

Project:	Lincoln Southern Bypass	Date:	07/12/2017
		TN Ref:	0003
Subject:	Options for Station road Over-Bridge		
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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 as Lincoln Southern Bypass (LSB). The proposed scheme is required to alleviate the current congestion and journey reliability issues associated with the south area of the city of Lincoln and 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 the Station Road Overbridge.

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.

From the available data various types of single span structures were considered. However a prestressed concrete beam and a steel concrete composite beam options appear to be the best viable solutions for the bridge structure. These two proposed forms also blend well with similar structures designed over Lincoln Eastern Bypass.

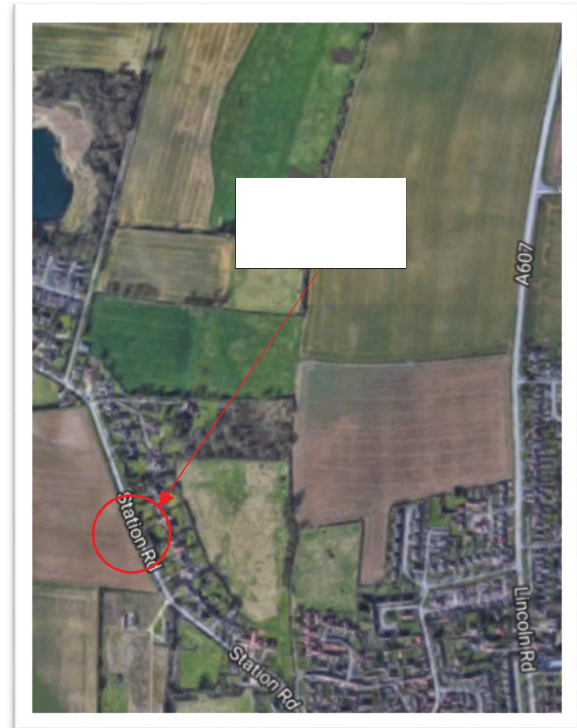
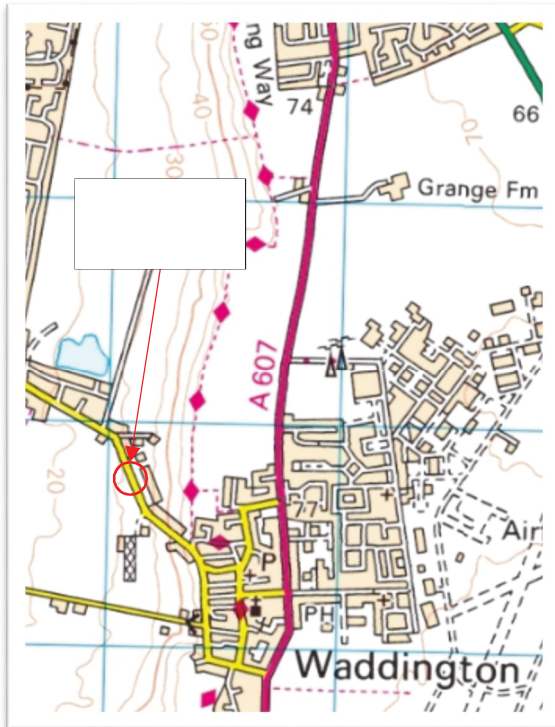
2. The Site

2.1. Description

The scheme is 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 proposed overbridge is located at the south of the city of Lincoln and at east of the Royal Air Force Station in Waddington. It is approximately 600m to the east of Lincoln Road A607.

2.2. Location Plan



3. Site Constraints

The site constraints can be grouped into the following categories:

- Headroom;
- Statutory undertakers;
- Archaeological constraints;
- Environmental constraints;
- Third party land ownership;
- 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 5.30m plus a sag curve. The minimum vertical clearance between beam soffit and the proposed highway level is 5.325m.

3.2. Statutory undertakers

The information of statutory undertakers will be updated once it is available. Reference should be made to 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	

3.3. 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.

