The Lake Lothing (Lowestoft) Third Crossing Order 201[*]

Lake Lothing THIRD CROSSING

Document 7.5: Design Report

Appendix 2

Author: Suffolk County Council

Lake Lothing Third Crossing Outline Approval in Principle for Approach Viaducts

Bridge Ref 10/67
Bridge Code 67

March 2018

Produced for
Suffolk County Council

Prepared by
Furqan Qamar

Knights House
2 Parade
Sutton Coldfield
West Midlands
B72 1PH

T +44 (0) 121 3622089
E furqan.qamar@wsp.com

DOCUMENT CONTROL SHEET

Project Title	Lake Lothing Third Crossing (LL3X)
Report Title	Lake Lothing Third Crossing Approval in Principle for Approach Viaducts
Bridge Ref	10/67
Bridge Code	67
Document No.	62240712-WSP-SBR-LL3X-CD-CB-0002
Status	FOR DCO SUBMISSION
Control Date	09/08/2017

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
Rev 0	For DCO Submission	Ricardo Romero	01/03/2018	Furqan Qamar	01/03/2018	Mark Nothing	01/03/2018

Distribution

Organisation	Contact	Copies
Suffolk County Council	Andrew Pearce	1
Suffolk County Council	Colin Godfrey	1

CONTENTS

Name of Project: **Lake Lothing Third Crossing (LL3X)**

Name of Structure: **Lake Lothing Third Crossing Approach Viaducts**

INTRODUCTION

Lake Lothing in Lowestoft, Suffolk is currently crossed by two road bridges, A47 Bascule Bridge carrying the A12 across the passage between the inner and outer harbours and the Mutford Bridge carrying the A1117 at Oulton Broad. Both crossings open to allow shipping to access the port causing significant traffic disruption. The proposed LL3X is a new road crossing over Lake Lothing, improving connectivity between both sides of the lake as well as relieving congestion in and around the town centre. The proposed bridge will comprise a central bascule river span, approach viaducts to both side and a portal frame structure for access to Nexen building.

The main obstacles crossed by the LL3X are the Lake Lothing and the East Suffolk Line.

The purpose of this document is to outline the design requirement for approach viaduct spans only and separate outline AIP documents will be produced for bascule river span and portal frame.

The bascule bridge has a single leaf rolling lift mechanism that is supported on the south approach viaduct. For further details see Appendix C. The details of the interdependency between the bascule bridge and the approach viaducts will be covered in the AIP at detailed design stage.

1 HIGHWAY DETAILS

1.1 Type of highway

Over: Single carriageway 2-lane A class all-purpose road carried by approach viaducts. For future proofing three lanes will be considered as detailed in section 4.1.9.

Under: None

1.2 Permitted traffic speed

Over: 30 mph.

Under: Not applicable.

1.3 Existing restrictions

Not Applicable

2 SITE DETAILS

2.1 Obstacles crossed

a) North approach viaduct – Land operated by Associated British Ports. This land will be used for all traffic associated with the port like HGV's, forklift truck etc.

– The East Suffolk Line.

b) South approach viaduct – Waveney District Council. Land below the structure will be paved and used for maintenance vehicles and access to control tower.

Refer to section 3.8.1 for details.

3 PROPOSED STRUCTURE

3.1 Description of structure and design working life

The LL3X will be a seven span structure that connects Waveney Drive in the south to Denmark Road/Peto Way in the north, via a new bascule bridge positioned centrally over the navigational channel of Lake Lothing. The multi-span bridge will be an in situ post tensioned structure at the approaches to the bascule bridge. The structure will have a total length including the approach viaducts and the bascule span of approximately 300m (measured along the centreline of the carriageway). The width of the deck is 19.26m at the south viaduct and bascule span and then increases in width at the north viaduct to permit the required visibility splays to a maximum width of approximately 19.86m (refer to the General Arrangement drawing in Appendix C). The bridge will have a curved horizontal alignment with a maximum radius at the north viaduct of approximately 135m with a transition to a straight alignment at the North end of the structure. Vertically there will be a longitudinal 5 % fall towards North and South abutments from the highest point. The abutments and piers will be perpendicular to the centreline of the carriageway.

The proposed cross section consists of the following:

Parapet plinth	0.73m
East verge	4.5m
Carriageway (2 No. lanes)	7.3m*
West verge NMU route	6m
Parapet plinth	0.73m

*Increases over north spans from 7.3m to a maximum of approximately 7.9m.

For more details of the proposed structure refer to drawings in Appendix C.

The superstructure shall comprise an in situ post tensioned single cell spine box with deviators. The section of the deck supporting the bascule bridge will be posttensioned transversely.

Pier 2 and 3 are located at the south of Lake Lothing and pier 6 and 7 are located at the north of Lake Lothing.

The two central piers (4 and 5) are placed on the water. The bascule bridge is supported on the deck. When the bascule bridge is closed its load is transmitted directly to the south water pier (support 4). Fenders will be attached to the piers 4 and 5 for vessel impact loading and also fenders will be provided at the approach to navigation channel. Fender design detail can be found in Appendix G.

The parapets will be supported by an in-situ reinforced concrete edge beam. The deck cantilever soffit angles will vary to provide a constant depth of edge beam along the structure.

The north abutment will be connected to in situ reinforced concrete wing walls parallel to the carriageway via integral connection. The south abutment fill will be retained by reinforced earth structures parallel to the carriageway. The reinforced earth structure will butt against the abutment. The reinforced earth structures details are covered in the separate SEAF document.

The piers, end abutments and approach fenders will be supported on reinforced concrete piled foundations.

The bridge shall be designed to have a design working life category 5 (≥120 years) in accordance with NA to BS EN 1990:2002. Expansion joints, waterproofing systems, parapets and safety barriers shall be a design working life category 2 (up to 50 years). Bearing will be category 5 but its proposed working life is 50 years in accordance to IAN 124/11.

To facilitate the preliminary design additional investigations were undertaken at the location of the north and south quays to investigate the presence of sheet pile ties. The south Quay anchor wall is located approx. 12 m away from the quay wall.

3.2 Structural type

Each approach viaduct will comprise of in situ post tensioned single cell spine box structure, supported on reinforced concrete abutments and reinforced concrete vertical cantilever intermediate piers.

3.3 Foundation type

The intermediate piers and abutments will be supported on reinforced concrete piled foundations.

3.4 Span arrangements

The span arrangements are as stated below, the spans are measured along the centreline of the horizontal alignment:

South Viaduct			Bascule bridge	North Viaduct		
Span 1	Span 2	Span 3	Span 4	Span 5	Span 6	Span 7
19.2 m	39.9 m	52.4 m	37.5 m	52.9 m	50.5 m	48.0 m

3.5 Articulation arrangements

At the approach viaducts superstructure will be supported on pot bearings. On each pier the deck will be supported on two pot bearings. However, support 4 at the south approach viaduct will be made integral with the deck after the construction of the deck. Pier 6 at north approach will provide restraint to the longitudinal movement of the deck. At the rest of the piers the deck will be free longitudinally. Expansion joint will be provided at the north water pier, south and north abutment.

During the construction of the approach spans with balanced cantilevers temporary restraint of the rotation of the deck will be needed. Further details for method of construction of approach span over the land and the east Suffolk line can be found in Appendix F.

Articulation arrangements are shown on the drawings in Appendix C.

3.6 Classes and levels

3.6.1 *Consequence class*

The Consequence Class for the whole structure is CC3.

3.6.2 *Reliability class*

The Reliability Class is RC3. K_{F1} taken as 1.0 in accordance with Note A1 Table A.2. of Interim Advice Note 124/11.

3.6.3 *Inspection level*

The Inspection Level during execution is IL3.

3.7 Road restraint systems requirements

Parapets will be very high containment H4a/W2 over the railway, bascule span and approaches (45m either side) and normal containment (N2/W2) elsewhere. The height of the parapet will be 1.8m over the railway, and at the approaches (45m either side in accordance with TD 19/06), 1.4m high for N2 parapets and 1.5m high will be provided for bascule span. The connection detail between approach and movable span will be considered in detailed design. There will be very small space for N2 parapet between bascule and railway span on north side, so 1.5m high parapet can be considered for North spans after railway span in detailed design stage. Material of parapet steel/concrete will be considered at detailed design stage.

A transition length will be provided between the very high containment and the normal containment parapets where necessary. Transitions between safety barriers and parapets shall be provided in accordance with DD ENV 1317-4. Road restraint risk assessment process (RRRAP) is included in Appendix H.

3.8 Proposed arrangements for future maintenance and inspection

The structure will be subject to regular General and Principal Inspections in line with Suffolk County Council's agreed programme of inspection.

The posttensioned deck has 5m depth at pier locations and a minimum depth of 2.4m at mid span to provide adequate headroom for inspection.

External post-tensioning within box is chosen to ensure posttensioned tendons can be inspected and replaced in the future. In order to allow for the replacement of tendons in the future design need to consider removal of 2 No. tendons under LM1 and LM2 loading.

Transverse tendons are required for the section supporting the bascule bridge. These strands will be within a HDPE sheath, filled with grease and therefore unbonded. For replacement, the existing strand will be connected to the existing and pulled out.

Access routes for inspection and jacking points to relieve the bearings of load will be provided. Additionally, it must by physically possible to replace the existing bearings. For bearing arrangements refer to Appendix C.

Expansion joint to accommodate temperature, creep and shrinkage movements are provided at water piers, north and south abutments. The joints will be able to be easily inspected and maintained and any part liable to wear will be designed to be easily replaceable.

For future maintenance of tracks supporting bascule bridge refer to bascule bridge OAIP.

3.8.1 Traffic management

Permission will be required from Associated British Ports and Network Rail for access to their land if an under-bridge inspection unit is used for close inspection of the underside of the structure.

A railway possession will also be required when a mobile underbridge inspection platform is used for inspection of areas over the railway.

3.8.2 *Arrangements for future maintenance and inspection of the structure. Access arrangements to structure.*

Access to the abutments will be via a 1500mm wide abutment gallery accessed by via permanent stair case. Alternative/emergency access will be provided through the deck flange over the pier 3 &6.

Access for inspection of the bridge soffit will be via an underbridge unit parked on the carriageway or cycleway verge above. A temporary closure of a carriageway lane or the cycleway verge will be required for this operation.

Access for inspection of posttensioned box will be provided at both ends of north and south approach viaduct and will be classified as confined space.

Access for maintenance of the abutments and piers will be required from ground under the structure. Access to the piers in the lake will be via a boat/barge. Further details can be found in Appendix C (1069948-WSP-SGN-LL-DR-CB-0026).

Details of requirement for permanent and temporary land acquisition can be found in the Appendix C (1069948-WSP-SGN-LL-DR-CB-0029&0030)

3.9 Environment and sustainability

An Environmental Statement (ES) will be submitted alongside the planning application for the scheme and its findings will be implemented.

Any protected species in the area will be appropriately protected during construction.

All applicable permanent and temporary consents required will be obtained from the Environment Agency.

A positive drainage system comprising deck mounted combined kerb drainage units and surface drainage channels will be installed. These will discharge into suitable pollution control features to reduce the risk of water pollution or degradation prior to discharge into Lake Lothing. All permanent and temporary consents required will be obtained from the Environment Agency.

3.10 Durability. Materials and finishes

3.10.1 *Materials*

Concrete

Element	Exposure Class
Blinding Concrete	N/A
Abutment	XC3/4, XD1, XF1
Parapet edge beam	XC3/4, XD3, XF4
Piers	XC3/4, XD1, XF1
Deck	XC3/4, XD1, XF1
Pile caps	XC2, XD2
Piles	DC-4 AC-3 See also Table 2

Table 1

Concrete strength, cover etc. to be confirmed in detailed design.

STRUCTURE NAME	ACEC CLASS OF SITE *[derived from BRE SD1]*	STRUCTURAL PERFORMANCE LEVEL	DESIGN CHEMICAL CLASS	OTHER REQUIREMENTS AND DESIGN CONSTRAINTS *[E.g. Limitations on drainage, Additional Protective Measures required etc.]*
Lake Lothing Third Crossing	AC3	100 years*	DC4	

Table 2 – Exposure class for buried concrete

*Note * SD1 provides for 1 in 100 year design*

Reinforcement

Reinforcement shall be Grade B500B ribbed reinforcement in accordance with BS 4449:2005+A2:2009, BS 8666:2005+A1:2008 and BS EN 1992-1:2004.

Characteristic yield strength for reinforcement bars f_{yk} = 500Mpa.

Ultimate tensile strength for steel in posttensioned strands f_{pu}= 1860 Mpa.

Yield strength for steel in posttensioned strands f_{yk}= 1670 Mpa.

Bond: Minimum relative rib area $f_{R,min}$ in accordance with Table C.2N of BS EN 1992-1:2004.

Any stainless steel reinforcement used in the structure shall conform to BS 6744:2001 Grade 500.

Waterproofing

The upper surface of the concrete bridge deck shall receive a spray-applied waterproofing system in accordance with SHW clause 2003 and complying with BD47/99. The waterproofing shall be applied to the internal face of the parapet edge beam to 100mm above the adjacent deck surface. The waterproofing shall also be taken down the rear face of the abutments to 200mm below the construction joint at the base of the abutment gallery wall. All buried concrete surfaces shall be waterproofed with two coats of bituminous resin waterproof paint in accordance with SHW clause 2004.

Superstructure Surface Water

The structure is at the summit of a vertical curve and has a longitudinal fall to the South and North and transverse falls. A combined kerb and drainage system will be provided along the full length of the bridge and shall connect into the road drainage system off the bridge. Combined drainage units shall comply with the requirements of the SHW as clarified and/or amended by IAN 117/08.

Superstructure Sub-Surface Water

The kerb deck drainage units will be slotted to collect sub-surface water.

Perforated sub-surface drainage conduits will be provided on the low side(s) of the deck and positively drained to discharge into the road drainage system off the bridge deck.

Substructure

A permeable backing layer in accordance with Cl. 513 shall be provided behind the abutment, with a 150mm diameter perforated drainage pipe installed at the base. It is proposed that the water collected behind the abutments shall be positively drained and connected to highway drainage system with adequate facilities for rodding.

3.10.2 *Finishes*

Exposed formed faces	F4
Buried formed faces	F1

Formed faces to receive bridge deck waterproofing	F3
Bridge deck soffit cantilever	F2
Surfaces to receive bridge deck waterproofing	U4
Abutment exposed faces	F4
Wing Wall exposed faces	F4
Pier column faces	F5
Exposed unformed surfaces	U3
Buried unformed surfaces	U1
Parapet edge beam	F3

In accordance with CHE Memo 227/08 pore lining impregnation will not be applied.

Bridge lighting strategy will be covered in a separate document and will not form part of this OAIP.

3.10.3 *Protective coating systems*

Bearings: Stainless steel bearings of grade 316 (1.4401) to BS EN10088 to avoid future maintenance cost

3.11 Risks and hazards considered for design, execution, maintenance and demolition. Consultation with and/or agreement from Principal Designer

The risks and hazards to both the general public and workforce during the construction, operation, maintenance and demolition of the bridge have been considered in a design risk assessment and will be reviewed as design progresses. The key points are:

(i) The viaducts will be constructed as in situ balance cantilever utilising Form Traveller, risks associated with this type of construction

(ii) The bridge will be constructed over the Lake Lothing and the east Suffolk line.

(iii) A construction sequence will be stated on the construction drawings, as stated in Section 5.1, to ensure stability of all elements of the structure during all phases of construction.

The Principal Designer is satisfied that the Designers for this structure are currently complying with their duties under Managing Health and Safety in Construction – Construction (Design and Management) Regulations 2015 – Guidance on Regulations (L153). For further details Designer's risk assessment can be found in the Appendix D.

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

Few options were considered for superstructure and span arrangements as stated below:

1- Land mark structures such as cable stayed bridge with two pylons either side of the bascule bridge, discounted base on significantly construction cost in comparison to the other options.

2- Steel, this option was discounted, due to high Capital and Whole Life Cost. Steel options would require repainting every 25 years.

3- Hybrid Option, this option utilises precast, Pre-stressed beams for all spans except over the railway line which required a steel span. The capital cost of this option is slightly cheaper than the proposal, however the Whole Life is higher due to maintenance requirements of the steel bridge over the railway. In addition aesthetically this option is not pleasing in comparison to the other options, due to varying edge cantilevers and also two material types used. The option of weathering steel is also considered and has been discounted as weathering steel is not suitable for marine environment.

4- In situ post-tensioned option with balance cantilevers, this option is proposed based on low maintenance over the railway, ease of construction, aesthetically pleasing structure and low whole life costing.

An option with four piers in the lake was also considered and discounted based on various disadvantages in comparison to two pier option.

Several options have also been considered for the bascule bridge including a single leaf bascule option, a double leaf bascule option and a single leaf rolling bascule option. Being the last one the preferred due to its smaller cost and better aesthetics.

For details of option refer to Bridge Design Options Report document ref: 1069948-MOU-SGN-LL_C13-CD-CB-0001, in Appendix E.

3.13 Proposed arrangements for construction

3.13.1 *Construction of structure*

The approach viaducts will be constructed using balance cantilever construction utilising Form Traveller techniques. For construction phasing see Section 5.1.

For the construction of the span over the railway the deck will be constructed using balance cantilevers parallel to the track over pier 7. Then, the deck will be rotated into position under track possession. Temporary props will be required for the rotation process as detailed in Appendix F.

Contractor to propose monitoring system, this will include as a minimum real time monitoring of all the points of permanent and temporary support.

3.13.2 *Traffic management*

None identified at this stage.

3.13.3 *Service diversions*

Liaison with statutory undertakers and corresponding surveys have been undertaken to determine locations of services.

3.13.4 *Interface with existing structures*

The foundation of pier 6 is located at approx. 7m from the existing quay structure. This structure needs to be considered during the construction process to avoid overloading.

The foundation of pier 5 is located at approx.3.4m from the retaining structure. This structure needs to be considered during the construction process to avoid overloading.

4 DESIGN CRITERIA

4.1 Actions

4.1.1 *Permanent actions*

All permanent actions are as outlined in BS EN 1991-1-1 and the National Annex;

- The nominal density of 'normal weight' concrete with a normal percentage of reinforcing steel will be taken as 25kN/m³ (26kN/m³ unhardened).
- The pavement material will be designed for a nominal density of 23kN/m³.
- The permanent formwork type and loading will be determined during detailed design.
- The verge infill material will be 'normal weight' concrete, with a nominal density of 24kN/m³ (25kN/m³ unhardened)
- No fill material is being used on the bridge structure in which any significant change in density is anticipated.

All the above values are in accordance with Annex A of BS EN 1991-1-1.

4.1.2 *Snow, Wind and Thermal actions*

All snow, wind and thermal actions are as outlined in BS EN 1991-1-3, 4 and 5 and the appropriate National Annexes.

Snow should be considered in accordance with local conditions. For those conditions prevailing in the United Kingdom, this loading should generally be ignored (refer NA 4.1.1 to BS EN 1991-1-3).

Thermal loading is to be applied in accordance with BS EN 1991-1-5 and the National Annex. Approach 2 will be used for the vertical temperature difference in the bridge.

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

Load models LM1 and LM2 shall be as outlined in BS EN 1991-2 and the appropriate National Annex. Clause 4.4.1, 4.4.2 and 4.6 for horizontal and fatigue loading of BS EN 1991-2 will be considered along with relevant NA clauses.

4.1.4 *Actions relating to General Order traffic under STGO regulations*

Load model LM3 designed for SV80, SV100, SV196 with accompanying Load Model 1.

4.1.5 *Footway or footbridge variable actions*

The verges shall have footway live loading applied as outlined in BS EN 1991-2 and the appropriate National Annex.

Accidental wheel loads shall be considered in the design of raised verges as outlined in BS EN 1991-2.

4.1.6 *Actions relating to Special Order traffic, provision for exceptional abnormal indivisible loads including location of vehicle track on the deck cross section.*

None.

4.1.7 *Accidental actions*

The design will take into account accidental actions, including impact on the supporting substructure not covered by fenders and superstructure, as outlined in NA BS EN 1991-1-7 Table NA.1 and the appropriate National Annex and IAN 124.

Impact load from shipping will be considered for pier 4 and 5 as detailed in section 1.10 of fender design technical note in Appendix G.

For impact loading to substructure and superstructure by derailment load in the hazard zone need to be considered as per railway standard GC/GN5612 issue 1.

For access to ABP land, pier 6 will be protected by Trief kerbs and will be designed for vehicle collision load as outlined in NA BS EN 1991-1-7 Table NA.1.

4.1.8 *Action during construction*

The design will take into account any adverse actions during execution as outlined in BS EN 1991-1-6 and the appropriate National Annex.

The criteria associated with serviceability limit states during execution will be the same as those applicable to the completed structure.

4.1.9 *Any special action not covered above*

The design will take into account the load that the bascule bridge applies to the south approach structure.

The design will take into account actions related to inspection works such as the load imposed by an underbridge unit supporting over the deck, according to BS EN 1991-2:2003.

The design will also take into account the future provision of an additional traffic lane by reducing the width of verges to 2.5m.

For approach dolphin fenders, with the 30° and perpendicular fender alignment an energy absorption of 3,466kNm is required. This fender unit would have an operational reaction

force of 4,575kN which would be the design load for the dolphin piles. Further detail of fender design can be found in Appendix G.

The impact of the bascule span striking the nose shock absorbers at the full operating speed at pier 5 will be considered.

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

None.

4.3 Minimum headroom provided

The headroom at the railway span shall not be less than 4.90 metres above the highest rail of the east Suffolk line.

Associated British port requires a 5.3m headroom at the north approach viaduct and will be considered as outline in TD 27/05.

4.4 Authorities consulted and any special conditions required

Authority	Plant/Apparatus	Special Conditions
Network Rail	None	• Headroom requirement as detailed in section 4.3. • Track and vibration monitoring will be required during the construction of the bridge span over the railway for all permanent and temporary works. • Surface water drainage from the bridge over the railway should all be directed away from NR land. • During the rotation of the railway span if adopted, would require possession details of which to be submitted to NR review and acceptance bearing in mind some possessions takes a long while to materialise. • Railway possession also need to be considered for permanent works if position of crane is such that pointing towards railway tracks. • Any crane lift near the railway would require a WPP with lifting plan for NR review and acceptance.
Associated British Ports	None	Headroom requirement as detailed in section 4.3.
Environment Agency	None	

Table 3

4.5 Standards and documents listed in the Technical Approval Schedule

See attached schedule in Appendix A.

4.6 Proposed Departures relating to departures from standards given in 4.5

Departure from standard for bespoke connection for parapet between approach and movable span.

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

None proposed.

5 STRUCTURAL ANALYSIS

5.1 Methods of analysis proposed for superstructure, substructure and foundations

The design of all the structural elements will take full account of the effects resulting from the construction sequence.

The anticipated construction sequence is:

a) Construct foundations.

b) Construct piers.

c) Construct abutments and wing walls.

d) Install geotechnical monitoring Instrumentation.

e) Construct embankments in accordance with the requirements of the Construction Sequence as set out in the 600 Series Specification.

f) Construct the first section of the deck over piers 3, 6 and 7 providing temporary support to avoid rotation of the deck.

g) Construct the deck by balanced cantilever method including the construction of the deck over pier 7 and the rotation of this part to its final position and connection with the rest of the deck.

h) Construction of the last part of the spans adjacent to the water piers (approximately 20m) using temporary supports on the water.

i) Install bridge verges and carriageway surfacing.

j) Install bridge furniture.

Superstructure

To be confirmed in detail design.

Foundations

To be confirmed in detail design.

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

To be confirmed after geotechnical investigation.

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

At the time of writing this AIP a Geotechnical Design Report had not been created and a Ground Investigation had not been undertaken. The information provided in this section is based on preliminary desk study investigations and is therefore are indicative only.

The ground conditions have been made based the British Geological Survey (BGS) Geological Map Sheet 176 for the Lowestoft area and the borehole information contained within the following GI Factual Reports:

- The East Anglian Ice Company Limited – September 1909
- Ground Engineering Ltd, dated 1991/1992
- Terresearch, dated 1962
- Alan Everett, dated May 1983

A total of 47 No. historic geotechnical boreholes located within the site corridor from four different geotechnical investigations. In addition, a 552.5m deep water well, drilled by the East Anglian Ice Company Ltd in 1909, providing a record of the geology present at depth. The anticipated ground conditions are summarised below in Table 6.1.

Stratum	Top of Stratum (Range)		Base of Stratum (Range)		Thickness (Range) (m)	Typical Descriptions
	Elevation (m AOD)	Depth (m bgl)	Elevation (m AOD)	Depth (m bgl)		
Made Ground	+5.28 to +2.37	0 to 1	+4.58 to -2.59	0.7 to 5	0.7 to 5	A mixture of materials comprising silty sands with varied amounts of clay and flint gravel inferred to be reworked Chalky Boulder Clay and Glaciofluvial deposits. Also contains brick, concrete and other building materials. Can also contain inorganic household waste. Note: Some boreholes located near Quay walls described an oily odour. Generally a granular deposit.
Peat	+0.24 to -1.76	2.8 to 4.5	-0.16 to -3.06	3.2 to 5.8	0.4 to 1.3	Peat generally comprises a firm, black fibrous Peat with varied sand content and pockets of clay.
Alluvium	+3.23 to -8.46	0 to 12.5	+2.53 to -11.46	0.4 to 15.5	0.3 to 3.9	Generally cohesive comprising grey to dark brown sand, silt or silty clay with varied gravel and organic content. Generally of low strength, soft to firm, with some plasticity. May also comprise thin lenses of peaty sand. River bed deposits encountered in the Central Crossing generally comprise a very soft Silt with varied sand content and minor gravel.
Granular Glaciofluvial	+4.58 to -20.57	0.4 to 21.8	+0.72 to -30.16	2.0 to 24.1	0.3 to 12.8	Glaciofluvial material can generally be grouped into two units. A granular sand and flint gravel upper unit overlying sands with silty and sandy clay layers. Layers are not laterally continuous and vary between boreholes. It is often hard to distinguish the Glaciofluvial from Alluvium. The thickness of the deposit is expected to
Cohesive	+3.07 to -21.09	1.4 to 23.5	+1.97 to -23.05	2.3 to 26	0.2 to 7.75	

Stratum	Top of Stratum (Range)		Base of Stratum (Range)		Thickness (Range) (m)	Typical Descriptions
	Elevation (m AOD)	Depth (m bgl)	Elevation (m AOD)	Depth (m bgl)		
Glaciofluvial						decrease to the north and south of Lake Lothing.
Crag	-18.03 to -30.16	14.4 to 26	-22.04 to -46.07	25 to 40.65	0.3 to 25*	Typically uniformly graded, dense to very dense dark grey medium grained sand with shells, fine gravel and occasional clay layers.

Table 6.1 Summary of Anticipated Ground Conditions

Limited information of the Topography of the scheme is available at the point of writing this document. To the north of the scheme along Denmark Road where the proposed crossing commences ranges in elevation from approximately 4.80m AOD in the west to 3.10m AOD to the east. Limited data is available for the Network rail land south of Denmark road and only a single point is available with the north side of the harbour at 3.15m AOD. The South Quay wall at the location of the proposed crossing ranges in elevation between 2.66m AOD to 2.83m AOD. Heading in the direction of the approach to the bridge the ground elevation raises to 3.42m AOD at Riverside Road which remains relatively levels leading to the junction with the B1531. The land located to the north east of the junction is at a reduced elevation to the road levels that range approximately between 2.35m AOD to 2.75m AOD.

Existing ground level at the bridge crossing varies between +3.47m OD at the north abutment and +4.55m OD at the south abutment, with the bridge deck level varying between +10.60m OD at the north abutment to +15.97m OD at support 5 for the north approach viaduct. The bridge deck level varies between +12.81m OD at the south abutment to +16m OD at support 4 for the south approach viaduct. The bridge abutments will be founded approximately 2.0m below existing ground level at an elevation of approximately between +1.39m and +2.52m OD.

A preliminary assessment of the available geotechnical laboratory data has been undertaken based on the results presented in the four GI Factual Reports.

From the available laboratory tests preliminary characteristic geotechnical parameters have been assessed based on cautious estimates, taking account of the variability of the available data. Engineering judgement has been applied in order to consider the appropriateness of individual design values, final characteristic values are summarised in Table 6.3.

Characteristic Parameter	Units	Made Ground	Alluvium	Glaciofluvial Granular	Glaciofluvial Cohesive	Crag
Bulk Unit Weight γb	kN/m^3	20	17	17.5	20	18.5
SPT $N/N_{1(60)}$ Value [Characteristic]	-	Range 2– 26 [4]	Range 1 – 24 [2]	Range 3 – 120 [N = 6-1.13 *z]	Range 6 – 90 [N = 6-1.13 *z]	Range 11 – 56 [N = -1(7.9+ 1.08*z)

Characteristic Parameter	Units	Made Ground	Alluvium	Glaciofluvial Granular	Glaciofluvial Cohesive	Crag
Natural Moisture Content [Characteristic]	%	Range 5 – 45 [12]	Range 34 – 94 [50]	Range 10 – 29 [16]	Range 14 – 34 [25]	Range 18 – 19 [18]
Average Atterberg Limits (PL /LL / PI)	%	(18/32/13)	(25/54/32)	N/A	(19/39/21)	N/A
Critical angle of shearing resistance ($\varphi'_{cv,k}$)	Degrees	28	20	34	25	34
Effective Cohesion (c')	kN/m^2	0	0	0	0	0
Characteristic Undrained Shear Strength (Cu)	kN/m^2	N/A	8	N/A	$c_u = 5 - 5*z$	N/A
Coefficient of Volume Compressibility (m_v)	m^2/MN	N/A	Range 0.009 – 1.097 [??]	N/A	Range 0.002 – 0.6 [??]	N/A
Compressibility Index (Cc)	-	N/A	Range 0.02 – 0.11 [0.06]	N/A	Range 0.004 – 0.067 [0.02]	N/A
Undrained and Drained Young's Modulus (E_u / E')	MN/m^2	2.24 / 4	2 / 1.2	N/A / 6–1.13*z	6–1.13*z / 3.6–0.678*z	N/A / -1(7.9+1.08*z)
pH	-	-	7.9	-	8.1	-

Characteristic Parameter	Units	Made Ground	Alluvium	Glaciofluvial Granular	Glaciofluvial Cohesive	Crag
Water soluble Sulfate [2:1 Extract]	mg/l	-	100	-	100	-
BRE SD1 ACEC Classification	-	-	DS-1 AC-1	-	DS-1 AC-1	-

Notes:
z = depth

Table 6.3 Preliminary Characteristic Design Parameters

Groundwater strikes were measured and recorded in 31 of the boreholes recovered from the historic ground investigations located near the proposed site. The Strikes occur between 1.6m bgl and 10.2m bgl (0.8m OD and -7.2m AOD). Groundwater rises were generally limited to within 0.5m above the strike depth with a maximum rise of 6.3m recorded in BH41. The rise recorded in BH41 is not consistent with the overall site conditions due to the borehole being drilled very near to the Quay wall and Harbour. It is considered to be unrepresentative of actual ground conditions and should not be considered in design.

The geotechnical design (i.e. foundation and earthworks) for the bridge will be finalised when the Scheme GIR will be issued. The Designer will accept the recommendations from the GDR Report, which will be incorporated in the design.

Table 6.1 Summary of Anticipated Ground Conditions and Preliminary Characteristic Design Parameters

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

At the time of writing this document no GDR has been undertaken and the final design of the structure has not been confirmed.

The geological sections present the available geological data from the available Geotechnical Factual Reports

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

Details of this cannot be provided at this 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

Refer to Section 6.1 above for a summary of the available geotechnical data and justification of the preliminary geotechnical design assumptions.

7 CHECK

7.1 Proposed Category and Design Supervision Level

Category III

Design Supervision Level – DSL3

7.2 If Category 3, name of proposed Independent Checker

Category III checker to be confirmed at detailed design.

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

The Contractor will be responsible for the temporary works design including the stability of structures in the temporary construction situations. This will include, but is not limited to:

- Installation of temporary piling platforms and ramps.
- Installation of temporary supports to the piers and abutments.
- Temporary works associated with construction of deck.
- Type of proposal will be confirm at detailed design.

8 DRAWINGS AND DOCUMENTS

8.1 List of Drawings (Including Numbers) and Documents Accompanying the Submission

See Appendices below

APPENDIX A – Technical Approval Schedule "TAS"

APPENDIX B – Location Plan

APPENDIX C – General Arrangement Drawing

APPENDIX D – Designers Risk Assessment

APPENDIX E – Options Report

APPENDIX F – Construction Note

APPENDIX G – Fender Design Technical note

APPENDIX H – Road Restraint Risk Assessment Process (RRRAP)

9 THE ABOVE IS SUBMITTED FOR ACCEPTANCE

Signed	
Name	Mark Northing
Position Held	Design Team Leader
Engineering Qualifications	MEng, CEng, MICE
Name of Organisation	WSP
Date	02/03/18

10 THE ABOVE IS REJECTED/AGREED SUBJECT TO THE AMENDMENTS AND CONDITIONS SHOWN BELOW

Following aspects need to be considered further in detail design:

- Mean to avoid debris trapped against the wall of the deck and the treadplates (ie: debris shield).
- Consideration of mechanism for drop arm barriers and pedestrians gates for enough width on the walkway.
- Enough clearance needs to be provided between Trief kerbs and piers 6&7 to reduce risk of accidental impact.
- Details of ship impact loading and restraint arrangement for the lifting span
- 5.3m headroom to access ABP building needed, enough headroom had been provided at an envelope at this stage, exact location of access road and extent of headroom to be fixed at detail design.
- Containment level of safety barriers over approach spans has to be specified at detail design stage.
- The contents/recommendations/loading contained within the Fender Design Technical Note are only preliminary and need to be confirmed at detailed design AIP stage.

Signed	Colin Godfrey.
Name	COLIN GODFREY
Position held:	STRUCTURES MANAGER
Engineering Qualifications	BSc CEng MICE
TAA	Suffolk County Council
Date	2/3/18

APPENDIX A – Technical Approval Schedule "TAS"

Technical Approval Schedule "TAS"

Schedule of Documents Relating to Design of Highway Bridges and Structures using Structural Eurocodes

British Standards

Non-conflicting with Eurocodes.

Used	Document & Publication Date	Title
✓	BS 4449:2005 +A2:2009	Steel for the reinforcement of concrete etc.
	BS 4483:2005	Steel fabric for the reinforcement of concrete.
	BS 5896:2012	High tensile steel wire and strand for the prestressing of concrete. Specification
	BS 5930:2015	Code of practice for ground investigations
	BS 6031:2009	Code of practice for earthworks
	BS 6744:2001+A2:2009	Stainless steel bars for the reinforcement of and use in concrete. Requirements and test methods
	BS 6779-4:1999	Highway parapets for bridges and other structures. . Specification for parapets of reinforced and unreinforced masonry construction
	BS 7818:1995	Specification for pedestrian restraint systems in metal
	BS 8006-1:2010	Code of practice for strengthened/reinforced soils and other fills
✓	BS 8500-1:2015	Concrete - Complimentary British standard to BS EN 206-1. Method of specifying and guidance for the specifier
✓	BS 8500-2:2015	Concrete – Complementary British Standard to BS EN 206. Specification for constituent materials and concrete.
✓	BS 8666:2005+A1:2008	Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete - Specification
	BS EN 14388: 2002	Road traffic noise reducing devices - Specification

Eurocodes and associated UK National Annexes

All national annexes will be used with the list of documents below. . Users to confirm latest Amendments and Corrigenda.

Used	Eurocode Part	Title	Publication Date	UK National Annex Publication Date
	Eurocode 0	**Basis of Structural Design**		
✓	BS EN 1990 +A1:2005	Eurocode 0: Basis of structural design	27-Jul-02	15-Dec-04
	Eurocode 1	**Actions on Structures**		
✓	BS EN 1991-1-1	Actions on structures – Part 1-1: General actions – Densities, self-weight and imposed loads	29-Jul-02	30-Dec-05
✓	BS EN 1991-1-3	Actions on structures – Part 1-3: General actions – Snow loads	24-Jul-03	23-Dec-05
✓	BS EN 1991-1-4 +A1:2010	Actions on structures – Part 1-4: General actions – Wind actions	25-Apr-05	30-Sep-08
✓	BS EN 1991-1-5	Actions on structures – Part 1-5: General actions – Thermal actions	04-Mar-04	30-Apr-07
✓	BS EN 1991-1-6	Actions on structures – Part 1-6: General actions – Actions during execution	15-Dec-05	30-May-08
✓	BS EN 1991-1-7	Actions on structures – Part 1-7: General actions – Accidental actions	29-Sep-06	31-Dec 08
✓	BS EN 1991-2	Actions on structures – Part 2: Traffic loads on bridges	31-Oct-03	30-May-08
	Eurocode 2	**Design of Concrete Structures**		
✓	BS EN 1992-1-1 +A1:2014	Design of concrete structures – Part 1-1: General – Common rules for building and civil engineering structures	23-Dec-04	08-Dec-05
✓	BS EN 1992-2	Design of concrete structures – Part 2: Bridges	02-Dec-05	31-Dec-07
	Eurocode 3	**Design of Steel Structures**		
	BS EN 1993-1-1	Design of steel structures – Part 1-1: General rules and rules for buildings	18-May-05	31-Dec-08

Used	Eurocode Part	Title	Publication Date	UK National Annex Publication Date
	BS EN 1993-1-3	Design of steel structures. General rules. Supplementary rules for cold-formed members and sheeting	30-Nov-06	28-Feb-09
	BS EN 1993-1-4	Design of steel structures – Part 1-4: General Supplementary rules for stainless steel	30-Nov-06	28-Feb-09
	BS EN 1993-1-5	Design of steel structures – Part 1-5: General – Strength and stability of planar plated structures without transverse loading	30-Nov-06	30-May-08
	BS EN 1993-1-6	Design of steel structures – Part 1-6 Strength and stability of shell structures	31-May-07	-
	BS EN 1993-1-7	Design of steel structures – Part 1-7: General – Design values for plated structures subjected to out of plane loading	31-Jul-07	Not yet published
	BS EN 1993-1-8	Design of steel structures – Part 1-8: General – Design of joints	17-May-05	31-Dec-08
	BS EN 1993-1-9	Design of steel structures – Part 1-9: General – Fatigue strength	18-May-05	30-May-08
	BS EN 1993-1-10	Design of steel structures – Part 1-10: General – Material toughness and through thickness assessment	18-May-05	31-Dec-08
	BS EN 1993-1-11	Design of steel structures – Part 1-11: General – Design of structures with tension components	30-Nov-06	31-Dec-08
	BS EN 1993-1-12	UK National Annex to Eurocode 3: Design of steel structures – Part 1-12 Additional rules for the extension of EN 1993 up to steel grades S 700	31-May-07	30-May-08
	BS EN 1993-2	Design of steel structures – Part 2-1: Bridges	30-Nov-06	30-May-08
	BS EN 1993-5	Design of steel structures – Part 5: Piling	30-Apr-07	31-Mar-09
	Eurocode 4	**Design of Composite and Concrete Structures**		
	BS EN 1994-1-1	Design of composite steel and concrete structures – Part 1-1: General – Common rules and rules for buildings	18-Feb-05	29-Aug-08
	BS EN 1994-2	Design of composite steel and concrete structures – Part 2: Bridges	02-Dec-05	31-Dec-07

Used	Eurocode Part	Title	Publication Date	UK National Annex Publication Date
	Eurocode 5	**Design of Timber Structures**		
	BS EN 1995-1-1 +A2:2014	Design of timber structures – Part 1-1: General – Common rules and rules for buildings	15-Dec-04	31-Oct-06
	BS EN 1995-1-2	Design of timber structures – Part 1-2: General – Structural fire design	15-Dec-04	31-Oct-06
	BS EN 1995-2	Design of timber structures – Part 2: Bridges	15-Dec-04	31-Oct-06
	Eurocode 6	**Design of Masonry Structures**		
	BS EN 1996-1-1	Design of masonry structures – Part 1-1: General – Rules for reinforced and unreinforced masonry, including lateral loading	30-Dec-05	31-May-07
	BS EN 1996-1-2	Design of masonry structures – Part 1-2: General – Structural fire design	30-Jun-05	31-May-07
	BS EN 1996-2	Design of masonry structures – Part 2: Selection and execution of masonry	15-Feb-06	31-May-07
	BS EN 1996-3	Design of masonry structures – Part 3: Simplified calculation methods for masonry structures	15-Feb-06	31-May-07
	Eurocode 7	**Geotechnical design**		
✓	BS EN 1997-1 +A1:2013	Geotechnical design – Part 1: General rules	22-Dec-04	30-Nov-07
✓	BS EN 1997-2	Geotechnical design – Part 2: Ground investigation and testing	30-Apr-07	31 Mar 09
	Eurocode 8	**Design of Structures For Earthquake Resistance**		
	BS EN 1998-1 +A1:2013	Design of structures for earthquake resistance – Part 1: General rules seismic actions and rules for buildings	08-Apr-05	29-Aug-08
	BS EN 1998-2 +A2:2011	Design of structures for earthquake resistance – Part 2: Bridges	20-Dec-05	30-June-09
	BS EN 1998-5	Design of structures for earthquake resistance – Part 5: Foundations, retaining structures and geotechnical aspects	08-Apr-05	29-Aug-08
	Eurocode 9	**Design of Aluminium Structures**		
	BS EN 1999-1-1 +A2:2013	Design of aluminium structures – Part 1-1: General – Common rules	31-Aug-07	31-Dec-08

Used	Eurocode Part	Title	Publication Date	UK National Annex Publication Date
	BS EN 1999-1-2	Design of aluminium structures – Part 1-2: General – Structural fire design	30-Apr-07	31-Mar-09
	BS EN 1999-1-3 +A1:2011	Design of aluminium structures – Part 1-3: Additional rules for structures susceptible to fatigue	31-Aug-07	31-Dec-08
	BS EN 1999-1-4	Design of aluminium structures – Part 1-4: Supplementary rules for trapezoidal sheeting	30-Apr-07	31-Mar-09
	BS EN 1999-1-5	Design of aluminium structures – Part 1-5: Supplementary rules for shell structures	30-Apr-07	31-Mar-09

BSI Published Documents

Used	Document Reference	Title	Date of Issue
✓	PD 6688-1-1	Background paper to the UK National Annex to BS EN 1991-1-1 [Actions on structures – General Actions – Densities, self-weight and imposed loads]	May 2011
	PD 6688-1-4	Background paper to the UK National Annex to BS EN 1991-1-4 [Actions on structures – General Actions – Wind actions]	2015
✓	PD 6688-1-7 +A1:2014	Recommendations for the design of structures to BS EN 1991-1-7 [Actions on structures – General Actions – Accidental actions]	2009
✓	PD 6688-2	Recommendations for the design of structures to BS EN 1991-2 [Actions on structures – General Actions – Traffic loads on bridges]	Mar 2011
✓	PD 6687-1	Background paper to the UK National Annex to BS EN 1992-1 & 3 [Design of concrete structures]	Dec 2010
✓	PD 6687-2	Recommendations for the design of structures to BS EN 1992-2 [Design of concrete structures - Bridges]	2008
✓	PD 6694-1	Recommendations for the design of structures subject to traffic loading to BS EN 1997-1 [Geotechnical Design – General rules]	May 2011
✓	PD 6695-1-9	Recommendations for the design of structures to BS EN 1993-1-9 [Design of steel structures – General – Fatigue Strength]	2008
✓	PD 6695-1-10	Recommendations for the design of structures to BS EN 1993-1-10 [Design of steel structures – General – Material toughness and through thickness assessment]	2009
✓	PD 6695-2 + A1:2012 Incorporating Corrigendum No.1	Recommendations for the design of bridges to BS EN 1993 [Design of steel structures]	2008
✓	PD 6696-2 +A1:2012	Background paper to BS EN 1994-2 and the UK National Annex to BS EN 1994-2 [Design of composite steel and concrete structures – Bridges]	2007
	PD 6698	Recommendations for the design of structures for earthquake resistance to BS EN 1998 [Design of structures for earthquake resistance]	2009
✓	PD 6703	Structural bearings – Guidance on the use of structural bearings	2009
✓	PD 6705-2 +A1:2013	Recommendations for the execution of steel bridges to BS EN 1090-2	Dec 2010

Execution Standards

Used	Document Ref	Title	Date
	BS EN 1090-1 +A1:2011	Execution of steel structures and aluminium structures. Requirements for conformity assessment of structural components	2009
	BS EN 1090-2 +A1:2011	Execution of steel structures and aluminium structures. Technical requirements for steel structures	2008
	BS EN 1090-3	Execution of steel structures and aluminium structures. Technical requirements for aluminium structures	2008
	BS EN 13670	Execution of concrete structures	2009

Product Standards

Used	Document Ref	Title	Date
✓	BS EN 1337	Structural Bearings, Parts 1 - 11.	Various
✓	BS EN 10080	Steel for the reinforcement of concrete. Weldable reinforcing steel	2005
✓	BS EN 10025	Hot rolled products of structural steels, Pt 1 to 6, example see below:	2004
✓	BS EN 10025-5	Hot rolled products of structural steels. . Technical delivery conditions for structural steels with improved atmospheric corrosion resistance (weathering steels)	2004
✓	BS EN 206-1 Corrigenda Nos. 1 and 2 and Amendments Nos. 1, 2 and 3.	Concrete. Specification, performance, production and conformity	2013
✓	BS 5896	High tensile steel wire and strand for the prestressing of concrete - Specification.	2012
	prEN 10138-3	DPC Prestressing steels Part 3: Strand - under development use BS 5896.	
✓	BS EN 1317-1-2010	Road Restraints Systems – Part 1, Terminology and general criteria for test methods	2010
✓	BS EN 1317-2-2010	Road Restraints Systems – Part 2, Performance classes, impact test acceptance criteria and test methods for safety barriers	2010
	BS EN 1317-3-2010	Road Restraints Systems – Part 3, Performance classes, impact test acceptance criteria and test methods for crash cushions	2010
✓	DD ENV 1317-4-2002	Road Restraints Systems – Part 4, Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers	2002
	BS EN 13369	Common rules for precast concrete products	2013
	BS EN 15050	Bridge elements	2007
	BS EN 14844 +A2:2011	Box culverts	2006
✓	BS EN 15258	Retaining wall elements	2008
	BS EN 12843	Masts and poles	2004

Used	Document Ref	Title	Date
✓	BS EN 12794	Foundation piles	2005

The Manual of Contract Documents for Highway Works (MCDHW)

Used	Title	Date of Issue
✓	Volume 1: Specification for Highway Works	Feb 2016
✓	Volume 2: Notes for Guidance on the Specification for Highway Works	Feb 2016
✓	Volume 3: Highway Construction Details	Nov 2005

The Design Manual for Roads and Bridges (DMRB)

The following have been reproduced from the current alpha-numeric index in the DMRB, Volume 0, Section 1, Part 1, dated Sept 2015.

