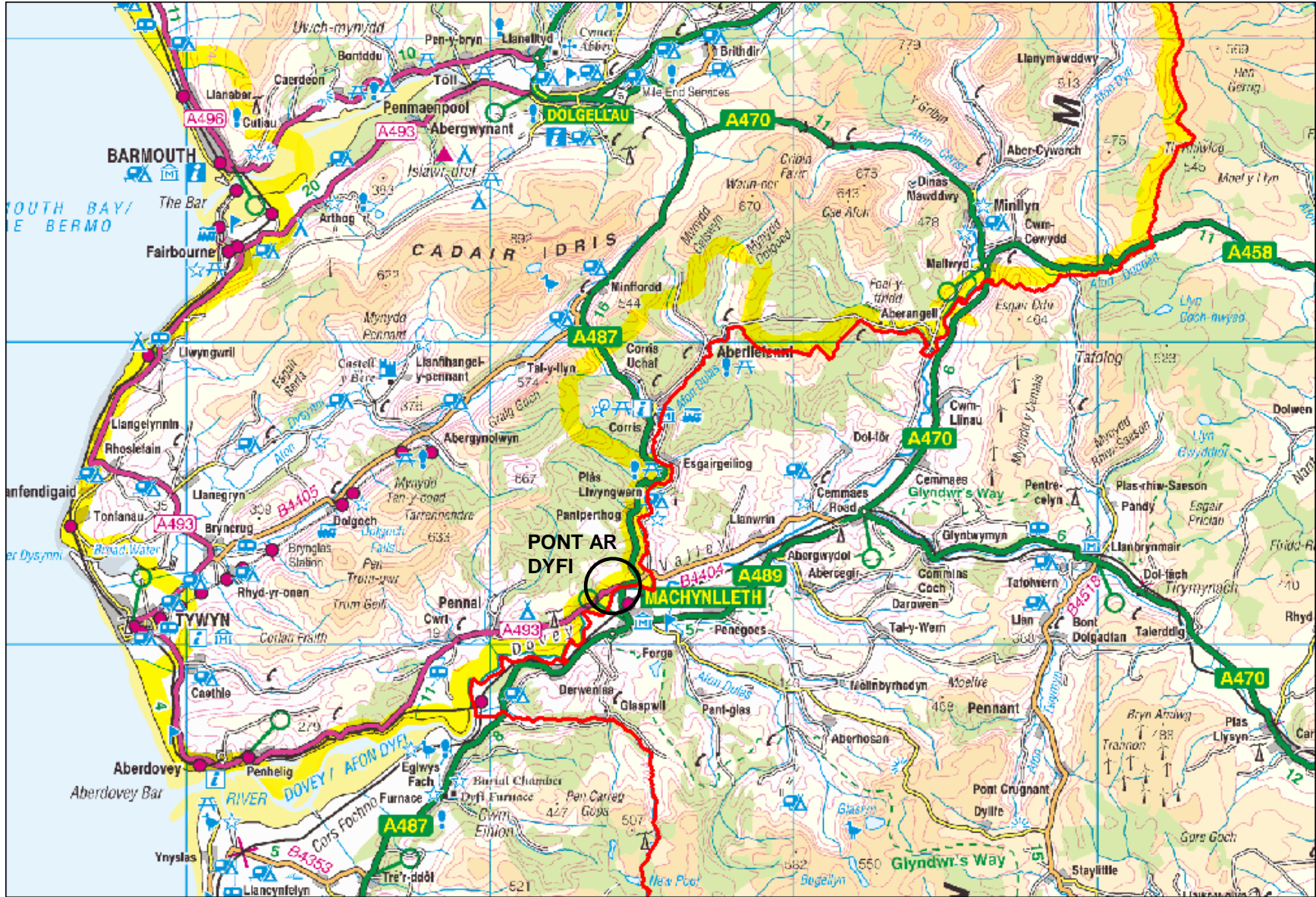
From this junction the A487 runs eastwards parallel to the river and, rising in elevation, towards Ffridd Farm before it turns northward towards Dolgellau.

The A489 runs eastwards from the centre of Machynlleth to join the A470 at Cemmaes Road.

The B4404 runs from the A487 on the northern side of the Afon Dyfi and crosses the river near Grofft where it rejoins the A489 west of Cemmaes Road.

The layout at the A487/A493 junction is sub-standard and presents difficulties to larger vehicles negotiating the turn onto the bridge. Photograph 17 shows a HGV attempting to negotiate the junction. The narrow approach to the bridge from both Corris and Aberdyfi exacerbates the problem. This is confirmed by the continual damage and repair to the parapets and spandrel walls and computer generated swept paths have been undertaken for a large articulated vehicle which are shown on Drawing No. 0396C/F/03. Visibility at the A487/A493 junction is also below standard.