3.4. Environmental constraints

The available data suggest the presence of green belt to the east of the River Witham. This should be confirmed by environmental survey.

3.5. Third party land ownership

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 and private houses. 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.

3.6. 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 proposed design.

4. Design Requirements

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

Geometric dimensions of the proposed road:

NMU way (north):	3.50 m
North Hardstrip:	1.00 m
Carriageway:	7.30 m
South Hardstrip:	1.00 m
South verge:	1.00 m
Others (Parapets and working widths):	2.80 m
Total square clear span of proposed structure:	16.60 m

Geometric dimensions of Station road:

West parapet beam:	0.50 m
West verge:	2.00 m
Carriageway:	7.30 m
East verge:	2.00 m
East parapet beam:	0.50 m
Total width of proposed structure:	12.3 m

The minimum headroom clearance between the soffit of the bridge and the proposed highway level has been taken as 5.325m (as previously suggested in Section 3.1). It should be noted that the dimensions will vary in preliminary design.

5. Proposed Options

There are two types of bridges considered for bridge skew spans approximately 23m and a skew angle of about 27° at the optioneering stage. The two proposed options are:

- 1) Precast pre-stressed concrete beams with in-situ slab and concrete infill;
- 2) Weathering steel I beams with in-situ reinforced concrete slab.

5.1. Option 1 – Precast pre-stressed concrete beams with in-situ slab and concrete infill

This section is to be read in conjunction with drawing 738233-WSP-SBR-XX-DR-C-0005 contained in Appendix A.

The bridge will be single span structure with approximate skew span of 23m at a skew angle of approximately 27°. 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 16 No. TY or similar precast prestressed beams. The beams will be made composite with a 300mm thick in-situ reinforced concrete deck slab. The beams span into integral insitu reinforced concrete diaphragms spanning transversely between the supports at the abutments. The diaphragms will be supported by mechanical bearings at each abutments. This arrangement will make the bridge a semi-integral structure.

The parapets will be supported by in-situ reinforced concrete edge beam. The deck cantilever soffit angles will vary to provide a constant depth of edge beam along the structure. N2 parapets with mesh infill have been proposed on both sides of the overbridge and approach ramps.

The end supports will comprise of reinforced abutment wall supported by reinforced concrete piled foundation. The approaches will be retained by reinforced concrete wing walls parallel to the carriageway supported by Load Transfer Platform and Control Modulus Columns. Bearings can be inspected in the future with a cherry picker that can be placed at the bottom of each abutment without the need of a road or lane closure.

The construction method would be from bottom to top according to the most common practice.

Construction method:

- Diversion of Station Road.
- 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 abutments.
- Construct the reinforced concrete walls and backfill up to the bearing shelf level.

- Construct abutment bank-seats and backfill behind abutment bank-seats.
- 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.
- Pour parapet plinths. Install the bridge parapets.
- Apply deck waterproofing.
- Install bridge verges, 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.
- Low future maintenance cost as the overbridge is semi-integral at the abutments, which helps reducing the amount of bearings used to support the superstructure. Also bearings can be inspected with a cherry picker positioned at the bottom of each abutment without the need of a lane/road closure.
- 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 option involves the lifting of heavy construction elements such as precast concrete beams.
- The option also involves the in-situ casting of reinforced concrete elements such as abutments and solid deck slab.
- The construction of this option would require Station Road to be shut down for longer time compared to the following option hence higher disruption and higher construction cost.
- There may be disruption to traffic during future maintenance work.

5.2. Option 2 – Weathering steel I beams with in-situ deck slab

This section is to be read in conjunction with drawing 738233-WSP-SBR-XX-DR-C-0006 contained in Appendix A.

The bridge will be single span structure with approximate skew span of 23m at a skew angle of approximately 27°. 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 6 No. weathering steel I Beams made composite with a 300 mm thick in-situ reinforced concrete deck slab. The beams would span into integral in-situ reinforced concrete diaphragms which will be made solid with the deck and pile cap in order to properly transfer actions. This arrangement will make the bridge an integral structure.

