highways england

Lower Thames Crossing

Pre-Consultation Scheme Assessment Report

Volume 4: Engineering, Safety and Cost Appraisal

Section 12: Appendices

Volume 4

Lower Thames Crossing
Route Consultation 2016

Contents

Appendix 4.1
Key Departures

Route 1 Key Departures
Route 2, 3 and 4 Key Departures

Halcrow Hyder

Highways Short listed Route 1
'Draft' Key Departure List

Departure No.	Route Option	Sketch Ref:	Departure Description	Location	Reason	Solutions
1	A1/A4	Junction 1a	Successive merge and diverge. Required distance needs to be 3.75 x design speed (TD22/06 Paragraph 4.30). Required is 318.75m (85kph design speed), actual achieved is 270m.	**A282** Master string Ch+3730.000 Junction 1a Northbound Merge	Proximity of the two junctions, not practicable to move this slip road elsewhere due to other slip roads and property constraints.	This could be designed out by relocating either Bridge / Tunnel diverge nose or jct 1a merge nose 50m further south or north respectively
2	A1/A4	Junction 1a	Geometric design parameters (TD22/06 Paragraph 4.30) for merging lanes Note 2 : Ghost island merges on urban roads are not permitted.	**A282** Master string Ch+3730.000 Junction 1a Northbound Merge	Ghost island is not permitted in an urban scenario therefore a Type D merge is recommended in accordance with Figure 2/3 AP All-Purpose Road Merging Diagram.	Provisional V1 traffic figures indicate that a Type F merge is required in accordance with Figure 2/3 AP All-Purpose Road Merging Diagram.
3	A1/A4	Junction 30/31	Departure from TD22/06 Figure 2/5 AP All-Purpose Road Diverging Diagram	**A282** Master string Ch+7290.000 Junction 31 Northbound Diverge	Provisional V1 traffic figures indicate that a Type E diverge is required in accordance with Figure 2/5 AP All-Purpose Road Diverging Diagram.	To allow for future traffic growth and possible results from V2 traffic figures it has been proposed that 3 lanes continue through to the A282 to make 5 lanes merging with the NB tunnel. Therefore only a single lane drop will be proposed instead of two lanes dropped.
4	A1/A4	Junction 30/31	Departure from TD22/06 &TD39/94 Figure 2/3 AP All-Purpose Road Merging Diagram. 3 lane bridge merging with 2 lane tunnel: Type E used with min 1000m Radii on the nearside channel.	**A282** Master string Ch+7610.000 Northbound Bridge and Tunnel Merge	There is no guidance on a merge type for a mainline to mainline merge with equal traffic flows and equal design speeds hierarchy.	Guidance required for mainline to mainline merge
5	A1/A4	Junction 30/31	Weaving Length, merge to diverge potentially less than desirable minimum for urban all-purpose roads (TD22/06 Paragraph 4.36). Actual weaving length is 470m.	**A282** Master string Ch+7610-8080 Northbound Bridge & Tunnel Merge to A13 diverge	Proximity of the A282 merge with the A13 diverge.	Absolute minimum urban AP weaving length in accordance with Figure 4/14 is circa 250m.
6	A1/A4	Junction 30/31	Departure from TD22/06 &TD39/94 Figure 2/3 AP All-Purpose Road Merging Diagram. 3 lane bridge merging with 2 lane tunnel: Type E used with min 1000m Radii on the nearside channel. Used	**A282** Master string Ch+7610.000 Southbound Bridge and Tunnel Merge	There is no guidance on a merge type for a mainline to mainline merge with equal traffic flows and equal design speeds hierarchy.	Guidance required for mainline to mainline merge
7	A1/A4	Junction 30/31	Geometric design parameters (TD22/06 Paragraph 4.30) for merging lanes Note 2 : Ghost island merges on urban roads are not permitted.	**A282** Master string Ch+7420.000 Southbound Junction 30 to A282 Interchange Link	It is recommended that the use of Type A / B merge is not permitted for interchange links, therefore a Type D is required.	To allow for future traffic growth and possible results from V2 traffic figures it has been proposed that a Type F lane gain arrangement is used
