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M4 Corridor around Newport

Approval in Principle – SBR 1000 River Usk Crossing

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M4CaN-DJV-SBR-Z3_1000-RP-CB-0001

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Contents

1 Highway Details

1.1 Type of highway

Over: M4 Corridor around Newport, dual 3 lane motorway

Under: River Usk, Newport Docks and associated buildings, Unclassified local roads (West Way Road, East Way Road, Corporation Road), Railway lines (West Port Rail, East Port Rail, Uskmouth Railway (ELR East Usk Railway))

1.2 Permitted traffic speed

Over Structure: Design speed limit of 120kph and a restricted speed limit of 70mph

Under Structure: 30 mph

1.3 Existing restrictions

N/A – Structure is a new bridge on a new highway network

2 Site details

2.1 Obstacles crossed

The following obstacles are crossed from west to east: -

Start Pier	End Pier	Obstacles crossed
WA	W8	West Way Road, Newport docks and private land
W8	W7	Newport docks and private land
W7	W6	West Port Rail, Newport docks and private land
W6	W5	Newport docks and private land
W5	W4	West Way Road, port buildings, Newport docks and private land
W4	W3	Newport docks and private land, North Dock Cut
W3	W2	Access road, port buildings, Newport docks and private land
W2	W1	Port buildings, Newport docks and private land
W1	WT	Port buildings, Newport docks and private land
WT	ET	River Usk, East Way Road, East Port Rail, port buildings, Newport docks and private land
ET	E1	Salt marsh, Wales Coast Path, Newport Docks and private land
E1	E2	Docks, industrial estates and private land
E2	E3	Docks, industrial estates and private land
E3	E4	Port buildings, industrial estates and private land
E4	E5	Port buildings, industrial estates and private land
E5	E6	Port buildings, industrial estates and private land
E6	E7	Port buildings, industrial estates and private land

E7	E8	Port buildings, industrial estates and private land
E8	E9	Corporation Road, industrial estates and private land
E9	E10	Uskmouth Railway (ELR: East Usk Railway), industrial estates and private land
E10	E11	Uskmouth Railway (ELR: East Usk Railway), industrial estates and private land
E11	E12	PolyChlorinated Biphenols (PCB) cell and private land
E12	E13	PCB cell and private land
E13	EA	Private land

3 Proposed structure

3.1 Description of structure and design working life

3.1.1 The 2152m long structure carries the proposed M4 3 lane dual carriageway over the River Usk and Newport Docks area. The structure consists of a cable stay bridge over the River Usk with a 440m long main span and 156m long back spans. The west approach viaduct consists of 7 spans varying in length from 52m to 80m and the east approach viaduct consists of 12 spans varying in length from 52m to 80m. The deck is continuous over the cable stayed structure and approach viaducts, with expansion joints provided at the abutments.

3.1.2 The bridge has a typical width of 30.0m between main girders and 37.5m between the outside faces of the wind shield. There is widening to accommodate slip roads for the Docks Way Interchange west of the bridge and additional width to maintain sight lines through the curved alignment on the east approach viaduct. Subsequently the super-elevation also varies between -2.5% to +7.0%. There is no pedestrian route on the bridge.

3.1.3 The typical highway cross section will consist of:

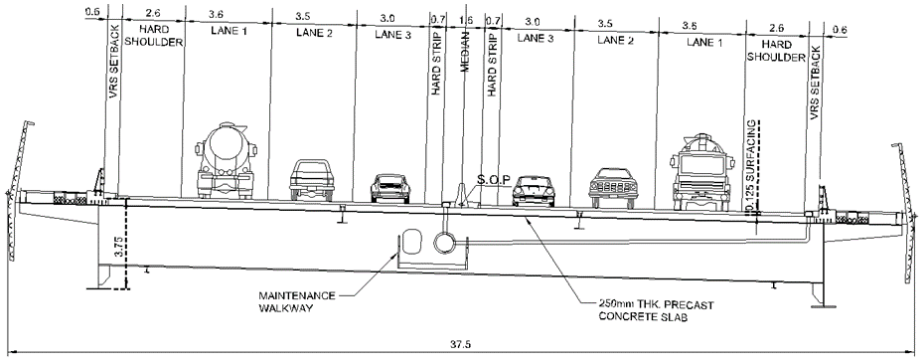


Figure 1: Typical section through cable stayed bridge main span

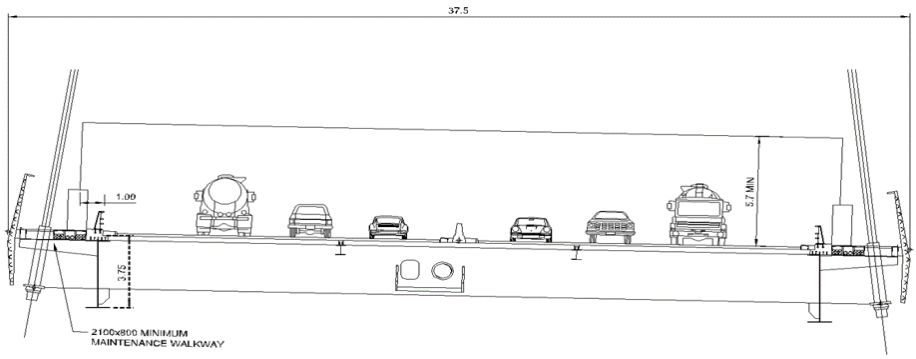


Figure 2: Typical section through cable stay bridge main span coincident with cables

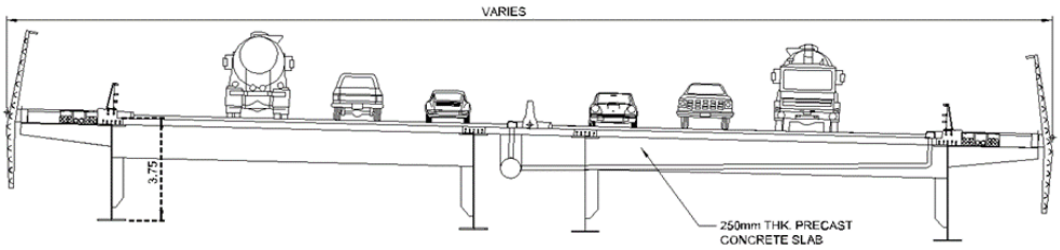


Figure 3: Typical section through approach viaduct

3.1.4 The bridge superstructure and substructure is to have a design working life of 120 years, category 5 in accordance with BS EN 1990, NA 2.1.1 and IAN 124/14(W), table A.1. Replaceable components are to have the following design lives subject to agreement with the supplier that they can be certified as such: -

Component	Minimum Design Working Life (years)
Stay cables and tie-down cables	120
Stay cable dampers	30
Bridge bearings	50
Movement joints	50
VRS, guardrails, wind shields	50
Sign gantries	50
Steelwork corrosion protection system	20
Tower internal access ladders, platforms etc. (galvanized)	40
Walkways, internal access provision	40
Drainage system	40
Bridge deck carriageway wearing course	40
Bridge deck waterproofing and base course	50
Road markings	5

3.2 Structural type

3.2.1 The proposed cable stay structure consists of a 440m long main span and 156m back spans. The hollow reinforced concrete towers of the cable stay structure will be of inclined diamond frame construction to approximately 147.784mAOD. Below the level of the deck cross beam the tower legs will tend towards each other and merge above the pilecap. Stay cables consisting of 17 pairs of cables per fan are external to the carriageway and anchored to the external edges of the deck. The cable stays are anchored within the tower through steel anchor box elements cast integrally with the tower legs. Tie-down cables are present in the piers E1 and W1 closest to the towers to counterbalance the asymmetry of the main to side span about the tower. The tower crossbeam at deck level will have internal prestressing. The steel composite deck will be of a steel ladder deck construction with a typical separation between the main girders of 30m. The deck width itself measured between outside faces of the wind shields will vary between 37.5m to 42.5m due to widening over the back spans. The deck will be formed of full-depth precast concrete deck panels with a section depth of 250mm and steel cross girder spacing of 4.125m. The towers will be supported on a pile group with a buried pilecap.

3.2.2 The approach spans will also be of steel composite ladder deck construction with varying deck width of 37.5m to 50.0m between outside faces of the wind shield to accommodate widening required for the Dock Way Interchange and to achieve sight lines. Main girders will have a typical spacing of 13.0m. The deck will consist of full-depth precast concrete panels with a section depth of 250mm. Steel cross girders will be spaced at approximately 4.00m, varying to account for horizontal curvature. Pier forms will be of reinforced concrete portal frame structure with the exception of pier E10 over the Uskmouth Railway (ELR: East Usk Railway) and pier E12 over the PolyChlorinated Biphenols (PCB) storage cell, where a steel box girder will be required spanning transversely to the bridge centreline. This removes the need to site piers close to the rail line and on the PCB cell. Pier columns will be supported on individual pile groups with a buried pilecap.

3.2.3 The east abutment will be of reinforced concrete construction built on a piled foundation. The adjacent approach embankment will be supported on a piled load transfer platform. The west abutment will comprise individual columns to support the deck girders. The west abutment columns will be supported on piled foundations. The west side of the expansion joint will be supported by a reinforced concrete upstand wall which is part of the Docks Way Junction Viaduct (SBR-0885 covered in a separate AIP submission).

3.2.4 Viaducts carrying slip roads for the proposed Docks Way Interchange will also run between WA to WT, where they will connect to the main girders of the mainline viaduct. These will also be of ladder deck construction.

3.2.5 A lightweight steel cantilever construction on both external edges of the concrete slab will be used to form the maintenance and bridge services area along the whole length of the structure. This will support the maintenance walkway, the 3m high wind shield, gantry supports and other bridge technology systems behind the safety barrier.

3.2.6 For further details of the structural arrangement refer to the General Arrangement drawings in Appendix B. These are current at the time of issue and the latest versions will be stored on Projectwise.

3.3 Foundation type

3.3.1 The tower, pier and abutment foundations will comprise bored cast in situ piles. Piles will be installed through the estuarine and fluvial alluvium into the Mercia Mudstone. Varying pile diameters are proposed with larger diameter piles for the tower foundations than for the pier and abutment foundations. Pier columns will have separate foundations. The piles for the foundations of piers W3 and W4 will larger as they will be designed to be able to withstand failure of the dock wall and associated large ground movements.

3.3.2 Pilecaps at the piers and tower will be buried. Pilecaps adjacent to the Uskmouth Railway (ELR: East Usk Railway) embankment will be above existing ground level and covered with landscape fill. Limits for settlement of the railway track as a result of raising the ground level will be agreed with the railway.

3.3.3 The east abutment will be of reinforced concrete construction built on a piled foundation. The adjacent approach embankment will be supported on a piled load transfer platform. The approach embankment will have side slopes at 1 in 2 and be supported on piles at relatively close centres.

3.4 Span arrangements

The bridge has a varying span arrangement as follows, measured horizontally along the centreline of the bridge. The bridge has a curved alignment with a varying radius. Expansion joints at the abutments will be square to the deck centreline.

Structure	Span	Span length (m)
West Approach Viaduct	WA – W8	52m
	W8 – W7	76m
	W7 – W6	76m
	W6 – W5	76m
	W5 – W4	80m
	W4 – W3	76m
	W3 – W2	76m
Cable Stay Bridge	W2 – W1	74.25m
	W1 – WT	81.75m
	WT – ET	440.0m
	ET – E1	81.75m
	E1 – E2	74.25m
East Approach Viaduct	E2 – E3	76m
	E3 – E4	76m
	E4 – E5	76m
	E5 – E6	76m
	E6 – E7	76m
	E7 – E8	76m
	E8 – E9	76m
	E9 – E10	76m

	E10 – E11	80m
	E11 – E12	72m
	E12 – E13	76m
	E13 - EA	52m

3.5 Articulation arrangements

3.5.1 The deck is to be fully articulated, with the fixed point being approximately in the centre of the River Usk main span. The bearings will be aligned tangentially to the centreline of the bridge. Guided and free sliding bearings are to be provided at all pier and tower locations.

3.5.2 The launching of the deck will take place without the deck slab, and hence temporary bracing will be required. During the launching phase temporary fixity may also be required to control the movement of the bridge.

3.5.3 Multi element 'elastomeric in metal runners' movement joints as defined in BD33 will be provided at the ends of the deck adjacent to the abutments. These will accommodate a longitudinal movement of approximately 1250mm due to cyclic thermal loading, traffic load and long term creep and shrinkage effects. They will also accommodate vertical movement through relative displacement of the joint rails due to differential settlement between the abutment and retained fill/adjacent structure.

3.6 Proposed classes and levels

3.6.1 Consequence class

The bridge shall be classified as High Consequence Class CC3 in accordance with BS EN 1990:2002 clause B3.1 and IAN 124/14(W) table A.2.

3.6.2 Reliability class

The bridge shall be classified as Reliability Class 3 (RC3) in accordance with BS EN 1990 clause B3.3 and IAN 124/14(W) table A.2. However K_{FI} shall be taken as 1.0 in accordance with IAN 124/14(W) table A.2 note A1.

3.6.3 Inspection level

The bridge shall be classified as Inspection Level IL3 (Extended Inspection), in accordance with BS EN 1990 cl. B5, Table B.5 and IAN 124/14(W) Table A.2.

3.7 Road restraint systems requirements

3.7.1 Over structure:

3.7.1.1 The road restraint system in the verges will be an unpainted galvanised steel safety highway barrier with a minimum height of 1m, N2 containment level and W2 working width (<800mm). Over the railway and the PCB cell area this will increase to a 1.5m H4a very high containment barrier with W3 working width (<1000mm). Adjacent to gantry supports a H1 barrier with W1 (<600mm) working width will be provided. These requirements and the extent of each barrier type will be confirmed by a RRRAP assessment.

3.7.1.2 A single H2 W2 double face concrete barrier will be provided in the central reserve.

3.7.1.3 The road restraint system provided over the structure will be in accordance with the requirements of TD 19/06 and BS EN 1317. Parapet products may be taken from the list of EN 1317 compliant road restraint systems available on the DMRB website. Alternatively the road restraint system must be successfully tested to BS EN 1317 by a Notified Body. Due to the large movement ranges at the expansion joints a departure from standard or crash testing may be required to verify the adequacy of the system.

3.7.1.4 Wind Shields

The bridge shall be designed to allow for high sided vehicles to safely use the crossing with wind gusts up to 130kph and other vehicles to safely use the crossing with wind gusts of up to 145kph. In practice this gives a way of managing traffic on the bridge during extreme wind conditions. This approach, albeit with different thresholds, is consistent with best practice on exposed long-span bridges equipped with wind shields around the world.

To enable traffic to cross safely the bridge, wind shields are provided along the outer edges of the bridge with a height of 3m above road level and a porosity of 50%. This combination of design parameters reduces the across-wind overturning moment on vehicles in the critical lane next to the barrier by a factor of about two, based on studies for the Forth Road Bridge. This results in less windiness than is likely to be experienced in open areas along the motorway approaches.

3.7.1.5 Restricting Means of Access to Suicides

The Welsh Government have implemented the “Talk to Me” national action plan to reduce suicide in Wales. The “Talk to Me” report describes how restricting access to the means of suicide is sometimes an effective means of preventing suicide where people have acute problems. The “landmark” status of the Usk Crossing and the height of the bridge make it a potential location for suicide attempts, though the risk is considered low due to the following factors:

a) There is no footpath on the bridge;

b) The bridge will be continuously monitored with CCTV as part of the ITS and an emergency response will be activated should a vehicle pull up on the hard shoulder;

c) The 3m high and inwardly inclined wind shields are a major barrier to jumping from the bridge.

The wind shields comprise of vertical posts with horizontal clear Perspex members to provide the wind shielding. The barrier will be arranged to provide a further degree of anti-climb. The barrier has inward incline and the gaps between the horizontal members will be too small to allow anybody to squeeze through. A return on the top will be provided to prevent people attempting to climb up the horizontal members to climb over the top.

3.7.2 Under structure:

Where the supporting piers pass adjacent to local roads the piers shall be located with sufficient clearance from the road, or alternatively, a road restraint system shall be provided subject to the outcomes of a risk assessment.

3.8 Proposed arrangements for future maintenance and inspection

The requirements for operation and maintenance of the bridge shall be fully considered in the design and are detailed in the River Usk Crossing Future Maintenance Report, document reference M4CaN-DJV-SBR-Z3_GEN-RP-CB-0004. An executive summary is provided in this AIP, Section 3.8.2.

3.8.1 Traffic management

3.8.1.1 It is anticipated that traffic management on the M4 will be required for the following operations: -

a) Inspection and replacement of cable stay pipes, strands and anchorages

b) Inspection of tower external faces

c) Inspection of deck soffit when utilising an underbridge inspection vehicle

d) Jacking up of bridge deck during bearing replacement

e) Replacement of expansion joints

f) Carriageway resurfacing works

g) Repair and replacement of safety barriers

h) Inspection and maintenance to overhead gantry structures and gantry mounted signs, signals and ITS technology mounted on overhead gantries and within the carriageway

3.8.1.2 At least three adjacent lanes of traffic per carriageway will remain open during strand replacement. It is anticipated that this will be carried out using strand by strand removal from the lower end of the cable using truck mounted equipment parked in the hard shoulder. In order to facilitate the replacement operation, the location of the adjacent lanes will be chosen to lie anywhere between the kerbs, provided there is sufficient setback to the vehicle restraint system in accordance with TD19. A single lane is 3.00m wide. A reduced vehicle design speed of 50mph will be considered during replacement operations in conjunction with reduced lane widths in accordance with Traffic Signs Manual Chapter 8 Cl D3.7. Abnormal loaded vehicles will not be permitted to cross the bridge during these works.

3.8.1.3 Lane 1 closure is anticipated for use of the underbridge inspection vehicle. Full carriageway closure is anticipated for several activities including stay pipe replacement and joint replacement, although these activities occur infrequently and can take place at night to minimise disturbance to road users.

Replacement of movement joints will require breaking out of the deck and abutment concrete. To avoid closing the bridge for an extended period of time a steel ramp system spanning over the joint will be used to allow traffic to travel

over the joint without any additional speed restrictions. During night closures these are then lifted to allow joint replacement works to continue. These systems are currently being used elsewhere on the UK motorway network.

3.8.1.4 Traffic management will also be required on East Way Road, West Way Road and Corporation Road under the bridge during inspection and maintenance of the deck soffit and bearings from mobile elevated working platforms.

Railway possessions or similar will be required for inspections and works over and adjacent to the railway lines as required by the track owner.

Restrictions will be imposed on water based traffic navigating the River Usk and Newport Docks to facilitate some maintenance activities which encroach into the clearance envelopes eg. repainting of the deck steelwork using temporary scaffold platforms

3.8.2 Arrangements for future maintenance and inspection of structure.

3.8.2.1 The main access to the bridge site is via a dedicated 2-lane maintenance track directly beneath the approach viaducts which is independent of the main carriageways. The track will be discontinuous to avoid the Dock Cut, railway lines and the PCB cell, with existing level crossings and unclassified roads used to gain access to different sections of the track. Existing access tracks already within the dock area will also be used to minimise land take and the need to demolish buildings, wherever possible.

To access the land under the shadow of the deck for maintenance and inspection purposes the land could be purchased. Alternatively a protocol shall be agreed with ABP and other land owners so that dock activities operate around the access track, with dedicated crossing points. This would allow bridge personnel to move within an agreed safe zone, rather than moving around dock operations, which they would not be familiar with.

A restrictive covenant shall be agreed with ABP and other land owners so that no permanent works are constructed below the plan of the deck which would prevent the use of plant and machinery below the deck. As a minimum there must be an agreement that they will grant access to anywhere under the deck soffit at short notice to enable inspection and maintenance works after an emergency event.

Restrictions on the storage of flammable, explosive and similar hazardous materials under the deck must also be agreed to reduce the likelihood of emergency events. A maximum surcharge loading under or adjacent to the deck associated with the future storage of materials must also be agreed for progression of the foundation design.

3.8.2.2 At the west tower, access into the tower is provided via an access door into the tower leg at ground level. The remaining height of the tower can be accessed from this location via stairways in each of the tower legs. A second access is also to be provided at deck level linking between each carriageway and the adjacent tower leg. At the east tower, deck level access will form the only access into the tower, as the base of the tower is below the flood water level and so an access door at ground level cannot be provided. To access the internal space inside the tower deck crossbeam, an access hatch through the top of the beam will be provided. Access to external faces of the tower will be achieved through the use of a tower top gondola.

3.8.2.3 The piers and bearings are accessed using a MEWP and scaffold towers from ground level. Anchors for clipping in to facilitate roped access will be provided on the pier crossheads to enable access and inspection of the concrete faces and bearings. Piers E1 and W1 are hollow and would also require ladder access within the void from a door at ground level.

3.8.2.4 Access to the abutments is provided at ground level, with stairs leading up to the bearing/movement joint inspection gallery. Heavy equipment can be moved up to bearing level using the lifting anchors that will be provided. There is no access provision linking the abutment to the deck. Measures will be taken to prevent unauthorised access to the inside of the abutments. As a minimum this will take the form of lockable doors, but a separate review of the security of the crossing may propose additional measures such as CCTV and intruder alarms. Any lifting equipment, such as hoists or eyebolts, will comply with the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER). Any procedures, as part of the operation, inspection and maintenance of the structure will also comply with the LOLER.

3.8.2.5 Access to the deck soffit is through a combination of MEWPs, scaffold towers, and underbridge inspection vehicles depending on constraints such as cable stays, the PCB cell and availability of access to the ground below the plan area of the deck. A walkway suspended underneath the deck along the deck centreline of the cable stay bridge section will also be provided.

3.8.2.6 For inspection of the cable stays a remotely operated vehicle which is attached to the cable and travels along it is proposed.

3.9 Environment and sustainability

3.9.1 The design proposed addresses sustainability issues as follows:

a) All foundations will be located outside of the wetted channel, which is defined as the MHW line, in order to not disturb key species found in the area including Sea Lamprey, Twaite Shad and European Otter.

b) The bridge deck will be constructed by cantilever method for the cable stay main span and launching methods used for the approach viaducts to minimise disturbance to the surrounding area and Newport docks. Use of these methods will also minimise the need for formwork and heavy craneage.

c) Plant rooms required to house transformers, generators, ITS equipment rooms will be incorporated into the abutment structure to minimise the amount of land take and make efficient use of the abutment form.

d) The deck, foundations and substructures are to be reinforced concrete with adequate concrete cover and mix design to ensure a durable construction.

e) GGBS cement replacement will be used in concrete mixes which reuses a by-product from iron blast furnaces which is abundant in South Wales. GGBS also improves the durability of concrete by reducing its permeability and increasing its resistance to chloride ingress and chemical attack. PFA cement replacement may also be used to reduce cement and therefore carbon content.

f) The structure is a new bridge on a new route, and will be constructed before the highway network is open to use in the area. The need for traffic management on the existing road network will therefore be limited. This will minimise traffic disruption and reduce the CO_2 output resulting from any delays.

g) Continuous deck construction with expansion joints only at abutments will minimise inspection and maintenance requirements, particularly adjacent to railway tracks.

3.9.2 In addition, any other requirements set out in the Environmental Statement and Construction Environmental Management Plan will be considered during the design. Throughout the design a structurally efficient solution will be developed to minimise the amount of material used and hence the amount of energy.

3.10 Durability, materials and finishes

3.10.1 All structural elements shall have sufficient durability to achieve a design working life of 120 years in accordance with the requirements of BS EN 1990, taking due recognition of the environmental exposure class and a consequence class of CC3 in accordance with Annex B of BS EN 1990:2002. To satisfy the durability requirements, the concrete mixes, exposure classes and covers set out in BS8500 for 100 year design life are deemed to satisfy the 120 year design life criteria for durability as stated in IAN 95/07(W). Structural details shall comply with the good practice described in CIRIA Document Report C543, Bridge Detailing Guide, where practicable.

3.10.2 The Design shall ensure the prevention of the accumulation of water, dirt and debris. This refers to both steel and concrete surfaces. The Design shall ensure that the drainage shall be formed in such a manner as to prevent passage of water along the underside of the deck and shall discharge to an area remote from the carriageway. Direct discharge from the bridge deck into the River Usk area is not permitted.

3.10.3 Drip checks shall be provided on all copings, parapet cantilevers, soffit edges and other locations to prevent water running along the underside of structures and adjacent vertical faces.

3.10.4 Concrete:

3.10.4.1 Cover to reinforcement and concrete class shall be as required by BS8500 and IAN95/07(W) for the exposure conditions and buried concrete classification appropriate to the site specific elements of the structure. The strength and exposure class of the concrete for design purposes will be as table overleaf:

Structural Element	Compressive Strength Class	Surface	Exposure Class			Δ_c
			XC	XD	XF	
Precast Deck Slab	C50/60	Exposed surfaces and deck cantilever	XC3	XD3	XF4	5
	C50/60	Surfaces covered by waterproofing	XC3	-	-	5
	C50/60	Deck Soffit (non-cantilever)	XC3	XD1	-	5
In-situ Deck Slab	C50/60	Exposed surfaces	XC4	XD1 XD3	XF4	15*
		Surfaces covered by waterproofing	XC3	-	-	15*
		Deck Soffit (non-cantilever)	XC3	XD1	-	15*
In-situ Parapet Beam	C50/60	Exposed surfaces	XC3	XD3	XF4	15
Abutment, pier	C50/60	Exposed surfaces > 10m from carriageway	XC3	XD1	XF4	15
		Exposed surfaces < 10m from carriageway	XC3	XD3	XF4	15
		Buried surfaces	XC2	XD2	XF1	15
Tower	C60/75	Exposed surfaces > 10m from carriageway	XC3	XD1	XF4	15
		Exposed surfaces < 10m from carriageway	XC3	XD3	XF4	15
Precast facing panels	C40/50	Facing panels	XC3	XD3	XF2	5
Wingwall	C40/50	Exposed surfaces > 10m from carriageway	XC3	XD1	XF4	15
		Exposed surfaces < 10m from carriageway	XC3	XD3	XF4	15
		Buried surfaces	XC2	XD2	XF1	15
Pile cap	C35/45	Buried surfaces	XC2	XD2	-	15
Pile	C35/45	Buried surfaces	XC2	XD2	-	N/A

*10mm will be adopted for in-situ deck stitches to ensure compatibility of cover with precast slab sections

3.10.4.2 Minimum concrete cover to reinforcement shall be appropriate to the most onerous exposure class at any particular location within a Structure for the intended working life of at least 120 years. Tolerance Δc between the minimum cover and the nominal cover to allow for fixing precision shall be in accordance with IAN 95/07(W). The following concrete covers to reinforcement shall be assumed:

Concrete Grade / Exposure Class	C32/40	C40/50	C50/60	C55/67	C60/75
XC1	25 + Δc	25 + Δc	25 + Δc	25 + Δc	25 + Δc
XC2	25 + Δc	25 + Δc	25 + Δc	25 + Δc	25 + Δc
XC3/4	40 + Δc	35 + Δc	30 + Δc	30 + Δc	30 + Δc
XD1	45 + Δc	35 + Δc	30 + Δc	30 + Δc	30 + Δc
XS1	40 + Δc	35 + Δc	35 + Δc	35 + Δc	35 + Δc
XD2	40 + Δc	40 + Δc	40 + Δc	40 + Δc	40 + Δc
XS2	40 + Δc	40 + Δc	40 + Δc	40 + Δc	40 + Δc
XD3	45 + Δc	45 + Δc	45 + Δc	45 + Δc	45 + Δc
XS3	45 + Δc	45 + Δc	45 + Δc	45 + Δc	45 + Δc

3.10.4.3 Particular mix requirements will be defined in the Series 1700 specification appendices.

3.10.5 Blinding concrete:

Blinding concrete shall be Class ST1 subject to satisfying design chemical class for ground water.

3.10.6 Concrete finishes:

Exposed deck concrete surfaces	F4
Towers	F4
Piers	F4
Pilecaps	F1, U1
Parapet Edge beam	F3, U3
Precast slabs:	F5
Precast panels	F4
Exposed abutments	F4, U3
Buried faces of concrete abutments foundations	F1, U1
Surfaces to be waterproofed	F2, U4
Pattern finish on retaining walls	F4

3.10.7 Structural steel

Typical grades:

S355J2+N to BS EN 10025-2-2004 for plate thicknesses ≤ 55mm

S355K2+N to BS EN 10025-2-2004 for plate thicknesses > 55mm

Piers E10 and E12 cross beams:

S460NL+N to BS EN 10025-3-2004

Testing will be carried out to determine whether the site can be considered as a marine environment which would prevent the use of adopting weathering steel in the future.

3.10.8 Steel connections

All bolts to be HR bolts to BS EN 14399-3:2005 unless otherwise stated. The maximum and minimum edge distances and pitch spacing are to be in accordance with BS EN 1993-1-8 as modified by EN 1993-1-9 for details subjected to fatigue loading.

3.10.9 Paint system

Corrosion protection systems shall be in accordance with the Manual of Contract Documents for Highway Works – Volume 1 - Specification for Highway Works Series 1900: Protection of Steelwork Against Corrosion.

3.10.10 Reinforcement:

Ribbed bars to BS 4449:2005, BS 8666 and BS EN 10080.

Characteristic yield strength f_{yk} = 500MPa; Grade B500B unless otherwise stated.

3.10.11 Stay cables:

Stay cables shall be type Group C (BS EN 1993-1-11: Table 1.1) comprising bundles of parallel seven wire (prestressing) strands, anchored with wedges.

Properties (in accordance with prEN 10138-3: Strands) shall be:

Parameter	Property
Nominal Diameter	15.7 mm
Nominal Area	150 mm^2
Tensile Strength	1860 MPa
Minimum Breaking Load P_n	279 kN
Elastic Modulus of single strand	195 kN/mm^2
Coefficient of thermal expansion	$\alpha_T = 12 \times 10^{-6}$ per ºC

The stay cables will have a maximum permissible serviceability stress limit of $0.45\sigma_{uk}$ in service and $0.55\sigma_{uk}$ during execution and transient load conditions. Suitability of the system should be proved through testing in accordance with BS EN 1993-1-11 and the associated National Annex to ensure performance, such

as cable strength, ductility, watertightness and durability of the corrosion protection system.

The cable stays shall be classified as Exposure class 5 (BS EN 1993-1-11: Table 2.1) and comprised of galvanised, greased, PE coated strands contained within a HDPE outer pipe.

3.10.12 Prestressing strands:

Prestressing strands will be 15.7mm diameter 7-wire super strands with nominal tensile strength of 1860 N/mm^2 and relaxation class 2. Prestressing strand shall be in accordance with BS EN 1992-1-1: 2004 and prEN 10138-3.

The following properties shall be adopted for preliminary design, until such time as the actual parameters are confirmed by the supplier: -

Parameter	Property
Nominal Diameter	15.7 mm
Nominal Area	150 mm^2
0.1% Proof Stress	1600 MPa
Tensile Strength	1860 MPa
Main Breaking Load, P_n	279 kN
Elastic Modulus	195 kN/mm^2
Coefficient of friction for bare and dry strands within a plastic tube	External: μ = 0.14/radian Internal: μ = 0.20/radian
Wobble Coefficient	External: k = 0rad/m Internal: k = 0.005rad/m
Pull in at anchorage	6 mm
Relative Humidity	80%
Relaxation after 1000h	2.5% @ 20°C and 0.7P_n

3.10.13 Prestressing bars:

Prestressing bars shall be in accordance with BS EN 1992-1-1:2004 and prEN 10138.

The following properties shall be adopted: -

Parameter	Property
Tensile Strength	1030 MPa
Elastic Modulus of single bar	185 kN/mm^2

3.10.14 Waterproofing:

A proprietary spray applied waterproofing system to BD47/99 and IAN 96/07(W) shall be applied to the deck. They shall have a current BBA Roads and Bridges Agreement Certificate.

The remainder of the buried parts of the structure are to have two coats of bituminous paint or equivalent, to SHW clause 2004.

In areas affected by de-icing salts, low toxicity hydrophobic impregnate and freeze/thaw aggregates shall be employed in accordance with BD43/03 and IAN95/07(W). Air quality testing will be carried out to ensure there is no impact on the environment.

3.10.15 Parapets

The parapet of the bridge will be an unpainted galvanised steel safety highway barrier, N2 containment level, W2 working width. Over the railway and PCB cell this will increase to a 1.5m high H4a very high containment solid infill barrier with W3 working width. Adjacent to gantries, H1 W1 barrier will be provided.

Edge protection to the wingwalls will consist of a strained wire fence to HCD Drawing H13. Edge protection and guardrails for elevated permanent access areas will be provided in accordance with BS5395 and BS6180 respectively.

3.10.16 Lighting

The M4 south of Newport is only to be lit at junctions. Due to the proximity of the bridge to the proposed Docks Way Interchange, street lighting will be supplied in the verges along the full length of the structure and slip roads at approximately 25m centres. The placement of the lighting columns will need to be coordinated with the stay cables to ensure coverage and avoid clashes.

3.10.17 Bearings

Bearings will be provided at all abutment, tower and pier locations. The fixed point will be approximately at the centre of the cable stayed main span, with guided bearings being orientated tangentially to the deck centreline axis. At the tower a vertically orientated bearing will be required to restrain the deck transversely. Fixity of the bearing unit must allow for the bearing to be replaced in the future.

Design and specification of bearings shall comply with BS EN 1337. Non-contradictory complementary information may be found in Published Document PD 6703:2009.

3.10.18 Joints:

Multi element ‘elastomeric in metal runners’ expansion joints will be provided at both abutments to accommodate a movement of approximately 1250mm.

3.10.19 Structural fill

Structural fill to be Class 6N or 6P for the embankment fill behind the east abutment.

The characteristic fill material properties are given in Section 5.4.

3.10.20 Drainage

Abutment structures shall be provided with a positive back of wall drainage system connected to the highway drainage system.