**Location Plan**

#### **4.5 Carriageway and Footway Widths**

The carriageway widths on the northern and southern approaches to the bridge vary between 6.98m and 6.15m with the typical width being around 6.70m. The A487 locally narrows to 6.15m at the tie-in to Pont ar Dyfi. This aspect therefore does not meet minimum width requirements for a single carriageway trunk road (7.3m).

The carriageway width on Pont ar Dyfi itself is less than the approaching trunk road and varies between 5.61m and 5.57m, no footway or pedestrian refuge is provided along the bridge.

The average width of the A493 on the approach to the A487 junction is 5.5m with a minimum width of 4.5m.

#### **4.6 Collision History**

There have been two recorded slight injury collisions in the vicinity of the bridge in the past five years. Both collisions involved vehicles traveling in opposite directions coming into conflict on the bridge.

Photographs showing one of the collisions are shown in Appendix A. This collision caused damage to the parapet and spandrel walls and required significant repair work. The bridge was closed on this occasion for the vehicles to be removed and the damage to the bridge to be assessed. The bridge has also been closed on other occasions due to vehicles being unable to pass through the sub-standard layout following collisions.

There have been numerous unrecorded damage only collisions or near misses that have taken place causing frequent damage to the parapets and boundary walls of nearby properties.

#### **4.7 Pont ar Dyfi**

##### **4.7.1 Bridge History**

Although a crossing of the Afon Dyfi may have previously existed at this location the first known recording is of a timber bridge erected in 1533, which was subsequently replaced by a masonry structure circa 1681.

The present Pont ar Dyfi is a five arch masonry structure that was constructed in 1805 and classified by CADW as a Category A site, being of 'national importance and presumed to be preserved and protected *in situ*'. The bridge also has statutory protection as a Grade II Listed structure and a Scheduled Ancient Monument (ref no SAM Mg002).

In the past 60 years there have been modifications and repairs to the bridge, the more significant of these are:

- Circa 1949 - Flared extensions to the north span were added to improve the junction with the county road;
- 1962:- Scour protection with Larsen piles downstream of structure;
- 1967/8:- Arch fill pressure grouted;
- 1975:- Repairs to paved invert;
- 1981:- Gabion training wall built downstream;
- 1990:- Assessment – Capacity of structure 17 tonnes;

- 1991:- Temporary strengthening with steel bracing to pier 1 and ties to remainder of spandrels;
- 2009:- Assessment – Capacity of Structure – 13 tonnes reducing to as low as 3 tonnes during flooding; and
- 1960 to date:- Frequent repairs to masonry parapets due to damage caused by bridge strikes.

In the past thirty years increasing traffic and continuing deterioration of the existing masonry structure has required structural strengthening works and repairs to ensure the bridge remains open to vehicular traffic. The bridge parapets regularly suffer vehicle collision damage due to the insufficient width and poor geometry, even though in 1949 the bridge was locally ‘widened’ on the northern side to ease this problem.

The structure is currently subject to annual maintenance costs of a minimum of £10,000, primarily for parapet damage repairs, although in some years the costs may be significantly more. For example, in June 2010 a 16m length of parapet was demolished by a vehicle failing to negotiate the junction and Photographs 15 and 16 show the damage. As a result the bridge was closed for safety reasons for two half days, HGV’s were diverted for 8 weeks and the cost of repairs was in excess of £40,000. It is likely that as the bridge continues to deteriorate these costs will increase and an anticipated spend in excess of £40,000 per annum has been estimated for future repairs.

#### **4.7.2 Principal Inspection**

In July 2006 a Principal Inspection was undertaken which identified that:-

- the stonework parapet walls have insufficient height with several excessive bulging sections;
- steel ties restrain bulging spandrel walls with additional bracing being used between arches 1 and 2;
- the carriageway width of 5.5m is too narrow for two large vehicles to pass resulting in frequent collision damage to the structure;
- no facility or refuge exists for pedestrians;
- the limitations imposed by the sub-standard bridge carriageway width are exacerbated by the poor geometry at the A487/A493 junction on the northern (right bank) side further reducing capacity and safety; and
- the spandrel walls are generally in poor condition.

#### **4.7.3 Assessment**

A structural assessment was carried out on Pont ar Dyfi in 1990 and the bridge has recently been re-assessed and results indicate that the bridge does not have the required capacity to accommodate 40/44 tonne vehicles. When the arch is subject to flooding the capacity of the arch barrel is further reduced as the weight of both the arch barrel and the fill is decreased due to buoyancy. Hence, the bridge is being managed under BD79 whilst further refinements/investigations are conducted to determine if the assessment can be improved. However, any improvement in carrying capacity will be offset by the deterioration of the fabric of the bridge and the long term viability of the crossing will continue to be compromised unless we intervene and carry out strengthening works.

The arch extensions are capable of carrying full highway load, however, the physical condition is poor with spalling concrete exposing the bottom flange of the cased steel beams.

Calculations show that the spandrel walls are unable to withstand the horizontal forces from the arch fill and the live loading surcharge and this lack of resistance is represented by localised tilting and bulging in the spandrel walls.