8	A1/A4	Junction 1a	Weaving Length, merge to diverge potentially less than desirable minimum for urban all-purpose roads (TD22/06 Paragraph 4.36). Actual weaving length is 250m.	**A282** Master string Ch+7420.000 Southbound Interchange Link merge to QE II bridge diverge	Proximity of the interchange link merge with the QE II diverge.	Absolute minimum urban AP weaving length in accordance with Figure 4/14 is circa 250m.
9	A1/A4	Junction 1a	Geometric design parameters (TD22/06 Paragraph 4.30) for merging lanes Note 2 : Ghost island merges on urban roads are not permitted.	**A282** Master string Ch+8280.000 Southbound A13 to A282 Connector road	It is recommended that the use of Type D merge is required in accordance with Figure 2/3 AP All-Purpose Road Merging Diagram.	To allow for future traffic growth and possible results from V2 traffic figures it has been proposed that a Type F lane gain arrangement is used
10	A1/A4	Junction 1b/1a	We are currently using IAN 161 as the design basis for smart motorways. Section 1.5 of this document however states that it is only applicable to motorways up to 4 lanes, and that guidance should be sought from the Highways England Project Manager in other circumstances. Since the A282 is not a motorway, and 5 lanes are planned in places, further guidance regarding which standards to use would be appropriate.	**A282** Junction 1a to junction 1b	Standard only applies to motorways of up to 4 lanes and we have 5 lanes (plus the A282 isn't technically a motorway)	Note that if IAN 161 is confirmed as applicable to All-Purpose highway at this location, this potential Departure will be devolved to a Relaxation.
11	A1/A4	Junction 1b/1a	It may not be possible to fit in ERA's between J2-1a on either carriageway. These should be provided every 2.5km within a scheme according to IAN 161.	**A282** Junction 1a to junction 1b	There is no physical space without additional land take.	Distances between junctions are very short, meaning slip roads could be taken in an emergency. Costs of removing retaining walls and acquiring additional land from adjacent housing would be high.
12	A1/A4	Junction 1b/1a	Due to the 5 lane width, gantry-mounted AMI's are likely to be used rather than an MS4 in the verge.	**A282** Junction 1a to junction 1b	Visibility of MS4's would not be good from the fifth lane	This approach has been taken on other schemes where 5 lane sections have occurred.
12a	A1/A4	Junction 1a-2	There are 2 very short links on this section that do not have the verge width to use the current HADECS 3 technology, thus they would require a departure either to enforce with the previous HADECS 2 system, or, due to the shortness of the links, not to enforce at all.	**A282** Junction 1a to junction 2	Lack of verge width for HADECS 3 installation.	Use HADECS 2 or, given the short length of road involved and the fact it is already a permanent 50mph limit, do not enforce this section.
13	A1/A4	Junction 30/31	Potential departure from TD22/06 for Weaving length between successive merge and diverge.	**Junction 30** Westbound A13 On slip from A126, to Westbound A13 off slip to J30,	Downstream connector road geometry and Interchange Link Fork for free-flow southbound A282 traffic movement requires a revised point of intercept with the A13 mainline, east of the 2 lane-drop design for the A13 Congestion Relief scheme, which is to be closed up under the LTC scheme. Consequently, the available weaving length, Act, is reduced to 340m. If "Rural" status is held by the A13 corridor, Act is below the 1 km length stipulated by TD22/06 cl 4.36. If "urban" status is held, this may be below the minimum calculated weave length requirement (as yet unknown).	If "Urban" status is inferred to the A13 by the application of a plated speed limit (50mph), Act is greater than the Absolute Minimum Urban AP weave length of 245m. On receipt of revised turn-movement traffic figures, a further calculation to cl 4.37 will be required to demonstrate compliance with, or departure from, urban weave criteria, or to assess the degree of departure from "rural".