This must be read in conjunction with DEM 134/11, Annex C. . Annex C includes guidance in lieu of BA 36, BA 42, BA 57, BA 59, BA 84, BD 20, BD 57 and BD 70. .

Reference to be made to superscript notes for conditions of use where applicable. .

Used	Document Reference	Title	Date of Issue	Decimal Ref.
Design Manual for Roads and Bridges (DMRB)				
✓	GD 01/15	Introduction to the Design Manual for Roads and Bridges	Aug 2015	0.1.2
✓	GD 02/08	Quality Management Systems for Highway Design	May 2008	0.2.1
	GD 04/12	Standard for Safety Risk Assessment on The Strategic Road Network	Nov 2012	0.2.3
	GD 5/16	Asbestos Management in Trunk Road Assets.		0.2.4
Bridges and Structures, Advice Notes (BA Series)				
	BA 09/81	The Use of BS 5400: Part 10: 1980 Code of Practice for Fatigue Amendment No.1	Dec 1981 Nov 1983	1.3
	BA 16/97	The Assessment of Highway Bridges and Structures. Amendment No. 1 Amendment No. 2	May 1997 Nov 1997 Nov 2001	3.4.4
	BA 19/85	The Use of BS 5400; Part 3; 1982	Jan 1985	1.3
	BA 26/94	Expansion Joints for Use in Highway Bridge Decks	Nov 1994	2.3.7

Used	Document Reference	Title	Date of Issue	Decimal Ref.
	BA 28/92	Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures	Aug 1992	1.2.2
	BA 30/94	Strengthening of Concrete Highway Structures Using Externally Bonded Plates	Feb 1994	3.3.1
	BA 35/90	Inspection and Repair of Concrete Highway Structures	Jun 1990	3b
	BA 36/90	The Use of Permanent Formwork	Feb 1991	2.3.7
	BA 37/92	Priority Ranking of Existing Parapets	Oct 1992	2.3.2
	BA 38/93	Assessment of the Fatigue Life of Corroded or Damaged Reinforcing Bars	Oct 1990	3.4.5
	BA 39/93	Assessment of Reinforced Concrete Half-joints	Apr 1993	3.4.6
	BA 40/93	Tack Welding of Reinforcing Bars	Apr 1993	1.3.4
✓	BA 41/98	The Design and Appearance of Bridges	Feb 1998	1.3.11
	BA 42/96	The Design of Integral Bridges [Incorporating Amendment No.1 dated May 2003]	Nov 1996	1.3.12
	BA 44/96	Assessment of Concrete Highway Bridge and Structures	Nov 1996	3.4.15
✓	BA 47/99 [1]	Waterproofing and Surfacing of Concrete Bridge Decks	Aug 1999	2.3.5
	BA 51/95	The Assessment of Concrete Structures Affected by Steel Corrosion	Feb 1995	3.4.13
	BA 52/94	The Assessment of Concrete Highway Structures Affected by Alkali Silica Reaction	Nov 1994	3.4.10
	BA 53/94	Bracing Systems and The Use of U-Frames in Steel Highway Bridges	Dec 1994	1.3.13
	BA 54/94	Load Testing for Bridge Assessment	Apr 1994	3.4.8
	BA 55/06	The Assessment of Bridge Substructures and Foundations, Retaining Walls and Buried Structures	May 2006	3.4.9
	BA 57/01	Design for Durability	Aug 2001	1.3.8
	BA 58/94	Design of Bridges and Concrete Structures with External Unbonded Prestressing	Nov 1994	1.3.10
	BA 59/94	Design of Bridges for Hydraulic Action	May 1994	1.3.6
	BA 67/96	Enclosure of Bridges	Aug 1996	2.2.8
	BA 72/03	Maintenance of Road Tunnels	May 2003	3.2.3
	BA 82/00	Formation of Continuity Joints in Bridge Decks	Nov 2000	2.3.7
	BA 83/02	Cathodic Protection for Use in Reinforced Concrete Highway Structures	Feb 2002	3.3.3
	BA 85/04	Coatings For Concrete Highway Structures & Ancillary Structures	May 2004	2.4.3
	BA 86/06	Advice Notes on the Non-Destructive Testing of Highway Structures	Aug 2006	3.1.7
	BA 87/04	Management of Corrugated Steel Buried Structures Correction No.1 Correction No.2	Aug 2004 Feb 2006 Nov 2009	3.3.4

Used	Document Reference	Title	Date of Issue	Decimal Ref.
	BA 88/04	Management of Buried Concrete Box Structures	Aug 2004	3.3.5
✓	BA 92/07	The Use of Recycled Concrete Aggregates in Structural Concrete	May 2007	2.3.9
	BA 93/09	Structural Assessment of Bridges with Deck Hinges	Feb 2009	3.1.5
Bridges and Structures, Standards (BD Series)				
✓	BD 02/12	Technical Approval of Highway Structures	May 2012	1.1.1
	BD 07/01	Weathering Steel for Highway Structures	Nov 2001	2.3.8
	BD 09/81	Implementation of BS 5400: Part 10: 1980. Code of Practice for Fatigue	Dec 1981	1.3
	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 13/06	Design of Steel Bridges. Use of BS 5400 -3: 2000	May 2006	1.3.14
	BD 15/92	General Principles for The Design and Construction of Bridges: Use of BS 5400: Part 1: 1988	Dec 1992	1.3.2
	BD 16/82	Design of Composite Bridges. Use of BS 5400: Part 5: 1979 Amendment No.1	Nov 1982 Dec 1987	1.3
	BD 20/92	Bridge Bearings. Use of BS 5400: Part 9: 1983	Oct 1992	2.3.1
	BD 21/01	The Assessment of Highway Bridges and Structures	May 2001	3.4.3
	BD 24/92	Design of Concrete Bridges. Use of BS 5400 part 4: 1990	Nov 1992	1.3.1
	BD 27/86	Materials for the Repair of Concrete Highway Structures	Nov 1986	3.3
	BD 29/17	Design Criteria for Footbridges	May 2017	2.2.8
	BD 30/87	Backfilled Retaining Walls and Bridge Abutments	Aug 1987	2.1
	BD 31/01	The Design of Buried Concrete Box and Portal Frame Structures	Nov 2001	2.2.12
✓	BD 33/94	Expansion Joints for Use in Highway Bridge Decks	Nov 1994	2.3.6
✓	BD 35/14	Quality Assurance Schemes 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 37/01	Loads for Highway Bridges	Aug 2001	1.3.14
	BD 43/03	The Impregnation of reinforced and Prestressed Concrete Highway Structures using Hydrophobic Pore-Lining Impregnants *Note HA moratorium, ref TAA*	Feb 2003	2.4.2
	BD 44/15	The Assessment of Concrete Highway Bridges and Structures	Aug 2015	3.4.14
	BD 45/93	Identification Marking of Highway Structures	Aug 1993	3.1.1
✓	BD 47/99	Waterproofing and Surfacing for Concrete Bridge Decks	Aug 1999	2.3.4

Used	Document Reference	Title	Date of Issue	Decimal Ref.
	BD 48/93	The Assessment and Strengthening of Highway Bridge Supports	Jun 1993	3.4.7
	BD 49/01	Design Rules for Aerodynamic Effects on Bridges	May 2001	1.3.3
	BD 51/14	Portal and Cantilever Signs/Signal Gantries	May 2014	2.2.4
	BD 53/95	Inspection and Records for Road Tunnels	Jul 1995	3.1.6
✓	BD 54/15	Management of Post-tensioned Concrete Bridges	Feb 2015	3.2.5
	BD 56/10	The Assessment of Steel Highway Bridges and Structures	Jun 2010	3.4.11
	BD 57/01	Design for Durability	Aug 2001	1.3.7
✓	BD 58/94	The design of Concrete Highway Bridges and Structures with External and Unbonded Prestressing	Nov 1994	1.3.9
	BD 60/04	Design of Highway Bridges for Vehicle Collision Loads	May 2004	1.3.5
	BD 61/10	The Assessment of Composite Highway Bridges and Structures	Jun 2010	3.4.16
✓	BD 62/07	As Built, Operational and Maintenance Records for Highway Structures	Feb 2007	3.2.1
	BD 63/07	Inspection of Highway Structures	Feb 2007	3.1.4
	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 70/03	Strengthened/Reinforced Soils and Other Fills for Retaining Walls and Bridge Abutments Use of BS 8006; 1995, incorporating Amendment No.1 (Issue 2 March 1999)	May 2003	2.1.5
	BD 78/99	Design of Road Tunnels	Aug 1999	2.2.9
	BD 79/13	The Management of Sub-standard Highway Structures	Feb 2013	3.4.18
	BD 81/02	Use of Compressive Membrane Action in Bridge Decks	May 2002	3.4.20
	BD 82/00	Design of Buried Rigid Pipes	Aug 2000	2.2.10
	BD 84/02	Strengthening of Concrete Bridge Supports Vehicle Impact Using Fibre Reinforced Polymers	Aug 2002	1.3.16
	BD 85/08	Strengthening Highway Structures Using Externally Bonded Fibre Reinforced Polymer	Nov 2008	1.3.18
	BD 86/11	The Assessment of Highway Bridges and Structures For The Effects of Special Types General Order (STGO) and Special Order (SO) Vehicles	Nov 2011	3.4.19
	BD 87/05	Maintenance Painting of Steelwork	May 2005	3.2.2
	BD 89/03	The Conservation of Highway Structures	Nov 2003	3.2.4
	BD 90/05	Design of FRP Bridges and Highway Structures	May 2005	1.3.17
	BD 91/04	Unreinforced Masonry Arch Bridges	Nov 2004	2.2.14
	BD 94/07	Design of Minor Structures	Feb 2007	2.2.1
	BD 95/07	Treatment of Existing Structures on Highway Widening Schemes	Aug 2007	1.2.3

Used	Document Reference	Title	Date of Issue	Decimal Ref.
	BD 97/12	Assessment of Scour and Other Hydraulic Actions at Highways Bridges	May 2012	3.4.21
	BD 101/11	Structural Review and Assessment of Highway Structures	Nov 2011	3.4.22
Bridges and Structures, Technical memoranda (BE Series)				
	BE 13	Fatigue Risk in Bailey Bridges	Apr 1968	3.4
	BE 23	Shear Key Decks Amendment No.1 to Annex	Nov 1970 Jun 1971	1.3
	BE 05/75	Rules for The Design and Use of Freyssinet Concrete Hinges in Highway Structures	Mar 1975	1.3
	BE 07/04	Departmental Standard (Interim) Motorway Sign/Signal Gantries	Aug 2004	2.2
Traffic Engineering and Control, Standards (TD and TA Series)				
	TA 11/09	Traffic Surveys by Roadside Interview	Nov 2009	5.1.4
	TA 12/07	Traffic Signals on High Speed roads	May 2007	8.1.1
	TA 15/07	Pedestrian Facilities at Traffic Signal Installations	May 2007	8.1.1
	TA 16/07	General Principles of Control by Traffic Signals	May 2007	8.1.1
	TA 22/81	Vehicle Speed Measurement on All-Purpose Roads	Nov 1981	5.1
	TA 23/81	Junctions and Accesses Determination of Size of Roundabouts and Major/Minor Junctions	Dec 1981	6.2
	TA 30/82	Choice Between Options for Use in The Assessment of New Rural Roads	Jul 1982	5.1
	TA 46/97	Traffic Flows Ranges for Use in The Assessment of New Rural Roads	Feb 1997	5.1.3
	TA 49/07	Appraisal of New and replacement Lighting on The Strategic Motorway and All Purpose Trunk Road Network	Aug 2007	8.3
	TA 56/87	Hazardous cattle Crossings: Use of Flashing Amber Lamps	Nov 1987	8.2
	TA 57/87	Roadside Features [Chapters 2 and 3 are superseded by TD 69/07]	Jan 1989	6.3
	TA 60/90	The Use of variable Message Signs on All-Purpose and Motorway Trunk Roads	Aug 1990	8.2
	TA 64/94	Narrow Lanes and Tidal Flow Operations at Roadworks on Motorways and Dual carriageway Trunk Roads with Full Width Hard Shoulders	Apr 1994	8.4.3
	TA 66/95	Police Observation Platforms on Motorways	Jan 1995	6.3.2
	TA 68/96	The Assessment and Design of Pedestrian Crossings	Nov 1996	8.5.1
	*TA 70/97	Motorways. Introduction	Feb 1997	9.2.1

Used	Document Reference	Title	Date of Issue	Decimal Ref.
	*TA 71/97	Motorways. Overview	Feb 1997	9.3.1
	*TA 72/97	National Motorways Communications Systems (NMCS)	Feb 1997	9.4.1
	*TA 73/16	Emergency roadside telephone	Aug 2016	9.2.1
	*TA 74/05	Motorway Signalling	Nov 2005	9.4.3
	*TA 76/97	Motorway Control Offices	Feb 1997	9.4.5
	TA 78/97	Design of Road Markings at Roundabouts	Nov 1997	6.2.3
	TA 79/99	Traffic Capacity of Urban Roads Amendment No. 1	Feb 1999 May 1999	5.1.3
	TA 80/99	Surface Drainage of Wide Carriageways	Feb 1999	4.2.2
	TA 81/99	Coloured Surfacing in Road Layout (Excluding Traffic Calming)	Feb 1999	6.3.4
	TA 82/99	The Installation of Traffic Signals and Associated Equipment	May 1999	8.1.1
	TA 83/05	Guide to The Use of Variable Message Signs for Strategic Traffic Management on Trunk Roads and Trunk Road Motorways	Nov 2005	9.4.6
	TA 84/06	Code of Practice for Traffic Control and Information for Systems for All-Purpose Roads [Incorporates Correction dated Feb 2007]	May 2006	8.1.2
	TA 85/01	Guidance of Minor Improvements to Existing Roads	Nov 2001	6.1.3
	TA 86/03	Layout of Large Signal Controlled Junctions	Feb 2003	6.2.8
	TA 87/04	Trunk Road Traffic Calming	Feb 2004	6.3.5
	TA 90/05	The Geometric Design of Pedestrian, Cycle and Equestrian Routes	Feb 2005	6.3.5
	TA 91/05	Provision for Non-Motorised Users	Feb 2005	5.2.4
	TA 92/03	Crossover and Changeover Design	Nov 2003	8.4.6
	TA 98/08	The Layout of Toll Plazas	Feb 2008	6.3.6
	TD 07/07	Statutory Approval of Traffic Control Equipment	May 2007	8.1.1
✓	TD 09/93	Road Geometry and Highway link design Amendment No.1	Jun 1993 Feb 2002	6.1.1
	TD 11/82	Use of Certain Departmental Standards in The Design and Assessment of Trunk Road Schemes	Jul 1982	5.1
	TD 16/07	Geometric Design of Roundabouts	Aug 2007	6.2.3
	TD 17/85	Criteria for The Provision of Closed Circuit Television on Motorways	May 1985	9.3
	TD 18/85	Criteria for The Use of Gantries for Traffic Signs and Matrix Traffic Signals on Trunk Roads and Trunk Road Motorways	Jul 1985	9.1
✓	TD 19/06[1]	Requirement for Road Restraint Systems Correction No. 1	Aug 2006 Feb 2008	2.2.8

Used	Document Reference	Title	Date of Issue	Decimal Ref.
	TD 22/06	Layout of Grade Separated Junctions	Feb 2006	6.2.1
	TD 23/99	Trunk Roads and Trunk Road Motorways Inspection and Maintenance of Road Lighting	Nov 1999	8.3
	TD 24/97	All-Purpose Trunk Roads Inspection and Maintenance of Traffic Signals and Associated Equipment	Aug 1997	8.1
	TD 25/01	Inspection and Maintenance of Traffic Signs on Motorway and All-Purpose Truck Roads	Feb 2001	8.2.2
	TD 26/07[1]	Inspection and Maintenance of Road Markings and Road Studs on Motorway and All-Purpose Truck Roads	May 2007	8.2.2
✓	TD 27/05	Cross sections and Headroom	Feb 2005	6.1.2
	TD 33/05	The Use of Variable Message Signs on All-Purpose and Motorway Trunk Roads	Nov 2005	8.2.2
	TD 34/07	Design of Road Lighting for The Strategic Motorway and All Purpose Trunk Road Network	Aug 2007	8.3
	TD 35/06	All Purpose Trunk Roads MOVA System of Traffic Control at Signals	May 2006	8.1.1
	TD 36/93	Subways for Pedestrians and Pedal Cyclists, Layout and Dimensions	Jul 1993	6.3.1
	TD 37/93	Scheme Assessment Reporting	Aug 1993	5.1.2
	TD 39/94	The Design of Major Interchanges	Apr 1994	6.2.4
	TD 40/94	The Layout of Compact Grade Separated Junctions	Jul 1994	6.2.5
	TD 41/95	Vehicular Access to All Purpose Trunk Roads	Mar 1995	6.2.7
	TD 42/95	Geometric Design of Major/Minor Priority Junctions	Jan 1995	6.2.6
	TD 45/94	Motorway Incident Detection and Automatic Signalling (MIDAS)	Dec 1994	9.1.2
	TD 46/05	Motorway Signalling	Nov 2005	9.1.1
	TD 49/07	Requirements for Lorry Mounted Crash Cushions	Nov 2007	8.4.7
	TD 50/04	The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts	Nov 2004	6.2.3
	TD 51/03	Segregated Left Turn Lanes and Subsidiary Deflection islands at Roundabouts	Nov 2003	6.3.5
	TD 52/04	Traffic Signs to Tourist Attractions and facilities in England: Tourist Signing – Trunk Roads	Feb 2004	8.2.4
	TD 53/05	Traffic Signs to Retail Destinations and Exhibition Centres in England and Wales – Trunk Roads	Feb 2005	8.2.6
	TD 54/07	Design of Mini Roundabouts	Aug 2007	6.2.2
	TD 69/07	The Location and layout of Lay-Bys and Rest Areas	Nov 2007	6.3.3
	TD 70/08	Design of Wide Single 2+1 Roads	Aug 2008	6.1.4
	TD 72/17	Transmission Infrastructure	Feb 2017	9.3.1
	TD 89/08	Use of Passively Safe Signposts, Lighting Columns & Traffic Signal Posts to BS EN 12767	May 2008	8.2.2

Notes: Refer to Annex C of IAN 124 for additional guidance/ requirements. Check current position with IAN 97/07 Assessment and Upgrading of Existing Parapets and TD 19/06 Requirement for Road Restraint Systems.

Advice Notes – Highways (HA Series)				
	HA 13/81	The Planting of Trees and Shrubs	Feb 1981	5.2
	HA 37/97	Hydraulic Design of Road Edge Surface Water Channels	Aug 1997	4.2
	HA 39/98	Edge of Pavement Details	Aug 1998	4.2.1
	HA 40/01	Determination of Pipe and Bedding Combinations for Drainage Works	Nov 2001	4.2.5
	HA 41/90	A Permeameter for Drainage Layers	Apr 1990	4.2
	HA 44/91	Design and Preparation of Contract Documents Amendment No. 1	Jun 1991 Apr 1995	4.1.1
	HA 55/92	New Roads Landform and Alignment	Dec 1992	10.1.1
	HA 56/92	New Roads Planting, Vegetation and Soils	Dec 1992	10.1.2
	HA 57/92	New Roads Integration with Rural Landscapes	Dec 1992	10.1.3
	HA 58/92	New Roads The Road Corridor Amendment No. 1	Dec 1992 Feb 1997	10.1.4
	HA 59/92	Mitigating Against Effects on Badgers	Feb 1997	10.4.2
	HA 60/92	New Roads Heritage	Dec 1992	10.1.5
	HA 63/92	Improving Existing Roads Improvement Techniques	Dec 1992	10.2.2
	HA 65/94	Design Guide for Environmental Barriers	Jul 1994	10.5.1
	HA 66/95	Environmental Barriers – Technical Requirements	Sep 1995	10.5.2
	HA 67/93	The Wildflower Handbook	Jun 1993	10.3.1
	HA 70/94	Construction of Highway Earthworks	Dec 1994	4.1.5
	HA 74/07	Treatment of Fill and Capping Materials using Either Lime or Cement or Both	May 2007	4.1.6
	HA 75/01	Trunk Roads and Archaeological Mitigation	Feb 2001	10.6.1
	HA 78/96	Design of Outfalls for Surface Water Channels	Jan 1996	4.2.2
	HA 79/97	Edge of Pavement Details for Porous Asphalt Surface Cones	Feb 1997	4.2.4
	HA 80/99	Nature Conservation Advice in Relation to Bats	May 1999	10.4.3
	HA 81/99	Nature Conservation Advice in Relation to Otters	May 1999	10.4.4
	HA 83/99	Safety Aspects of Road Edge Drainage Features	Nov 1999	4.2.4
	HA 84/01	Nature Conservation and Biodiversity (supersedes the section in HA 59/92 (Nature Conservation). Mitigating Against Effects on Badgers is extant in 10.4.2)	Feb 2001	10.4.1
Advice Notes – Highways (HA Series)				
	HA 85/01	Road Improvement within Limited Land Take	Feb 2001	10.2.1

	HA 86/01	Principles and Guidance	Feb 2001	10.0.1
	HA 87/01	Environmental Functions	Feb 2001	10.0.2
	HA 88/01	Landscape Elements	Feb 2001	10.0.3
	HA 89/01	Environmental Elements	Feb 2001	10.0.4
	HA 90/01	Planning and Policy Features	Feb 2001	10.0.5
	HA 91/01	Environmental Database System	Feb 2001	10.0.6
	HA 92/01	Scheme Development, Implementation and Management	Feb 2001	10.0.7
	HA 93/01	Contract Performance Requirements	Feb 2001	10.0.8
	HA 94/01	Glossary of Terms	Feb 2001	10.0.9
	HA 97/01	Nature Conservation Management Advice in Relation to Dormice	Feb 2001	10.4.5
	HA 98/01	Nature Conservation Management Advice in Relation to Amphibians	Feb 2001	10.4.6
	HA 99/01	Policy and Guidance	Feb 2001	10.7.1
	HA 102/00	Spacing of Road Gullies	Nov 2000	4.2.3
	HA 103/06	Vegetative Treatment Systems for Highway Runoff	May 2006	4.2.1
	HA 104/09	Chamber Tops and Gully Tops for Road Drainage and Services: Installation and Maintenance	Nov 2009	4.2.5
	HA 105/04	Sumpless Gullies	Feb 2004	4.2.3
	HA 106/04	Drainage of Runoff from Natural Catchments	Feb 2004	4.2.1
	HA 107/04	Design of Outfall and Culvert Details	Nov 2004	4.2.7
	HA 108/04	The Landscape Management Handbook	Nov 2004	10.3.2
	HA 113/05	Combined Channel and Pipe System for Surface Water Drainage	Feb 2005	4.2.6
	HA 115/05	The establishment of An Herbaceous Plant Layer In Roadside Woodland	Feb 2005	10.3.3
	HA 116/05	Nature Conservation Advice in Relation to Reptiles and Roads	May 2005	10.4.7
	HA 117/08	Cultural Heritage Asset Management Plans	Aug 2008	10.6.2
	HA 118/06	Design of Soakaways	May 2006	4.2.8
	HA 119/06	Grassed Surface Water Channels for Highway Runoff	May 2006	4.2.9
	HA 120/08	Guidance on The Trenchless Installation of Services Beneath Motorways and Trunk Roads	Aug 2008	4.1.8
	HA 200/08	Aims and Objectives of Environmental Assessment Correction No. 1	Aug 2008 Aug 2009	11.1.1
	HA 201/08	General Principles and guidance of Environmental Impact Assessment	Aug 2008	11.2.1
	HA 202/08	Environmental Impact Assessment	Aug 2008	11.2.2
	HA 204/08	Scoping of Environmental Impact Assessments	Aug 2008	11.2.4

Advice Notes – Highways (HA Series)				
	HA 205/08	Assessment and Management of Environmental Effects	Aug 2008	11.2.5
	HA 207/07	Air Quality	May 2007	11.3.1
	HA 208/07	Cultural Heritage	Aug 2007	11.3.2
	HA 217/08	Alternative Filter Media and Stabilisation Techniques for Combined Surface and Sub-Surface Drains	Aug 2008	4.2.4
	HA 218/08	Glossary of Terms Used in The Design Manual for Roads and Bridges Volume 11 Sections 1 and 2	Aug 2008	11.2.7
	HA 219/09	Determination of Pipe Roughness and Assessment of Sediment Deposition to Aid Pipeline Design	Nov 2009	4.2.4
Highways, Standards (HD Series)				
	HD 19/15	Road Safety Audit	Mar 2015	5.2.2
	HD 20/05	Detector Loops for Motorways	Nov 2005	9.3.1
✓	HD 22/08	Managing Geotechnical Risk	Aug 2008	4.1.2
	HD 23/99	General Information	Feb 1999	7.1.1
	HD 24/06	Traffic Assessment Correction No. 1	Feb 2006 Nov 2006	7.2.1
	HD 26/06	Pavement Design	Feb 2006	7.2.3
	HD 27/15	Pavement Construction Methods	Sep 2015	7.2.4
	HD 28/15	Skidding Resistance	July 2015	7.3.1
	HD 29/08	Data for Pavement Assessment	May 2008	7.3.2
	HD 30/08	Maintenance Assessment Procedure	May 2008	7.3.3
	HD 31/94	Maintenance of Bituminous Roads Amendment No. 1 Amendment No. 2	Jan 1994 Mar 1995 Feb 1998	7.4.1
	HD 32/94	Maintenance of Concrete Roads	Jan 1994	7.4.2
	HD 33/16	Surface and Sub-Surface Drainage Systems for Highways	May 26	4.2.3
	HD 35/04	Conservation and The Use of Secondary and recycled Materials	Nov 2004	7.1.2
	HD 36/06	Surfacing Materials for New and Maintenance Construction	Nov 2006	7.5.1
	HD 37/99	Bituminous Surfacing Materials and Techniques Amendment No. 1	Feb 1999 May 1999	7.5.2
	HD 38/97	Concrete Surfacing and Materials Amendment No. 1	Aug 1997 Feb 1999	7.5.3
	HD 39/01	Footway Design	May 2001	7.2.5
	HD 41/15	Maintenance of Highway Geotechnical Assets	July 2015	4.1.3

Highways, Standards (HD Series)				
	HD 43/04	Drainage Data Management System for Highways	Nov 2004	4.2.4
	HD 44/09	Assessment of Implications (of Highways and/or Roads Projects) on European Sites (Including Appropriate Assessment)	Feb 2009	11.4.1
	HD 45/09	Road Drainage and The Water Environment	Nov 2009	11.3.10
	HD 47/08	Screening of Projects for Environmental Impact Assessment	Aug 2008	11.2.3
	HD 48/08	Reporting of Environmental Impact Assessment	Aug 2008	11.2.6
	HD 49/16	Highway Drainage Design Principal requirements	May 2016	4.2.1
	HD 50/16	The certification of Drainage Design	May 2016	4.2.1
	HD 213/11	Noise and Vibration Revision 1	Feb 2011 Nov 2011	11.3.7

Fender Design Standard:

Used	Document Ref	Title	Date
✓	BS6349-4:2014	Code of practice for design of fendering and mooring systems	
✓		PIANC “Ship Collisions due to the Presence of Bridges” INCOM report of WG19, 2001	
✓		PIANC “Guidelines for the design of Fender Systems”, 2002	

Roads Service Policy, Interim Advice and Miscellaneous

Used	Document Ref	Title	Date
✓	IAN 41/02	European cement standards	Jan 02
✓	IAN 48/03	Measures to minimise the risk of sulphate attack (including thaumasite) – New construction and structures under construction	Jan 03
	IAN 49/13	Use of warning signs for new asphalt road surfaces	Feb 13
✓	IAN 69/05	Designing for maintenance	Dec 05
✓	IAN 70/06	Implementation of new reinforcement standards (BS4449:2005, BS4482:2005, BS4483:2005 and BS8666:2005)	Jan 06
✓	IAN 95/07	Revised guidance regarding the use of BS8500:2006 for the design and construction of structures using concrete	May 07
✓	IAN 96/07r1	Guidance on implementing results of research on bridge deck waterproofing	Aug 07
✓	IAN 105/08	Implementation of construction (design and management) 2007 and the withdrawal of SD 10 and SD 11	Jan 08
✓	IAN 117/08 r2	Certification of combined kerb and drainage products	Jun 10
✓	IAN 124/11	Use of Eurocodes for the design of highway structures	Jul 11
✓	IAN 131/11	Deflection of permanent formwork	May 11
✓	IAN 154/12	Revision of clause 903, clause 921 and clause 942	Sep 12
✓	CIRIA C543	Bridge Detailing Guide	
✓	CIRIA C660	Early Thermal Cracking	
✓	CIRIA C686	Safe access for maintenance and repair	
✓	CIRIA R155	Bridges - design for improved durability	

Network Rail Standards for Bridge Design

As defined on NR standard NR/L3/CIV/020

Used	Document Ref	Title	Date
	NR/GN/CIV/001	Waterproofing of underline Bridge decks	
	NR/GN/CIV/002	The use of protective coatings and sealants	
	NR/GN/CIV/025	The structural Assessment of underbridges	
	NR/GN/CIV/202	Management of the risk of Bridge strikes	
✓	NR/L3/CIV/003	Technical Approval of design, construction and maintenance of Civil Engineering Infrastructure	
	NR/L1/AMG/1010	Policy on working safely in the vicinity of buried services	
	NR/L2/AMG/1020	Buried services data provision	
	NR/L2/AMG/1030	Working safely in the vicinity of buried services	
	NR/L2/AMG/1040	Buried services data feedback	
✓	NR/L2/CIV/140	Model Clauses for Civil Engineering works	
✓	NR/L2/CIV/177	Monitoring Track Over or Adjacent to Buildings and Civil Engineering Works	
✓	NR/BS/LI/349	Compatibility of materials specified in the Design of structures	
✓	NR/L3/CIV/005	Railway drainage systems manual	
	NR/L3/CIV/006	Handbook for the examination of structures	
	NR/L3/CIV/037	Managing the risk arising from mineral extraction and landfill operations	
	NR/L3/CIV/038	Managing the potential effects of coal mining subsidence	
	NR/L3/CIV/039	Specification for the assessment and certification of protective coatings and sealants	

	NR/L3/CIV/040	Specification for the use of protective coating systems	
	NR/L3/CIV/041	Waterproofing systems for underline Bridge decks	
✔	NR/L3/CIV/044	Planning, Design & Construction of Undertrack Crossings	
	NR/L3/CIV/071	Geotechnical design	
	NR/L3/CIV/076	Management of Bridge strikes from road vehicles and waterborne vessels	
✔	NR/L3/CIV/140	Model Clauses for Civil Engineering works	
	NR/L3/CIV/151	Technical Approval of Standard Details and Designs for Civil Engineering works	
✔	NR/L3/INI/CP0063	Piling Adjacent to the Running Lane	
	NR/L3/MTC/089	Asset management plan	
	NR/SP/ELP/21085	Design of earthing and bonding systems for 25 kV a.c. electrified lines	
✔	NR/L2/INI/CP0047	Application of the Construction (Design and Management) Regulations to Network Rail construction works	
	NR/SP/OHS/069	Lineside facilities for personal safety	
	NR/L1/TRK/05200	Vegetation	
	NR/L2/TRK/2049	Track Design handbook	
	NR/L2/TRK/2102	Design and construction of track	
	NR/L2/TRK/2500	Technical Approval in the design of track infrastructure	
✔	NR/L2/TRK/5100	Management of Fencing and Other Boundary Measures	
	NR/L2/TRK/038	Longitudinal timbers - design, installation and maintenance	
	RT/CE/C/015	The Assessment of underbridge capacity	
	RT/CE/S/035	Assessment of structures	

International Union of Railways

	UIC 719-R	Earthworks and track bed construction for railway lines
	UIC 774-3R	Track-Bridge interaction. Recommendations for calculations
✔	UIC 777-2R	Structures built over railway lines. Construction requirements in the track zone

Used	Network Rail Standards	
	GC/RT5033	Terminal tracks - requirements for buffer stops, arresting devices and end impact walls
✔	GC/RT5212	Requirements for defining and maintaining clearances
	GE/RT8006	Assessment of compatibility of rail vehicle weights and underline bridges
	GE/RT8073	Requirements for the application of standard vehicle gauges
	GE/RT8025	Electrical protective provisions for electrified lines
	GE/RT8029	Management of clearances and gauging [superseded]
	GI/RT7016	Interface between station platforms, track and trains
	GL/RT1253	Mitigation of d.c. stray current effects
	GM/RT2149	Requirements for defining and maintaining the size of railway vehicles
	GO/RT3413	Provision of information and signs for access on the railway
	GE/GN8573	Guidance on gauging.
✔	GC/GN5612	Guidance on loading requirements for design of railway structures

9 THE ABOVE IS SUBMITTED FOR ACCEPTANCE

Signed	
Name	Mark Northing
Position Held	Design Team Leader
Engineering Qualifications	MEng, CEng, MICE
Name of Organisation	WSP
Date	02/03/18

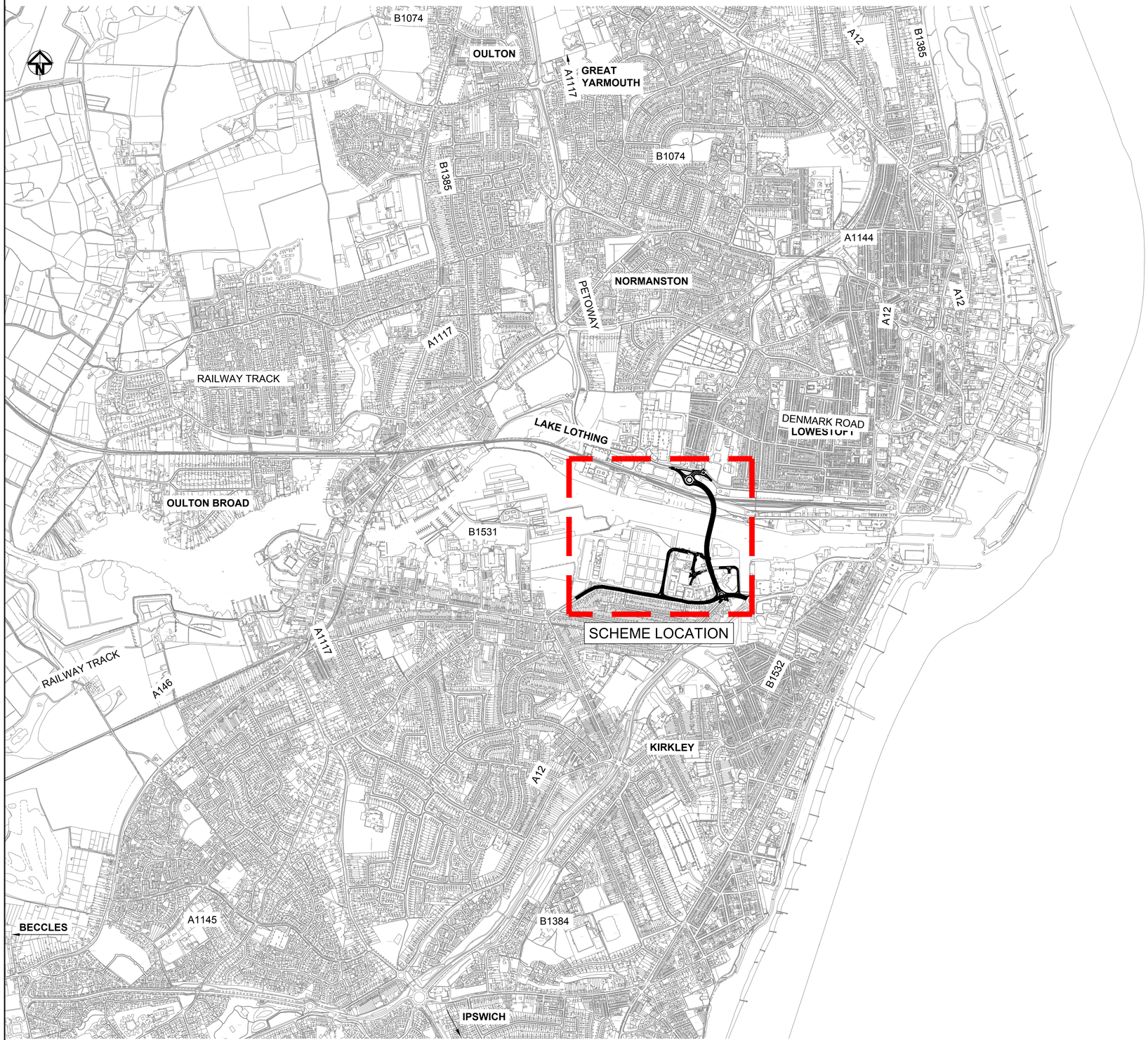
10 THE ABOVE IS REJECTED/AGREED SUBJECT TO THE AMENDMENTS AND CONDITIONS SHOWN BELOW

Following aspects need to be considered further in detail design:

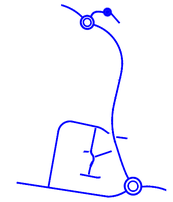
- Mean to avoid debris trapped against the wall of the deck and the treadplates (ie: debris shield).
- Consideration of mechanism for drop arm barriers and pedestrians gates for enough width on the walkway.
- Enough clearance needs to be provided between Trief kerbs and piers 6&7 to reduce risk of accidental impact.
- Details of ship impact loading and restraint arrangement for the lifting span
- 5.3m headroom to access ABP building needed, enough headroom had been provided at an envelope at this stage, exact location of access road and extent of headroom to be fixed at detail design.
- Containment level of safety barriers over approach spans has to be specified at detail design stage.
- The contents/recommendations/loading contained within the Fender Design Technical Note are only preliminary and need to be confirmed at detailed design AIP stage.