Main deck surface drainage shall not tie into the back of wall drainage and will instead link to an elastomer jointed pipe system within the abutment plant rooms that will accommodate movement under longitudinal effects. At the west abutment this system will outfall into the River Ebbw via an oil separator. At the east abutment this system will outfall into an attenuation pond via an oil separator. A

further bridge deck drainage outfall will be provided at pier E10. This will outfall to a pollution control lagoon, which in turn will outfall to the River Usk.

Subsurface drains will be provided in the area adjacent to the expansion joint outfalling to combined kerb drainage units to ensure water does not build up adjacent to the joints.

A combined kerb drainage system will be provided where required at the low side of the carriageway. The combined surface drain shall also be capable of collecting subsurface run-off but the flow need not be separated. Inspection points and flushing boxes will be provided.

3.11 Risks and hazards considered for design, execution, maintenance and demolition.

3.11.1 Details of the hazards identified, associated design mitigation measures and residual hazards are recorded in Appendix D. Each hazard listed has an associated item in the scheme Construction Design and Management (CDM) Hazard Log which is regularly reviewed by the CDM Principal Designer and project team.

3.11.2 Below is a list of the main hazards and hazardous activities relating to the proposed design that have currently been identified:

a) Disproportionate bridge collapse due to a ship collision with the deck (approach viaducts) – physical mitigation works will be provided to prevent larger vessels contacting the bridge structure or the length of quay wall at the north of the South Dock.

b) Stability of Structural Elements during Erection – The Costain Vinci Joint Venture (CVJV) is to ensure all structural elements are sufficiently supported and stable during erection, particularly during launching and cantilever construction stages. This does not negate the need for the Design Joint Venture (DJV) to design the structure to ensure adequacy under temporary construction cases.

c) Working at Height – CVJV operatives are to be appropriately contained (ie. scaffolding, safety barriers, mobile elevated working platforms (MEWP), etc.) within their working area to eliminate the possibility of a fall occurring. Where the operatives cannot be practically contained, safety harnesses and lanyards or other suitable safety tethering devices are to be used. No operative is to work at height without some measure of fall arrest device or barrier.

d) Working over/near Water – CVJV operatives working over water are to be appropriately tethered with certified safety equipment to prevent falls in water. Safety barriers are to be installed where operatives working at ground level near the River Usk. Where this is not practical, operatives are to wear appropriate floatation Personal Protective Equipment (PPE).

e) Working on a site where there are hazardous chemicals, including those stored in the PCB cell and within the Solutia plant.

f) Lifting Operations – The CVJV is to ensure heavy craneage to be stable on the present soft ground conditions.

g) Working within and adjacent to an operating dock

h) Working adjacent to live carriageway

i) Working adjacent to live railway. Railway possessions required for some operations. Works to comply with procedures enforced by the private owners of the track. Network Rail may also require representation on site and a track monitoring system in accordance with NR/BS/LI/045 Issue 2.

j) Accuracy and completeness of available information, including existing services

k) Demolition of this structure is technically demanding. Should this be necessary, it must be carried out by a suitably qualified team of consulting engineers and contractors, who shall fully appraise themselves of the constraints to demolition inherent in the design. A full detailed design for the demolition will be required, together with full construction planning for every stage.

3.11.3 Ice Accretion on Stay Cables

3.11.3.1 The build-up of ice on stay cables presents a hazard to motorists below, resulting in broken windscreens and accidents. In the UK the phenomenon is well known for overhead power lines, but the only known incidents in the UK on a major bridge were on both Severn Bridges on the 6th and 10th February 2009.

3.11.3.2 The right climatic combination of cold temperatures, high humidity, precipitation, wind speed and wind direction are required for ice to build up on stay cables.

3.11.3.3 There are two mechanisms for ice accretion. The first mechanism is :

a) High winds, wet snow and temperatures close to or below freezing occur;

b) The wind drives the snow against non-horizontal surfaces, causing the snow to accrete;

c) The accreted snow melts from the residual heat of the surface;

d) Wind chill causes the melted snow to refreeze as ice;

e) The accretion continues to grow as more snow is blown against the newly formed ice;

f) Ice fall occurs when either the accretion reaches a critical mass at which adhesive forces at the surface cannot support the weight of accretion, or the temperature rises, creating a melted layer at the interface between the ice and surface.

The second mechanism develops as a result of water at high altitude that falls as super-cooled water droplets. These droplets, even at temperatures of -42°C, remain liquid until they turn to ice when it hits a solid object. If sufficient droplets fall without colliding with other droplets then ice build will occur on solid objects at ground level. If the temperature of the solid object is above freezing then a melted layer will form that can result in the ice accretion to fall.

3.11.3.4 The risk of collisions due to falling ice is judged to be very low at this site given the necessary climatic conditions for this to occur and the very low reported occurrence of this phenomena in the UK. Given what happened at the Severn

Bridges, there is a residual risk that an accident as a result of ice fall could occur and a monitoring system, using the structural health monitoring system, is proposed to anticipate ice accretion events and implement traffic management measures such as warning messages or road closures. Details of the monitoring process required and identification of possible events shall be detailed in the Operations Manual for the structure.

3.11.3.5 As an indication of the recurrence of weather conditions likely to cause ice to form in the critical way, reference is made to the Severn Bridge. Here the number of closures in 49 years has been twice with both events occurring within 4 days of each other.

3.12 Estimated cost of proposed structure together with other structural forms considered (including where appropriate proprietary manufactured structure), and the reasons for their rejection (including comparative whole life costs with dates of estimates)

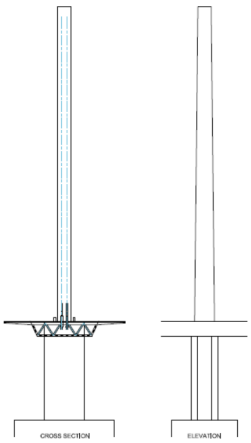
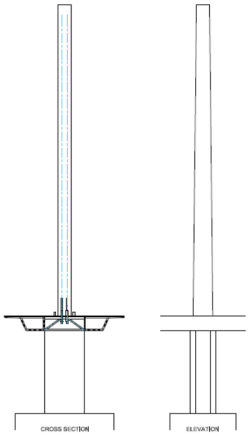
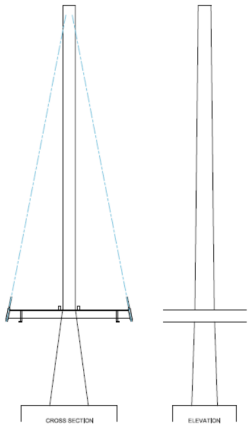
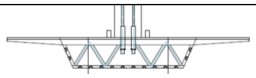
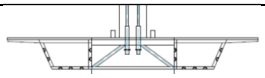
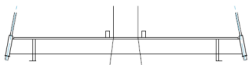
A number of alternative structural forms, for both the river crossing, as well as the approach viaducts, have been considered. The following gives an overview of the options considered.

3.12.1 River Usk Crossing cable stay bridge

For comparison purposes the construction cost associated with the current design for the River Usk Crossing cable stay bridge has been estimated to be £206 million with an uncertainty of 20% due to the current development stage of the design.

The annual maintenance cost of the bridge with the current design is estimated to be £1.44m, or £173m over the 120 year life of the structure before HM Treasury discount rates are applied. This has been calculated assuming the annual maintenance cost is 0.7% of the construction cost, which is reasonable considering that maintenance costs for the first 30 years detailed in the River Usk Crossing Future Maintenance Report, found that the annual cost of maintenance would be on average 0.63% of the construction cost.

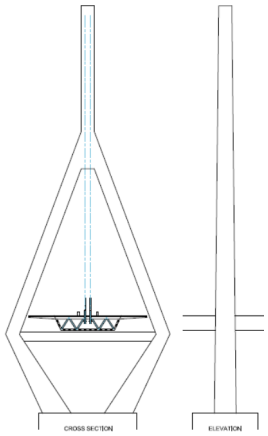
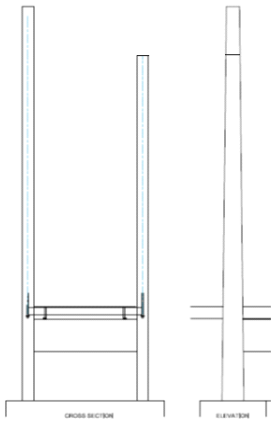
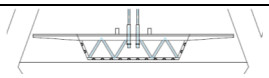
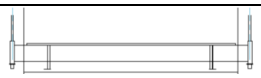
3.12.1.1 River crossing mono pole pylon alternatives

No.	1	2	3
Key Sketch (cross section and elevation near pylon)			
Deck Cross Section			
Description	Mono tower with single central box girder deck, integral with the towers. Piers below deck are leaf piers to achieve flexibility required to accommodate temperature movements. Two central stay cable planes in the shadow of the tower.	Mono tower with twin box girder deck, integral with the towers. Delta frames between box girders accommodate stay anchorages. Piers below deck are leaf piers to achieve flexibility required to accommodate temperature movements. Two central stay cable planes in the shadow of the tower.	Mono tower with ladder beam deck, floating at the tower locations with openings in the deck. Stay cables are attached to the outside of the deck to achieve torsional stiffness.
Reasons for rejection	Significantly more expensive deck, design risks with integral pylon – deck connection, buildability issues with large deck box segments	Significantly more expensive deck, design risks with integral pylon – deck connection, buildability issues with deck box segments and delta frame instalment insitu	Increased cost due to increased deck width (central pylon), geometric issues with stay cable angles near pylon, questionable aesthetics

Construction cost difference	+ £13.9m	+ £12.4m	+ £11.0m
Maintenance cost difference	- £1.3m*	+ £10.4m*	+ £9.2m*
Whole life cost difference	+ 12.6m	+ 22.8m	+ 20.2m

*The maintenance cost difference has been calculated based upon the annual maintenance cost of the bridge being 0.65% of the construction cost for option 1, and 0.7% of the construction cost for options 2 and 3.

3.12.1.2 River crossing non-mono pole pylon alternatives

No.	4	5
Key Sketch (cross section and elevation near pylon)		
Deck Cross Section		
Description	Inverted Y-shaped pylon with single central box girder deck and two central stay cable planes in the centre of the deck. Deck floating at tower location. Crossbeam at tower location to contain bearings to	Asymmetric H-tower with ladder beam deck and two vertical stay cable planes at the outside of the deck. H-tower legs staggered to reflect skew alignment of the bridge relative to the River Usk. Deck

	transfer deck torsion into tower.	floating at tower locations.
Reasons for rejection	Significantly more expensive deck, more complex pylon construction	Unproven arrangement with severe buildability issues, risk of unacceptable dynamic performance
Construction cost difference	Qualitatively estimated to be higher than the monopole tower options 1 and 2	Not estimated as no proven construction method identified
Whole life cost difference	Qualitatively estimated to be higher than the monopole tower options 1 and 2	Qualitatively estimated to be higher than the monopole tower options 1 and 2

Various alternative pylon shapes in combination with suitable deck types and stay cable arrangements have been considered. All decks are of steel-concrete composite construction as this is considered to be the most economic structural type for a main span of 440m to 500m.

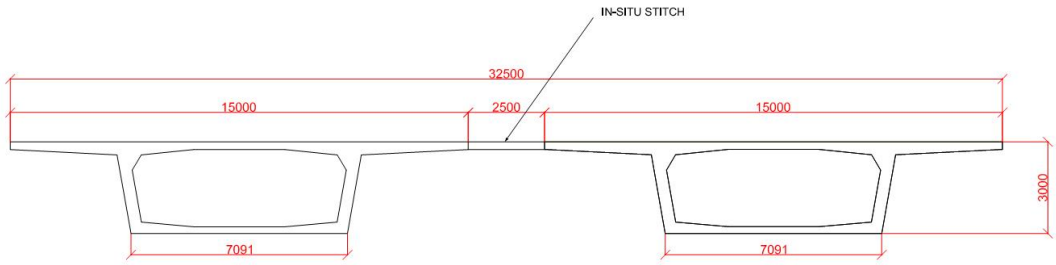
All alternative options have been evaluated for potential improvement in various categories compared to the base case.

None of the alternative options has a higher overall score than the base case. This is mainly due to unfavourable combinations of increased construction cost, impact on deliverability, buildability concerns and increases in programme and construction cost risk.

Although the mono pole pylon schemes have potential for improved maintenance of the stays and the deck, it is still considered that the base case gives the best option overall in terms of construction cost, buildability and delivery for the given constraints.

3.12.2 Approach structures

Alternative structural forms have been considered for the approach viaducts, mainly the option of concrete box girders with spans of 45m-60m.



The concrete box girder option was considered to be of precast segmental type construction. In-situ construction was ruled out due to economic and constructability reasons.

A variable depth box girder option for spanning the PCB cell has also been considered, this would have resulted in spans of 160m.

The alternative option has been rejected due to the following reasons:

- Reduced spans resulting in approximately 10 no. additional pier supports and foundations.
- Slightly increased dead load on foundations resulting in increased foundation costs (relative weight increase due to change in material is slightly more than weight reduction due to change in span).
- Due to the variability in the deck width to maintain sight lines and widening for the Dock Way Interchange, it would not be economical to use precast elements as a large number of forms would be needed. This would also apply to cast in situ construction. It is likely that it would not be possible to retain a constant deck edge detail, which would also lead to additional formwork.
- Increased risks of conflict with ground level constraints due to increased number of foundations.
- Increased complications with connection between composite main span and concrete approaches.
- Negative impact on construction programme due to increased number of foundations.
- Increased requirements for access during construction due to the need to supply segments at each span location.
- Investment in segment precast factory not fully efficient for the aggregated length of viaduct, the great variability of deck width and the long slip road merging area requiring specific elements.
- Solely based on direct cost associated with the construction activities and without taking into account the increased logistics issues, the longer programme, the increased risk of encountering utilities and without a developed design of the complex slip road / main line merging areas the construction cost of this option is estimated to be already slightly higher than the current solution by £7million. In turn the whole life cost is estimated to be £5.6million higher than the current option.

3.12.3 Approach viaduct pier form

Individual pier columns underneath the main girders were considered as an alternative to the portal frame structure taken forward.

This option was rejected due to the following reasons:

- Due to the presence of slip roads on the west viaduct leading to various beam arrangements and the curved alignment over the length of the

approach structures there would be multiple columns at each pier location in an irregular arrangement. This would create a 'forest of piers' and present an aesthetic intrusion.

- The horizontal alignment has significant curvature which will result in transverse loading onto the pier structure. Individual pier columns will provide less resistance to transverse loads when compared to a portal frame structure.
- To accommodate bearing jacking points from the pier columns the cross section would need to be increased beyond what is required for structural adequacy, whereas the width of the portal frame crossbeam inherently provides jacking locations within the pier form.

3.13 Proposed arrangements for construction

3.13.1 Construction of structure

The construction of the River Usk Crossing will be divided into three main structures; Approach Viaduct West, Approach Viaduct East and the Cable Stayed Bridge. It is intended that these structures will be programmed to be constructed in parallel to minimise construction time.

Detailed information of the construction sequence is given in the Constructability, Buildability and Phasing Report of the River Usk Crossing, document reference M4CaN-CJV-GEN-Z3_GEN-RP-WM-0001.

East and West Approach Viaduct

Construction of the approach structures will broadly be carried out in the following stages:-

a) Construction of bored piles using a piling rig;

b) Construction of the pilecap to be progressed following progressive construction of the pile groups;

c) Construction of abutments, piers and pier heads.

d) Launching of the deck steelwork from launching locations behind the West Abutment on the Docks Way Junction Viaduct (SBR-0885) (launching to W3), at the East abutment (launching to E9) and between piers E08-E07 (launching to E3), Connection of launched steelwork sections will be carried out by crane.

e) Installation of concrete precast deck slabs and cast in-situ concrete stitches.

Cable Stayed Bridge

Construction of the cable stayed bridge will broadly be carried out in the following stages: -

a) Simultaneous construction of bored piles at East and West Tower and piers W1, W2, E1, E2 using a piling rig.

b) Simultaneous construction of pilecaps and piers on both sides of the River Usk following progressive construction of the pile groups.

c) Construction of East and West tower pylons, with both legs being built in parallel using self-climbing formwork.

d) Launching of deck steelwork for back spans.

e) Installation of main span steelwork segments, precast slabs and cast in-situ concrete stiches once pylons have been sufficiently progressed to install stay cables. East and West sides of the main span to be constructed simultaneously.

3.13.2 Traffic management

The M4CaN is an offline bypass route thus construction of this bridge will not require any traffic management to the existing M4.

Construction of the proposed bridge will require some periods of traffic management on East Way Road, West Way Road, Corporation Road and Newport Dock access tracks beneath the bridge. Where possible there shall be a segregation of works traffic and dock traffic during construction to minimise the risk of an accident.

Railway possessions will be required for works over and adjacent to the East Port Rail Line, West Port Rail Line and Uskmouth Railway (ELR: East Usk Railway).

3.13.3 Service diversions

3.13.3.1 The following services exist in the river crossing and approach viaduct area: -

East approach:

a) Buried 100mm diameter oxygen pipeline

b) Buried 150mm diameter HDPE Nitrogen and 75mm diameter CSTL hydrogen pipeline

c) 1830mm diameter concrete sewer pipe

d) Water mains of various diameters

e) Copper coaxial communications cables

f) 132kV overhead power lines. These will be diverted prior to the works commencing

g) Buried high voltage 11kV cables

West approach:

a) Water mains of various diameters

b) Copper coaxial communications cables

Utility drawings for the scheme will show the locations of these services.

3.13.3.2 Further privately owned utilities are also present such as those held by the Welsh Government and Associated British Ports (ABP). An as-built utility plan will be developed throughout the project.

3.13.3.3 For construction of the bridge, the 132kV overhead power lines will require permanent diversion at the east approach viaduct.

Other services may also need to be diverted, and exact service locations must be identified prior to ground works starting. Statutory undertakers will be consulted throughout the project and all relevant services identified will be marked on drawings. Spare uPVC ducts will be placed in the verges for possible future services.

3.13.4 Interface with existing structures

There are no existing bridge structures in the vicinity of the proposed structure. Existing building structures are located underneath and adjacent to the bridge. The location of the bridge and the positioning of the supports have been selected to minimise the demolition of existing buildings. Some of these will however need to be demolished to enable construction of the bridge, although this will be minimised wherever possible through design development and use of alternative construction methods (such as launching the steelwork).

4 Design criteria

4.1 Actions

Actions are listed below. Values from the relevant standards and combination rules are detailed in the Design Criteria Report, document reference M4CaN-DJV-SBR-Z3_GEN-RP-CB-0016. An executive summary of the main actions is provided here.

4.1.1 Permanent actions

4.1.1.1 Permanent actions will be applied using the recommended values in BS EN 1991-1-1:2002 and the associated National Annex, and will be taken as follows: -

Structural concrete	25 kN/m^3
Structural steel	77 kN/m^3
Mass concrete	24 kN/m^3
Surfacing – hot rolled asphalt	23 kN/m^3
Soil infill (class 6N material), typical value given	20 kN/m^3

The density of the structural concrete will be increased as appropriate for elements which have a high reinforcement density.

4.1.1.2 For surfacing, the design shall be based on a thickness of 125mm (inclusive of waterproofing and surfacing) for concrete deck slabs. In determining the upper and lower bound characteristic values of depth of surfacing and other coatings from their nominal value, a deviation of +/-20% shall be assumed. This will be raised under a Departure from Standards, see Section 4.6. The reduction in variability will require tighter control and monitoring of surfacing operations, and will be identified in the Operations and Maintenance Manual. This level of control is expected for long span bridges.

4.1.1.3 Superimposed dead loads shall allow for vehicle restraint systems, parapets, wind shields, sign/signal gantries and services such as power cables and lighting. Loads will be based on actual dimensions, densities and locations. Wind and thermal loading onto highway furniture such as wind shields and gantries will also be added as appropriate.

4.1.1.4 The self-weight of stay cables shall be calculated in accordance with clause 2.3.1 of BS EN 1993-1-11:2006 based on data from the chosen supplier. Appropriate allowances for the weights of stay cable anchorages, dampers and other accessories shall be included.

4.1.1.5 Characteristic material properties for the fill at each abutment are given in Section 5.4.

4.1.2 Snow, Wind and Thermal actions

4.1.2.1 Snow

In accordance with the requirements of BS EN 1991-1-3:2003 and the associated National Annex, snow loads are not applicable to the in-service condition.

4.1.2.2 Wind

Wind loads will be applied to the structure in accordance with BS EN 1991-1-4:2002 and the associated National Annex.

The following site-specific reference wind speeds will be used. This is the characteristic value of the hourly mean wind speed with an equivalent mean return period of 50 years.

	i = 'longitudinal' (parallel to bridge axis)	i = 'lateral' (perpendicular to bridge axis)
Hourly mean speed at deck level [m/s] (Height above ground level of 35m)	24.2	24.1
Hourly mean speed at top of pylon height [m/s] (Height above ground level of 150m)	30.6	29.4

Wind and thermal actions will not be used in the same design combination in accordance BS EN 1990:2002, cl.A2.2.2(6).

The effect of wind on both the completed bridge and during construction shall be considered. Since the cable stayed bridge is a dynamically sensitive structure it shall be designed to resist the dynamic effects of wind actions also. Mean wind load, and gust loading (including buffeting response, vortex shedding, galloping, flutter instabilities and interference effects) shall be taken into account and shall have no detrimental effect on the performance of the bridge.

Derivation of the wind load shall account for the effects of the wind shield provided along the edges of the deck assuming a 50% porosity.

A wind climate study, wind buffeting analysis and wind tunnel testing will be further used to determine the wind loading onto the structure and it's dynamic response for the construction and in service condition. Further detail is provided in the Design Criteria Report, Document reference M4CaN-DJV-SBR-Z3_GEN-RP-CB-0016.

4.1.2.3 Thermal

Thermal actions will be applied to the structure in accordance with BS EN 1991-1-5:2003 and the associated National Annex.

The following minimum and maximum shade air temperatures for the site will be used (before adjustment for annual probability of being exceeded p other than 0.02):

T_{min}= -12°C

T_{max}= 32°C

4.1.3 Actions relating to normal traffic under AW regulations and C&U regulations

4.1.3.1 Traffic loading shall be applied to the structure in accordance with BS EN 1991-2:2003 and the associated National Annex. Traffic loading shall be applied behind abutment structures in accordance with PD6694-1:2011.

4.1.3.2 A project specific Load Model 1 has been developed to account for the reduction in load intensity due to loaded lengths in excess of 200m. Equation 4.2 of BS EN 1991-2 is to be replaced by the following equation:

LM1 UDL = $\Delta.\alpha_{qi}.q_{ki}$ (4.2.a)

Where:

For $0< L \leq 200$ m $\Delta = 1.0$

For $200 \text{ m} < L \leq 500$ m $\Delta = 7.6\ (1/L)^{0.395} + 0.34\ L/1000$

For $500 \text{ m} < L \leq 1500$ m $\Delta = 1.59\ (1/L)^{0.107}$

For $L > 1500$ m $\Delta = 0.73$

All other parameters, including the tandem system, will be applied as stated in the UK National Annex to EN 1991-2.

4.1.3.3 Load Model 2 shall be applied in accordance with BS EN 1991-2:2003 and the associated National Annex.

4.1.4 Actions relating to General Order Traffic under STGO regulations

Load model 3 will be considered in accordance with BS EN 1991-2:2003 and the associated National Annex. Special vehicle SV80, SV100 and SV196 models are to be adopted. Dynamic amplification factors in accordance with Table NA.2 shall be applied to this load.

4.1.5 Footway or footbridge variable actions

4.1.5.1 Footway loading shall be applied to the structure in accordance with BS EN 1991-2:2003 and the associated National Annex. These will be used only in local design.

4.1.5.2 Accidental vehicle loading will be applied to the verges in accordance with BS EN 1991-2 clause 4.7.3.1 and PD 6688-2 Cl 3.13.2

4.1.6 Actions relating to Special Order Traffic, provision for exceptional abnormal indivisible loads including location of vehicle track on deck cross-section

No special order vehicles, Heavy or High Load Routes are to be adopted.

4.1.7 Accidental actions

4.1.7.1 Actions due to vehicular loading

Collision forces on vehicle restraint systems that are transferred to the bridge deck will be applied in accordance with clause 4.7.3.3 of BS EN 1991-2 and the associated National Annex. To determine collision forces, Class A is to be used in Table NA.6 of NA to BS EN 1991-2:2003, which corresponds to a normal containment flexible parapet. For very high containment and/or concrete parapets, other parapet classes are to be used with table NA.6.

Collision forces on kerbs should be considered in accordance with BS EN 1991-2:2003 clause 4.7.3.2.

Bridge supporting members will be located within the Newport Dock area and are therefore adjacent to local unclassified roads and areas where there is the movement of heavy plant and machinery. The outer face of the West Abutment reinforced soil walls and piers shall be designed for traffic collision with a category "Bridges over other roads where speed limit < 45mph" in Table A.4 of IAN 124/14(W). The speed of vehicles in the dock area is limited to 10 mph. The selected forces in Table A.4 are based upon vehicle speeds of up to 45 mph. It is judged therefore that the loads are sufficient for both applications. The outer face of the East Abutment walls shall be designed for traffic collision loads with a category "Courtyard with access to lorries" in table 4.1 of BS EN 1991-1-7:2006.

The superstructure will be designed to withstand the vehicle impact loading described in clause 4.3.2 of BS EN 1991-1-7, associated National Annex and clause 2.8 of PD 6688-1-7. The mobile crane in operation in the dock is the Leibherr500, with a weight of 452t and a maximum travelling speed of 1.5m/s. As the crane can only travel with its boom in the vertical position, with a boom tip height of 35.3m, the risk of the crane attempting to pass under the structure is deemed to be negligible and hence a crane collision load will not be designed for.

Impact forces for gantry supports protected by vehicle restraint systems compliant with BS EN 1317 will be determined in accordance with BD51/14. A risk ranking factor R_{de} will be calculated individually for each support location in accordance with clause NA.2.11.2.3.3 of BS EN 1991-1-7 National Annex to determine the appropriate collision loads to apply, or whether the forces for minimum robustness are sufficient. The deck will be designed for collision loads on the gantry transferred through the structural support.

4.1.7.2 Actions due to ship impact loading

Ship impact forces on the bridge shall be determined in accordance with EN 1991-1-7: 2006, associated National Annex and clause 2.11 of PD 6688-1-7. The effect of collision with the dock walls on the bridge piers and foundations shall also be considered.

It is not anticipated that application of these rules will have any significant effect on the scheme design or cost of the main cable stayed span over the River Usk for the following reasons:

a) The West foundation of the River Usk span is located west of the river and is separated from the river by the railway and local road.

b) The East foundation of the River Usk span is located east of the High Water Line and the adjacent river bank is of a shallow slope hence there is insufficient water draught for large vessels to approach and cause significant impact on the pier or its foundation even at High Water Level.

c) The minimum soffit level (40.03mAOD) of the main girders of the River Usk Span are located significantly higher than the specified navigational clearance. Even so, the structure has been checked for mast impact according to the preliminary rules described in EN 1991-1-7: 2006 and found adequate.

For the Western Viaduct, which passes over the Junction Cut, separate physical mitigation measures are required to reduce the risk of ship impact on the bridge to a “tolerable”, “broadly acceptable” or “acceptable” level. These would be needed to prevent the larger vessels from errantly contacting the bridge superstructure, pier, foundations and the existing quay wall along the north of the South Dock. Such mitigation measures would be the subject of separate Approvals in Principle.

The superstructure, piers and foundations of the Western Approach viaduct in the vicinity of the Junction Cut will need to be designed for the residual risk of impact from the smaller vessels which are able to enter the North Dock. The residual accidental design effects which will be considered are:

a) Accidental mast impact from vessels able to enter the North Dock. The structure has been checked for mast impact according to the preliminary rules described in EN 1991-1-7: 2006 and found adequate (additional local cross bracing may be provided to the girder lower flange in this region to fully eliminate risk of failure)

b) Errant vessels, which are able to enter the North Dock, impacting the dock walls in both the North and South Dock. Bow impact forces associated with these impacts could be large, but the dock wall and soil behind would act to spread the load / absorb impact energy, reducing the effects on the viaduct foundations. Direct bow impact with the pier foundations is not considered because either the dock wall will be present, or if it has failed, it will still provide an obstacle to direct impact.

The equivalent static forces for a) and b) above shall be agreed with the relevant authorities at a later stage of design.

4.1.7.3 Actions due to train derailment

All piers are located at a clearance greater than 4.5m to the railway and therefore will not be designed for train derailment loading.

4.1.7.4 Actions due to rupture of Stay Cables or Tie-down cables

The structure shall be designed to accommodate the accidental loss of one stay cable or one tie down cable in accordance with BS EN 1993-1-11:2006 and the associated National Annex. A value of 1.8 shall be used for ‘k’ in equation 2.4 of the Eurocode to calculate the dynamic effect of removing a cable.

4.1.7.5 Actions due to fire

The preliminary design shall accommodate the loss of strength and stiffness of the cable stays and deck due to a 50MW vehicle fire. A fire hazard assessment is pending which will determine appropriate actions due to fire. The action of fire on the structure shall be checked in accordance with BS EN 1991-1-2:2002, the associated National Annex and further conditions described in The SFPE (Society of Fire Protection Engineers) Handbook of Fire Protection Engineering, 2002.

4.1.7.6 Actions due to seismic events

Seismic actions are not normally critical in the UK. A seismic hazard assessment is pending.

4.1.8 Actions during construction

4.1.8.1 Actions during construction shall be calculated in accordance with BS EN 1991-1-6 and the associated National Annex. The actions during execution shall be consistent with the contractor's method statement in terms of type of plant, arrangement and duration envisaged. Actions including thermal, wind and snow will be added as appropriate depending on construction durations.

4.1.8.2 Where structures are subject to mobile construction plant essential to the method of construction, the structures shall be checked for construction loads at each construction stage and the assumed loads will be indicated on the drawings.

4.1.8.3 Refinements or amendments to the options and choices will not be known until the detailed design stage. These may include restriction of free construction loads, the specification of fixed loads, other specialist controls, the use of special construction vehicles/equipment on the structure, changes to the return periods for the calculation of design loads, or the specification of different loads or factors.

These controls, restrictions or amendments will be confirmed at detailed design stage and recorded in the Project Specification, Drawings or Contractor's Method Statement as appropriate.

4.1.9 Any special action not covered above

4.1.9.1 All elements of the River Usk Crossing except for the foundations shall be checked for fatigue using Fatigue Load Model 1. Load models 2, 3, 4 and 5 will not be used.

4.1.9.2 Loads due to inspection, maintenance and repair requirements, will be considered in association with frequent load combinations. During replacement works at the structure, for example the replacement of stay cables, at least three adjacent lanes of traffic shall remain open during replacement operations. The location of the adjacent lanes may be chosen to lie anywhere between the kerbs, as required to facilitate the replacement operation. Reduced lane widths, a reduced vehicle design speed and a restriction on the passage of SV vehicles will be considered during replacement operations.

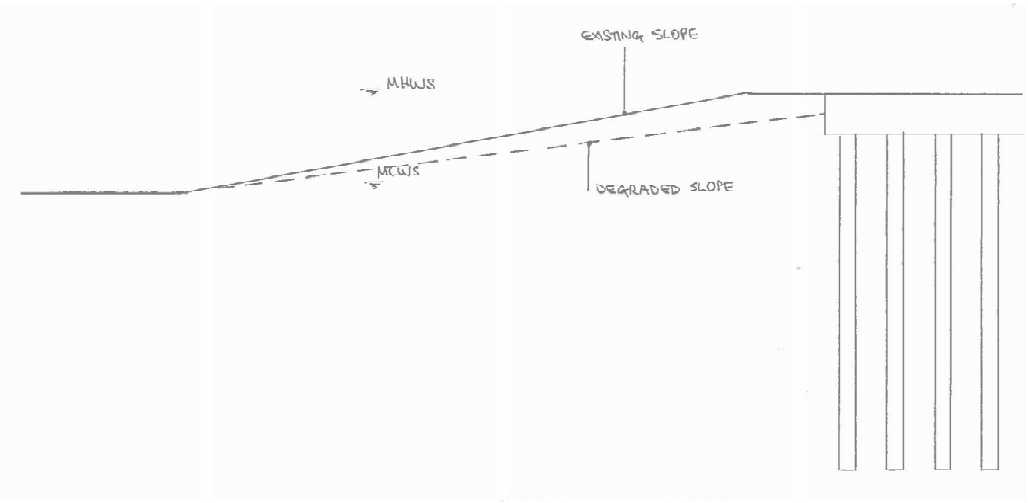
The bridge and the movement joints will be checked for the effect of the deck being jacked up by 10 mm at bearing positions to facilitate removal and replacement of bearings. Each bearing may be considered separately.

The design will permit the removal and replacement of the stay cables and the tie-down cables. The bridge will be checked for the case of any single whole cable removed. The check will be carried out at SLS and ULS in accordance with BS EN 1993-1-11:2006.

4.1.9.3 As the River Usk Crossing is located over the ABP dock area and other industrial land, there is the possibility that in the future areas over and adjacent to the foundations will be used for the storage of materials. This would exert a surcharge loading on foundations and retaining structures resulting in vertical and lateral ground movements and additional loads onto piles, which must be allowed for. A permissible surcharge loading of 50kPa within the dock area, to be confirmed with ABP and adjacent land owners, will therefore be taken as an additional design loading.

4.1.9.4 The east tower is located in close proximity to the bank of the River Usk. If the stability of the bank slope is found to be below the requirements of BS EN1997-1

a degraded slope and associated out of balance lateral loading will be considered in the foundation design as shown below:



4.1.9.5 The design of foundations in close proximity to the existing dock walls at piers W3 and W4 will consider potential failure of the dock wall and associated large ground movements. This will be considered as a persistent design situation in the analysis of the effects on piers W3 and W4 foundation piles. The effect of collision with the dock walls on the bridge foundations shall also be considered as discussed in 4.1.7.2, with equivalent static forces to be agreed with the relevant authorities.