The parapets will be supported by in-situ reinforced concrete edge beam. The deck cantilever soffit angles will vary to provide a constant depth of edge beam along the structure. N2/ 1.4m parapets with mesh infill have been proposed on both sides of the overbridge and approach ramps.

The pile cap would sit over contiguous bored piles foundation that will also retain the backfill under the approaches to the overbridge. The design of the piles would be confirmed at preliminary design stage when geotechnical information becomes available.

The construction method would be the so-called “deck-on-piles” (from top to bottom). This consist of building the overbridge superstructure prior to start excavating to accommodate the proposed new highway. This way disruption to traffic on Station Road is minimised.

Construction method:-

- Provision of temporary access to the site and diversion of Station Road.
- Construct pile foundations and pile caps for abutments.
- Construct the contiguous bored piled walls and pile caps
- Backfill up to the temporary bearing shelf level.
- Erect falsework for abutment diaphragms.
- Install temporary bearing pads for I beams.
- Lift weathering steel I beams onto position.
- Install steel bracings.
- Cast the deck slab and the end diaphragms.
- Decommission of the falsework for abutment diaphragms after the concrete has attained its designated strength.
- Complete backfill operations.
- Pour parapet plinths. Install bridge parapets.
- Apply deck waterproofing.
- Install bridge verges, apply deck surfacing and install movement joints.
- Install bridge furniture.

Advantages:-

- The use of weathering steel beams would require lower maintenance when compared to conventional mild steel beams.
- The structure would be easy to construct as the steel fabrication work would be done offsite.

- 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 into position.
- A lighter superstructure reduces substructures dimensions hence substructure cost.
- Due to the use of contiguous bored piles foundations, the construction of this option would require Station Road to be shut down for a shorter time compared to the previous option hence lower disruption and lower construction cost.
- It should be noted that a similar type of bridge has been agreed in principle for the Lincoln Eastern Bypass. Therefore manufacture and fabrication of the same type of bridge may be simple comparing to the previous option.

Disadvantages:-

- The cost of construction using steel beams would be higher than the cost of using precast concrete beams.
- The option also involves the casting of in-situ reinforced concrete elements, such as pile cap and deck slab.
- Although primarily constructed of weathering steel, moderate maintenance would still be required.
- There may be disruption to traffic during future maintenance work.

5.3. Options Summary

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 prestressed concrete beams with in-situ slab and concrete infill)	Simple	Require temporary site/access	High – but precast beams and parapet beams will be cast offsite and crane-lifted into the position	No	120 yrs	Low	Standard	Normal
Option 2 (Weathering steel I beams with in-situ concrete deck)	Simple	Require temporary site/access	Moderate – but vast majority of steel elements will be fabricated offsite and crane-lifted into the position	No	120 yrs	Normal	Standard	Normal