Signed	Colin Godfrey.
Name	COLIN GODFREY
Position held:	STRUCTURES MANAGER
Engineering Qualifications	BSc CEng MICE
TAA	Suffolk County Council
Date	2/3/18

APPENDIX B – Location Plan



OVERALL SCHEME PLAN (NTS)



LEGEND

NOTES

REVISION	DRAWN	CHECKED	APPROVED	DATE
P01	MS	RR	FQ	01/09/2017

DESCRIPTION: FIRST ISSUE

Suffolk County Council

PROJECT TITLE: Lake Lothing THIRD CROSSING

DRAWING TITLE: LOCATION PLAN

DRAWING STATUS: SUITABILITY

DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
MS	RR	FQ	MN	S0

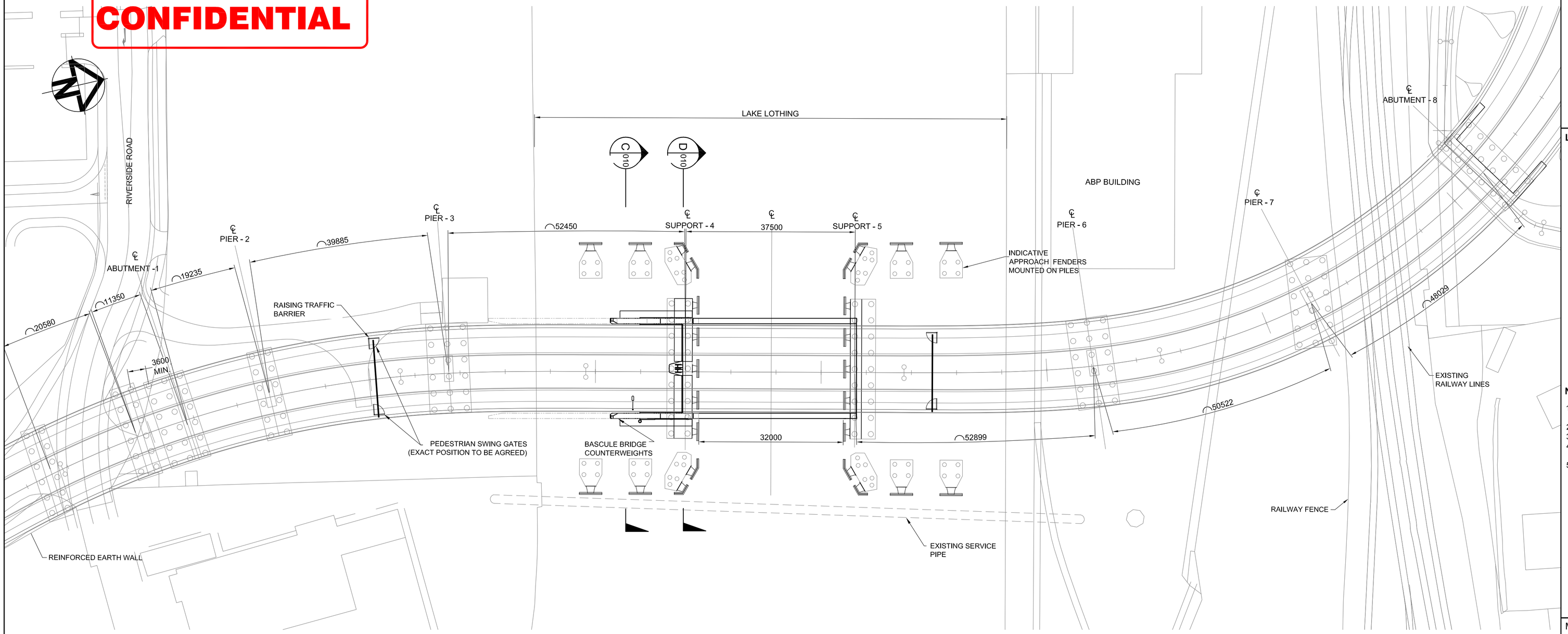
SCALE @ A1 SIZE	DATE	REVISION
1:10000	01/09/2017	P01

DRAWING NUMBER

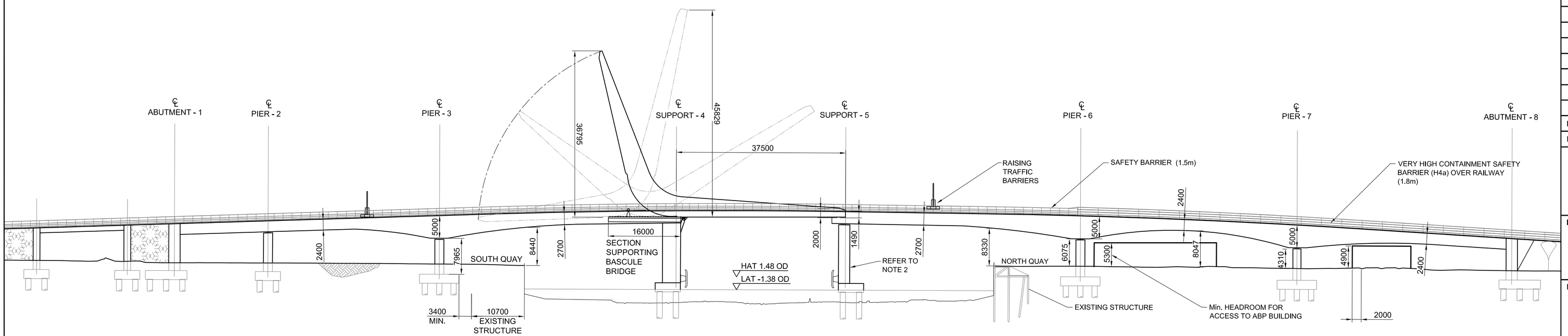
Project	Originator	Volume	Location	Type	Role	Number
1069948	WSP	SGN	LL	C13	DR	CB-0020

APPENDIX C – General Arrangement Drawing

DRAFT AND CONFIDENTIAL

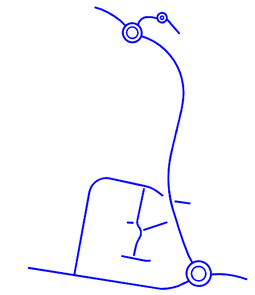


PLAN
SCALE 1:500



ELEVATION
SCALE 1:500

OVERALL SCHEME PLAN (NTS)



LEGEND

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. PIER SHAPE IS INDICATIVE AND IN DEVELOPMENT PROCESS.
3. FOR BEARING DETAILS REFER TO DRAWING 0019.
4. FOR ACCESS AND MAINTENANCE DETAILS REFER TO DRAWING 0026.
5. CONTAINMENT LEVEL OVER THE BASCULE BRIDGE AND APPROACH VIADUCTS WILL BE DEFINED AT DETAILED DESIGN.

REVISION	DRAWN	CHECKED	APPROVED	DATE
P15	KT	FQ	MN	13/02/2018
DECK SAFETY BARRIER AMENDED				

DESCRIPTION

Suffolk County Council

PROJECT TITLE

Lake Lothing THIRD CROSSING

DRAWING TITLE

LL3X APPROACH SPANS AND BASCULE BRIDGE PLAN AND ELEVATION

DRAWING STATUS

OAIP

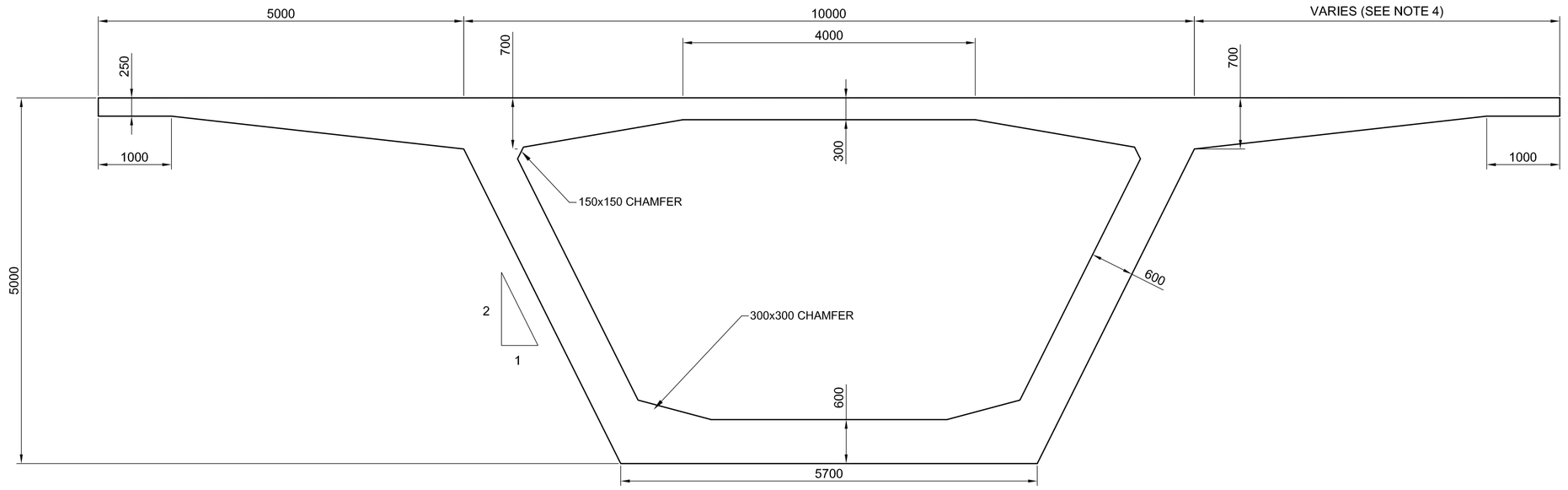
DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
EL	RR	FQ	MN	S0

SCALE @ A1 SIZE	DATE	REVISION
AS SHOWN	03/10/2017	P15

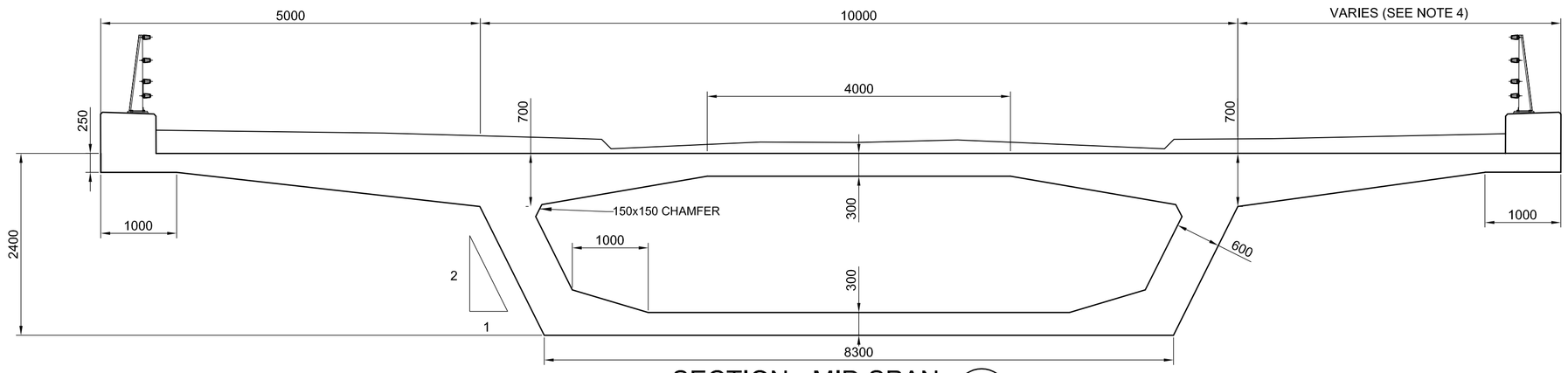
DRAWING NUMBER

Project	Originator	Volume	Location	Type	Role	Number
1069948	WSP	SGN	LL	C19	DR-CB	0011

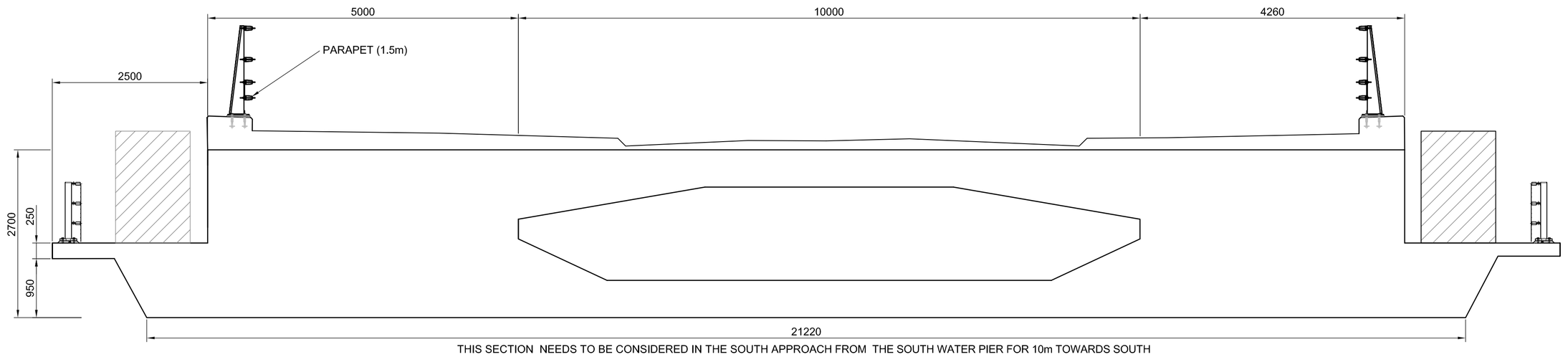
DRAFT AND CONFIDENTIAL



SECTION AT PIERS 3, 6 AND 7 (-)
Scale 1:50

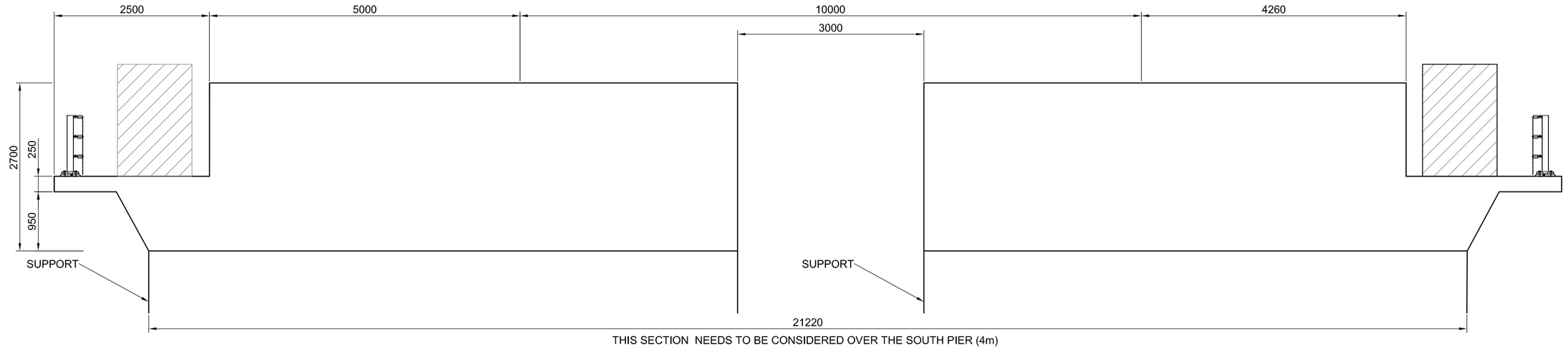


SECTION - MID SPAN (-)
Scale 1:50



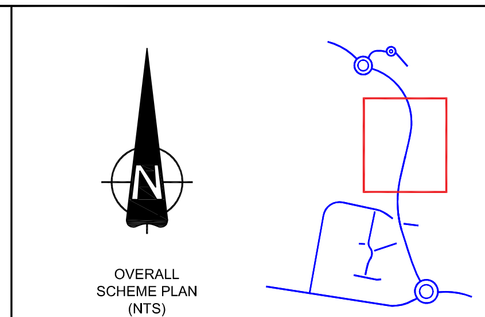
THIS SECTION NEEDS TO BE CONSIDERED IN THE SOUTH APPROACH FROM THE SOUTH WATER PIER FOR 10m TOWARDS SOUTH

SECTION - SUPPORTING BASCULE BRIDGE (C 011)
Scale 1:50



THIS SECTION NEEDS TO BE CONSIDERED OVER THE SOUTH PIER (4m)

SECTION - SUPPORTING BASCULE BRIDGE (D 011)
Scale 1:50



OVERALL SCHEME PLAN (NTS)

LEGEND

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. REFER TO DRAWING 0011 FOR GENERAL ARRANGEMENT DRAWING.
3. REFER TO DRAWING 0026 FOR ACCESS AND MAINTENANCE DETAIL.
4. CANTILEVER VARIES FROM 4260mm AT THE SOUTH VIADUCT TO 4860 AT THE NORTH ABUTMENT.
5. CONTAINMENT LEVEL OVER THE BASCULE BRIDGE AND APPROACH VIADUCTS WILL BE DEFINED AT DETAILED DESIGN.

REVISION	DRAWN	CHECKED	APPROVED	DATE
P08	KT	FQ	FQ	13/02/2018

PARAPET AMENDED ON DECK

DESCRIPTION

Suffolk County Council

PROJECT TITLE
Lake Lothing THIRD CROSSING

DRAWING TITLE
LL3X APPROACH SPANS AND BASCULE BRIDGE SECTIONS

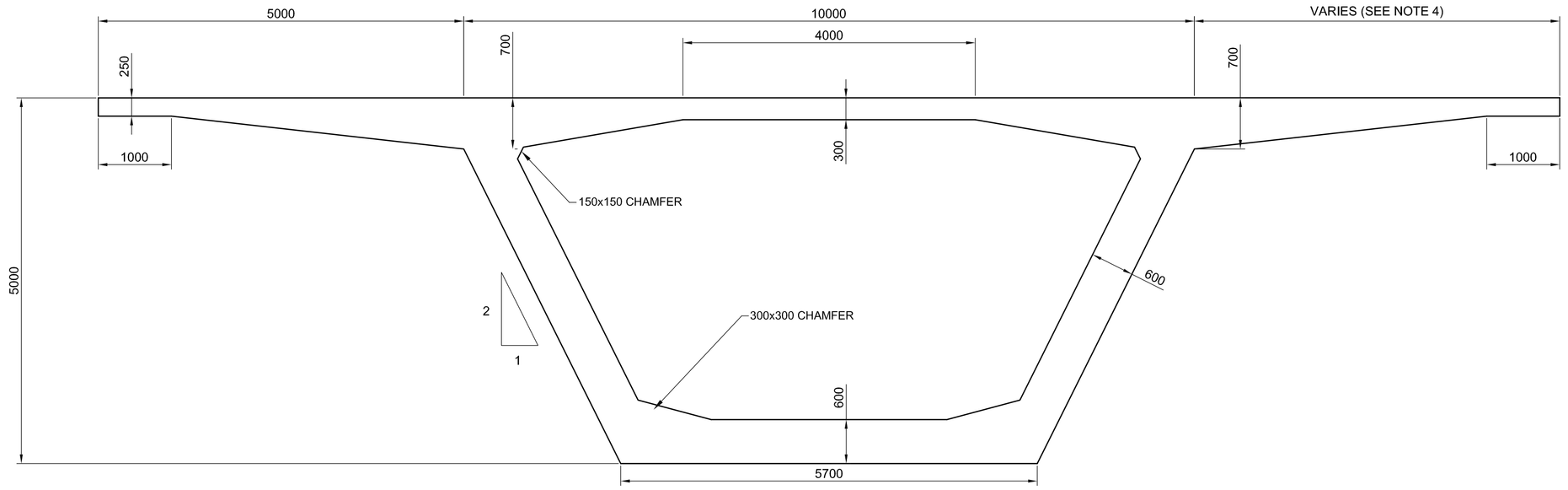
DRAWING STATUS
OAIP

DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
MS	RR	FQ	MN	S0

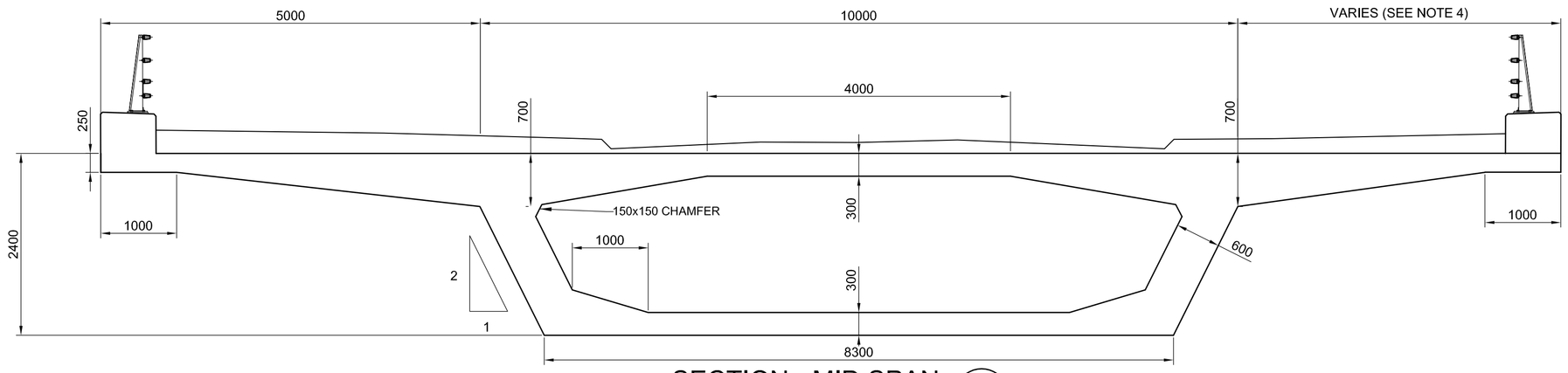
SCALE @ A1 SIZE	DATE	REVISION
AS SHOWN	05/10/2017	P08

DRAWING NUMBER
Project | Originator | Volume
1069948-WSP-SGN-LL_C19-DR-CB-0010
Location | Type | Role | Number

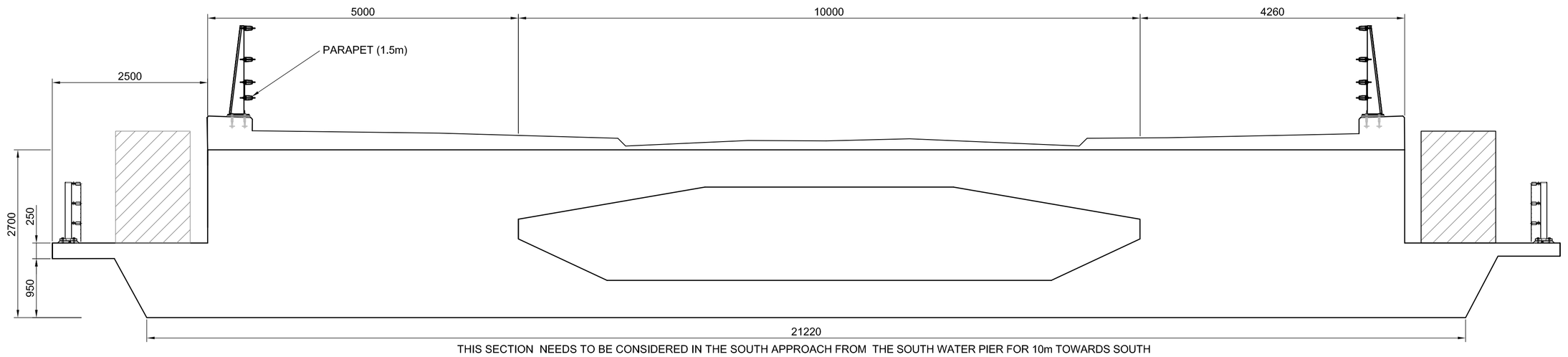
DRAFT AND CONFIDENTIAL



SECTION AT PIERS 3, 6 AND 7 (-)
Scale 1:50

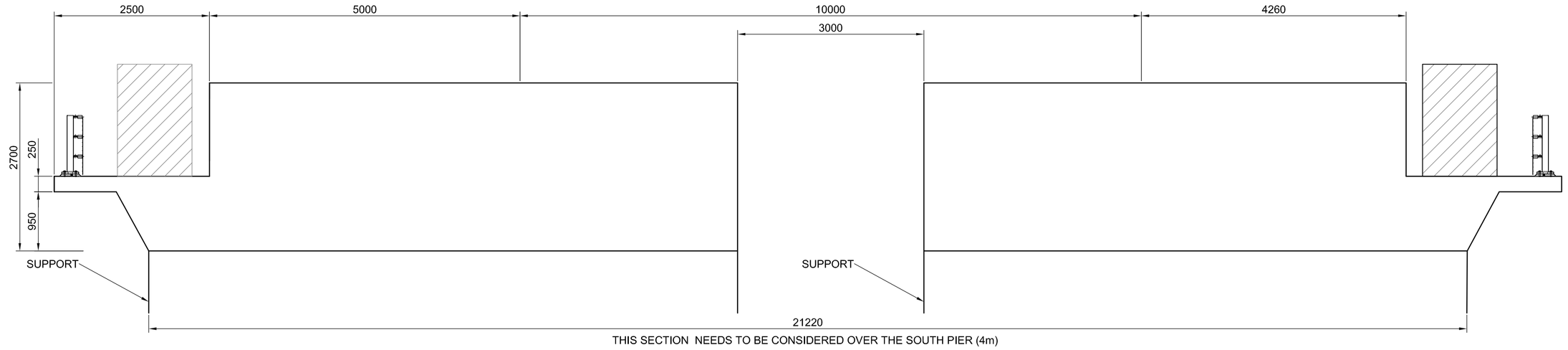


SECTION - MID SPAN (-)
Scale 1:50



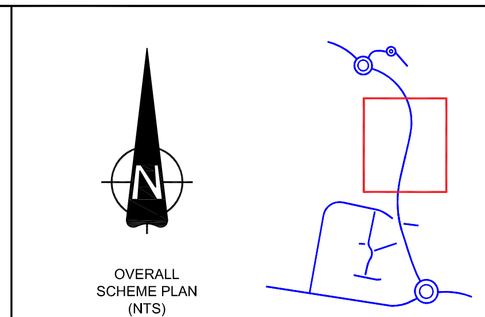
THIS SECTION NEEDS TO BE CONSIDERED IN THE SOUTH APPROACH FROM THE SOUTH WATER PIER FOR 10m TOWARDS SOUTH

SECTION - SUPPORTING BASCULE BRIDGE (C 011)
Scale 1:50



THIS SECTION NEEDS TO BE CONSIDERED OVER THE SOUTH PIER (4m)

SECTION - SUPPORTING BASCULE BRIDGE (D 011)
Scale 1:50



OVERALL SCHEME PLAN (NTS)

LEGEND

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. REFER TO DRAWING 0011 FOR GENERAL ARRANGEMENT DRAWING.
3. REFER TO DRAWING 0026 FOR ACCESS AND MAINTENANCE DETAIL.
4. CANTILEVER VARIES FROM 4260mm AT THE SOUTH VIADUCT TO 4860 AT THE NORTH ABUTMENT.
5. CONTAINMENT LEVEL OVER THE BASCULE BRIDGE AND APPROACH VIADUCTS WILL BE DEFINED AT DETAILED DESIGN.

REVISION	DRAWN	CHECKED	APPROVED	DATE
P08	KT	FQ	FQ	13/02/2018

PARAPET AMENDED ON DECK

DESCRIPTION

Suffolk County Council

PROJECT TITLE
Lake Lothing THIRD CROSSING

DRAWING TITLE
LL3X APPROACH SPANS AND BASCULE BRIDGE SECTIONS

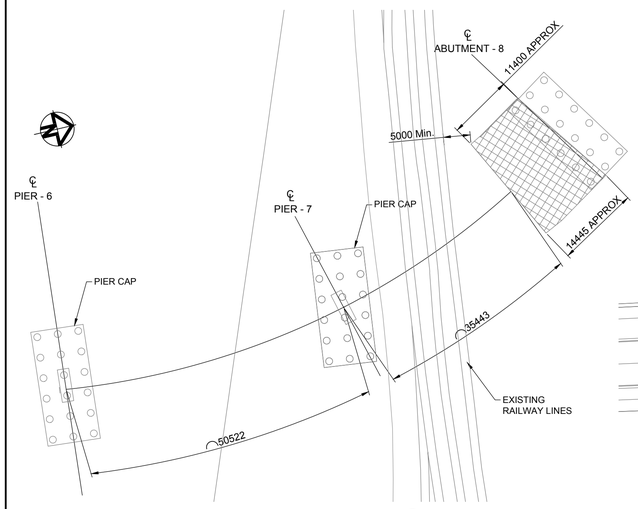
DRAWING STATUS
OAIP

DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
MS	RR	FQ	MN	S0

SCALE @ A1 SIZE	DATE	REVISION
AS SHOWN	05/10/2017	P08

DRAWING NUMBER
Project | Originator | Volume
1069948-WSP-SGN-LL_C19-DR-CB-0010
Location | Type | Role | Number

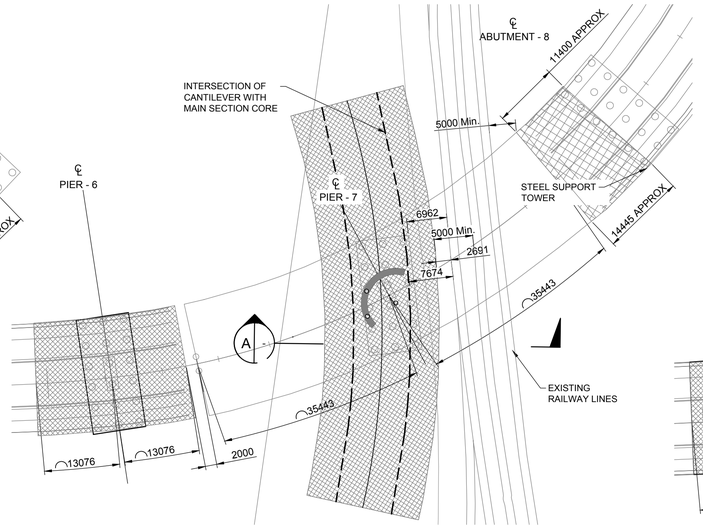
DRAFT AND CONFIDENTIAL



CONSTRUCTION SEQUENCE 1

SCALE 1:500

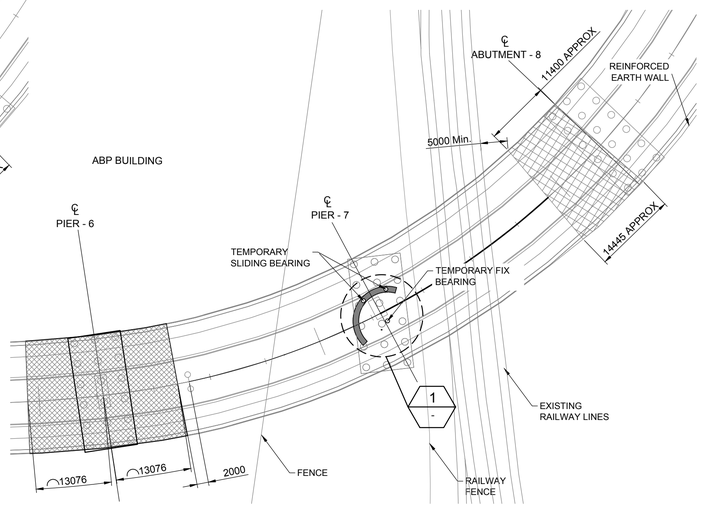
1. CONSTRUCT PILE CAPS & PIERS
2. INSTALL STEEL SUPPORT SYSTEM 5000mm FROM RAIL TRACK BETWEEN ABUTMENT 8 AND PIER NO. 7



CONSTRUCTION SEQUENCE 2

SCALE 1:500

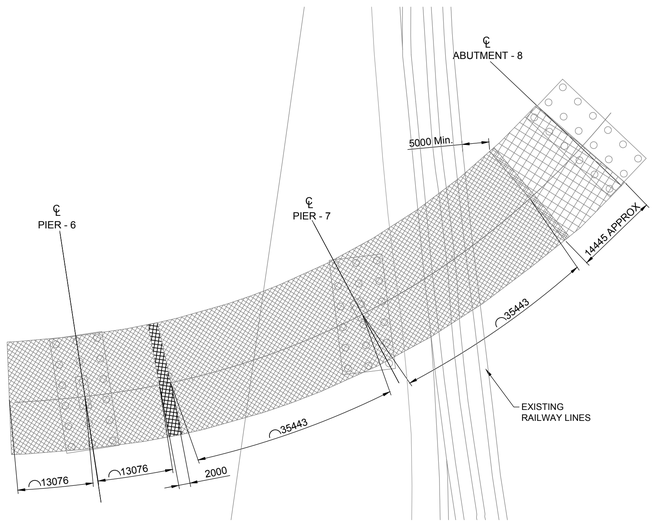
1. CAST DECK CONCRETE IN STAGES AT PIER 6. SIMULTANEOUSLY BOTH SIDES.
2. ROTATE DECK ON BEARING AT PIER 7 AND CAST DECK CONCRETE IN STAGES. SIMULTANEOUSLY BOTH SIDES



CONSTRUCTION SEQUENCE 3

SCALE 1:500

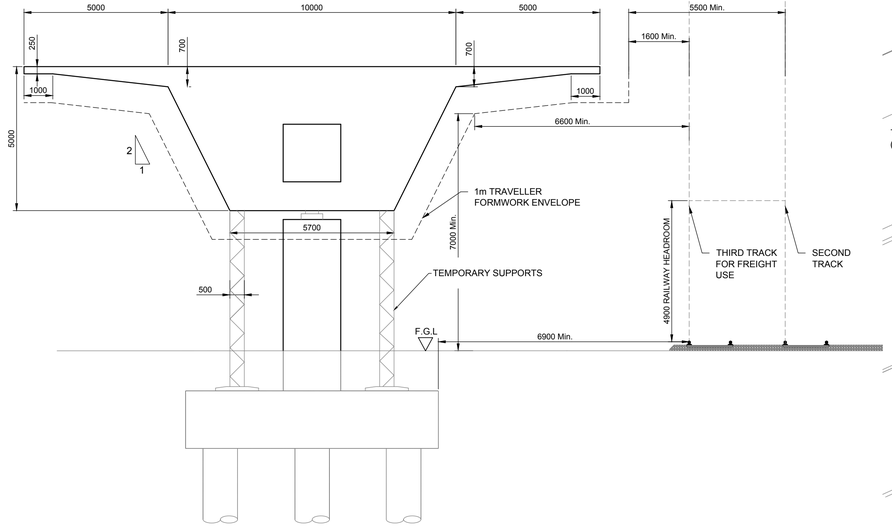
1. AFTER DECK ABOVE PIER 7 HAS REACHED REQUIRED STRENGTH, ROTATE AS ALIGNMENT



CONSTRUCTION SEQUENCE 4

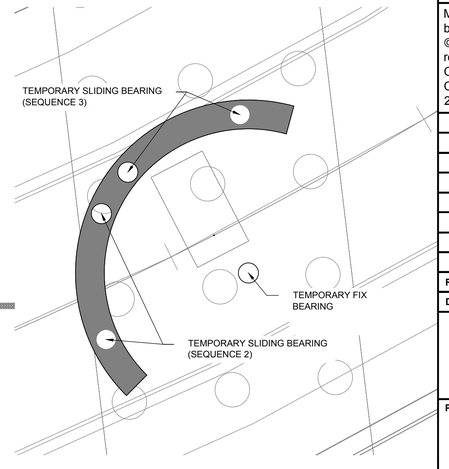
SCALE 1:500

1. CAST DECK CONCRETE 2000mm TO JOIN CASTING OVER PIER 6 & PIER 7

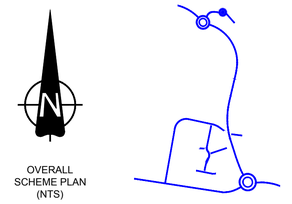


SECTION A

SCALE 1:100



1 DETAIL: ARRANGEMENT FOR ROTATION



OVERALL SCHEME PLAN (NTS)

LEGEND

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

REVISION	DRAWN	CHECKED	APPROVED	DATE
P06	EL	FQ	MN	08/12/2017
MINOR AMENDMENTS				
P05	EL	FQ	MN	05/12/2017
MINOR AMENDMENTS				
P04	EL	FQ	MN	03/10/2017
MINOR AMENDMENTS				
P03	EL	FQ	MN	22/09/2017
MINOR AMENDMENTS				

DESCRIPTION

Suffolk County Council

PROJECT TITLE

Lake Lothing THIRD CROSSING

DRAWING TITLE

CONSTRUCTION SEQUENCE BETWEEN PIER 6 AND ABUTMENT 8

DRAWING STATUS

SUITABILITY

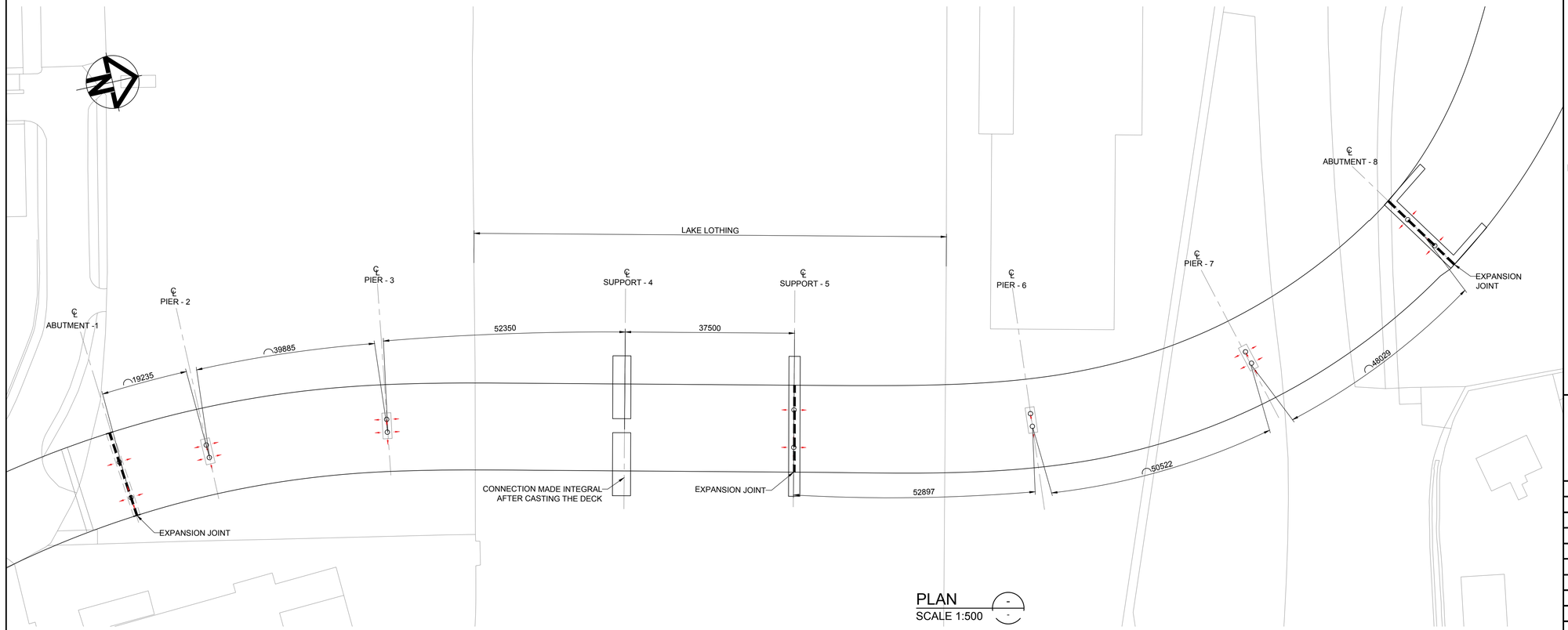
DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
EL	RR	FQ	MN	S0

SCALE @ A1 SIZE	DATE	REVISION
AS SHOWN	03/10/2017	P06

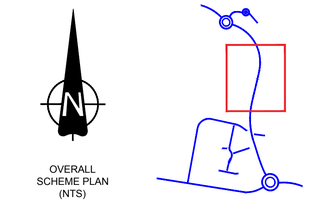
DRAWING NUMBER

Project	Originator	Volume	Location	Type	Role	Number
1069948	WSP	SGN	LL	C13	DR	CB-0018

DRAFT AND CONFIDENTIAL



PLAN
SCALE 1:500



OVERALL SCHEME PLAN (NTS)

LEGEND

FREE BEARING

GUIDED BEARING

FIXED BEARING

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE
2. REFER TO DRAWING 0011 FOR LL3X APPROACH SPANS AND BASCULE BRIDGE PLAN AND ELEVATION.