4.1.9.6 The remaining residual risk of ground instability will be transmitted to the CVJV during construction, and mitigation methods are to be recorded in the Design Risk Register.

4.2 Heavy or high load route requirements and arrangements being made to preserve the route, including any provision for future heavier loads or future widening

The structure is not on a Heavy or High Load Route.

4.3 Minimum headroom provided

4.3.1 On M4 carriageway

A minimum headroom from the M4 carriageway to the tower will be 5.3m, measured perpendicular to the carriageway surface. The minimum headroom used has been enhanced to 5.7m to stay cables and gantries to minimise the risk of collision with sensitive components. This should be taken over the width of the structure free zone which includes the VRS working width in the verges.

4.3.2 To bridge deck soffit

4.3.2.1 For roads under, a minimum headroom of 5.3m will be provided to the deck soffit with additional 100mm to allow for construction tolerances and settlement.

4.3.2.2 The East Port Rail Line, West Port Rail Line and Uskmouth Railway (ELR: East Usk Railway) pass below the structure. A vertical clearance of 4.78m will be provided from the highest point of the rail to the structure soffit with additional allowance for construction tolerances.

4.3.2.3 At the River Usk, an in-service vertical navigational clearance of 25.5m from the Mean High Water Springs (MHWS) level of +6.49mAOD is provided over the full width of the navigable water channel, with additional allowance for construction tolerances.

4.3.2.4 At the North Dock Cut a clearance of 26.2m is provided over the full width of the cut, with additional allowance for construction tolerances, to the bridge soffit from the Impounded Water Level (IWL) level of +8.4mAOD. The IWL is the Newport dock is controlled and the value given above, which has been agreed with ABP, represents the level of the new outer lock gates.

4.3.2.5 The soffit of the bridge deck, and any permanent attachments to it, shall remain clear of the minimum navigation clearance under all SLS characteristic load combinations, including all non-recoverable deformations (i.e. creep, shrinkage and settlement), and making allowance for construction tolerances.

4.4 Authorities consulted and any special conditions required

4.4.1 At the time of writing this report, discussions with the following parties are ongoing:

Statutory Consultees:

- Welsh Government Technical Approval Authority (TAA)
- Welsh Government Network Management Operations Team
- South Wales Trunk Road Agent (SWTRA)
- Natural Resources Wales (NRW)
- Monmouthshire County Council (MCC)
- Newport City Council
- Harbour commissioners

Other consultees:

a) Design Commission for Wales (DCfW)

b) Statutory Undertakers eg. Associated British Ports, Solutia

Any special conditions by these authorities may result in changes to this AIP.

4.4.2 River Navigation requirements

In addition to the vertical clearances as covered in Section 4.3, minimum horizontal navigation clearances should be provided as follows: -

Location	Marked Navigation Channel
River Usk	145.0m
North Dock Cut	20.0m

Navigation lighting aids shall be provided on the river and dock cut spans in accordance with IAA Maritime Buoyage System.

4.4.3 Railway lateral clearances

In addition to the vertical clearances as covered in Section 4.3, a lateral clearance of 4.50m from the centre of the nearest rail to the vertical face of a pier shall be provided where possible to avoid designing for derailment loading in accordance with NR/L3/CIB/020 Clause 14.4. At the Uskmouth Railway (ELR: East Usk Railway) there are future plans to increase the number of track from one to two, and so the design is to assume a two track line is present.

4.4.4 Clearances to PolyChlorinated Biphenols (PCB) cell

A disposal cell containing PCB's is located to the South West of the Solutia Chemical Plant. This cell is not to be disturbed and no construction is permitted within the footprint of this PCB cell.

A minimum headroom of 5.0m shall be provided between ground level on top of the PCB cell and the soffit of the bridge structure to permit inspection and maintenance of the bridge structure and access to the surface of the cell below. The only exception to this is under the transverse cross beam at pier E12 where the headroom will reduce to an approximate minimum of 2.5m.

4.5 Standards and documents listed in the Technical Approval Schedule

Refer to Appendix A.

4.6 Proposed Departures from standards given in 4.5

4.6.1

The following departures will be raised for the River Usk Crossing:

a) Reduction in surfacing deviation allowances from those given in BS EN 1991-1-1:2002 for bridge deck surfacing to +/-20%.

Further departures from standard may be required as the design develops, for which this section will be updated.

4.7 Proposed Departures relating to methods for dealing with aspects not covered by standards in 4.5

4.7.1 SLS Comfort Requirements

4.7.1.1

In addition to those required by the Eurocodes, the following SLS requirements shall be considered for the main span of the cable stayed bridge:

a) The functioning of the structure or structural members under normal use (in relation to its performance as perceived by the road users) shall not be impaired;

b) Road safety in terms of rapid changes in road gradient and super elevation or disruption to sight lines shall not be compromised;

c) Excessive ponding of surface water shall be prevented;

d) The perceived loss of comfort to road users in terms of wind oscillations and wind speed shall be minimised; and

e) The appearance of the works in terms of deflections and twists shall be considered.

4.7.1.2 The requirements of Section 4.7.1.1 above shall be deemed to have been satisfied if the following criteria are observed:

a) The highway alignment shall be checked for compliance inclusive of any co-existent deformations occurring on the main span due to the application of the SLS frequent combination of actions as modified by Section 4.7.1.3 below.

b) The functioning of the road drainage system shall be checked for compliance inclusive of any co-existent deformations occurring on the main span due to the application of the SLS frequent combination of actions as modified by Section 4.7.1.3 below.

c) Vibrations and oscillations of the bridge deck or its cable stays due to wind flow shall comply with the requirements set out in Section 4.7.1.4 below.

d) Wind shields shall be provided over the full extent of the bridge.

4.7.1.3 In order to limit the number of permutations of traffic patterns to be studied in complying with Section 4.7.1.2 above, it is acceptable to limit the loaded lengths on the main span to multiples of $1/6^{th}$ of the span length and to assume that the whole width of either carriageway is either fully loaded or fully unloaded with traffic load type LM1 (UDL) alone.

4.7.1.4 Comfort Criteria Against Wind Actions

Where the 10-minute mean wind speed $V_{10min} < 25$ m/s, the deck vibration amplitude, with wind of 0 degree incidence, shall be limited as follows:

a) For vortex shedding only, 0.04 m displacement in each of the vertical and lateral directions over the frequency range 0.1- 0.5 Hz

b) For all wind phenomena, 0.2m/s2 acceleration in each of the vertical and lateral directions over the frequency range 0.5-1.0Hz inclusive. These revised targets are consistent with the methods outlined in ISO 2631-1:1997 and BS 6841:1987.

4.7.2 Aerodynamic Stability

4.7.2.1 Global wind stability analyses of the bridge will be carried out for wind conditions in smooth flow and turbulent flow at both SLS and ULS. The completed bridge and the bridge during construction will be checked.

4.7.2.2 The aerodynamic responses will be assessed against the criteria in BD 49/01 and the UK supplementary guidance to EN 1991-1-4, UK PD6688-1-4 Annex A.

4.7.2.3 Aerodynamic instability shall be considered to occur when the wind response is divergent and the maximum vertical deflection of the bridge deck exceeds 1/500 times the span length or when the maximum angular deflection around the shear centre of the bridge deck exceeds 2^{o}.

4.7.3 Further departures from standard may be required as the design develops, for which this section will be updated.

4.8 List of record of options and choices (for Categories 2 and 3 checks)

The Eurocode related choices list will be completed as part of the detailed design process and will be distributed to the Category 3 checker.

Refer to Appendix F.

5 Structural analysis

A detailed description of the structural analysis methods to be used is given in a Structures Design Statement that will be produced during later design stages.

5.1 Methods of analysis proposed for superstructure, substructure and foundations

5.1.1 Superstructure

The analysis of the superstructure will be carried out by linear elastic methods using MIDAS or similar suitable finite element analysis software package. For global analysis, the structure will be analysed using a 3D model consisting of beam elements and bar or cable elements for cables. Analysis of the staged construction will be achieved through the activation of elements, loads and boundary conditions in accordance with the construction sequence to be adopted. This will also allow for time dependent effects such as creep and shrinkage to be built up correctly.

Geometrical non linearity arising from P-delta effects will also be modelled using a large displacement analysis. Analysis will also account for initial imperfections, construction tolerances and cable sag.

Local effects in the deck slab will be determined by a refined grillage model or Pucher charts. Other local effects will be checked by finite element models, hand calculations or by other appropriate methods.

Wind buffeting analysis and wind design code checks on the structure will be performed using RM Bridge. Experimental wind tunnel testing on a scaled model of the deck will also be used to assess the aerodynamic stability of the deck cross section. The tests will be carried out for the construction and in service conditions under wind fields characterised by the Wind Climate Report.

If results of the aeroelastic tests show that the proposed deck profile in service is prone to aerodynamic instability, additional tests will be undertaken in order to optimize the proposed configuration of wind shields and barriers and/or to design appropriate aerodynamic mitigation measures.

The static force coefficients required for design, e.g. drag, lift and moment, shall be measured for the deck section in construction and for the section in service with optimized configuration of wind shields and barriers, and aerodynamic migration measures if required. Static tests shall be carried out for varying angles of wind incidence and in smooth flow.

Concrete structural elements will be designed in accordance with BS EN 1992-2 and the associated National Annex. Steel structural elements will be designed in accordance with BS EN 1993-2:2006 and the associated National Annex. Stay cables and tie-down cables will be designed in accordance with BS EN 1993-1-11:2006. In the application of BS EN 1993-1-11:2006, clause 5.3 and clause NA2.7 of the associated National Annex, the cable stayed bridge will be classified as having a ‘flexible deck’ leading to the formulation of (G+P)γ for persistent design during service, where ‘G’ is the permanent actions due to gravity and ‘P’ is preloads or prestressing.

5.1.1.1 In applying clause 5.3(2) of EN 1993-1-11 for a structure containing mixed materials having different partial load factors, the values of $\gamma_{G,sup}$ and $\gamma_{G,inf}$ shall be determined by calculation, accounting for the relative contribution of each material type.

5.1.1.2 The design of composite steel and concrete structures shall be carried out to BS EN 1994-2:2005, the associated National Annex and PD 6696-2:2007.

5.1.2 Substructure

Substructures will be analysed using a 3D space frame model using MIDAS or similar software package. The model will include equivalent cantilevers to represent the pile group behaviour so that soil structure interaction can be modelled. The section properties and lengths of the equivalent cantilevers about both axes will be chosen so that they have the same flexibility matrix as the pile group determined from geotechnical analyses, and therefore will produce the correct rotation and displacement at pilecap level. Alternatively, the pile group can be modelled explicitly in the global model.

Analysis will include, where relevant, constructional tolerances and second order deflections due to the effects of slenderness.

Consideration will be made for both temporary loads during the launched construction/cantilever construction stage and final loads under the in service condition.

5.1.3 Foundations

Pile groups will be analysed either using PIGLET or a 3D finite element model in LS DYNA. Any passive resistance gained from the pile cap will be ignored. A range of lateral resistance within the Made Ground and Estuarine alluvium will be considered where foundations are in close proximity to dock walls or adjacent to the River Usk to give the most onerous case for foundation stiffness or ultimate resistance.

The analyses will determine the deflection and rotation of the pile group and the axial, shear and bending loads within the individual piles.

In PIGLET the ground is modelled as a linear elastic material with constant or linearly varying stiffness with depth and incorporates a semi empirical procedure to allow for interaction of piles within the group. The pile cap is assumed to be rigid and the pile heads fixed against rotation at the underside of the pile cap. Where appropriate the axial pile forces may be limited to specified design loads and redistributed loads calculated. The ground stiffness profiles will be calibrated against non linear single pile lateral loading analyses using Oasys Alp.

In the 3D finite element model the ground, piles and pile cap will be modelled using solid elements, with interface elements at the pile perimeter. A layered ground model will be used and non linear ground response included using a Mohr-Coulomb soil model and shear limits for shaft friction. The stiffness of the pile cap will be taken into account.

Consideration will be made for both temporary loads during the launched construction/cantilever construction stage and final loads under the in service condition.

5.2 Description and diagram of idealised structure to be used for analysis

The analysis of the superstructure will be carried out by linear elastic methods using MIDAS or similar suitable finite element analysis software package. For global analysis, the structure will be analysed using a model consisting of beam elements and bar elements for cables. Wind buffeting analysis on the structure will be analysed using RM Bridge.

Local effects in the deck slab will be determined by a refined grillage model.

Substructures will be analysed using a 3D space frame model using MIDAS or similar analysis software package. The model will include the substructure and equivalent cantilevers to represent the pile group behaviour and piles so that soil structure interaction can be modelled.

Pile groups will be analysed either using PIGLET or a 3D finite element model in LS DYNA.

The idealised structure diagram is shown in Appendix E

5.3 Assumptions intended for calculation of structural element stiffness

Section properties shall be appropriate to the effect being modelled and the level of stress in the section to determine whether uncracked, cracked or intermediate section properties should be used in the analysis. The effective width of the section will depend on the effect being analysed and the presence of shear lag.

Reference should be made to the technical paper 'Design of cross-girders and slabs in ladder deck bridges' published by the Proceedings of the Institution of Civil Engineers.

The long term effects of creep and shrinkage will be allowed for through the use of staged construction within MIDAS.

5.4 Proposed range of soil parameters to be used in the design of earth retaining elements

The backfill to the east abutment will be class 6N/6P.

Characteristic fill material properties provided below will be used: -

Table 1: Backfill material properties

Back and Overfill		
Property	Value	Reference
Unit Weight	γ = 20 kN/m^3	BS 8002:2015 Figure 1
Cohesion	c = 0	
Angle of Friction	Φ' = 38°	BS8002:2015 Table 1

Values of lateral earth pressure coefficient will be chosen taking account of the anticipated lateral displacement of the retaining structure. Account will be taken of compaction induced pressures.

6 Geotechnical conditions

6.1 Acceptance of recommendations of the Geotechnical Design Report to be used in the design and reasons for any proposed changes

The scheme is currently in the preliminary design stage and is supported by a Geotechnical Design Report (GDR) (Key Stage3) issued as Draft in March 2016. The GDR (Key Stage 3), in the context of preliminary design presents the proposed design methodologies for the geotechnical elements of the structures on the scheme. The GDR will be updated and further developed during Key Stage 6 and will provide final detail on the design of geotechnical elements.

In this AIP a Form C (Highway Structure Summary Form) has been included. This provides a summary of the anticipated ground conditions. It is proposed that the Form C will be updated (if required) and presented as part of the detailed design GDR (Key Stage 6) rather than requiring a reissue of this AIP.

6.2 Summary of design for highway structure in the Geotechnical Design Report

The Form C for this structure is included in Appendix C of this document which provides a summary of the geotechnical design.

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6.3 Differential settlement to be allowed for in the design of the structure

Differential settlement will be considered at both ULS and SLS. Differential settlement will be classified as a permanent action. For the substructure settlement will be modelled directly by the use of equivalent cantilevers in the substructure models, which will allow for the displacement and rotational movement under the applied loads.

Additional allowances for differential settlements in excess of the predicted response shall be made in the design. The minimum criteria for these additional differential settlements are shown in the table below: -

	Towers	Piers
Differential vertical settlement relative to adjacent piers/tower/whole portals (mm)	20	10
Additional imposed tilt (in both longitudinal and transverse directions)	1:4000	1:2000

Additionally, an allowance for differential settlement will be made between the abutment and the embankment fill/structure (SBR-0885). Movement will be accommodated over the multi element 'elastomeric in metal runners' joint through relative displacement of the joint rails. The amount of differential settlement at abutments under working load conditions that the bridge will be designed to accommodate will be confirmed at detailed design stage.

6.4 If the Geotechnical Design Report is not yet available, state when the results are expected and list the sources of information used to justify the preliminary choice of foundations

The Geotechnical Design Report (Key Stage 3) was issued as Draft in March 2016 and it will be updated during Key Stage 6 as the designs are developed.

The GDR (Key Stage 3) is based on the Ground Investigation Report (GIR) as issued in February 2016. The GIR sets out the available information in terms of ground investigation for the Scheme. Data referred to and summarised in the GIR includes borehole logs, trial pit records, the results of in situ and laboratory testing and details of groundwater encountered. This information has been used to prepare the Form C included in this AIP which summarises the preliminary foundation choice

7 Check

7.1 Proposed Category and Design Supervision Level

Category 3 to BD2/12. Design Supervision level 3.

7.2 If Category 3, name of proposed Independent Checker

AECOM.

7.3 Erection proposals or temporary works for which Types S and P Proposals will be required, listing structural parts of the permanent structure affected with reasons

Type S and P Proposals will be required to determine the effects on the structure from the lifting gantry for installation of the cable stay bridge main span segments and launching of the bridge deck at all approach viaduct launching locations. Further S and P proposals may also be required for other construction activities, such as if travelling formwork is used for the casting of deck edge units.

8 Drawings and documents

8.1 List of drawings (including numbers) and documents accompanying the submission

Drawing number	Drawing title	Rev
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1001	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – GENERAL ARRANGEMENT	P05
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1002	M4 CORRIDOR AROUND NEWPORT – SBR1000 - RIVER USK CROSSING – PLAN AND ELEVATION SHEET 1 OF 3	P06
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1003	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – PLAN AND ELEVATION SHEET 2 OF 3	P05
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1004	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – PLAN AND ELEVATION SHEET 3 OF 3	P04
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1005	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – TOWERS	P03
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1006	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – SECTIONS SHEET 1 OF 4	P04
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1007	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – SECTIONS SHEET 2 OF 4	P05
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1008	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – SECTIONS SHEET 3 OF 4	P03
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1009	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – SECTIONS SHEET 4 OF 4	P04
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1010	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – DECK	P02

M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1011	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – WEST ABUTMENT	P05
M4CaN - DJV - SBR – Z3_GEN - DR - CB – 1012	M4 CORRIDOR AROUND NEWPORT – SBR 1000 - RIVER USK CROSSING – EAST ABUTMENT	P03

9 The Above is Submitted for Acceptance

Signed:	
Name:	Martin Hooton
	Design Team Leader
Engineering Qualifications	MEng MICE CEng
	For and on behalf of
Name of organisation	DJV
Date:	18/01/2017

10 The above is Agreed Subject to the Amendments and Conditions Shown Below

Signed: _____

Name: _____

Position held: _____

Engineering Qualifications: _____

TAA

Date: _____

Appendices

Appendix A – List of the relevant documents from the TAS

TECHNICAL APPROVAL SCHEDULE "TAS" (August 2014)
SCHEDULE OF DESIGN DOCUMENTS RELATING TO DESIGN OR ASSESSMENT OF HIGHWAY BRIDGES AND STRUCTURES (All documents are taken to include revisions current at date of this TAS)

A.1.1 BRITISH STANDARDS

BS 5395: 2011	Code of practice for stairs and walkways
BS 5930: 1999+ A2:2010	Site Investigations [Amendment No. 1 December 2007 and amd 2 Aug 2010]. Partially replaced by BS EN ISO 22475-1:2006, BS EN ISO 14688-1:2002, BS EN ISO 14689-1:2003, BS EN 1997-2:2007, BS EN ISO 14688-2:2004+A1:2013, BS EN ISO 22476-2:2005+A1:2011, BS EN ISO 22476-3:2005+A1:2011, BS EN ISO 22282-1:2012, BS EN ISO 22282-2:2012, BS EN ISO 22282-3:2012, BS EN ISO 22282-4:2012, BS EN ISO 22282-5:2012, BS EN ISO 22282-6:2012, BS EN ISO 22476-1:2012, BS EN ISO 22476-5:2012, BS EN ISO 22476-7:2012, BS EN ISO 22476-4:2012
BS 6031: 2009	Code of practice for earthworks [Corrigendum August 2010]
BS 6180: 2011	Code of practice for barriers in and about buildings
BS 7818: 1995	Specification for Pedestrian Restraint Systems in Metal AMD15047, AMD16540
BS 8006-1:2010	Code of practice for strengthened/reinforced soils and other fills Corrigendum June 2012
BS 8006-2: 2011	Code of practice for strengthened/reinforced soils Soil nail design. Corrigenda Sept and Nov 2013
BS 8002:2015	Code of practice for earth retaining structures
BS 8500-1:2006+A1:2015	Concrete – Complementary British Standard to BS EN 206-1 Part 1: Method of specifying and guidance for the specifier
BS 8500-1:2006+A1:2015	Concrete – Complementary British Standard to BS EN 206-1 Part 2: Specification for constituent materials and concrete

A.1.2 EUROCODES (National Annexes and PDs not Listed)

BS EN 1317-1: 2010	Road Restraints Systems Terminology and General Criteria for Test Methods
BS EN 1317-2: 2010	Road Restraints Systems Performance Classes, Impact Test Acceptance Criteria and Test Methods for Safety Barriers
BS EN 1317-3: 2010	Road Restraints Systems Performance Classes, Impact Test Acceptance Criteria and Test Methods for Crash Cushions
DD ENV 1317-4: 2002	Performance Classes, Impact Test Acceptance Criteria and Test Methods for Terminals and Transitions of Safety Barriers
BS EN 1317-5: 2007+A2:2012	Road restraint systems Product requirements and evaluation of conformity for vehicle restraint systems Amendment, August 2013

BS EN 1337:2007	Structural Bearings
BS EN 14475: 2006	Execution of special geotechnical works – Reinforced fill
BS EN 1990:2002 +A1:2005	Eurocode - Basis of structural design AMD 16226 March 2006. Amends and replaces BS EN 1990:2002. Corrigendum June 2009. Corrigendum July 2010.
BS EN 1991	**Eurocode 1: Actions on structures**
BS EN 1991-1-1:2002	Eurocode 1: Actions on structures. General actions - Densities, self-weight, imposed loads for buildings (AMD Corrigendum 15507 and Corrigendum February 2010.
BS EN 1991-1-2:2002	Eurocode 1: Actions on structures. General actions - Actions on structures exposed to fire (incorporating corrigendum May 2009 and Corrigendum, February 2013.
BS EN 1991-1-3:2003	Eurocode 1 - Actions on structures. General actions - Snow loads (incorporating corrigenda December 2004 and March 2009) AMD15509 (COR1 TO BSEN1991-1-3: 2003) AMD 15509 is a Corrigendum. Corrigendum June 2009.
BS EN 1991-1-4:2005 +A1:2010	Eurocode 1: Actions on structures. General actions - Wind actions Corrigendum December 2009. Corrigendum August 2010. Amendment January 2011
BS EN 1991-1-5:2003	Eurocode 1 - Actions on structures. General actions - Thermal actions AMD 15510 is a Corrigendum. Corrigendum, February 2010
BS EN 1991-1-6:2005	Eurocode 1: Actions on structures. General actions - Actions during execution Corrigendum February 2010. Corrigendum, February 2013
BS EN 1991-1-7:2006 +A1:2014	Eurocode 1: Actions on structures. General actions - Accidental actions Corrigendum April 2010. Amendment, July 2014.
BS EN 1991-2:2003	Eurocode 1: Actions on structures. Traffic loads on bridges (AMD Corrigendum 15508) Corrigendum, April 2010.
~~BS EN 1991-4:2006~~	~~Eurocode 1 - Actions on structures. Silos and tanks Corrigendum, February 2013 Corrigendum, March 2013 Corrigendum, July 2013~~
BS EN 1992	**Eurocode 2: Design of concrete structures**
BS EN 1992-1-1:2004	Eurocode 2: Design of concrete structures. General rules and rules for buildings Corrigendum June 2008. Corrigendum August 2011. Corrigendum, February 2014.
BS EN 1992-1-2:2004	Eurocode 2: Design of concrete structures. General rules - Structural fire design Corrigendum February 2010.
BS EN 1992-2:2005	Eurocode 2: Design of concrete structures. Concrete bridges - Design and detailing rules Corrigendum February 2010.
BS EN 1993	**Eurocode 3: Design of steel structures**
BS EN 1993-1-1:2005	Eurocode 3: Design of steel structures. General rules and rules for buildings (AMD Corrigendum 16568 Corrigendum, February 2010

BS EN 1993-1-2:2005	Eurocode 3: Design of steel structures. General rules - Structural fire design (AMD Corrigendum 16290) (AMD Corrigendum 16572 Corrigendum, February 2010)
~~BS EN 1993-1-4:2006~~	~~Eurocode 3: Design of steel structures. General rules - Supplementary rules for stainless steels~~
BS EN 1993-1-5:2006	Eurocode 3 - Design of steel structures. Plated structural elements Corrigendum February 2010.
BS EN 1993-1-6:2007	Eurocode 3 - Design of steel structures. Strength and stability of shell structures Corrigendum February 2010.
BS EN 1993-1-7:2007	Eurocode 3 - Design of steel structures. Plated structures subject to out of plane loading Corrigendum February 2010
BS EN 1993-1-8:2005	Eurocode 3: Design of steel structures. Design of joints (AMD Corrigendum 16291) (AMD Corrigendum 16571) Corrigendum, February 2010. Corrigendum, August 2010.
BS EN 1993-1-9:2005	Eurocode 3: Design of steel structures. Fatigue (AMD Corrigendum 16292) (AMD Corrigendum 16570) Corrigendum, February 2010
BS EN 1993-1-10:2005	Eurocode 3: Design of steel structures. Material toughness and through-thickness properties (AMD Corrigendum 16293) (AMD Corrigendum 16569) Corrigendum, February 2010
BS EN 1993-1-11:2006	Eurocode 3 - Design of steel structures. Design of structures with tension components Corrigendum February 2010.
~~BS EN 1993-1-12:2007~~	~~Eurocode 3 - Design of steel structures. Additional rules for the extension of EN 1993 up to steel grades S 700 Corrigendum April 2010.~~
BS EN 1993-2:2006	Eurocode 3: Design of steel structures. Steel bridges. Corrigendum January 2010.
~~BS EN 1993-5:2007~~	~~Eurocode 3 - Design of steel structures. Piling. Corrigendum August 2009.~~
~~BS EN 1993-6:2007~~	~~Eurocode 3: Design of steel structures. Crane supporting structures Corrigendum April 2010~~
BS EN 1994	**Eurocode 4: Design of composite steel and concrete structures**
BS EN 1994-1-1:2004	Eurocode 4: Design of composite steel and concrete structures. General rules and rules for buildings Corrigendum October 2009.
BS EN 1994-1-2: 2005+A1:2014	Eurocode 4: Design of composite steel and concrete structures. General rules - Structural fire design. Corrigendum February 2010. Amendment, April 2014. Corrigendum, August 2014
BS EN 1994-2:2005	Eurocode 4: Design of composite steel and concrete structures. General rules and rules for bridges Corrigendum February 2010.
BS EN 1995	**Eurocode 5: Design of timber structures**

~~BS EN 1995-1-1:2004~~ +A2:2014	~~Eurocode 5: Design of timber structures. General - Common rules and rules for buildings) (incorporating corrigendum June 2006)~~ AMD 16499 is a Corrigendum. Amendment January 2009. Amends and replaces BS EN 1995-1-1:2004. Amendment, May 2014. Amends and replaces BS EN 1995-1-1:2004+A1:2008.
~~BS EN 1995-1-2:2004~~	~~Eurocode 5: Design of timber structures. General - Structural fire design (AMD Corrigendum 16498) Corrigendum, August 2009~~
~~BS EN 1995-2:2004~~	~~Eurocode 5: Design of timber structures. Bridges~~
BS EN 1996	**Eurocode 6: Design of masonry structures**
~~BS EN 1996-1-1:2005 +A1:2012~~	~~Eurocode 6 - Design of masonry structures. General rules for reinforced and unreinforced masonry structures (AMD Corrigendum 16209) Corrigendum, December 2009. Amendment, April 2013. Amends and replaces BS EN 1996-1-1:2005.~~
~~BS EN 1996-1-2:2005~~	~~Eurocode 6: Design of masonry structures. General rules - Structural fire design~~ Corrigendum July 2011
~~BS EN 1996-2:2006~~	~~Eurocode 6 - Design of masonry structures. Design considerations, selection of materials and execution of masonry~~ Corrigendum March 2010.
~~BS EN 1996-3:2006~~	~~Eurocode 6 - Design of masonry structures. Simplified calculation methods for unreinforced masonry structures~~ Corrigendum March 2010.
BS EN 1997	**Eurocode 7: Geotechnical design**
BS EN 1997-1:2004 +A1:2013	Eurocode 7: Geotechnical design. General rules Corrigendum January 2010. Amendment, July 2014. Amends and replaces BS EN 1997-1:2004.
BS EN 1997-2:2007	Eurocode 7: Geotechnical design. Ground investigation and testing Corrigendum October 2010.
BS EN 1998	**Eurocode 8: Design of structures for earthquake resistance**
BS EN 1998-1:2004 +A1:2013	Eurocode 8: Design of structures for earthquake resistance. General rules, seismic actions and rules for buildings Corrigendum February 2010. Corrigendum January 2011 Amendment, May 2013. Amends and replaces BS EN 1998-1:2004.
BS EN 1998-2:2005 +A2 :2011	Eurocode 8: Design of structures for earthquake resistance. Bridges Amendment August 2009. Amends and replaces BS EN 1998-2:2005. Corrigendum May 2010. Amendment December 2011. Amends and replaces BS EN 1998-2:2005+A1:2009. Corrigendum February 2012.
BS EN 1998-5:2004	Eurocode 8: Design of structures for earthquake resistance. Foundations, retaining structures and geotechnical aspects
~~BS EN 14388: 2005~~	~~Road Traffic Noise Reducing Devices Specifications [Corrigendum February 2009]~~

A.2 DEPARTMENT OF TRANSPORT LOCAL GOVERNMENT AND THE REGIONS (DTLR)

~~Simplified Tables of External Loads on Buried Pipelines, 1986, (published by TSO)~~

~~Traffic Management Act 2004~~

A.3 MISCELLANEOUS

~~Circular Roads No 61/72 – Routes for Heavy and High Abnormal Loads~~

A.4 THE MANUAL OF CONTRACT DOCUMENTS FOR HIGHWAY WORKS (MCDHW)

Volume 1: Specification for Highway Works, 1998 (with revisions, latest amendment December 2014)

Volume 2: Notes for Guidance on the Specification for Highway Works, 1998 (with revisions, latest amendment December 2014)

Volume 3: Highway Construction Details, 1998 (with revisions, latest amendment Nov 2008)

A.5 THE DESIGN MANUAL FOR ROADS & BRIDGES (DMRB)

A.5.1 Advice Notes – Bridges and Structures (BA Series)

BA 26/94	Expansion Joints for Use in Highway Bridge Decks	Nov 1994	2.3.7
BA 28/92	Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures	Aug 1992	1.2.2
BA 41/98	The Design and Appearance of Bridges	Feb 1998	1.3.11
BA 47/99	Waterproofing and Surfacing of Concrete Bridge Decks	Aug 1999	2.3.5
~~BA 67/96~~	~~Enclosure of Bridges~~	~~Aug 1996~~	~~2.2.8~~
~~BA 68/97~~	~~Crib Retaining Walls~~	~~Feb 1997~~	~~2.1.4~~
~~BA 82/00~~	~~Formation of Continuity Joints in Bridge Decks~~	~~Nov 2000~~	~~2.3.7~~
BA 85/04	Coatings for Concrete Highway Structures & Ancillary Structures	May 2004	2.4.3
BA 92/07	Use of recycled concrete aggregates in structural concrete	May 2007	2.3.9

A.5.2 Bridges and Structures, Standards (BD Series)

BD 2/12	Technical Approval of Highway Structures	May 2012	1.1.1
~~BD 7/01~~	~~Weathering Steel for Highway Structures~~	~~Nov 2001~~	~~2.3.8~~
~~BD 10/97~~	~~Design of Highway Structures in Areas of Mining Subsidence~~	~~May 1997~~	~~1.3.14~~
~~BD 12/01~~	~~Design of Corrugated Steel Buried Structures with Spans Greater than 0.9 metres and up to 8.0 metres~~	~~Nov 2001~~	~~2.2.6~~
~~BD 29/04~~	~~Design Criteria for Footbridges~~	~~Aug 2004~~	~~2.2.8~~
BD 33/94	Expansion Joints for Use in Highway Bridge Decks	Nov 1994	2.3.6

BD 35/14	Quality Assurance Scheme for Paints and Similar Protective Coatings	Aug 2014	2.4.1
BD 36/92	Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures	Aug 1992	1.2.1
BD 43/03	The Impregnation of Reinforced and Prestressed Concrete Highway Structures using Hydrophobic Pore-Lining Impregnants	Feb 2003	2.4.2
BD 45/93	Identification Marking of Highway Structures	Aug 1993	3.1.1
BD 47/99	Waterproofing and Surfacing of Concrete Bridge Decks	Aug 1999	2.3.4
BD49/01	Design rules for aerodynamic effects on bridges	May 2001	1.3.3
BD 51/14	Portal and Cantilever Sign / Signal Gantries	May 2014	2.2.4
BD 62/07	As Built, Operational & Maintenance Records for Highway Structures	Feb 2007	3.2.1
~~BD 65/14~~	~~Design Criteria for Collision Protector Beams~~	~~Dec 2014~~	~~2.2.5~~
~~BD 67/96~~	~~Enclosures of Bridges~~	~~Aug 1996~~	~~2.2.7~~
~~BD 68/97~~	~~Crib Retaining Walls~~	~~Feb 1997~~	~~2.1.3~~
~~BD 78/99~~	~~Design of Road Tunnels~~	~~Aug 1999~~	~~2.2.9~~
~~BD 82/00~~	~~Design of Buried Rigid Pipes~~	~~Aug 2000~~	~~2.2.10~~
~~BD 90/05~~	~~Design Of FRP Bridges and Highway Structures~~	~~May 2005~~	~~1.3.17~~
~~BD 94/07~~	~~Design of Minor Structures~~	~~Feb 2007~~	~~2.2.1~~

