Project:	Lincoln Southern Bypass	**Date:**	12/12/2017
		TN Ref:	0005
Subject:	Options for A607 Overbridge. Dual Carriageway Option		
Author:	Jon Pecina	**Project Ref:**	738233-WSP-SBR-XX-RP-S-0005
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1. Introduction

A new route to the south of the city of Lincoln linking the A15 at Waddington to the A46 at South Hykeham has been proposed which is known at Lincoln Southern Bypass (LSB). The proposed scheme is required to alleviate the current congestion and journey reliability issues associated with the south of the city of Lincoln which will also complete the ring road around the city. There are three bridge structures identified to form the LSB. This document outlines the design criteria and procedures to be adopted for the design of A607 Bridge.

The purpose of this desk study is:

- To identify the location of the structure;
- To review the known constraints;
- To identify the unknown constraints;
- To propose initial sizing of the structure;
- To prepare the viable solutions for the bridge structure;
- To provide the comparison between the possible solutions and recommendations;
- To identify the possible risks and hazards of the recommended solutions.

The ground condition at structure location appeared to be poor. Various options for bridge widening or replacement have been reviewed and evaluated. Table 2 summarising and comparing various structural types, and other factors including design, constructability, aesthetics, future maintenance, traffic and environmental impacts.

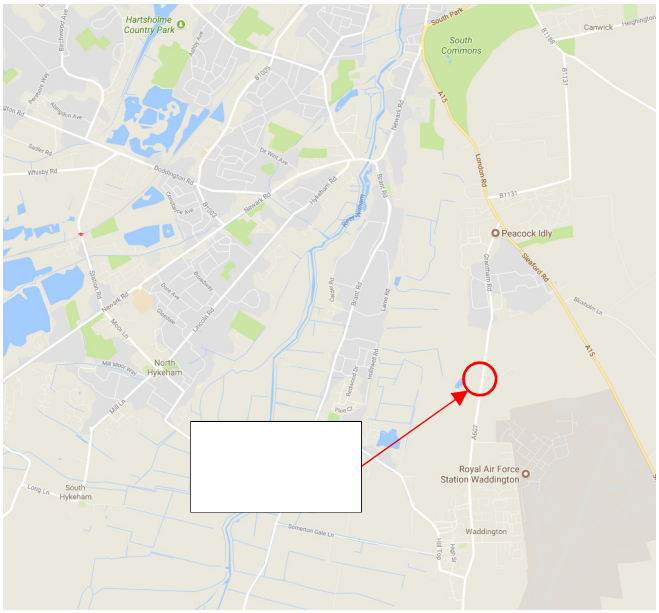
2. The Site

2.1. Description

The scheme located to the south of the city of Lincoln joining the A15 at Waddington to the A46 at South Hykeham. The route will run south-west from the A15 at Bracebridge Heath, passing through fields to the north of RAF Waddington, crossing the A607 Grantham Road before heading sharply down the slope and across Station Road, Waddington. After this, the route passes flat lying fields up to the junction of Brant Road and Somerton Gate Lane before heading further west across the River Witham and to the south of the village of South Hykeham. The route turns north-west past the town, crossing Boundary Lane and further fields before joining the existing A46 Hykeham roundabout. At Waddington, the site level is around 70m Above Ordnance Datum (AOD) to the top of the Lincoln Edge where the level drops sharply to about 40m AOD at the toe of the scarp. The ground then gently falls to about 10m AOD in the Witham valley and remains around this level to the A46 roundabout.

The structure will be located at the south of Lincoln, on A607 by the Waddington RAF base, as identified in the pictures below.

2.2. Location Plan



3. Site Constraints

The site constraints can be grouped into the following categories:

- Headroom;
- NMU routes;
- Statutory undertakers;
- Archaeological Survey information;
- Environmental constraints;
- Third party land ownership; and,
- Geotechnical information.