REVISION	DRAWN	CHECKED	APPROVED	DATE
P04	EL	FQ	MN	18/12/2017
MINOR AMENDMENTS				
P03	EL	FQ	MN	22/09/2017
MINOR AMENDMENTS				
P02	KET	FQ	MN	14/08/2017
MINOR AMENDMENTS				
P01	EL	MN	MN	07/08/2017
FIRST ISSUE				

DESCRIPTION

Suffolk County Council

PROJECT TITLE

Lake Lothing THIRD CROSSING

DRAWING TITLE

LL3X APPROACH SPANS AND BASCULE BRIDGE BEARING DETAILS

DRAWING STATUS

OAIP

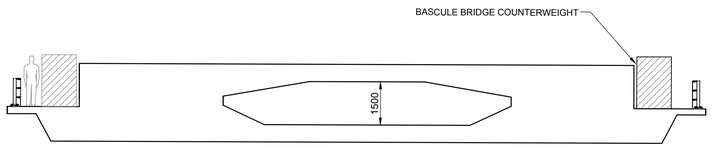
DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
MS	RR	MN	MN	S0

SCALE @ A1 SIZE	DATE	REVISION
AS SHOWN	07/08/2017	P04

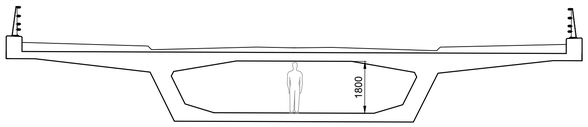
DRAWING NUMBER

Project | Originator | Volume
1069948-WSP-SGN-LL_C19-DR-CB-0019
Location | Type | Role | Number

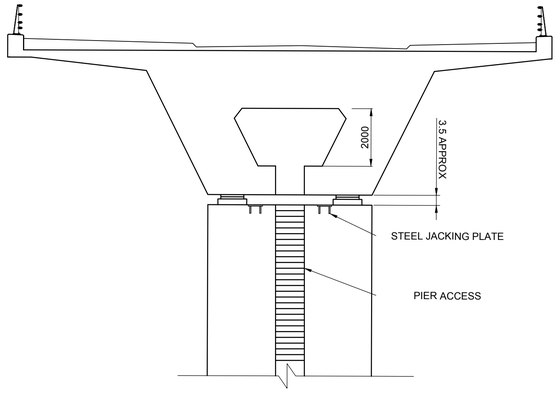
DRAFT AND CONFIDENTIAL



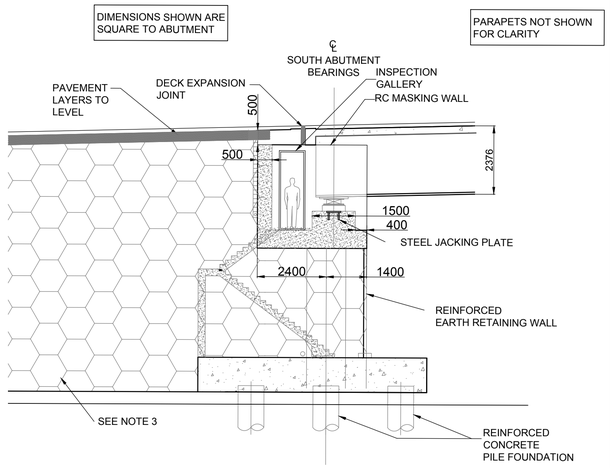
INSPECTION OF SECTION SUPPORTING BASCULE 1A
SCALE 1:100



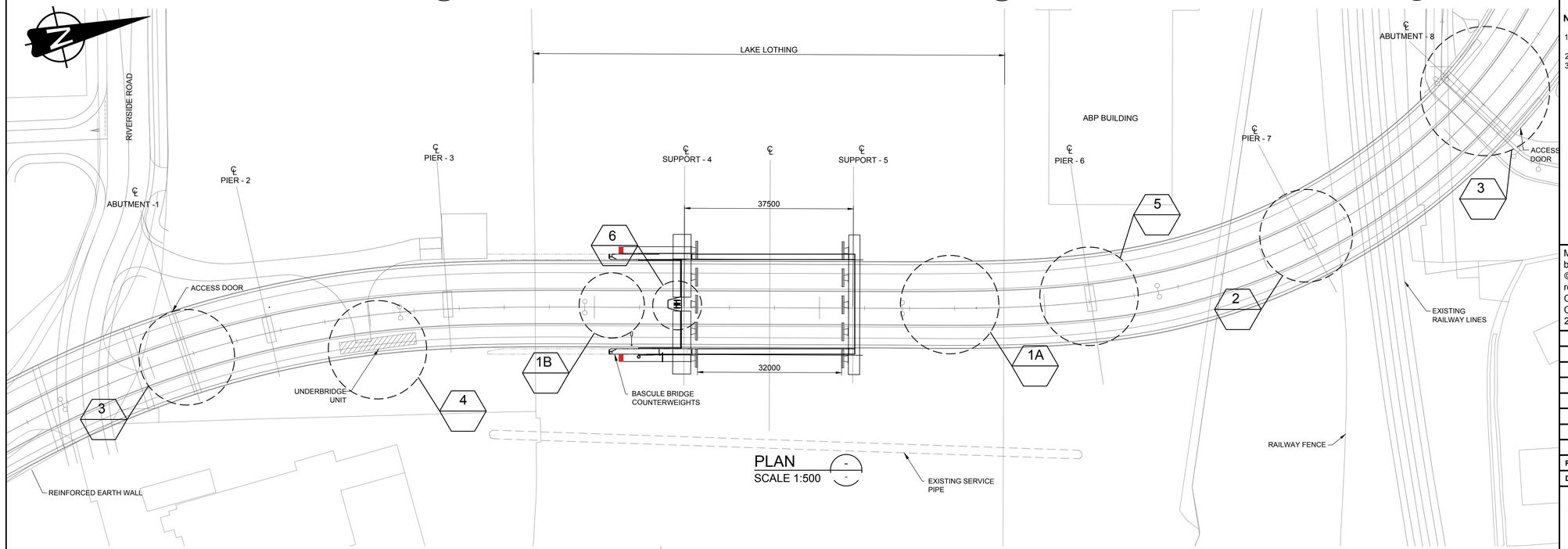
TYPICAL DETAIL OF DECK INSPECTION 1B
SCALE 1:100



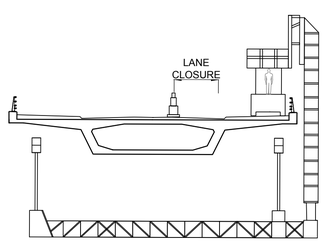
TYPICAL DETAIL OF JACKING POINTS FOR BEARING REPLACEMENT AND DECK ACCESS THROUGH PIER 3 AND 6 2
SCALE 1:100



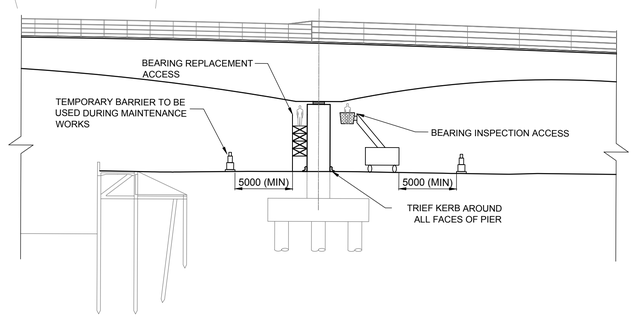
ABUTMENT ACCESS GALLERY 3
SCALE 1:100



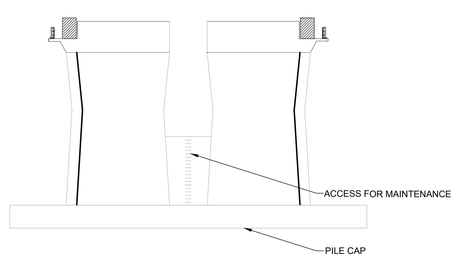
PLAN -
SCALE 1:500



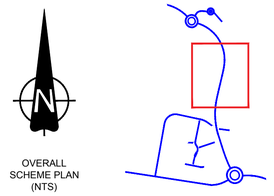
UNDERBRIDGE UNIT DECK SOFIT 4
SCALE 1:200



INSPECTION AND MAINTENANCE OF PIERS AND BEARINGS 5
SCALE 1:250



TYPICAL DETAIL OF ACCESS TO WATER PIER 6
SCALE 1:250



OVERALL SCHEME PLAN (NTS)

LEGEND

- RESTRICTED AREA DURING INSPECTION FALL ARREST SYSTEM
- ℄ CENTRE LINE

DESIGN SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

NOTES

1. ALL DIMENSIONS ARE IN MILIMITERS UNLESS NOTED OTHERWISE
2. PIER SHAPE IS INDICATIVE AND IN DEVELOPMENT PROCESS
3. DETAIL 3 IS A TYPICAL DETAIL FOR ABUTMENT ACCESS GALLERY ABUTMENT AND WILL HAVE WING WALLS

REVISION	DRAWN	CHECKED	APPROVED	DATE
P02	EL	FQ	MN	18/12/2017
MINOR AMENDMENTS				
P01	EL	FQ	MN	25/10/2017
ORIGINAL ISSUE				

DESCRIPTION

Suffolk County Council

PROJECT TITLE
Lake Lothing THIRD CROSSING

DRAWING TITLE
APPROACH SPANS AND BASCULE BRIDGE MAINTENANCE DETAILS

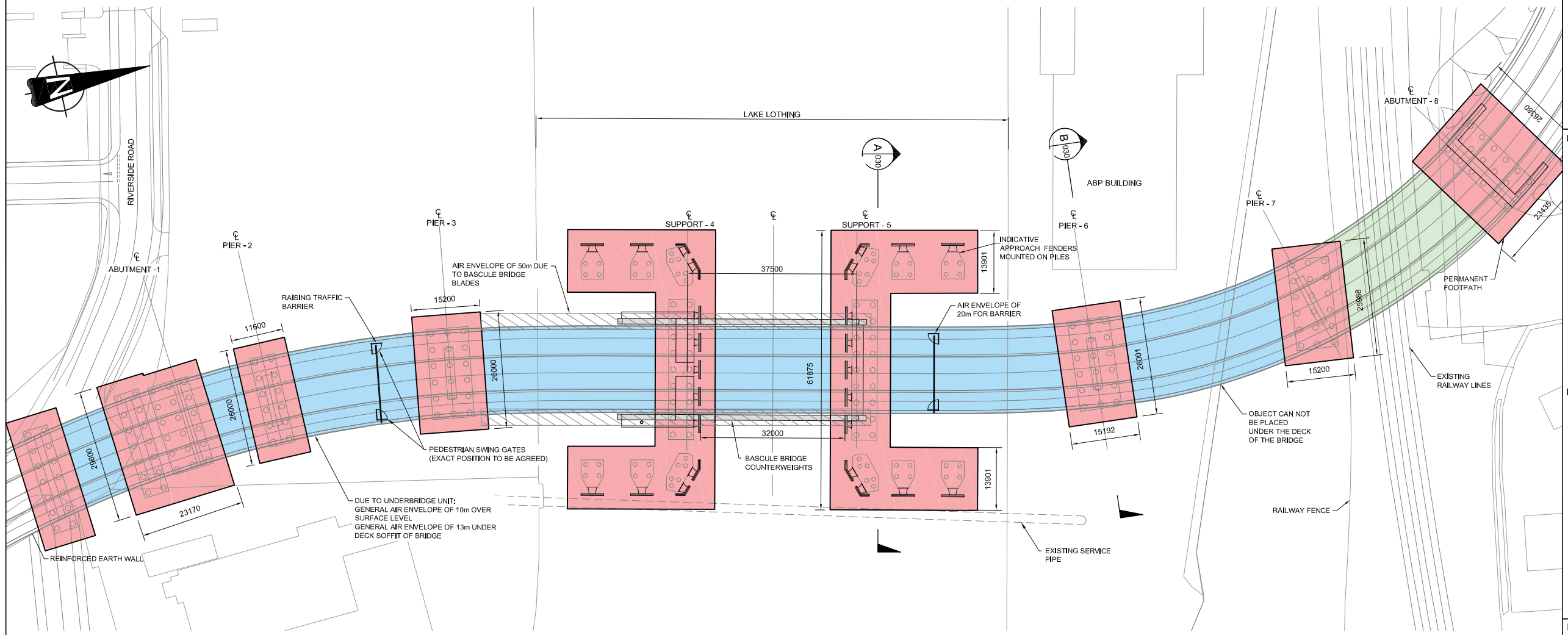
DRAWING STATUS
OAIP

DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
EL	RR	FQ	MN	S0

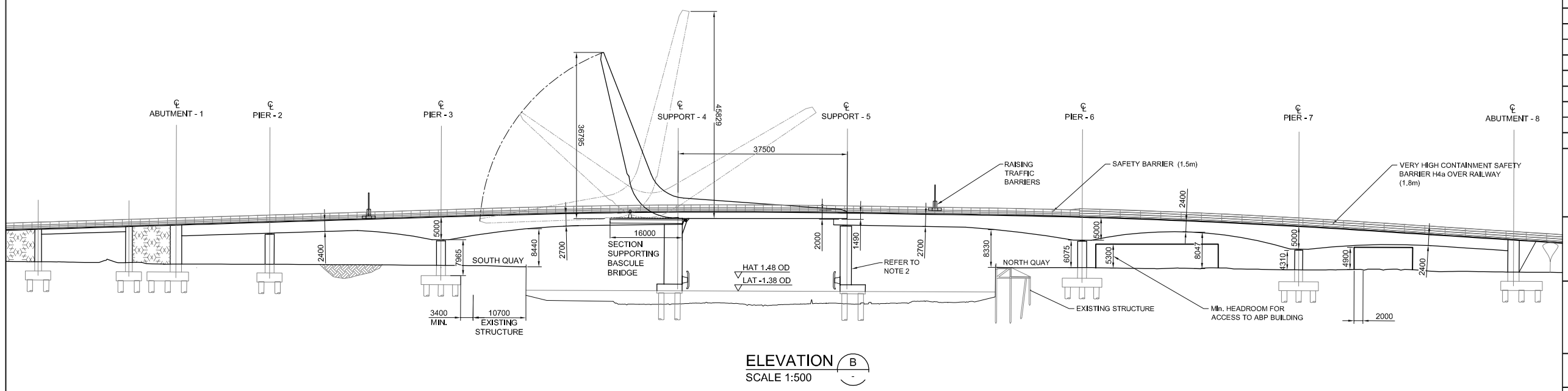
SCALE @ A1 SIZE	DATE	REVISION
AS SHOWN	25/10/2017	P02

DRAWING NUMBER

Project	Originator	Volume		
1069948	WSP	SGN	LL	DR-CB-0026
Location	Type	Role	Number	

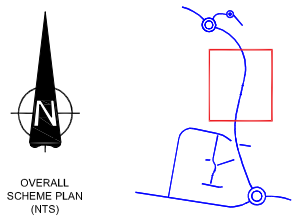


PLAN
SCALE 1:500



ELEVATION
SCALE 1:500

DRAFT AND CONFIDENTIAL



LEGEND

- PERMANENT ACQUISITION
- PERMANENT ACQUISITION OF RIGHTS OVER LAND
- TEMPORARY POSSESSION OF LAND
- ℄ CENTRE LINE

DESIGN SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

NOTES

1. ALL DIMENSIONS ARE IN MILIMITRES UNLESS NOTED OTHERWISE.
2. PIER SHAPE IS INDICATIVE AND IN DEVELOPMENT PROCESS.
3. FOR ACCESS AND MAINTENANCE DETAILS REFER TO DRAWING 0026 FOR APPROACH SPANS AND BASCULE BRIDGE ACCESS AND MAINTENANCE DETAILS.
4. CONTAINMENT LEVEL OVER THE BASCULE BRIDGE AND APPROACH VIADUCTS WILL BE DEFINED AT DETAILED DESIGN.

REVISION	DRAWN	CHECKED	APPROVED	DATE
P03	KT	FQ	MN	13/02/2018
PARAPET AMENDED				
P02	EL	FQ	MN	18/12/2017
MINOR AMENDMENTS				
P01	EL	FQ	MN	25/10/2017
ORIGINAL ISSUE				

DESCRIPTION

Suffolk County Council

PROJECT TITLE
Lake Lothing THIRD CROSSING

DRAWING TITLE
LAND ACQUISITION

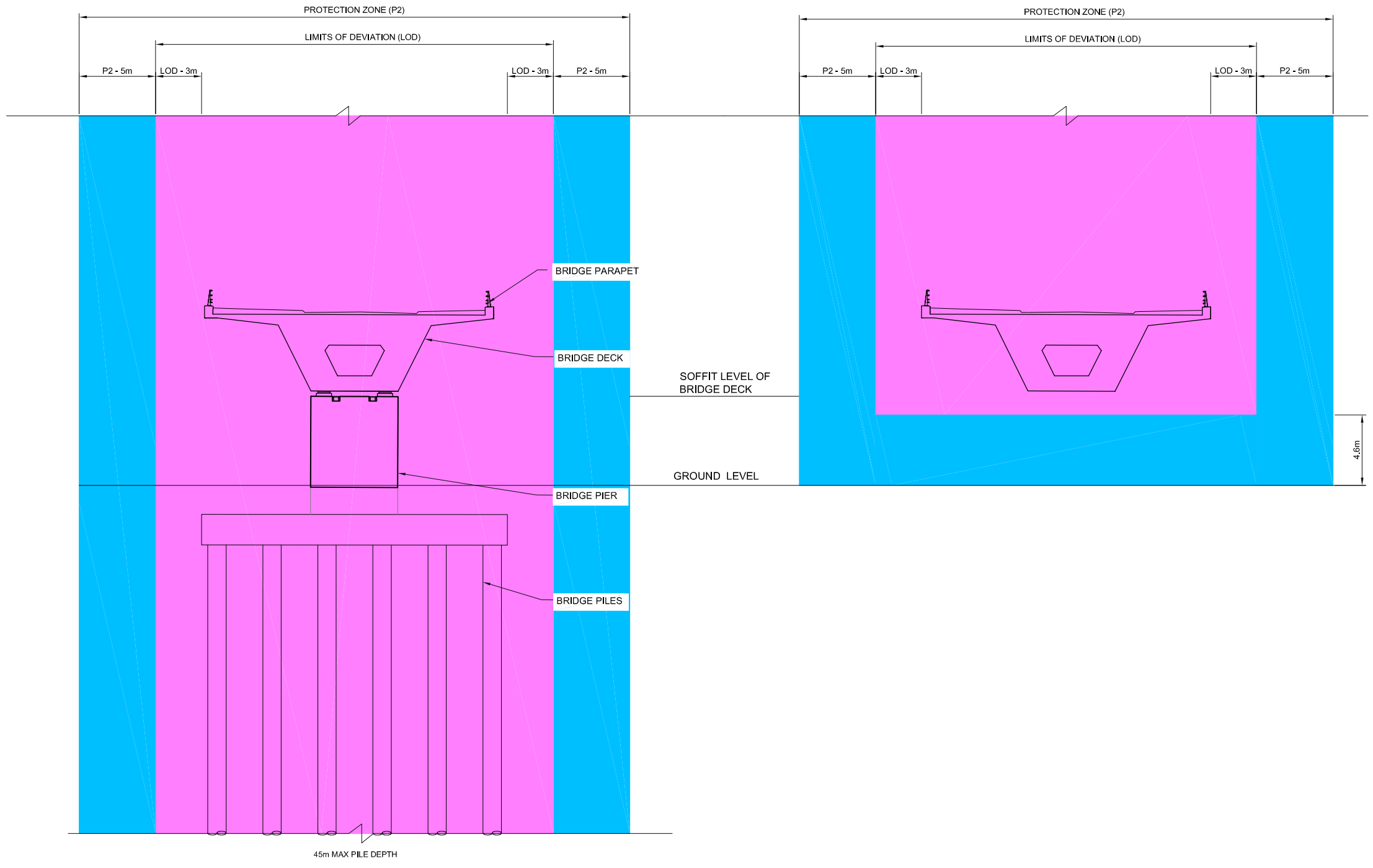
DRAWING STATUS
OAIP

DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
EL	RR	FQ	MN	S0

SCALE @ A1 SIZE	DATE	REVISION
AS SHOWN	25/10/2017	P03

DRAWING NUMBER

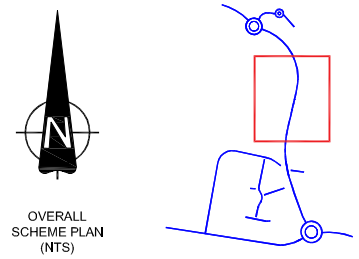
Project	Originator	Volume	Location	Type	Role	Number
1069948	WSP	SGN	LL	DR	CB	0029



LAND PIER SECTION -
SCALE 1:200

DECK SECTION OVER LAND -
SCALE 1:200

DRAFT AND CONFIDENTIAL



OVERALL SCHEME PLAN (NTS)

KEY

PERMANENT ACQUISITION OF LAND

PERMANENT ACQUISITION OF RIGHTS OVER LAND

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. THESE ENGINEERING SECTION DRAWINGS, ELEVATIONS AND PLANS SHOULD BE READ IN CONJUNCTION WITH THE KEY PLAN ALONGSIDE OTHER PLANS AND DOCUMENTS IN THE DEVELOPMENT CONSENT ORDER APPLICATION, IN PARTICULAR THE WORKS PLANS AND SCHEDULE 1 (AUTHORISED DEVELOPMENT) TO THE DEVELOPMENT CONSENT ORDER.
3. WORK No. REFERENCES ARE DETAILED IN SCHEDULE 1 (AUTHORISED DEVELOPMENT) TO THE DEVELOPMENT CONSENT ORDER.
4. THESE ENGINEERING SECTION DRAWINGS, ELEVATIONS AND PLANS WILL BE SUBJECT TO THE DETAILED DESIGN DEVELOPMENT; ANY CHANGES WILL BE LIMITED TO BEING WITHIN THE ORDER LIMITS AND ANY OTHER CONSTRAINTS INCLUDED IN THE DEVELOPMENT CONSENT ORDER.

DESIGN SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

REVISION	DRAWN	CHECKED	APPROVED	DATE
P03	KT	FQ	MN	26/01/2018
MINOR AMENDMENTS				
P02	EL	FQ	MN	08/01/2018
MINOR AMENDMENTS				
P01	EL	FQ	MN	13/12/2017
ORIGINAL ISSUE				

DESCRIPTION

Suffolk County Council

PROJECT TITLE

Lake Lothing THIRD CROSSING

DRAWING TITLE

ENGINEERING SECTION DRAWINGS
ELEVATION AND PLAN
LAND ACQUISITION SECTIONS
REGULATIONS (5(2)(o), 2(2)(p) AND 6 (2)(a)
SHEET 1 OF 2

DRAWING STATUS

COLD TOWEL REVIEW

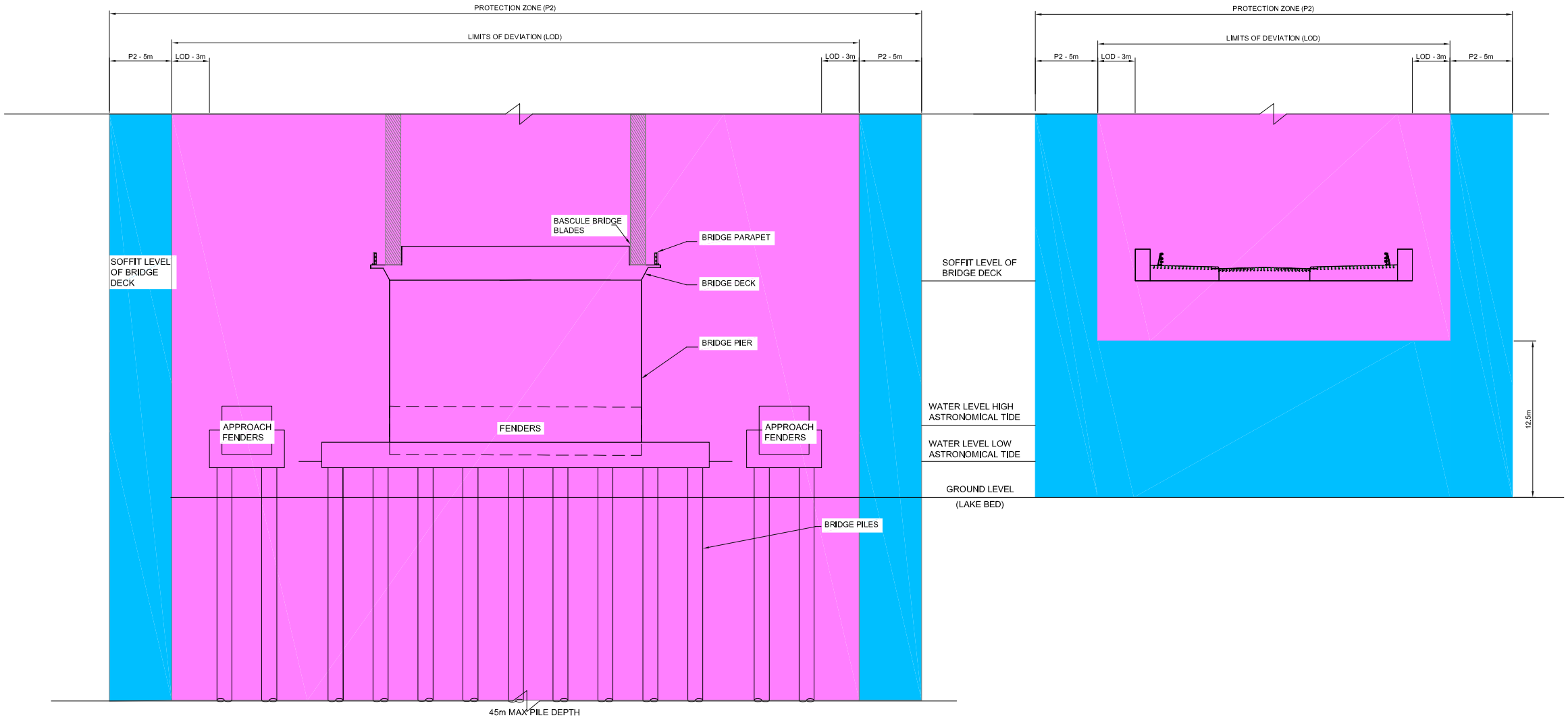
DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
EL	RR	FQ	MN	S0

SCALE @ A1 SIZE	DATE	REVISION
AS SHOWN	25/10/2017	P03

DRAWING NUMBER

Project	Originator	Volume	Location	Type	Role	Number
1069948	WSP	SGN	LL	DR	CB	0041

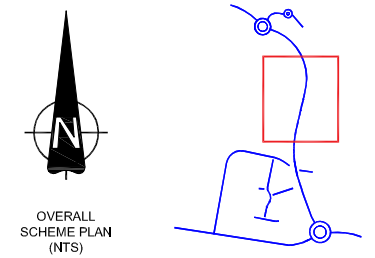
1069948-WSP-SGN-LL-DR-CB-0041



WATER PIER SECTION -
SCALE 1:200

SECTION OF BASCULE BRIDGE OVER WATER -
SCALE 1:200

DRAFT AND CONFIDENTIAL



OVERALL SCHEME PLAN (NTS)

KEY

- PERMANENT ACQUISITION OF LAND
- PERMANENT ACQUISITION OF RIGHTS OVER LAND

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. THESE ENGINEERING SECTION DRAWINGS, ELEVATIONS AND PLANS SHOULD BE READ IN CONJUNCTION WITH THE KEY PLAN ALONGSIDE OTHER PLANS AND DOCUMENTS IN THE DEVELOPMENT CONSENT ORDER APPLICATION, IN PARTICULAR THE WORKS PLANS AND SCHEDULE 1 (AUTHORISED DEVELOPMENT) TO THE DEVELOPMENT CONSENT ORDER.
3. WORK No. REFERENCES ARE DETAILED IN SCHEDULE 1 (AUTHORISED DEVELOPMENT) TO THE DEVELOPMENT CONSENT ORDER.
4. THESE ENGINEERING SECTION DRAWINGS, ELEVATIONS AND PLANS WILL BE SUBJECT TO THE DETAILED DESIGN DEVELOPMENT; ANY CHANGES WILL BE LIMITED TO BEING WITHIN THE ORDER LIMITS AND ANY OTHER CONSTRAINTS INCLUDED IN THE DEVELOPMENT CONSENT ORDER.

DESIGN SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

P03	KT	FQ	MN	26/01/2018
MINOR AMENDMENTS				
P02	EL	FQ	MN	08/01/2018
MINOR AMENDMENTS				
P01	EL	FQ	MN	13/12/2017
ORIGINAL ISSUE				
REVISION	DRAWN	CHECKED	APPROVED	DATE
DESCRIPTION				

Suffolk County Council

PROJECT TITLE
Lake Lothing THIRD CROSSING

DRAWING TITLE
ENGINEERING SECTION DRAWINGS
ELEVATION AND PLAN
LAND ACQUISITION SECTIONS
REGULATIONS (5(2)(o), 2(2)(p) AND 6 (2)(a)
SHEET 2 OF 2

DRAWING STATUS
COLD TOWEL REVIEW

DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
EL	RR	FQ	MN	S0

SCALE @ A1 SIZE	DATE	REVISION
AS SHOWN	25/10/2017	P03

DRAWING NUMBER

Project	Originator	Volume	Location	Type	Role	Number
1069948	WSP	SGN	LL	DR	CB	0042

APPENDIX D – Designer's Risk Assessment

Hazard information							Initial risk				Designer mitigation (POP and ERIC)		Residual risk				Review
Hazard Checklist ref	Unique ref	Design discipline	Designer	Activity/element	Stage	Hazard/ H&S issue	Initial RAG	Initial L	Initial S	Initial risk rating	Designer mitigation (POP and ERIC)	Designer actions	Residual RAG	Residual L	Residual S	Residual risk rating	Hazard /risks review date
		S	Furqan Qamar	Unforseen ground conditions	C	Inadequacy of design, cost implications	A	5	4	20	Planned Geotech investigations, obtained historical data	update design based on GI results and GDR.	R	2	3	6	01/12/2017
		S	Furqan Qamar	Temporary instability of structural elements (in	C	Collpase of structure.	A	2	6	12	detailed design, contact with the specialist, appointment of competent contractor	Preliminary calculations outline design, early contractor involvment	A	2	6	12	01/03/2018
		S	Furqan Qamar	Inadequate rail clearance (both vertical and lateral)	C	Disruption to rail network.	R	3	6	18	Liasion with NR, Identify their requirements	Provide adequate vertical and horizontal clearance, identify method of construction	G	1	4	4	
		S	Furqan Qamar	Objects falling onto railway tracks.	C	Fatalities and disruption to rail network.	A	2	6	12	Method of construction to avoid railway track, design of high containments parapets	liasion with the specialist and NR	G	1	4	4	
		S	Furqan Qamar	Working adjacent to live railway.	C	Fatalities and disruption to rail network.	R	5	4	20	Network Rail possessions, method of construction to avoid interference with railway track, maintain minimum clearance	Liasion with the specialist and NR and outline design according to their requirements	A	2	3	6	
		S	Furqan Qamar	Railway possession overruns	C	Disruption to rail network.	A	3	4	12	Method of construction to avoid railway track to minimize time of possession needed.	Preliminary design of deck rotation over NR land.	A	2	3	6	
		S	Furqan Qamar	Disruption to live railway during construction	C	Disruption to rail network.	A	3	4	12	Method of construction to avoid railway track.	Preliminary design of deck rotation over NR land.	G	2	2	4	
		S	Furqan Qamar	Pollution of watercourse during construction.	C	Ecological impact.	A	3	4	12	Reduction can be achieved by appointing competent contractor.	carry out Environemntal survey					
		S	Furqan Qamar	Craning or lifting operations.	C	Fall of objects from height.	A	3	5	15	Reduction is achieved by appointing specilist contractor.	minimize activiites involving fall of height					
		S	Furqan Qamar	Working adjacent to port traffic on land.	C	Collision	R	3	6	18	Method of construction should take into account situations that could lead to collision undertaking the measures tu prevent it.	Decision of construction of deck using traveller form will reduce the interference with the port.	A	2	4	8	
		S	Furqan Qamar	Rotation of the deck over the railway	C	Loss of stability of structure during rotation	R	3	6	18	detailed design, contact with the specialist, appointment of competent contractor. Control of minimum distance to railway tracks	Preliminary calculations outline design, early contractor involvment	A	2	5	10	
		S	Furqan Qamar	4.9m Headroom over Network rail considered in an envelope that is at 2m from the tracks. Risk of NR requiring a wider envelope with that headroom on their land.	C	Inadequacy of design.	A	3	5	15	Reduction is achieved by contacting NetworkRail to identify their requierments.	Additional calculations considering reduced concrete deck at piers to identify alternatives.	A	2	4	8	
		S	Furqan Qamar	Reduced headroom for inspection in section supporting bascule bridge	M	Possible hazzard for future inspections of the box	A	4	3	12	Provide adequate space which is feasiblke for inspection	Risk assesment need to be considered prior to inspection	A	2	3	6	
		S	Furqan Qamar	Posttension needed longittudinally and transversally	C	Risk associated during stressing proccess due to the possible realease of tendon forces	A	3	6	18	Reduction is achieved by appointing specilist contractor.	Preliminary calculations outline design, early contractor involvment	A	2	5	10	
		S	Furqan Qamar	Risk of settlement of structures	C	Collapse of structure	A	3	6	18	Reduction is achieved by geotechnical investigation, monitoring settlement on site and introducing some level of settlement in the desing of the bridge.	Preliminary calculations outline design, early contractor involvment	A	2	5	10	
		S	Furqan Qamar	Collapse of falsework during cast of spans adjacent to bascule bridge	C	Collapse of structure	A	3	6	18	Reduction is achieved by appointing specilist contractor.	Minimize length of falsework needed by using the traveller form over the lake as much as possible.	A	2	5	10	

Hazard information							Initial risk				Designer mitigation (POP and ERIC)		Residual risk				Review
Hazard Checklist ref	Unique ref	Design discipline	Designer	Activity/element	Stage	Hazard/ H&S issue	Initial RAG	Initial L	Initial S	Initial risk rating	Designer mitigation (POP and ERIC)	Designer actions	Residual RAG	Residual L	Residual S	Residual risk rating	Hazard /risks review date
		S	Furqan Qamar	Delay in geotech investigation	C	Delay in the design stage, Inadequacy of design	A	3	5	15	Responsible team involved to ensure geotech investigation is carried out on time	Update design based on GI results and GDR.	A				
		S	Furqan Qamar	Inadequate power availability to lift bascule span	C	Inadequacy of design.	A	3	5	15	Detailed design to investigate existing power available and the requirement	sugggestion of laternative generator need to be considered in detailed design	A				
		S	Furqan Qamar	Deep water	C	Drowning	R	3	6	18	Reduction is achieved by appointing specilist contractor and complying with health and safety standards on site.	Pile cap bottom level is defined 500mm below LAT	A				
		S	Furqan Qamar	Presence of unknown services on land.	C	Electrocution/disruption to services.	A	3	5	15	Undertake service investigation prior to detail design	Avoid services/utilites in the design					
		S	Furqan Qamar	Inadequate navigation clearance (both vertical and lateral)	C	Bridge strike.	A	3	5	15	Infinite clearance is provided when the bascule bridge is open	Vertical and horizontal clearance has been defined to provide sufficient clearance	A	2	3	6	
		S											A	3	2	6	
Insert above this line																	

APPENDIX E – Options Report

CONFIDENTIAL

Bridge Design

Options Report

Lake Lothing Third Crossing (LL3X)

28th July 2017
Produced for
Suffolk County Council

Prepared by
Mark Northing
Technical Director

Knights House
2 Parade
Sutton Coldfield
West Midlands
B72 1PH

T 0121 355 8949
F 0121 355 8901

Document Control Sheet

Project Title	Lake Lothing Third Crossing (LL3X)
Report Title	Bridge Design Options Report
Report ref no.	1069948-MOU-SGN-LL_C13-CD-CB-0001
Version	P04
Status	S3
Report Date	28th July 2017

Record of Issue

Version	Status	Author	Date	Checked by	Date	Approved by	Date
P01	S3	M Chowdry	22/12/16	M Northing	22/12/16	M Northing	22/12/16
P02	S3	T Kazemi	13/01/17	S Keeley	23/01/17	M Northing	14/02/2017
P03	S3	FQamar	17/07/17	MNorthing	21/07/17	M Northing	21/07/17
P04	S3	FQamar	27/07/17	MNorthing	28/07/17	M Northing	28/07/17

Distribution

Date	Organisation	Contact	Format	Copies

Limitations

This report is presented to Suffolk County Council in respect of Lake Lothing Third Crossing and may not be used or relied on by any other person. It may not be used by Suffolk County Council in relation to any other matters not covered specifically by the agreed scope of this Report.

Notwithstanding anything to the contrary contained in the report, WSP Limited is obliged to exercise reasonable skill, care and diligence in the performance of the services required by Suffolk County Council and WSP Limited shall not be liable except to the extent that it has failed to exercise reasonable skill, care and diligence, and this report shall be read and construed accordingly.

This report has been prepared by WSP Limited. No individual is personally liable in connection with the preparation of this report. By receiving this report and acting on it, the client or any other person accepts that no individual is personally liable whether in contract, tort, for breach of statutory duty or otherwise.

Contents

1 Executive Summary

The proposed route of the third crossing of Lake Lothing, connects Waveney Drive in the south to Denmark Road/Peto Way in the north, via a new bascule bridge positioned centrally over the navigational channel of Lake Lothing. Three significant design decisions have been identified to date which are examined in this Bridge Design Options Report. The decisions relate to the span arrangements within Lake Lothing, the superstructure form of construction and the type of the bascule bridge. The two span arrangements considered within the lake and type of bascule bridge can both be made to work with all the superstructure forms under consideration. Hence the three decisions can essentially be made independently**. The decision to progress with option for two piers within Lake Lothing was accepted by the Client based on version P02 of this report and does not need to be revisited in this version of the report.**

A costing exercise and discussion with specialists have been carried out for these three decisions.. The costs estimates is based on the currently available information and initial designs for comparison purposes only and are presented in this report.

Based on the findings of this report it is recommended to use the two pier arrangement within the lake (which is already discussed and agreed with the Client), in situ post tensioned balanced cantilever structure for the superstructure and single leaf rolling type bascule bridge.

2 Background

Lake Lothing divides Lowestoft between north and south. The existing road crossings in the east and west are inadequate for existing traffic demand. The problem of congestion has blighted the town for years. Congestion causes problems for businesses; it discourages existing firms from expanding and discourages new businesses from moving into the area. There have been improvements to local roads in recent years, but a third crossing remains the missing link. It is proposed that an additional crossing be constructed to reduce severance and to allow the road network to operate efficiently, providing vital extra capacity. It will reduce congestion and help Lowestoft to attract investment and achieve its full potential as a place in which to live and work

.

3 Introduction

The LL3X will be a multi span structure, carrying a new road between the vicinity of Riverside Road to the south and Denmark Road to the north over Lake Lothing. This Bridge Design Options Report outlines the rationale behind key design decisions relating to the structural form of the LL3X to date. Recommendations will be made at the end of the report.

There is an underpass at the south end of the south approach providing access to Nexen. This structure will be independent from the main structure, due to the headroom requirement. The headroom requirement necessitate a thinner construction depth structure at this location. Options related to the underpass are not included in this Options Report, however to minimise maintenance requirement a reinforced concrete portal frame type structure is proposed for this underpass.

The bridge structure extends up to the underpass on the south, as this is expected to maximise potential land use and to minimise flooding impact.