Departure No.	Route Option	Sketch Ref:	Departure Description	Location	Reason	Solutions
14	A1/A4	Junction 30/31	Potential Departure from TD22/06 cl 3.4, Table 3/1a for Cross-Sections for Connector Roads, to/from Mainline All-Purpose Roads	**Junction 30** A282 Northbound to A13 Westbound on-slip connector road.	Currently available traffic figures indicate a required single-lane+ Hard shoulder cross-section of IL1C or IL1D (Rural/Urban). The proposed layout provides for 2 lanes to IL2C or IL2D as an over-provision.	The indicated 2 lane cross section is provided in advance of revised traffic demand figure which are anticipated to be higher than currently available data. Until such times as revised traffic figures are available, and until agreement on Urban/Rural status is agreed, this item is considered to be a *Potential* departure, only.
15	A1/A4	Junction 30/31	Potential Departure from TD22/06 2.29 for Merge form.	**Junction 30** A13 Westbound on-slip	Indicated Merge type C/D(urban) shown in advance of determination of connector road urban/rural status, in the absence of traffic data.	To be reassessed on receipt of updated traffic data. Note that if IAN 161 is confirmed as applicable to All-Purpose highway at this location, this potential Departure will be devolved to a Relaxation.
16	A1/A4	Junction 30/31	Departure from TD22/06 cl 2.34 for provision of straight or near straight to back of nose.	**Junction 30** A13 Westbound on-slip	Merge occurs on the outside of an approx. 720m radius curve. Preceding connector road geometry and Interchange Forks and proximity with side road overbridge precludes provision of straight or near straight at the back of nose. The incipient curvatures of the merge nosing have been carried-though and transitioned off a straight in advance of the back of nose.	The near-parallel alignment of the connector, compared to the mainline, gives an extended opportunity to assess mainline traffic speeds. Note that the mainline will be limited to 50 (max) mph in free-flow configuration, therefore, speed-matching will be more easily achieved. Further design iterations, at the expense of increase land take and higher structure costs, may render this departure nul.
17	A1/A4	Junction 30/31	Departure from TD22/06 cl 2.34 for provision of straight or near straight to back of nose.	**Junction 30** A13 Eastbound on-slip	Connector road geometry preceding the point of merge is constrained by proximity with an existing half-dumbbell junction, new railway under bridge and by a side road overpass immediately following the point of merge. Horizontal radius approaching the back of nose is greater than desirable minimum of 510m with full transition provision.	The intended merge type provides a lane gain which provides considerable opportunity for lane 1 gap determination, speed matching and lane-changing maneuvers. The alignment and gradient of the connector road immediately prior to the nose will not negatively impact upon speed-matching opportunities for the merging lane 2. Visibility will not be impeded by mainline curvature. Further design iterations, at the expense of increase land take and higher structure costs, may render this departure nul.
18	A1/A4	Junction 1a	Departure from TD22/06 cl 2.43 for provision of layout differs from that derived from the use of Figure 2/5 AP.	**Junction 1A** J1A Southbound Diverge - A282 Southbound after Queen Elizabeth II Bridge	From use of Figure 2/5AP, recommended layouts are either Type D or Type E (2 lane drop). The proposed use of Type D layout will provide a single lane drop from 4 lanes of existing QEII bridge which is more appropriate than providing 2 lane drop as vehicles on QEII bridge on nearside Lane 01 (especially HGVs) will have to weave across 2 lanes if these are not using Junction 1A and this is anticipated on steep downgrade approach of bridge. Also this layout will produce high capacity on through lanes. It is also proposed to use Type D Option 2 Not preferred (auxiliary lane) layout to minimise extent of proposed works to QEII bridge approach (in case if Type D standard layout with ghost island is used).	To be reassessed on receipt of updated traffic data. Note that if IAN 161 is confirmed as applicable to All-Purpose highway at this location, this potential Departure will be devolved to a Relaxation.