#### 4.7.4 Severance Due to Flooding

The Afon Dyfi is some 50km long from its source near Blaenpennant to its estuary at Aberdyfi. The catchment area of 465 square kilometres comprises short steep sided valleys with correspondingly steep fast flowing watercourses.

At Machynlleth the floodplain is approximately 500m wide and floods regularly, severing the A487 south of Pont ar Dyfi for periods up to three days at a time. The bridge is not subject to inundation, however, its capacity is significantly reduced. Upstream, flooding also periodically severs the B4404. Hydrological studies undertaken in 2001 suggest that a 1 in 2 year flood will result in the overtopping of the trunk road. Photographs of typical flood events at Pont ar Dyfi are shown in Appendix A. Flood severance events since 2006 are listed in the table below. The table shows that the road is closed for a minimum of four days per annum due to flooding and was closed for six days in 2008. The number of days that the route is severed is likely to increase in the future as a consequence of climate change. It is considered there are significant costs to the economy associated with this regular closure of the strategic route. Photographs 11-12 show flooding at this location.

A separate flooding mechanism below the Cambrian Line Railway Bridge has been identified which occurs independently of the Afon Dyfi flooding and frequently interrupts the use of the A487. This has been the subject of separate studies to identify the optimum solution and Photograph 14 shows its extent.

<i>Date of Initial Closure</i>	<i>Closure Length</i>	<i>Flood Level m AOD</i>
5 December 2006	1 day	9.330
11 December 2006	3 days	9.602
18 January 2007	1 day	9.393
7 December 2007	2 days	9.559
20 January 2008	1 day	9.640
6 September 2008	1 day	9.348
5 October 2008	1 day	9.691
26 October 2008	1 day	9.618
6 December 2008	2 days	9.691
18 November 2009	2 days	9.462
14 September 2010	2 days	9.538
15 January 2011	3 days	
5 February 2011	36 hours	

**Table Showing Pont ar Dyfi Flood Severance Periods due to Flooding**

#### 4.7.5 Road Closure Disruption

Currently tactical diversions are being prepared to be put in place when sections of the trunk road network are closed due to issues relating to the bridge or flooding of the A487 south of the bridge. The tactical diversion to be used when the A487 is closed at this location follows the trunk road network via the A489 to Cemmaes Road and the A470 at Cross Foxes. The length of this diversion is approximately 33 miles. A shorter route of 11 miles is available via the B4404, however, this is only suitable for light vehicles and is not

signed as an alternative. This route has also been subject to closure by flooding on a number of occasions.

Consultations with the local Fire Brigades have revealed that the severance of the A487, when the bridge is closed does not affect their fire fighting capability, since there are a sufficient number of appliances located either side of the river to meet the required level of service.

The Welsh Ambulance Services NHS Trust serves Machynlleth and south west Gwynedd with ambulances stationed in Machynlleth, Tywyn and Dolgellau. Although there are Cottage Hospitals in each of the towns, the main hospital for medical emergencies for the region is the Bronglais General Hospital in Aberystwyth. The Trust is subject to performance standards which have set response targets to be met within time scales. The main aim is for ambulance services to respond to a patient with an immediately life-threatening condition within eight minutes. The Trust indicated that an eight minute window covers an area of approximately 6 miles radius from Machynlleth. The additional journey time required to travel the diversion via Grofft results in impairment of service and has serious consequences for patients. However, it has not been possible to carry out a detailed comparison of emergency trips during road closures for reasons of patient confidentiality.

Outpatients travelling to Aberystwyth also have increased journeys and may cancel at short notice having an adverse effect on NHS services.

## 5. IMPROVEMENT OPTIONS

Pont ar Dyfi suffers from a number of problems that affect its ability to function adequately within the highway network. These problems include:-

- substandard capacity for highway loading which reduces further during flood conditions;
- substandard alignment and carriageway cross section;
- substandard parapets;
- poor condition and ongoing deterioration of the structure; and
- lack of pedestrian facilities.

Earlier studies have identified possible options that will address these particular issues either individually or in combination. These options ranged from 'Do Nothing' to the construction of a new offline structure across the Dyfi estuary.

This report will look at the structure in isolation and as detailed previously will not consider the issues of flooding between Pont ar Dyfi and the Eco Park or at the railway bridge. Four improvement options have been identified and investigated as follows:-

## **5.1 OPTION 1 - DO NOTHING**

### **5.1.1 Introduction**

Pont ar Dyfi has been assessed as having insufficient load carrying capacity and this is being addressed in the short term by the development of a management plan in accordance with the Design Manual for Roads and Bridges standard BD79 "The Management of Sub Standard Structures".

Vehicles are also known to attempt to negotiate the trunk road during flood conditions and become trapped in floodwater south of the bridge. Photograph 13 shows an example of this. Therefore, barriers/bollards, variable message signs (VMS) and improved signing are being developed to prevent vehicle and pedestrian access to flooded areas of the trunk road and .Report No. 0396C/10/DC has been prepared to investigate the options. Monitoring of the crossing is also undertaken using CCTV and this together with the Environment Agency flood warnings will provide early notice of flood events and allow timely road closures.

