Project:	Lincoln Southern Bypass		**Date:**	11/12/2017
			TN Ref:	0001
Subject:	Options for Station road Over-Bridge – Dual Carriageway option			
Author:	Gaia Corelli	**Project Ref:**	738233-WSP-SBR-XX-RP-S-0006	
Reviewed:	Gauravkumar Panchal	**Date:**	11/12/2017	
Approved:		**Date:**	11/12/2017	

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.

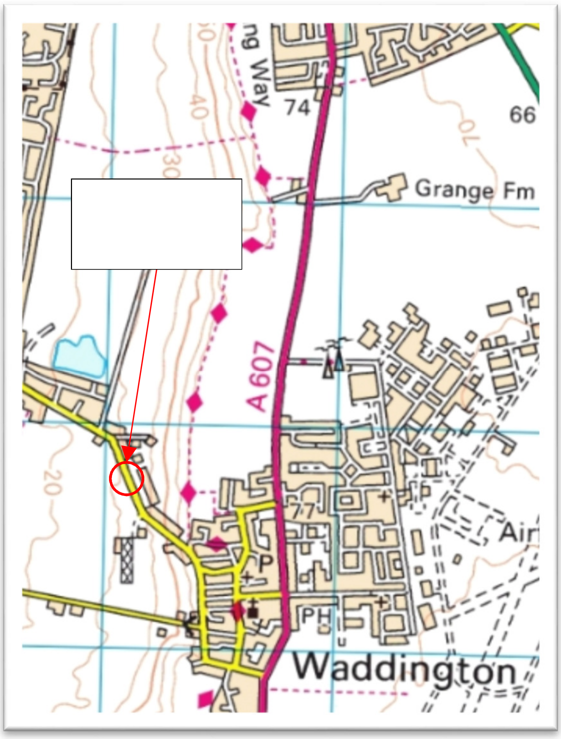
2. The Site

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 5.70m plus a sag curve. The minimum vertical clearance between beam soffit and the proposed highway level is 5.725m.

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

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.

3.5. 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:

Hard Strip:	1.00 m
NMU way (north):	3.00 m
Verge:	2.50 m
Hard Strip:	1.00 m
Carriageway:	7.30 m
Hard Strip:	1.00 m
Central Reserve:	7.75 m
Hard Strip:	1.00 m
Carriageway:	7.30 m
Hard Strip:	1.00 m
Proposed NMU:	5.80 m
Total square clear span of proposed structure:	**38.65 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 5.725m (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 different types of bridge forms considered. The bridge has a skew span approximately 46.60m and a skew angle of about 30° at the optioneering stage. The two proposed options are:

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

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

This section is to be read in conjunction with drawing 738233-WSP-SBR-XX-DR-C-00011 contained in Appendix A.

The bridge will be single span structure with approximate skew span of 46.60m at a skew angle of approximately 30°. 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 4 No. W precast prestressed beams or similar that will be made composite with a 250mm thick in-situ reinforced concrete deck slab. Each beam is supported on two bearings at both the abutments. In-situ reinforced concrete abutment diaphragms span transversely between the beams and are present at both supports. The aforementioned arrangement will make the bridge a simply supported 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/W2 parapets 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. The bearings can be inspected in the future using MEWP. The MEWP can be placed in front 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 abutment bank-seats and backfill behind abutment bank-seats.
- Construct the reinforced concrete wingwalls and backfill up to the bearing shelf level.
- Install bearings at abutments.
- 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.
- Pour 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.
- Low future maintenance cost as W beams are used, 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-0012 contained in Appendix A.

The bridge will be single span structure with approximate skew span of 46.60m at a skew angle of approximately 30°. 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 250 mm thick in-situ reinforced concrete deck slab. The beams will be supported by bearings supported by the pile cap at both ends. This arrangement will make the bridge a simply supported 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/W2 parapets have been proposed on both sides of the overbridge and approach ramps.

The pile cap will be supported by contiguous bored piles foundation which will also retain the backfill under the approaches to the overbridge.

The top down construction method will be adopted for the construction of the structure. This consist of building the overbridge superstructure prior to start excavating under to accommodate the proposed new highway. This method will reduce the disruption to traffic on Station Road during the construction.