4 Design Decisions

Three significant design decisions have been identified to date which are examined in this section of the report. The decisions relate to the span arrangements within Lake Lothing, the superstructure form of construction and the type of bascule bridge. The span arrangement outside the lake is driven by the form of construction and other site constraints such as the railway and the north and south quay. The choice of substructures is limited to reinforced concrete supported on piles.

4.1 Span Arrangements within Lake Lothing (substructure only)

Note the decision to progress with the option for two piers within Lake Lothing was accepted by the Client based on version P02 of this report. The text has been left in as a record of this decision. This decision does not need to be revisited in this report.

The initial proposed span arrangement for the LL3X crossing (which was formed part of the concept bridge design within the Outline Business Case) was based on four piers within the lake channel, hereafter referred to as the "four pier" option within the lake channel. The concept for the "four pier" option was principally driven by the aspiration to eliminate risks associated with siting land piers adjacent to the quay walls. At this stage details of the north quay wall and the south quay wall were not available. The "four pier" option maximised the distance between the first land pier and the quay walls. This minimised the risk of the first land pier interfering with the quay wall structures and associated foundations, thereby reducing the risk of costly remedial works to the existing structure. See Appendix A and B for elevations of the two options.

Since then, an alternative "two pier" option, with only the bascule bridge span piers within the lake channel, has been proposed for the following reasons:

- *Existing Quay Wall information*: drawings detailing the construction of the north quay wall are now available, enabling the first land piers to be positioned to avoid impact on the quay wall structure. In addition a site investigation has been carried out locating the anchor wall for the south quay which is 10.7m. Therefore the risks associated with a "two pier" option has been mitigated by positioning the first land piers such that it will not have an impact on the existing quay wall structures.

- *Reduction in loss of berth:* the reduction in the number of water piers will also minimise the loss of berth from approximately 33m on either side for a "four pier" option, as compared to approximately 12m on either side for a "two pier" option. For this reason the "two pier" option is likely to be favoured by the port authority, ABP.

- *Reduction in change of flow*: reducing the number of water piers will minimise changes to the flow patterns within the lake, and therefore reduce the potential for changes within the sediment transport regime. It will also reduce the effect

the bridge will have on the ability of ABP, to undertake dredging works by removing the pier in close proximity to the existing quay walls so allowing better access to the quay front.

- *Contractor feedback*: feedback from contractors attending the LL3X Industry Day held in September 2016 suggests that a "two pier" option is preferable from a constructability perspective.

- *Less environmental impact:* the environmental constraints have not been fully surveyed, but a four pier solution would require greater construction in the water and hence greater risk of environmental issues occurring such as spillages etc. Having a four pier solution would also lead to the generation of a greater amount of probable contaminated sediment that would require offsite disposal. With regard to benthic species, this survey has not yet been undertaken, but if something in this respect is found during the survey programmed for the spring, then a four pier solution would result in greater disruption/disturbance.

- *Reduction in the risk of impact:* the reduction in the number if the water piers will reduce the risk of vessel impact on the piers.

The "two pier" option is also likely to have a number of benefits with reference to the substructures as follows:

- Significant cost saving due to an overall reduction in the number of piles, pile caps and piers required for the crossing;

- Reduction in the amount of temporary works required due to fewer piles in water.

It should however be kept in mind that the "two pier" option has longer spans, so savings in substructure cost will be partially off-set by an increase in superstructure cost due to increase in the construction depth. However following completion of the detailed costing exercise it is expected the overall cost of the two pier solution will be comparable or lower than the four pier solution. The "two pier option already discussed and agreed with the Client, its included in this option report to keep the record of the decision considered.

4.2 Superstructure Form

Due to significantly high capital cost and maintenance cost, land mark structures such as a cable stayed bridge with one tower either side of the bascule bridge has been discounted and not been considered in detail. The options considered in detail are presented below.

The maximum span on land is approximately 53m to 54m (depending on the option), on the north approach. Three alternative superstructure options have been considered for the approach viaducts (see below). Option 4.2.2 is a hybrid option, as precast beams alone are unable to achieve the long span requirement over the railway.

4.2.1 Steel girders with concrete deck slab

Advantages

- Standard design.
- Minimal disruption to the port and railway due to the use of prefabricated components (deck slab will be cast on permanent formwork or precast segments that can be dropped and stitched on site).
- The beams can be curved reducing the cantilevers supporting the parapets.

Disadvantages

- Uncertainty around method of erection due to possible crane access issues
- High whole life costs due to the requirement to paint the steel girders every 20-25 years (note that weathering steel is not suitable due to the marine environment).

4.2.2 Precast beams for approach span, steel beams over the railway.

Advantages

- Standard design;
- Minimal disruption to the port and railway due to the use of prefabricated/precast components.
- Low long term maintenance requirements for precast beams due to factory controlled conditions of manufacture

Disadvantages

- Precast beams would be straight and require varying length cantilever, and longer at the mid-span in comparison to the steel option resulting in a less aesthetic structure
- Uncertainty around method of erection due to possible crane access issues
- Requirement for painting of steel girders over the railway span. See Option 4.2.1.
- Discontinuity in the structural forms, which is not pleasing for bridge aesthetic, see section 5 for more detail.

4.2.3 *In situ Post Tensioned Balanced Cantilever*

Advantages

- Aesthetically pleasing providing cleaner lines and curves, see section 5 for more detail;
- Low long term maintenance requirements compared to steel option;
- Suited to sites with poor access from below.

Disadvantages

- Higher design costs and more specialist contractor required;
- High start-up costs;
- Greater requirement for temporary works;
- Greater vehicle movements.

4.3 Type of Bascule Bridge.

4.3.1 *Single leaf option*

Advantages

- Actuation machinery located below deck;
- Not suspect to collision damage from traffic;
- Can be gear or hydraulically actuated;

Disadvantages

- Complex foundation requirement;
- Large counterweight pit requirement;

4.3.2 *Double leaf option*

Advantages

- Actuation machinery located below deck;
- Not suspect to collision damage from traffic;
- Can be gear or hydraulically actuated;

Disadvantages

- Complex foundation requirement
- Counterweight pit requirement for both piers

4.3.3 Single leaf rolling lift option

Advantages

- Aesthetically pleasing;
- Moving span rolls back during raising
- Kentledge can be located in bascule pit or overhead to each side of deck.
- Unlimited air draft can be achieved more quickly across navigation channel
- Simplified foundation construction compared to counterweight pit

Disadvantages

- Complex fabrication as compared to other options;

A whole life costing for each of the above options has been prepared to enable a recommendation to be made.

5 Design Quality Review Statement (Landscape and Urban design WSP)

5.1 Introduction

The project team and LPA together have developed design concept of marine tech which provides a utilitarian, beautiful and contemporary reference point that can help to focus the development of options and bring cohesion to the separate elements of the structure towards a single aesthetic purpose.

(CABE Design advice Notes following Advice workshop date 29.07.17),

It has also been suggested by CABE that the design team identify the preferred option for each individual element by considering the whole structure and that the choice of structural materials, including the choice between post tensioned concrete/precast concrete and steel, is as consistent as possible so as to reduce the sense of change from the deck to the bascule.

5.2 Options

5.2.1 Precast beams for approach span, steel beams over the railway (hybrid)

Is still focusing on the functional requirements and doesn't allow the exploration and development of more creative solutions to develop the design of the deck and the piers.

The deck will either remain very different in appearance: a series of parts divided by steel and concrete material and differing construction, into sections, or an add-on soffit solution will be required to mask the discontinuity between the steel beams and the concrete deck.

Whilst design sketch development has considered how this could be delivered, the constraints to improving the pier in line with the design concept are great. Particularly in regard to the in *water* supporting structures below the opening mechanism, where two cantilever piers are required.

Deck edge /deck construction

- Depth of 2300 mm minimum significantly greater deck edge than the cantilever option
- the blade will be very visibly supported by the thicker horizontal line of deck

Piers

- The piers in this option must be transverse walls supporting the full width of the deck, thus presenting a reduction in opportunities for developing the design in line with the design principle of marine tech
- And/or increasing their visibility (viewed as it will be, generally, from the land)
- And/or reducing the coherence of forms across the whole design.

5.2.2 In Situ post-tensioned (Balanced Cantilever)

The concept sketch design for the bridge is currently a simple, minimalist and elegant structure with a continuous sense of flow from end to end. In order to retain this concept into the design, the box girder offers a more sleek underdeck form with more elegant pier interfaces and a significant visible reduction from two to one, of the cantilever in water piers. This asymmetry reflects the counterweight form.

Deck edge / deck construction

- Depth of 750mm at parapet beam face represents a very fine horizontal deck-line
- which allows the blade structure above to 'float' over the water
- The box element mid -span – 2400mm – (5000mm at piers) is under the centre of the deck less visible and generally in shadow.

Piers

- There are 4 on land piers, the box girders need to be at 5000mm at pier positions
- But they curve to this depth and the depth here can become integrated with the pier structure as one continuous supporting form

5.3 Conclusion (Design Quality Review)

CABE go on to recommend (see introduction) that the mechanism and the experience of its opening and closing will constitute a piece of moving sculpture which can go beyond its functional requirements to be celebrated by users and onlookers and that to maximise this opportunity suggest the design throughout is kept minimal, thereby highlighting the mechanism of the structure.

Furthermore it is expected that the design testing ensures slender, elegant shapes throughout the structure. Which we endorse and would add that the blade opening mechanism should be highlighted and be presented as an element in flight on a discrete supporting horizontal line, as uninterrupted as possible by varied, distracting elements.

With this very much in mind we recommend the post-tensioned cantilever option to facilitate the design development as outlined above.

6 Summary

In this section a summary of advantages and disadvantages of the options discussed above is presented:

	Option	Advantages	Disadvantages
Span Arrangement (Substructures)	Four Pier	• Currently lower risk (until the details of the south quay is confirmed and impact mitigated in the two pier option)	• More piers in the water • Higher Environmental risk due to more piers in the water • More impact of the flow pattern within the lake
	Two Pier	• Less piers in the water • Lower Environmental risk due to only two piers in the water • Lower impact to the flow pattern within the lake	• Longer spans for the superstructure
Superstructure	Steel girders with concrete deck slab	• Standard design; • Minimal disruption to the port due to the use of prefabricated elements	• Uncertainty around method of erection due to possible crane access issues • Steel beam requires repaint at 20-25 year intervals. Associated scaffolding costs make the cost of these interventions prohibitive
	Precast beams for approach span, steel beams over the railway	• Standard design; • Minimal disruption to the port and railway due to the use of prefabricated/precast elements • Low long term maintenance requirements for precast beams due to factory controlled conditions of manufacture	• Long Cantilevers supporting the parapet • Uncertainty around method of erection due to possible crane access issues • Steel beam requires repaint at 20-25 year intervals. • Discontinuity of structural form, aesthetically unapealling • Wider pier requirement to support bascule bridge with more no of piles
	In Situ post-tensioned Balanced Cantilever	• Aesthetic form provides cleaner lines; • Low long term maintenance requirements compared to steel option.	• Higher design costs and more specialist contractor required; • High start-up costs; • Greater requirement for temporary works;

		• Suited to sites with poor access from below • Thinner pier requirement supporting bascule bridge with less no of piles	• Greater vehicle movements.
Type of Bascule Bridge (based on mechanism)	Single leaf bascule	• Actuation machinery located below deck; • Not suspect to collision damage from traffic; • Can be gear or hydraulically actuated;	• Complex foundation requirement; • Large counterweight pit requirement;
	Double leaf bascule	• Actuation machinery located below deck; • Not suspect to collision damage from traffic; • Can be gear or hydraulically actuated	• Complex foundation requirement • Counterweight pit requirement for both piers
	Single leaf rolling bascule	• Aesthetically pleasing; • Moving span rolls back during raising • Kentledge can be located in bascule pit or overhead to each side of deck. • Unlimited air draft can be achieved more quickly across navigation channel • Simplified foundation construction compared to counterweight pit	• Complex fabrication as compared to other options;

7 Cost Estimate

A cost estimate exercise has been carried out for the proposed options. The cost estimate for the proposed options are presented in the tables below.

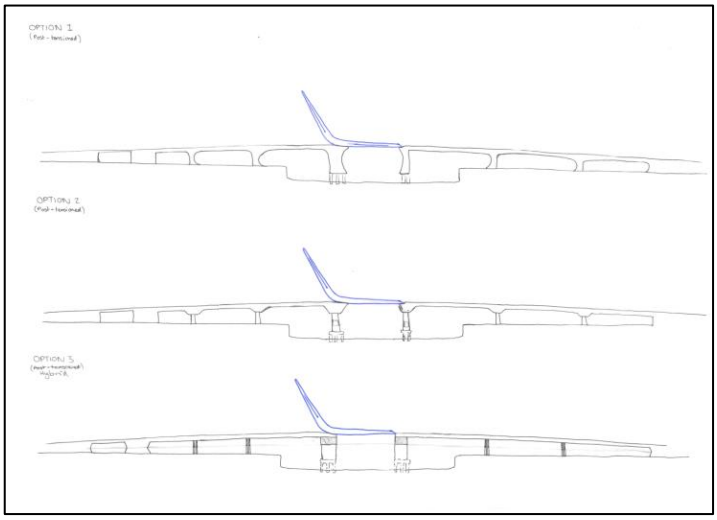
Substructure

Option	Capital Cost	Comments
Two Pier in the water -Steel and Hybrid Options	£19,200,000	Assumes 2 temporary islands are constructed to carry out piling works
Two Pier in the water – In Situ Balanced Cantilever Option	£16,300,000	Assumes 2 temporary islands are constructed to carry out piling works
Four Pier in the water	£23,500,000	Assumes 2 temporary peninsulas are constructed to carry out piling works

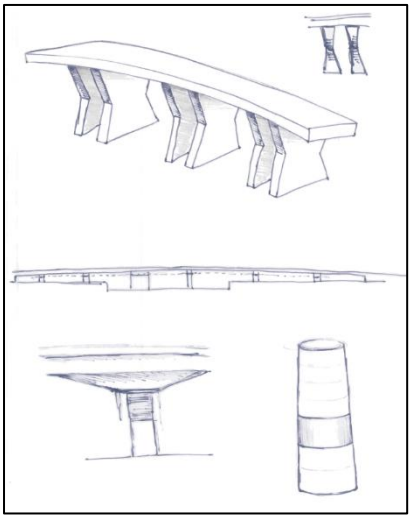
Pricing Notes
Span arrangement (Substructure) option estimates include an allowance for professional fees and a 50% allowance for risk to reflect the early stage of design and stakeholder involvement and the need for further Ground Investigation to determine the length of piles and extent of temporary works.

The difference in the capital cost for the “Two Pier” substructure for hybrid and In Situ balanced cantilever option is mainly due to the reason that for hybrid option bascule bridge will be supported over the pier which will require wider pier with significantly more piles whereas for Insitu balanced cantilever option the bascule bridge will be supported over the deck resulting in thinner pier with less piles.

Whilst the size of the piers and the loads to be carried has a significant impact on cost the specific form of the piers are still in the process of development as per sketch 1 & 2 below and will be finalised in the next stage. The final form of the piers under consideration will not have a significant impact on the scheme costs.



Sketch 1



Sketch 2

Superstructure

Option	Capital Cost	Comments
Steel Girders	£10,300,000	Standard fabrication, less cost than post tensioned option
Precast beams for approach span, steel beams over the railway	£7,600,000	Low initial cost but higher maintenance cost
In situ Post Tensioned Balanced Cantilever	£10,700,000	High initial cost based on superstructure alone.

Pricing Notes:
The steel girder capital cost includes cost information supplied by suppliers/erectors. There is further consideration required to be given to the method of erection as access for cranes may be restricted.

The precast beam capital cost includes cost information supplied by beam manufacturers. Again, there is further consideration required to be given to the method of erection as access for cranes may be restricted.

Constructability generally and cost advice for the travelling formwork and post tensioning has been obtained from a specialist contractor for the in situ balanced cantilever option.

All option costs assume that the north and south decks will be constructed concurrently.

The estimated cost of scaffolding the underside of the bridge decks in order to carry out life cycle interventions has been obtained from a specialist contractor. These costs are prohibitive forming 65 - 70% of the intervention base costs.

The superstructure whole life cost option estimates include an allowance for professional fees and a 40% allowance for risk to reflect the early stage of design and stakeholder involvement.

Bascule Bridge

Option	Capital Cost	Comments
Single leaf bascule	£5,043,485	Higher cost, complex foundation requirement
Double leaf bascule	£5,133,690	Higher cost, double bascule pit requirement
Single leaf rolling bascule	£4,968,990	Less cost with better aesthetics

Overall Capital Cost

Option	Total Capital Cost	Comments
Steel Composite Options	£34,469,000	Higher cost, more maintenance requirement
Hybrid Option	£31,769,000	Less cost for superstructure but more expensive substructure
In Situ Balanced Cantilever Option	£31,969,000	Greater depth of deck for supporting bascule but thinner substructure with less no of piles

Whole Life Costing

Whole life costing exercise is carried out only for the superstructure as for substructure and bascule bridge whole life costing will be similar for all options so therefore not included in the table below.

Option	Capital Cost	Superstructure Life Cycle Interventions Cost (discounted rate)	Whole Life Cost	Comments
Steel Girders	£34,469,000	£6,651,000	£41,120,000	Repainting interventions at year 15, 25, 40, 50, 65, 75, 90, 100 and 115.
Precast beams for approach span, steel beams over the railway	£31,769,000	£2,822,000	£34,591,000	Repainting interventions at year 15, 25, 40, 50, 65, 75, 90, 100 and 115. Concrete repairs to beams and deck in years 40, and 80.
In situ Post Tensioned Balanced Cantilever	£31,969,000	£1,172,000	£33,141,000	Concrete repairs and post tensioning maintenance to box and wings in years 40 and 80.

8 Assumptions

Following critical assumptions are considered for railway span in the design which still required confirmation from relevant authority

- For Railway span, in situ balanced cantilever option considered which is constructed parallel to the track and will be revolved after casting during the night time to minimise the disruption for the network rail. Construction methodology submitted to network rail and awaiting response from them.
- There is a requirement of maintaining vertical clearance of 4.9m over the railway span which is considered in the design, the horizontal clearance from the railway track for which the 4.9m needs to be maintained has been assumed to be 2m which requires acceptance from network rail.

9 Recommendations

9.1 Span Arrangements within Lake Lothing (substructure)

It is recommended that the “two pier” option is taken forward as the preferred solution for the span arrangement within Lake Lothing due to its many advantages as compared to the “four pier” option. The costing exercise supports this recommendation. This recommendation has been accepted by the Client based on version P02 of this report and does not need to be revisited.

9.2 Superstructure Form

The recommendation for the superstructure form based on low maintenance over the railway, ease of construction, aesthetically pleasing structure and low whole life costing would be the in situ post tensioned balanced cantilever.

9.3 Type of Bascule Bridge

Based on the whole life cost and aesthetics the single leaf rolling lift bascule bridge is recommended and design will be further developed in the next stage.

10 Appendices

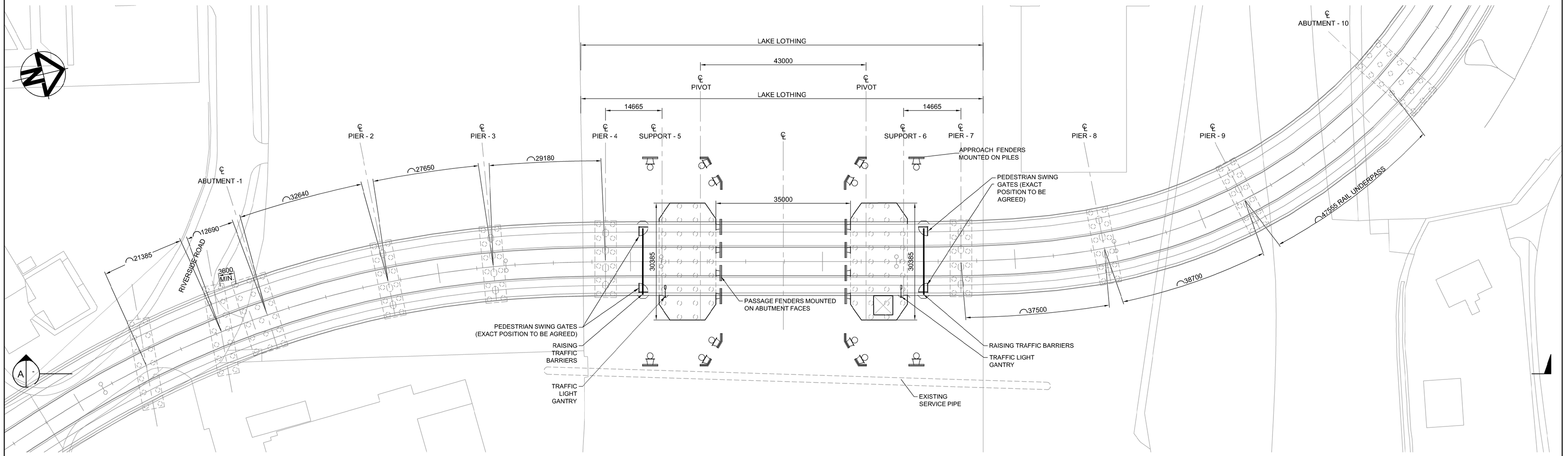
Appendix A – Span Arrangements within Lake Lothing Option Drawings

Appendix B – Superstructure Options

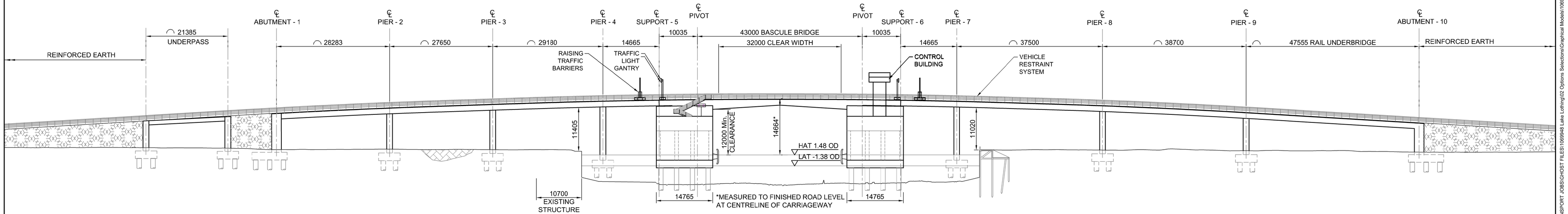
Appendix C – Whole Life Costing Breakdown

Appendix A

Span Arrangements within Lake Lothing Option



PLAN
Scale 1:500 (A -)



ELEVATION (A -)
Scale 1:500

DRAFT AND CONFIDENTIAL

Revision	Amendment	Drawn/Designed	Checked	Approved	Date
P05	COMPANY LOGO CHANGED	EL	FQ	MN	28/07/17
P04	CLEARANCE INCORPERATED	OW	TK	MN	24/02/17
P03	DRAWING TITLE CHANGED	RR	TK	MN	14/02/17
P02.2	MINOR AMENDMENTS	EL	TK	MN	10/02/17
P02.1	REVISED FOUNDATION PIER	OW	TK	MN	-

Project
LAKE LOTHING THIRD CROSSING

Drawing Title
STRUCTURES PLAN AND ELEVATION 4 PIERS OPTION

Office
KNIGHTS HOUSE, 2 PARADE
SUTTON COLDFIELD, B72 1PH
TEL: 0121 355 6949
WWW.MOUCHEL.COM

Client
Lake Lothing THIRD CROSSING

Scale	Designed / Drawn	Checked	Approved	Authorised
As shown	OW	MC	MN	MN
Original Size: A1	Date: 20/12/16	Date: 20/12/16	Date: 20/12/16	Date: 20/12/16

Status: FOR INFORMATION

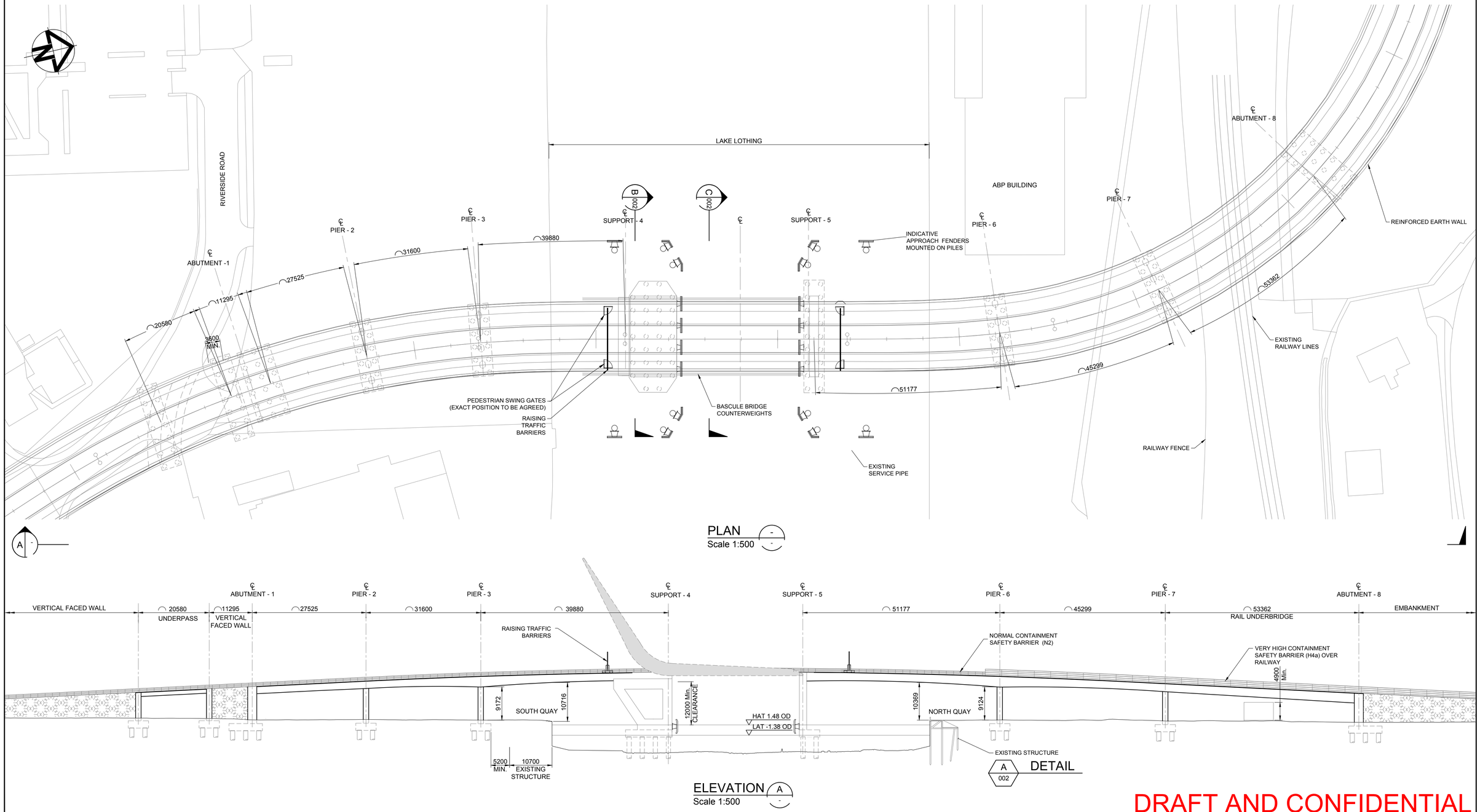
Drawing No: Project	Originator	Volume	Location	Type	Role	Number	Suitability	Revision
1069948	MOU		SGN				S3	P05
LL_C13	DR		CB			0009		

filepath: W:\Highways\TRANSPORT JOBS\GHOST FILES\1069948 Lake Lothing\02 Options Selections\Graphical Models\1069948-MOU-SGN-LL-C13-DR-CB-0009-P05.dwg
pcd date: 28/07/2017 10:16:42
by: Emma Luckman

Appendix B

Superstructure Options with Two Piers in the Water

DRAFT AND CONFIDENTIAL



PLAN
Scale 1:500

ELEVATION A
Scale 1:500

A 002 DETAIL

DRAFT AND CONFIDENTIAL

Revision	Amendment	Drawn/Designed	Checked	Approved	Date
P07	MINOR AMENDMENTS	EL	RR	MN	21/07/2017
P06	MINOR AMENDMENTS	EL	RR	MN	29/06/2017
P05	1 LEAF BASCULE BRIDGE	EL	RR	MN	28/06/2017
P04	MINOR AMENDMENTS	OW	TK	MN	03/04/2017
P03	CLEARNACE INCORPERATED	OW	TK	MN	24/02/2017

Project
LAKE LOTHING THIRD CROSSING

Drawing Title
STRUCTURES GENERAL ARRANGEMENT STEEL COMPOSITE OPTION SHEET 1 OF 2

Office
KNIGHTS HOUSE, 2 PARADE
SUTTON COLDFIELD, B72 1PH
TEL. 0121 355 8949
WWW.MOUCHEL.COM

Client
Lake Lothing THIRD CROSSING

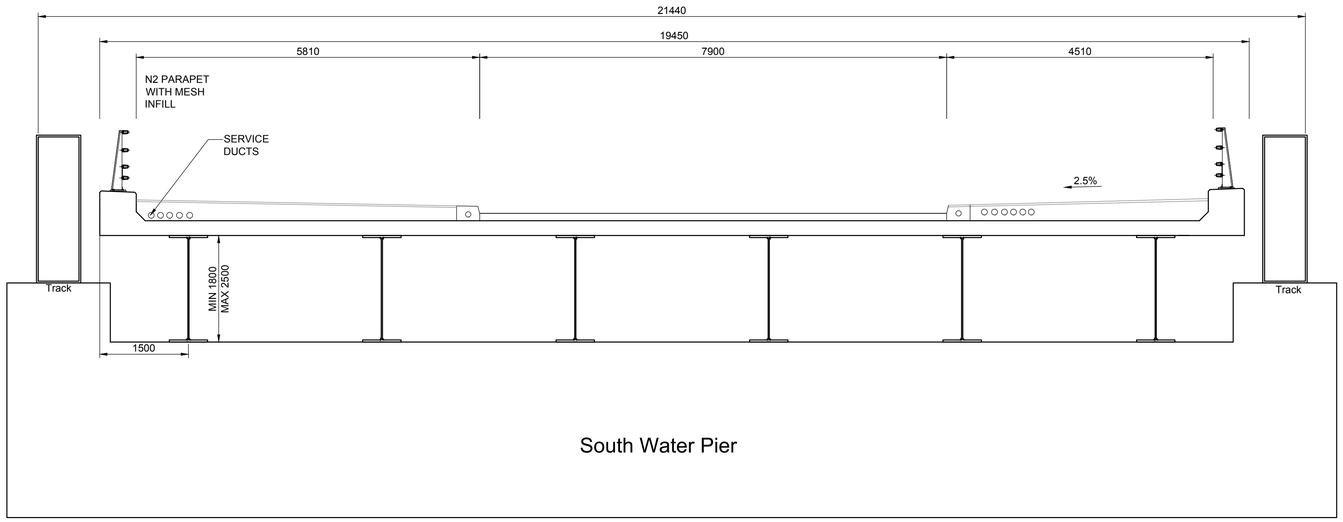
Scale	Designed / Drawn	Checked	Approved	Authorised
As shown	MS	MC	MN	MN
Original Size	Date	Date	Date	Date
A1	25/10/16	25/10/16	25/10/16	25/10/16

Status: FOR INFORMATION

Drawing No	Project	Originator	Volume	Suitability
	1069948	MOU	SGN	S2
Location	LL_C13	DR	CB	0001
Type / Role / Number				Revision: P07

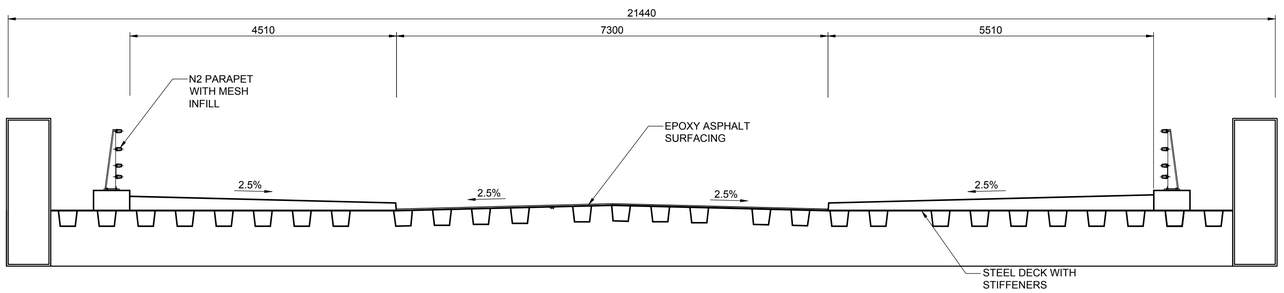
filepath: W:\Highways\TRANSPORT JOBS\SHOST FILES\1069948 Lake Lothing\02 Options Selections\Graphical Models\1069948-MOU-SGN-LL_C13-DR-CB-0001-P07.dwg
plot date: 21/07/2017 15:35:52
by: Emma Luckman

DRAFT AND CONFIDENTIAL

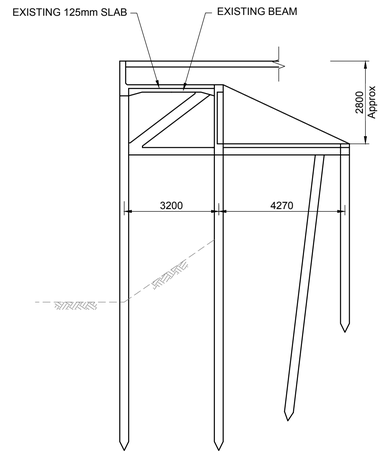


1.8m GIRDER HEIGHTS AT SUPPORTS 1,2,4,5,7 & 8
2.5m GIRDER HEIGHTS AT SUPPORTS 3 & 6
(REFER TO ELEVATION A - DWG 0001)

SECTION B
Scale 1:50



SECTION C
Scale 1:50



A 001 DETAIL
1:100

DRAFT AND CONFIDENTIAL

Revision	Amendment	Drawn/Designed	Checked	Approved	Date
P04	MINOR AMENDMENTS	EL	RR	MN	21/07/2017
P03	1 LEAF BASCULE BRIDGE	EL	RR	MN	28/06/2017
P02	DRAWING TITLE CHANGED	RR	TK	MN	14/02/2017

Project
LAKE LOTHING THIRD CROSSING

Drawing Title
STRUCTURES GENERAL ARRANGEMENT STEEL COMPOSITE OPTION SHEET 2 OF 2

Office
KNIGHTS HOUSE, 2 PARADE
SUTTON COLDFIELD, B72 1PH
TEL: 0121 355 8949
WWW.MOUCHEL.COM

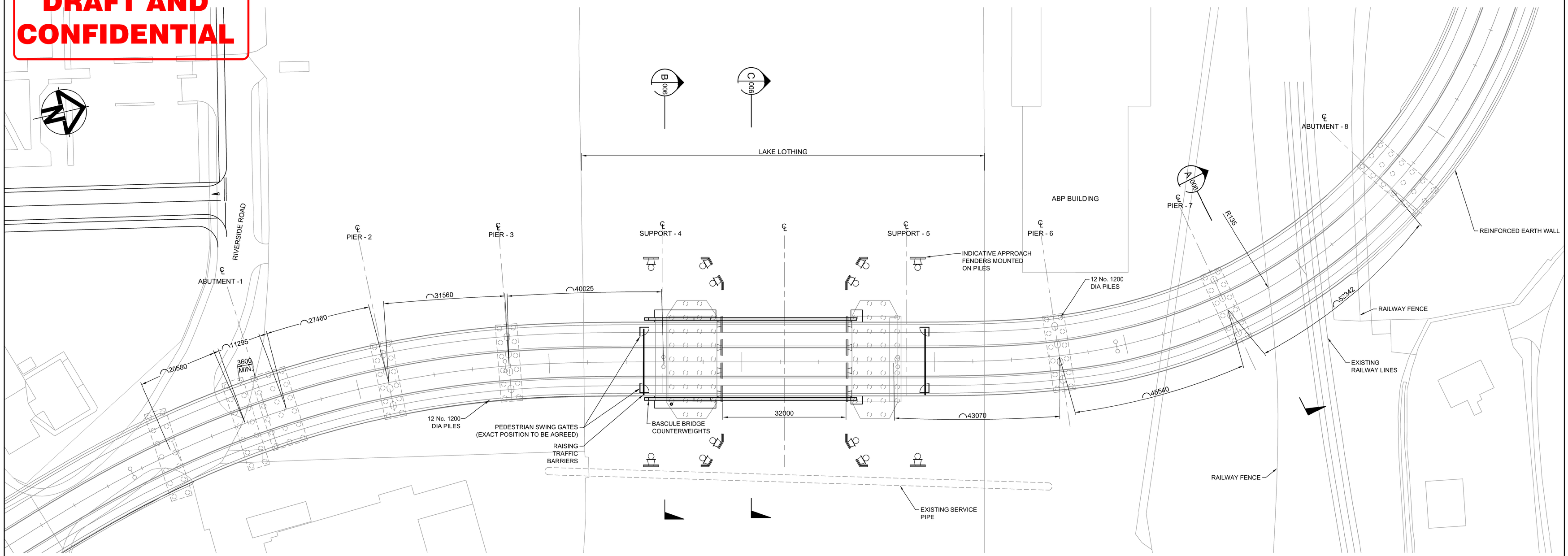
Client
Lake Lothing THIRD CROSSING

Scale	Designed / Drawn	Checked	Approved	Authorised
As shown	MS	MC	MN	MN
Original Size	Date	Date	Date	Date
A1	25/10/16	25/10/16	25/10/16	25/10/16

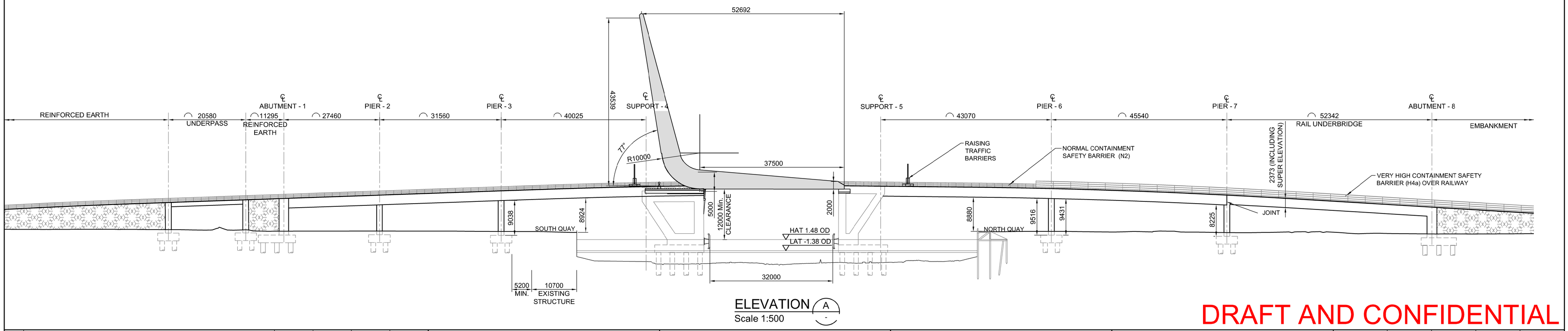
Status: FOR INFORMATION

Drawing No				Suitability
Project	Originator	Volume		S2
1069948	MOU		SGN	Revision
LL_C13	DR	CB	0002	P04
Location	Type	Role	Number	

DRAFT AND CONFIDENTIAL



PLAN - Scale 1:500



ELEVATION A - Scale 1:500

DRAFT AND CONFIDENTIAL

Revision	Amendment	Drawn/Designed	Checked	Approved	Date
P09	MINOR AMENDMENTS	EL	FQ	MN	27/07/2017
P08	MINOR AMENDMENTS	EL	RR	MN	21/07/2017
P07	MINOR AMENDMENTS	EL	RR	MN	18/07/2017
P06	MINOR AMMENDMENTS	EL	RR	MN	29/06/2017
P05	1 LEAF BASCULE BRIDGE	EL	TK	MN	28/06/2017

Project: **LAKE LOTHING THIRD CROSSING**

Drawing Title: **STRUCTURES GENERAL ARRANGEMENT PRECAST CONCRETE-STEEL HYBRID OPTION (SHEET 1 OF 2)**

Office
KNIGHTS HOUSE 2 PARADE
SUTTON COLDFIELD, B72 1PH
TEL: 0121 355 8949
WWW.MOUCHEL.COM

Client: Lake Lothing THIRD CROSSING

Scale	Designed / Drawn	Checked	Approved	Authorised
As shown	EL	RR	MN	MN
Original Size: A1	Date: 14/07/17	Date: 14/07/17	Date: 14/07/17	Date: 14/07/17