The "Do Nothing" option will result in the continued deterioration of the structure and will take the form of further and progressive distortion of the parapet and spandrel walls from lateral loading, collision damage and reduction in strength due to flooding events. Future remedial action will be required to prevent worsening failure of the parapets and spandrel walls. There will be a reduction in load carrying capacity with the likelihood of a weight limit being applied and in the worse case the loss of the structure.

### **5.1.2 Effects of Implementing a Weight Limit**

Should a weight limit be applied, heavier vehicles with a fully laden weight over that specified, which may include national and local bus and coach services, would be required to use the alternative route. The impact of downgrading this route and the diversion of heavier vehicles will be to increase fuel costs, cause delay in the provision of supplies/services and increase environmental damage due to fumes and carbon emissions. In addition, resilience of the route is removed, journey reliability is decreased and disruption to both traffic and local residents increased. There are also a number of sections of the A470 that have poor alignments and cause some difficulties to larger vehicles negotiating bends.

The environmental costs should also be recognised. Road transport is one of the biggest contributors to carbon emissions. Noise and vibration may have an adverse impact on properties close to the alternative route. The carbon footprint of goods and services will inevitably increase for anyone affected by the imposition of a weight limit.

### **5.1.3 Pedestrian Use**

Due to the sub-standard width of the bridge, typically 5.7m between parapets, there are no footways and pedestrians are fully exposed to highway traffic. The risk is further exacerbated by the low height of the parapets, typically 700mm in height, which are unlikely to fully prevent falls over the edge of the bridge.

### **5.1.4 Collision Damage**

The parapets display evidence of multiple collisions due to the below standard junction at the north end of the bridge and the restricted width of the carriageway. Each collision results in damage to the masonry and copings. This sometimes results in material being lost in the river resulting in new masonry having to be used for repairs. Often the impact will stress and displace the spandrel wall below and as a result the alignment and integrity of the masonry is compromised.

Due to the strategic importance of the highway for both local and national transport there is a reluctance to obtain a closure of the route for repair works. Repairs are therefore usually undertaken with traffic continuing to use the bridge. Gaining access from the river side of the bridge via scaffolding requires the written consent of the Environment Agency which will normally take 8 weeks to process. The repair works are therefore undertaken from the carriageway with limited space for men and materials. Understandably, compromises are made both in terms of the materials used and workmanship with the emphasis being on minimising the time spent in a high risk situation. Previous repairs bear evidence to this.

### **5.1.5 Spandrel Walls**

The spandrel walls have suffered from both traffic impact damage and excessive lateral loading from the arch fill and live loading. Cyclic freeze-thaw action and flood saturation in combination with intermittent high vertical loading has resulted in small incremental horizontal outward movements of the spandrels. Some movement may recover but most will be irreversible and result in progressive movement and distortion.

The temporary steel bracing to pier 1 (Photograph 9) and ties and patress plates to the remaining spandrel walls, installed in 1991, serve a purpose but are unsightly and at the time were only envisaged as a short-term solution. Failure to undertake long term strengthening and improvement will inevitably lead to a series of similar unsightly repairs. This type of emergency repair is often disproportionately expensive.

### **5.1.6 Flooding Events**

The frequent flooding events that occur at this location have a direct effect on the structural fabric of the bridge. The high level floods cause partial or substantial saturation of the arch barrel, spandrel walls and arch fill which significantly reduce the load carrying capacity of the structure, typically by a factor of 1.6 to 1.8 of non-flooded strength.



## **5.2 OPTION 2 – INSTALLATION OF PERMANENT TRAFFIC SIGNALS**

### **5.2.1 Introduction**

To avoid the problem of traffic conflict on the bridge, which results in collisions and damage to the structure, consideration has been given to having traffic flow over the bridge controlled by traffic signals. This would allow traffic to proceed over the bridge in one direction only at a time, reducing vehicle conflict and hence vehicle to vehicle collisions. However, vehicle collisions with the parapet at the northern end are likely to continue as there is no improvement to the geometry of substandard junction. The traffic signals would need to be three way due to the junction of the A487 with the A493 on the north side of the bridge. It is likely that footways could be constructed over the bridge to provide pedestrian facilities.

The provisional estimated cost to provide signals is £95,000 with annual running costs of £2,000.

### **5.2.2 Use of Temporary Traffic Signals**

Recent repairs to the west parapet required the use of three way traffic signals. During peak periods there were delays of up to 20 minutes with traffic backing up into Machynlleth. Without further detailed analysis it is considered that the provision of traffic signals is not feasible without causing long delays to traffic which would be exacerbated during the summer months when traffic volumes increase substantially.

