Structures Feasibility Report

Sturry Link

CO04300392/004 Revision 00

July 2017

Document Control Sheet

Project Name:	Sturry Link
Project Number:	CO04300392
Report Title:	Structures Feasibility Report
Report Number:	004

Issue Status/Amendment	Prepared	Reviewed	Approved
00 Draft	Name: [redacted] Signature: [redacted] Date: 19.06.2017	Name: [redacted] Signature: [redacted] Date: 10.07.2017.	Name: [redacted] Signature: [redacted] Date: 12/07/17
	Name: Signature: Date:	Name: Signature: Date:	Name: Signature: Date:
	Name: Signature: Date:	Name: Signature: Date:	Name: Signature: Date:
	Name: Signature: Date:	Name: Signature: Date:	Name: Signature: Date:

Executive Summary

Amey have been commissioned by Kent County Council (KCC) to develop the concept design of a new link road in the Borough of Canterbury, Kent, to link the A28 Sturry Road to the A291 Herne Bay Road. The scheme involves constructing a new link road spanning two arms of the Stour River and a railway line (see Figure 1) in order to serve the intended development scheme to the west of Sturry.

This report discusses feasibility options for the design and construction of the structures included in the proposed scheme. The options are to span the River Stour, the railway line and to reduce the impact on the flood plain where possible. The link road is to provide a single lane carriageway, multi-user foot/cycleway and addition bus lane if required.

This feasibility report considers four arrangement options for the structures, and concludes with a recommendation for a preferred option. The various factors affecting the choice of a preferred option are discussed, and are primarily the requirements of the design brief, the impact on existing watercourses, the impact on Network Rail (NR) infrastructure and the overall project cost.

Location Plan

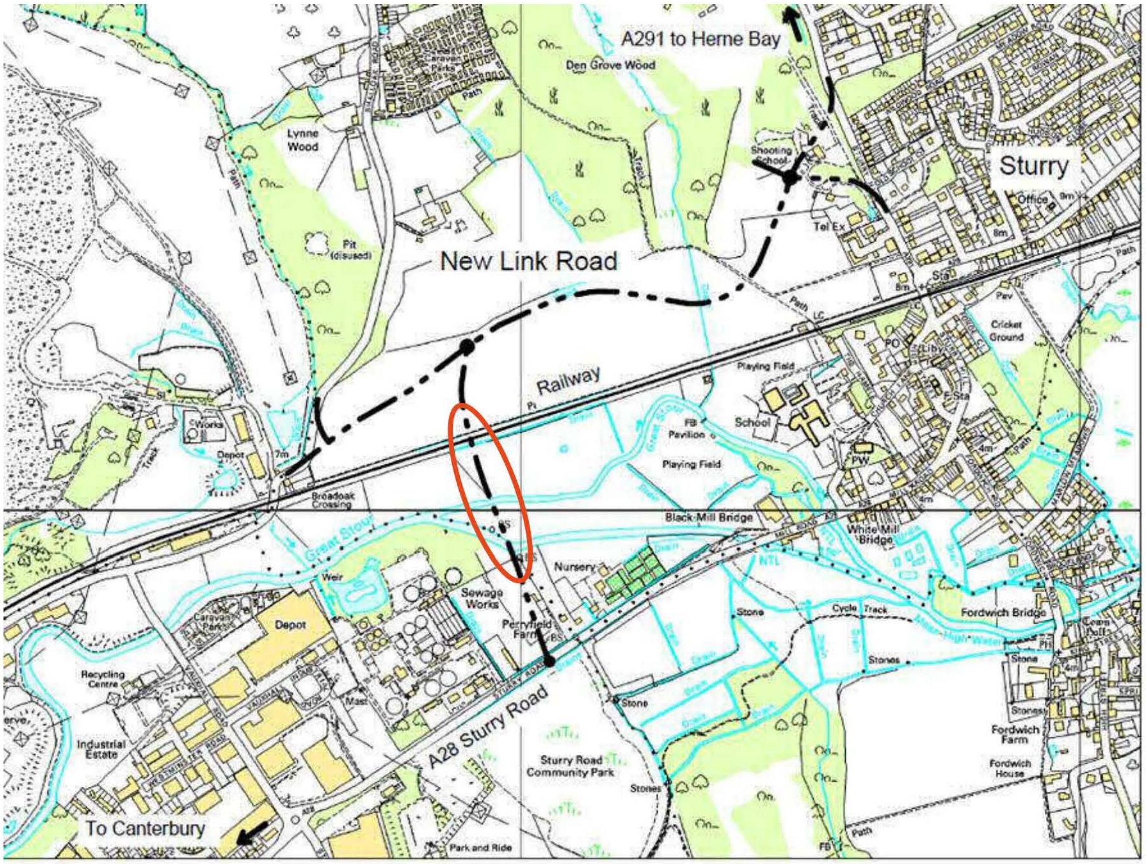


Figure 1 Location Plan (viaduct circled in red)

Not to scale.

Network Rail (NR) chainage: Mile 72+350yrds

Contents

1 Introduction

1.1 Client brief

Amey has been tasked by Kent County Council (KCC) to investigate and propose structure options to span the two arms of the Stour River and railway lines of the A28 to A291 Link Road in Sturry, Kent. This structures options report examines the possible options for new structures. The structures are discussed and illustrated, outlining various options considered.

1.2 Aims of the study

This feasibility study is to identify the viable link road arrangement for a detailed options study.

1.3 Background

The proposed structure location is centred on grid reference E616942 N160042, to the west of Sturry in Kent. The link road is to comprise single carriageway construction connecting the A291 Sturry Hill Road in the east to the A28 Sturry Road in the south. From the A291 the route follows a westerly route north of the railway line before heading southwards to span over the railway and across the Great Stour and its floodplain and connect to the A28 (see Figure 1).

2 Bridge Design Considerations

2.1 General Requirements

The feasibility options proposed in Section 3 of this report have been based on the requirements as set out by the Environmental Agency and Network Rail as described below.

2.1.1 Initial Meeting with Environmental Agency

In an initial meeting with the Environmental Agency, dated 8th July 2014, the following design requirements were raised:

Flood risk issues

- Bridge must maintain the continuity of the flood plain.
- Piling / columns are preferred.
- Bridge soffit needs to be above the 1 in 100 year + climate change flood level plus 600mm freeboard. Operational requirements will require greater height for maintenance access etc.
- Both branches are classified as main river and access for maintenance required for both but not necessarily to both banks of both arms.
- EA deploy a deflector where the river diverges with a restriction across the north channel, diverting weed along the south channel where it can be removed. Access to this junction needs to be maintained.
- EA has a gauging station near Vauxhall Road.
- The river is owned by riparian landowners.
- Flood modelling has recently been completed using the latest LIDAR data so no need for extensive surveys.
- Feasibility of improving defences at Fordwich modelled as part of this model.
- Flood defence and river management structures are in the model.
- With piling / columns the EA are less concerned about modelling the river with the bridge structure in place. With an embankment detailed modelling would be required. Ground conditions indicate that piling will be required and hence columns make sense.