19	A1/A4	Junction 1a	Departure from TD22/06 cl 4.30 for substandard spacing between tips of noses of successive diverge and merge	**Junction 1A** J1A Southbound Diverge - A282 Southbound after Queen Elizabeth II Bridge	It is recommended to use minimum spacing of 3.75V (318.75m in proposed 85kph design speed) as per clause 4.30 TD 22/06.	Due to space restrictions and to minimise works required to existing QEII bridge, it is proposed to use 130m spacing between tips of noses. This proposal least onerous than other option which is to move tip of nose between 3 lanes from QEII bridge and 2 lanes from existing tunnel
20	A1/A4	Junction 1a	Departure from Standards is required from clause 4.9 TD22/06 for substandard horizontal curvature provided for a loop	**Junction 1A** J1A diverge loop from A282 mainline southbound	It is recommended to use minimum horizontal curvature of 50m as per Table 4/2 All-purpose but due to space constraints it is proposed to use 38m horizontal radius.	Due to space restrictions, between A282 mainline and merge slip road originates from east roundabout of Junction 1A, it is not possible to use recommended 50m radius. Sufficient carriageway width is provided to cater for large vehicle's swept paths.
21	A1/A4	Junction 1b/1a	Type F Rural 100kph merge	**Junction 1B** J1B NB Merge	The route has an urban classification, precluding the use of a ghost island merge, but the merging traffic flow indicates a ghost island merge is required	Guidance to be sought from HE regarding application of IAN 161 and whether a shorter ghost island merge is applicable
22	A1/A4	Junction 1a/1b	Narrow hard strip	**A282** J1B to 1A	Hard strip to be reduced to 600mm where space is at a premium	It is intended that this section of road is managed Trunk road so the lack of a full hard strip will be less dangerous. 600mm is the minimum set back required to a VRS. Existing situation appears to be less than 1m so departures may already be in force
23	A1/A4	Junction 1a	Type C Rural 100kph merge	**Junction 1A** J1A SB Merge	The route has an urban classification, precluding the use of a ghost island merge, but the merging traffic flow indicates a ghost island merge is required	Guidance to be sought from HE regarding application of IAN 161 and whether a shorter ghost island merge is applicable
24	A1/A4	Junction 1b/1a	Narrow Lanes	**Junction 1B** J1B to 1A	Narrow running lanes may be required to avoid land take and extensive demolition and rebuilding of structures	It is intended that this section of road is managed Trunk road so narrow lanes will be less dangerous.
25	A1/A4	Junction 1b/1a	Relaxations in SSD	**A282** J1B to 1A	The existing available cross section may not be enough to develop full SSD in all locations.	Guidance to be sought from HE regarding application of IAN 161 and whether combinations of relaxations are allowable
26	A1/A4	Junction 1b/1a	Sub standard weaving lengths	**A282** J1B to 1A	Existing junction locations are fixed	Awaiting latest traffic figures. Existing situation so departures may be in place
27	A1/A4	Junction 1b/1a	Possible sub standard super elevation	**A282** J1B to 1A	Existing structures such as Bow Lane Rail Bridge NB	Accurate Topographical survey required