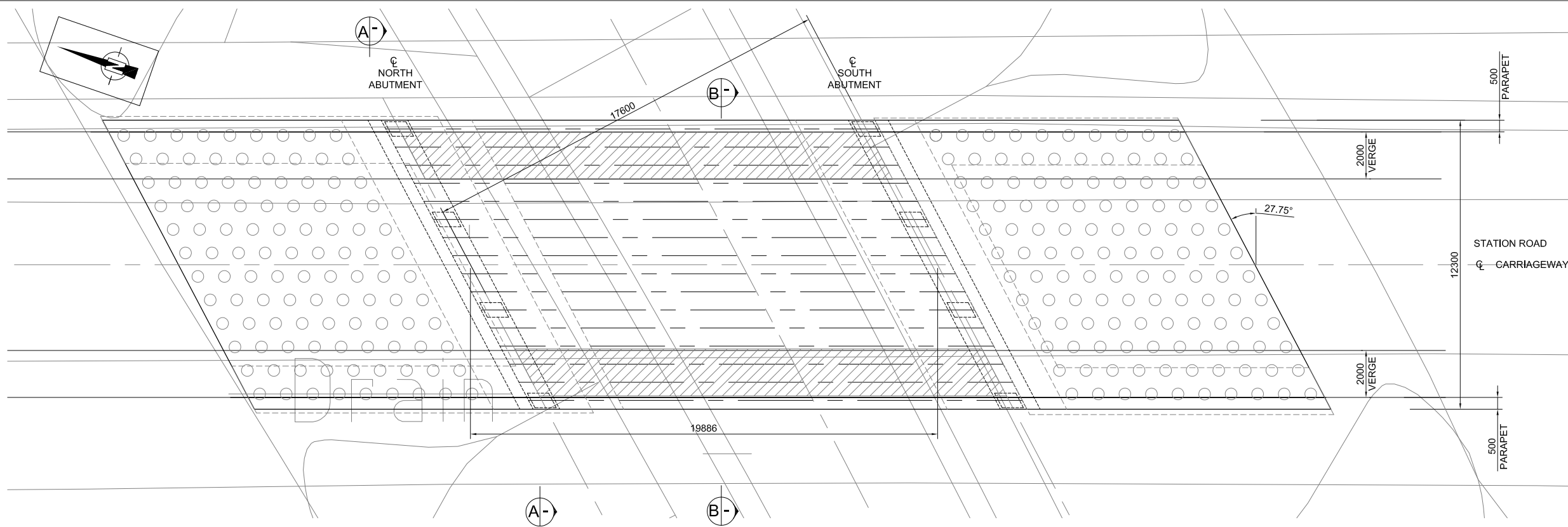
6. Risks and Hazards

The possible risks and hazards have been listed below:

1. Construction is adjacent to existing private housing.
2. Bridge excavations, e.g. walls and other structures. Falling into excavations, groundwork collapse, slope instability, construction workers.
3. Setting up formworks for abutments, foundations and walls during construction. Temporary instability. Instability of cured concrete structures, such as abutments and foundations. Instability of temporary works, such as setting up formworks. And Instability of permanent structure during construction. Construction workers.
4. Piling, craning or lifting operations. Failure during lifting due to asymmetric lifting, uncontrolled lifting, construction workers.
5. Access for maintenance. Exposure to live traffic, working from height etc. for maintenance.
6. Maintenance Operatives.
7. Presence of services (relocating existing STATS during construction/demolition). Electrocutation - striking services leading to injury. Construction workers.
8. Hot work carried out for steel composite bridge through welding and cutting activities - working under hot environment lead to injury and vision damage.
9. Agree software that should be used in preliminary and detailed design stages.
10. Unknown level profile for Station Road. By looking at the contours within the area it seems reasonable to assume Station Road to be horizontal over the proposed highway at the moment.