- Two options a) calculate volume of columns and water displaced and provide equivalent compensatory flood storage elsewhere or b) re-run model with bridge structure in position and determine impact on flood depths and extents.
- Approximate flood cell extents are from Fordwich to Vauxhall Bridge. Flood compensatory storage would be required within the flood cell.
- No columns would be allowed within 8m of the bank or in the river channel itself.
- Realignment of the river would be OK from a flood risk perspective but no loss of channel would be allowed from a biodiversity perspective.
- The river channel could be realigned if the same or a greater length is created elsewhere. Could create a braided channel with links between the two main channels. The intermediate channels would flow under different flood conditions. Potential to create a wetland area under the bridge to compensate for loss of channel length.
- Movement of channel would be possible provided no loss of channel.
- EA maps do not show any EA landownership. Landownership is available from EA estates if required.

Ecology issues

- River is fished. Organised by the Canterbury and District Angling Association who have private agreements with landowners. Individuals obtain rod licences from the EA.
- Otters may come back to the river. With columns this is not an issue but with an embankment it could be.
- There is a desire to create a riverside walk from Fordwich to Canterbury.
- The river is a migratory route for sea trout, salmon and lamprey. Lighting over the road needs to be designed to minimise glare on the river. Bridge needs to cross river as close to 90° as possible. Potential for channel realignment to facilitate this.
- Canoeists use the river but there is no right of navigation.
- Nigel Holmes has produced a report outlining river enhancement works for this length of the Stour. EA to provide a copy of the report. Works confined to the river channel and include providing banks and deeper areas within the channel.

- Potential to remove old bridge by Vikings Garage as the river forms a very poor channel between the two bridges.

2.1.2 Network Rail Requirements

Consultation with Networks Rails South East Asset Protection Engineer highlighted the following design requirements:

- Location is ELR: ACR, 72m 0298yds. Line speed is 70mph.
- For vertical clearances requires a minimum of 5100mm from top of high rail to the underside of the bridge deck soffit.
- For horizontal clearances requires a minimum of 1624mm clearance laterally from nearest running edge.
- Careful consideration should be given to carrying out piling operations, particularly adjacent to the railway. Monitoring of the tracks may be required during construction to detect any indication of heave.
- Network Rail will require that sightlines are not impaired whilst all works are carried out

3 Bridge Design Options

The following arrangements of bridge structures have been considered in order to meet the requirements highlighted previously. For the purposes of feasibility, all of the structures within these options comprise a composite in-situ reinforced concrete deck supported on steel beams.

The basic design options are numbered accordingly:

Option 1	Multi-span viaduct
Option 2	3 span and single span
Option 3	3 single spans
Option 4	2 single spans with river diversion.

There are two variations of the carriageway layout. These are:

Option A	with bus lane
Option B	without bus lane

3.1 Option 1: Multi-span Viaduct

3.1.1 Description

Option 1 is a 6 span 253m long viaduct that spans both arms of the Great Stour River and the railway. The spans are 33.5 m (north end spans), 45.0 m (internal spans) and 39.5m (south end span).

Refer to drawing 4300392/SK/01 in Appendix A.

3.1.2 Benefits and Dis-benefits

Benefits

- No additional flood modelling assessment required at this stage
- Only embankment approaches to the viaduct required
- Reduced impact on Great Stour river compared to other options
- Columns preferred by EA
- Both arms of the main river unaffected
- Minimum land acquisition required
- No impact on potential otter return to river
- Semi integral construction (with bearings but no joints over bearing shelves)
- Minimal embankment construction within the flood plain, avoiding risk of excessive settlements over time.

Dis-benefits

- Longest structure (usually more expensive)
- Greatest number of foundations required within flood plain
- Piling operations required adjacent to railway
- Small potential for additional flood storage capacity requirements
- Viaduct is too long to allow fully integral construction

3.2 Option 2: 3 Span and Single Span

3.2.1 Description

Option 2 comprises a 33.5m single span integral bridge spanning the railway with a 3 span viaduct made up of a 45.0 m (north end span), 45.0 m (internal span) and 39.5m (south end span) spanning the two arms of the Great Stour River and 90.0m of embankment between. 3 culverts in the embankment shall be position at regular intervals to reduce damming effects of the embankments during times of high water due to flooding.

Refer to drawing 4300392/SK/02 in Appendix A.

3.2.2 Benefits and Dis-benefits

Benefits

- Reduced impact on flood storage reduction compared to other options due to 3 span viaduct
- Columns preferred by EA
- Both arms of the main river unaffected
- No impact on potential otter return to river
- Integral bridge over the railway minimizes maintenance and possession requirements

Dis-benefits

- Additional flood modelling assessment required
- Potential for the need of additional flood storage capacity requirements
- Two dis-similar bridge designs required
- Culverts required for flood alleviation
- Some land acquisition required
- Embankment construction on the soft alluvial deposits may result in excessive settlements over time.

3.3 Option 3: 3 Single Spans

3.3.1 Description

Option 3 comprises 3 single span bridges connected with embankments. The bridge spans are 33.5m spanning the railway, 38.5m spanning the north arm of the river and 39.5m spanning the south arm of the river. The 3 bridges are connected with a 90.0m and 51.5m embankment respectively. 3 No. culverts in the north embankment and 2 No. culverts in the south embankment shall be position at regular intervals to reduce damming effects on the embankments during times of high water due to flooding and allow EA access to the deflector where the river diverges for maintenance.

Refer to drawing 4300392/SK/03 in Appendix A.

3.3.2 Benefits and Dis-benefits

Benefits

- 3No. small integral bridges, all of similar design
- Integral bridges have reduced maintenance requirement when compared with longer structure

Dis-benefits

- Additional flood modelling assessment required
- Large potential for the need of additional flood storage capacity requirements
- Land acquisition required
- Large number of culverts required for flood alleviation
- Embankment construction on the soft alluvial deposits may result in excessive settlements over time.

3.4 Option 4: 2 Single Spans with River Diversion

3.4.1 Description

Option 4 offers a watercourse diversion of the north arm into the south arm of the Great Stour prior to the link road, then re-diverting the river to the two arms after. The link road comprises a 33.5m single span bridge spanning the railway and a 39.5m single span bridge spanning the remaining south arms of the Great Stour River with, 180.0m of embankment between. 5 No. culverts shall be position at regular intervals through the embankment to reduce damming effects on the embankments during times of high water due to flooding.

Refer to drawing 4300392/SK/04 in Appendix A.