## **5.3 OPTION 3 – DO MINIMUM, STRENGTHENING WORKS ONLY**

### **5.3.1 Introduction**

In the recent assessment of Pont ar Dyfi three of the five spans were identified as being below full loading capacity. The management strategy recommends a monitoring regime rather than the implementation of a weight limit at the present time. However a weight limit is likely to become necessary as further deterioration occurs.

### **5.3.2 Weight Limit**

In order to eliminate the need for a weight limit, strengthening of the below capacity spans or the entire structure, as preventative maintenance, may be undertaken. For this work to proceed, consultation and authorisation from CADW will be necessary.

### **5.3.3 Proposed Works**

The works considered for this option are the minimum necessary to ensure that the load carrying capacity of Pont ar Dyfi meets the trunk road standard for this type of structure (40/44 tonnes), maintains the bridge as a viable crossing of the Dyfi, minimises the requirements for non-routine maintenance works and maximises service life. The parapets should also to be strengthened and increased in height or replaced, in order to comply with current standards and provide adequate vehicular restraint and a compliant barrier for pedestrians. The improvement of the parapets may result in them being marginally wider which could lead to a slightly reduced carriageway width.

There are a number of options that could be employed to strengthen Pont ar Dyfi, however, as the structure has ancient monument status only methods which will have a minimal effect on the external appearance of the bridge should be considered.

In order to provide a serviceable crossing the preferred strengthening method should ensure that:

- the arch barrels are strengthened;
- stability is provided to the spandrel walls, allowing the removal of the temporary beams supporting pier one and the plates that help to stabilise the spandrel walls;
- waterproofing of the arch barrels is undertaken;
- ingress of water is prevented; and
- the parapets are strengthened and increased in height to meet current standards.

The splayed additions at the north end of the structure, though assessed as suitable to carry full highway loading are showing signs of disrepair with spalling concrete and exposed and corroding steelwork. Any strengthening option would also need to address this problem.

In order to prevent the capacity of the bridge reducing significantly during flooding events it will be necessary to utilise a concrete saddle solution over the arches.

### **5.3.4 Impact Damage**

Any strengthening option alone will not address the issues of highway geometry and pedestrian safety and the structure will continue to sustain impact damage. The bridge will also need to be closed during flooding of the A487 to the south to prevent access, although the bridge itself will generally be unaffected.

### **5.3.5 Traffic Implications Whilst Undertaking Works**

Due to the nature of the works a road closure will be required throughout their duration, possibly up to two years depending on EA requirements. This will result in significant diversions for local and long distance traffic. It may be possible to construct a temporary bridge for the duration of the works, however, this is estimated to cost in the region of £500,000 and the highway alignment would have well below standard junctions with the existing road network. Approval would also be required from the EA for any bridge and their specific requirements would need to be taken into consideration.

### **5.3.6 Traffic Signals**

Traffic signals may also be incorporated into this option.

## **5.4 OPTION 4 – WIDENING AND STRENGTHENING OF THE EXISTING BRIDGE**

### **5.4.1 Introduction**

This option consists of the widening of the existing bridge on the downstream side to incorporate a wider carriageway and new footway provision. Extensions to the downstream side will avoid complex land purchase issues which would arise if widening was undertaken to the upstream side. For this work to proceed, consultation and authorisation from CADW will be necessary. It is proposed that the extension will be formed in masonry, or be masonry clad, to replicate the original form of the structure. If required the detailing can such that the original and new sections can be clearly delineated.

### **5.4.2 Proposed Works**

The existing bridge will be widened by 7.6m to provide a 7.3m carriageway, a two metre hatched separation strip between traffic lanes and footways 2.0m wide on each side. See Drawing No. 0396/F/12.

Works can be undertaken without the need for a road closure, therefore eliminating the need for a lengthy diversion or temporary bridge. However, three way traffic control will be required. The extension will be constructed first and traffic diverted onto the new section whilst the original bridge is strengthened and refurbished.

Widening of the structure will require working within the river and will therefore have associated risks, including flooding, which will require management and mitigation. Consultation with the Environment Agency is likely to identify additional constraints that will need to be taken into account during the design and construction process. These may include periods when work is not allowed on the bridge or restrictions on the number of arch extensions to be constructed simultaneously.

The extension is proposed to be of a similar form to the original bridge, i.e. a 5 span masonry or masonry faced arch but with a clear demarcation between the existing and new structures. The upstream spandrel walls will be retained where possible, or rebuilt using existing or similar stone. Parapets will be rebuilt with a reinforced concrete core to standard height. Existing steel beam and concrete extensions to the north side will be removed and replaced with half arches in keeping with the rest of the structure. The new piers and abutments will be formed in mass or reinforced concrete and clad in stonework to match the original.

On completion of the abutments and piers the new arch barrels can be constructed. Traditional construction would require the use of arch support for the construction of a traditional masonry arch barrel or one made from reinforced concrete. Whichever method/material is used this would be a slow process, especially if the EA restricted the use of any arch support system to one arch at a time. Once the arch barrels are complete the spandrel and parapet walls can be constructed in either masonry or stonework faced reinforced concrete. To speed up the process it is feasible to use precast concrete sections for the arch barrels, similarly the spandrel and parapet walls can be precast and faced with stonework to match the original structure. On completion of the arch and spandrel walls the arches would be waterproofed, backfilled and surfacing laid.