Construction method:-

- Provision of temporary access to the site and diversion of Station Road.
- Construct the contiguous bored piled walls and pile caps.
- Backfill up to the temporary bearing shelf level.
- Install bearings.
- Lift weathering steel I beams into position.
- Install steel bracings.
- Cast the deck slab.
- Complete backfill operation.
- Pour parapet plinths. Install bridge parapets.
- Apply deck waterproofing.
- Install bridge kerbs, 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 steel being a more performing material the structure depth is lower compared to pre-stressed pre-cast beams option.
- 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 period of 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)	Simple	Require temporary site/access	High – but precast 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

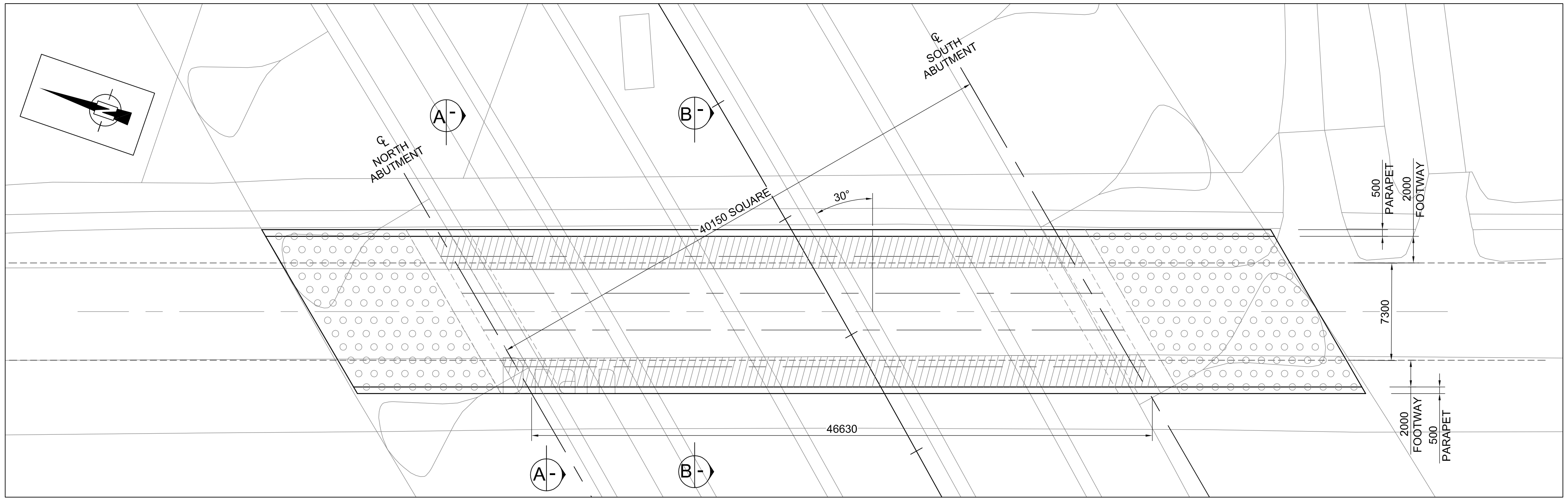
6. Risks and Hazards

The possible risks and hazards have been listed below:

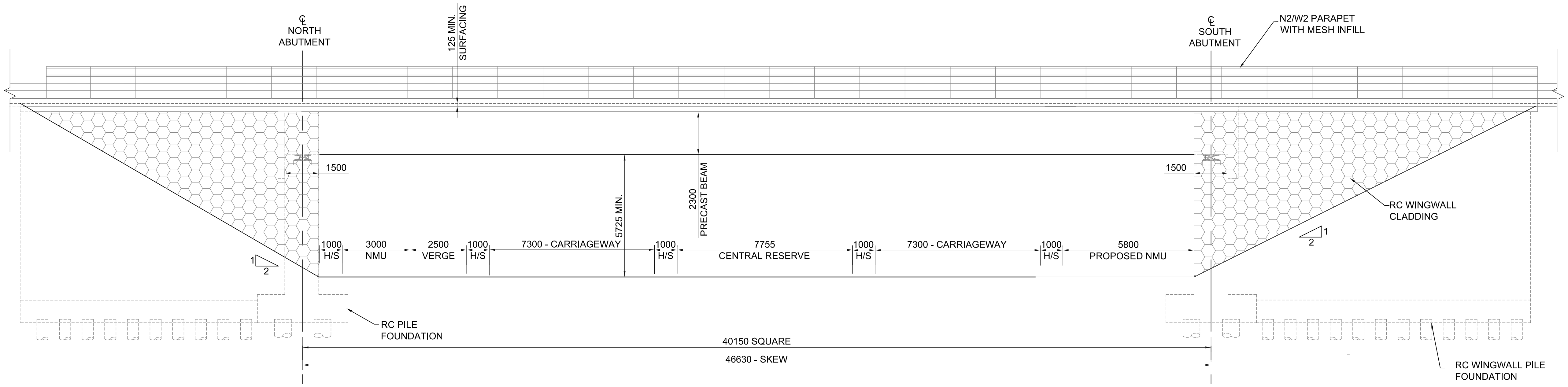
1. Construction is adjacent to existing private housing.
2. Bridge excavations, e.g. walls and other structures. Falling into excavations, groundwork collapse, slope instability, construction workers.
3. Setting up formworks for abutments, foundations and walls during construction. Temporary instability. Instability of cured concrete structures, such as abutments and foundations. Instability of temporary works, such as setting up formworks. 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). Electrocution - 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.
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