3.4.2 Benefits and Dis-benefits

Benefits

- Minimum number of bridges (usually least expensive)
- Integral bridges have reduced maintenance requirement when compared with longer structure

Dis-benefits

- Significant additional flood modelling assessment required
- Greatest potential need of additional flood storage capacity requirements
- EA consent required for river diversion works
- Downstream channel design required to confirm no loss of channel from a biodiversity perspective
- Greatest land acquisition required
- Maximum number of culverts required for flood alleviation
- Embankment construction on the soft alluvial deposits may result in excessive settlements over time

4 Discussion

4.1 Estimated Project Costs

A detailed breakdown of the estimated cost is given in Appendix B.

The estimated project costs for the bridge options with bus lane are shown in Table 1 and bridge options without bus lane are shown in Table 2.

Table 1 Comparable Cost estimates for options with bus lane

	Estimated Project Costs
Option 1A Multi-span viaduct option	£28,336,527
Option 2A 2 bridge option	£29,362,253
Option 3A 3 single span bridges option	£30,744,376
Option 4A 2 single span bridges with river diversion option	£29,468,570

Table 2 Comparable Cost estimates for options without bus lane

	Estimated Project Costs
Option 1B Multi-span viaduct option	£26,061,339
Option 2B 2 bridge option	£27,427,280
Option 3B 3 single span bridges option	£29,170,882
Option 4B 2 single span bridges with river diversion option	£27,916,339

The estimated project costs show the viaduct to be the most cost effective option, although having the highest piling, concrete and steelwork cost.

Options 2, 3 and 4 have significant cost increases for the earthworks and culverts. This is due to the slope stability assumption that a 1:2.5 slope is required to allow for the load to spread on the soft alluvium with a maximum embankment height of approximately 9m. Any additional ground preparation which may be required to limit excessive consolidation of the alluvial deposits beneath the embankments in the flood plain is not included in the above costs.

5 Conclusions and Recommendations

Provided all matters regarding the preservation of the environment and ecology, as well as the requirements of Network Rail are met, the choice of crossing the flood plain and the railway will primarily be determined by cost.

Aesthetically it can be argued that a single multi-span viaduct is less visually intrusive than a series of smaller structures linked by embankment.

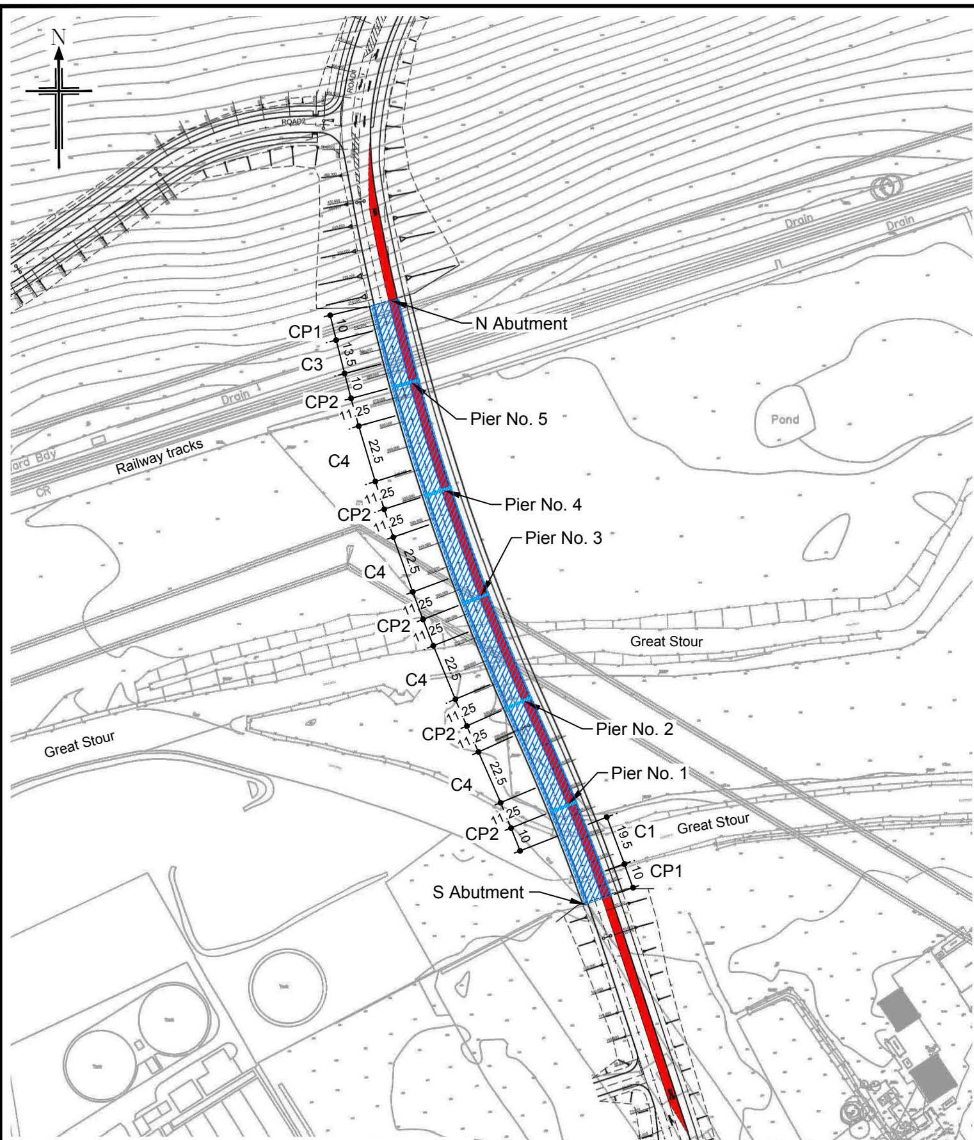
Single span structures can be fully-integral, which minimizes future maintenance owing to the absence of any bearings. However, the multi-span viaduct can be designed as semi-integral, having bearings but without joint above. This form of construction has proved very favourable, still reducing the likely maintenance associated with corroding bearings since leaking joints are eliminated.

In principle, the greater the amount of embankment required within the flood plain, the greater the environmental impact to the existing ecology and the greater the amount of compensatory storage that must be found elsewhere, which may itself displace current species.