A.5.3 Bridges, Technical Memoranda (BE Series)

A.5.4 Traffic Engineering and Control, Standards (TD Series)

TD 19/06	Requirements for Road Restraint Systems [correction 1 Feb 2008]	Aug 2006	2.2.8
TD 27/05	Cross Sections and Headroom	Feb 2005	6.1.2

A.5.5 Highways, Advice Notes (HA Series)

~~HA 66/95~~	~~Environmental Barriers Technical Requirements~~	~~Sep 1995~~	~~10.5.2~~

A.5.6 Highways, Standards (HD Series)

HD 45/09	Road Drainage and the Water Environment	Nov 2009	11.3.10

A.6 Interim Advice Notes (IAN)

~~WO1A.1 (IAN 1)~~	~~TD 37/93 Scheme Assessment Reporting~~	~~Jan 1996~~
WO1A.3 (IAN 3)	BA 50/93 Post Tensioned Concrete Bridges	Apr 1997
~~WO1A.4 (IAN 4)~~	~~BD 44/95 The Assessment of Concrete Highway Bridges and Structures~~	~~Oct 1996~~
~~IAN 49~~	~~Use of Warning Signs for New Asphalt Road Surfaces~~	~~Apr 2004~~

~~IAN 53~~	~~Concrete Half-Joint Deck Structures~~	~~May 2004~~
~~IAN 56~~	~~Maintenance of Traffic Signs with Dew Resistant Coatings~~	~~Jan 2005~~
~~IAN 64/05~~	~~Driver Information Signs at Road Works~~	~~May 2005~~
IAN 70/06 (W)	Implementation of New Reinforcement Standards (BS 4449:2005, BS 4482:2005, BS 4483:2005 & BS 8666:2005)	Jan 2006
~~IAN 71~~	~~Marker Posts on Lay-By Segregation Islands~~	~~Sep 2007~~
IAN 73/06	Design of Pavement Foundations	Nov 2009
~~IAN 83/06 (W)~~	~~Principal & General Inspection of Sign/Signal Gantries, & Gantries with Low Handrails or Open Mesh Flooring~~	~~Aug 2006~~
~~IAN 85/07 (W)~~	~~Design of Passively Safe Portal Signal Gantries~~	~~Jan 2008~~
IAN 86/07 (W)	Amendments to Design Requirements for Portal & Cantilever Sign/Signal Gantries	Jan 2008
IAN 95/07 (W)	Implementation of New Concrete Standards	May 2007
IAN 96/01 (W)	Guidance on Implementing Results of Research on Bridge Deck Waterproofing	Jul 2007
~~IAN 97/07 (W)~~	~~Assessment & Upgrading of Existing Parapets~~	~~Jan 2009~~
IAN 105/08 (W)	Implementation of Construction (Design Management) Regulations 2007 & The Withdrawal of SD 10/05 & SD11/05	Jan 2008
~~IAN 110/08 (W)~~	~~Assessment of Implications (Of Highways Plans & Projects) on European Sites (Including Appropriate Assessment)~~	~~Dec 2008~~
~~IAN 116/08 (W)~~	~~Nature Conservation Advice in Relation to Bats~~	~~Sep 2009~~
IAN 124/14 (W)	Use of Eurocodes for the Design of Highway Structures	May 2014
IAN 154/14 (W)	Revision of SHW Clause 903, Clause 921 and Clause 942	Aug 2014
IAN 156/14 (W)	Revision of Aggregate Specification for Pavement Surfacing	Aug 2014
IAN 157/14 (W)	Thin Surface Course Systems - Installation and Maintenance	Aug 2014
IAN 177/14 (W)	Introduction of the Construction Products Regulation (EU) 305_2011	Aug 2014

A.7 RAILWAY SAFETY AND STANDARDS BOARD DOCUMENTS

~~GC/GN5612~~	~~Issue 1~~	~~Dec 2014~~	~~Guidance on Loading Requirements for the Design of Railway Structures~~
GC/GN5612	Issue 1	Dec 2014	Guidance on Loading Requirements for the Design of Railway Structures.
GC/RT5212	Issue 1	Feb 2003	Requirements for defining and maintaining clearances [plus amendment AM002]
~~GM/RT2149~~	~~Issue 3~~	~~Feb 2003~~	~~Requirements for defining and maintaining the size of railway vehicles [plus amendments AM001,AM002 and AM003]~~
~~GO/RT3413~~	~~Issue 1~~	~~Aug 2008~~	~~Provision of Information and Signs for Access on the Railway [Supersedes GCRT5203 Iss 3]~~
NR/L3/CIV/020	Issue 1	Jun 2011	Design of Bridges [Replaces RT/CE/S/007 Issue 1]
~~NR/L3/CIV/140~~	~~Various Issues~~	~~Various dates~~	~~Model clauses for specifying civil engineering work (Various Sections, on different topics)~~
~~NR/L3/CIV/151~~	~~Issue 6~~	~~March 2012~~	~~Engineering Assurance of Standard Designs & Details for Building & Civil Engineering Works~~
~~NR/GN/CIV/025~~	~~Issue 3~~	~~Jun 2006~~	~~Structural assessment of underbridges~~
~~NR/L2/CIV/003~~	~~Issue 4~~	~~June 2012~~	~~Engineering Assurance of Building and Civil Engineering Works~~
~~NR/L2/TRK/2049~~	~~Issue 12~~	~~Mar 2010~~	~~Track design handbook~~
~~NR/L2/TRK/2102~~	~~Issue 6~~	~~Mar 2010~~	~~Track construction standards~~

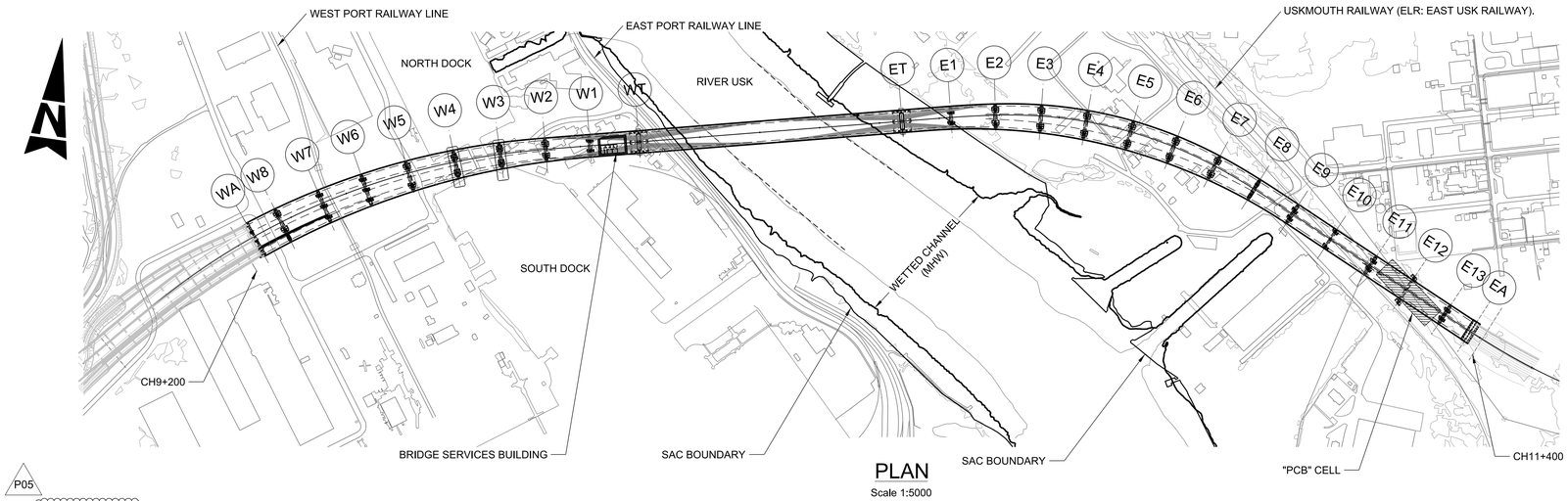
A.8 OTHER RELEVANT SUPPLEMENTARY STANDARDS & REFERENCES

BRE Special Digest 1, 2005	Concrete in Aggressive Ground [3rd Edition]
CIRIA Document C1	A guide to the design of anchor blocks for post-tensioned prestressed concrete members
CIRIA Document C543	Bridge detailing guide
CIRIA Document C660	Early-age thermal and crack control in concrete
CIRIA Document C686	Safe access for maintenance and repair
SETRA Document	Recommendations of French Interministerial commission on Prestressing

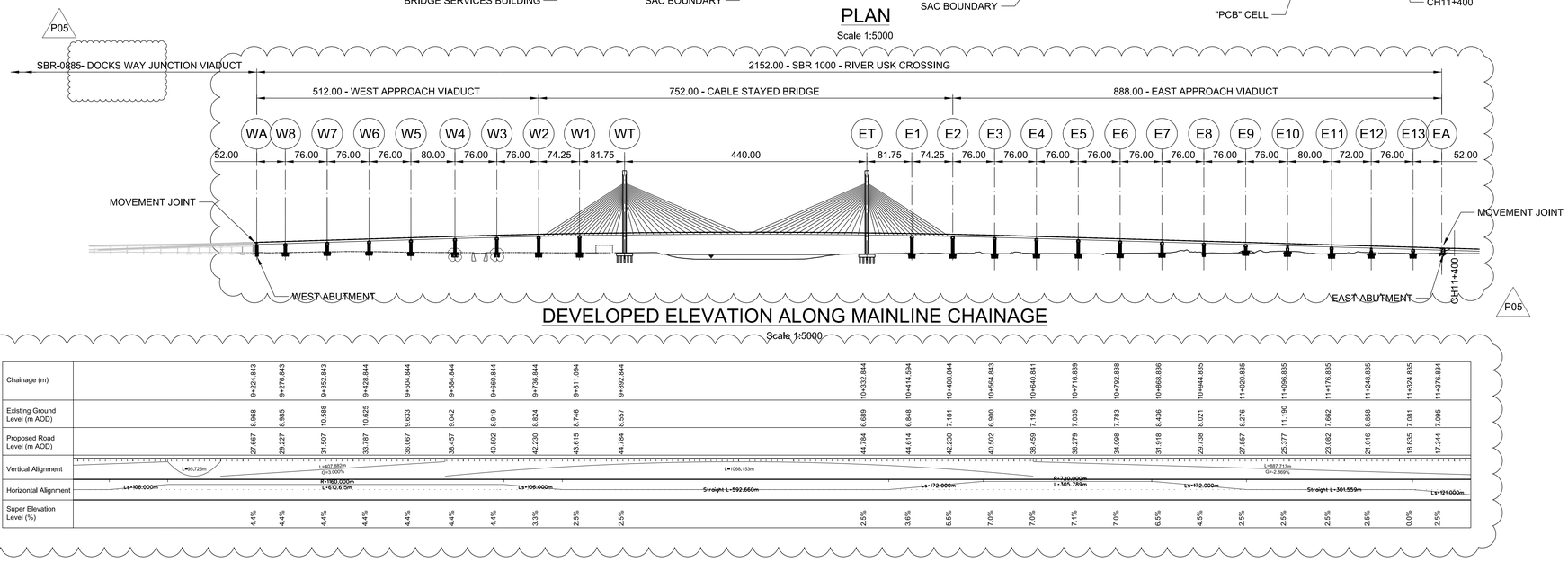
Appendix B– Drawings

DO NOT SCALE

Millimetres 100 0 10



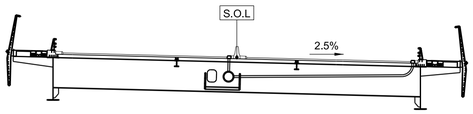
PLAN
Scale 1:5000



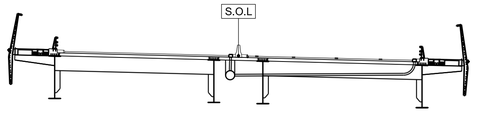
DEVELOPED ELEVATION ALONG MAINLINE CHAINAGE
Scale 1:5000

Chainage (m)	9+224.843	9+276.843	9+352.843	9+428.844	9+504.844	9+584.844	9+660.844	9+736.844	9+811.094	9+892.844	10+332.844	10+414.594	10+488.844	10+564.843	10+640.841	10+716.839	10+792.838	10+868.836	10+944.835	11+020.835	11+096.835	11+176.835	11+248.835	11+324.835	11+376.834
Existing Ground Level (m AOD)	8.988	8.985	10.388	10.625	9.633	9.042	8.919	8.824	8.746	8.557	6.689	6.848	7.181	6.900	7.192	7.035	7.783	8.436	8.021	8.276	11.190	7.862	8.838	7.081	7.095
Proposed Road Level (m AOD)	27.667	29.227	31.507	33.797	36.067	38.457	40.502	42.230	43.615	44.784	44.784	44.614	42.230	40.502	38.459	36.279	34.098	31.918	29.738	27.557	25.377	23.062	21.016	18.835	17.344
Vertical Alignment	L=95.726m		L=407.862m Gr3.000%								L=1068.153m						R=330.000m L=305.789m				L=887.713m Gr-2.869%				
Horizontal Alignment	Ls=106.000m		R=1500.000m L=430.67m				Ls=106.000m				Straight L=592.660m			Ls=172.000m					Ls=172.000m			Straight L=301.559m			Ls=121.000m
Super Elevation Level (%)	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	3.3%	2.5%	2.5%	2.5%	3.6%	5.5%	7.0%	7.0%	7.1%	7.0%	6.5%	4.5%	2.5%	2.5%	2.5%	2.5%	0.0%	2.5%

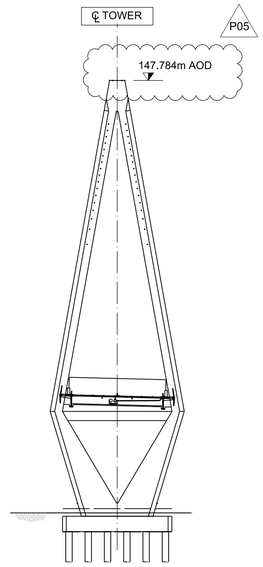
ALIGNMENT PROFILE
Scale 1:5000



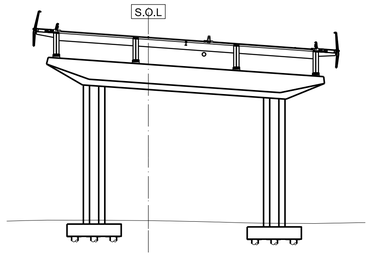
TYPICAL MAIN SPAN SECTION
Scale 1:250



TYPICAL APPROACH SPAN SECTION
Scale 1:250



TYPICAL TOWER ELEVATION
Scale 1:1000



TYPICAL APPROACH PIER SECTION
Scale 1:500

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1010 FOR LOCATION OF SETTING OUT LINE.
4. ABBREVIATIONS:
   E.G.L - EXISTING GROUND LEVEL
   F.G.L - FINISHED GROUND LEVEL
   mAOD - METRES ABOVE ORDNANCE DATUM
   CH - CHAINAGE
   CL - CENTRE LINE
   I.W.L - IMPOUNDED WATER LEVEL
   M.E.W.P - MOBILE ELEVATED WORKING PLATFROM
   M.H.W - MEAN HIGH WATER LEVEL
   M.L.W.S - MEAN LOW WATER SPRINGS
   S.F.Z - STRUCTURE FREE ZONE
   S.O.L - SETTING OUT LINE
   S.O.P - SETTING OUT POINT
   V.R.S - VEHICLE RESTRAINT SYSTEM
5. REFER TO DRAWINGS 1002,1003 AND 1004 FOR ROADS RAIL AND NAVIGATION CLEARANCES

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 significant residual risks (Reference shall also be made to the design hazard log).

Construction
None

Maintenance / Cleaning
None

Use
None

Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	21/06/16	TOM LEWIS VIADUCT ADDED	IIE	MYG	MYG
P04	29/09/16	AIP UPDATE	PDA	MYG	MYG
P05	02/12/16	AIP UPDATE	DAW	MYG	MYG

Drawing Status: FOR COSTING
Suitability: D1
Project Team
Client: Llywodraeth Cymru Welsh Government

Project Title: M4 CORRIDOR AROUND NEWPORT
Drawing Title: SBR 1000 - RIVER USK CROSSING GENERAL ARRANGEMENT

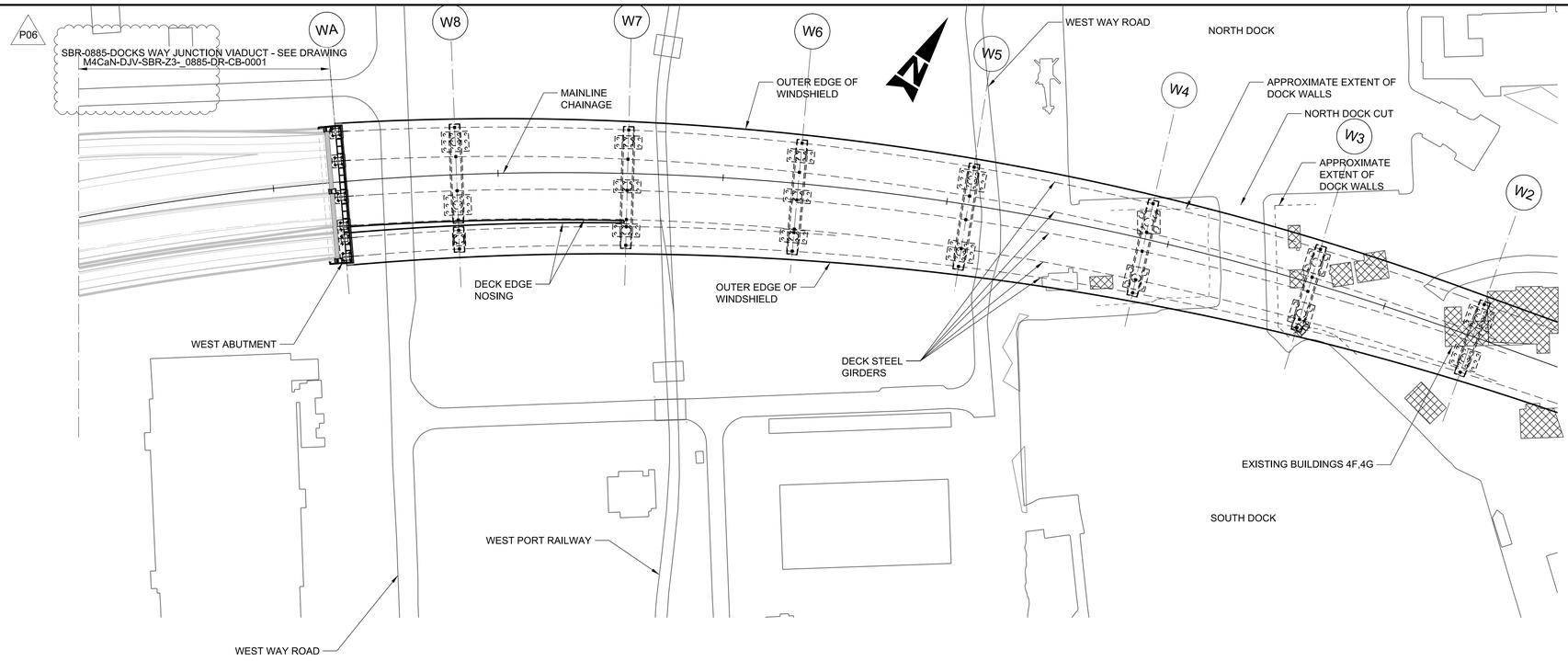
Scale	Designed / Drawn	Checked	Approved	Authorised
1:500	DAW	MYG	MYG	GRD
Original Size	**Date**	**Date**	**Date**	**Date**
A1	11/11/16	11/11/16	13/11/16	02/12/16

Drawing Number: Project | Originator | Volume
M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1001
Location | Type | Role | Number

Revision: P05

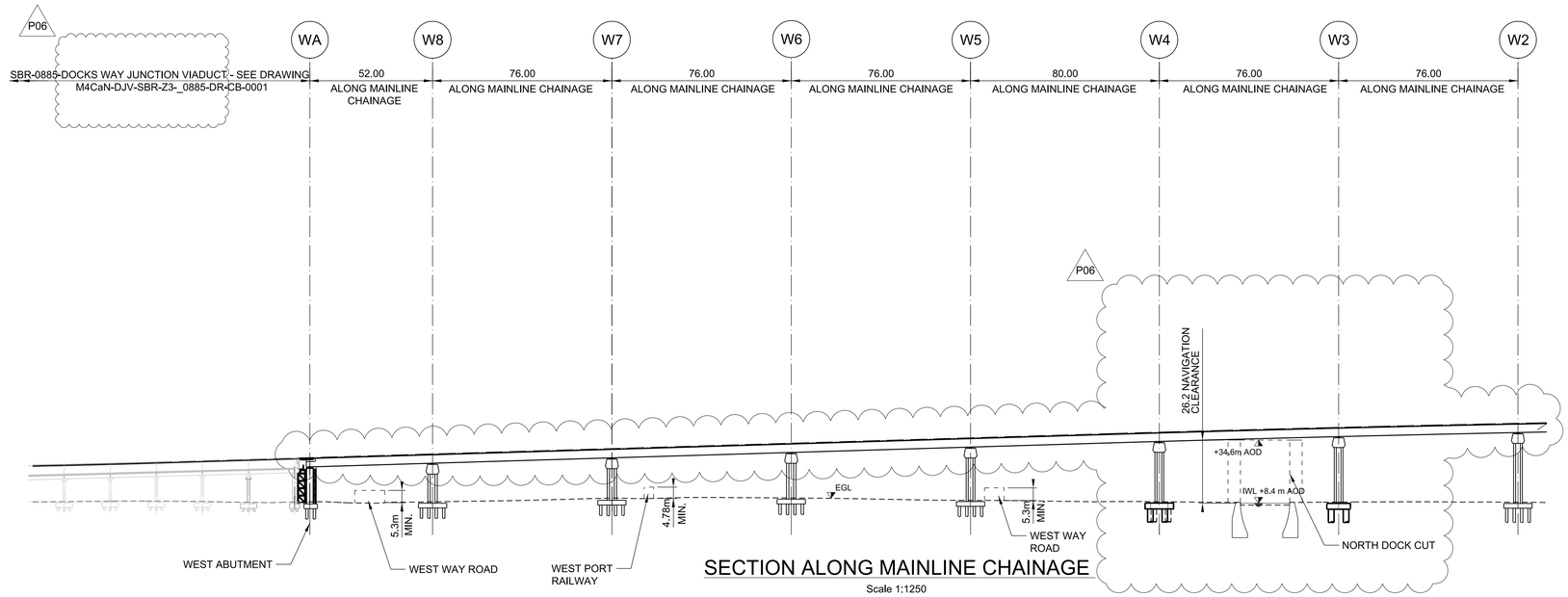
DO NOT SCALE

Millimetres 0 10 100



PLAN

Scale 1:250



SECTION ALONG MAINLINE CHAINAGE

Scale 1:1250

CH8+920

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1001 FOR ABBREVIATIONS
4. FOR EXISTING BUILDING CLASSIFICATIONS REFER TO NEWPORT DOCKS HISTORIC BUILT ENVIRONMENT ASSESSMENT.
5. PRELIMINARY FOUNDATION SIZING HAS BEEN BASED ON LIMITED SPT DATA WITHIN THE MERCIA MUDSTONE. REFER TO THE AIP FORM C FOR DETAILS OF THE AVAILABLE GROUND INFORMATION AND DESIGN ASSUMPTIONS.

BUILDINGS REQUIRING DEMOLITION OR MODIFICATION FOR PERMANENT AND TEMPORARY WORKS

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 significant residual risks (Reference shall also be made to the design hazard log).

Construction
None

Maintenance / Cleaning
None

Use
None

Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	15/02/16	FINAL ISSUE	DAW	MAH	MYG
P04	21/06/16	TOM LEWIS VIADUCT ADDED	IIE	MYG	MYG
P05	29/09/16	AIP UPDATE	PDA	MYG	MYG
P06	01/12/16	AIP Update	DAW	MYG	MYG

Drawing Status: FOR COSTING
Suitability: D1

Project Team

Client: Llywodraeth Cymru Welsh Government

Project Title: M4 CORRIDOR AROUND NEWPORT

Drawing Title: SBR 1000 - RIVER USK CROSSING PLAN & ELEVATION SHEET 1 OF 3

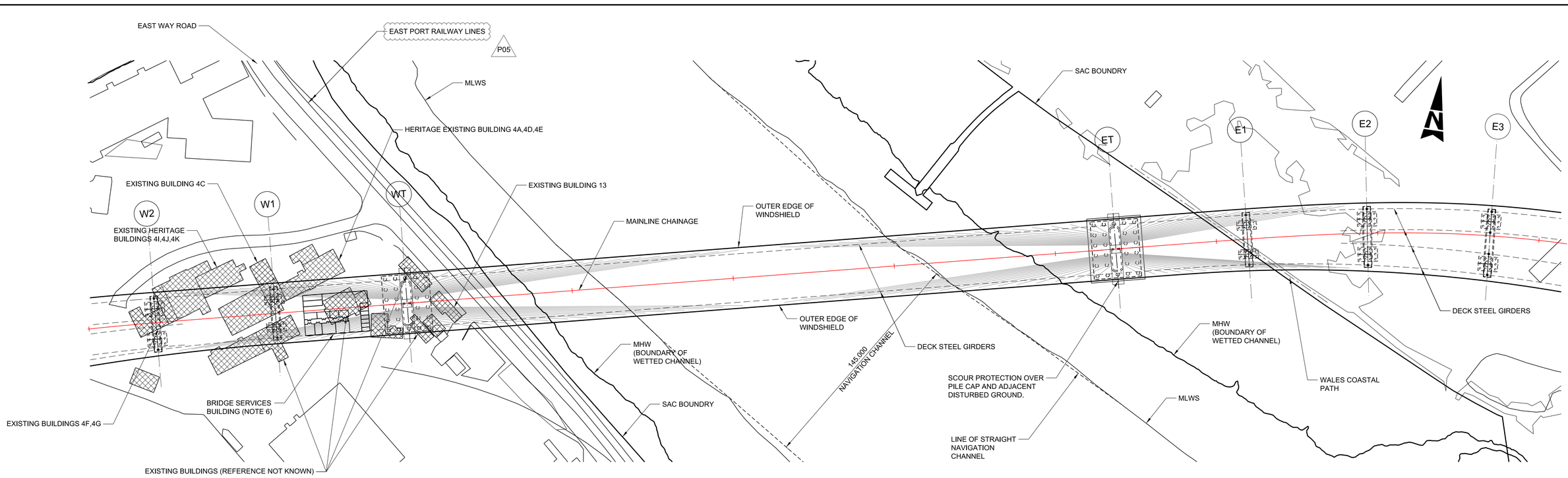
Scale	Designed / Drawn	Checked	Approved	Authorised
1:1250	DAW	MYG	MYG	GRD
Original Size	**Date**	**Date**	**Date**	**Date**
A1	11/11/16	13/11/16	13/11/16	01/12/16

Drawing Number: Project | Originator | Volume | Location | Type | Role | Number
M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1002

Revision: P06

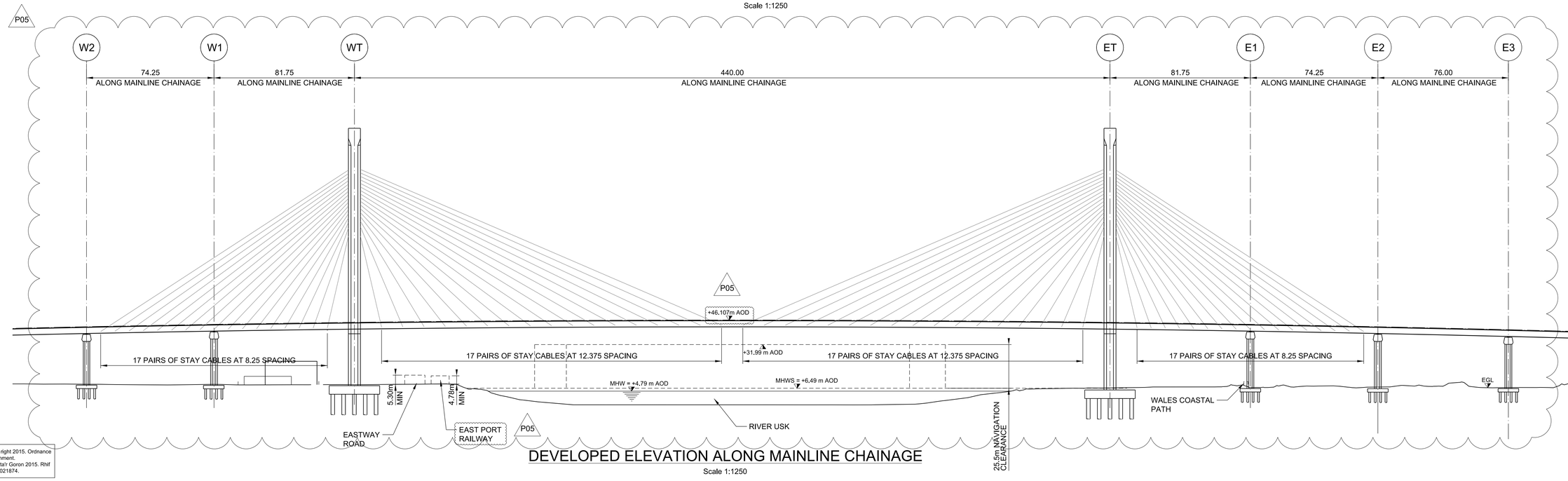
DO NOT SCALE

Millimetres 0 10 100



PLAN

Scale 1:1250



DEVELOPED ELEVATION ALONG MAINLINE CHAINAGE

Scale 1:1250

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1001 FOR ABBREVIATIONS.
4. FOR EXISTING BUILDING CLASSIFICATIONS REFER TO NEWPORT DOCKS HISTORIC BUILT ENVIRONMENT ASSESSMENT.
5. PRELIMINARY FOUNDATION SIZING HAS BEEN BASED ON LIMITED SPT DATA WITHIN THE MERCIA MUDSTONE. REFER TO THE AIP FORM C FOR DETAILS OF THE AVAILABLE GROUND INFORMATION AND DESIGN ASSUMPTIONS.
6. REFER TO DRAWING 2008 FOR PLAN LAYOUT OF THE BUILDING SERVICES BUILDING.

BUILDINGS REQUIRING DEMOLITION OR MODIFICATION FOR PERMANENT AND TEMPORARY WORKS

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 significant residual risks (Reference shall also be made to the design hazard log).