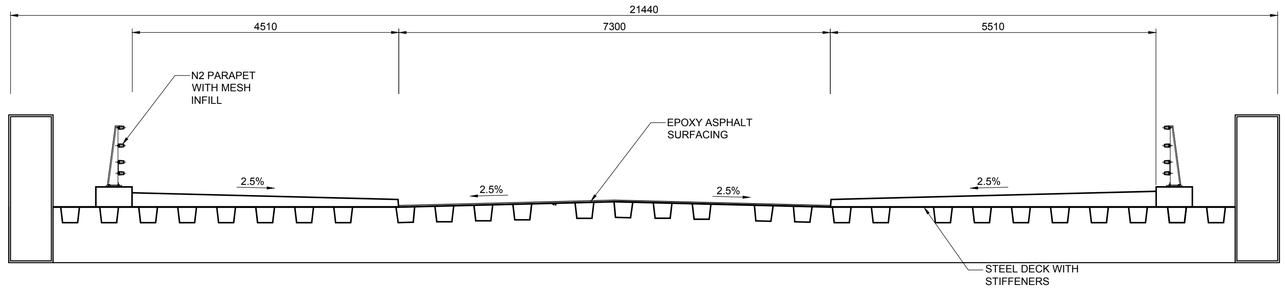
Status: FOR INFORMATION

Drawing No Project	Originator	Volume	Location	Type	Role	Number	Suitability	Revision
1069948	MOU		SGN				S2	P09
LL_C13			CB			0005		

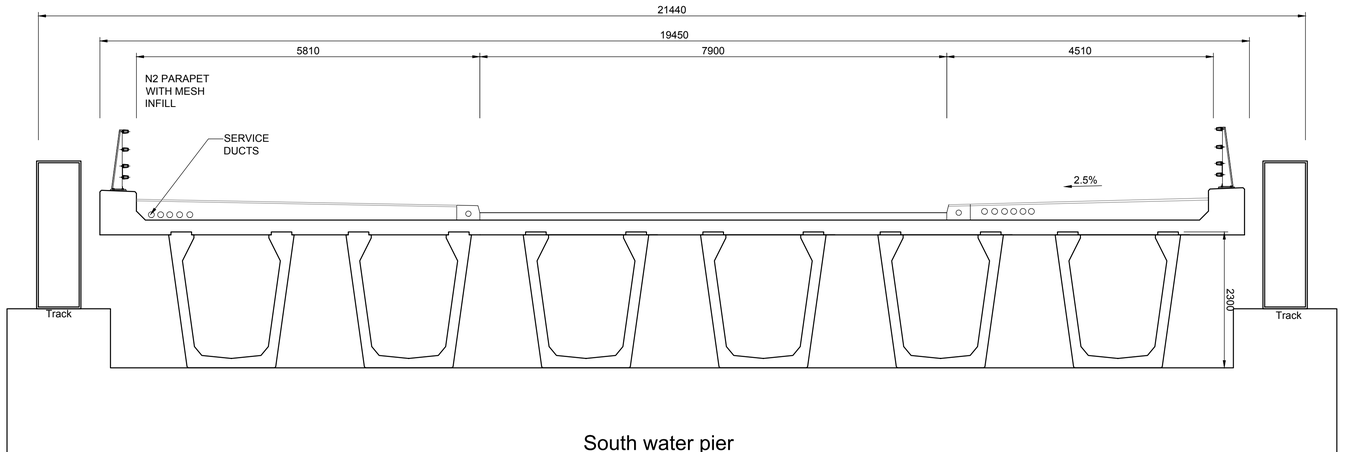
filepath: W:\Highways\TRANSPORT JOBS\GHOST FILES\1069948 Lake Lothing\02 Options Selections\Graphical Models\1069948-MOU-SGN-LL_C13-DR-CB-0005-P09.dwg

plot date: 28/07/2017 10:06:47 by: Emma Luckman

DRAFT AND CONFIDENTIAL

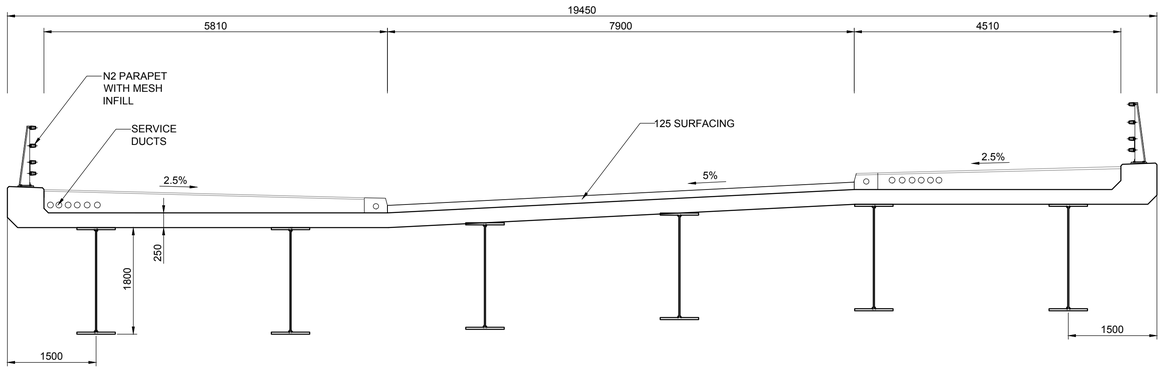


SECTION C
Scale 1:50



South water pier

SECTION B
Scale 1:50



SECTION A
Scale 1:50

DRAFT AND CONFIDENTIAL

Revision	Amendment	Drawn/Designed	Checked	Approved	Date
P05	MINOR AMENDMENTS	EL	RR	MN	28/06/2017
P04	1 LEAF BASCULE BRIDGE	EL	RR	MN	28/06/2017
P03	MINOR AMENDMENTS TO SECTION C-C	OW	TK	MN	07/04/2017
P02	DRAWING TITLE CHANGED	RR	TK	MN	14/02/2017

Project
LAKE LOTHING THIRD CROSSING

Drawing Title
STRUCTURES GENERAL ARRANGEMENT PRECAST CONCRETE-STEEL HYBRID OPTION (SHEET 2 OF 2)

Office
KNIGHTS HOUSE, 2 PARADE
SUTTON COLDFIELD, B72 1PH
TEL: 0121 355 8949
WWW.MOUCHEL.COM

Client
Lake Lothing THIRD CROSSING

Scale	Designed / Drawn	Checked	Approved	Authorised
As shown	RR	MC	MN	MN
Original Size: A1	Date: 25/10/16	Date: 21/11/16	Date: 21/11/16	Date: 21/11/16

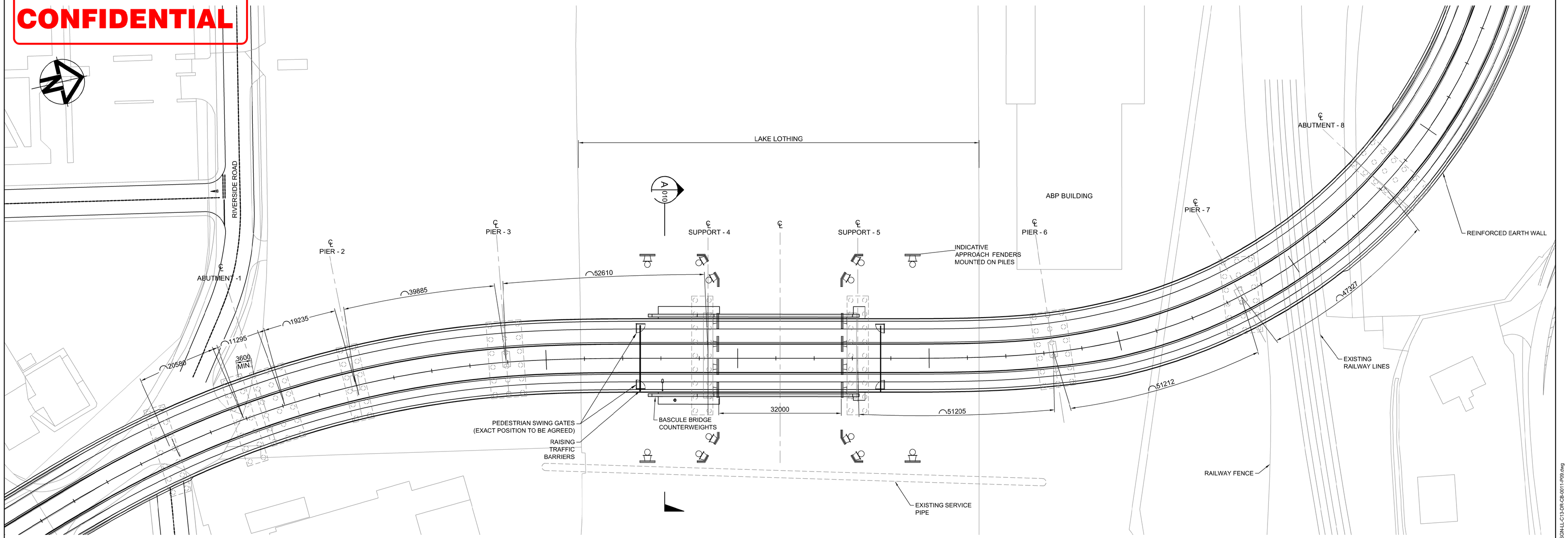
Status: FOR INFORMATION

Drawing No: Project 1069948 | Originator MOU | Volume SGN | Location LL_C13 | Type DR | Role CB | Number 0006

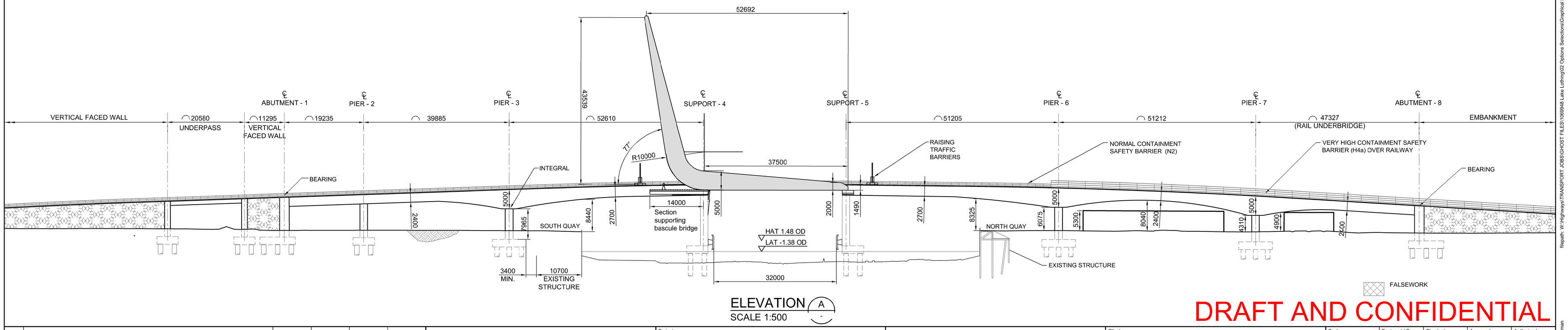
Suitability: S2

Revision: P05

DRAFT AND CONFIDENTIAL



PLAN
SCALE 1:500



ELEVATION
SCALE 1:500

DRAFT AND CONFIDENTIAL

Revision	Amendment	Drawn/Designed	Checked	Approved	Date
P09	MINOR AMENDMENTS	EL	FQ	MN	27/07/2017
P08	MINOR AMENDMENTS	EL	RR	MN	21/07/2017
P07	MINOR AMENDMENTS	EL	RR	MN	18/07/2017
P06	MINOR AMENDMENTS	EL	MN	MN	29/06/2017
P05	1 LEAF BASCULE BRIDGE	OW	TK	MN	27/06/2017

Project
LAKE LOTHING THIRD CROSSING

Drawing Title
STRUCTURES GENERAL ARRANGEMENT IN SITU BALANCED CANTILEVER OPTION (SHEET 1 OF 2)

Office
KNIGHTS HOUSE 2 PARADE
SUTTON COLDFIELD, B72 1PH
TEL: 0121 355 8949
WWW.MOUCHEL.COM

Client
Lake Lothing THIRD CROSSING

Scale	Designed / Drawn	Checked	Approved	Authorised
As shown	EL	RR	MN	MN
Original Size: A1	Date: 14/07/17	Date: 14/07/17	Date: 14/07/17	Date: 14/07/17

Status: FOR INFORMATION

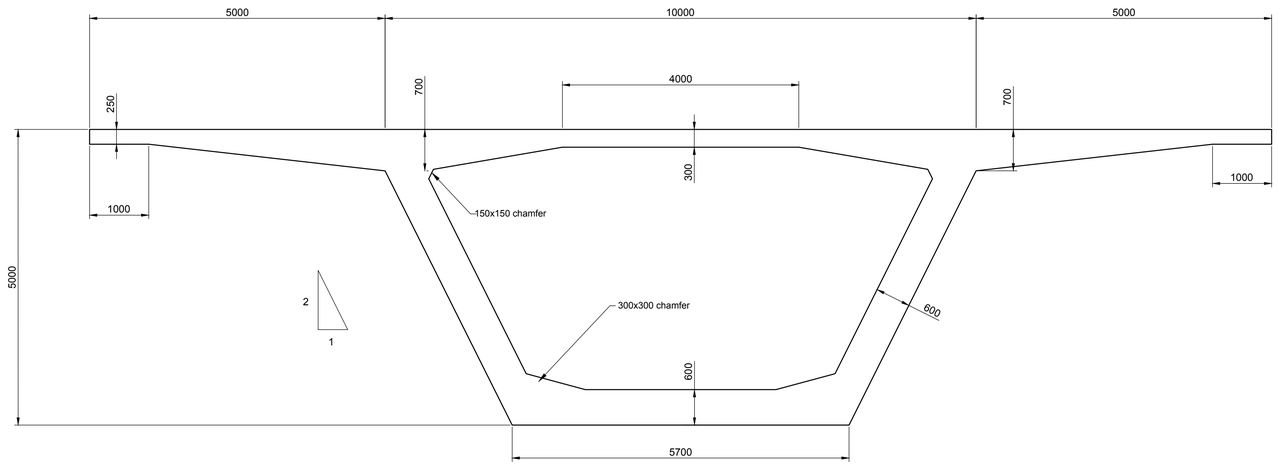
Drawing No Project	Originator	Volume	Location	Type	Role	Number	Suitability	Revision
1069948	MOU		SGN	LL_C13	DR	CB	0011	S3	P09

filepath: W:\Highways\TRANSPORT JOBS\GHOST FILES\1069948 Lake Lothing\02 Options Selections\Graphical Models\1069948-MOU-SGN-LL-C13-DR-CB-0011-P09.dwg

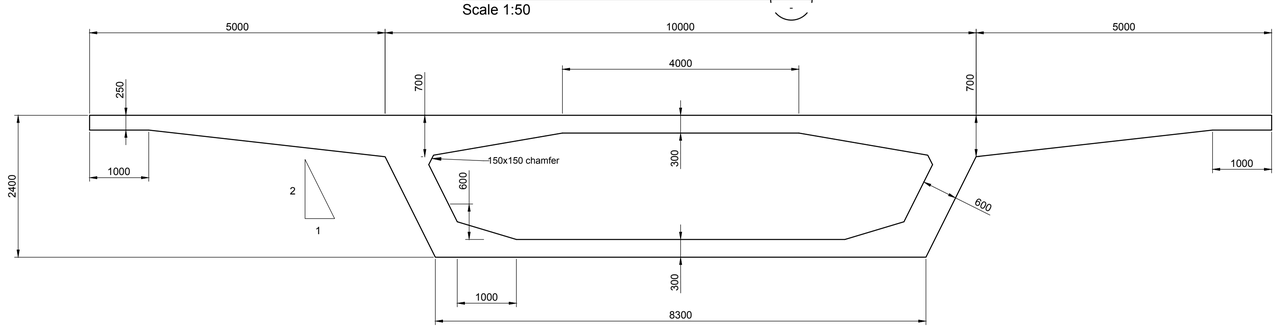
by: Emma Luckman

plot date: 28/07/2017 10:01:35

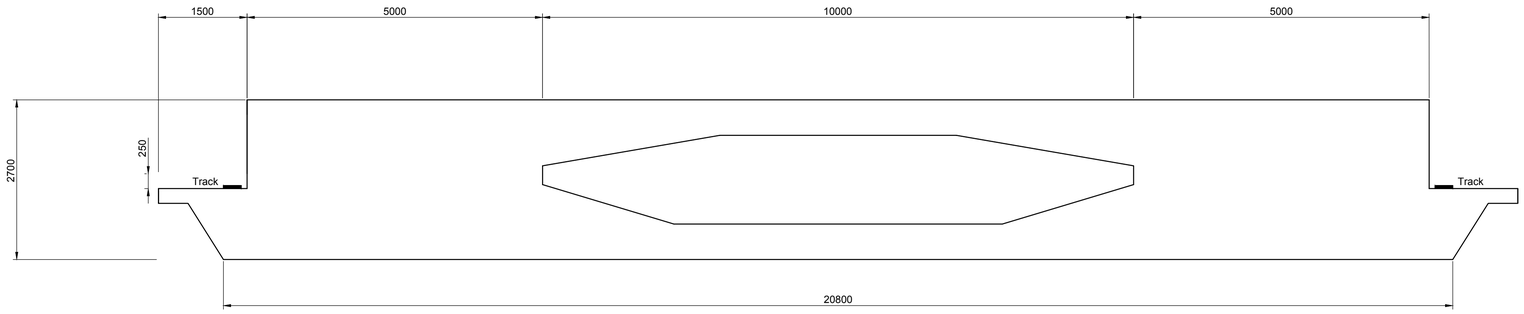
DRAFT AND CONFIDENTIAL



SECTION AT PIERS 3, 6 AND 7 (-)
Scale 1:50



SECTION - MID SPAN (-)
Scale 1:50



SECTION - SUPPORTING BASCULE BRIDGE (C/011)
Scale 1:50

This section needs to be considered in the south approach from the south water pier for 21m towards south

DRAFT AND CONFIDENTIAL

Revision	Amendment	Drawn/Designed	Checked	Approved	Date
P05	MINOR AMMENDMENTS	EL	RR	MN	21/07/2017
P04	BASCULE BRIDGE SUPPORTED ON DECK	RR	FQ	FQ	18/07/2017
P03	DEPTH INCREASE AT MID SPAN	OW	TK	MN	24/02/17
P02	DRAWING TITLE CHANGED	RR	TK	MN	14/02/17
P01	ORIGINAL ISSUE	RR	RR	MN	JAN 2017

Project: **LAKE LOTHING THIRD CROSSING**

Drawing Title: **STRUCTURES GENERAL ARRANGEMENT IN SITU BALANCED CANTILEVER OPTION (SHEET 2 OF 2)**

Office: KNIGHTS HOUSE, 2 PARADE
SUTTON COLDFIELD, B72 1PH
TEL: 0121 355 8949
WWW.MOUCHEL.COM

Client: Lake Lothing THIRD CROSSING

Scale	Designed / Drawn	Checked	Approved	Authorised
As shown	KET	MC	MN	MN
Original Size	Date	Date	Date	Date
A1	05/01/17	05/01/17	05/01/17	05/01/17

Status: FOR INFORMATION

Drawing No Project	Originator	Volume	Suitability
1069948	MOU	SGN	S3
LL_C13	DR	CB	0010
Location	Type	Role	Number

Revision: P05

Appendix C

Whole Life Costing Breakdown

ESTIMATE CONTROL SHEET

PROJECT NAME: LAKE LOTHING C13 - APPROACH VIADUCT DECK OPTIONS

ESTIMATE REFERENCE: ROUGH ORDER OF MAGNITUDE ESTIMATE

VERSION	PREPARED BY	CHECKED / APPROVED BY	AUTHORISED BY
1.0	K Howieson	S Keeley	S Keeley
	30/11/2016	30/11/2016	01/12/2016
2.0	S Keeley	K Howieson	S Keeley
	20/01/2017	23/01/2017	23/01/2017
2.0	A Rana	S Keeley	S Keeley
	20/07/2017	20/07/2017	21/07/2017

Lake Lothing Bridge C13 - Approach Viaduct Deck Options

ROUGH ORDER OF MAGNITUDE ESTIMATE

SUMMARY OF OPTION STUDY COSTS

Option	Total Cost
Insitu Cantilever	£10,700,000

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Dwg 1069948/MOU/SGN/010 (Post Tensioned Insitu Cantilever Deck Cross Sections)
Dwg 1069948/MOU/SGN/011 (Post Tensioned Insitu Cantilever Deck Long Section)

Client	**Lake Lothing Third Crossing**	
Project:	**Lake Lothing Bridge C13 - Insitu Cantilever Estimate**	
Title:	**Initial guide price estimate for Structural Deck only**	

Location details	Construction considered	Quantity	Unit	Rate		Amount	Notes/assumptions
Early stage costings for an approximate budget allowance only (pricing deemed current Q1 2017							
Elemental costs only considered in the main							
Concrete Deck	Concrete	4,540	m3	150		681,000	
	Formwork (2 Pairs of Travellers)		Item			1,750,000	
	Reinforcement	908	t	1,500		1,362,000	200kg/m3
	Prestressing	204	t	5,000		1,020,000	45kg/m3
					sub-total	4,813,000	
	Items of construction contingency for items not identified and precise detail/spec			allowed at	5.0%	241,000	
	Preliminaries/TM/OH & P			allowed at	30%	1,516,000	
				Approximate basic construction costs		**6,570,000**	
ADD Other considerations							
	Work by Statutory undertakers and others			excluded	0.0%	0	
	Survey/Investigate/Design/Procure/Supervise/manage & liase			allowed at	16%	1,051,000	
	sub-Total incl Stats/Others & Design etc. but excl risk					**7,621,000**	Based on early option outline only - to be progressed prior to construction 40% risk/OB allowed in the absence of QRA
NB Risk and OB figures are for completeness of this estimate summary only and must be replaced by the factors being applied at the current stage of reporting.	Risk/Optimism Bias/contingency	only illustrative details		allowance currently made	**40%**	3,048,000	
				Approximate Indicative Total Budget Estimate		**10,669,000**	
assumptions/allowances as noted	*Prepared by Steve Keeley 20/7/17 for Mouchel*						

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Dwg 1069948/MOU/SGN/010 (Post Tensioned Insitu Cantilever Deck Cross Sections)
Dwg 1069948/MOU/SGN/011 (Post Tensioned Insitu Cantilever Deck Long Section)

Bridge Deck

Dims

Description	Dims				Unit	Calculations & Comments
Bridge Deck						
In situ Concrete						
Section at Pier					**16 m3**	
Section A			1.00			
			5.70			
			5.00	28.50		
Section B		2	1.00			
			2.15			
			0.70	3.01		
Section C	2	0.5	1.00			5.00
			2.15		ddt	-0.70
			4.30	9.25		**4.30**
Section D		2	1.00			
			5.00			
			0.25	2.50		
Section E	2	0.5	1.00			
			4.00			
			0.45	1.80		
			ddt			2.15
ddt section C	2	0.5	1.00		ddt	-0.60
			1.55			**1.55**
			3.00	-4.65		
ddt section A			1.00			5.00
			6.00		ddt	-0.60
			4.10	-24.60		-0.30
1A		0.5	1.00			**4.10**
			0.40			
			0.80	0.16		
1B		0.5	1.00			
			0.30			
			0.70	0.11		
1C & D	2	0.5	1.00			
			0.80			
			0.20	0.16		
				16.23		

Section - Mid Deck

13 m3

							4.00
Section A			1.00			+	2.30
			8.60				2.30
			2.10	18.06			8.60
Section B		2	1.00				
			0.60				
			0.70	0.84			
Section C	2	0.5	1.00				2.10
			0.60			ddt	-0.70
			1.40	0.84			**1.40**
Section D		2	1.00				
			5.00				
			0.25	2.50			
Section E	2	0.5	1.00				
			4.00				
			0.45	1.80			
			ddt				2.10
ddt 1A			1.00			ddt	-0.30
			4.00				-0.30
			1.50	-6.00			**1.50**
ddt 2a		2	1.00				
			1.30				1.50
			1.30	-3.38		ddt	-0.20
							1.30
ddt 3a	2	0.5	1.00				
			0.30				
			1.30	-0.39			
	2	0.5	1.00				
			0.40				
			1.30	-0.52			
ddt 4a	2	0.5	1.00				
			1.30				
			0.20	-0.26			
				13.49			

Section - Supporting Bascule Bridge					50.75	m3
A			1.00			
			20.00			
			2.40	48.00		
B		2	1.00			
			1.50			
			0.25	0.75		
C		2	1.00			
			0.80			
			1.00	1.60		
D	2	0.5	1.00			
			0.40			
			1.00	0.40		
				50.75		
Total volume of concrete					**4,539**	**m3**

Section at Pier	16.23
Section at Mid Deck	13.49
Average	14.86

Abutment - 1 to Pier-2						
			19.23			
			1.00			
			13.49	259.41		
Pier -2 to Pier - 3			19.94			
			1.00			
			13.49	268.99		
			19.94			
			1.00			
			14.86	296.31		
Pier - 3 to Support - 4			26.31			
			1.00			
			14.86	390.89		
			5.31			
			1.00			
			13.49	71.56		
Supporting Bascule Bridge			21.00			
			1.00			
			50.75	1065.75		
Suuport - 5 to Pier - 6			26.37			
			1.00			
			13.49	355.66		
			26.37			

	1.00		
	14.86	391.78	
Pier - 6 to Pier - 7	54.48		
	1.00		
	14.86	809.57	
Pier - 7 to Abutment	22.18		
	1.00		
	14.86	329.59	
	22.18		
	1.00		
	13.49	299.21	
		4538.74	

Formwork

Section at Pier

Length Calculation

Mid Deck	Mid deck & Pier Av		
24.35	19.94	Abutment - 1 to Pier-2	24.35
19.94	19.94	Pier-2 to Pier-3	39.88
19.94	19.94	Pier-3 to Support-4	39.88
19.94	54.48	**North quay length**	
22.18	22.18	Support-5 to Pier-6	39.88
106.35 m	136.48 m	Pier-6 to Pier-7	54.48
		Pier-7 to Abutment-8	44.36
			242.8 m

F3 Formwork, vertical to deck section **121 m2**

Section 1	2	242.83	
		0.25	121.42

F3 Formwork, horizontal to deck section **4319 m2**

Section 2	2	242.83	
		5.00	2428.30
Section 5 - Mid Deck		106.35	
		8.60	914.61
Section 5 - Average		136.48	
		7.15	975.83
			4318.74

F3 Formwork, inclined to deck section — **1133 m2**

					Section 6		**Section 6**			
					5.00					
Section 6 - Mid Deck	2	106.35		ddt	-0.70		1.40	1.40		1.96
		1.57	332.93		4.30		0.70	0.7	+	0.49
Section 6 - Average	2	136.48								2.45
		2.93	800.49						Sq Root	1.57
			1133.42							

F1 Formwork, inclined to deck section — **889 m2**

				Section 7		**Section 7**		
Section 7 - Mid Deck	2	106.35		5.00		2.10		
		1.10	233.97	-0.70		-0.70		
Section 7 - Average	2	136.48		ddt	-0.60	ddt	-0.30	Average
		2.40	655.10	3.70		1.10		2.40
			889.07					

F1 Formwork, horizontal to deck section — **2088 m2**

				Section 3	
				10.00	
Section 3		242.83		-0.70	
		8.60	2088.34	ddt	-0.70
				8.60	

Client	**Lake Lothing Third Crossing**
Project:	**Lake Lothing Bridge C13 - Insitu Balanced Cantilever Option**
Title:	**Initial guide price estimate for Structural Deck only**

Location details	Construction considered	Unit	Rate	Basis/Source
Early stage costings for an approximate budget allowance only (pricing deemed current Q1 2017				
Elemental costs only considered in the main				
Concrete Deck	Concrete	m3	£150	Spons 2017 HW suspended slabs
	Formwork Horizontal F1	m2	£60	Spons 2017 HW
	Formwork Horizontal F3	m2	£80	Spons 2017 HW
	Formwork Inclined F1	m2	£70	Spons 2017 HW
	Formwork Inclined F3	m2	£90	Spons 2017 HW
	Formwork Vertical F3 less than 300mm wide	m2	£100	Spons 2017 HW
	Alternative Formwork			
	Travellers/Ancillary Shutters - 2 pairs		£1,150,000	VSL - Conversation with Frederic Turlier (20/1/17)
	Labour & Plant		£600,000	CBDG Cost Data - Formwork only
			£1,750,000	
	Reinforcement	t	£1,500	Spons 2017 HW
	Prestressing	t	£5,000	VSL
assumptions/allowances as noted	*Prepared by Steve Keeley 20/1/17 for Mouchel*			

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Dwg 1069948/MOU/SGN/010 (Post Tensioned Insitu Cantilever Deck Cross Sections)
Dwg 1069948/MOU/SGN/011 (Post Tensioned Insitu Cantilever Deck Long Section)

ESTIMATE CONTROL SHEET

PROJECT NAME: LAKE LOTHING C13 - APPROACH VIADUCT DECK OPTIONS - WHOLE LIFE COSTS

ESTIMATE REFERENCE: ROUGH ORDER OF MAGNITUDE ESTIMATE

VERSION	PREPARED BY	CHECKED / APPROVED BY	AUTHORISED BY
1.0	K Howieson	S Keeley	S Keeley
	30/11/2016	30/11/2016	01/12/2016
2.0	S Keeley	K Howieson	S Keeley
	20/01/2017	23/01/2017	23/01/2017

Lake Lothing Bridge C13 - Approach Viaduct Deck

ROUGH ORDER OF MAGNITUDE ESTIMATE

SUMMARY OF OPTION STUDY WHOLE LIFE COSTS

	Option Cost for Bridge Deck Only	Capital Cost of Bridge Deck Only £	Intervention in year 15, 55 and 95 (Painting steel) 50%	Intervention in year 40, 80 and 120 (Painting steel) 100%	Intervention in year 40, 80 and 120 (minor concrete repairs)	Total Maintenance Costs over life of bridge - 120 years	Total WLC of Structural Deck	Description of Maintenance Work
1	Steel Girders	10,300,000	3,200,000	4,400,000	800,000	25,200,000	35,500,000	Painting 50% of steelwork at 15, 55 and 95 years and 100% at 40, 80 and 120 years Repairs(15% of deck) to damaged concrete every 40 years.
2	Precast Concrete W Beams	7,600,000	700,000	1,000,000	4,400,000	18,300,000	25,900,000	Minor repair (5% of pcc beams area) to damaged concrete every 40 years. Painting 50% of railway bridge steelwork at 15, 55 and 95 years and 100% at 40, 80 and 120 years Repairs(15% of deck) to damaged concrete every 40 years.
3	Insitu Cantilever	9,100,000	0	0	3,700,000	11,100,000	20,200,000	Repairs (15% of external box) to damaged concrete every 40 years Repairs (4%) to post tensioning every 40 years

Capital Cost

Option 1 includes for steel girders to both the main viaduct and the railway bridge
Option 2 includes for precast concrete W beams in the viaduct and steel girders for the railway bridge
Option 3 includes for insitu cantilever structure in both the viaduct and railway bridge

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:

Email from Ricardo Romero dated 6/1/17 (Steel Girder sizing)
Email from Masood Chowdhury dated 21/11/16 (Precast Beam Spec)
Dwg 1069948/MOU/SGN/005 (Steel Girder and PCC Long Section)
Dwg 1069948/MOU/SGN/006 (Steel Girder and PCC Beam Arrangement)
Dwg 1069948/MOU/SGN/010 (Post Tensioned Insitu Cantilever Deck Cross Sections)
Dwg 1069948/MOU/SGN/011 (Post Tensioned Insitu Cantilever Deck Long Section)

Lake Lothing Bridge C13 - Approach Viaduct Deck Options

ROUGH ORDER OF MAGNITUDE

SUMMARY OF OPTION STUDY CAPITAL COSTS

Option	Total Cost
Plate Girder	£10,300,000
Precast Beam	£7,600,000
Insitu Cantilever	£9,100,000

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Email from Ricardo Romero dated 6/1/17 (Steel Girder sizing)
Email from Masood Chowdhury dated 21/11/16 (Precast Beam Spec)
Dwg 1069948/MOU/SGN/005 (Steel Girder and PCC Long Section)
Dwg 1069948/MOU/SGN/006 (Steel Girder and PCC Beam Arrangement)
Dwg 1069948/MOU/SGN/010 (Post Tensioned Insitu Cantilever Deck Cross Sections)
Dwg 1069948/MOU/SGN/011 (Post Tensioned Insitu Cantilever Deck Long Section)

Lake Lothing Bridge C13 - Approach Viaduct Deck Options

ROUGH ORDER OF MAGNITUDE ESTIMATE

SUMMARY OF LIFE CYCLE INTERVENTION COSTS

Option	Total Cost per Intervention
Plate Girder - Painting Steel (50%)	£3,200,000
Plate Girder - Painting Steel (100%)	£4,400,000
Plate Girder - Repairs to Concrete Deck	£800,000
PCC Beam - Painting Steel (50%)	£700,000
PCC Beam - Painting Steel (100%)	£1,000,000
PCC Beam - Repairs to Concrete Beams/Deck	£4,400,000
Insitu Cantilever - Repairs to Concrete Box/Wings	£3,700,000

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Email from Ricardo Romero dated 6/1/17 (Steel Girder sizing)
Email from Masood Chowdhury dated 21/11/16 (Precast Beam Spec)
Dwg 1069948/MOU/SGN/005 (Steel Girder and PCC Long Section)
Dwg 1069948/MOU/SGN/006 (Steel Girder and PCC Beam Arrangement)
Dwg 1069948/MOU/SGN/010 (Post Tensioned Insitu Cantilever Deck Cross Sections)
Dwg 1069948/MOU/SGN/011 (Post Tensioned Insitu Cantilever Deck Long Section)

Client	**Lake Lothing Third Crosiing**									
Project:	**Lake Lothing Bridge C13 - Plate Girder Option**									
Title:	**Initial guide price estimate for Life Cycle Intervention Cost for Painting Steel (50%)**					**Drwg no** -				
Location details	**Construction considered**		**Area**		**Unit**	**Approx. all in rate**		**Amount**		**Notes/assumptions**
Early stage costings for an approximate budget allowance only (pricing deemed current Q4 2015										***General assumptions :***
Elemental costs only considered in the main						All inclusive roadworks rates used				**Normal hours working** **Reasonable levels of productivi**
Painting of Viaduct steelwork	Scaffolding		4,655		sq m	265		1,233,600		
	Containment Sheeting		1,960		sq m	15		29,400		
	Maintenance Painting down to sound paint		6,150		sq m	41		252,150		
							sub-total	1,515,000		
	Items of construction contingency for items not identified and precise detail/spec					allowed at	0.0%	0		
	Preliminaries/TM/OH & P					allowed at	30%	455,000		
							Approximate basic construction costs	**1,970,000**		
ADD Other considerations										
	Work by Statutory undertakers and others		allowed at			allowed at	0.0%	0		
	Survey/Investigate/Design/Procure/Supervise/manage & liase					allowed at	16%	315,000		
			sub-Total incl Stats/Others & Design etc. but excl risk					**2,285,000**		
NB Risk and OB figures are for completeness of this estimate summary only and must be replaced by the factors being applied at the current stage of reporting.	Risk/Optimism Bias/contingency		only illustrative details			allowance currently made	**40%**	914,000	Based on early option outline only - to be progressed prior to construction 40% risk/OB allowed in the absence of QRA	
							Approximate Indicative Total Budget Estimate	**3,199,000**		
assumptions/allowances as noted	*Prepared by Steve Keeley 19/1/17 for Mouchel*									

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Email from Ricardo Romero dated 6/1/17 (Steel Girder sizing)
Dwg 1069948/MOU/SGN/005 (Steel Girder and PCC Long Section)
Dwg 1069948/MOU/SGN/006 (Steel Girder and PCC Beam Arrangement)

ty

Client		**Lake Lothing Third Crosiing**								
Project:		**Lake Lothing Bridge C13 - Plate Girder Option**								
	Title:	**Initial guide price estimate for Life Cycle Intervention Cost for Painting Steel**				**Drwg no** -				
Location details		**Construction considered**	**Area**		**Unit**	**Approx. all in rate**		**Amount**		**Notes/assumptions**
Early stage costings for an approximate budget allowance only (pricing deemed current Q4 2015										***General assumptions :***
Elemental costs only considered in the main						All inclusive roadworks rates used				**Normal hours working** **Reasonable levels of productivity**
Painting of Viaduct steelwork		Scaffolding	4,655		sq m	265		1,233,600		
		Containment Sheeting	1,960		sq m	15		29,400		
		Maintenance Painting down to clean steel	12,300		sq m	65		799,500		
							sub-total	2,063,000		
		Items of construction contingency for items not identified and precise detail/spec				allowed at	0.0%	0		
		Preliminaries/TM/OH & P				allowed at	30%	619,000		
							Approximate basic construction costs	**2,682,000**		
ADD Other considerations										
		Work by Statutory undertakers and others	allowed at			allowed at	0.0%	0		
		Survey/Investigate/Design/Procure/Supervise/manage & liase				allowed at	16%	429,000		
						sub-Total incl Stats/Others & Design etc. but excl risk		**3,111,000**		
NB Risk and OB figures are for completeness of this estimate summary only and must be replaced by the factors being applied at the current stage of reporting.		Risk/Optimism Bias/contingency	only illustrative details			allowance currently made	**40%**	1,244,000		Based on early option outline only - to be progressed prior to construction 40% risk/OB allowed in the absence of QRA
							Approximate Indicative Total Budget Estimate	**4,355,000**		
assumptions/allowances as noted		*Prepared by Steve Keeley 19/1/17 for Mouchel*								

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Email from Ricardo Romero dated 6/1/17 (Steel Girder sizing)
Dwg 1069948/MOU/SGN/005 (Steel Girder and PCC Long Section)
Dwg 1069948/MOU/SGN/006 (Steel Girder and PCC Beam Arrangement)

Client		**Lake Lothing Third Crosiing**								
Project:		**Lake Lothing Bridge C15 - Maintenance - Painting steel girders**								
	Title:	**Initial guide price estimate for Life Cycle Intervention Cost for Concrete Repairs**								
							Drwg no -			
Location details		**Construction considered**	**Area**		**Unit**	**Approx. all in rate**		**Amount**		**Notes/assumptions**
Early stage costings for an approximate budget allowance only (pricing deemed current Q4 2015										***General assumptions :***
Elemental costs only considered in the main						All inclusive roadworks rates used				**Normal hours working** **Reasonable levels of productivity**
Concrete repairs to deck		Assume 15% area 125mm thick - Scaffolding included in painting steelwork	720		sq m	550		396,000		
							sub-total	396,000		
		Items of construction contingency for items not identified and precise detail/spec				allowed at	0.0%	0		
		Preliminaries/TM/OH & P				allowed at	30%	119,000		
						Approximate basic construction costs		**515,000**		
ADD Other considerations										
		Work by Statutory undertakers and others	allowed at			allowed at	0.0%	0		
		Survey/Investigate/Design/Procure/Supervise/manage & liase				allowed at	16%	82,000		
						sub-Total incl Stats/Others & Design etc. but excl risk		**597,000**		
NB Risk and OB figures are for completeness of this estimate summary only and must be replaced by the factors being applied at the current stage of reporting.		Risk/Optimism Bias/contingency	only illustrative details			allowance currently made	**40%**	239,000		Based on early option outline only - to be progressed prior to construction 40% risk/OB allowed in the absence of QRA
						Approximate Indicative Total Budget Estimate		**836,000**		
assumptions/allowances as noted		*Prepared by Steve Keeley 19/1/17 for Mouchel*								

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Email from Ricardo Romero dated 6/1/17 (Steel Girder sizing)
Dwg 1069948/MOU/SGN/005 (Steel Girder and PCC Long Section)
Dwg 1069948/MOU/SGN/006 (Steel Girder and PCC Beam Arrangement)

Client	**Lake Lothing Third Crosiing**									
Project:	**Lake Lothing Bridge C13 - Plate Girder Option**									
Title:	**Initial guide price estimate for Life Cycle Intervention Cost for Painting Steel (50%)**					**Drwg no** -				
Location details	**Construction considered**		**Area**		**Unit**	**Approx. all in rate**		**Amount**		**Notes/assumptions**
Early stage costings for an approximate budget allowance only (pricing deemed current Q4 2015										***General assumptions :***
Elemental costs only considered in the main						All inclusive roadworks rates used				**Normal hours working** **Reasonable levels of productivity**
Painting of Railbridge steelwork	Scaffolding		1,045		sq m	265		276,900		
	Containment Sheeting		440		sq m	15		6,600		
	Maintenance Painting down to sound paint		1,350		sq m	41		55,350		
							sub-total	339,000		
	Items of construction contingency for items not identified and precise detail/spec					allowed at	0.0%	0		
	Preliminaries/TM/OH & P					allowed at	30%	102,000		
						Approximate basic construction costs		**441,000**		
ADD Other considerations										
	Work by Statutory undertakers and others		allowed at			allowed at	0.0%	0		
	Survey/Investigate/Design/Procure/Supervise/manage & liase					allowed at	16%	71,000		
			sub-Total incl Stats/Others & Design etc. but excl risk					**512,000**		
NB Risk and OB figures are for completeness of this estimate summary only and must be replaced by the factors being applied at the current stage of reporting.	Risk/Optimism Bias/contingency		only illustrative details			allowance currently made	**40%**	205,000	Based on early option outline only - to be progressed prior to construction 40% risk/OB allowed in the absence of QRA	
						Approximate Indicative Total Budget Estimate		**717,000**		
assumptions/allowances as noted	*Prepared by Steve Keeley 19/1/17 for Mouchel*									