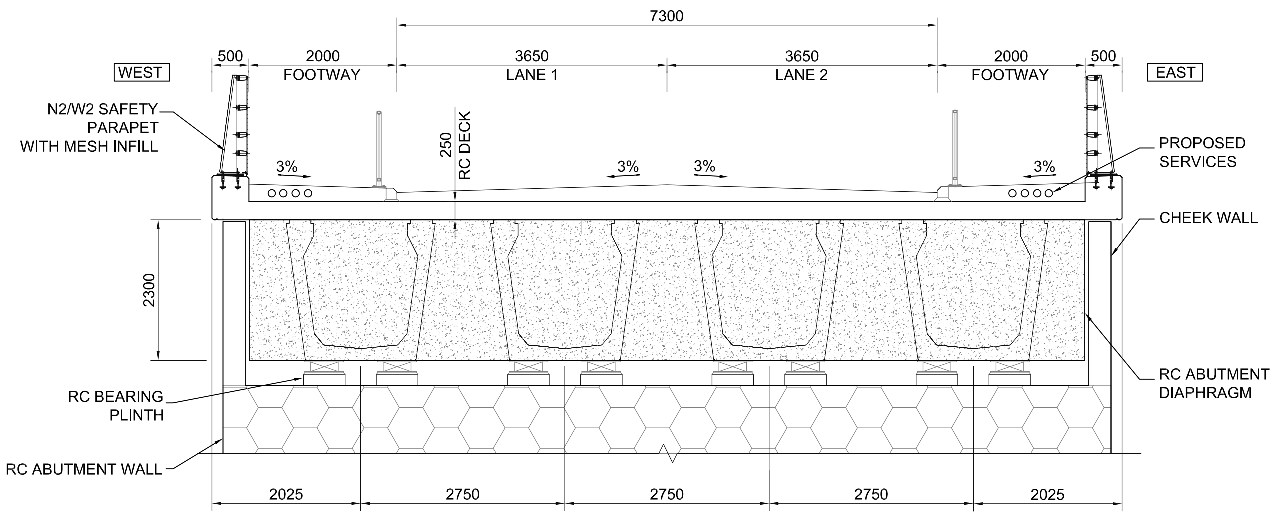
General Arrangement Drawings



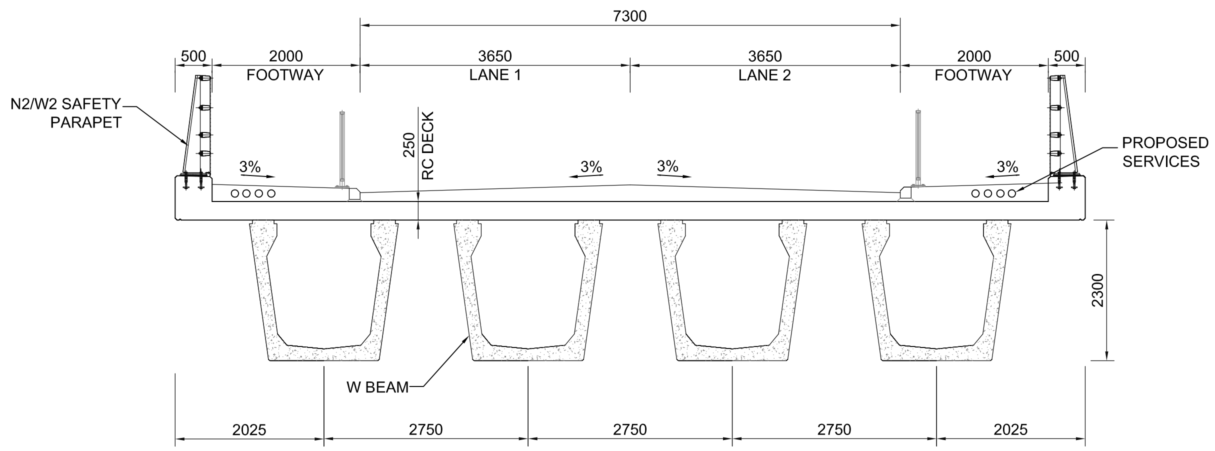
PLAN
Scale 1:200



SQUARE ELEVATION
Scale 1:100



SECTION A
Scale 1:50



SECTION B
Scale 1:50

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.

Lincolnshire Highway Alliance drawing created using base information supplied by external party detailed below:
Base Information Provided By:
Client Provided Drawing Number:

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH AIP REFERENCE 70036923-WSP-SBR-LEB_RWB-RP-S-0001

FOR THIRD PARTY USE, THIS DRAWING SHALL BE DEEMED CURRENT ONLY AT THE DATE OF APPROVAL. PLEASE CHECK FOR AMENDMENTS BEFORE USE

Revision:	Description:	Drawn By:	CAD By:	Approved By:	Approval Date

Amendment Details

Drawing 1st Approval
1st Approval by: GP | Date: 14 DEC 2017

Drawn/Designed by: GC
CAD Drawing Creation
Created By: KT | Date: 11/12/17

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

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

Certificate No. FS20705

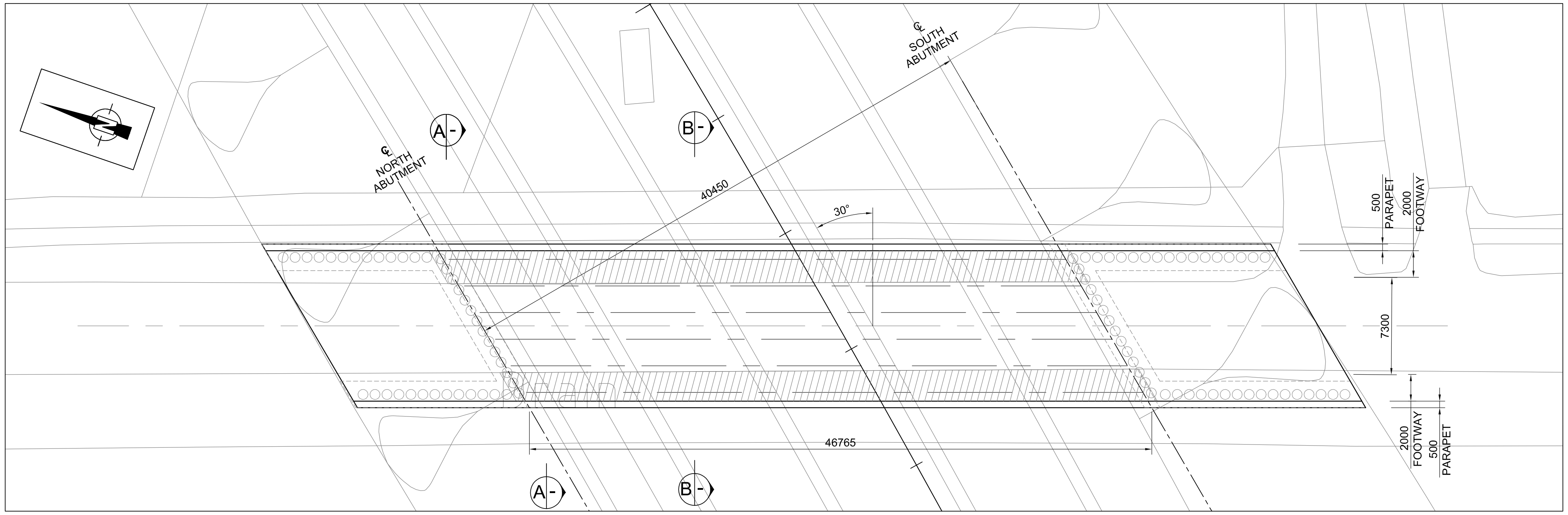
738233-WSP /	SBR /	XX-DR /	C-0011	Rev.A1
Scheme Reference	Job Ref.	DFT Series No.	Drawing No.	Revision.