Construction
None

Maintenance / Cleaning
None

Use
None

Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	21/10/15	SECOND ISSUE	---	MAH	MYG
P04	15/02/16	FINAL ISSUE	DAW	MAH	MYG
P05	02/12/16	AIP Update	DAW	MYG	MYG

Drawing Status: FOR COSTING
Suitability: D1

Project Team

Client: Llywodraeth Cymru Welsh Government

Project Title: M4 CORRIDOR AROUND NEWPORT

Drawing Title: SBR 1000 - RIVER USK CROSSING PLAN & ELEVATION SHEET 2 OF 3

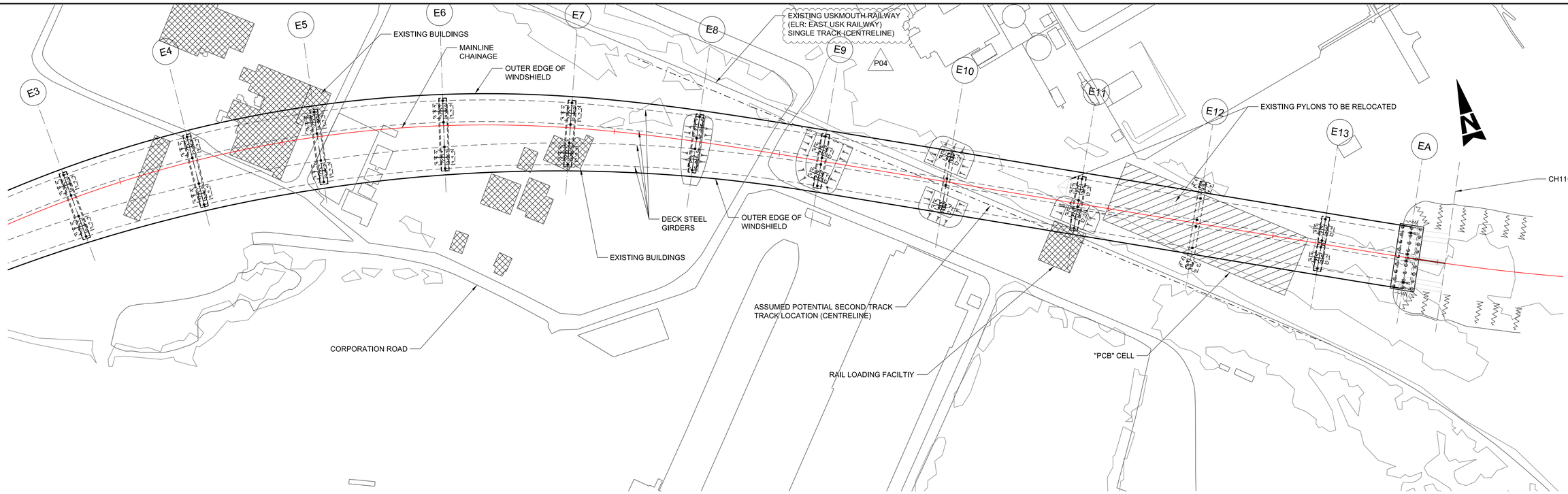
Scale	Designed / Drawn	Checked	Approved	Authorised
1:1250	DAW	MYG	MYG	GRD
Original Size	**Date**	**Date**	**Date**	**Date**
A1	10/11/16	13/11/16	13/11/16	02/12/16

Drawing Number: Project | Originator | Volume
M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1003
Location | Type | Role | Number

Revision: P05

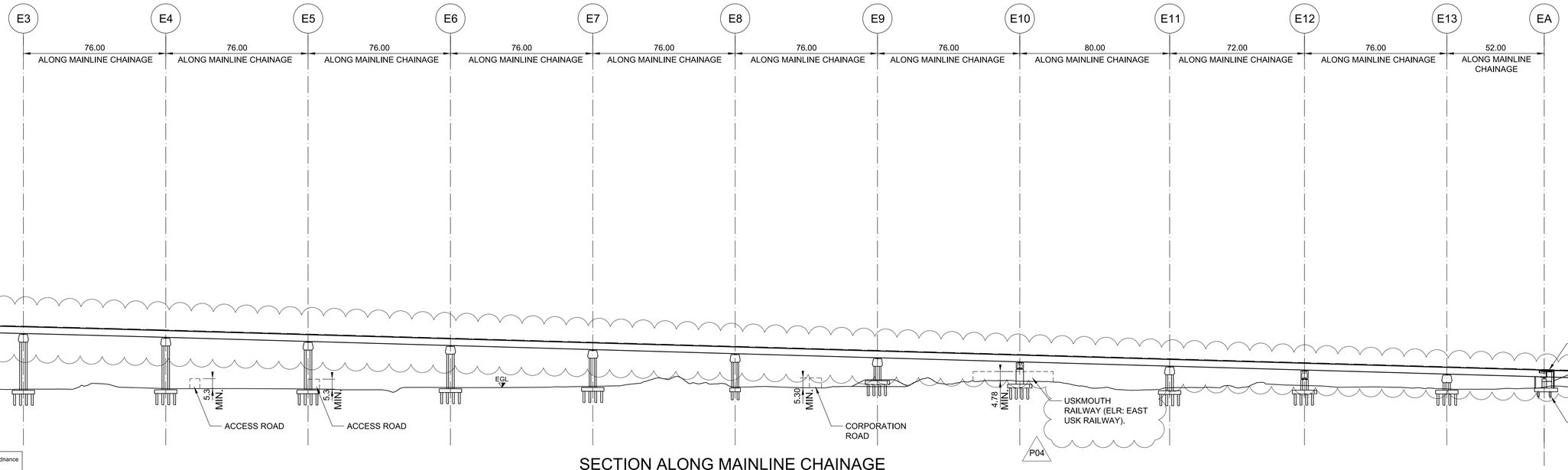
DO NOT SCALE

Millimetres 0 10 100



PLAN

Scale 1:1250



SECTION ALONG MAINLINE CHAINAGE

Scale 1:1250

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1001 FOR ABBREVIATIONS
4. FOR EXISTING BUILDING CLASSIFICATIONS REFER TO NEWPORT DOCKS HISTORIC BUILT ENVIRONMENT ASSESSMENT.
5. PRELIMINARY FOUNDATION SIZING HAS BEEN BASED ON LIMITED SPT DATA WITHIN THE MERCIA MUDSTONE. REFER TO THE AIP FORM C FOR DETAILS OF THE AVAILABLE GROUND INFORMATION AND DESIGN ASSUMPTIONS.

BUILDINGS REQUIRING DEMOLITION OR MODIFICATION FOR PERMANENT AND TEMPROARY WORKS

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 significant residual risks (Reference shall also be made to the design hazard log).

Construction
The PCB cell is a highly contaminated zone No construction to take place directly on this zone

Maintenance / Cleaning
None

Use
None

Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	15/02/16	FINAL ISSUE	DAW	MAH	MYG
P04	02/12/16	AIP UPDATE	DAW	MYG	MYG

Drawing Status: FOR COSTING
Suitability: D1
Project Team
Client: Llywodraeth Cymru Welsh Government

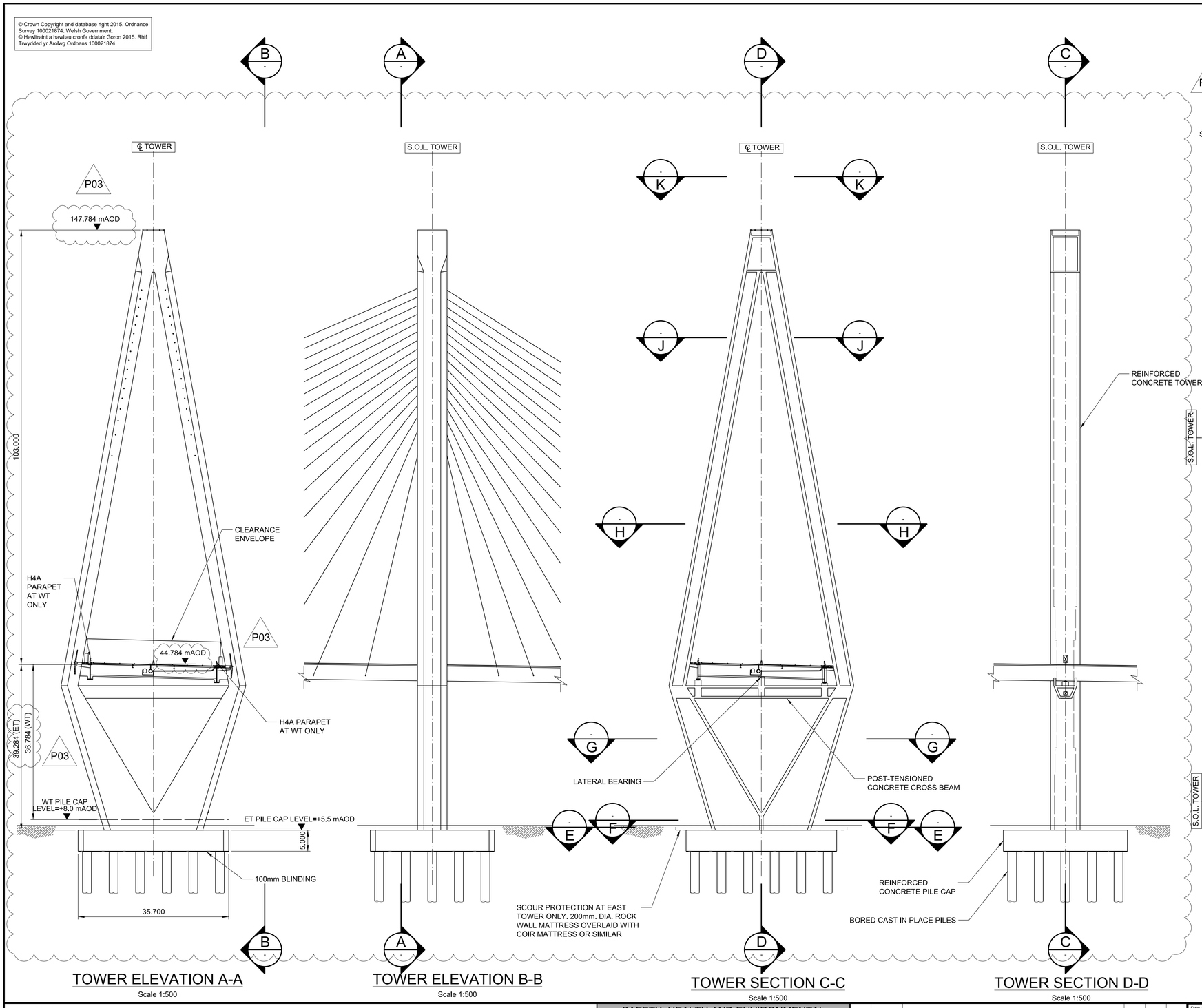
Project Title: M4 CORRIDOR AROUND NEWPORT
Drawing Title: SBR 1000 - RIVER USK CROSSING PLAN & ELEVATION SHEET 3 OF 3

Scale	Designed / Drawn	Checked	Approved	Authorised
1:1250	DAW	MYG	MYG	GRD
Original Size	Date	Date	Date	Date
A1	10/11/16	13/11/16	13/11/16	02/12/16

Drawing Number: Project | Originator | Volume | Locatlon | Type | Role | Number
M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1004
Revision: P04

Millimetres 100 10 0

DO NOT SCALE

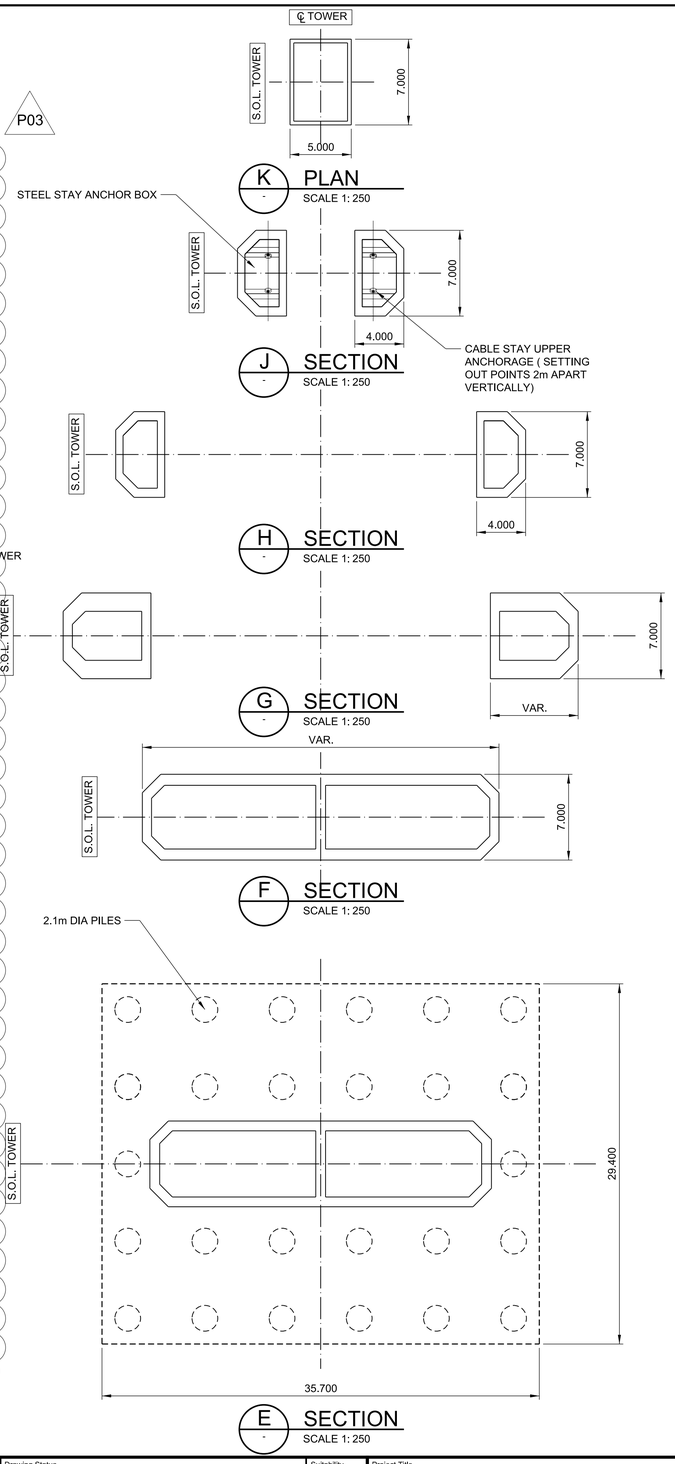


TOWER ELEVATION A-A
Scale 1:500

TOWER ELEVATION B-B
Scale 1:500

TOWER SECTION C-C
Scale 1:500

TOWER SECTION D-D
Scale 1:500



GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1001 FOR ABBREVIATIONS.
4. EAST TOWER SHOWN, WEST TOWER SIMILAR AS NOTED.

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 significant residual risks (Reference shall also be made to the design hazard log).

Construction
None

Maintenance / Cleaning
None

Use
None

Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	02/12/16	AIP UPDATE	DAW	MYG	MYG

Drawing Status: FOR COSTING
Suitability: D1
Project Title: M4 CORRIDOR AROUND NEWPORT
Project Team:
Drawing Title: SBR 1000 - RIVER USK CROSSING TOWERS
Client: Llywodraeth Cymru Welsh Government

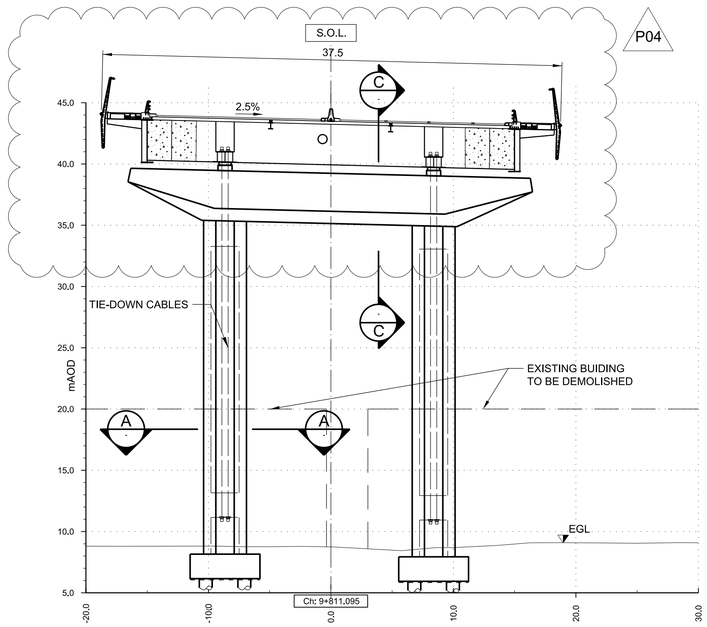
Scale	Designed / Drawn	Checked	Approved	Authorised
1:500,1:	DAW	MYG	MYG	GRD
Original Size	Date	Date	Date	Date
A1	10/11/16	13/11/16	13/11/16	02/12/16

Drawing Number: Project | Originator | Volume
M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1005
Location | Type | Role | Number

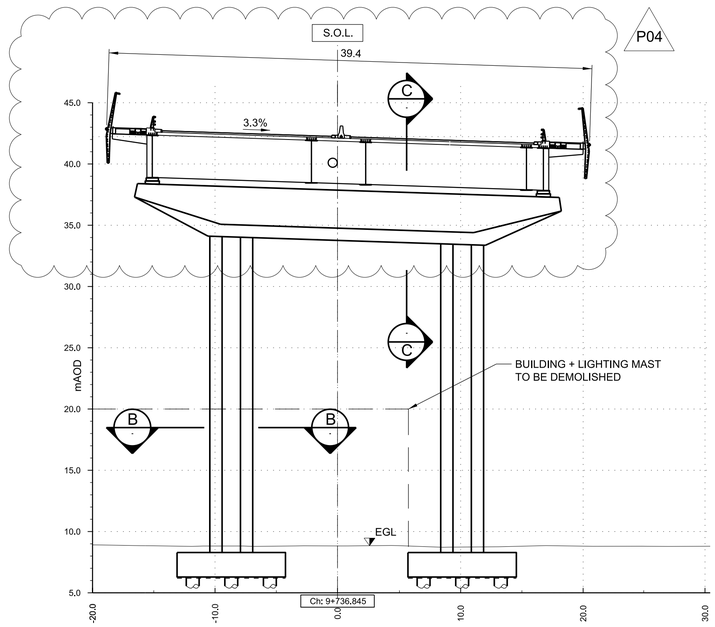
Revision: P03

DO NOT SCALE

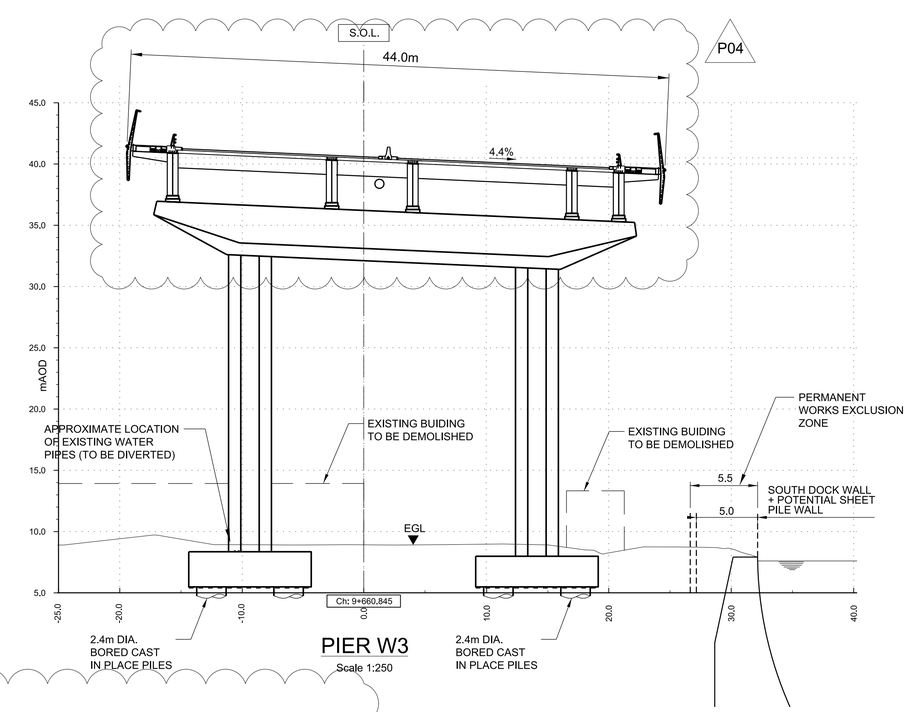
Millimetres 0 10 100



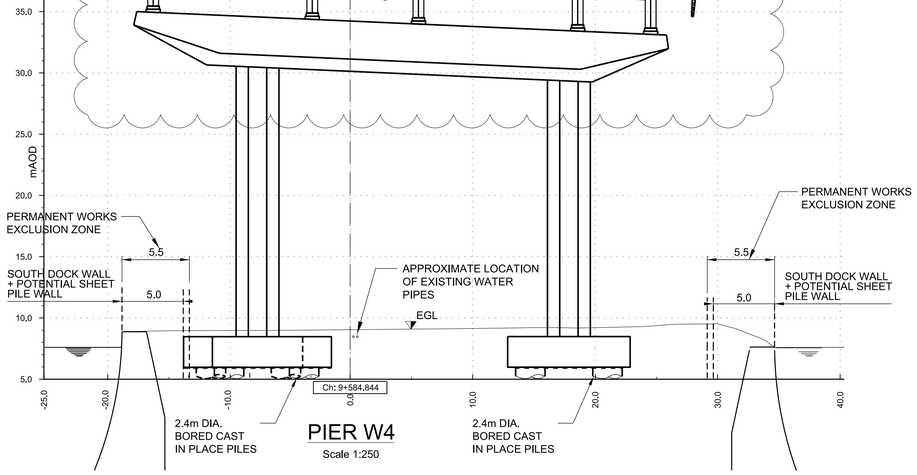
PIER W1
Scale 1:250



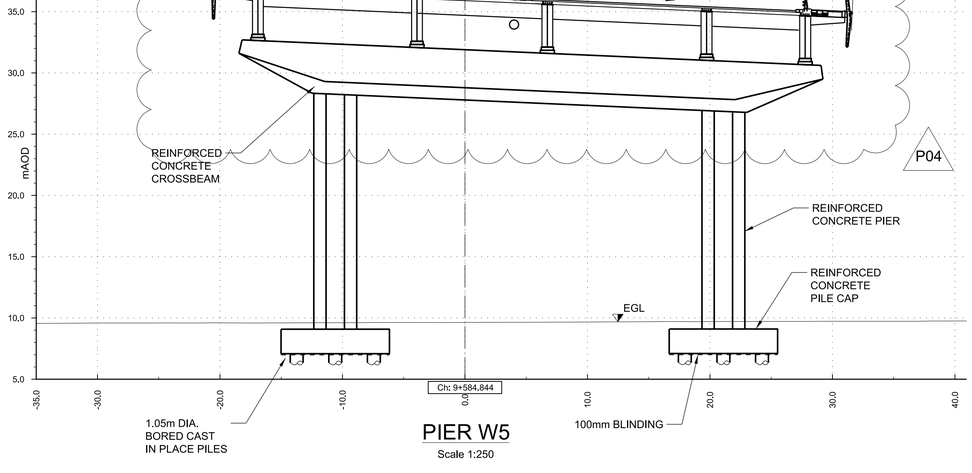
PIER W2
Scale 1:250



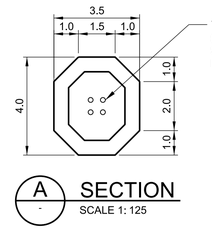
PIER W3
Scale 1:250



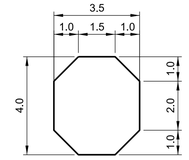
PIER W4
Scale 1:250



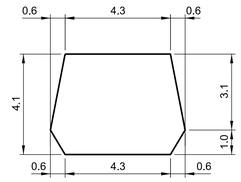
PIER W5
Scale 1:250



A SECTION
SCALE 1: 125



B SECTION
SCALE 1: 125



C SECTION
SCALE 1: 125

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1001 FOR ABBREVIATIONS.

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 significant residual risks (Reference shall also be made to the design hazard log).

Construction
None

Maintenance / Cleaning
None

Use
None

Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	29/09/16	AIP UPDATE	PDA	MYG	MYG
P04	01/12/16	AIP Update	DAW	MYG	MYG

Drawing Status: FOR COSTING
Suitability: D1

Project Team

Client: Llywodraeth Cymru / Welsh Government

Project Title: M4 CORRIDOR AROUND NEWPORT

Drawing Title: SBR 1000 - RIVER USK CROSSING SECTIONS SHEET 1 OF 4

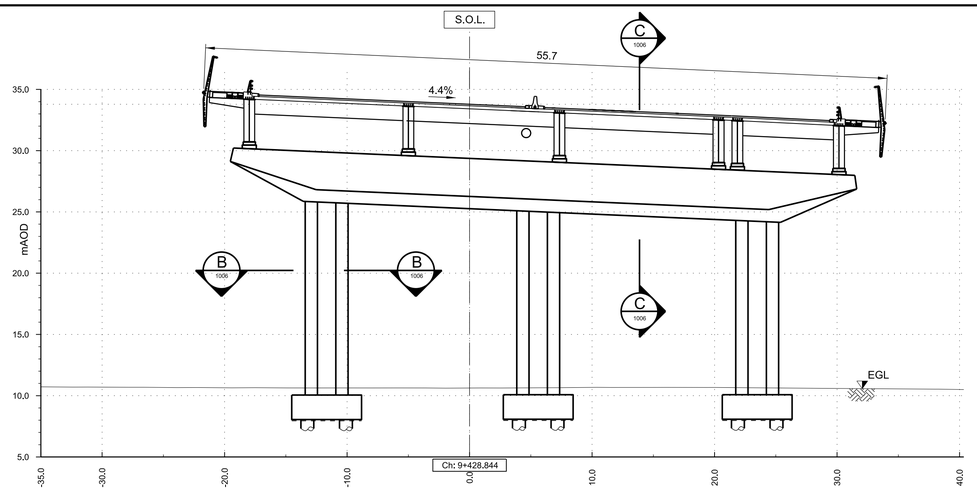
Scale	Designed / Drawn	Checked	Approved	Authorised
1:250,1:	DAW	MYG	MYG	GRD
Original Size	**Date**	**Date**	**Date**	**Date**
A1	10/11/16	13/11/16	13/11/16	01/12/16

Drawing Number: M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1006
(Project | Originator | Volume | Location | Type | Role | Number)

Revision: P04

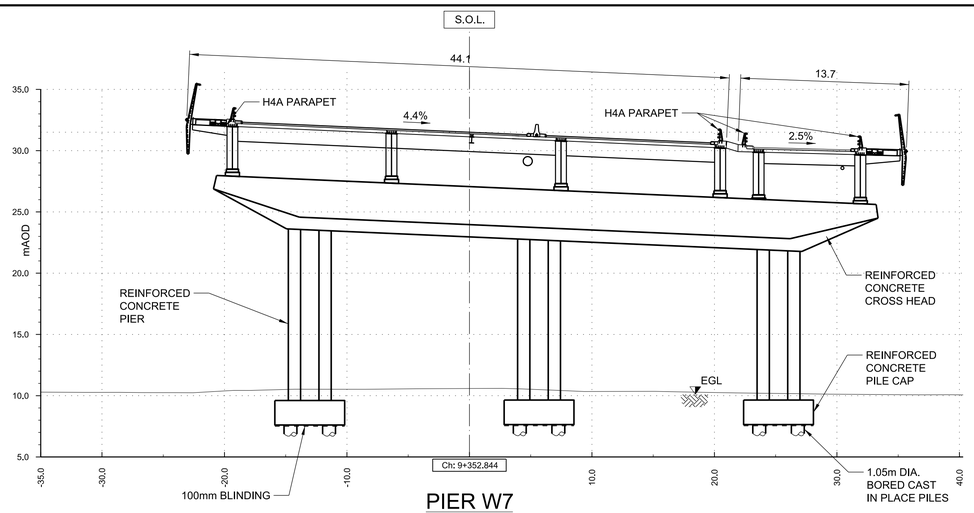
DO NOT SCALE

Millimetres 0 10 100



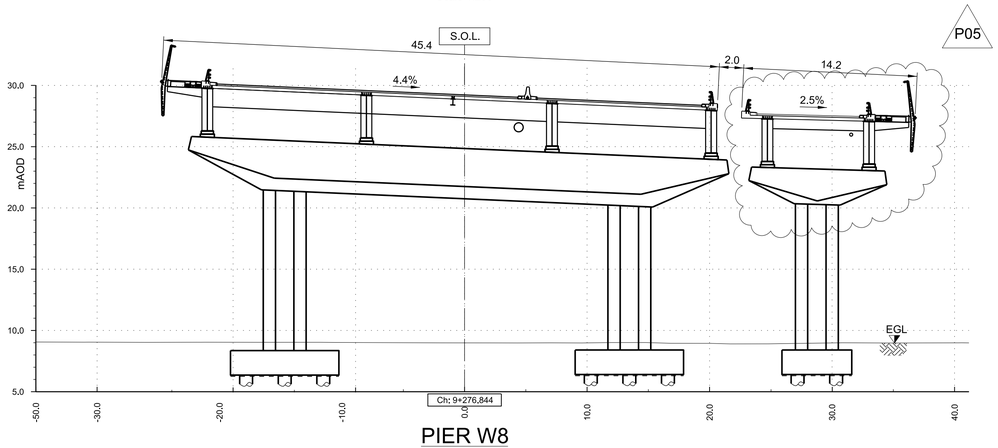
PIER W6

Scale 1:250



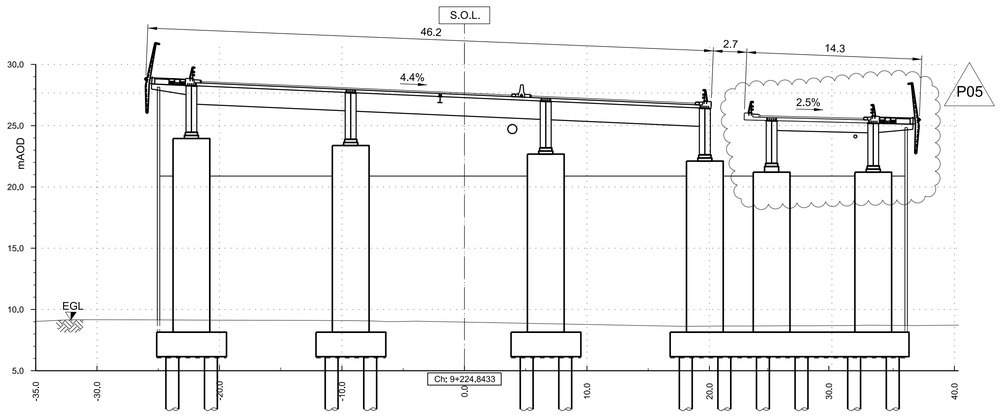
PIER W7

Scale 1:250



PIER W8

Scale 1:250



WEST ABUTMENT WA

Scale 1:250

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1001 FOR ABBREVIATIONS.

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 significant residual risks (Reference shall also be made to the design hazard log).
Construction None
Maintenance / Cleaning None
Use None
Decommissioning / Demolition None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	21/06/16	SECTIONS REMOVED	IIE	MYG	MYG
P04	01/12/16	AIP UPDATE	DAW	MYG	MYG
P05	26/01/17	Final Issue	MJW	MAH	BCS

Drawing Status: FOR COSTING
Suitability: D1

Project Team

Client: Llywodraeth Cymru Welsh Government

Project Title: M4 CORRIDOR AROUND NEWPORT

Drawing Title: SBR 1000 - RIVER USK CROSSING SECTIONS SHEET 2 OF 4

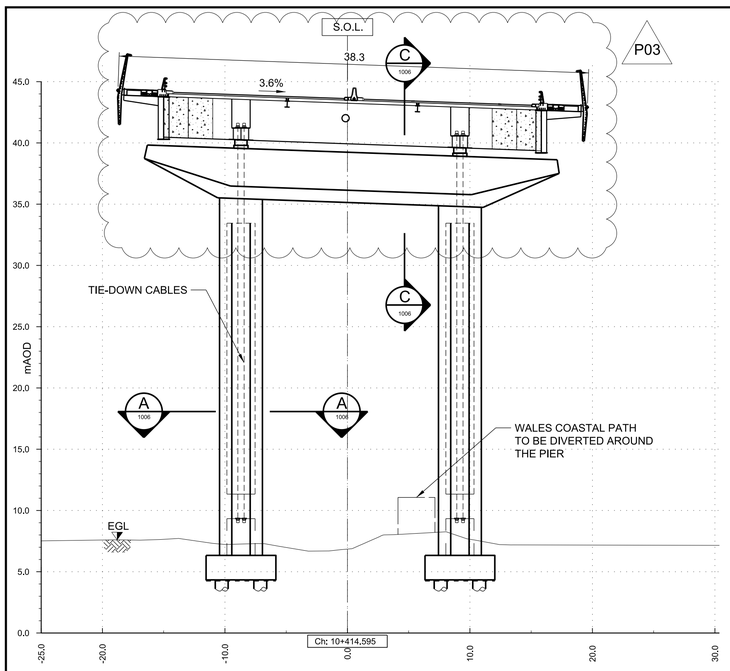
Scale	Designed / Drawn	Checked	Approved	Authorised
1:250, 1	MJW	MAH	BCS	BCS
Original Size	**Date**	**Date**	**Date**	**Date**
A1	25/01/17	25/01/17	26/01/17	26/01/17

Drawing Number: Project | Originator | Volume | Location | Type | Role | Number
M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1007