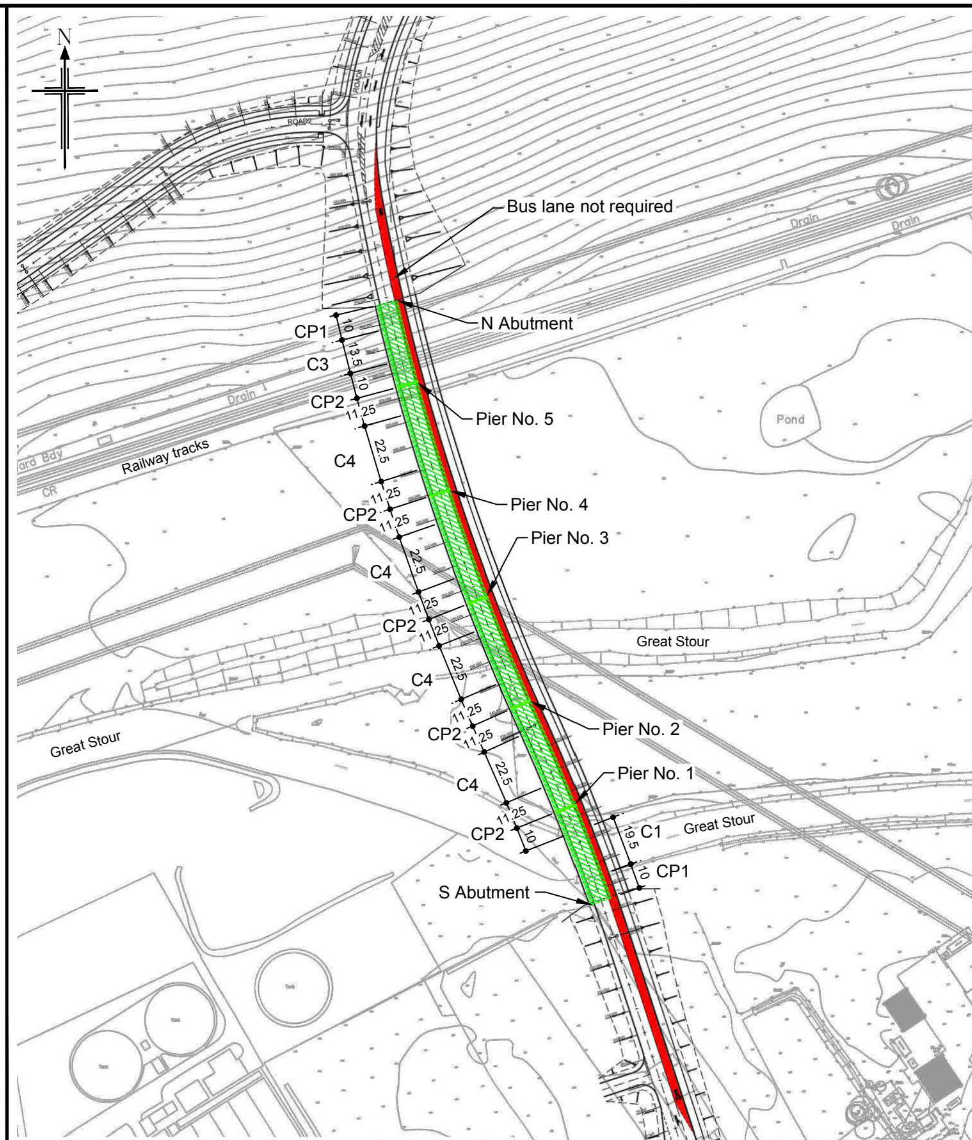
Unless adequate time is available for pre-loading the embankments on the soft alluvial deposits within the floodplain, it may prove difficult to ensure consolidation settlements remain within acceptable limits over time. Additional load can be reduced by use of lightweight fill, but care is needed that it is not jeopardized in time of flood. Any additional ground preparation, for example drainage blanket and wick drains, would incur additional costs, which are not included in this exercise.

Due to the benefits and cost it is recommended that a multi-span viaduct option be designed for the new link road. The viaduct shall reduce the impact on the flood plain, reduce stability issues in the weak alluvium soils and has the least overall project cost compared to the other options.