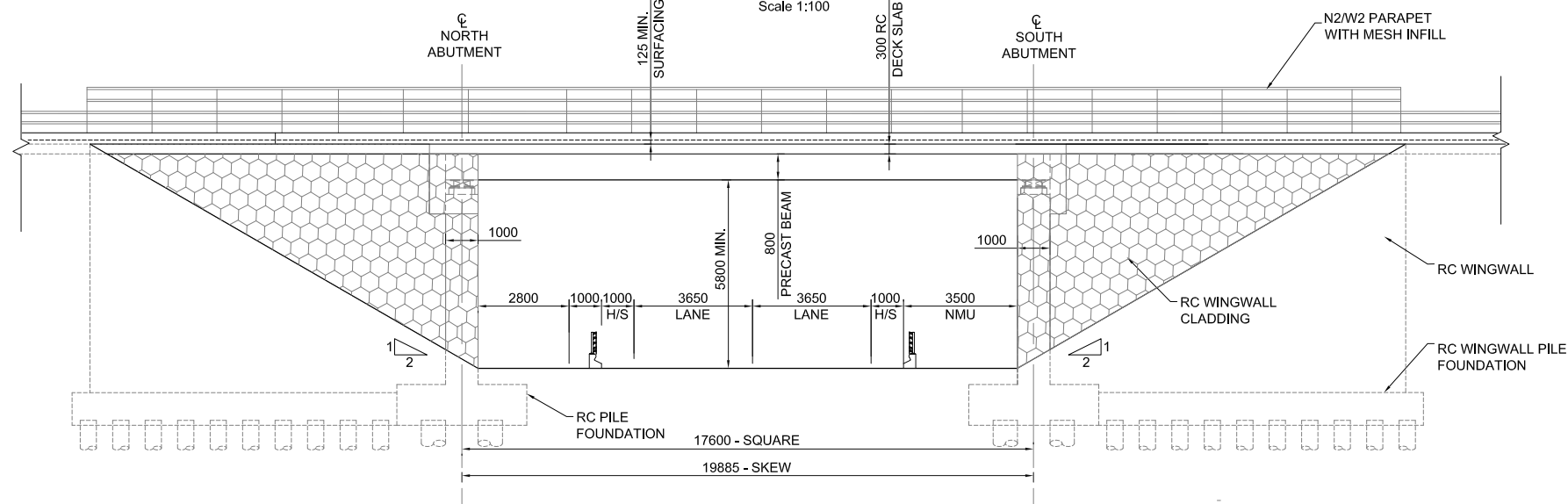
Appendix A

General Arrangement Drawings



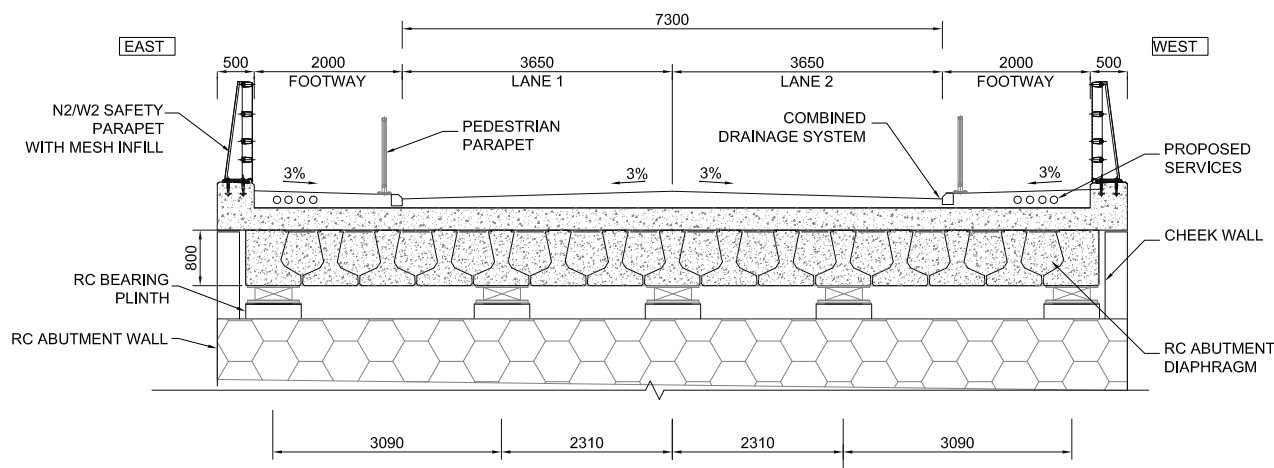
PLAN

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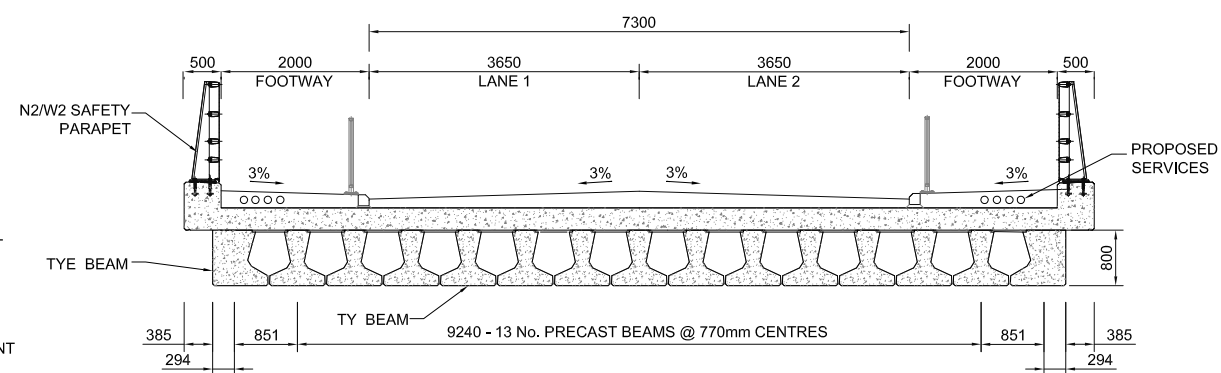
ELEVATION

Scale 1:100



SECTION A-A

Scale 1:50



SECTION B-B

Scale 1:50

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.

Lincolnshire Highway Alliance drawing created using base information supplied by external party detailed below.
 Base Information Provided By:
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Revision Details: Drawn: GC, CAD: KT, Approved: GP, Date: 28 NOV 2017

Amendment Details: Drawing 1st Approval
 1st Approval by: GP Date: 28 NOV 2017
 Drawn/Designed by: GC CAD Drawing Creation
 Created By: KT Date: 27/11/17

Scale: (@A1)
 Primary: AS SHOWN (Do not scale from this drawing)
 Secondary:

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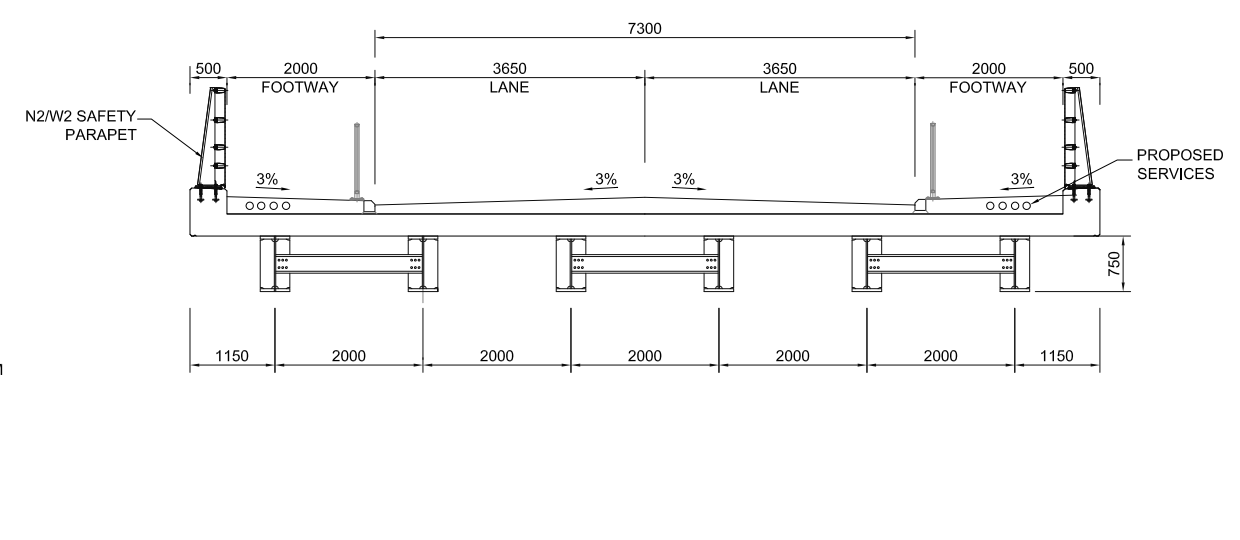
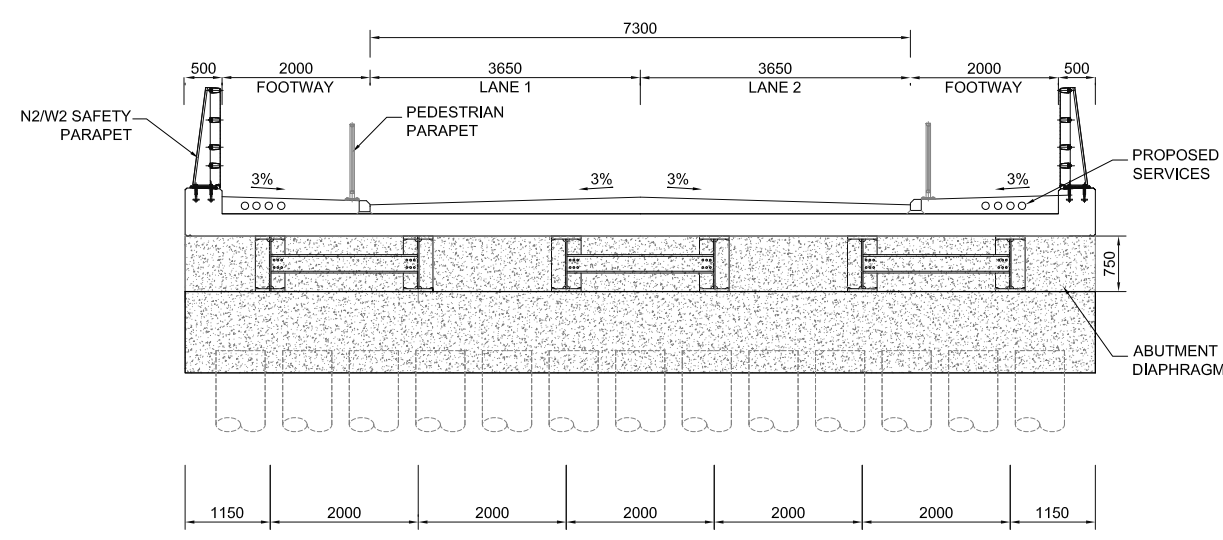
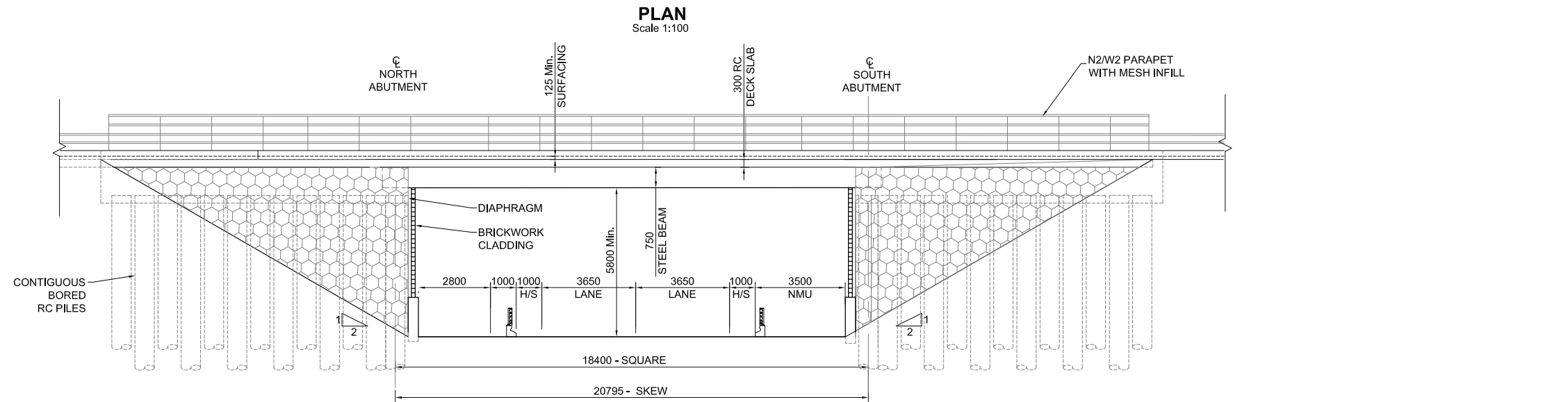
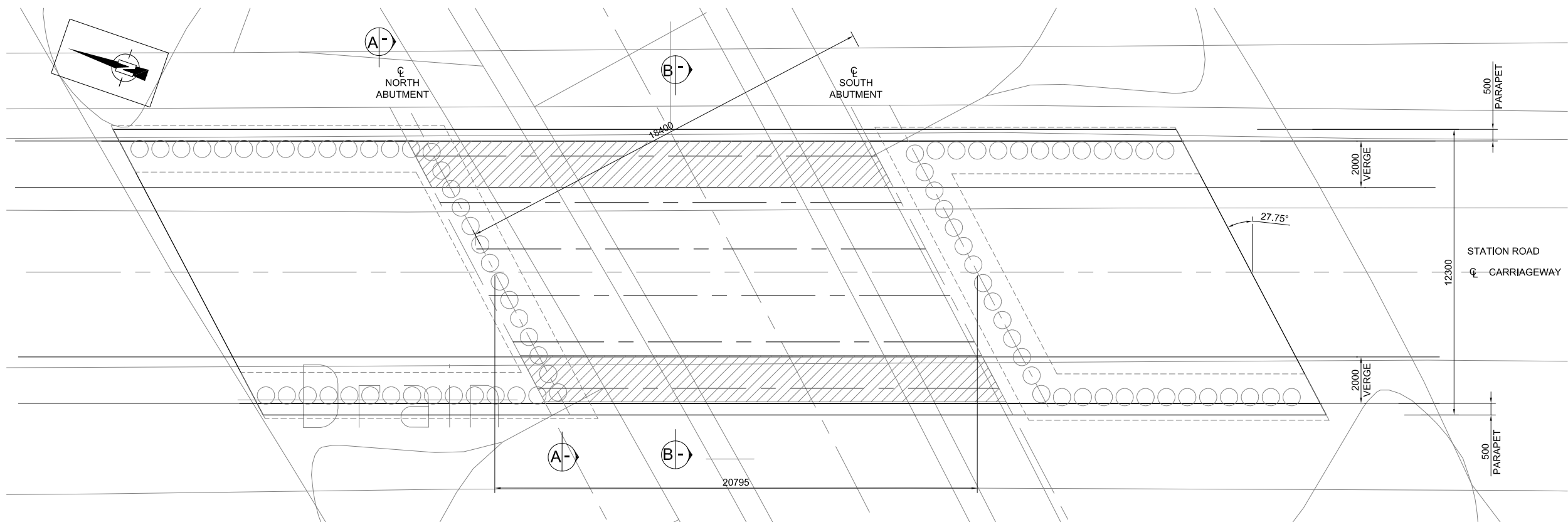
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Alternative Scheme Code: Job Ref: DFT Series No. Drawing No. Road No:

Parish: LINCOLN

Structure No: SCN No: Site Ref:

Description:
 LINCOLN SOUTHERN BYPASS
 STATION ROAD OVERBRIDGE
 GENERAL ARRANGEMENT
 OPTION 1



- Notes:
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Revision Details

Rev	By	Appr	Date

Drawing 1st Approval
1st Approval by: GP Date: 28 NOV 2017

Drawn/Designed by: GC CAD Drawing Creation
Created By: KT Date: 27/11/17

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738233-WSP / SBR / XX-DR / C-0006 Rev.A1

Alternative Scheme Code: Road No:
Parish: LINCOLN

Structure No: SCN No: Site Ref:

Description:
LINCOLN SOUTHERN BYPASS
STATION ROAD OVERBRIDGE
GENERAL ARRANGEMENT
OPTION 2