3.1. Headroom

The minimum headroom clearance between the soffit of the overbridge and the proposed highway level will be in accordance with TD 27/05. As per Table 6.1 of TD 27/05 the standard headroom for new Overbridges has to be at least 5.70m plus a sag curve. The minimum vertical clearance between beam soffit and the proposed highway level is 5.725m.

3.2. NMU routes

An existing NMU route is identified on the A607 Grantham Road. It comprises an off-highway shared pedestrian and cycle route, 1.5m wide, adjacent to the southbound carriageway. According to this, it is proposed to provide continuity over A607 Bridge, with a 3m wide footway along the south edge.

3.3. Statutory undertakers

The information of statutory undertakers will be updated once it is available. Reference should be made to the corresponding drawings. Information should include gas, water, electricity and

telecommunications plant cross the bridge. Trial holes should be carried out to confirm the presence of services during preliminary design stage.

Table 1 Statutory Summary

Authority	Service	Details	Location
Network Rail	Hazards	Not present	

3.4. Archaeological constraints

There is no archaeological survey data available. The information may potentially affect the location of the foundations/substructures. The archaeological information will be updated once it is available.

3.5. Environmental constraints

There are no data available suggest the presence of green belt. This should be confirmed by environmental survey. If green belt presents in this area, a design option that reduced the impact on the green belt should be taken into consideration.

3.6. Third party land ownership

The alignment of the LSB may still be subjected to change, which may affect the extent of third party land use.

However, land ownership details have currently not been requested from HM Land Registry. It should be noted that the proposed locations are surrounded by farm lands. It is thought unlikely that this will have a significant bearing upon proposals, however, it is recommended that land ownership details should be obtained during this stage to confirm the assumptions.

3.7. Geotechnical information

The geotechnical information will be updated once it is available. It should be noted that the geotechnical information should include an asbestos survey to clarify the risk of asbestos in the proposed area. It should also include any other information of ground conditions that may affect the design proposals.

4. Design Requirements

The outline design of the bridge has been progressed using the following criteria:-

Geometric dimensions of the A607 carriageway over the bridge:

East footway + cycling path:	3.00 m
Single carriageway:	7.30 m
North Verge:	1.00 m
Others (Parapet Plinth etc):	1.00 m
Total width of proposed structure:	12.30 m

Geometric dimensions of the LSB carriageway under the bridge:

South verge:	5.80 m
Eastbound South hardstrip:	1.00 m
Eastbound carriageway:	7.30 m
Eastbound North hardstrip:	1.00 m
Central reserve:	8.25 m
Westbound South hardstrip:	1.00 m
Westbound carriageway:	7.30 m
Westbound North hardstrip:	1.00 m
North verge:	2.50 m
North NMU path:	3.00 m
Others	1.00 m
Total clear, squared span between abutment faces:	39.15 m

It should be noted that the actual span of the beams is measured from the centre of the bearings, which are placed a further 0.75m from the abutment face. Therefore, the span for beams is 40.65m.

The minimum headroom clearance between the soffit of the bridge and the existing ground level has been taken as 5.70m+S (as previously suggested). It should be noted that the dimensions may vary in preliminary design.

5. Proposed Options

Two different options are proposed at the optioneering stage, which span approximately 40.650m at a skew angle of about 31°. The two proposed options are:

1) Single-span precast pre-stressed concrete beams with in-situ slab and concrete infill;
2) Single span weathering steel I beams with in-situ reinforced concrete slab.

5.1. Option 1 – Single-span precast beams with a cast in-situ deck

This section is to be read in conjunction with drawing 738233-WSP-SBR-XX-RP-DR-C-0009 contained in Appendix A.

The bridge will be a single span structure with an approximate total skew span of 40.65m at a skew angle of approximately 31°. The actual length of the span may vary based on the outcome of the geotechnical investigation on a later stage, which may lead to foundations being positioned at a different location.

The superstructure shall comprise of 4No. W or similar Precast beams. The beams will be made composite with a 250mm thick in-situ reinforced concrete deck slab. The simply supported beams span between insitu reinforced concrete diaphragms spanning transversely between the supports at the abutments.