The next stage would be to switch traffic onto the new section to enable works to strengthen and refurbish the original structure to proceed. Once complete the original downstream parapet would be removed and the surfacing, and footways and road markings completed.

The splayed additions at the north east end of the structure, though assessed as suitable to carry full highway loading are showing signs of disrepair with spalling concrete and

exposed and corroding steelwork. It is proposed that these should be replaced with half arches to be more in keeping with the existing structure.

#### **5.4.3 Outcome of Works**

The existing bridge will be strengthened and refurbished and together with the increased width the structure will provide a link across the River Dyfi that can carry full highway traffic loading, reduce collisions and provide a safe crossing for pedestrians.

6. ADVANTAGES/DISADVANTAGES OF OPTIONS

Option	1 – Do Nothing	2 – Traffic Signals	3 – Do Minimum Strengthening Works Only	4 – Widening and Strengthening
<b>Advantages</b>	Minimal capital input Maximum retention of historic bridge Minimal environmental impact	Minimal capital input Improvement for pedestrians Possible reduction in collisions with structure Maximum retention of historic bridge Minimal environmental impact	Improved network resilience Removes unsightly repairs Preservation of existing bridge Eliminates the need for weight restrictions May allow waterproofing of arch barrel Reduces risk during flood events Provides a compliant parapet Minimal environmental impact if temporary bridge is not utilised	Guarantees long term viability of bridge Partly preserves the original bridge Provides pedestrian facilities Eliminates the need for weight restrictions Removes unsightly repairs Reduced hazards during construction/future maintenance Reduced risk of collisions and bridge damage Provides improved pedestrian/vehicular parapet protection Increase in manoeuvrability for turning at north end

Option	1 – Do Nothing	2 – Traffic Signals	3 – Do Minimum Strengthening Works Only	4 – Widening and Strengthening
<b>Disadvantages</b>	<p>No waterproofing to structure</p> <p>Regular remedial works to repair impact damage and associated unacceptable risk to workforce</p> <p>Likelihood of weight limit being applied</p> <p>Substandard height parapets</p> <p>Continued deterioration of the fabric of the bridge</p> <p>Reduced confidence in longevity of structure</p> <p>Continued severance of strategic highway link due to flooding</p> <p>Continued risks at times of flooding to public and structure</p> <p>No highway safety or alignment improvements</p> <p>No improvement to pedestrian facilities</p> <p>Not an acceptable long term position</p> <p>Lack of network resilience</p>	<p>Likely extensive traffic delays especially during the summer months</p> <p>Visual impact of traffic signals on the surrounding area</p> <p>No waterproofing to structure</p> <p>Regular remedial works to repair impact damage and associated unacceptable risk to workforce</p> <p>Likelihood of weight limit being applied</p> <p>Substandard height parapets</p> <p>Continued deterioration of the fabric of the bridge</p> <p>Reduced confidence in longevity of structure</p> <p>Continued severance of strategic highway link due to flooding</p> <p>Continued risks at times of flooding to public and structure</p> <p>No highway safety or alignment improvements</p> <p>Not an acceptable long term position</p> <p>Lack of network resilience</p>	<p>Continuing need for remedial works to repair impact damage to parapets and associated disruption to traffic</p> <p>Ongoing maintenance liability and associated costs</p> <p>No highway safety alignment or pedestrian facility improvements</p> <p>Road closure required for up to two years resulting in extensive disruption to traffic</p>	<p>Medium to short term environmental impact;</p> <p>Significant cost; and</p> <p>Likely to affect character of existing bridge.</p>

## 7. COMPARISON OF COSTS FOR EACH OPTION

Option	Works Budget Estimate	Description
1	£40,000 p.a.	Do Nothing:- Reactive and routine maintenance only
2	£95,000 plus £2,000 p.a. running costs	Installation of Permanent Traffic Signals
3	£1,100,000 plus annual parapet repair costs of £40,000	Do Minimum:- Strengthening and refurbishment works assuming bridge closure
4	£3,000,000	Widening and strengthening of existing bridge (9.3m carriageway with 2m footways)

The estimates, as shown, are for construction works only and design, land costs etc are not included at this stage. The costs are of a preliminary nature and as such are likely to vary significantly from this feasibility stage to the construction stage as design and construction techniques are finalised. Rates for individual items of work, such as concrete and the associated quantities are established to an appropriate level of accuracy at this stage. However, the risk associated with undertaking activities such as in river works in this semi-tidal location has not been established. The type of works required makes accurate pricing difficult to establish, however, it is believed the pricing of each option comparative to each other is reasonable. Once a preferred option is chosen and the requirements of the consultees are known it is recommended that a form of early Contractor involvement is established. This will give the advantage of using a Contractor's expertise in construction methods and help to achieve an accurate cost of the proposed improvement thus reducing financial risks.