Alternative Scheme Code: | Road No:

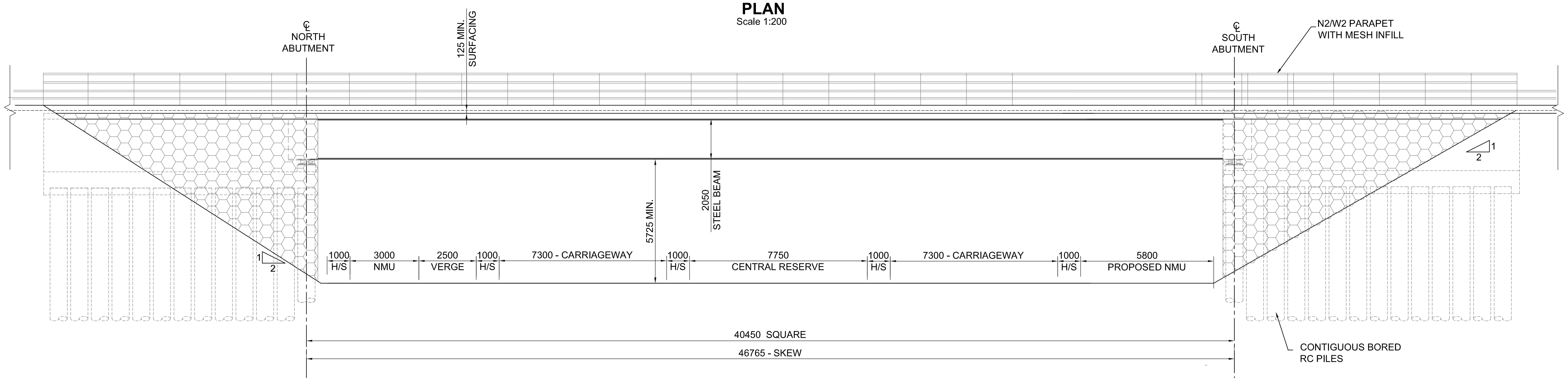
Parish: LINCOLN

Structure No: | SCN No: | Site Ref:

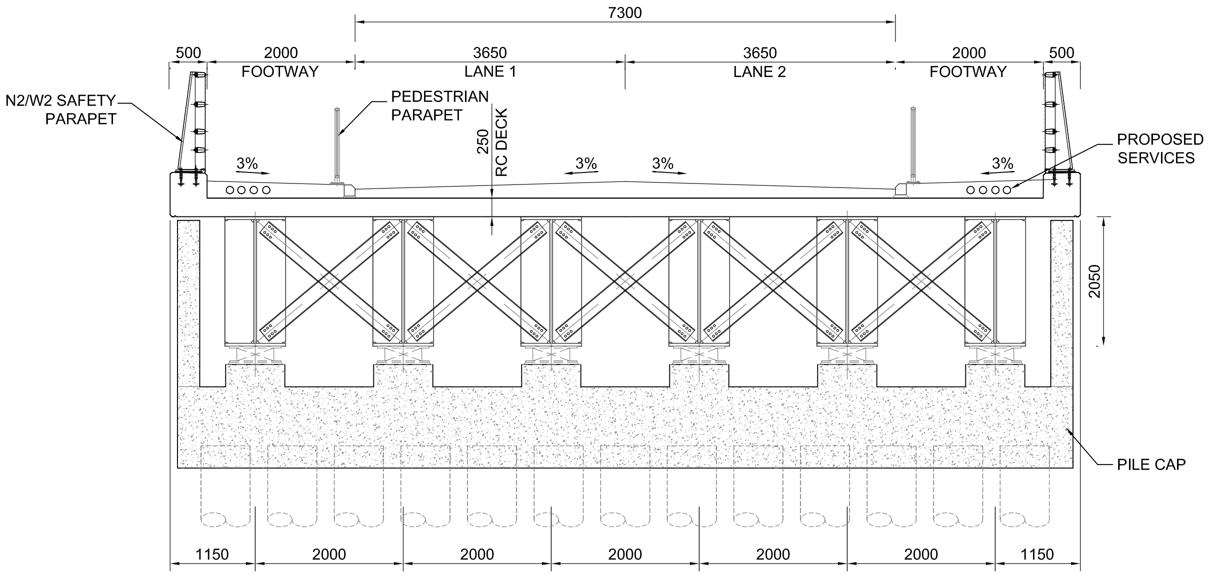
Description:
LINCOLN SOUTHERN BYPASS
STATION ROAD OVERBRIDGE
GENERAL ARRANGEMENT
DUAL CARRIAGEWAY - OPTION 1



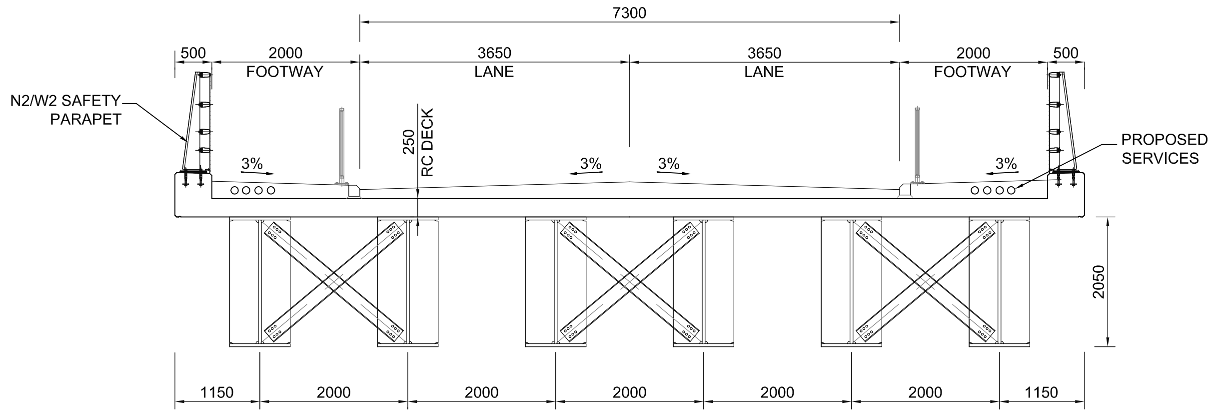
PLAN
Scale 1:200



SQUARE ELEVATION
Scale 1:100



SECTION A
Scale 1:50



SECTION B
Scale 1:50

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.

Lincolnshire Highway Alliance drawing created using base information supplied by external party detailed below:
Base Information Provided By:
Client Provided Drawing Number:

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH AIP REFERENCE 70036923-WSP-SBR-LEB_RWB-RP-S-0001

FOR THIRD PARTY USE, THIS DRAWING SHALL BE DEEMED CURRENT ONLY AT THE DATE OF APPROVAL. PLEASE CHECK FOR AMENDMENTS BEFORE USE

Revision:	Description: Amendment Details	Drawn By:	CAD By:	Approved By:	Approval 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

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

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

Certificate No. FS20705

738233-WSP	SBR	XX-DR	C-0012	Rev.A1
Scheme Reference	Job Ref.	DFT Series No.	Drawing No.	Revision.

Alternative Scheme Code: | Road No:

Parish: LINCOLN

Structure No: | SCN No: | Site Ref:

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