The parapets will be supported by an in-situ reinforced concrete edge beam. N2/W2 parapet with mesh infill have been proposed on south side and N2/W2 parapets on north side of the overbridge and approach ramps.

The abutment wall is supported by reinforced concrete piled foundation. The design of the piles will be confirmed at preliminary design stage when geotechnical information is available.

Reinforced concrete retaining structures will be constructed to contain the backfill. The details of which will be specified at a later stage.

Bottom-up construction method to be employed for the bridge construction.

Construction method:

- Diversion of A607.
- Excavation and provision of temporary access to the site.
- Construct pile foundations and pile caps for the abutments, control modulus columns and load transfer platform for the wing walls.
- Construct abutment bank-seats and backfill behind abutment bank-seats.
- Construct the reinforced concrete walls and backfill up to the bearing shelf level.
- Install bearings at abutments.
- Erect falsework for abutments and temporary supports for pre-cast beams.
- Lift beams into position and place the permanent formwork.

- Fix the reinforcement and cast concrete deck slab. Casting stages will be studied more in detail at a later design stage.
- Cast concrete diaphragms at the abutments.
- Decommissioning of the falsework for temporary supports of beams after the concrete has attained its designated strength.
- Construct parapet plinths. Install the bridge parapets.
- Apply deck waterproofing.
- Install bridge kerbs, apply deck surfacing and install movement joints.
- Install bridge furniture.

Advantages:

- The bridge would be easy to construct compared to a conventional cast-in-situ construction. Precast concrete beams can be manufactured offsite and lifted onto position.
- Precast and reinforced concrete bridge elements will require fairly low maintenance costs compared to steel bridge elements.
- This option may have less environmental impact due to lower future maintenance requirements.

Disadvantages:

- Prestressed concrete beams are heavier compared to steel beams and require substantially larger substructure therefore higher construction cost.
- The construction method used causes considerable disruption to the A607 users, which may well translate into higher construction costs.
- There may be disruption to traffic during future maintenance work.

5.2. Option 2 – Steel Composite Beams and In-situ Deck

This section is to be read in conjunction with drawing 738233-WSP-SBR-XX-RP-DR-C-0010 contained in Appendix A.

The bridge will be a single span structure with an approximate total skew span of 40.65m at a skew angle of approximately 31°. The actual length of the span may vary based on the outcome of the geotechnical investigation on a later stage, which may lead to foundations being positioned at a different location.

The superstructure shall comprise of 6No. fabricated steel girders. The beams will be made composite with a 250mm thick in-situ reinforced concrete deck slab. The simply supported beams will be supported by bearings, which sit on reinforced concrete plinths at the abutments.

The parapets will be supported by an in-situ reinforced concrete edge beam. N2/W2 parapet with mesh infill have been proposed on south side and N2/W2 parapets on north side of the overbridge and approach ramps.

The abutment will be comprised of a contiguous bored piles wall and a pile cap. The in-situ contiguous bored piles wingwall will be extended parallel to the abutment. The design of the piles will be confirmed at preliminary design stage when geotechnical information is available.

Top-down construction method to be employed for the bridge construction.

- Provision of temporary access to the site and diversion of the A607.
- Construct contiguous bored piles foundations and pile caps for the abutments.
- Install bearings on the RC plinths to support the steel beams.
- Lift pairs of steel beams into position and place the permanent formwork.
- Fix the reinforcement and cast concrete deck slab. Casting stages will be studied more in detail at a later design stage.
- Decommissioning of the falsework for temporary supports of beams after the concrete has attained its designated strength.
- Construct the parapet plinths. Install the bridge parapets.
- Apply deck waterproofing.
- Install bridge kerbs, apply deck surfacing and install movement joints.
- Install bridge furniture.
- Open A607 to the traffic.
- Excavate to road level and construct road.
- Provide brickwork cladding on the abutment walls

Advantages:

- The structure would be easy to construct as the steel fabrication work would be done offsite.
- Top-down construction method considerably reduces the disruption to the A607 users compared to the previous option No. 1, thus lower construction cost.
- The lifting weight for steel beams would be lower when compared to precast concrete beams. A relatively lighter crane would be required to place the beams in to the position. Lighter construction also reduces the substructure cost.