## 8. CONSULTATION AND CONSENTS

### 7.1 Environment Agency

The Afon Dyfi is a Statutory Main River, and therefore falls under the jurisdiction of the Environment Agency (EA) as provided for in the Water Resources Act 1991. Flood Defence Consent, under the provisions of the Land Drainage Act (1991), must also be obtained from the EA for any works across or adjacent to a main river. These procedures ensure that the Environment Agency is consulted regarding any major scheme that may induce fundamental change in the floodplain environment.

Following initial discussions with the EA on 1st February 2011 it was agreed that an analysis of the flood risks resulting from the widening and strengthening option would be undertaken using numerical modelling techniques if this option was preferred.

### 7.2 Countryside Council for Wales

The Afon Dyfi and its flood plain have a number of environmental designations starting at a point approximately 4 km downstream of Pont-ar-Dyfi. They include:

- SSSI (Special Site of Scientific Interest) The Dyfi SSSI has been designated in stages since 1954, 2262 hectares of the site form the Dyfi National Nature Reserve.
- SAC (Special Area of Conservation). The SAC, Llyn Peninsula and the Sarnau were designated on 13<sup>th</sup> December 2004 and not only include the Dyfi Estuary but a large part of the North Wales coast.
- SPA (Special Protection Area) Dyfi Estuary SPA was classified on 29<sup>th</sup> June 1992



- Ramsar (A wetland of international importance) and includes Cors Fochno and the Dyfi.

Though of obvious importance the proposed works at Pont ar Dyfi are, at this stage, believed to be unlikely to have a direct effect on the SSSI or SAC and should fall outside the scope of requiring a full environmental impact assessment. This would need to be confirmed during the preliminary design stage when consultation with CCW and other bodies will be undertaken.

### **7.3 CADW**

The need to preserve the best examples of ancient monuments has long been recognised by Parliament. Legislation giving statutory protection began in 1882 with the first Ancient Monuments Protection Act. Several subsequent Acts of Parliament afforded wider protection to ancient monuments and archaeological remains of national importance, up to the present Ancient Monuments and Archaeological Areas Act 1979.

The Ancient Monuments and Archaeological Areas Act 1979 provides the legislative framework for the protection of ancient monuments and also embraces properties in the direct care of the State. Aspects of this work are covered in Welsh Office Circular 61/96. The Welsh Assembly Government receives advice on matters related to ancient monuments from the Ancient Monuments Board for Wales.

Before any work or alterations can be undertaken at a scheduled ancient monument, Scheduled Monument Consent has to be obtained from the National Assembly for Wales. This function is administered by Cadw. The consent is usually accompanied by a number of conditions. It may, for example, stipulate what building material has to be used, or the way in which work must be done. Certain works may have to be supervised by an archaeologist, and the work must be inspected by Cadw staff. It is proposed to maintain liaison with CADW, the Clwyd Powys Archaeological Trust and other relevant parties to come to a solution which will achieve the aim of providing a safe and long lived structure suitable for today's use while preserving its historic nature.

Before each application is determined, comments are sought from external consultees. These include local authorities, the Council for British Archaeology, the four regional Welsh Archaeological Trusts, and the Royal Commission on the Ancient and Historical Monuments of Wales. Cadw's Inspectors of Ancient Monuments and Conservation Architects also make their own assessments.

### **7.4 Snowdonia National Park**

The boundary of the Snowdonia National Park crosses Pont ar Dyfi. It is likely that any extensive changes to Pont ar Dyfi will be subject to the planning process under the authority of the National Park.

## 9. ENVIRONMENTAL EFFECTS – ENVIRONMENTAL ASSESSMENT

A Stage II Environmental Assessment (EA) was undertaken in 2003 which considered the Do Nothing, strengthening and refurbishment and various off-line options. The main points arising from the assessment were that:-

- Environmental effects of undertaking works to the bridge were limited to Pont ar Dyfi bridge which has been identified as a site of national importance and is a Scheduled Ancient Monument. The row of six cottages opposite the north end of Pont ar Dyfi are Grade II Listed;
- On-line options will have very little effect on the ecology of the area;
- A positive benefit that will result from the widening option is that Pont ar Dyfi would become more accessible to pedestrians, improving access to nearby properties and for leisure purposes;
- Increased sight lines and visibility splays will help to reduce driver fear and driver uncertainty; and
- Well established construction practices will be used and the requirements of the Environment Agency and other bodies incorporated into the contract documentation to minimise potential impacts. At all times every effort will be made to prevent pollution of the river.

## **10. DISCUSSION/CONCLUSION**

### **10.1 Issues Outside Scope of Report**

There are a number of issues that are relevant to the Afon Dyfi floodplain and its crossing and when considering any improvement will need to be taken into account. In order to eliminate severance due to flooding a major scheme will be required which is outside the scope of this report.