Appendix A Structures Options Drawings



PLAN OF OPTION 1A WITH BUS LANE



PLAN OF OPTION 1B WITHOUT BUS LANE

Rev	Revision details	Chkd	Appd	Date

Notes

amey
www.amey.co.uk

Client
Kent County Council
kent.gov.uk

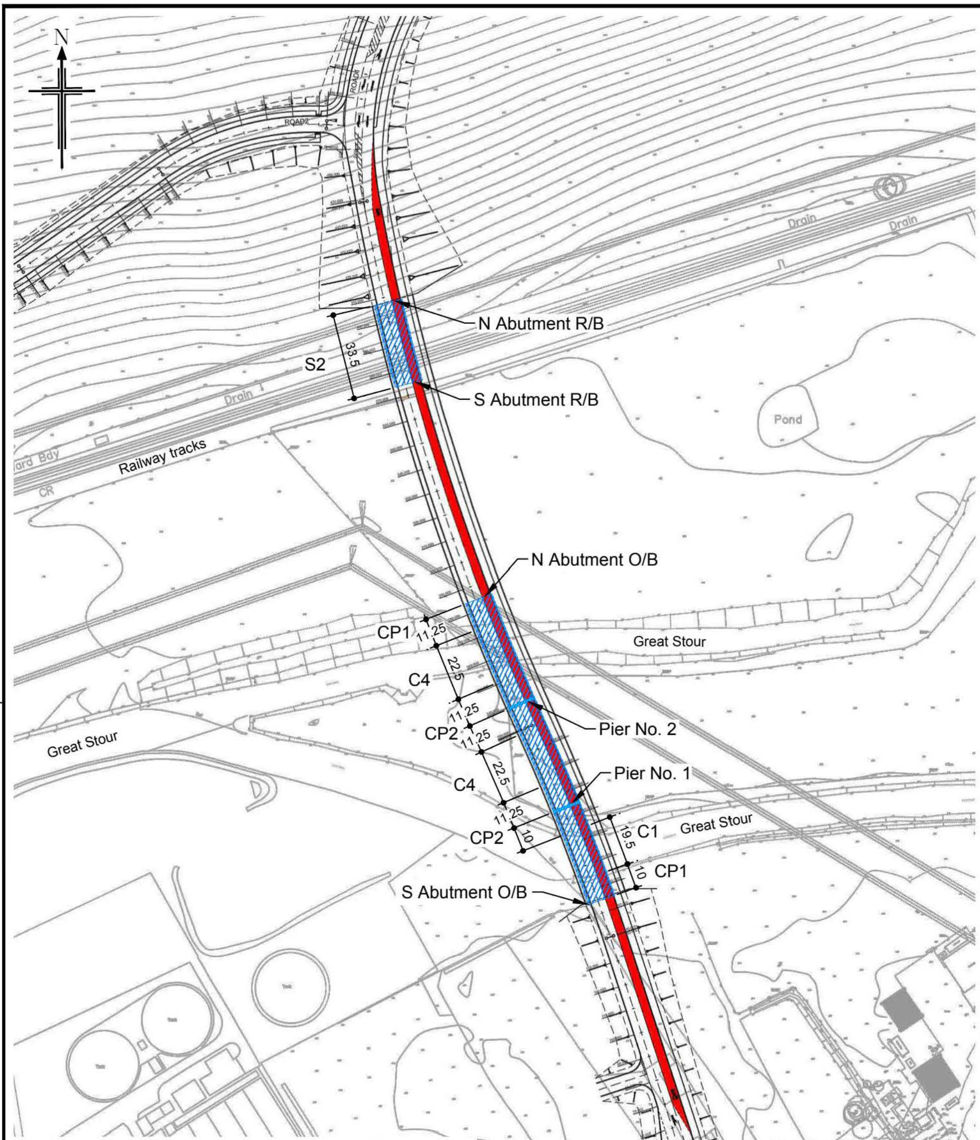
Project Name
A28 STURRY LINK ROAD

Drawing Title
PLAN SHOWING OPTION 1A AND 1B

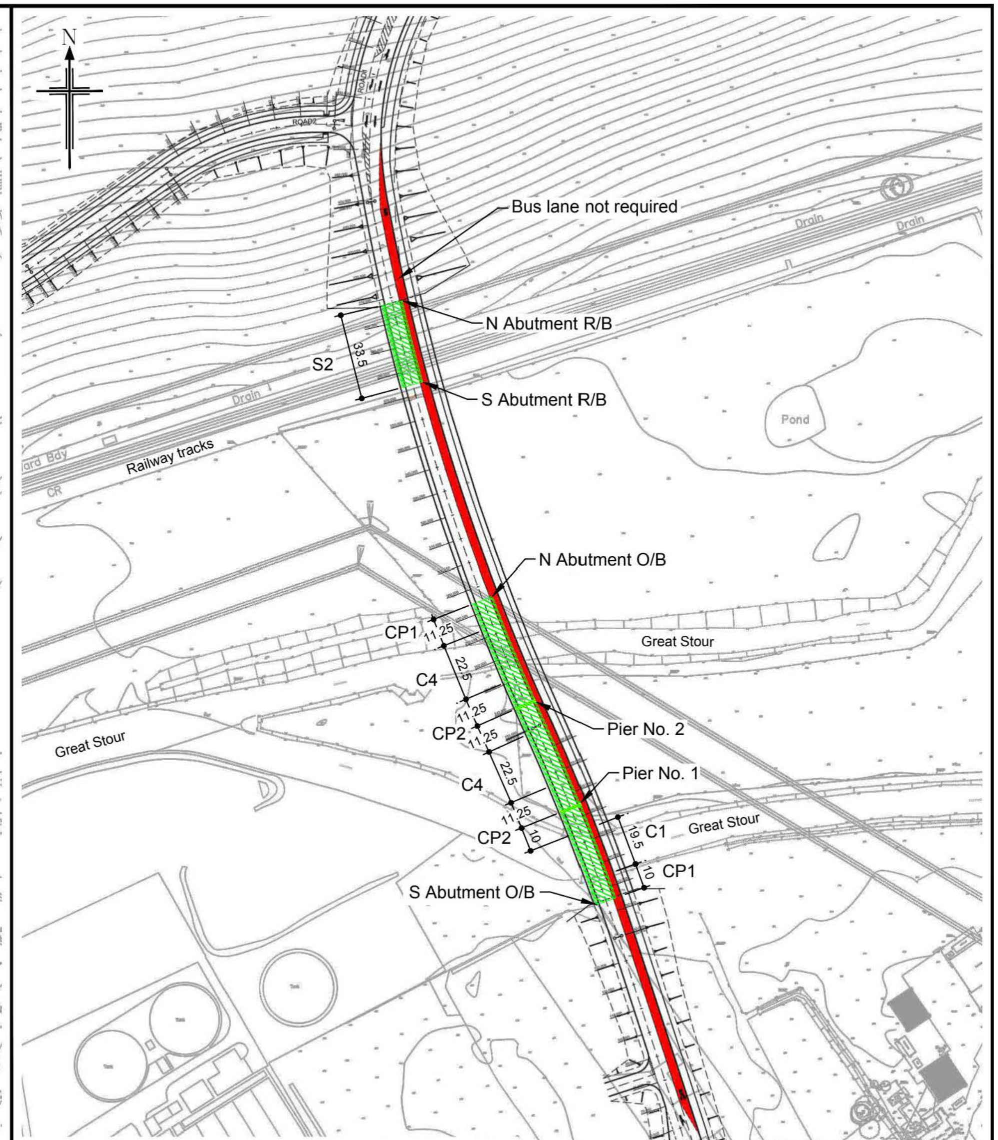
Drawn:	AJM	Preliminary	
Design:	-----	For Comment	
Chkd:		For Tender	
Appd:	-----	For Construction	
Date:	JAN 2016	As Constructed Record	
Project Nº:	CO04300392	For Information Only	✓

Original Drg Size : A3
Dimensions : m
Scale : 1:2000
Copyright © Amey
Drawing No
CO04300392/SK/01
Rev
P0

File ref - p:\d - projects\co04300392 - a28 sturry link rd\102.drawings\01. working\1700 structures\scheme drawings.dwg



PLAN OF OPTION 2A WITH BUS LANE



PLAN OF OPTION 2B WITHOUT BUS LANE

Rev	Revision details	Chkd	Appd	Date

Notes

amey

www.amey.co.uk

Client: Kent County Council kent.gov.uk

Project Name: A28 STURRY LINK ROAD

Drawn:	AJM	Preliminary	
Design:	-----	For Comment	
Chkd:		For Tender	
Appd:	-----	For Construction	
Date:	JAN 2016	As Constructed Record	
Project №:	CO04300392	For Information Only	✓