Disadvantages:

- The cost of construction using steel beams would be higher than the cost of using precast concrete beams.
- There may be disruption to traffic during future maintenance work.
- The option also involves the casting of insitu reinforced concrete elements such as abutments, piers and deck slab.
- Routinely inspections and maintenance will be required, although the use of weathering steel might lower down the costs and maintenance work frequency.

5.3. Options Summary

As noted in the horizontal alignment, the central reserve on the A607 bridge location is approximately 8.25m wide, which may provide enough room for a middle pier, thus shortening the spans. This may well be a feasible option to consider at a later stage, depending on soil conditions and highway alignments, i.e. visibility requirements.

It should be noted that a single-span option is doable, especially if visibility and/or future proofing requirements dictate the design. However, the beam depth increases as the span increases, and given the current highway vertical alignments, there may not be enough headroom clearance to fit such deep beam. Providing that enough headroom is given, a single-span is buildable.

Table 2 Structures Options Summary

Option Ref	Relative Ease of construction	Specialist site preparation	Extensive temporary works Required?	Complex construction methodology	Design life / Extension	Maintenance costs	Aesthetics	Environmental Impact
Option 1 (Precast beams with a cast in-situ deck)	Simple	Require temporary site/access	Moderate – but vast majority of precast components will be cast offsite, and crane-lifted into the position	No	120 yrs	Low	Standard	Normal
Option 2 (Steel composite beams and in-situ deck)	Simple	Require temporary site/access	Moderate – but vast majority of steel fabrication will be assembled offsite, and crane-lifted into the position	No	120 yrs	Moderate - Low	Standard	Normal

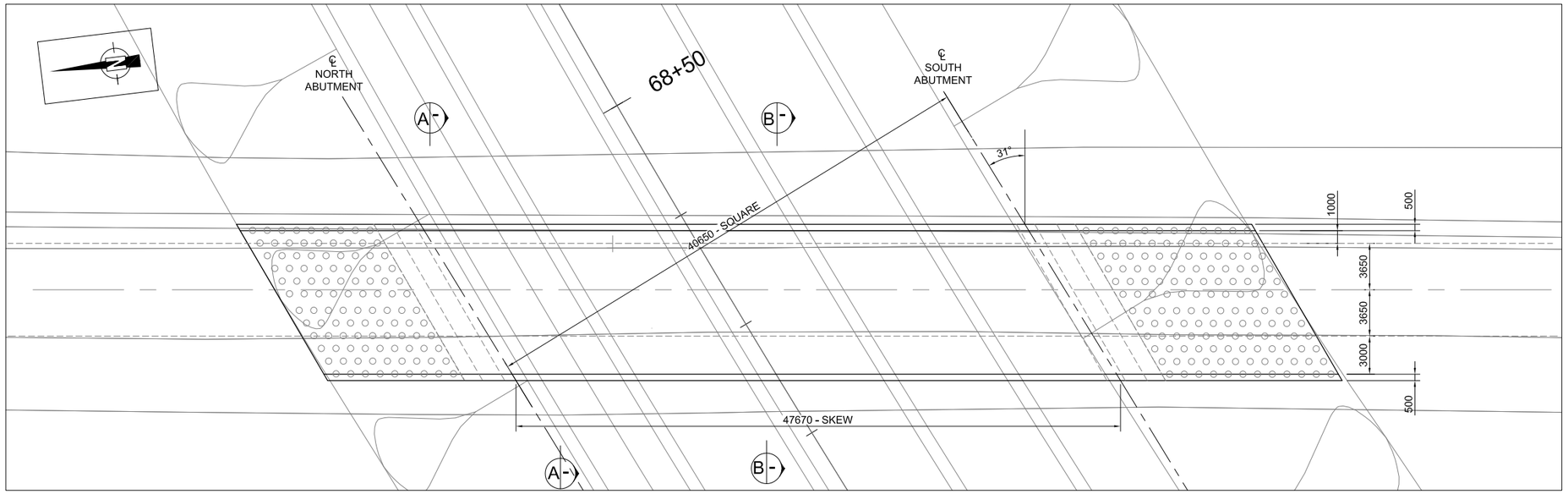
6. Risks and Hazards

The possible risks and hazards have been listed below:

1. The A607 structures put forward as part of the conceptual design may vary in their geometry as changes in the vertical/horizontal alignment happen.
2. The vertical alignment used does not make provision for the headroom requirements –i.e. 5.7m. According to this, the carriageway level needs to be lowered down to the required level in order to maintain the minimum vertical clearance specified.
3. Bridge excavations, e.g. walls and other structures. Falling into excavations, groundwork collapse, slope instability, construction workers.
4. Setting up formworks for foundations and walls during construction. Temporary instability. Instability of cured concrete structures, such as walls, piers and foundations. Instability of temporary works, such as setting up formworks. And Instability of permanent structure during construction. Construction workers.
5. Craning or lifting operations. Failure during lifting due to asymmetric lifting, uncontrolled lifting, Construction workers.
6. Access for maintenance. Exposure to live traffic, working from height etc. for maintenance.
7. Maintenance Operatives.
8. Presence of services (relocating existing STATS during construction/demolition). Electrocution - striking services leading to injury. Construction workers.
9. Hot work carried out for steel composite bridge widening. Welding and cutting - working under hot environment lead to injury and vision damage.
10. Agree software that should be used in preliminary and detail stage.
11. Insufficient headroom and wider central reserve. The wider central reserve leads to longer structures and bigger bridge elements. This will result in too low headroom for current highway alignment. The visibility envelope at central reserve doesn't allow any support in central reserve. So structure will have to be designed as single span structure. The current highway profile has to be amended to accommodate the change.

APPENDIX A

General Arrangement Drawings



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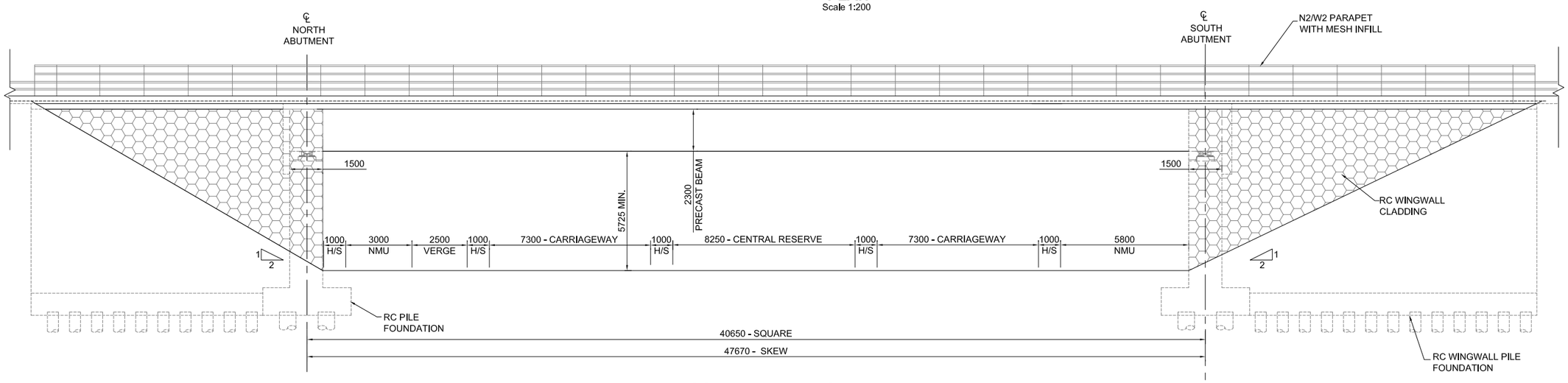