Initial studies have been undertaken into the feasibility of providing a new structure adjacent to the existing, however, due to the existing alignment at the likely tie-in points and EA requirements for waterway area beneath any new structure likely to result in the new soffit being 4.5 metres higher than the existing bridge soffit, this option has been discounted.

### **10.2 Summary of Options**

A summary of the advantages and disadvantages of each option is included in Section 6.

#### **10.2.1 Option 1 - Do Nothing**

The 'Do Nothing' Option 1 will result in the deterioration of the bridge with the likelihood of an imposed weight limit and ever increasing unsightly repairs to a vital river crossing. The poor condition of the parapets will progressively spread down through the spandrel walls. There is an increasing potential for the complete loss of the structure as deterioration progresses. Therefore 'Do Nothing' is not a viable option.

#### **10.2.2 Option 2 – Permanent Traffic Signals**

Although the installation of traffic signals has been considered as a possible option it is recognised that the resulting delays will be significant and therefore this option has been discounted.

#### **10.2.3 Option 3 – Do Minimum, Strengthening Works Only**

The "Do Minimum" Option 3 will arrest the deterioration of the bridge and allow all vehicles within the legal weight limits to use the crossing, however, the poor junction alignment will not be addressed and parapet strikes and minor collisions will continue to be an issue. Pedestrian safety has not been addressed and the lack of any designated footway will still be a potential hazard for pedestrians wanting to cross the bridge.

In order to construct this option a road closure will be required for a period of up to two years. It may be possible to erect a temporary bridge, however, this will be costly, result in a sub-standard alignment and require approval from the EA

#### **10.2.4 Option 4 – Widening and Strengthening of Existing Bridge**

It is recognised that substantial works are required to the existing bridge to maintain a viable, safe trunk road crossing of the Dyfi Estuary and preserve the integrity of the structure. Consultation with the EA will be required when deciding on any preferred option. If the number of collisions and associated repair and closure costs are to be reduced then widening of the existing structure is essential.

This option will eliminate the traffic conflict and carriageway problems on the bridge. There is likely to be an immediate benefit for vehicles making any of the possible manoeuvres at the junction. The provision of footways will improve pedestrian safety and amenity within the area.

Swept paths show that there are benefits to manoeuvrability although it was still necessary for articulated vehicles to enter the opposing traffic lane to complete the

turning movements. It is unlikely that the junction could be designed to comply fully with the requirements of the DMRB without obtaining additional land.

The proposed refurbishments and widening will remove unsightly repairs and additions and leave the bridge in a condition which, though changed, will be in keeping with the design and aesthetics of the original structure. Impact damage from vehicles is likely to be reduced.

## **11. RECOMMENDATIONS**

It is recommended that Option 4 be adopted as it has the advantage of making the bridge fit for purpose and ensures the protection of this historic structure and preserves as much as is practicable. In evaluating the proposed strengthening and refurbishment it must be recognised that the area is designated as environmentally sensitive and great care will be needed in delivering the solution.

The widening and strengthening option has a medium level of financial risk but has the dual benefits of preserving the existing bridge and providing a safe traffic route with optimum environmental impact. Once completed the structure's long term viability will be secure with relatively low maintenance costs.

It should be noted that flood severance of the trunk road to the south will continue, possibly up to four times a year and therefore the installation of barriers will be essential to mitigate risks to vehicles crossing the flood plain during flood conditions.

Until any improvements are brought into effect it is recommended that the interim measures recommended in accordance with BD79 are implemented to improve highway safety.

## **12. APPENDIX A – PHOTOGRAPHS**

- Photograph 1:- View Looking West Towards Pont Ar Dyfi**
- Photograph 2:- View Of Southern A487 Approach To Pont Ar Dyfi**
- Photograph 3:- View Of Southern A487 Approach To Pont Ar Dyfi**
- Photograph 4:- View Looking North Along A487 On Pont Ar Dyfi**
- Photograph 5:- View Looking East Along A493 Towards A487junction**
- Photograph 6:- View Looking West Along A487 Towards A493 Junction**
- Photograph 7:- Upstream View Showing Collision Damage To Bridge**
- Photograph 8:- View Showing Unsightly Collision Repair Works**
- Photograph 9:- View Showing Temporary Bracing To Spandrel Walls**
- Photograph 10:- View Showing Collision On Bridge**
- Photograph 11:- View Showing Flood Event At Pont Ar Dyfi**
- Photograph 12:- View Showing Flooding On A487 In Pont Ar Dyfi Area**
- Photograph 13:- View Showing Vehicle Trapped In Floodwater On A487**
- Photograph 14:- View Showing Flooding Under Cambrian Line Railway Bridge**
- Photograph 15:- View Showing Collision Damage To Parapet June 2010**
- Photograph 16:- View Showing Collision Damage To Parapet June 2010**

**13. APPENDIX B – DRAWINGS**

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Cymru*