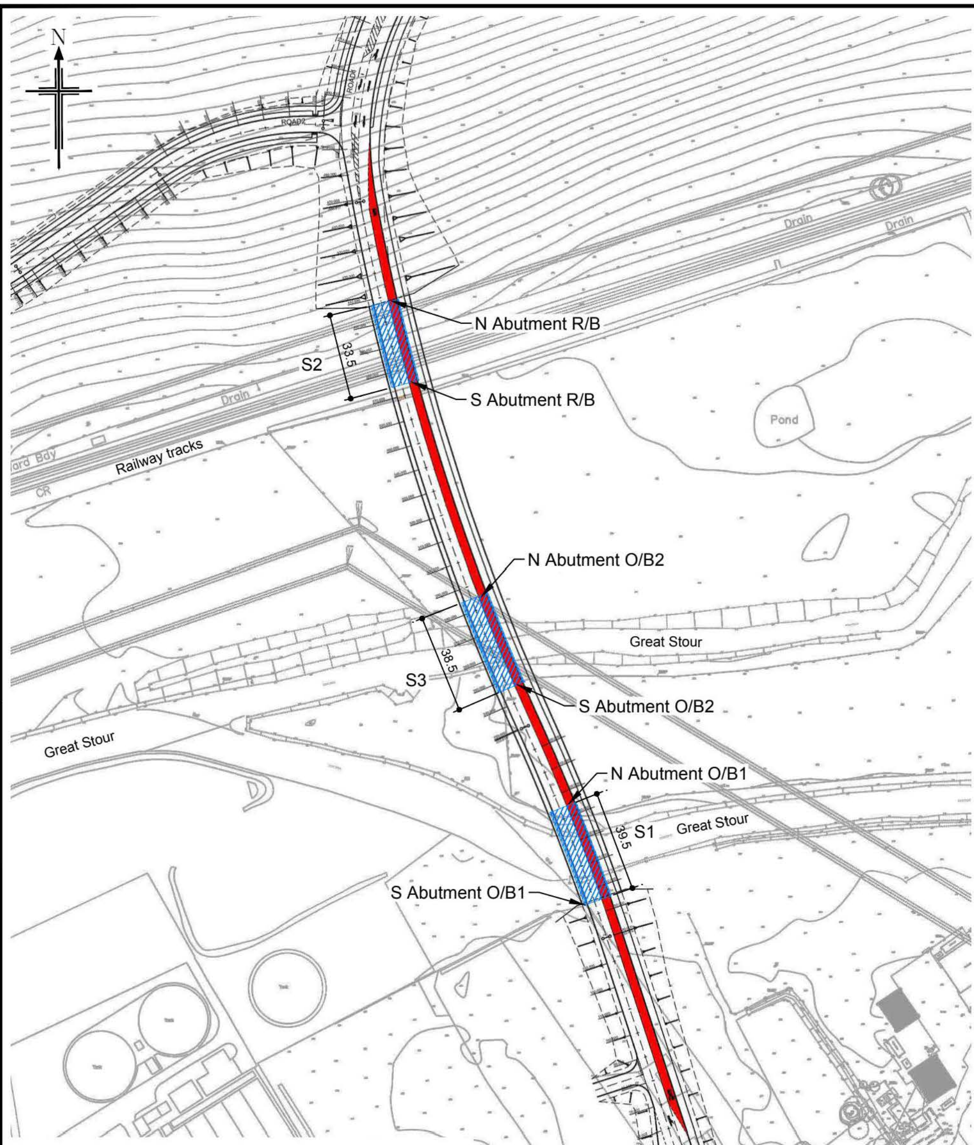
Drawing Title: PLAN SHOWING OPTION 2A AND 2B

Original Drg Size : A3	Dimensions : m
Scale : 1:2000	Copyright © Amey

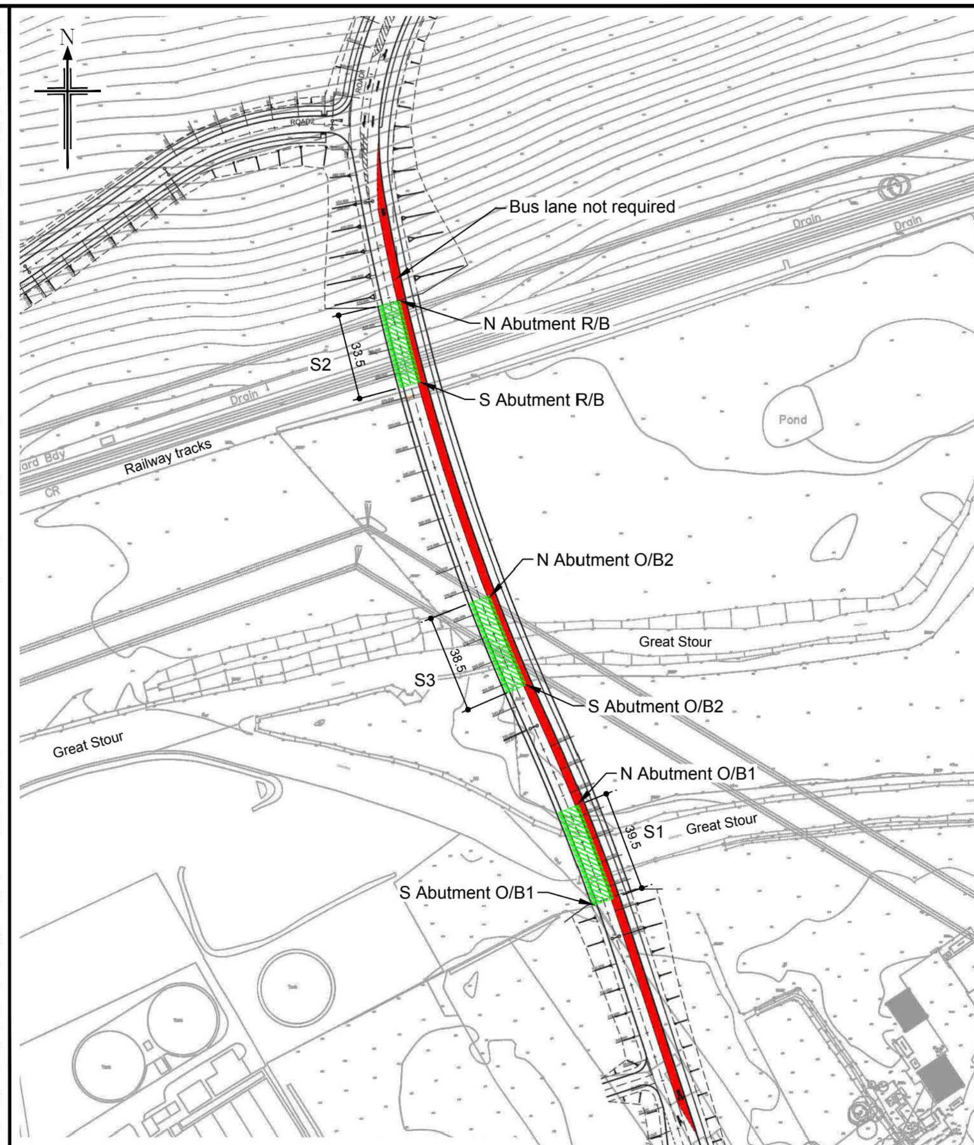
Drawing No: CO04300392/SK/02

Rev: P0

File ref - p:\d - projects\co04300392 - a28 sturry link rd\102.drawings\01. working\1700 structures\scheme drawings.dwg