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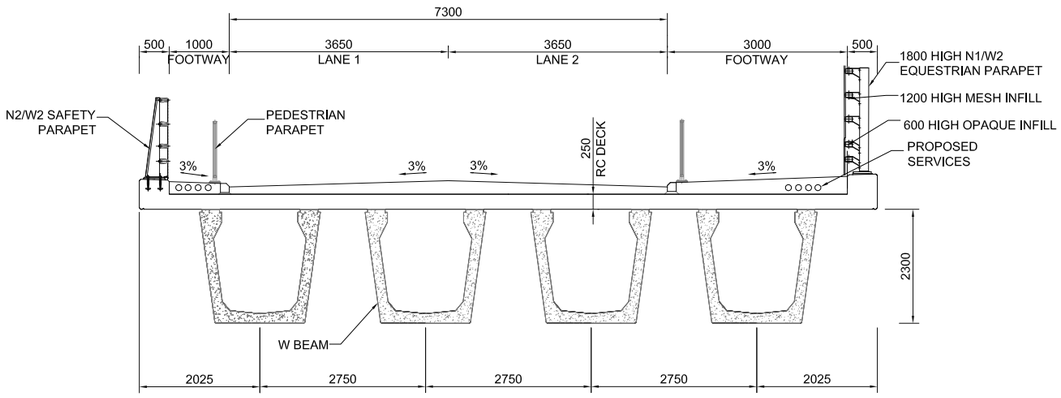

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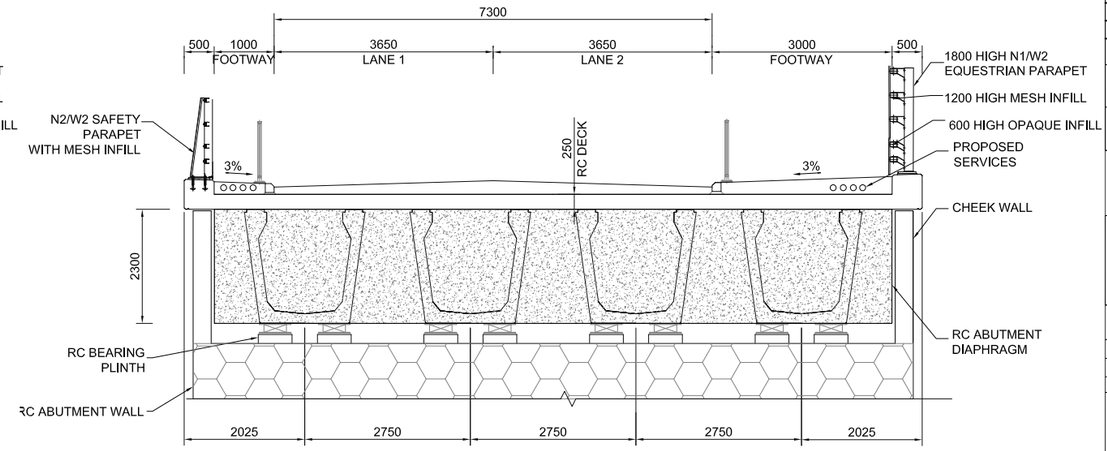

SECTION B
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X-Refs & Blocks used in this Drawing

Notes:

1. Do not scale from this drawing.
2. All dimensions are in millimetres unless otherwise noted.
3. The structure element dimensions are shown based on conceptual design and subject to change at detailed preliminary design stage.