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Email from Masood Chowdhury dated 21/11/16 (Precast Beam Spec)
Dwg 1069948/MOU/SGN/005 (Steel Girder and PCC Long Section)
Dwg 1069948/MOU/SGN/006 (Steel Girder and PCC Beam Arrangement)

Client	**Lake Lothing Third Crosiing**									
Project:	**Lake Lothing Bridge C13 - Plate Girder Option**									
Title:	**Initial guide price estimate for Life Cycle Intervention Cost for Painting Steel (50%)**					**Drwg no** -				
Location details	**Construction considered**		**Area**		**Unit**	**Approx. all in rate**		**Amount**		**Notes/assumptions**
Early stage costings for an approximate budget allowance only (pricing deemed current Q4 2015										***General assumptions :***
Elemental costs only considered in the main						All inclusive roadworks rates used				**Normal hours working** **Reasonable levels of productivity**
Painting of Railbridge steelwork	Scaffolding		1,045		sq m	265		276,900		
	Containment Sheeting		440		sq m	15		6,600		
	Maintenance Painting down to clean steel		2,700		sq m	65		175,500		
							sub-total	459,000		
	Items of construction contingency for items not identified and precise detail/spec					allowed at	0.0%	0		
	Preliminaries/TM/OH & P					allowed at	30%	138,000		
						Approximate basic construction costs		**597,000**		
ADD Other considerations										
	Work by Statutory undertakers and others		allowed at			allowed at	0.0%	0		
	Survey/Investigate/Design/Procure/Supervise/manage & liase					allowed at	16%	96,000		
			sub-Total incl Stats/Others & Design etc. but excl risk					**693,000**		
NB Risk and OB figures are for completeness of this estimate summary only and must be replaced by the factors being applied at the current stage of reporting.	Risk/Optimism Bias/contingency		only illustrative details			allowance currently made	**40%**	277,000		Based on early option outline only - to be progressed prior to construction 40% risk/OB allowed in the absence of QRA
						Approximate Indicative Total Budget Estimate		**970,000**		
assumptions/allowances as noted	*Prepared by Steve Keeley 19/1/17 for Mouchel*									

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Email from Masood Chowdhury dated 21/11/16 (Precast Beam Spec)
Dwg 1069948/MOU/SGN/005 (Steel Girder and PCC Long Section)
Dwg 1069948/MOU/SGN/006 (Steel Girder and PCC Beam Arrangement)

Client	**Lake Lothing Third Crosiing**									
Project:	**Lake Lothing Bridge C15 - Maintenance - Minor concrete repairs to Precast W beam**									
Title:	**Initial guide price estimate per intervention**						**Drwg no** -			
Location details	**Construction considered**	**Area**		**Unit**	**Approx. all in rate**		**Amount**		**Notes/assumptions**	
Early stage costings for an approximate budget allowance only (pricing deemed current Q4 2015									***General assumptions :***	
Elemental costs only considered in the main					All inclusive roadworks rates used				**Normal hours working** **Reasonable levels of productivity** **No contaminated materials**	
Minor concrete repairs to Precast W beam	Scaffolding	3,610		sq m	265		956,700			
	Containment Sheeting	1,520		sq m	15		22,800			
	Assume 5% of beams @ 50mm depth	2,123		sq m	325		689,910			
Concrete repairs to deck	Assume 15% area 125mm thick	720		sq m	550		396,000			
						sub-total	2,065,000			
	Items of construction contingency for items not identified and precise detail/spec				allowed at	0.0%	0			
	Preliminaries/TM/OH & P				allowed at	30%	620,000			
						Approximate basic construction costs	**2,685,000**			
ADD Other considerations										
	Work by Statutory undertakers and others	allowed at			allowed at	0.0%	0			
	Survey/Investigate/Design/Procure/Supervise/manage & liase				allowed at	16%	430,000			
					sub-Total incl Stats/Others & Design etc. but excl risk		**3,115,000**			
NB Risk and OB figures are for completeness of this estimate summary only and must be replaced by the factors being applied at the current stage of reporting.	Risk/Optimism Bias/contingency	only illustrative details			allowance currently made	**40%**	1,246,000	Based on early option outline only - to be progressed prior to construction 40% risk/OB allowed in the absence of QRA		
						Approximate Indicative Total Budget Estimate	**4,361,000**			
assumptions/allowances as noted	*Prepared by Steve Keeley 19/1/17 for Mouchel*									

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Email from Masood Chowdhury dated 21/11/16 (Precast Beam Spec)
Dwg 1069948/MOU/SGN/005 (Steel Girder and PCC Long Section)
Dwg 1069948/MOU/SGN/006 (Steel Girder and PCC Beam Arrangement)

Client	**Lake Lothing Third Crosiing**									
Project:	**Lake Lothing Bridge C15 - Maintenance - Minor concrete repairs to Precast W beam**									
Title:	**Initial guide price estimate per intervention**						**Drwg no** -			
Location details	**Construction considered**	**Area**		**Unit**	**Approx. all in rate**		**Amount**		**Notes/assumptions**	
Early stage costings for an approximate budget allowance only (pricing deemed current Q4 2015									***General assumptions :***	
Elemental costs only considered in the main					All inclusive roadworks rates used				**Normal hours working** **Reasonable levels of productivity** **No contaminated materials**	
Minor concrete repairs to Insitu Cantilever Option	Scaffolding	4,655		sq m	265		1,233,600			
	Containment Sheeting	1,960		sq m	15		29,400			
	Assume 15% of exposed concrete @ 125mm depth	818		sq m	550		449,625			
	Post tensioning strengthening/repair @ 4%	6.2		t	9,000		55,800			
						sub-total	1,768,000			
	Items of construction contingency for items not identified and precise detail/spec				allowed at	0.0%	0			
	Preliminaries/TM/OH & P				allowed at	30%	530,000			
					Approximate basic construction costs		**2,298,000**			
ADD Other considerations										
	Work by Statutory undertakers and others	allowed at			allowed at	0.0%	0			
	Survey/Investigate/Design/Procure/Supervise/manage & liase				allowed at	16%	368,000			
		sub-Total incl Stats/Others & Design etc. but excl risk					**2,666,000**			
NB Risk and OB figures are for completeness of this estimate summary only and must be replaced by the factors being applied at the current stage of reporting.	Risk/Optimism Bias/contingency	only illustrative details			allowance currently made	**40%**	1,066,000	Based on early option outline only - to be progressed prior to construction 40% risk/OB allowed in the absence of QRA		
					Approximate Indicative Total Budget Estimate		**3,732,000**			
assumptions/allowances as noted	*Prepared by Steve Keeley 20/1/17 for Mouchel*									

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Dwg 1069948/MOU/SGN/010 (Post Tensioned Insitu Cantilever Deck Cross Sections)
Dwg 1069948/MOU/SGN/011 (Post Tensioned Insitu Cantilever Deck Long Section)

Client	**Lake Lothing Third Crosiing**
Project:	**Lake Lothing Bridge C13 - Plate Girder Option**
Title:	**Rates used in Initial guide price estimate for Life Cycle Interventions**

Location details	Construction considered	Quantity	Unit	Rate	Amount	Notes/assumptions
Early stage costings for comparative purposes only (pricing deemed current 1Q 2017)						
Rate Build Ups						
Painting						
Steelwork	Scaffolding		m2	£265		Hadley Scaffolding target cost (Dave Taylor 01634-566-979)
	Containment Sheeting		m2	£15		Hadley Scaffolding target cost (Dave Taylor 01634-566-979)
	Painting		m2	£41		Spons HW 2017 - Maintenance painting down to sound paint
			m2	£65		Based on Area 13 Tebay Deck Refurb 2013 rates updated to 1Q'17 down to clean steel
Concrete Repairs	50mm thick					Based on Area 13 Tebay Deck Refurb 2013 rates updated to 1Q'17
	Break out		m2	£70		
	Concrete		m2	£80		
	Formwork		m2	£175		
				£325		
	125mm thick to slab					
	Break out		m2	£175		
	Concrete		m2	£200		
	Formwork		m2	£175		
				£550		
	Post Tensioning		t	£9,000		80% uplift on normal rate based on Area 13 Tebay Deck Refurb uplift for reinforcement in concrete repairs
assumptions/allowa	*Prepared by Steve Keeley 20/1/17 for Mouchel*					

Exclusions

Demolitions
Land acquisition
Waterproofing,roadworks generally,
Substructure (Piers/Abutments/Piling/Fenders etc)
Bascule Bridge
Programme considerations
STATS
VAT
Future Inflation beyond 1Q 2017
Legal issues

Cost estimates are based on the following documents:
Email from Ricardo Romero dated 6/1/17 (Steel Girder sizing)
Email from Masood Chowdhury dated 21/11/16 (Precast Beam Spec)
Dwg 1069948/MOU/SGN/005 (Steel Girder and PCC Long Section)
Dwg 1069948/MOU/SGN/006 (Steel Girder and PCC Beam Arrangement)
Dwg 1069948/MOU/SGN/010 (Post Tensioned Insitu Cantilever Deck Cross Sections)
Dwg 1069948/MOU/SGN/011 (Post Tensioned Insitu Cantilever Deck Long Section)

APPENDIX F – Construction Note

Construction Note

Construction of the Post –Tensioned Balanced Cantilever deck

Lake Lothing Third Crossing (LL3X)

08th December 2017
Produced for
Suffolk County Council

Prepared by
Furqan Qamar

Knights House
2 Parade
Sutton Coldfield
West Midlands
B72 1PH

T +44 12 13622089

Document Control Sheet

Project Title	Lake Lothing Third Crossing (LL3X)
Report Title	Construction Note
Report ref no.	1069948-MOU-SGN-LL_C13-CD-CB-0005
Version	P03
Status	S3
Report Date	12 June 2017

Record of Issue

Version	Status	Author	Date	Checked by	Date	Approved by	Date
P01	Draft	T Kazemi	19/06/2017	M Northing	20/06/17	M Northing	20/06/17
P02	Draft	R Romero	25/09/2017	F Qamar	05/10/2017	M Northing	06/10/2017
P03	Draft	R Romero	08/12/2017	F Qamar	08/12/2017	F Qamar	08/12/2017

Distribution

Date	Organisation	Contact	Format	Copies

Limitations

This report is presented to Suffolk County Council in respect of Lake Lothing Third Crossing and may not be used or relied on by any other person. It may not be used by Suffolk County Council in relation to any other matters not covered specifically by the agreed scope of this Report.

Notwithstanding anything to the contrary contained in the report, WSP Limited is obliged to exercise reasonable skill, care and diligence in the performance of the services required by Suffolk County Council and WSP Limited shall not be liable except to the extent that it has failed to exercise reasonable skill, care and diligence, and this report shall be read and construed accordingly.

This report has been prepared by WSP Limited. No individual is personally liable in connection with the preparation of this report. By receiving this report and acting on it, the client or any other person accepts that no individual is personally liable whether in contract, tort, for breach of statutory duty or otherwise.

Contents

1 Introduction

An Option Report was produced for the superstructure of the Lake Loathing 3rd Crossing (see Report 1069948-MOU-SGN-LL_C13-CD-CB-0001). Three options were presented in the report, steel, hybrid and post tensioned balanced cantilever option.

This Note has been produced to present the construction methodology of preferred option of post-tensioned balanced cantilever.

In this document the construction of the north approach viaduct is covered. The construction of the north viaduct includes several stages including the rotation of the deck constructed over pier 7 to avoid disruption to Network rail. For the construction of the south approach viaduct the same construction method as the north viaduct using the traveller form with balance cantilever method will be used.

2 Construction of the north approach spans

The post-tensioned concrete option will consist of 3 spans at the south and 3 spans at the north of the channel. The 3 north spans lengths are currently 52.89m, referred to as water span for the purpose of this report, 50.52m and 48.03m referred to as the rail span. See Figure 1 below.

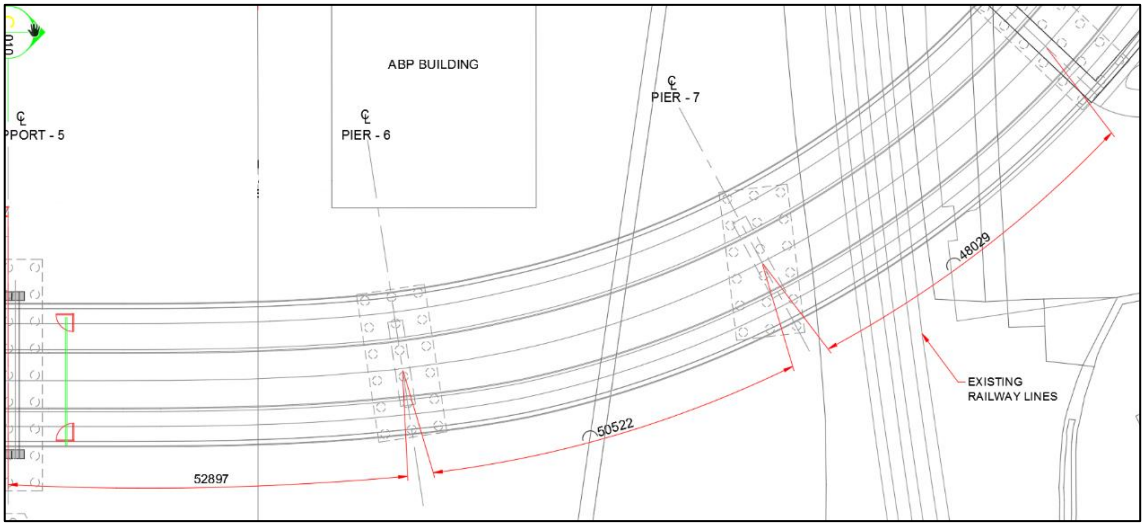


Figure 1 Final Span configuration on the north of the channel

The construction of the north approach viaduct divided into 3 main stages as described below.

Stage 1:

The construction of the deck will start from pier 6 and pier 7, the box deck will be constructed using the traveller form with balance cantilevers progressing symmetrically over the piers. Over pier 7 the deck will be cast parallel to the rail tracks to avoid disruption to NR (See Figure 2 below) and will be rotated in the final position.

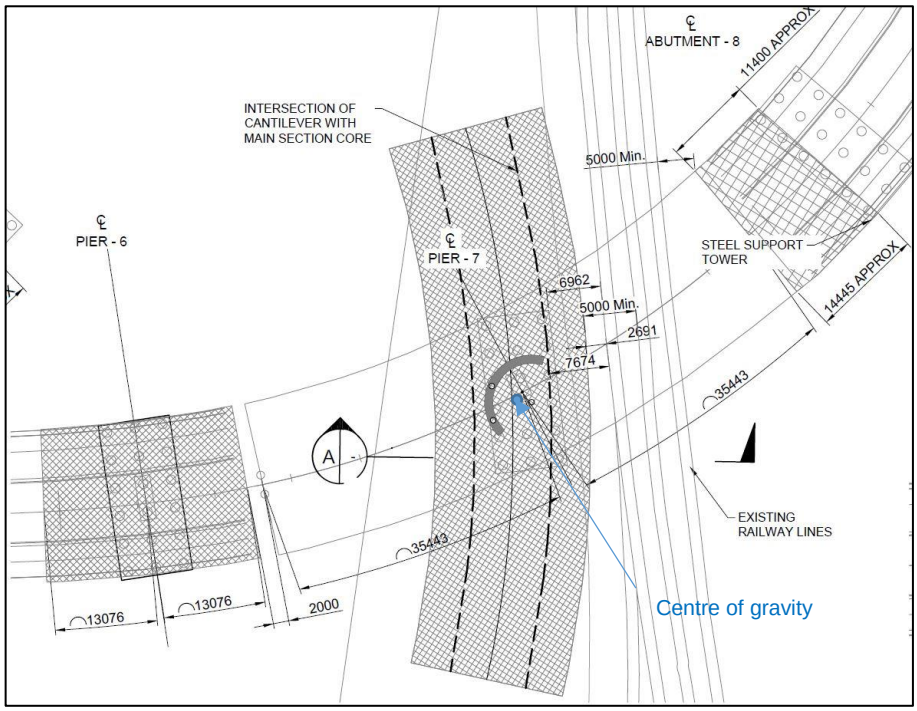


Figure 2. Plan view of construction stage 1 construction of superstructure using balance cantilever method (Refer to Drawing 018 for Horizontal and Vertical Clearance with Formwork)

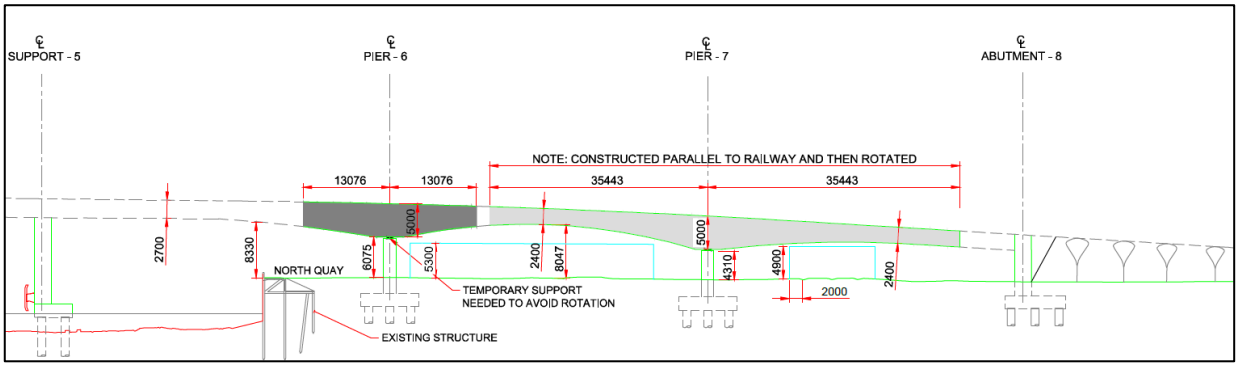


Figure 3. Elevation of Construction stage 1 after rotation.

For rotation process, the support arrangement over pier 7 will consist of 3 temporary bearings (2 sliding bearings and one fix). See Figure 4 and drawing 0018 for further information of this arrangement.

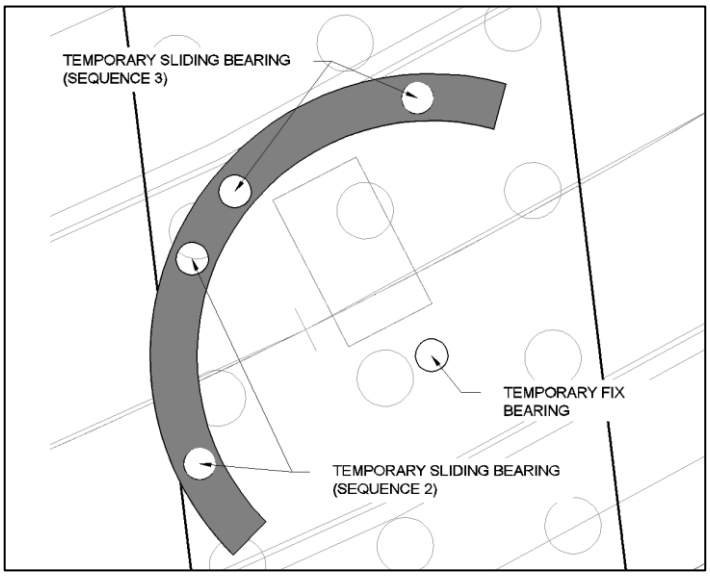


Figure 4. Temporary support arrangement for deck rotation.

During the rotation the centre of gravity of the deck will be inside the triangle formed by these 3 bearings. These 3 bearing will be on top of 2 temporary columns, one of them will be semi-circular and will support the 2 sliding bearings as shown on Figure 4 above.

A solid diaphragm is needed in the area in which the 3 bearings for rotation are located to transfer the load from the deck to the bearings. To ensure sufficient stability is achieved during the rotation, the calculations will allow a higher factor of safety (i.e 2.5-3).

Figure 5 below shows how this stage has been modelled in the preliminary design after the rotation of the deck.

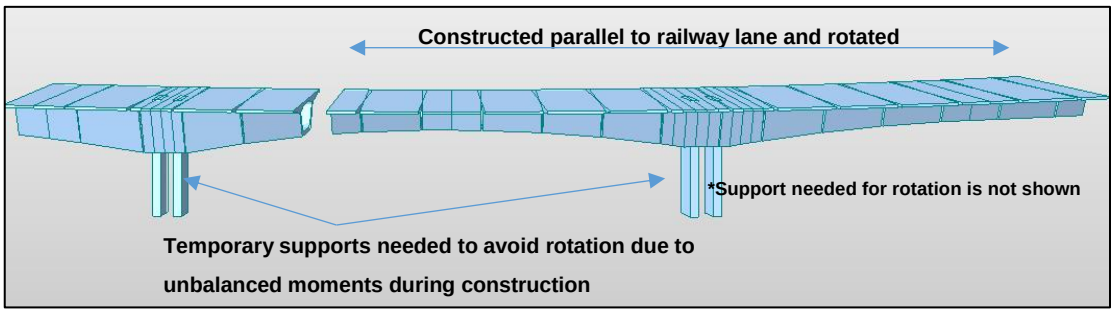


Figure 5. Construction stage 1 modelled on Midas

Stage 2:

In this stage the section constructed over pier 6 and 7 in the previous stage will be connected by casting the remaining section as shown in Fig 6 & 7. Temporary support used during rotation process will remain until this stage is completed.

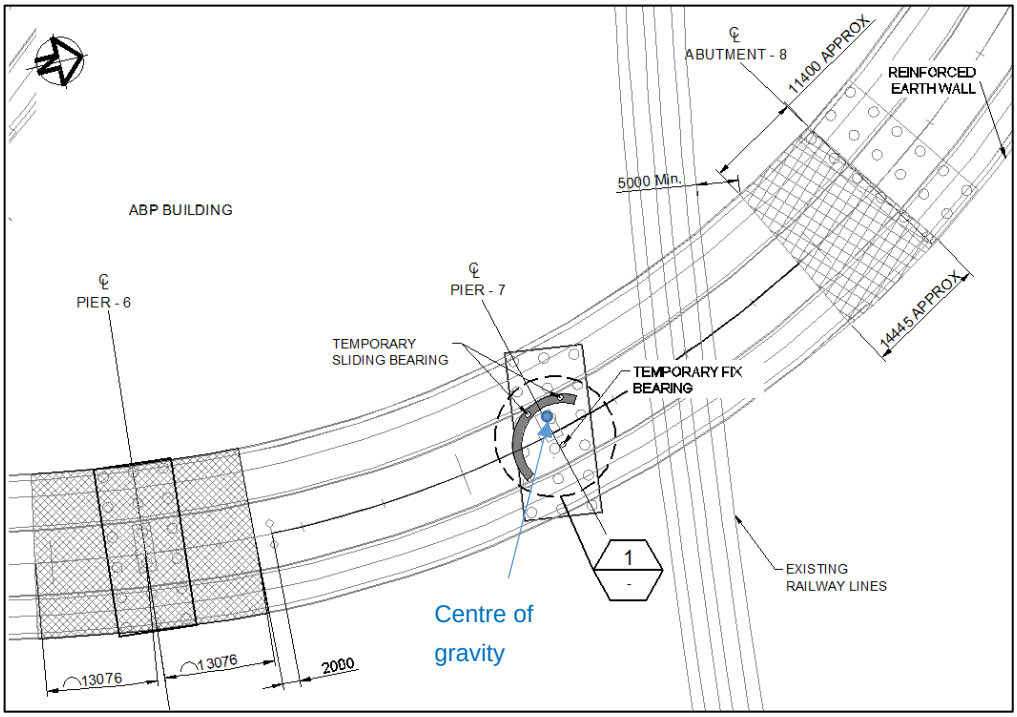


Figure 6. Construction stage 2 on plan.

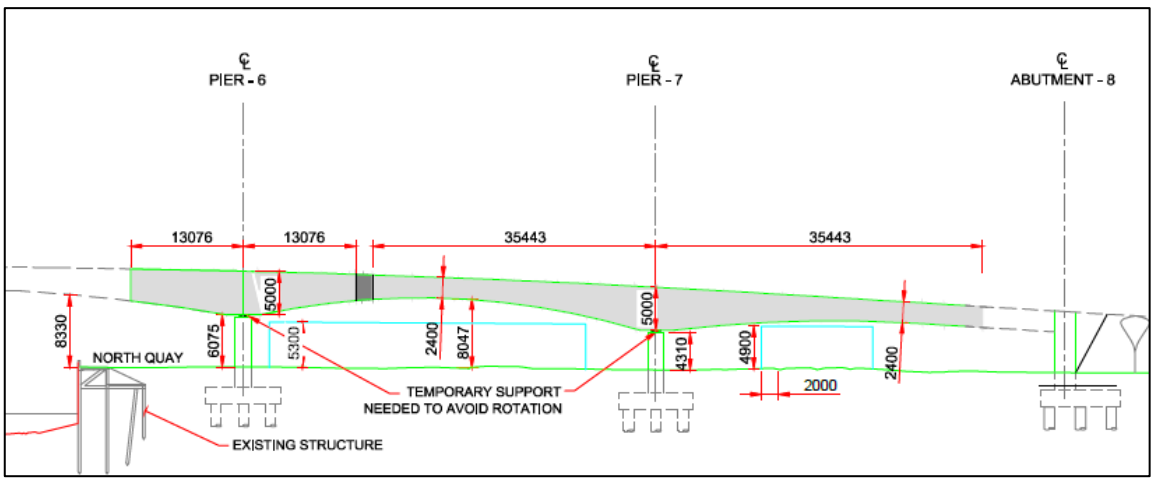


Figure 7. Construction stage 2 on elevation.

Stage 3:

After the completion of stage 2, in this stage water span up to the water pier and last section of railway span will be completed as shown in the figure below.

Water span will be casted with the form traveller approx. 30m in length and remaining 20m by using falsework, whereas the railway section will be completed by using falsework only.

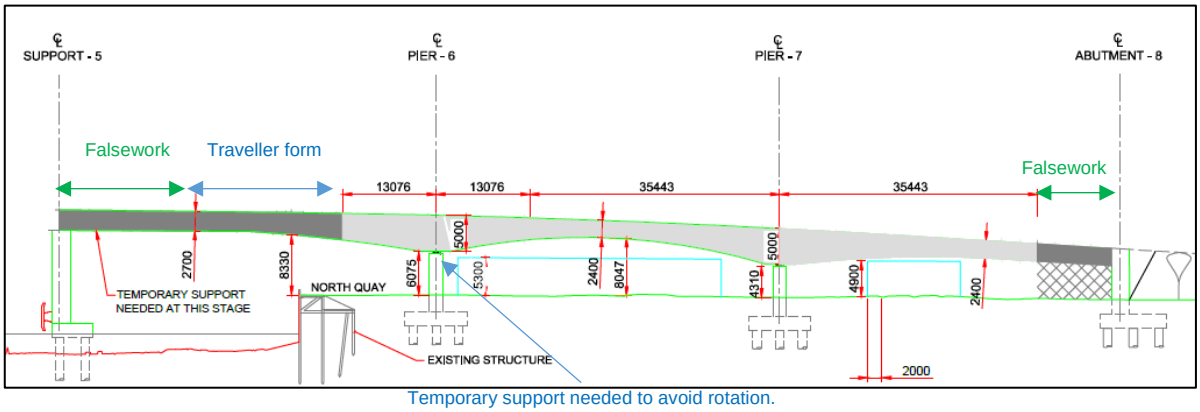


Figure 8. Construction stage 3

The use of traveller form as described above has some advantages over use of falsework for the whole span. The former reduces the cost of falsework and minimize the interaction with the land below.

The only drawback of the traveller form is having peak hogging moment and that need to be supported by temporary works. For that reason combination of traveller and falsework suggested as above.

The design of temporary works need to be considered for all stages in the detailed design phase.

If unbalanced moments were excessive to be resisted by the temporary supports in detailed design, the possibility of using the integral pier with twin walls can be considered. At this stage this type of construction process has not been chosen mainly due to aesthetic reasons to create uniformity between water and earth piers. Another option could be to support a longer section on falsework instead of 20m the section supported could increase up to almost 40m reducing the unbalanced moment that had to be supported by the temporary restraint.

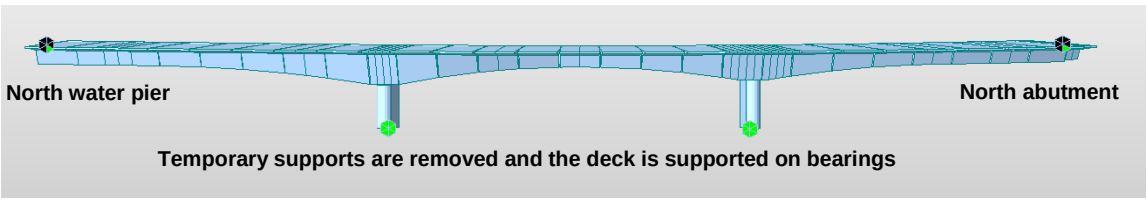


Figure 9. Final stage modelled in Midas, temporary support removed.

Summary

In summary, following 3 stages considered for north approach viaduct;

1. Construction of span over pier 6 and 7 (parallel to the track and rotated to its original position.

2. Construction of connecting sections between pier 6 and 7.

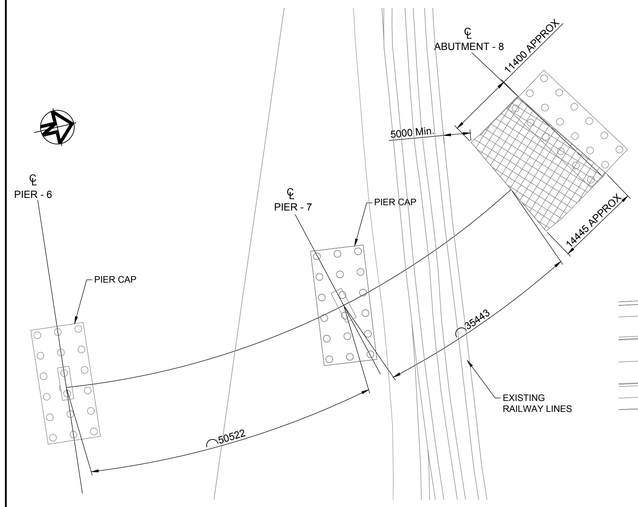
3. Construction of water span and remaining railway span.

South approach viaduct will be constructed in a similar way using the balanced cantilever and falsework methods, but there will be no requirement for span rotation.

3 Appendices

Appendix A – Drawing 0018: “Construction sequence between pier 6 and abutment 8”.

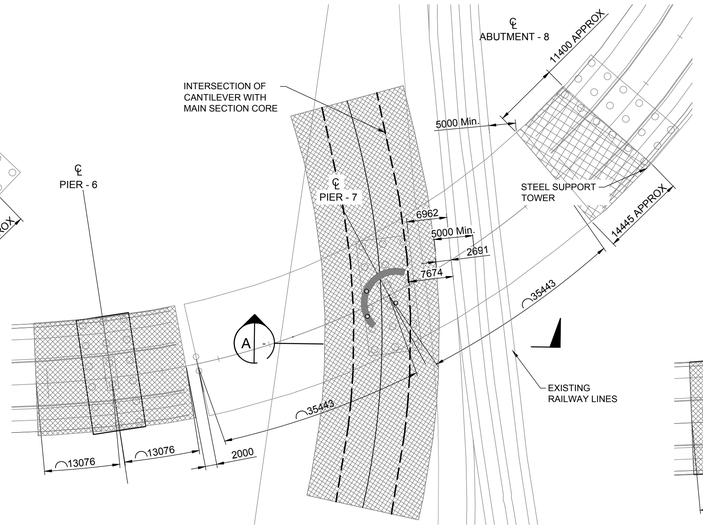
DRAFT AND CONFIDENTIAL



CONSTRUCTION SEQUENCE 1

SCALE 1:500

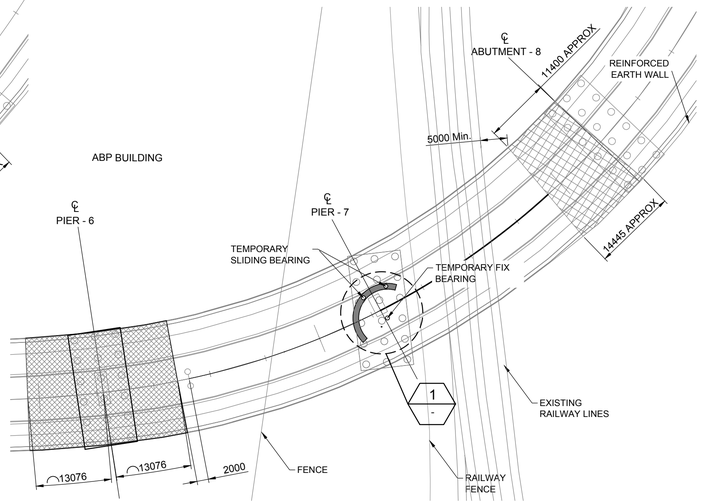
1. CONSTRUCT PILE CAPS & PIERS
2. INSTALL STEEL SUPPORT SYSTEM 5000mm FROM RAIL TRACK BETWEEN ABUTMENT 8 AND PIER NO. 7



CONSTRUCTION SEQUENCE 2

SCALE 1:500

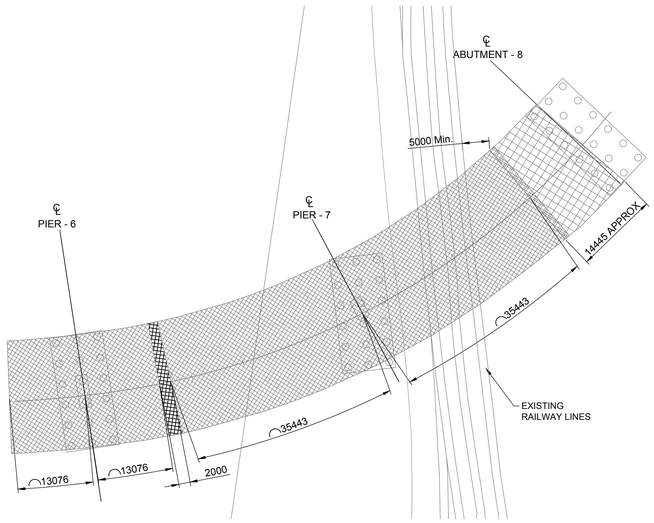
1. CAST DECK CONCRETE IN STAGES AT PIER 6. SIMULTANEOUSLY BOTH SIDES.
2. ROTATE DECK ON BEARING AT PIER 7 AND CAST DECK CONCRETE IN STAGES. SIMULTANEOUSLY BOTH SIDES



CONSTRUCTION SEQUENCE 3

SCALE 1:500

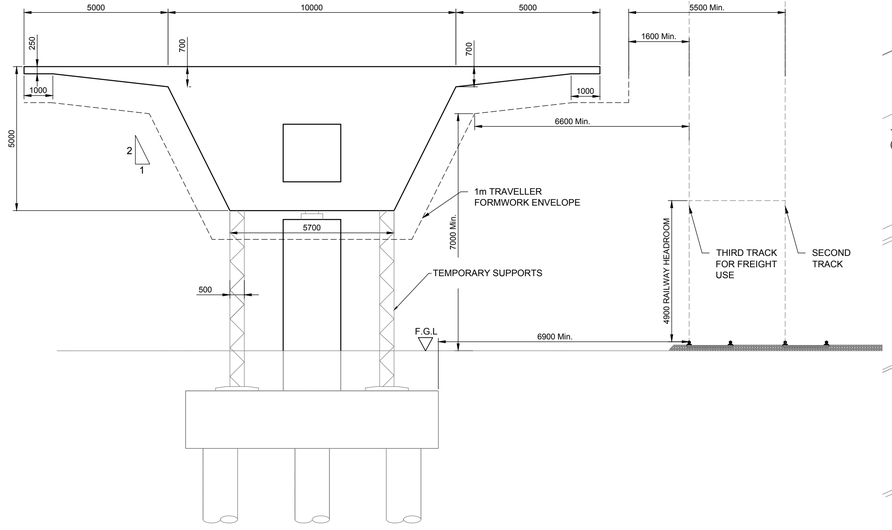
1. AFTER DECK ABOVE PIER 7 HAS REACHED REQUIRED STRENGTH, ROTATE AS ALIGNMENT



CONSTRUCTION SEQUENCE 4

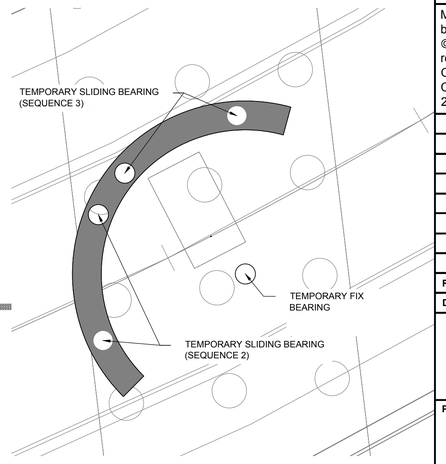
SCALE 1:500

1. CAST DECK CONCRETE 2000mm TO JOIN CASTING OVER PIER 6 & PIER 7

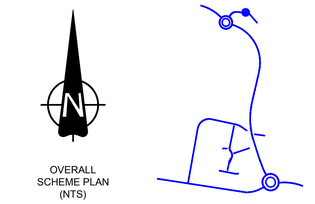


SECTION A

SCALE 1:100



1 DETAIL: ARRANGEMENT FOR ROTATION



OVERALL SCHEME PLAN (NTS)

LEGEND

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.

REVISION	DRAWN	CHECKED	APPROVED	DATE
P06	EL	FQ	MN	08/12/2017
MINOR AMENDMENTS				
P05	EL	FQ	MN	05/12/2017
MINOR AMENDMENTS				
P04	EL	FQ	MN	03/10/2017
MINOR AMENDMENTS				
P03	EL	FQ	MN	22/09/2017
MINOR AMENDMENTS				

DESCRIPTION

Suffolk County Council

PROJECT TITLE

Lake Lothing THIRD CROSSING

DRAWING TITLE

CONSTRUCTION SEQUENCE BETWEEN PIER 6 AND ABUTMENT 8

DRAWING STATUS

SUITABILITY

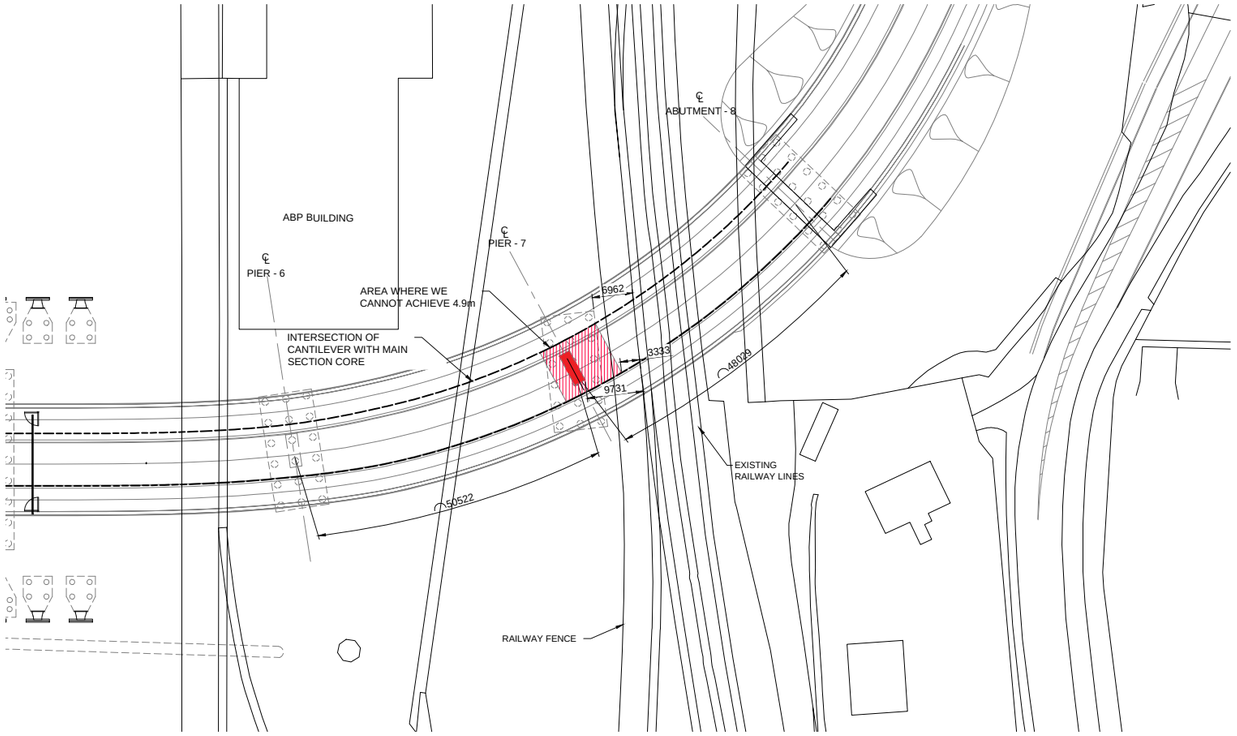
DRAWN	CHECKED	APPROVED	AUTHORISED	SUITABILITY
EL	RR	FQ	MN	S0

SCALE @ A1 SIZE	DATE	REVISION
AS SHOWN	03/10/2017	P06

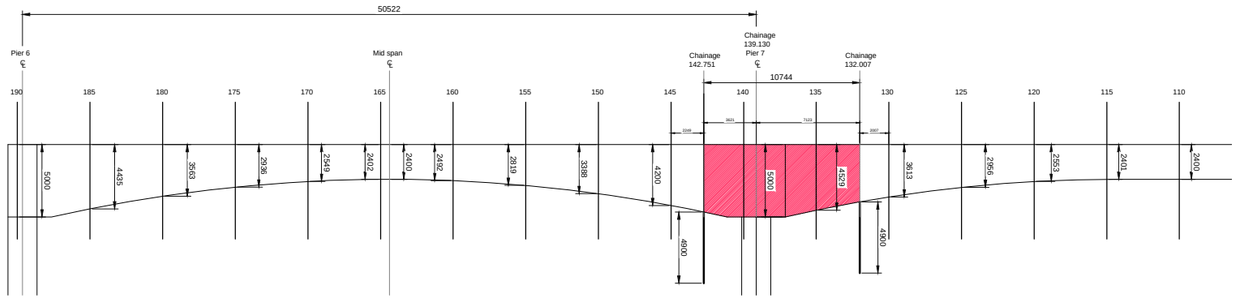
DRAWING NUMBER

Project	Originator	Volume	Location	Type	Role	Number
1069948	WSP	SGN	LL_C13	DR	CB	0018

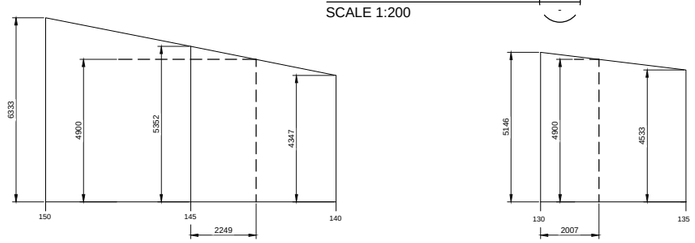
Appendix B – Drawing 0027: “Horizontal and vertical clearance after construction”.