Revision: P05

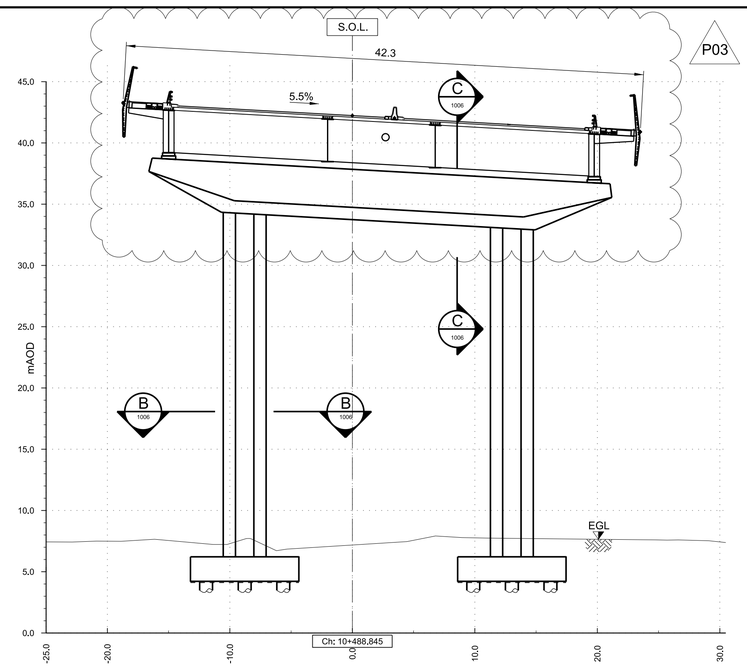
DO NOT SCALE

Millimetres 0 10 100



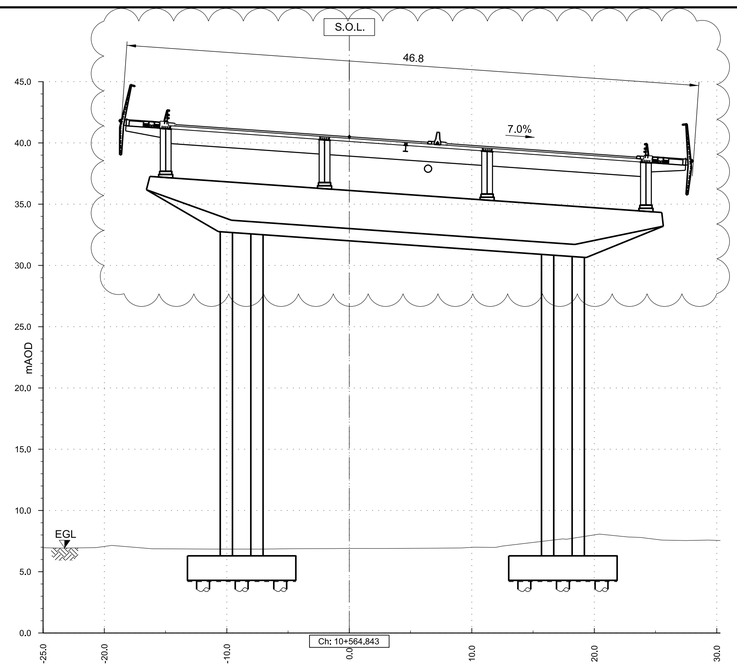
PIER E1

Scale 1:250



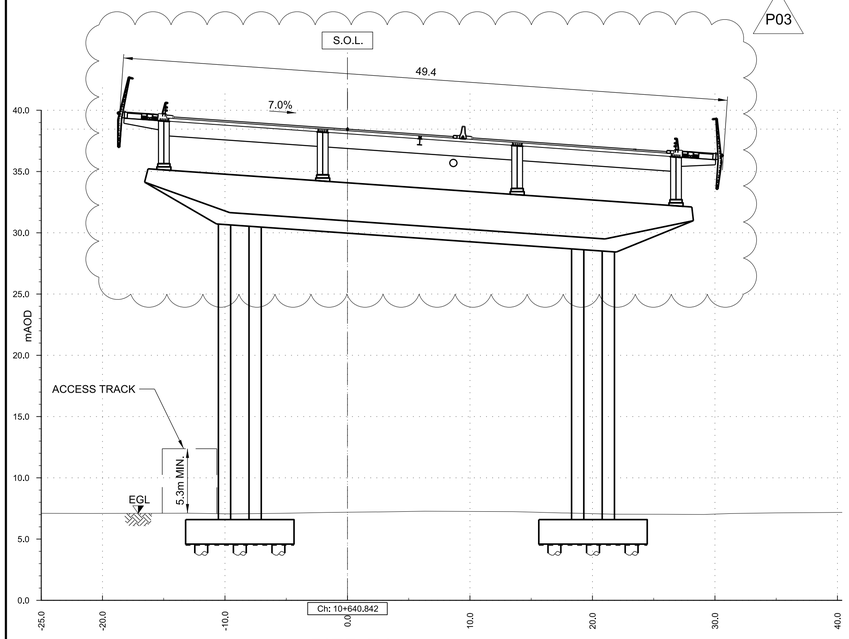
PIER E2

Scale 1:250



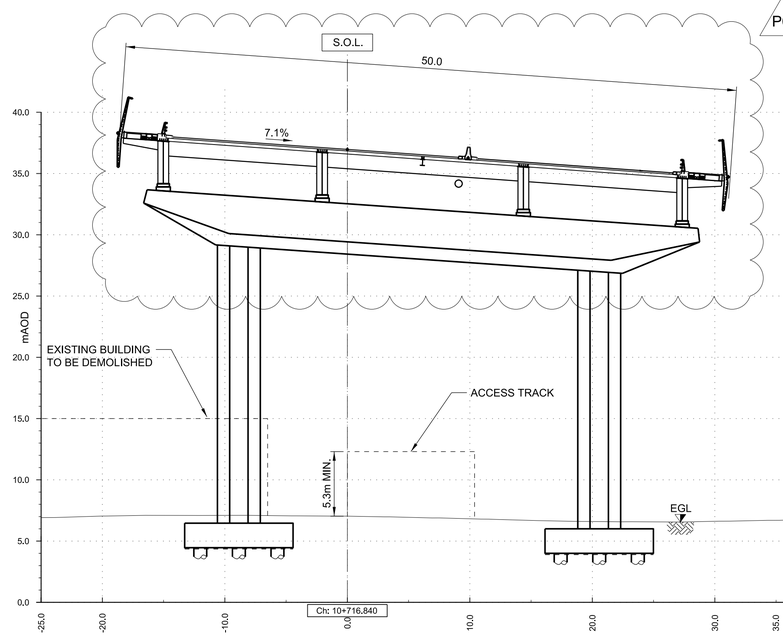
PIER E3

Scale 1:250



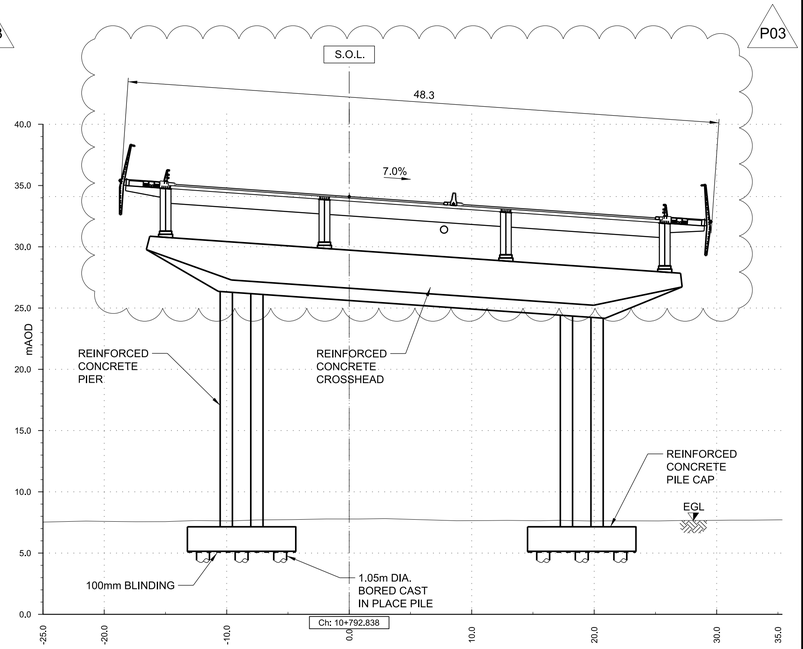
PIER E4

Scale 1:250



PIER E5

Scale 1:250



PIER E6

Scale 1:250

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING NUMBER 1001 FOR ABBREVIATIONS

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 significant residual risks (Reference shall also be made to the design hazard log).

Construction
None

Maintenance / Cleaning
None

Use
None

Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	01/12/16	AIP Update	DAW	MYG	MYG

Drawing Status: FOR COSTING
Suitability: D1

Project Team

Client: Llywodraeth Cymru / Welsh Government

Project Title: M4 CORRIDOR AROUND NEWPORT

Drawing Title: SBR 1000 - RIVER USK CROSSING SECTIONS SHEET 3 OF 4

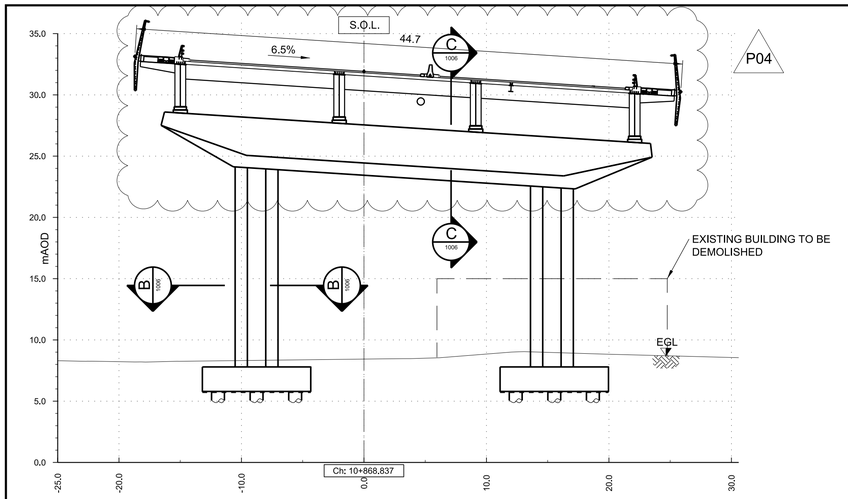
Scale	Designed / Drawn	Checked	Approved	Authorised
1:250	DAW	MYG	MYG	GRD
Original Size	**Date**	**Date**	**Date**	**Date**
A1	10/11/16	13/11/16	13/11/16	01/12/16

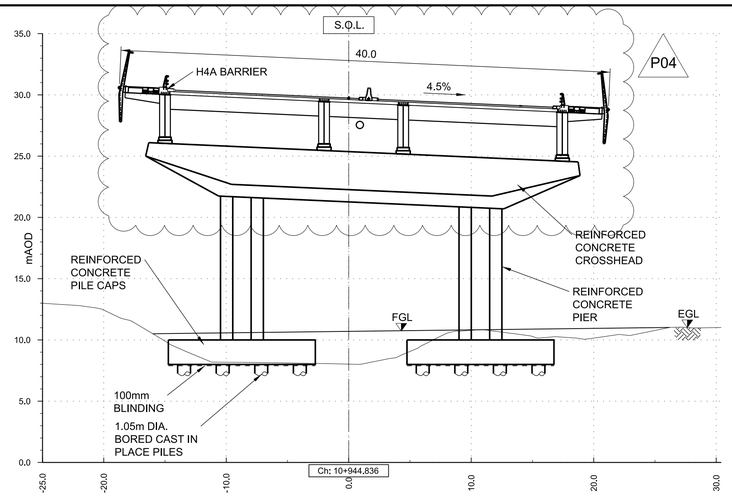
Drawing Number: Project | Originator | Volume: M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1008 (Location | Type | Role | Number)

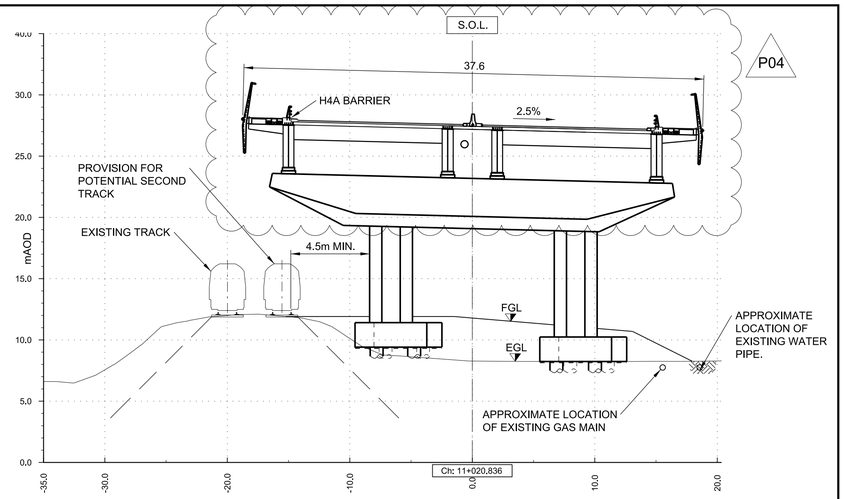
Revision: P03

DO NOT SCALE

Millimetres 0 10 100

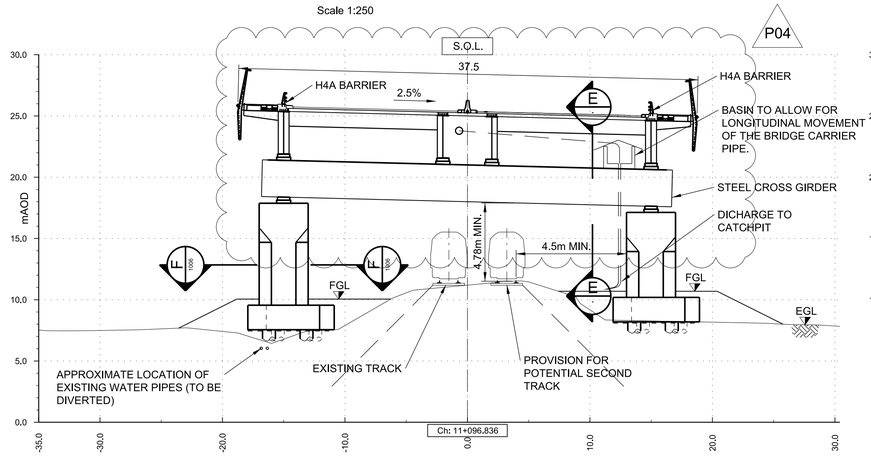






PIER E7

Scale 1:250



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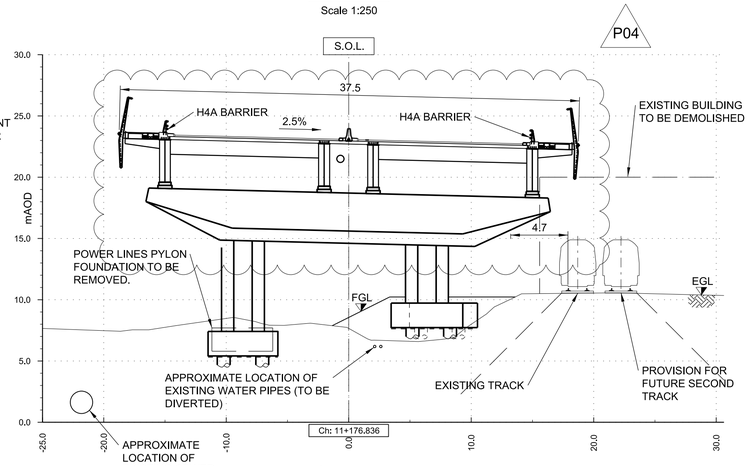

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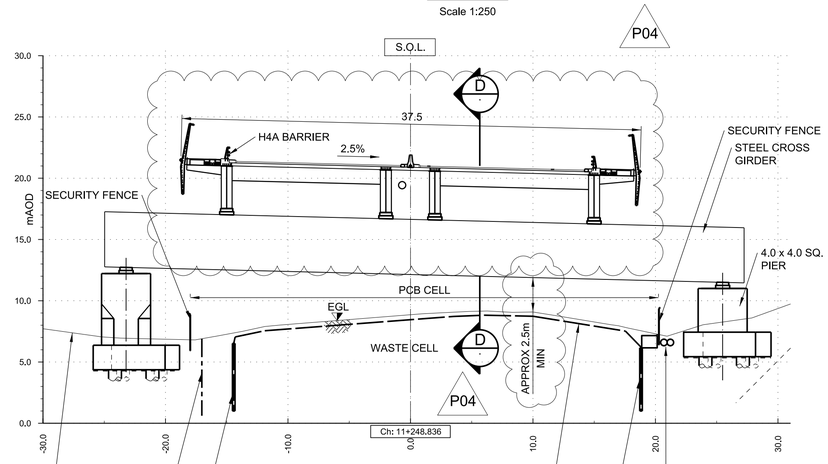

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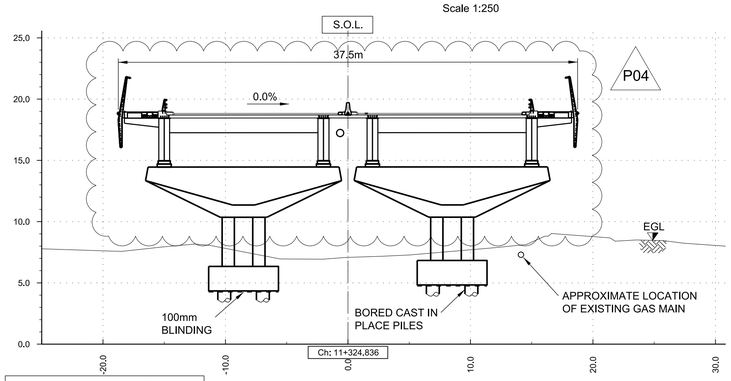

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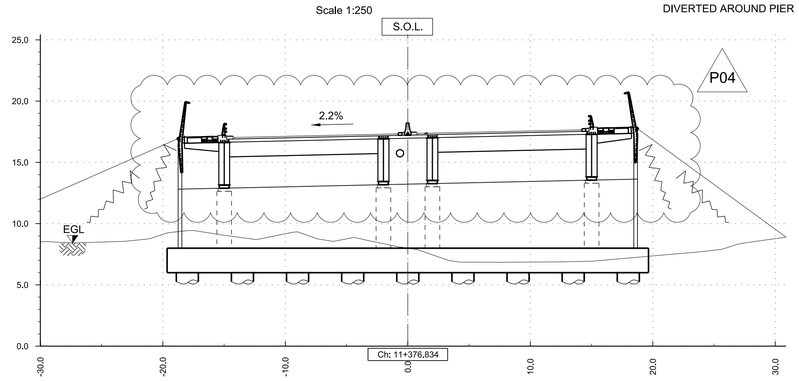
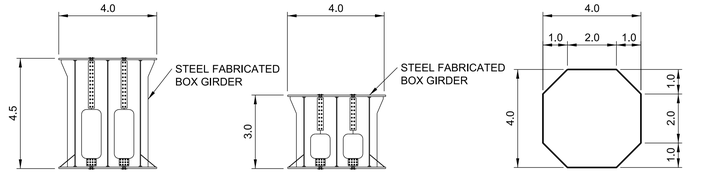


EAST ABUTMENT EA

Scale 1:250



D - SECTION SCALE 1: 125

E - SECTION SCALE 1: 125

F - SECTION SCALE 1: 125

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1001 FOR ABBREVIATIONS.
4. PCB CELL DETAILS ARE INDICATIVE AND TAKEN FROM WESTPILE DRAWING SG3339-04 REV.C

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 significant residual risks (Reference shall also be made to the design hazard log).
Construction
None
Maintenance / Cleaning
None
Use
None
Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	15/02/16	FINAL ISSUE	DAW	MAH	MYG
P04	01/12/16	AIP UPDATE	DAW	MYG	MYG

Drawing Status: FOR COSTING

Suitability: D1

Project Team

Client: Llywodraeth Cymru Welsh Government

Project Title: M4 CORRIDOR AROUND NEWPORT

Drawing Title: SBR 1000 - RIVER USK CROSSING SECTIONS SHEET 4 OF 4

Scale	Designed / Drawn	Checked	Approved	Authorised
1:250	DAW	MYG	MYG	GRD
Original Size: A1	Date: 10/11/16	Date: 13/11/16	Date: 13/11/16	Date: 01/12/16

Drawing Number: Project | Originator | Volume: M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1009; Location | Type | Role | Number

Revision: P04

DO NOT SCALE

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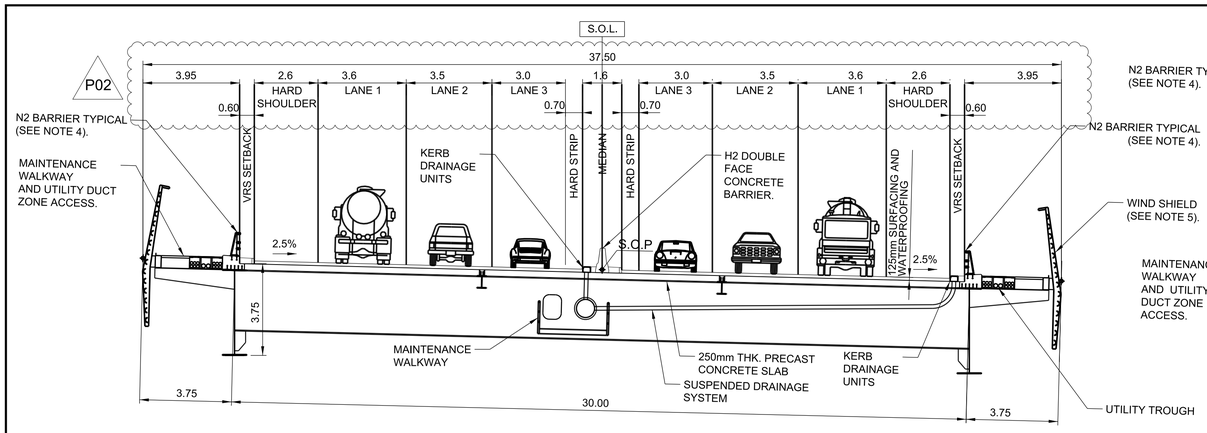
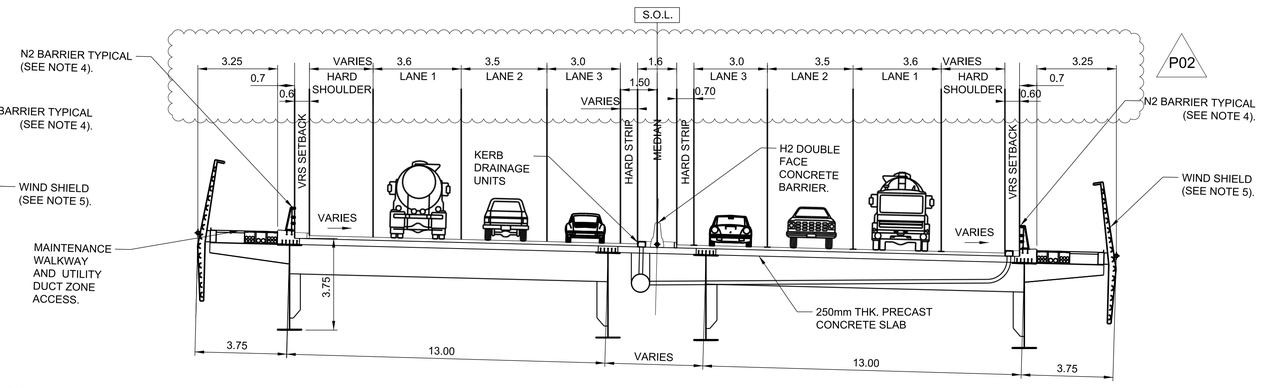


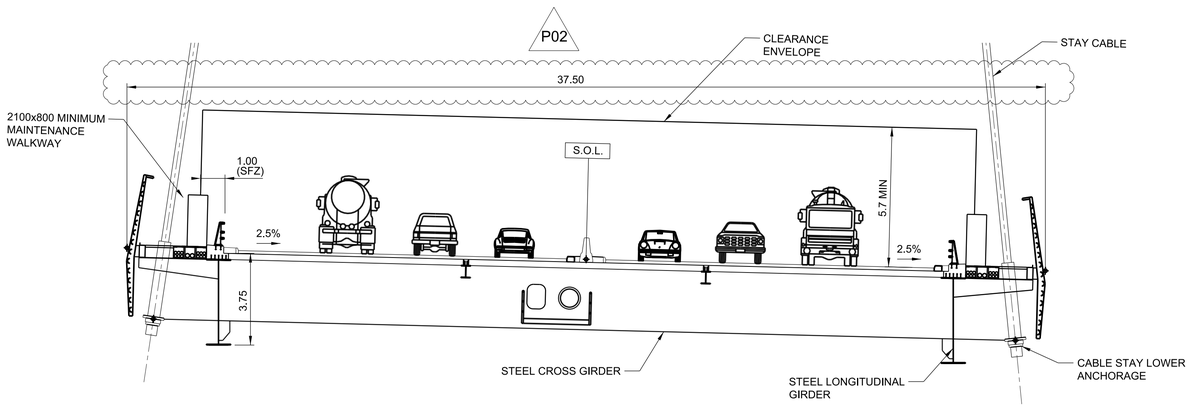
MAIN SPAN SECTION

Scale 1:125



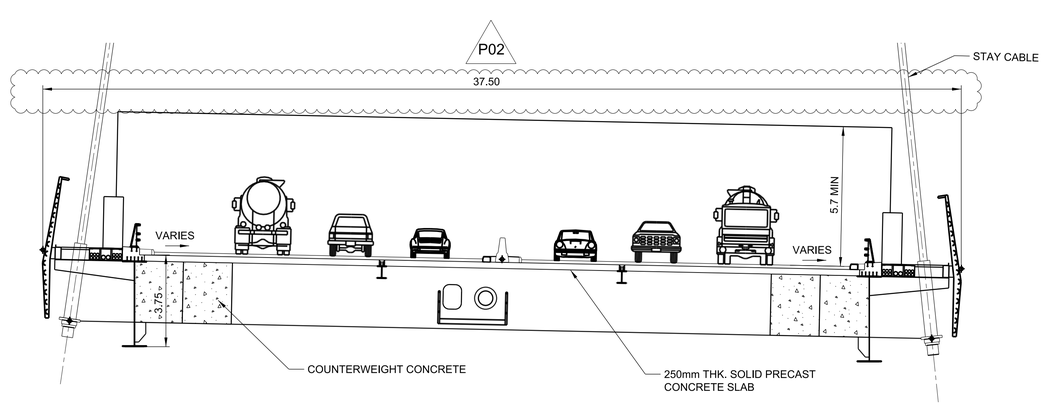
TYPICAL APPROACH VIADUCT SECTION

Scale 1:125



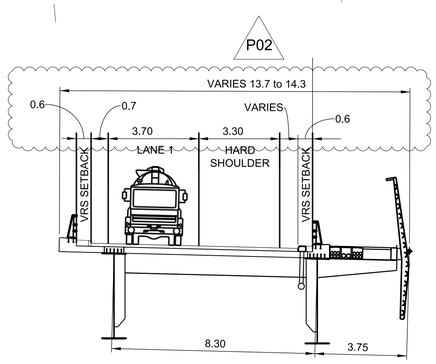
MAIN SPAN STAY CABLE SECTION

Scale 1:125



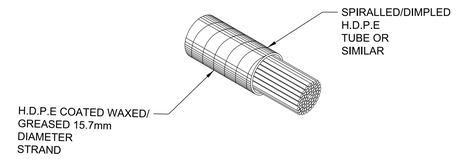
BACK SPAN STAY CABLE SECTION

Scale 1:125



SOUTHERN SLIP ROAD SECTION

Scale 1:125



TYPICAL SKETCH ON CABLE STAY

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1001 FOR ABBREVIATIONS.
4. N2 BARRIERS TYPICALLY. H4A BARRIERS REQUIRED OVER RAILWAY LINES AND ADJACENT TO THE SOLUTIA SITE. H1 BARRIERS REQUIRED AT GANTRIES.
5. WIND SHIELD IS 3M HIGH ABOVE ROAD LEVEL AND 50% POROUS AND SHALL BE PROVIDED ALONG THE FULL LENGTH OF BOTH OUTER EDGES OF THE DECK, FROM WA TO EA. THE WIND SHIELD SHALL BE DESIGNED WITH A DEGREE OF ANTI-CLIMB TO REDUCE SUICIDE RISK.

P02

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 significant residual risks (Reference shall also be made to the design hazard log).
Construction
None
Maintenance / Cleaning
None
Use
None
Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG

Drawing Status: FOR COSTING
Suitability: D1
Project Team
Client: Llywodraeth Cymru Welsh Government

Project Title: M4 CORRIDOR AROUND NEWPORT
Drawing Title: SBR 1000 - RIVER USK CROSSING DECK

Scale	Designed / Drawn	Checked	Approved	Authorised
1:125	DAW	MAH	MYG	PHP
Original Size	Date	Date	Date	Date
A1	09/10/15	12/10/15	13/10/15	16/10/15

Drawing Number: Project | Originator | Volume
M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1010
Location | Type | Role | Number
Revision: P02

DO NOT SCALE

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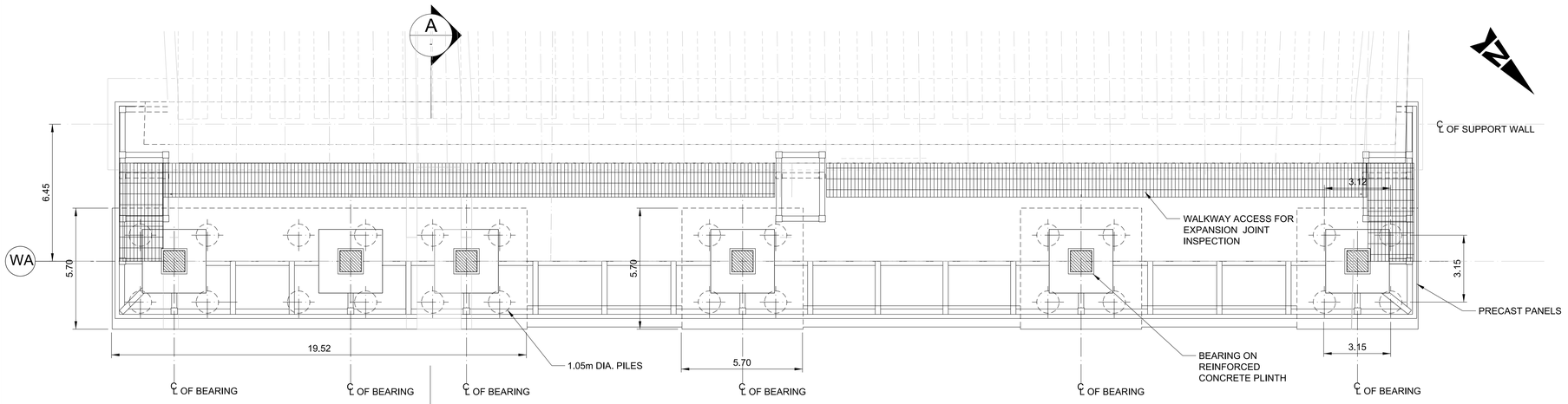
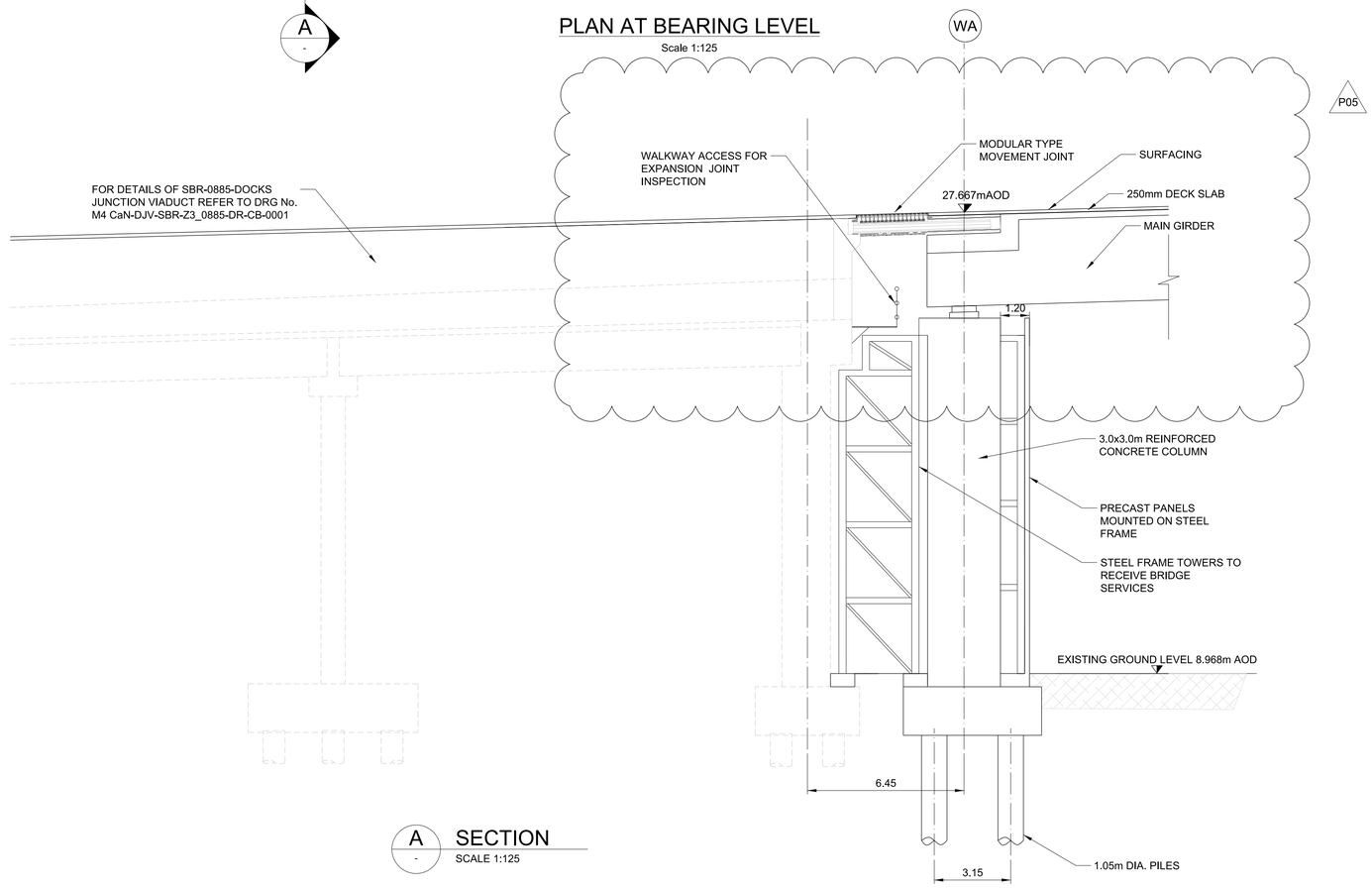


PLAN AT BEARING LEVEL

Scale 1:125



A SECTION

A
-

SCALE 1:125

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1001 FOR ABBREVIATIONS

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 significant residual risks (Reference shall also be made to the design hazard log).