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Amendment Details					

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Date: 28 NOV 2017

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Created By: KT
Date: 27/11/17

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Primary: AS SHOWN (Do not scale from this drawing)
Secondary:

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Highways Alliance
TECHNICAL SERVICES PARTNERSHIP
5th FLOOR
MILL HOUSE
BRAYFORD WHARF NORTH
LINCOLN LN1 1YT
Customer Service Centre : (01522) 782070

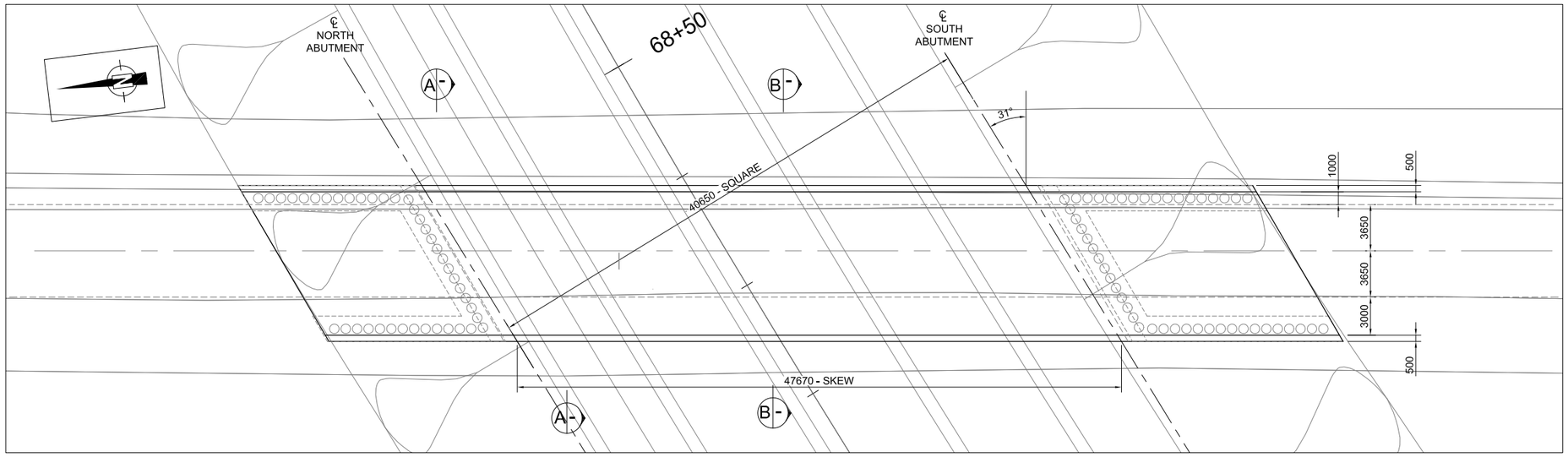
Certificate No. FS20705

Scheme Reference	Job Ref.	DFT Series No.	Drawing No.	Revision.
738233-WSP	SBR	XX-DR	C-0009	Rev.A1

Alternative Scheme Code:
Road No:
Parish: LINCOLN
Structure No:
SCN No:
Site Ref:

Description:
LINCOLN SOUTHERN BYPASS
GRANTHAM ROAD OVER BRIDGE
GENERAL ARRANGEMENT
DUAL CARRIAGEWAY - OPTION 1

TSP Border Issue 2016



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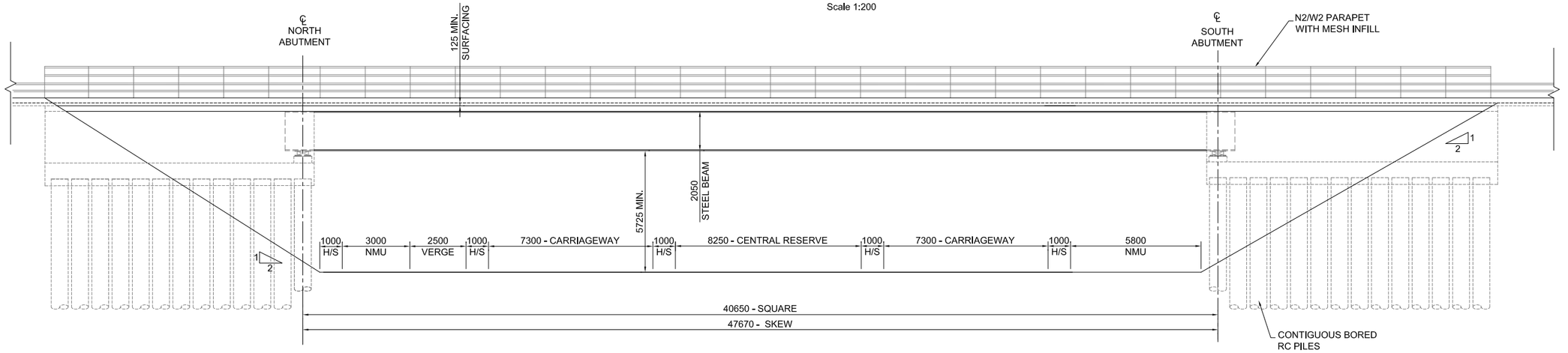