PLAN OF OPTION 3A WITH BUS LANE



PLAN OF OPTION 3B WITHOUT BUS LANE

Rev	Revision details	Chkd	Appd	Date

Notes

amey
www.amey.co.uk

Client: Kent County Council kent.gov.uk

Project Name: A28 STURRY LINK ROAD

Drawing Title: PLAN SHOWING OPTION 3A AND 3B

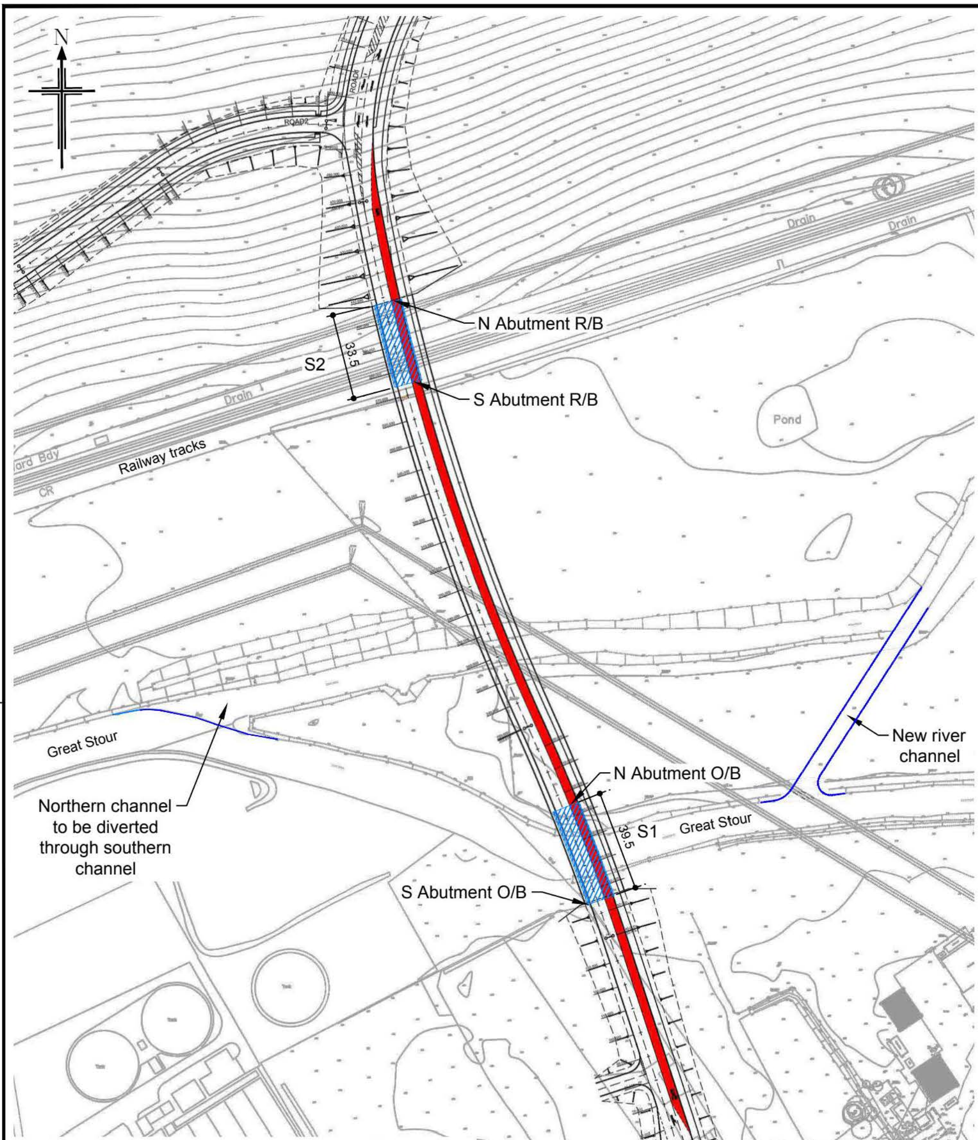
Drawn:	AJM	Preliminary	
Design:	-----	For Comment	
Chkd:		For Tender	
Appd:	-----	For Construction	
Date:	JAN 2016	As Constructed Record	
Project №:	CO04300392	For Information Only	✓