Construction
None

Maintenance / Cleaning
None

Use
None

Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	21/06/16	WEST ABUTMENT REVISED	IIE	MYG	MYG
P04	29/09/16	AIP UPDATE	PDA	MYG	MYG
P05	02/12/16	AIP UPDATE	DAW	MYG	MYG

Drawing Status: FOR COSTING

Suitability: D1

Project Team

Client: Llywodraeth Cymru Welsh Government

Project Title: M4 CORRIDOR AROUND NEWPORT

Drawing Title: SBR 1000 - RIVER USK CROSSING WEST ABUTMENT

Scale	Designed / Drawn	Checked	Approved	Authorised
1:100	DAW	MYG	MYG	GRD
Original Size	**Date**	**Date**	**Date**	**Date**
A1	10/11/16	13/11/16	13/11/16	02/12/16

Drawing Number: Project | Originator | Volume | Location | Type | Role | Number
M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1011

Revision: P05

DO NOT SCALE

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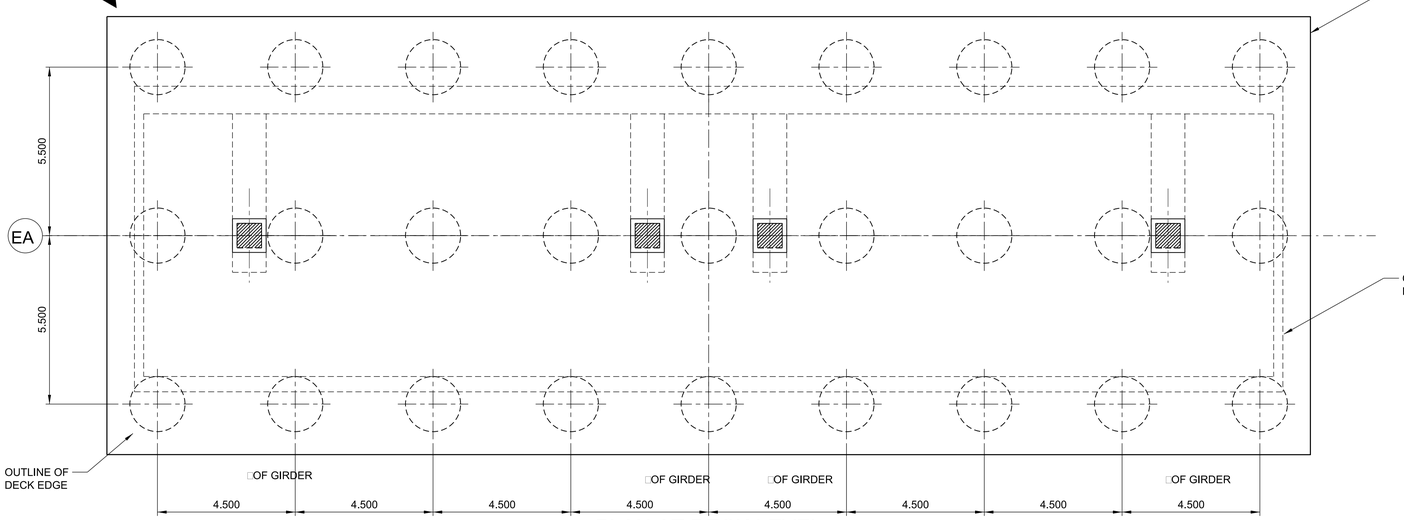
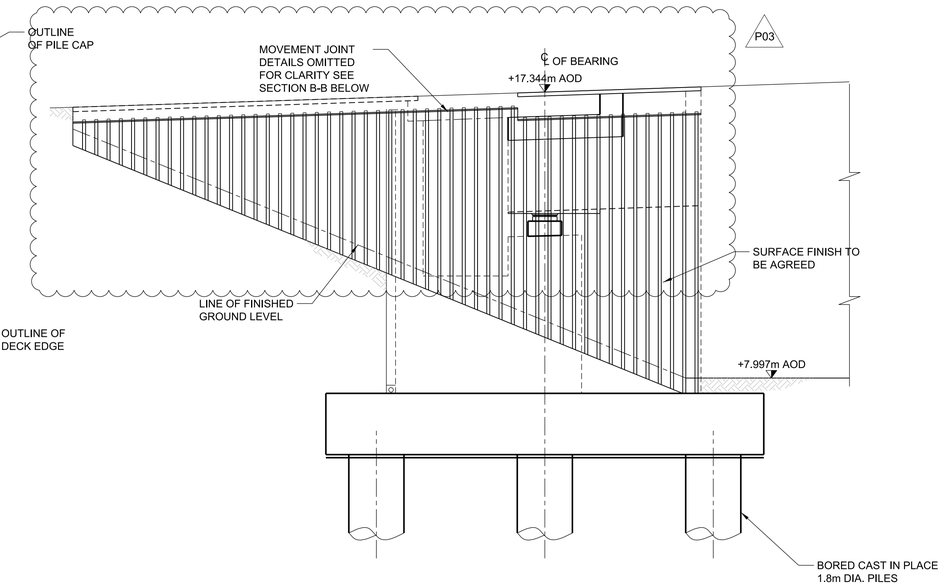


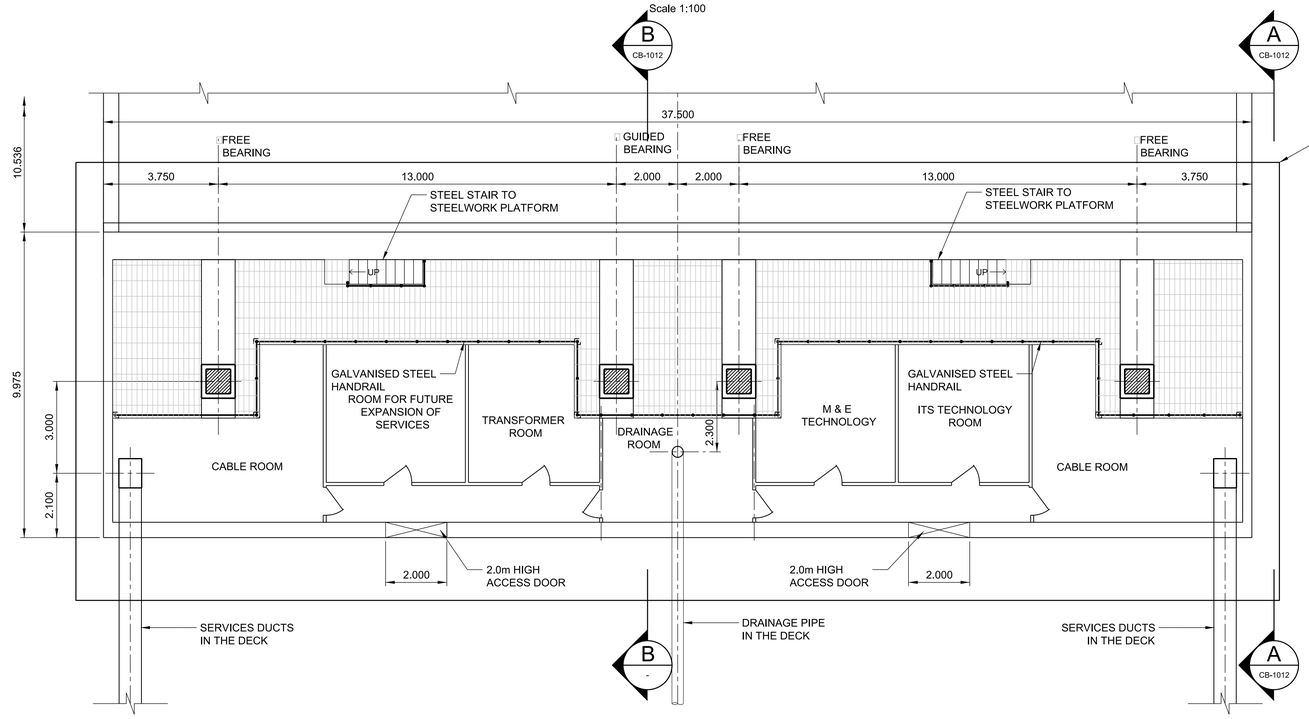
PLAN AT DECK LEVEL

Scale 1:100



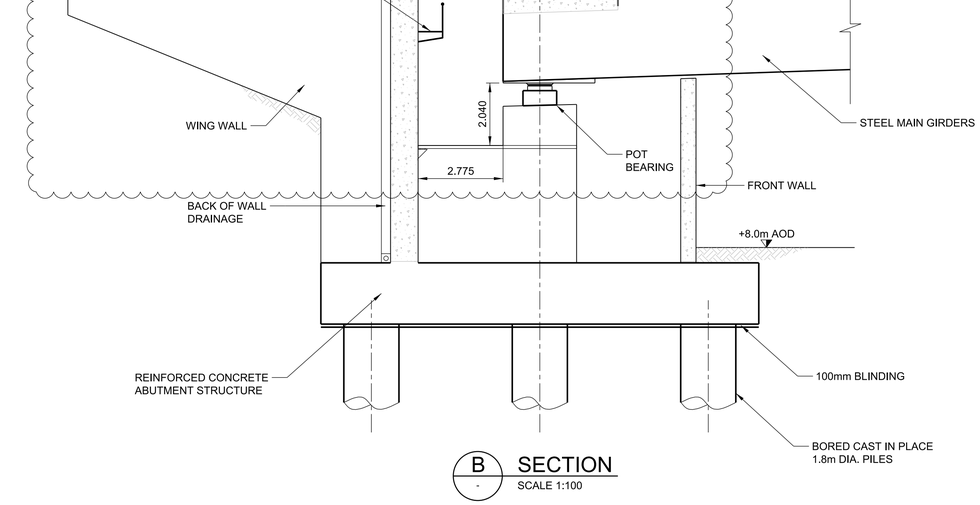
A - ELEVATION

SCALE 1:100



PLAN AT BEARING LEVEL

Scale 1:100



B - SECTION

SCALE 1:100

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED, DO NOT SCALE.
3. REFER TO DRAWING 1001 FOR ABBREVIATIONS.

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 significant residual risks (Reference shall also be made to the design hazard log).

Construction
HIGH LEVEL OF GROUND CONTAMINATION ARE KNOWN TO BE IN THE AREA

Maintenance / Cleaning
None

Use
None

Decommissioning / Demolition
None

Rev.	Date	Description	By	Chk'd	App'd
P01	24/07/15	FIRST ISSUE	SKA	MAH	MYG
P02	16/10/15	SECOND ISSUE	DAW	MAH	MYG
P03	01/12/16	AIP Update	DAW	MYG	MYG

Drawing Status: FOR COSTING
Suitability: D1

Project Team

Client: Llywodraeth Cymru Welsh Government

Project Title: M4 CORRIDOR AROUND NEWPORT

Drawing Title: SBR 1000 - RIVER USK CROSSING EAST ABUTMENT

Scale	Designed / Drawn	Checked	Approved	Authorised
1:100	DAW	MYG	MYG	GRD
Original Size	**Date**	**Date**	**Date**	**Date**
A1	10/11/16	13/11/16	13/11/16	01/12/16

Drawing Number: M4CaN - DJV - SBR - Z3_GEN - DR - CB - 1012
(Project | Originator | Volume | Location | Type | Role | Number)

Revision: P03

Appendix C– Geotechnical Summary Sheet

Form C
Highway Structure Summary Information Sheet
Usk Crossing SBR1000

CHAINAGE INTERVAL:	9+140 to 11+400	TYPE:	River bridge and approach viaducts	REFERENCES /COMMENTS
AIP REF No:	M4CaN-DJV-SBR-Z3_1000-RP-CB-0001	DESIGN LIFE:	120 years	
RELEVANT EXPLORATORY HOLES				
F4, F5, F6, G1, G2, G3, G4, G5, G6				Ground Investigation. M4 Relief Road for The Welsh office. NR/SR/F10895. Norwest Holst Soil Engineering Ltd. April 1998
419, 420, 421, 422, 423, 424, 425, 426				M4 Corridor around Newport Factual Report on Ground Investigation, Geotechnical Engineering Ltd Report Ref:30238, July 2015
LOCATION-SPECIFIC GROUND PROFILE				
STRATA	DEPTH TO BASE (m)	STRATA DESCRIPTION		
Made Ground	0 to 3	Sandy gravel with brick, rubble, slag		Limited test data for Mercia Mudstone. SPTs below upper 1 to 2m only carried out in 1998 investigation giving profile at G3, otherwise widely spaced. Inconsistent borehole log descriptions between 1998 and 2015 investigations. The implied strength from the 2015 descriptions is lower than from the 1998 investigation results. Preliminary foundation sizing has been based on the available SPT data. Further investigation and testing will be required to resolve the inconsistencies between the existing investigations. An exploratory hole location plan and geological long section are attached.
Estuarine Alluvium	12.5 to 17	Very soft to soft silty clay		
Fluvial Alluvium	absent to 23	Dense to very dense sandy gravel with cobbles		
Mercia Mudstone	up to 64 proven	Variably weathered. 1998 investigation describes as very weak to moderately weak, completely to slightly weathered. Highly and moderately weathered mudstone with closely spaced fractures to completely fractured. 2015 logs identify as predominantly weathering grade II or III. Zones of weathering Grade III described as stiff, very stiff or hard gravelly clay.		
PREVIOUS GROUND HISTORY	Newport Docks development history is described in the PSSR. Potential contaminated land sites are summarised in Table 12 of the GIR.			

CONTAMINATION RISK ASSESSMENT	To be included in the GDR.	
GROUNDWATER	The river Ebbw is tidal with MHWS at 6.3mOD and MLWS at -5.3mOD. Results of groundwater monitoring and groundwater levels are discussed in Section 6.18 of the GIR.	

SPREAD FOUNDATION DESIGN

STRUCTURE ELEMENT	BASE (mOD)	FOUNDING STRATUM	FOOTING SIZE (m)	'ALLOWABLE' BEARING PRESSURE (kN/m^2)
N/A	N/A	N/A	N/A	N/A

PRELIMINARY PILE DESIGN

The design of the piles will be detailed in the GDR. The preliminary design given here is subject to review following completion of the 2015-16 supplementary ground investigation and further design development.

PILE TYPE:	Bored cast in situ
CRITERIA FOR TOE:	Rock socket into Mercia Mudstone
NEG. SKIN FRICTION:	To be addressed in detailed design

STRUCTURE ELEMENT	TOE LEVEL (mOD)	FOUNDING STRATUM	LENGTH[1] (m)	DIAMETER (m)	ULS DESIGN LOAD[2] (kN)
West abutment WA	-20	Mercia Mudstone	26	1.05	5000
Pier W8	-29	Mercia Mudstone	35	1.05	10200
Pier W7	-29	Mercia Mudstone	35	1.05	10200
Pier W6	-29	Mercia Mudstone	35	1.05	10200
Pier W5	-26	Mercia Mudstone	32	1.05	8600
Pier W4	--30	Mercia Mudstone	36	2.4	26500
Pier W3	-32	Mercia Mudstone	38	2.4	26500
Pier W2	-22	Mercia Mudstone	28	1.05	5800
Pier W1	-22	Mercia Mudstone	28	1.05	-1600/6000
West tower WT	-42	Mercia Mudstone	45	2.1	33600
East tower ET	-42	Mercia Mudstone	43	2.1	33600
Pier E1	-22	Mercia Mudstone	26	1.05	-1600/6000
Pier E2	-22	Mercia Mudstone	26	1.05	5800
Pier E3	-23	Mercia Mudstone	27	1.05	8600
Pier E4	-23	Mercia Mudstone	27	1.05	8600
Pier E5	-23	Mercia Mudstone	27	1.05	8600
Pier E6	-23	Mercia Mudstone	27	1.05	8600
Pier E7	-23	Mercia Mudstone	28	1.05	8600

Pier E8	-21	Mercia Mudstone	29	1.05	7800	
Pier E9	-21	Mercia Mudstone	30	1.05	7800	
Pier E10	-22	Mercia Mudstone	31	1.05	7900	
Pier E11	-21	Mercia Mudstone	29	1.05	7900	
Pier E12	-24	Mercia Mudstone	28	1.05	7900	
Pier E13	-20	Mercia Mudstone	24	1.05	6000	
East abutment EA	-19	Mercia Mudstone	23	1.8	6600	

SETTLEMENT

STRUCTURE ELEMENT	**BASE (mAOD)**	**IMMED'TE (mm)**	**TOTAL (mm)**	**90% (Months)**	**REMAINING (mm)**	To be confirmed at detailed design.
DIFFERENTIAL (mm):				See AIP Section 6.3		

CHEMICAL ANALYSIS

SPECIES	**2:1 EXTRACT**	**SOIL**	**WATER**	**OTHER**	Results of chemical analysis are presented in the GIR Section 6.20.
$SO_4^-/S^{2-}/S$:					
CHLORIDE:					
pH:					
Mg:					
REDOX:					
BRE SD1 CLASSES (DS/ACEC/DC):			To be determined in the GDR		

OTHER DESIGN FEATURES (e.g. foundation treatment/hazards)

Eastern approach embankment to bridge to be piled with load transfer platform.
Consideration of potential erosion/instability of the east river bank and any impact on the tower foundation design to be addressed in detailed design.
Dock wall failure and ship impact on dock wall at piers W3 and W4 to be taken into account in detailed design.

NOTES

[1]Length below underside of pile cap
[2]ULS Design Load with Set C/combination 1 load factors

.

Appendix D– CDM Hazard Log

M4 CaN - M4 Corridor around Newport
Design Hazard Log - Key Stage 3 - Preliminary Design
M4 CaN-ATK-GEN-01_GEN-DO-C-0003

Notes:
1. This Design Hazard Log does not use conventional risk scoring. In its place is a requirement to determine whether the residual risk is "Significant"
2. The Design Hazard Log should be used in conjunction with the RAG List dated November 2008 (See "RAG List" sheet)
3. The provision of items on the Red and Amber Lists does not remove from the designer any obligation to identify and assess hazards and risks specific to the project
4. Refer also to Guidance Worksheet
5. Risks not on the RAG list should be compared with Red and Amber items on the list to help judge their risk rating

Ref No.	Ref Code (use File naming on PW)	Discipline	Date	Designer (Name)	Hazard / Risk	Location	Specific Location Description	RAG Item No. and abbreviated description (Click here to see list and full description)	Risk Rating Red - Extreme, Amber - Significant or Not Significant	Project Stage	PART B - RISK ELIMINATION /	Date design measure suggested	Can the risk be eliminated	If a Green RAG list item employed to significantly reduce risk, list it here (Click here to see green list of preferred materials, elements and processes)	Designer measures taken and considered to eliminate or reduce risk	RESIDUAL RISK	Risk Rating Red - Extreme, Amber - Significant or Not Significant	Residual risk information to pass onto Contractor	Means of communicating significant residual risk (RED and Amber items will go into PCI and drawings)
808	SBR	Structures	17 Jul '15	MH	Contaminated ground may be present during foundation construction	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Amber - Significant**	C		17 Jul '15	Yes	None applicable	If the GI shows contaminated ground, soil remediation methods to be used or methods/design altered to avoid disturbance of contaminated areas.		**Not Significant**	Risk reduced to acceptable levels. Normal construction hazards to be managed by Contractor	Employer's Requirements to include dealing with contaminated land. Risk must be mitigated in method statement.
809	SBR	Structures	17 Jul '15	MH	Hazards associated with tower construction including falls from height and dropped objects	Section 3 - Usk Crossing	Cable-stayed Bridge	G5 - Early installation of permanent means of access, with hand rails or edge protection	**Red - Extreme**	C		17 Jul '15	No	G5 - Early installation of permanent means of access, with hand rails or edge protection	Use of simple cross-section improves buildability and reduces time spent at height Preformed steel anchor box reduces time spent at height Use jump formwork to construct tower to reduce the time and number of operatives working at height. Install permanent access as soon as practical		**Amber - Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
810	SBR	Structures	17 Jul '15	MH	Hazards associated with deck construction by cantilever methods including: falls from height, droped objects, hot works and lifting large deck units	Section 3 - Usk Crossing	Cable-stayed Bridge	G19 - Designer to consider lifting operation feasibility of and risks	**Red - Extreme**	C		17 Jul '15	No	G19 - Designer to consider lifting operation feasibility of and risks	Standardise beam cross section to maximise amount of welding done in fabrication yard. Temporary deck bracing to be specified if required. Precast deck panels minimise time spent at height. Lightweight ladder beam deck section reduces lifting weight.		**Amber - Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
811	SBR	Structures	17 Jul '15	MH	Falls from height or dropped objects during the construction of stays	Section 3 - Usk Crossing	Cable-stayed Bridge	G19 - Designer to consider lifting operation feasibility of and risks	**Red - Extreme**	C		17 Jul '15	Yes	G19 - Designer to consider lifting operation feasibility of and risks	Stay anchorages positioned so that stressing is carried out in a protected space for the upper anchorage region.		**Not Significant**	Risk reduced to acceptable levels	
812	SBR	Structures	17 Jul '15	MH	Stability of crane on soft ground during lifting operations	Section 3 - Usk Crossing	Cable-stayed Bridge	G19 - Designer to consider lifting operation feasibility of and risks	**Red - Extreme**	C		17 Jul '15	Yes	G19 - Designer to consider lifting operation feasibility of and risks	Lifting operations within site minimised using cantilever deck erection methods		**Amber - Significant**	Hazards associated with soft ground still remains.	Heavy lifts to be identified on drawings
813	SBR	Structures	17 Jul '15	MH	Hazards associated with ancillary item installation (parapets, wind shields, platforms, stairs, etc) including hand-arm vibration, manual handling and dropped objects	Section 3 - Usk Crossing	Cable-stayed Bridge	G4 - Avoid drilling by specifying pre-cast fixings in concrete	**Red - Extreme**	C		17 Jul '15	Yes	G4 - Avoid drilling by specifying pre-cast fixings in concrete	Lighting column fixings have been integrated with wind shield support structure. Specify cast in anchors where practicable. Parapet and vehicle barrier fixings to be cast in cradles. Integrate wind barrier fixings with temporary edge protection fixings.		**Not Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
814	SBR	Structures	17 Jul '15	MH	Impregnation of concrete surfaces within road splash zone: Silane impregnation is highly toxic and flammable. It is skin, eye and respiratory irritant.	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Amber - Significant**	C		17 Jul '15	Yes	None applicable	Specification of silane free impregnation such as PAVIX CCC100.		**Not Significant**	None.	
815	SBR	Structures	17 Jul '15	MH	Impregnation of buried concrete surfaces: Exposure to bitumen paint, a flammable material. It may cause lung damage if swallowed. Repeated exposure may cause skin dryness or cracking. Vapours may cause drowsiness and dizziness	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Amber - Significant**	C		17 Jul '15	No	None applicable	No measures available		**Amber - Significant**	Normal construction hazards to be managed by Contractor	
816	SBR	Structures	17 Jul '15	MH	Hazards associated with the preparation of surfaces and application of painting systems on site including working at height and hazards to health from solvents, resins, hardeners etc present in paints.	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	C		17 Jul '15	No	None applicable	All steel elements are designed to be painted as a part of fabrication process in controlled environment where access is not limited and safe.		**Not Significant**	Hazards associated with preparation of surfaces and application of painting systems remain.	
817	SBR	Structures	17 Jul '15	MH	Collapse during deck construction	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Use of ladder beam deck to reduce deck segment weights and lower lifting loads. Temporary deck bracing to be specified where required.		**Amber - Significant**	Normal construction hazards to be managed by Contractor	

Issue: 2
Printed: 23/01/2017

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818	SBR	Structures	17 Jul '15	MH	Hazards associated with construction over water (River Usk) including falls from height, drowning and water borne diseases	Section 3 - Usk Crossing	Cable-stayed Bridge	G19 - Designer to consider lifting operation feasibility of and risks	**Red - Extreme**	C		17 Jul '15	Yes	G19 - Designer to consider lifting operation feasibility of and risks	Towers located outside of wetted channel to reduce working above water however hazard of working at height and above mud flats remain.		**Amber - Significant**	1. Hazard of working at height remains 2. Hazard of working above water, mud and land remains 3. Hazard of water borne diseases remains 4. Construction hazards to be managed by Contractor	
819	SBR	Structures	17 Jul '15	MH	Risk of collision with traffic from working adjacent to live carriageways (East Way Road adjacent to the West Tower)	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Tower and pier locations have been designed to leave a minimum clearance to local roads. Simple tower and pier geometry simplifies construction and minimises time spent working adjacent to live carriageways.		**Amber - Significant**	Normal construction hazards to be managed by Contractor	
820	SBR	Structures	17 Jul '15	MH	Damage to eyes or cuts to flesh from cutting of metalwork walkways	Section 3 - Usk Crossing	Cable-stayed Bridge	G18 - Prevent work at height by constructing bridges off site / at grade	**Amber - Significant**	C		17 Jul '15	No	G18 - Prevent work at height by constructing bridges off site / at grade	Hazard still remains		**Not Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
821	SBR	Structures	17 Jul '15	MH	Collapse due to aerodynamic instability during construction	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Wind tunnel testing will be carried out to assess stability of structure under wind loading and optimise deck cross section. Maximum permitted wind speeds to be specified for construction.		**Amber - Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	Maximum permitted wind speeds during deck segment placement to be given on construction drawings
822	SBR	Structures	17 Jul '15	MH	Loss of deck segment during deck cantilever construction	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Design to allow for a 100% dynamic amplification factor of the loads occurring due to loss of a deck segment		**Amber - Significant**	Risk reduced to acceptable levels	
823	SBR	Structures	17 Jul '15	MH	Hazards associated with prestressing in towers deck crossbeam including falls from height and injury during stressing operations	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Amber - Significant**	C		17 Jul '15	No	None applicable	Number of stressing cables minimised through efficient design.		**Not Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
824	SBR	Structures	17 Jul '15	MH	Hazards associated with the construction of east tower foundations and cofferdam in salt marsh including instability of temporary works and flooding	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	C		17 Jul '15	No	None applicable	Hazard still remains		**Amber - Significant**	Hazards associated with instability of temporary works and flooding remain.	
825	SBR	Structures	17 Jul '15	MH	Instability or collapse of tower jump forms	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	C		17 Jul '15	No	None applicable	Use of a simple tower cross section simplifies layout, construction and operation of jump forms.		**Amber - Significant**	Risk to be managed by specialist jump form manufacturer & subcontractor.	
826	SBR	Structures	17 Jul '15	MH	Instability or collapse during the construction of horizontal diaphragms in towers	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Minimise weight of diaphragm, taking account of structural requirements.		**Amber - Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
827	SBR	Structures	17 Jul '15	MH	Hazards associated construction above and adjacent to East Port Rail including electrocution, collision with train movement and slips, trips and falls working on tracks	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Pier locations designed to achieve minimum 4.5m horizontal clearance to railway lines. Working procedures from railways owners to be identified and allowed for during design development.		**Amber - Significant**	Hazards associated with construction above and adjacent to railway lines still remain.	Presence of rail lines to be marked on drawings.
828	SBR	Structures	17 Jul '15	MH	Hazards associated with the interface with ABP activities such as ABP lifting operations clashing with structure, storage of hazardous materials and unforeseen surcharge loading from stored materials	Section 3 - Usk Crossing	Cable-stayed Bridge	G1 - Minimise vehicle reversing requirements	**Red - Extreme**	C		17 Jul '15	No	G1 - Minimise vehicle reversing requirements	Structure design for surcharge loading to be agreed. Identify clearance zones adjacent to bridge structure. Agree with ABP what materials can be stored and at which locations		**Amber - Significant**	Hazards associated with ABP activities still remain.	Employer's Requirements to state that all operations must be agreed with ABP. Operation and Maintenance Manual to detail restrictive covanent agreed with ABP
829	SBR	Structures	17 Jul '15	MH	Collapse due to aerodynamic instability in service	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	O		17 Jul '15	No	None applicable	Wind tunnel testing carried out to confirm design assumptions and optimise cross section to prevent dynamic instability		**Amber - Significant**	Hazards associated with aerodynamic instability still remain.	Operation and Maintenance Manual to include requirements for bridge monitoring.

Issue: 2
Printed: 23/01/2017

M4 CaN - M4 Corridor around Newport
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830	SBR	Structures	17 Jul '15	MH	Disproportionate bridge collapse as a result of accidental stay loss	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	O		17 Jul '15	Yes	None applicable	Design bridge to accommodate the loss of one stay. Dynamic effect to be accounted for.		**Amber - Significant**	Risk reduced to acceptable levels.	
831	SBR	Structures	17 Jul '15	MH	Disproportionate bridge collapse as a result of vehicles on the structure colliding with structural members (tower and cable stays) at deck level	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	O		17 Jul '15	Yes	None applicable	Design bridge to accommodate the loss of one stay. Dynamic effect to be accounted for. Road restraint system provided in central reserve and verges in accordance with TD 19.		**Amber - Significant**	Risk reduced to acceptable levels.	
832	SBR	Structures	17 Jul '15	MH	Disproportionate bridge collapse as a result of vehicles travelling on roads under colliding with support members at ground level	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	O		17 Jul '15	Yes	None applicable	Locate piers further than 4.5m from existing carriageways. Design of substructures for residual collision loads.		**Amber - Significant**	Risk reduced to acceptable levels.	
833	SBR	Structures	17 Jul '15	MH	Disproportionate bridge collapse as a result of vehicles travelling on roads under colliding with the deck superstructure	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	O		17 Jul '15	Yes	None applicable	Provide sufficient vertical clearance for roads under crossing. Design of superstructure for collision loads		**Amber - Significant**	Risk reduced to acceptable levels.	
834	SBR	Structures	17 Jul '15	MH	Damage to structure caused by a vehicle fire on the deck or below	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	O		10 Feb '16	No	None applicable	Produce a Fire Hazard Assessment		**Amber - Significant**	Risk reduced to acceptable levels.	Evacuation procedures to be given in Operation and Maintenance Manual.
835	SBR	Structures	17 Jul '15	MH	Disproportionate bridge collapse due to a ship collision with the deck	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Amber - Significant**	O		18 Jan '17	No	None applicable	AAJV undertook a deterministic assessment to assess ship impact on the River Usk Bridge cable stayed span crossing the River Usk. This assessment demonstrates that the impact force on the deck of the bridge is of a magnitude that can be designed for and therefore the bridge will be designed to resist this force. Navigation lighting is to be provided to mark out the navigation channel and the presence of the bridge.		**Not Significant**	Risk reduced to acceptable levels.	
836	SBR	Structures	17 Jul '15	MH	Disproportionate bridge collapse due to an aeroplane collision with the towers	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Amber - Significant**	O		17 Jul '15	No	None applicable	Warning beacons to be provided on the towers.		**Amber - Significant**	Risk reduced to acceptable levels.	
837	SBR	Structures	17 Jul '15	MH	Damage to the structure from explosion	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Amber - Significant**	O		17 Jul '15	No	None applicable	Maintenance access areas to be secured to prevent access by unauthorised people		**Amber - Significant**	Risk reduced to acceptable levels.	Evacuation procedures to be given in Operation and Maintenance Manual.
838	SBR	Structures	17 Jul '15	MH	Damage to the deck caused by fire underneath due to ABP operations	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	O		17 Jul '15	Yes	None applicable	Restrictive covenant to be agreed with ABP to prevent storage of flammable materials under bridge. Fire Risk Assessment to be undertaken.		**Not Significant**	Risk reduced to acceptable levels.	Evacuation procedures to be given in Operation and Maintenance Manual.
839	SBR	Structures	17 Jul '15	MH	Damage to the structure caused by an explosion under the deck due to ABP operations	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Amber - Significant**	O		17 Jul '15	Yes	None applicable	Restrictive covenant to be agreed with ABP to prevent storage of explosive materials under bridge. Fire Risk Assessment to be undertaken.		**Amber - Significant**	Risk reduced to acceptable levels.	Evacuation procedures to be given in Operation and Maintenance Manual.
840	SBR	Structures	17 Jul '15	MH	Hazards associated with the interface with ABP activities such as ABP lifting operations clashing with structure, storage of hazardous materials and unforeseen surcharge loading from stored materials	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	O		17 Jul '15	No	None applicable	Structure design for surcharge loading to be agreed. Identify clearance zones adjacent to bridge structure. Agree with ABP what materials can be stored and at which locations		**Not Significant**	Risk reduced to acceptable levels.	Restrictive covanent with ABP to be given in Operation and Maintenance Manual
841	SBR	Structures	17 Jul '15	MH	Injury to vehicle occupants and non-motorised users from vehicle collision with structural members at deck level or leaving deck	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	O		17 Jul '15	No	None applicable	Road restraint system with appropriate containment and impact severity level in accordance with TD 19.		**Not Significant**	Risk reduced to acceptable levels.	