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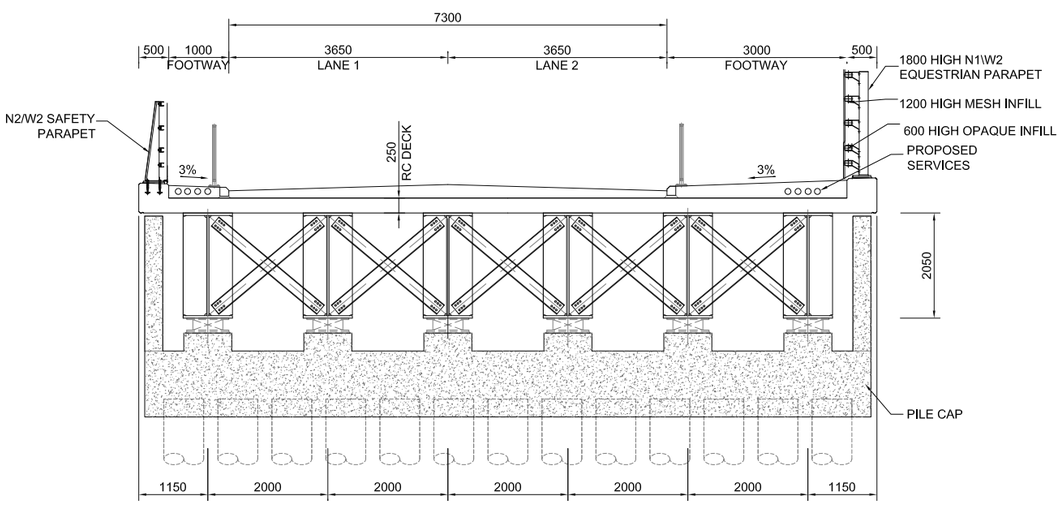

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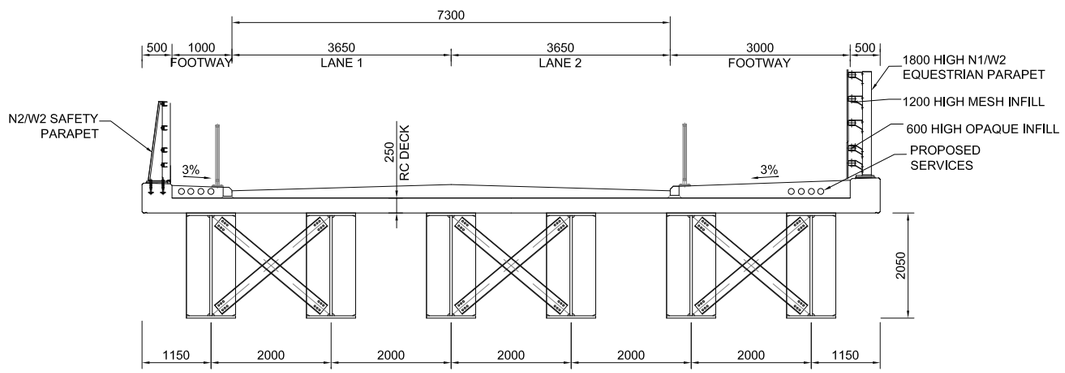

SECTION B
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