Original Drg Size : A3 | Dimensions : m

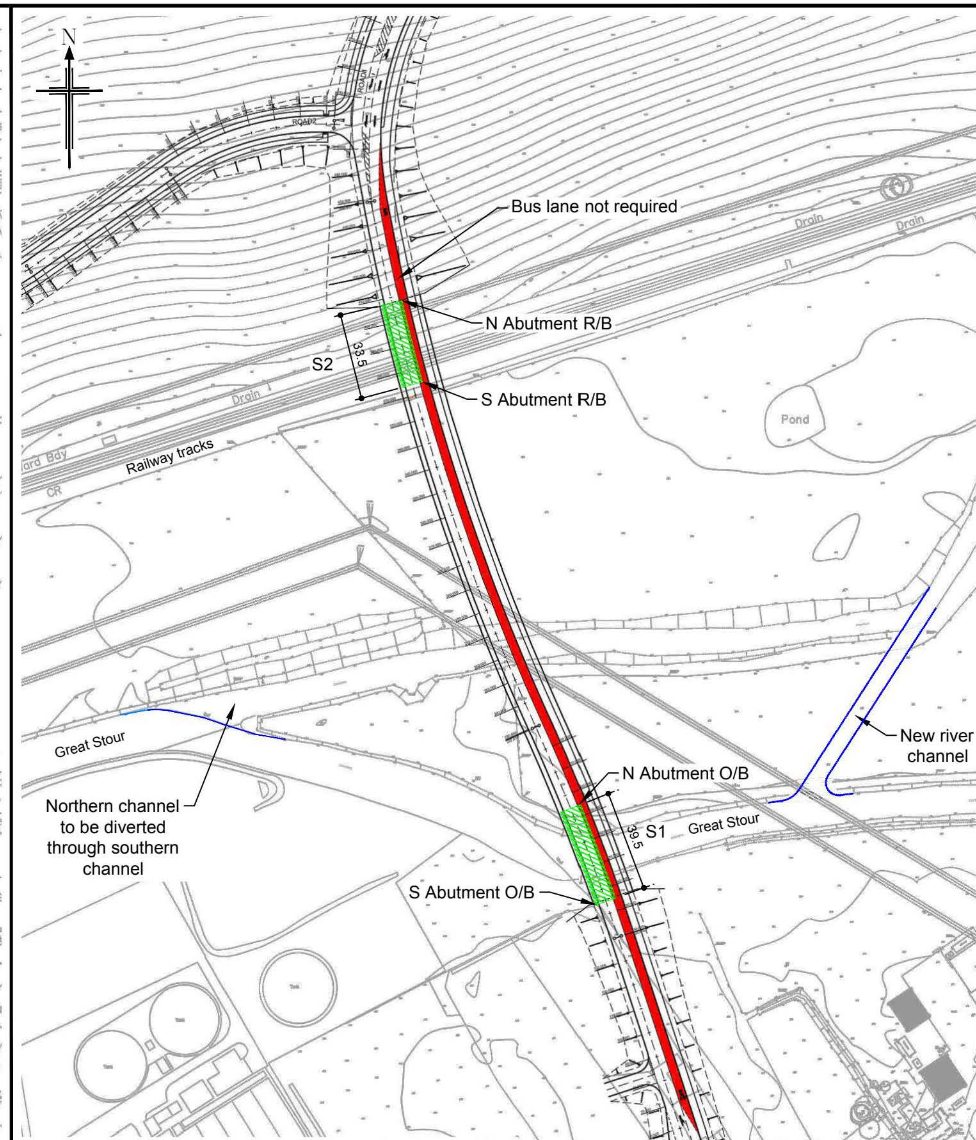
Scale : 1:2000 | Copyright © Amey

Drawing No: CO04300392/SK/03 | Rev: P0

File ref - p:\d - projects\co04300392 - a28 sturry link rd\102.drawings\01. working\1700 structures\scheme drawings.dwg



PLAN OF OPTION 4A WITH BUS LANE



PLAN OF OPTION 4B WITHOUT BUS LANE

Rev	Revision details	Chkd	Appd	Date

Notes

amey
www.amey.co.uk

Client: Kent County Council kent.gov.uk

Project Name: A28 STURRY LINK ROAD

Drawing Title: PLAN SHOWING OPTION 4A AND 4B

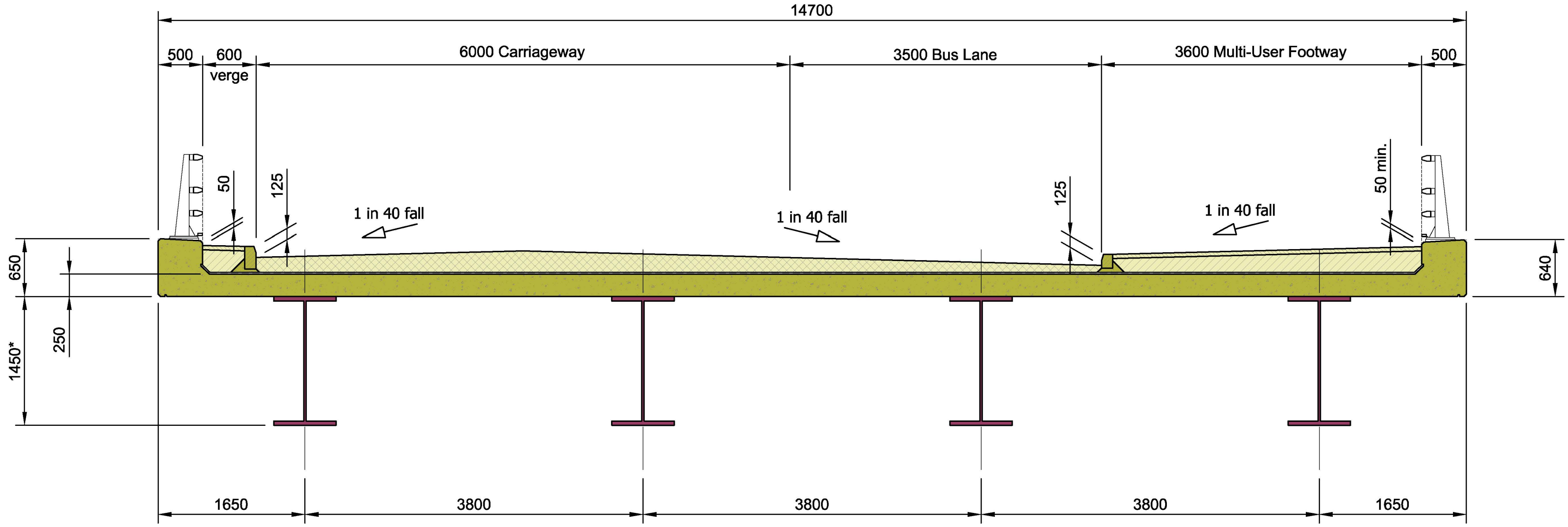
Drawn:	AJM	Preliminary	
Design:	-----	For Comment	
Chkd:		For Tender	
Appd:	-----	For Construction	
Date:	JAN 2016	As Constructed Record	
Project Nº:	CO04300392	For Information Only	✓

Original Drg Size : A3
Dimensions : m
Scale : 1:2000
Copyright © Amey
Drawing No: CO04300392/SK/04
Rev: P0

File ref - p:\d - projects\co04300392 - a28 sturry link rd\102.drawings\01. working\1700 structures\scheme drawings.dwg

TABLE 1 - GIRDER ELEMENTS

SECTION CODE	SPAN (m)	TYPE OF SPAN	SECTION DEPTH (mm)	FLANGE WIDTH (mm)	TOP FLANGE DEPTH (mm)	BOT FLANGE DEPTH (mm)	WEB WIDTH (mm)
C1	19.5	CONTINUOUS - END	1450	700	30	50	15
C3	13.5	CONTINUOUS - END	1450	700	22.5	45	12.5
CP1	10 OR 11.25	CONTINUOUS - END	1450	700	35	70	22.5
CP2	21.25 OR 22.5	CONTINUOUS - INT.	1450	700	35	70	22.5
C4	22.5	CONTINUOUS - INT.	1450	700	25	45	12.5
S1	39.5	SIMPLY SUPPORTED	1320	700	50	80	20
S2	33.5	SIMPLY SUPPORTED	1120	700	40	70	15
S3	38.5	SIMPLY SUPPORTED	1320	700	50	80	20



* Depth of girder shown is for continuous spans only.
Refer to Table1 - Girder Elements for depth for simply supported spans and additional girder details.

TYPICAL CROSS SECTION

Scale 1:50

Rev	Revision details	Chkd	Appd	Date

Notes
1. All dimensions in millimetres unless stated otherwise.

amey www.amey.co.uk

Client: Kent County Council kent.gov.uk

Project Name: A28 STURRY LINK ROAD

Drawn:	AJM	Preliminary	
Design:	-----	For Comment	
Chkd:		For Tender	
Appd:	-----	For Construction	
Date:	JAN 2016	As Constructed Record	
Project Nº:	CO04300392	For Information Only	✓

Drawing Title: TYPICAL CROSS SECTION OF BRIDGE DECK OPTIONS 1A, 2A, 3A & 4A (WITH BUS LANE)

Original Drg Size : A3 | Dimensions : mm
Scale : NOT TO SCALE |

Drawing No: CO04300392/SK/05 | Rev: P0

File ref - p:\d - projects\co04300392 - a28 sturry link rd\102.drawings\01. working\1700 structures\scheme drawings.dwg