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842	SBR	Structures	17 Jul '15	MH	Collision due to falling ice from cables	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	O		17 Jul '15	Yes	None applicable	Weather station to be used to identify conditions when ice may form. O&M manual to include recommendations for when Bridge should be closed when these conditions arise. Road restraint system with appropriate impact severity level in accordance with TD 19 to limit severity of a collision.		**Not Significant**	Risk reduced to acceptable levels.	Operation and Maintenance Manual to include conditions and procedures for bridge closure.
843	SBR	Structures	17 Jul '15	MH	Slips, trips and falls during emergency evacuation on maintenance walkways and through tower	Section 3 - Usk Crossing	Cable-stayed Bridge	G5 - Early installation of permanent means of access, with hand rails or edge protection	**Amber - Significant**	O		17 Jul '15	No	G5 - Early installation of permanent means of access, with hand rails or edge protection	Maintenance access routes to be designed in accordance with BS5395. Access routes to be provided with non slip surfaces, signs and emergency lighting Positive drainage to prevent ice. Anti-slip coatings to be provided on waterproofed surfaces. Emergency evacuation strategy to be developed.		**Not Significant**	None.	
844	SBR	Structures	17 Jul '15	MH	Falls from height during internal tower access	Section 3 - Usk Crossing	Cable-stayed Bridge	G2 - Provision for maintenance / replacement access	**Red - Extreme**	M		17 Jul '15	Yes	G2 - Provision for maintenance / replacement access	Platforms present every 6m to reduce falling height. Maintenance access routes to be designed in accordance with BS5395. Access routes to be provided with non slip surfaces, signs and emergency lighting Positive drainage to prevent ice. Anti-slip coatings to be provided on waterproofed surfaces. Emergency evacuation strategy to be developed.		**Not Significant**	Risk reduced to acceptable levels.	
845	SBR	Structures	17 Jul '15	MH	Falls from height during external tower access using inspection gondola	Section 3 - Usk Crossing	Cable-stayed Bridge	G2 - Provision for maintenance / replacement access	**Red - Extreme**	M		17 Jul '15	No	G2 - Provision for maintenance / replacement access	Simple tower geometry and tapering cross section to make tower face easy to traverse using gondola		**Amber - Significant**	Hazards associated with external tower access. Contractor to manage risk.	
846	SBR	Structures	17 Jul '15	MH	Hazards associated with deck inspection maintenance and underbridge inspection vehicle such as falls from height and falling objects	Section 3 - Usk Crossing	Cable-stayed Bridge	G5 - Early installation of permanent means of access, with hand rails or edge protection	**Red - Extreme**	M		17 Jul '15	Yes	G5 - Early installation of permanent means of access, with hand rails or edge protection	Walkway provided under deck soffit to minimise time spent in underbridge inspection vehicle.		**Amber - Significant**	Normal maintenance risk of falls from height, slips and trips to be managed by the maintainer.	
847	SBR	Structures	17 Jul '15	MH	Hazards associated with stays inspection and replacements including falls from height and falling objects	Section 3 - Usk Crossing	Cable-stayed Bridge	G11 - Use technology (eg. VMS) to mitigate TM risks	**Red - Extreme**	M		17 Jul '15	Yes	G11 - Use technology (eg. VMS) to mitigate TM risks	Design to take account of the removal of one stay for testing or replacement to minimise working from height. Anchorages located in protected environment within tower for cable stressing operations.		**Not Significant**	Safe methods of work required to deal with residual risk Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	Stay cable replacement method to be detailed in Operation and Maintenance Manual.
848	SBR	Structures	17 Jul '15	MH	Hazards associated with the inspection and maintenance of pier external faces and bearings such as falls from height and falling objects	Section 3 - Usk Crossing	Cable-stayed Bridge	G2 - Provision for maintenance / replacement access	**Red - Extreme**	M		17 Jul '15	No	G2 - Provision for maintenance / replacement access	Hardstanding to be provided around piers to ensure stability of scaffold or MEWP Bearings to be left exposed so that they can be accessed easily for visual inspection.		**Amber - Significant**	Normal maintenance risk of falls from height, slips and trips to be managed by the maintainer.	
849	SBR	Structures	17 Jul '15	MH	Hazards associated with the inspection of pier internal faces such as falls from height and falling objects	Section 3 - Usk Crossing	Cable-stayed Bridge	G2 - Provision for maintenance / replacement access	**Red - Extreme**	M		17 Jul '15	No	G2 - Provision for maintenance / replacement access	Ladders to be provided on internal faces to avoid abseiling techniques Pier internal lighting to be provided.		**Amber - Significant**	Normal maintenance risk of falls from height, slips and trips to be managed by the maintainer.	
850	SBR	Structures	17 Jul '15	MH	Hazards associated with bearing replacement such as falls from height and falling objects	Section 3 - Usk Crossing	Cable-stayed Bridge	G2 - Provision for maintenance / replacement access	**Red - Extreme**	M		17 Jul '15	No	G2 - Provision for maintenance / replacement access	Deck to be jacked from portal frame crosshead to minimise temporary works and therefore working from height.		**Amber - Significant**	Normal maintenance risk of falls from height, slips and trips to be managed by the maintainer.	Notes on drawings to identify provision for temporary jacking during bearing replacement.
851	SBR	Structures	17 Jul '15	MH	Manoeuvring heavy jack equipment within the towers during strand/stay cable replacement	Section 3 - Usk Crossing	Cable-stayed Bridge	G19 - Designer to consider lifting operation feasibility of and risks	**Amber - Significant**	M		17 Jul '15	No	G19 - Designer to consider lifting operation feasibility of and risks	Where possible reduce the size of the tendons to allow smaller jacks to be used Provision for lift or winch for transporting heavy equipment up the tower		**Not Significant**	Hazard of manoeuvring heavy equipment remains. Contractor to manage risk.	

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852	SBR	Structures	17 Jul '15	MH	Slips, trips and falls during use of maintenance access walkways and stairs	Section 3 - Usk Crossing	Cable-stayed Bridge	G5 - Early installation of permanent means of access, with hand rails or edge protection	**Red - Extreme**	M		17 Jul '15	Yes	G5 - Early installation of permanent means of access, with hand rails or edge protection	Use of stairs limited by providing internal tower lift. Maintenance access routes to be designed in accordance with BS5395. Access routes to be provided with non slip surfaces, signs and lighting Use ladders instead of stairs wherever possible.		**Amber - Significant**	Normal maintenance risk of falls from height, slips and trips to be managed by the maintainer.	
853	SBR	Structures	17 Jul '15	MH	Slips, trips and falls during access/egress into towers	Section 3 - Usk Crossing	Cable-stayed Bridge	G5 - Early installation of permanent means of access, with hand rails or edge protection	**Red - Extreme**	M		17 Jul '15	No	G5 - Early installation of permanent means of access, with hand rails or edge protection	Design adequate sized access holes At east tower access hatch at ground level not provided as this is below the flood water level Provide two forms of access wherever possible so access can be obtained at the most appropriate location.		**Not Significant**	Normal maintenance risk of falls from height, slips and trips to be managed by the maintainer.	
854	SBR	Structures	17 Jul '15	MH	Risk to maintenance personnel in central reserve if a road traffic accident occurs	Section 3 - Usk Crossing	Cable-stayed Bridge	G9 - Safe stopping places for maintenance operations	**Red - Extreme**	M		17 Jul '15	No	G9 - Safe stopping places for maintenance operations	Minimise amount of time in the central reserve by locating lighting columns and ducts in the verges. Provide concrete safety barrier in central reserve which requires less maintenance than a bolted steel system		**Amber - Significant**	Risk reduced to acceptable levels.	
855	SBR	Structures	17 Jul '15	MH	Risk of collision with traffic to maintenance personnel when working next to live carriageways	Section 3 - Usk Crossing	Cable-stayed Bridge	G9 - Safe stopping places for maintenance operations	**Red - Extreme**	M		17 Jul '15	Yes	G9 - Safe stopping places for maintenance operations	Tower and pier locations have been designed to leave a minimum clearance to local roads and protected by a safety barrier in accordance with TD19		**Not Significant**	Hazard of working next to live carriageways remain. Contractor to manage risk.	
856	SBR	Structures	17 Jul '15	MH	Hazards associated with working over water such as falling from height, drowning and water borne diseases	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	M		17 Jul '15	Yes	None applicable	Walkway provided between towers to provide permanent working platform over River Usk		**Amber - Significant**	1. Hazard of working at height remains 2. Hazard of working above water, mud and land remains 3. Hazard of water borne diseases remains	
857	SBR	Structures	17 Jul '15	MH	Electrocution, gas leaks or sewage leaks as a result of inspection and maintenance operations in the vicinity of existing services	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	M		17 Jul '15	Yes	None applicable	Foundations to be located away from existing services where possible. Existing services identified and to be marked on drawings.		**Amber - Significant**	Hazards associated with working in the vicinity of existing services reamins. Contractor to manage risk.	HV overhead power lines and gas mains to be stated in SHE boxes on drawings.
858	SBR	Structures	17 Jul '15	MH	Hazards associated with inspection and maintenance activities above and adject to East Port Rail such as electrocution, collision with train movements and slips, trips and falls working on tracks	Section 3 - Usk Crossing	Cable-stayed Bridge	G9 - Safe stopping places for maintenance operations	**Red - Extreme**	M		17 Jul '15	No	G9 - Safe stopping places for maintenance operations	Tower location designed to achieve minimum 4.5m clearance to railway lines.		**Amber - Significant**	Hazards associated with working above and adjacent to railway lines remain. Contractor to manage risk.	Presence of rail lines to be marked on drawings.
859	SBR	Structures	17 Jul '15	MH	Collision with ABP activities	Section 3 - Usk Crossing	Cable-stayed Bridge	G9 - Safe stopping places for maintenance operations	**Red - Extreme**	M		17 Jul '15	Yes	G9 - Safe stopping places for maintenance operations	Dedicated maintenance access track under west back span deck soffit to separate maintainers from ABP operations		**Amber - Significant**	Hazard still remains. Contractor to manage risk of working alongside ABP operations.	Operations and maintenance manual to include agreement for working procedures alongside ABP activities
860	SBR	Structures	17 Jul '15	MH	Unanticipated release of locked in stresses or removal/modification of critical structural components, causing injury to personnel and /or change of structural behaviour leading to formation of hinges, instability and/or collapse.	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	D		17 Jul '15	No	None applicable	Details of construction sequence to be recorded in H&S File, O&M Manuals and on As-Built Drawings. Parts of the structure with significant locked in stresses or with critical structural function (no redundancy) to be identified.		**Amber - Significant**	Hazard still remains. Contractor to manage risk.	Details of construction sequence to be recorded in H&S File, O&M Manuals and on As-Built Drawings. Parts of the structure with significant locked in stresses or with critical structural function (no redundancy) to be identified. Demolition risks to be outlined in Operation
861	SBR	Structures	17 Jul '15	MH	Sudden release of stored energy in prestressing, causing injury to personnel and/or change of structural behvious leading to formation of hinges, instability and/or collapse.	Section 3 - Usk Crossing	Cable-stayed Bridge	None applicable	**Red - Extreme**	D		17 Jul '15	No	None applicable	All prestressing to be clearly identified in the H&S File, O&M Manuals and on the As-Built Drawings.		**Amber - Significant**	Hazard still remains. Contractor to manage risk.	All prestressing to be clearly identified in the H&S File, O&M Manuals and on the As-Built Drawings. Demolition risks to be outlined in Operation and Maintenance Manual.

M4 CaN - M4 Corridor around Newport
Design Hazard Log - Key Stage 3 - Preliminary Design
M4 CaN-ATK-GEN-01_GEN-DO-C-0003

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862	SBR	Structures	18 Jul '15	MH	Contaminated ground may be present during foundation construction	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Amber - Significant**	C		17 Jul '15	Yes	None applicable	If the GI shows contaminated ground, soil remediation methods to be used or methods/design altered to avoid disturbance of contaminated areas.		**Not Significant**	Risk reduced to acceptable levels. Normal construction hazards to be managed by Contractor	Employer's Requirements to include dealing with contaminated land. Risk must be mitigated in method statement.
863	SBR	Structures	19 Jul '15	MH	Hazards associated with abutment wall and floor slab construction such as falls from height and dropped objects	Section 3 - Usk Crossing	Approach Viaducts	R9 - Working at height without provision for suitable working platform	**Red - Extreme**	C		17 Jul '15	Yes	G5 - Early installation of permanent means of access, with hand rails or edge protection	Abutment height minimised through vertical alignment design. Use of simple cross-section improves buildability and reduces time spent at height . Construct permanent access provision at earliest opportunity		**Amber - Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
864	SBR	Structures	20 Jul '15	MH	Damage to eyes or cuts to flesh from cutting of metalwork walkways	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Amber - Significant**	C		17 Jul '15	Yes	G18 - Prevent work at height by constructing bridges off site / at grade	Locate walkways on existing concrete structure wherever possible. Prefabricate off site in controlled environment.		**Not Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
865	SBR	Structures	21 Jul '15	MH	Hazards associated with portal frame pier construction such as falls from height and dropped objects	Section 3 - Usk Crossing	Approach Viaducts	R9 - Working at height without provision for suitable working platform	**Red - Extreme**	C		17 Jul '15	Yes	G5 - Early installation of permanent means of access, with hand rails or edge protection	Portal frame pier heights minimised through vertical alignment design. Portal frame pier form with simple cross-section improves buildability and reduces time spent at height. Construct rail from which to anchor onto when using roped access on pier top at earliest opportunity		**Amber - Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
866	SBR	Structures	22 Jul '15	MH	Hazards associated with the deck construction by launched methods such as falls from height, dropped objects, hot works and lifting large deck units	Section 3 - Usk Crossing	Approach Viaducts	R9 - Working at height without provision for suitable working platform	**Red - Extreme**	C		17 Jul '15	Yes	G19 - Designer to consider lifting operation feasibility of and risks	Launched sections to minimise overhead lifting. Standardise beam cross section to maximise amount of welding done in fabrication yard. Precast deck panels minimise time spent at height. Minimise number of launching positions to reduce working from height. Lightweight ladder beam deck section reduces lifting weight.		**Amber - Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
867	SBR	Structures	23 Jul '15	MH	Stability of crane on soft ground during lifting operations	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	G19 - Designer to consider lifting operation feasibility of and risks	Lifting operations minimised by launching deck as opposed to lifting sections into place		**Amber - Significant**	Where soft ground is present contractor to ensure cranage is stable using temporary platforms or similar.	Heavy lifts to be identified on drawings
868	SBR	Structures	24 Jul '15	MH	Hazards associated with ancillary item installation (parapets, wind shields, platforms, stairs, etc) including hand-arm vibration, manual handling and dropped objects	Section 3 - Usk Crossing	Approach Viaducts	A4 - Materials weighing > 20kgs requiring manual handling	**Red - Extreme**	C		17 Jul '15	Yes	G4 - Avoid drilling by specifying pre-cast fixings in concrete	Lighting column fixings have been integrated with wind shield support structure. Specify cast in anchors where practicable. Parapet and vehicle barrier fixings to be cast in cradles. Integrate wind barrier fixings with temporary edge protection fixings.		**Not Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	
869	SBR	Structures	25 Jul '15	MH	Impregnation of concrete surfaces within road splash zone: Silane impregnation is highly toxic and flammable. It is skin, eye and respiratory irritant.	Section 3 - Usk Crossing	Approach Viaducts	A2 - Use of "Harmful" COSHH / EH40 substances	**Amber - Significant**	C		17 Jul '15	Yes	None applicable	Specification of silane free impregnation such as PAVIX CCC100.		**Not Significant**	None.	
870	SBR	Structures	26 Jul '15	MH	Impregnation of buried concrete surfaces: Exposure to bitumen paint, a flammable material. It may cause lung damage if swallowed. Repeated exposure may cause skin dryness or cracking. Vapours may cause drowsiness and dizziness	Section 3 - Usk Crossing	Approach Viaducts	A2 - Use of "Harmful" COSHH / EH40 substances	**Amber - Significant**	C		17 Jul '15	No	None applicable	No measures available		**Amber - Significant**	Normal construction hazards to be managed by Contractor.	
871	SBR	Structures	27 Jul '15	MH	Hazards associated with the preparation of surfaces and application of painting systems on site including working at height and hazards to health from solvents, resins, hardeners etc present in paints.	Section 3 - Usk Crossing	Approach Viaducts	A2 - Use of "Harmful" COSHH / EH40 substances	**Red - Extreme**	C		17 Jul '15	No	None applicable	All steel elements are designed to be painted as a part of fabrication process in controlled environment where access is not limited and safe.		**Not Significant**	Hazards associated with preparation of surfaces and application of painting systems remain.	

Issue: 2
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M4 CaN - M4 Corridor around Newport
Design Hazard Log - Key Stage 3 - Preliminary Design
M4 CaN-ATK-GEN-01_GEN-DO-C-0003

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872	SBR	Structures	28 Jul '15	MH	Hazards associated with construction over water such as falls from height, drowning and water borne diseases.	Section 3 - Usk Crossing	Approach Viaducts	R9 - Working at height without provision for suitable working platform	**Red - Extreme**	C		17 Jul '15	Yes	G19 - Designer to consider lifting operation feasibility of and risks	Deck will be constructed using launched methods therefore no work will be carried out over water		**Amber - Significant**	Hazards associated with construction at height still remain. Contractor to manage risk.	
873	SBR	Structures	29 Jul '15	MH	Electrocution, gas leaks or sewage leaks as a result of construction in the vicinity of existing services	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Foundations to be located away from existing services where possible. Existing services identified and to be marked on drawings.		**Amber - Significant**	Hazards associated with working in the vicinity of existing services reamins. Contractor to manage risk.	HV overhead power lines and gas mains to be stated in SHE boxes on drawings.
874	SBR	Structures	30 Jul '15	MH	Risk of collision with traffic from working adjacent to live carriageways	Section 3 - Usk Crossing	Approach Viaducts	A7 - Use of traffic cones not solid barriers to protect people from errant vehicle	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Pier and abutment locations have been designed to leave a minimum clearance to local roads in accordance with TD19. Simple abutment and pier geometry simplifies construction and minimises time spent working adjacent to live carriageways.		**Amber - Significant**	Hazard of working next to live carriageways remain. Contractor to manage risk.	
875	SBR	Structures	31 Jul '15	MH	Hazards associated with the construction of movement joints such as falling through voids and limbs trapped during jacking	Section 3 - Usk Crossing	Approach Viaducts	R9 - Working at height without provision for suitable working platform	**Amber - Significant**	C		17 Jul '15	Yes	G2 - Provision for maintenance / replacement access	Provide covers over joint during construction. Use shims to ensure appropriate residual gap during jacking		**Not Significant**	Safe system of work required to deal with residual risk Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	Joint presetting distances to be given on joint drawings for range of installation temperatures
876	SBR	Structures	1 Aug '15	MH	Instability during push launched construction methods	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	G19 - Designer to consider lifting operation feasibility of and risks	Design to consider most onerous launching position. Maximum permitted wind speeds to be specified for construction. Temporary bracing to be specified where required.		**Amber - Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	Maximum permitted wind speeds during launching to be given on construction drawings
877	SBR	Structures	2 Aug '15	MH	Chemical leakage, fire and explosion as a result of constructing near PCB cell	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Amended pier design to use a transverse spanning cross beam over the PCB cell which will avoid constructing on the storage site.		**Amber - Significant**	Hazards associated with working near PCB cell remain. Contractor to manage risk.	Presence of PCB cell to be marked on drawings and identified in SHE box.
878	SBR	Structures	3 Aug '15	MH	Hazards associated construction above and adjacent to West Port Rail and Uskmouth Railway including electrocution, collision with train movement and slips, trips and falls working on tracks	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Pier locations designed to achieve minimum 4.5m clearance to railway lines. Working procedures from railways owners to be identified and allowed for during design development.		**Amber - Significant**	Hazards associated with working alongside and above railway lines remain. Contractor to manage risk.	Presence of rail lines to be marked on drawings.
879	SBR	Structures	4 Aug '15	MH	Hazards associated with the interface with ABP activities such as ABP lifting operations clashing with structure, storage of hazardous materials and unforeseen surcharge loading from stored materials	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	C		17 Jul '15	No	G1 - Minimise vehicle reversing requirements	Foundations to be designed for an agreed surcharge loading. Fire Risk Assessment to be undertaken and findings shared with ABP.		**Amber - Significant**	Hazards associated with interface with ABP still remain. Contractor to mange risk.	Employer's Requirements to state that all operations must be agreed with ABP. State in operations and maintenance manual the agreed restrictive covanent with ABP.
880	SBR	Structures	5 Aug '15	MH	Hazards associated with constructing near Solutia chemical plant including leakage from oxygen, hydrogen and nitrogen pipelines leading to fire and explosion	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	C		17 Jul '15	Yes	None applicable	Pier locations designed to be clear of Solutia facilities		**Amber - Significant**	Risk reduced to acceptable levels.	Presence of services to be given on drawings and in SHE box.
881	SBR	Structures	6 Aug '15	MH	Disproportionate bridge collapse as a result of vehicles travelling on roads under colliding with support members at ground level	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	O		17 Jul '15	Yes	None applicable	Locate piers further than 4.5m from existing carriageways. Design of substructures for residual collision loads.		**Amber - Significant**	Risk reduced to acceptable levels.	

M4 CaN - M4 Corridor around Newport
Design Hazard Log - Key Stage 3 - Preliminary Design
M4 CaN-ATK-GEN-01_GEN-DO-C-0003

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882	SBR	Structures	7 Aug '15	MH	Disproportionate bridge collapse as a result of vehicles travelling on roads under colliding with the deck superstructure	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	O		17 Jul '15	Yes	None applicable	Provide sufficient vertical clearance for roads under crossing. Design of superstructure for collision loads		**Amber - Significant**	Risk reduced to acceptable levels.	
883	SBR	Structures	8 Aug '15	MH	Damage to structure caused by a vehicle fire on the deck and below	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	O		17 Jul '15	No	None applicable	Produce a Fire Hazard Assessment. Findings to be shared and recommended evacuation procedres to be given in O&M manual.		**Amber - Significant**	Risk reduced to acceptable levels.	Evacuation procedures to be given in Operation and Maintenance Manual.
884	SBR	Structures	9 Aug '15	MH	Disproportionate bridge collapse due to a ship collision with the deck	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Amber - Significant**	O		18 Jan '17	No	None applicable	A geometric study to assess to potential for ship impact on the River Usk Bridge viaduct crossing the Junction Cut was undertaken by Global Maritime on behalf of the WG. Using the data of this study, AAJV undertook a probabilistic risk assessment of ship impact which showed that without mitigation, the risk of impact resulting in bridge collapse would be unacceptable. The subsequent agreed mitigation measure would be to provide physical works to prevent larger ships getting close to the bridge and thereby reducing the residual risk to acceptable levels. Refer also to ship impact risk assessment reports and mitigation studies. Navigation lighting also to be provided to mark out the navigation channel and the presence of the bridge		**Not Significant**	Risk reduced to acceptable levels.	
885	SBR	Structures	10 Aug '15	MH	Damage to the structure from explosion	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Amber - Significant**	O		17 Jul '15	No	None applicable	Maintenance access areas to be secured to prevent access by unauthorised people		**Amber - Significant**	Risk reduced to acceptable levels.	Evacuation procedures to be given in Operation and Maintenance Manual.
886	SBR	Structures	11 Aug '15	MH	Damage to the deck caused by fire underneath due to ABP operations	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	O		17 Jul '15	Yes	None applicable	Restrictive covenant to be agreed with ABP to prevent storage of flammable materials under bridge.		**Not Significant**	Risk reduced to acceptable levels.	Evacuation procedures to be given in Operation and Maintenance Manual.
887	SBR	Structures	12 Aug '15	MH	Damage to the structure caused by an explosion under the deck due to ABP operations	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Amber - Significant**	O		17 Jul '15	Yes	None applicable	Restrictive covenant to be agreed with ABP to prevent storage of explosive materials under bridge.		**Amber - Significant**	Risk reduced to acceptable levels.	Evacuation procedures to be given in Operation and Maintenance Manual.
888	SBR	Structures	13 Aug '15	MH	Hazards associated with the interface with ABP activities such as ABP lifting operations clashing with structure, storage of hazardous materials and unforeseen surcharge loading from stored materials	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	O		17 Jul '15	No	None applicable	Structure design for surcharge loading to be agreed.		**Not Significant**	Hazards associated with interface with ABP still remain. Contractor to mange risk.	Restrictive covanent with ABP to be given in Operation and Maintenance Manual
889	SBR	Structures	14 Aug '15	MH	Injury to vehicle occupants and non-motorised users from vehicle collision with structural members at deck level or leaving deck	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	O		17 Jul '15	No	None applicable	Road restraint system with appropriate containment and impact severity level in accordance with TD 19.		**Not Significant**	Risk reduced to acceptable levels.	
890	SBR	Structures	15 Aug '15	MH	Hazards associated with the inspection and maintenance of the deck soffit such as falls from height and falling objects	Section 3 - Usk Crossing	Approach Viaducts	R9 - Working at height without provision for suitable working platform	**Red - Extreme**	M		17 Jul '15	No	G5 - Early installation of permanent means of access, with hand rails or edge protection	Deck designed to ensure it is possible to inspect using appropriate access equiptment. Hazards associated with working from height, slips and trips still remain.		**Amber - Significant**	Normal maintenance risk of falls from height, slips and trips to be managed by the maintainer.	
891	SBR	Structures	16 Aug '15	MH	Hazards associated with the inspection and maintenance of piers and bearings such as falls from height and falling objects	Section 3 - Usk Crossing	Approach Viaducts	R9 - Working at height without provision for suitable working platform	**Red - Extreme**	M		17 Jul '15	No	G2 - Provision for maintenance / replacement access	Hardstanding to be provided around piers to ensure stability of scaffold or MEWP Bearings to be left exposed so that they can be accessed easily from a MEWP or scaffold for visual inspection.		**Amber - Significant**	Normal maintenance risk of falls from height, slips and trips to be managed by the maintainer.	
892	SBR	Structures	17 Aug '15	MH	Hazards associated with bearing replacement such as falls from height and falling objects	Section 3 - Usk Crossing	Approach Viaducts	R9 - Working at height without provision for suitable working platform	**Red - Extreme**	M		17 Jul '15	No	G2 - Provision for maintenance / replacement access	Deck to be jacked from portal frame crosshead to minimise temporary works and therefore working from height.		**Amber - Significant**	Normal maintenance risk of falls from height, slips and trips to be managed by the maintainer.	Notes on drawings to identify provision for temporary jacking during bearing replacement.

M4 CaN - M4 Corridor around Newport
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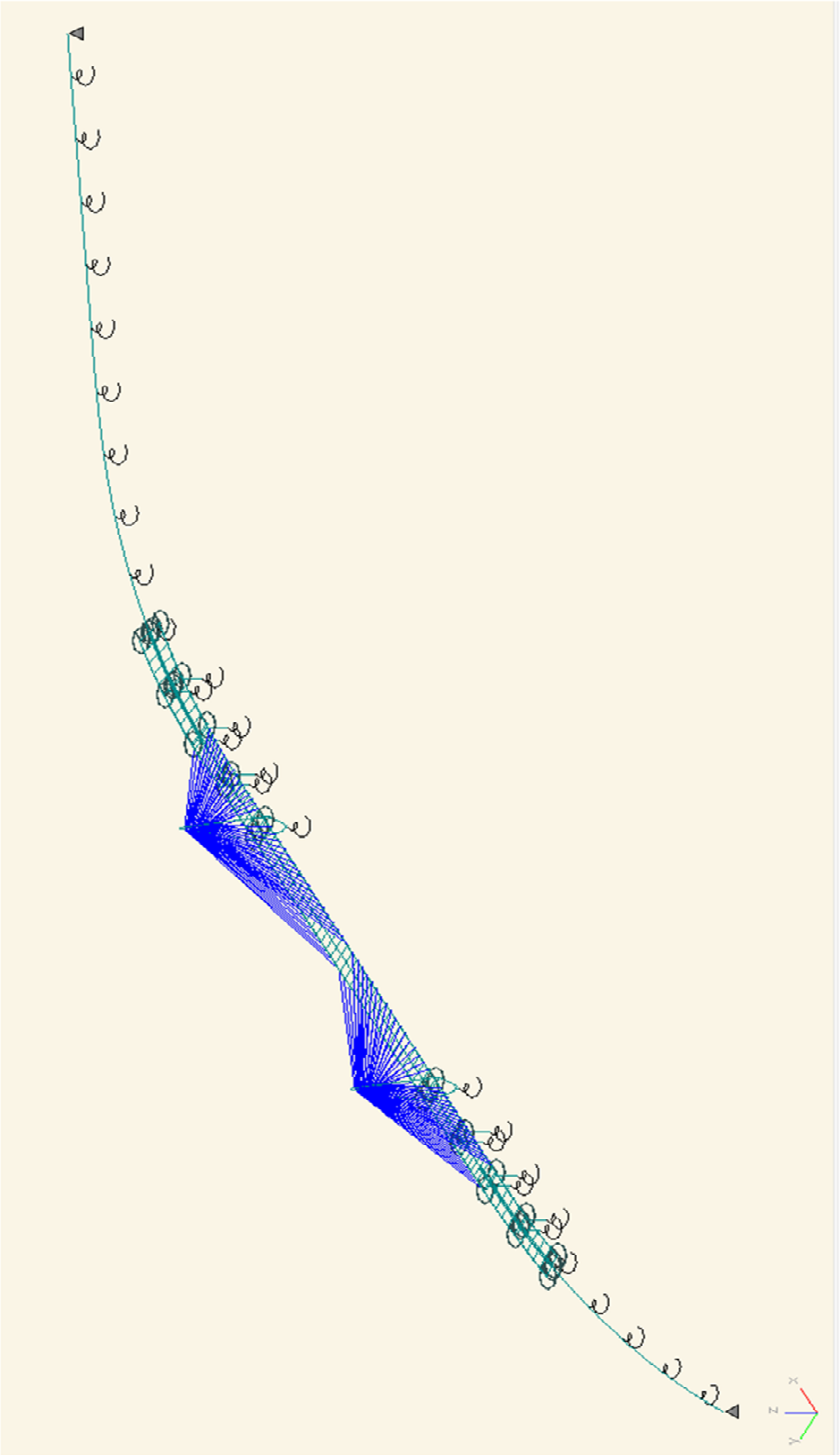
893	SBR	Structures	18 Aug '15	MH	Risk to maintenance personnel in central reserve if a road traffic accident occurs	Section 3 - Usk Crossing	Approach Viaducts	A7 - Use of traffic cones not solid barriers to protect people from errant vehicle	**Red - Extreme**	M		17 Jul '15	No	G9 - Safe stopping places for maintenance operations	Minimise amount of time in the central reserve by locating lighting columns and ducts in the verges. Provide concrete safety barrier in central reserve which requires less maintenance than a bolted steel system.		**Amber - Significant**	Risk reduced to acceptable levels.	
894	SBR	Structures	19 Aug '15	MH	Slips, trips and falls during use of maintenance access walkways and stairs in the abutments	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	M		17 Jul '15	No	G5 - Early installation of permanent means of access, with hand rails or edge protection	Maintenance access routes to be designed in accordance with BS5395. Access routes to be provided with non slip surfaces, signs and lighting Use ladders instead of stairs wherever possible.		**Amber - Significant**	Normal maintenance risk of falls from height, slips and trips to be managed by the maintainer.	
895	SBR	Structures	20 Aug '15	MH	Injury to hearing from activities involving working in the abutments	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Amber - Significant**	M		17 Jul '15	Yes	None applicable	Add specification item to limit noise to 80 db. Access gap between back of deck and abutment wall designed to be 600mm minimum.		**Amber - Significant**	Risk reduced to acceptable levels. Normal construction risks to be managed by Maintainer	
896	SBR	Structures	21 Aug '15	MH	Injury from explosion in the hoppers following a spillage of inflammable liquids causing injury to those working in the abutments	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Amber - Significant**	M		17 Jul '15	Yes	None applicable	Eliminate drainage hoppers and use closed drainage system with articulated pipes through the abutments.		**Not Significant**	Risk reduced to acceptable levels. Normal construction risks to be managed by Maintainer	
897	SBR	Structures	22 Aug '15	MH	Risk of collision with traffic to maintenance personnel when working next to live carriageways	Section 3 - Usk Crossing	Approach Viaducts	A7 - Use of traffic cones not solid barriers to protect people from errant vehicle	**Red - Extreme**	M		17 Jul '15	Yes	G9 - Safe stopping places for maintenance operations	Pier and abutment locations have been designed to leave a minimum clearance to local roads and protected by a safety barrier in accordance with TD19.		**Amber - Significant**	Hazards associated with working next to live carriageways remain. Risk to be managed by maintainer.	
898	SBR	Structures	23 Aug '15	MH	Electrocution, gas leaks or sewage leaks as a result of inspection and maintenance operations in the vicinity of existing services	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	M		17 Jul '15	Yes	None applicable	Foundations to be located away from existing services where possible. Existing services identified and to be marked on drawings.		**Amber - Significant**	Hazards associated with working in the vicinity of existing services reamins. Maintainer to manage risk.	HV overhead power lines and gas mains to be stated in SHE boxes on drawings.
899	SBR	Structures	24 Aug '15	MH	Hazards associated with inspection and maintenance activities above and adject to West Port Rail and Uskmouth Railway such as electrocution, collision with train movements and slips, trips and falls working on tracks	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	M		17 Jul '15	No	G9 - Safe stopping places for maintenance operations	Pier locations designed to achieve minimum clearance to railway lines.		**Amber - Significant**	Hazards associated with working above and alongside railway lines still remain. Maintainer to manage risks.	Presence of rail lines to be marked on drawings.
900	SBR	Structures	25 Aug '15	MH	Collision with ABP activities	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	M		17 Jul '15	Yes	G9 - Safe stopping places for maintenance operations	Dedicated maintenance access track under deck soffit to separate maintainers from ABP workers.		**Amber - Significant**	Hazards associated with working alongside ABP operations remain. Maintainer to manage risks.	Operations and maintenance manual to include agreement for working procedures alongside ABP activities
901	SBR	Structures	26 Aug '15	MH	Injury to those carrying out inspection and maintenance works due to chemical leakage, fire and explosion as a result of works near PCB cell	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	M		17 Jul '15	Yes	None applicable	Amended pier design to use a transverse spanning cross beam over the PCB cell which will avoid locating a pier over the storage cell.		**Amber - Significant**	Risk reduced to acceptable levels Normal construction hazards to be managed by Contractor	Presence of PCB cell to be marked on drawings and identified in SHE box.
902	SBR	Structures	27 Aug '15	MH	Unanticipated release of locked in stresses or removal/modification of critical structural components, causing injury to personnel and /or change of structural behaviour leading to formation of hinges, instability and/or collapse.	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	D		17 Jul '15	No	None applicable	Details of construction sequence to be recorded in H&S File, O&M Manuals and on As-Built Drawings. Parts of the structure with significant locked in stresses or with critical structural function (no redundancy) to be identified.		**Amber - Significant**	Residual risks remain. Hazards to be managed by Contractor	Details of construction sequence to be recorded in H&S File, O&M Manuals and on As-Built Drawings. Parts of the structure with significant locked in stresses or with critical structural function (no redundancy) to be identified.
903	SBR	Structures	28 Aug '15	MH	Removal of structural elements spanning over the PCB cell	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	D		17 Jul '15	No	None applicable	All lifting operations to be developed to ensure no surcharge loading on PCB cell.		**Amber - Significant**	Residual risks remain. Hazards to be managed by Contractor	PCB cell to be marked on drawings. Demolition risks to be outlined in Operation and Maintenance Manual.
904	SBR	Structures	28 Aug '15	MH	Removal of structural elements spanning over the PCB cell	Section 3 - Usk Crossing	Approach Viaducts	None applicable	**Red - Extreme**	D		17 Jul '15	No	None applicable	All lifting operations to be developed to ensure no surcharge loading on PCB cell.		**Amber - Significant**	Residual risks remain. Hazards to be managed by Contractor	PCB cell to be marked on drawings. Demolition risks to be outlined in Operation and Maintenance Manual.

Appendix E– Idealised Structure Diagrams



Appendix F– Schedule of Eurocode Options and Choices

To be completed