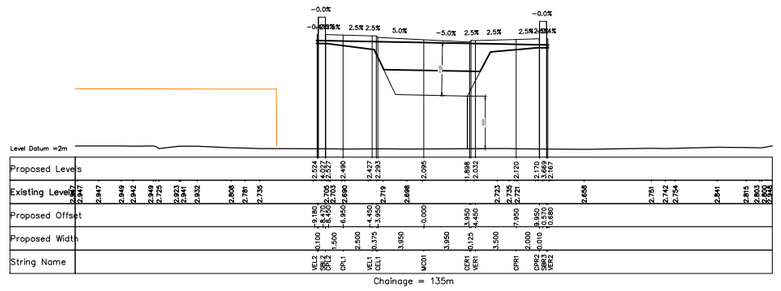
PLAN
SCALE 1:500

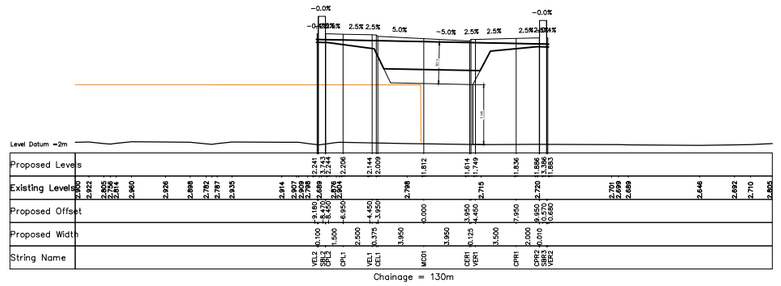


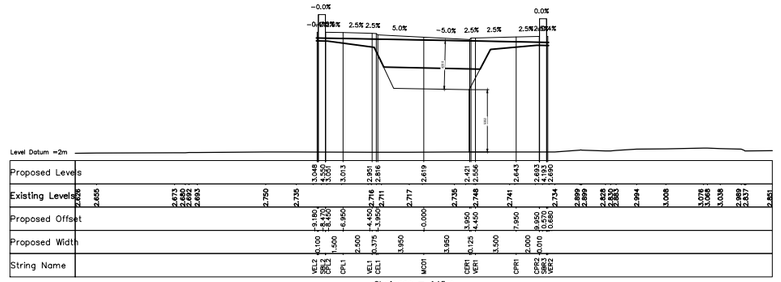
IDEALISED SECTION
SCALE 1:200

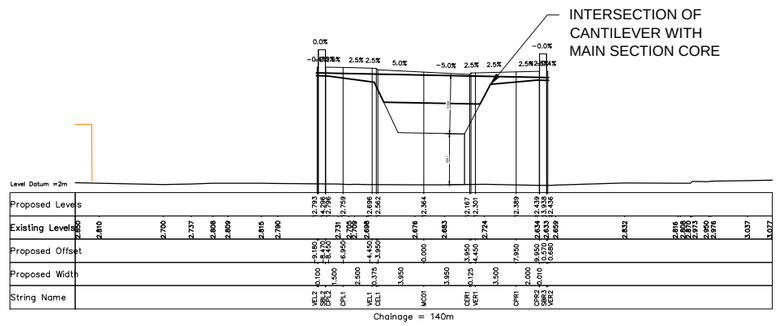


LINEAR INTERPOLATION
1:100









Revision	Amendment	Drawn/Designed	Checked	Approved	Date
P03	MINOR AMENDMENTS	EL	RR	FQ	08/12/17
P02	MINOR AMENDMENTS	EL	RR	FQ	06/12/17

Project
LAKE LOTHING THIRD CROSSING

Drawing Title
HORIZONTAL AND VERTICAL CLEARANCE AFTER CONSTRUCTION

Office
KNIGHTS HOUSE, 2 PARADE
SUTTON COLDFIELD, B72 1PH
TEL: 0121 355 8949
WWW.MOUCHEL.COM

Client
Lake Lothing THIRD CROSSING

Scale	Designed / Drawn	Checked	Approved	Authorised
AS SHOWN	EL	RR	FQ	MN
Original Size	Date	Date	Date	Date
A1	02/10/17	02/10/17	02/10/17	02/10/17

Status: FOR INFORMATION

Drawing No Project	Originator	Volume	Suitability
1069948	MOU	SGN	S3
LL_C13 (Location)	DR (Type)	CB (Role)	0027 (Number)
			Revision: P03

APPENDIX G – Fender Design Technical Note

Lake Lothing Third Crossing Fender Design Technical Note

Bridge Ref 10/67

Bridge Code 67

October 2017

Produced for

Suffolk County Council

Prepared by

Stephen Horne

T +44 15 1243 9970

E Stephen.Horne@wsp.com

1.1 Codes, Standards and Guidelines

The following design standards and reference documents have been used in the preparation of the fender design;

[1] BS6349-4:2014 – Code of practice for design of fendering and mooring systems

[2] PIANC "Ship Collisions due to the Presence of Bridges" INCOM report of WG19, 2001

[3] PIANC "Guidelines for the design of Fender Systems", 2002

1.2 Bridge Data

The bridge has been envisaged as an elevated (12m clear height over water) single leaf bascule bridge with fixed spans over the remaining waterway and operational quay areas of the port. The clear width between supports on the bascule section is set at 35m.

1.3 Services Data

An underground service tunnel is located approximately 20m east of the eastern edge of the proposed bridge deck, it is understood to be a 2m diameter circular culvert of brick construction carrying multiple HV electric cables. There are notes of a number of abandoned HV electric cables lain on the lake bed a further 15m east of the service tunnel, the presence of these has not yet been confirmed. There is potentially a fibre communications cable situated approximately 20m east of the service tunnel, its location and construction are at present unconfirmed.

The exact locations of fender piles may need to be adjusted following confirmation of the services precise locations.

1.4 Vessel Data

The following design vessels, taken from the Kongsberg vessel simulation models catalogue, have been considered for the fender design. These vessels are those previously agreed with Associated British Ports as representative of the type of vessels which call at the Port of Lowestoft and used in the navigation simulation trials undertaken.

Vessel Designation	Vessel Description	Displacement (T)	Length between perpendiculars (m)	Length Overall (m)	Beam (m)	Draught (m)
BARGE03L	Towed flat top barge	2200.00	73.40	76.20	17.07	1.83
BULKC11L	Typical small laden CCP coastal bulker	5906.00	84.98	89.99	14.00	5.68
CNTNR24B	Small coastal container in ballast	7022.00	108.20	121.40	20.80	4.67
FERRY50	Medium size ferry	5415.00	108.00	117.00	20.00	4.39
DREDG05L	Laden trailer suction dredger	7247.00	88.45	96.10	18.00	5.10

SUPLY10L	Large laden offshore supply vessel	6550.00	75.40	86.20	19.00	6.00
TUG05A	Harbour class tugboat	550.00	30.50	32.00	10.97	2.50
TUG09	Deep draughted tug	668.00	30.02	32.66	9.45	4.12
SUPLY05L	Medium laden offshore supply vessel	2302.00	57.80	66.00	14.00	4.55
TUG15	High performance ocean tug	575.00	28.00	29.50	11.00	2.78

1.5 Navigation Data

The existing navigation channel within Lake Lothing is 73m wide and, under the current proposals, this is to be narrowed in the vicinity of the new bridge to allow supports to be located at 35m face to face. The design criteria for the minimum navigation channel between the supports has been set as 30m. The existing bascule bridge provides a clear navigation channel of 22.778m.

The maximum speed of vessels within the harbour is restricted to 4 knots under regulation 9 of the Lowestoft Harbour Bye-laws 1993.

Vessel simulations were undertaken in October 2016 and May 2017 to confirm the navigational impacts of the bridge design as proposed. The outcomes of these simulations have been used to refine the fender designs, see Mouchel Document Ref:1069948-MOU-MAR-LL-RP-MA-003.

1.6 Fender capacity design

The impact energy of a vessel during a collision (that which has to be absorbed by the fender) is calculated in accordance with BS6349-4.

1.7 Impact Velocities

For the support passage fenders the impact velocity has been taken as;

$$V_B = V \cdot \sin(\alpha)$$

Where

V Vessel velocity, taken as 4 knots.

α Vessel impact angle, taken as the lesser of a 35m bow to stern misalignment or 20°, as shown below.

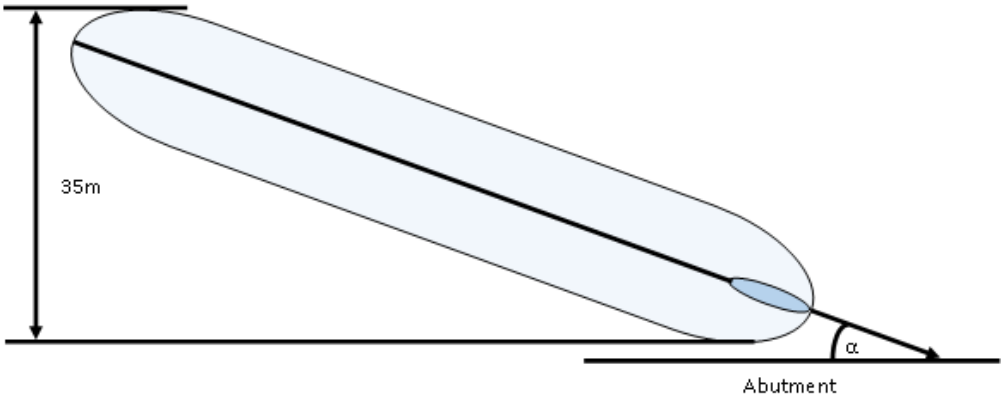


Figure 1 - Passage Fender Impact Velocity

For the angled channel approach dolphin fenders the impact velocity is taken as;

$$V_B = V \cdot \sin(\alpha)$$

Where

V Vessel velocity, taken as 4 knots.

α Angle of fender line from straight ahead course less 2.5° course correction, shown below.

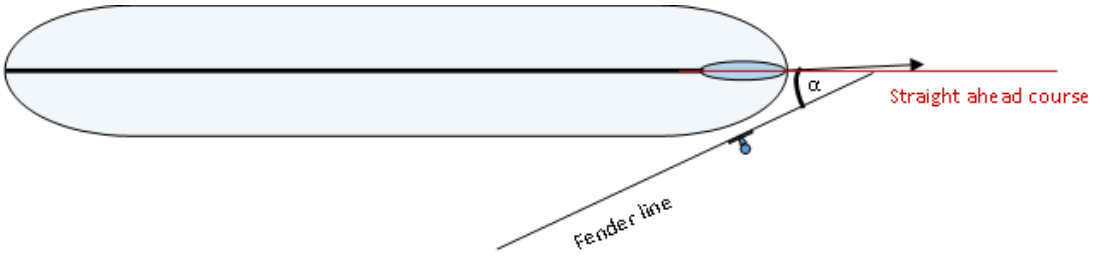


Figure 2 - Approach Dolphin Fender Impact Velocity

For the perpendicular approach fenders, the impact velocity has been taken as 0.905m/s for vessels over 2,500T M_D and 1.03m/s for vessels below this, equating to 50% of the typical transit speeds recorded during the navigation simulations.

The navigation assumptions above have been shown to be conservative following the undertaking of the vessel simulations. See Mouchel document 1069948-MAR-MISC-003 Vessel Simulation Report for details.

1.8 Fender Locations

The design of the fender locations has been undertaken with regard to the level of protection afforded to the bridge supports and the constraints that the fenders would place on the operation of the port when constructed. In particular consideration of the loss of usable berth length east and west of the bridge has been considered. The proximity of the HV electric service tunnel to the east of the bridge and associated clearance requirements limit the locations for siting fenders on this side of the bridge.

A variety of options for positioning of fenders on and approaching the supports have been considered. The fendering within the bridge passage is limited by the structure of the bridge supports and has been design accordingly. Potential variants for the approach fendering were developed and one of these taken forward for inclusion within the vessel simulation. Following this simulation a refinement of the layout has

been developed, based on feedback from ABP port pilots, to lessen the impact on navigation.

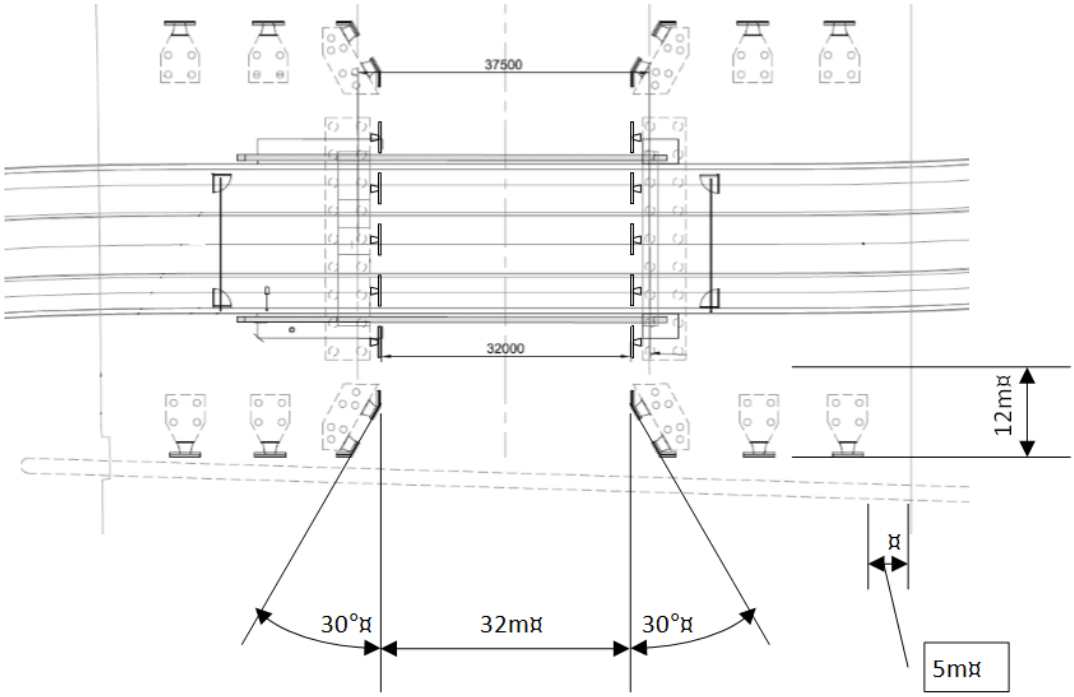


Figure 3 - Revised 30° Approach Dolphin Fenders

1.9 Energy Calculations

Energy calculations have been undertaken, in accordance with BS6349pt4, the calculated energies for each fender type based on the above principles are abnormal loads and are therefore not factored for design.

1.10 Fender Rubber Design

1.10.1 Passage Fenders

The passage fenders are required to absorb an impact energy of 997.5kNm. Using the Fendercare Marine product catalogue and considering the other design factors a grade G4 1200 cone fender with a rated energy absorption capacity of 1,124kNm satisfies the requirements. This fender will have a maximum operational reaction force of 2,193kN, this force must be considered during the design of the support foundations.

1.10.2 30° Approach Dolphin Fenders

With the 30° fender alignment an energy absorption of 3,466kNm is required. A grade E2 SCN2000 cone fender from Fentek Marine with a rated energy absorption of 3,800kNm satisfies the requirements. This fender unit would have an operational reaction force of 4,575kN which would be the design load for the dolphin piles.

1.10.3 Perpendicular Approach Dolphin Fenders

For the perpendicular fenders an energy absorption of 3,466kNm is required. A grade E2 SCN2000 cone fender from Fentek Marine with a rated energy absorption of 3,800kNm satisfies the requirements. This fender unit would have an operational reaction force of 4,575kN which would be the design load for the dolphin piles.

1.11 Fender Panel Design

In plan, the fenders must be close enough to minimise the risk that a vessel could pass between units and collide with the structure. For the passage fenders a spacing of 6m with panels of 4m is considered to give suitable coverage, giving exposed gaps of 2m between panels. The plan length of the dolphin panels is partially dictated by the potential torsional effect of an acute impact on the outer edge of a large panel and for this reason we propose that the approach fender panels should be restricted to a similar length.

In elevation the fender panels must provide an impact face at a suitable level for all states of the tide. We consider that a lower panel level of LAT + 0.5m and an upper level of HAT+1.5m will provide sufficient height range for the anticipated vessels. This would give a total panel height of 4m.

Suitable chamfers should be allowed for in the panel designs to reduce the likelihood of a vessel becoming either trapped under or hung up on the fender panels.

APPENDIX H – Road Restraint Risk Assessment Process (RRRAP)

Welcome to the Road Restraint Risk Assessment Process (RRRAP)

RRRAP version number	Issue 1.3a

Issue date	05/12/2011

Notes

1. Designers must download and use a fresh copy of the RRRAP spreadsheet for each Section of each road for which they are determining the Vehicle Restraint provision. The data input into the RRRAP and the outcome from it must be retained by the Design Organisation as a record.
2. Designers must read TD 19/06 in conjunction with this RRRAP to ensure that mandatory requirements and relevant Guidance contained in the written Standard are complied with or followed as appropriate.

I confirm that I have read TD 19/06 (name) D. Goodwin *Date read:* 01-May-09

3. TD 19/06 requires that Designers visit the site during design prior to use of the RRRAP **and** during construction to ensure that assumptions made during the design are and remain valid and that appropriate Vehicle Restraint Provision is made. TD 19/06 Paragraphs 1.23, 3.17 and 3.111 refer.

I confirm that site visit was undertaken during design (name) No Site Visit Undertaken *Date of visit* -

4. This worksheet can be used to quickly navigate around the other worksheets within the RRRAP, by clicking on the coloured boxes below

Help and Guidance Worksheets

Key to Basic Features

Outline Flowchart

Overview of RRRAP and interface with HA

Data Input Worksheets

Basic (Common Details)

Hazard Listing

Barrier and Option Costs

Temporary Hazards

Data Output Worksheets

Collation of Data on Hazards

Output Report

Restraint Summary

User Comments

Basic Features of the RRRAP Spreadsheet and their significance

Basic Feature of Spreadsheet		Significance, and comment
Border around worksheet		Marks out the lateral and vertical limit of the Worksheet
Asterisk	*	Data items with an asterisk (*) MUST be completed for the programme to run
Cell colouring	(Light green)	Requires data entry by the Designer
	(Light yellow)	Requires data entry by the Designer (gives drop down listing)
	(Black)	Cell blacked out to aid reading, not containing information or requiring data entry
	(Grey)	Auto fill based on a calculation and or copying information already entered elsewhere
	(White)	Cell usually contains a heading, a question, or a statement
	20.00 (Red)	Risk is in Unacceptable region
	25.00 (Amber)	Risk is in the Tolerable region
	35.00 (Green)	Risk is in the Broadly acceptable region
		Question cells where information is required, but in the current version, it is not contributing to the risk / benefit cost calculation, but will provide useful background information. Future (refined) versions may well use this type of information in the calculation process.
Cell protection		Note that many cells are write protected, these are generally cells containing formulae or other information that the Designer is not allowed to alter.
Help buttons		These help menus can be retained on the screen and moved to a convenient place whilst data is input. They are closed by clicking on the x in the top right hand corner of the help menu.
"Action" buttons		Note: 1. Action buttons that take the Designer to another part of the worksheet can be 'undone' by clicking on the return button. 2. Action buttons that perform a calculation or a macro cannot be undone. Care must therefore be taken to ensure that inputs are complete and checked prior to use of this type of button.

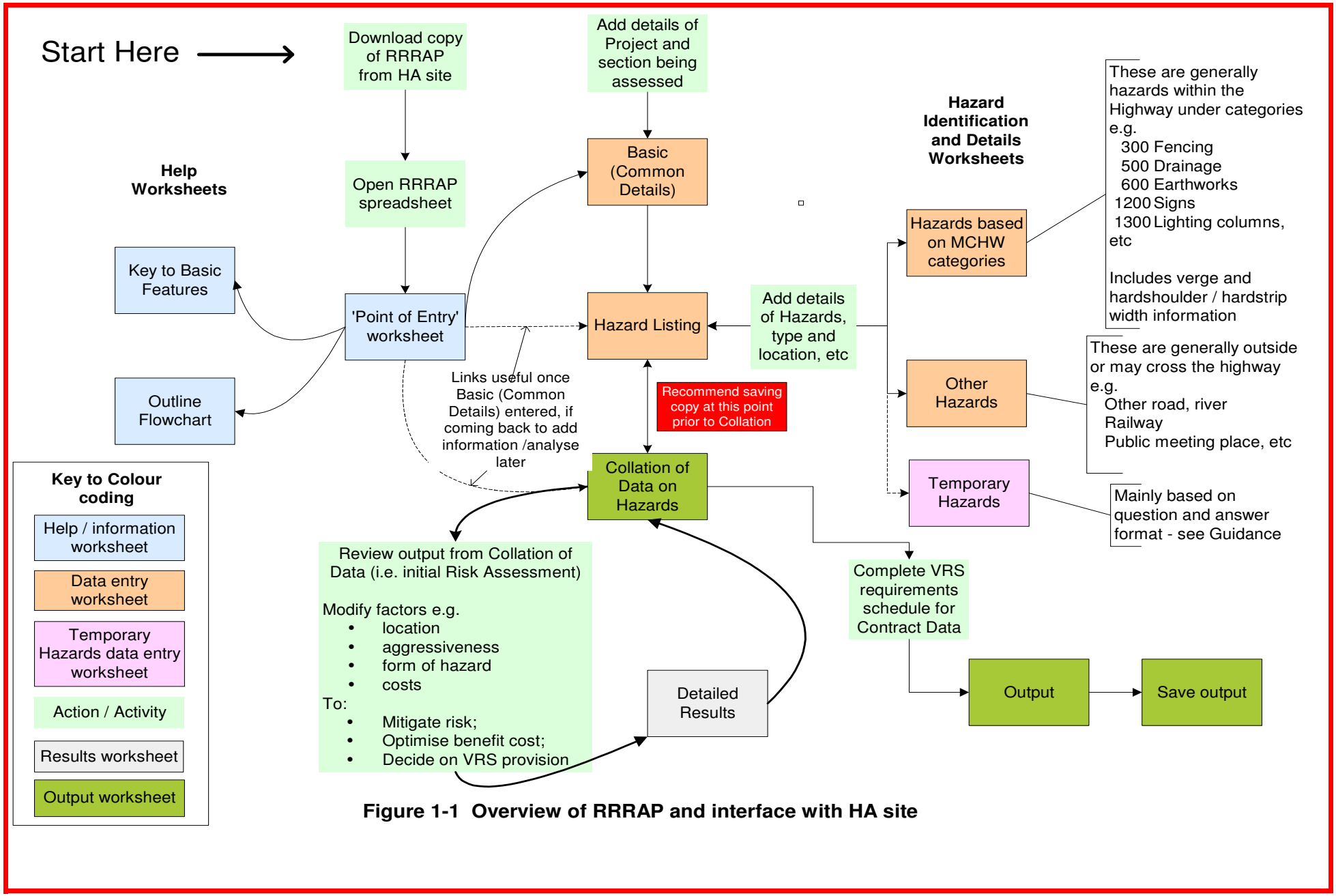
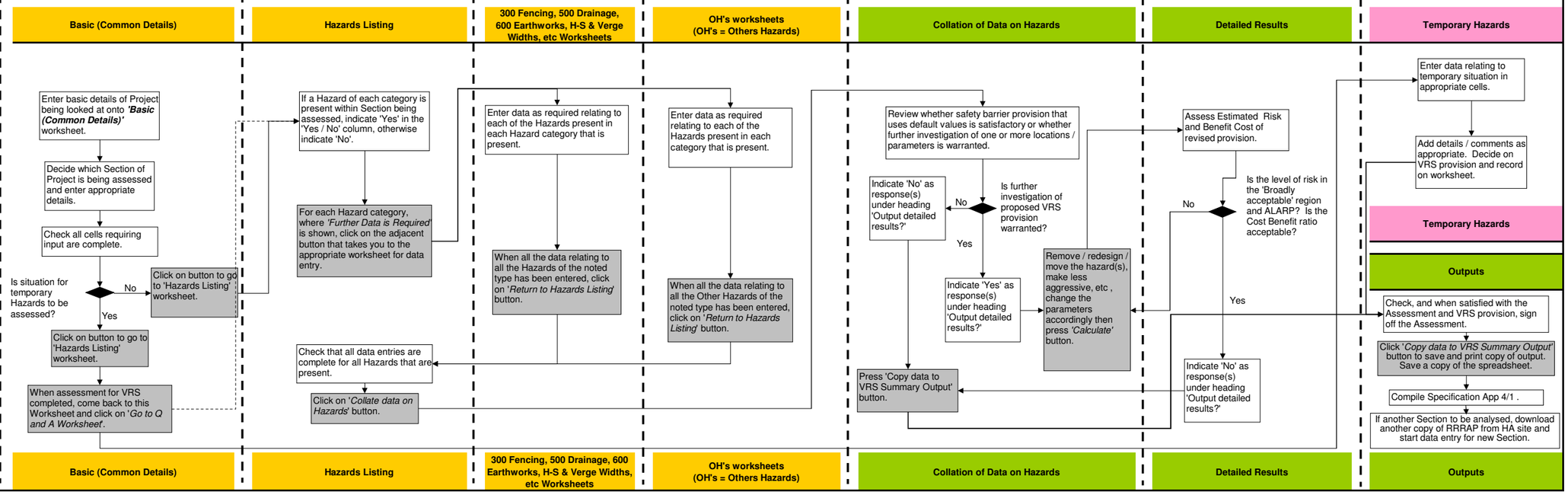


Figure 1-1 Overview of RRRAP and interface with HA site

Road Restraint Risk Assessment Process (RRRAP) - Process Overview and Process Flowchart

Worksheet	Basic (Common Details)	Hazards Listing	300 Fencing, 500 Drainage, 600 Earthworks, H-S & Verge Widths, etc Worksheets	OH's worksheets (OH's = Others Hazards)	Collation of Data on Hazards	Detailed Results	Temporary Hazards
What Worksheet is for	This worksheet records key details about the Project being designed and reasons why the Vehicle Restraint Provision is being assessed.	This worksheet is to identify for the Section of the Project being looked at, whether there are any hazards of the particular category present.	These worksheets are for inputting particulars relating to each hazard in each category present.	These worksheets are for inputting particulars relating to each hazard where Others might be affected by an errant vehicle or by another hazard that is hit by an errant vehicle.	This worksheet collates all the information entered on the individual *Hazard* and *Other Hazard* worksheets, and puts them into ascending chainage order on the one worksheet. The RRRAP also calculates the length of need of VRS in advance of and beyond each hazard, based on a default N2 Containment Level and W2 working width. It identifies whether the provision is 'Broadly acceptable', 'Tolerable' or 'Unacceptable' (ref TD 19 Fig 2-1).	This worksheet is to advise the Designer of the respective levels of the Risk and the Cost Benefit ratios of each option. It allows direct comparison of differing options and enables the Designer to ascertain the level of risk and cost benefit accruing from any proposed provision.	To assist the Designer in considering and documenting the process of determining what VRS provision, if any, is required to protect temporary hazards.
Examples of information req'd	**Basic Details** e.g. • Designer and Design Organisation names • *Project Name, PIN No. and Project* type **Restraint provision associated with** e.g. • New section of road or upgrading to existing **Details of Section of Road being assessed** e.g. • Road name and number • Location: junction / marker post / chainage • Which side of road e.g. n/s verge **Traffic Information** e.g. • AADT • % large goods vehicles.	A 'Yes' or a 'No' response is required (i.e. 'Yes', there are hazards of that category present or 'No', there are not). Help buttons can be pressed to help identify the type of hazard that is included under each heading, e.g. Drainage include? If a 'Yes' is entered, the programme indicates that further information is required. The appropriate worksheet for entering this is accessed by clicking on the adjacent button, e.g. 500	Nature of hazard (from a drop down list). Start chainage, length and width of hazard. Offset of hazard from Psb (point from which set-back is measured). Other information relating to the local alignment and location.	Information required is broadly similar to that for the hazards in the column adjacent and to the left of this one, but will include items that will allow an assessment to be undertaken of the number of Others that might be affected.	The worksheet allows the Designer to decide whether, for each hazard, the safety barrier provision based on default values is satisfactory or not. The Designer can decide to investigate further, and can change one or more of the following parameters and recalculate the risk level based on the revised choice, e.g. • Cost of Vehicle Restraint System[1]; • Length, width, aggressiveness of hazard[2]; • Barrier containment, and or Working Width Class[3]; • Offset of hazard from Psb. Help menus give guidance where appropriate. [1,2,3] - See Notes below	The Designer is required to produce a design that results in the risk being in the green 'Broadly acceptable' region. The '*Calculate Risk*' button will automatically colour code the cells as follows: green denoting a 'Broadly acceptable' provision and risk level, amber a 'Tolerable' risk level and red with white text, an 'Unacceptable' risk level.	
Notes	1. The Designer is required to split the Project into Sections. Assessment of nearside verge, offside verge and central reserve will always be in different Sections. 2. At least one assessment will need to be carried out for each Section. Also, the nearside verge, offside verge and central reserve will need to be subdivided into further Sections where either AADT, % Large Goods and or Medium Vehicles, or speed limit differ significantly along the length.	1. If the '*To collate data on Hazards press here*' button is pressed, and it is subsequently realised that the information relating to the Hazards is incomplete, the requisite information can be added on the appropriate worksheet(s) and the button re-pressed. This action will over-write the previous collated data. 2. Information on '600 Earthworks', '1100 Kerbs and Edge of Pavement Details', and 'Hardshoulder / hardstrip width & verge width details' are always required for the full length of the Section, as these factors are used to calculate key information at intermediate points.	1. The type of information requested is broadly similar for each type of hazard. 2. Help menus will assist the Designer with the format for some of the information and in determining e.g. from and to where measurements are taken. 3. Each hazard is automatically allocated a unique reference number and assigned an aggressiveness value based on its nature.		1. Cost of Option is based on a default value. The Designer is able to override the default cost if he has better information available about the whole life costing of particular VRS. The basis for the revised costings must be documented and justified up by the Designer. The factors to be included in the costings are shown on the Barrier and Option Costings worksheet. 2. The Designer can assess the effect of changing the size, offset and the aggressiveness of the hazard (e.g. using passively safe sign posts rather than standard, or changing a retaining wall having wide deep profiles to be smooth faced). 3. Safety barrier Containment Level and Working Width Class are initially based on a default of N2 and W2. The Designer can assess the effect of changing these parameters. Remember, if considering changing the Working Width Class, to check that the requirements of the various Figures in TD 19 (e.g. Figures 3-1 and 3-2) are complied with.	1. Further guidance on Assessing the Risk, mitigating the Risk and the Benefit / Cost ratio for Options that involve provision of VRS is given in TD 19 Chapter 2. 2. The Detailed Risk spreadsheet indicates in tabular form the Estimated Risk to the Vehicle Occupant, Estimated Risk to Others and, hence, Estimated Total Risk that arise given incremental increases in safety barrier length from zero to 100 m. These figures are colour coded according to whether the risk levels fall in the 'Unacceptable' , 'Tolerable', or 'Broadly acceptable' regions. The estimated Benefit Cost ratio is also given, 3. The Designer is able to re-calculate the level of risk and cost benefit consequent on changing one or more of the parameters. The programme appends the output into the Detailed Results worksheet enabling direct comparison of each Option investigated on the same sheet.	1. The methodology for determining whether or not temporary safety barrier is to be provided is different to that for assessing permanent safety barrier provision. This is mainly due to the transient nature, variety, and often complexity of the factors that need to be considered and their interaction. 2. The process is on the lines of posing a series of questions that the Designer should consider and respond to. Many of these are issues that historically the Designer (or Contractor) would have potentially looked at, but may not have been documented in any formal or consistent way.

The Process



Basic Details	
Project Name	Lake Lothing
Project Reference (e.g. Naris Number)	1069948
Agent / Designer Company Name	WSP
Agent's Ref	WSP
Contract Type	
Contract sub-type	
Region	Suffolk

Restraint Provision is associated with	
New section of Road	Yes
Widening existing carriageway	No
Upgrade / improvement to existing carriageway	No
Downgrade existing carriageway	No
Replacement of existing restraint	No
New restraint on existing road	No
Temporary works	No

Details Relating to Particular Section Covered by Assessment		
Class and Standard		
Road Classification *	Other Classified Road	
Road Number		
Road name		
Road sub-type eg. D2 *	Single	
Road Location eg. Urban	Urban	
To current geometric standards?	Yes	
Location	**From**	**To**
Junction Name		
Junction No.		
Marker Post		
Section Label		
Chainage of Section (m) *	40	500
Section / Direction being assessed	Southbound	
Nearside or Offside Verge being assessed?*	N/S Verge	
Does road have near side hardshoulder or hardstrip? *	No	
Are Environmental considerations likely to influence provision?	No	

Traffic Information	
Permanent Speed Limit (mph) *	50
AADT (2-way unless motorway link or slip) *	31759
% Large Vehicles *	1.5
% Medium Vehicles *	11.9
Model accident frequency (Nearside)	0.057
Model accident frequency (Offside)	0.031

Scheme duration *	

Check List	
Are all required fields with yellow or green boxes on this sheet complete?	Yes
Date of design / submission	13-Sep-17
Date of TD 19/06 Standard used in assessment	01-Aug-06

NOTE
Data items highlighted with an asterix (*)
MUST be completed for the program to run.

When all fields are complete, click on button below

	Yes / No	Further Data Required	If 'Further Data Required' click on button below to go to appropriate worksheet
Are any of these hazards present inside or within X m beyond the Highway Boundary along the length of carriageway under Consideration? The value of X is 5m where the road is in cutting deeper than 3m on side under consideration, and 15m in all other situations			Hazards
300 Fencing			
500 Drainage Features			
600 Earthworks	Yes	Further Data Required	
1100 Kerbs and Edge of Pavement Details	Yes	Further Data Required	
1200 Traffic Signs or Signals			
1300 Road Lighting Columns			
1500 Motorway Communications (above ground)			
1600 Piles and Retaining Walls			
1700 1800 Structural Concrete and Steel			
400 Parapets	Yes	Further Data Required	
2500 Special Structures			
Telegraph poles / Pylons			
Trees			
Water	Yes	Further Data Required	
Hardshoulder / hardstrip width & Verge width details	Yes	Further Data Required	
Are other hazards present that could potentially be reached by errant vehicle or falling object that is hit? Hazards up to 100m from the carriageway should be considered.			
Railway	Yes	Further Data Required	
Road	Yes	Further Data Required	
Public building, sports or playground, or other place where significant numbers of people congregate			
Chemical or fuel installation			

If all fields in worksheets where Further Data Required have been completed, click on button below

	Description of Feature								Description of Barrier																										
ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Is risk without VRS acceptable?	What is level of risk with optimum length VRS?	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	*Barrier Containment*	*Barrier working width class*	Barrier working width (m)	Offset of Barrier from PSb	Is parapet/structure to be placed contiguously with barrier?	Parapet Containment	Output detailed results?	Cost of Option (average per year, £)	Length of hazard	Width of hazard	Aggressiveness	Other Risk Type	*Total Number of people at risk*	Substandard headroom over any part paved carriageway?	Substandard headroom over Verge or C/res?	Structure Carries / Parapet protecting	Designed for collision loading?	Width of adjacent Hardshould er or Hardstrip	Width verge / Central Reserve	Overall width slope	Overall Height slope	Multiplicative factor for runoff rate	Topography Factor	Other Consequences Multiplicative factor	Angle of hazard to PSb (Degrees)
0600.0001	Falling 1:2.5 or steeper	40.00	99.00	5.75	Yes										No	0.00	59.00	11.50	2.00							0.00	5.75	11.50	-4.60	0.97	1.00		
0600.0002	Falling 1:2.5 or steeper	99.00	100.00	5.75	Yes										No	0.00	1.00	18.10	2.00							0.00	5.75	18.10	-7.25	0.97	1.00		
0600.0003	Nominally at Grade	100.00	419.00	4.50	Yes										No	0.00	319.00	0.10	0.00							0.00	4.50	0.10	0.00	0.97	1.00		
1700.0001	Parapet over vertical drop >2m	100.00	175.00	4.50								4.50	No	N2	No	0.00	75.00	0.25	2.50					Waterway e.g. Canal or River	N/A	0.00	4.50	0.10	0.00	0.97	1.00		
8100.0001	Railway	100.00	135.00	5.25	No	Acceptable	52.0	29.0	N2	W2	0.80	1.20			No	0.00	35.00	50.00		OH's - Railways						0.00	4.50	0.10	0.00	0.97	0.75	0.75	120.00
1700.0002	Parapet over railway	175.00	375.00	4.50								4.50	No	N2	No	0.00	200.00	0.25		OH's - Railways				Railway Protected	N/A	0.00	4.50	0.10	0.00	0.97	1.00	0.75	
6800.0001	Water > 1m Depth	210.00	315.00	5.25	Yes										No	0.00	105.00	50.00	1.50							0.00	4.50	0.10	0.00	0.97	1.00		0.00
1700.0003	Parapet over road	375.00	500.00	4.50								4.50	No	N2	No	0.00	125.00	0.25		OH's - Roads				Road Protected	N/A	0.00	4.50	0.10	0.00	0.97	1.00	0.50	
6200.0001	Adjacent Road Single	410.00	490.00	5.25	No	Acceptable	36.0	16.0	N2	W2	0.80	1.20			No	0.00	80.00	50.00		OH's - Roads						0.00	4.50	0.10	0.00	0.97	0.75	0.50	105.00
0600.0004	Nominally at Grade	419.00	420.00	4.50	Yes										No	0.00	1.00	0.10	0.00							0.00	4.50	0.10	0.00	0.97	1.00		
0600.0005	Falling 1:1 or steeper	420.00	500.00	5.25	Yes										No	0.00	80.00	0.10	2.50							0.00	4.50	0.10	-7.50	0.97	1.00		
1700.0004	Parapet over vertical drop >2m	420.00	500.00	4.50								4.50		N2	No	0.00	80.00	0.25	2.50					Built up area Protected	N/A	0.00	4.50	0.10	-7.50	0.97	1.00		

Road Restraint Risk Assessment Process (RRRAP) VRS Summary

RRRAP version number	Issue 1.3a
Issue date	05/12/11

Verge assessed	N/S Verge
Section / Direction	Southbound

Date of Design/ Submission	13/09/2017

Road Number	
Road name	

Location	From	To
Junction Name		
Junction No.		
Marker Post		
Section Label		

Were any of the results unexpected?	

Were any of the results unexpected?

ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	Barrier Containment	Barrier working width class	Parapet Containment	Barrier working width (m)	Offset of Barrier from PSb	Comments
1700.0001	Parapet over vertical drc	100.00	175.00	4.50					N2		4.50	
8100.0001	Railway	100.00	135.00	5.25	36.0	16.0	H4A	W2		0.80	1.20	
1700.0002	Parapet over railway	175.00	375.00	4.50					N2		4.50	
1700.0003	Parapet over road	375.00	500.00	4.50					N2		4.50	
8200.0001	Adjacent Road Single	410.00	490.00	5.25	21.0		N2	W2		0.80	1.20	
1700.0004	Parapet over vertical drc	420.00	500.00	4.50					N2		4.50	