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Highways Short Listed Route 2, 3 and 4
'Draft' Key Departures List

Departure No.	Route Option	Departure Description	Location	Reason	Solutions
1	2	Weaving Length, merge to diverge less than desirable minimum of 2km for rural motorways (TD22/06 Paragraph 4.35). Actual weaving length is approximately 1.8km.	**M25 northbound** Between LTC northbound on slip road and M25 diverge for Junction 29	LTC northbound slip road merge is 1.8km south of Junction 29 diverge. M25 northbound has a downhill gradient of approximately 2% which increases the length of the slip road which is also coming down towards the M25.	Potential to decrease radius on slip road as it crosses the M25 to 2 steps below which could provide the required additional 200m.
2	2	Successive diverges. Required distance needs to be 3.75 x design speed (TD22/06 Paragraph 4.30). Required on A13 is 450m (120kph design speed), actual achieved is 210m.	**A13 eastbound** Diverge from A13 to LTC northbound to existing diverge A1089 southbound.	Proximity of the two diverges. Both slip roads required for free flow junction.	Possible to combine slip road diverge, or move A13 to LTC northbound further west. Review of traffic figures and movement on A13 to LTC northbound is low, decision needed on if this link is required.
3	2	Successive merges. Required distance needs to be 3.75 x design speed (TD22/06 Paragraph 4.30). Required on interchange link is 320m (85kph design speed), actual achieved is 100m.	**A13** Slip road from LTC northbound to A13 westbound and slip from LTC southbound to A13 westbound	Insufficient space to separate these links and merge onto the A13 without additional property take.	Review of traffic data indicates slip road from LTC southbound to A13 westbound has minimal traffic so decision needed as to weather this link is required.
4	2	Successive diverges. Required distance needs to be 3.75 x design speed (TD22/06 Paragraph 4.30). Required on A13 is 450m (120kph design speed), actual achieved is 162m.	**A13 westbound** Diverge from A13 to LTC northbound to existing diverge A1089 southbound.	Proximity of the two diverges. Both slip roads required for free flow junction.	Possibility to combine slip road diverges.
5	2	Weaving Length, merge to diverge less than desirable minimum of 1km for rural all-purpose roads (TD22/06 Paragraph 4.36). Actual weaving length is 230m.	**A13 westbound** Diverge from Orsett Cock Interchange to LTC diverge from A13 westbound to LTC northbound.	Proximity of the two junctions, not practicable to move this slip road elsewhere due to other slip roads and property constraints.	Existing merge from Orsett Cock to A13 westbound diverge to A1089 southbound has a weaving length of approximately 800m.
6	2	Weaving Length, merge to diverge less than desirable minimum of 1km for rural all-purpose roads (TD22/06 Paragraph 4.36). Actual weaving length is 520m.	**A13 eastbound** Merge from LTC to A13 eastbound to diverge at Orsett Cock.	Proximity of the two junctions, not practicable to move this slip road elsewhere due to other slip roads and property constraints.	
1	3	Weaving Length, merge to diverge less than desirable minimum of 2km for rural motorways (TD22/06 Paragraph 4.35). Actual weaving length is approximately 1.8km.	**M25 northbound** Between LTC northbound on slip road and M25 diverge for Junction 29	LTC northbound slip road merge is 1.8km south of Junction 29 diverge. M25 northbound has a downhill gradient of approximately 2% which increases the length of the slip road which is also coming down towards the M25.	Potential to decrease radius on slip road as it crosses the M25 to 2 steps below which could provide the required additional 200m.
2	3	Weaving Length, merge to diverge less than desirable minimum of 1km for rural all-purpose roads (TD22/06 Paragraph 4.35). Actual weaving length is approximately 900m.	**A13 Eastbound** Between LTC southbound to A13 EB slip road and diverge at existing EB Orsett Cock Interchange	Proximity of the two junctions, not practicable to move this slip road elsewhere due to other slip roads and property constraints.	

Departure No.	Route Option	Departure Description	Location	Reason	Solutions
3	3	Weaving Length, merge to diverge less than desirable minimum of 1km for rural all-purpose roads (TD22/06 Paragraph 4.35). Actual weaving length is approximately 860m.	**A13 Westbound** Between LTC northbound to A13 westbound on slip and diverge at existing A1012 junction	Proximity of the two junctions, not practicable to move this slip road elsewhere due to other slip roads and property constraints.	
4	3	Weaving Length, merge to diverge less than desirable minimum of 1km for rural all-purpose roads (TD22/06 Paragraph 4.35). Actual weaving length is approximately 820m.	**A13 Eastbound** Between A13 eastbound to LTC northbound off slip and the existing merge at the A1012 junction	Proximity of the two junctions, not practicable to move this slip road elsewhere due to other slip roads and property constraints.	
5	3	Weaving Length, merge to diverge less than desirable minimum of 1km for rural all-purpose roads (TD22/06 Paragraph 4.35). Actual weaving length is approximately 635m.	**A13 Westbound** Between A13 Orsett Cock WB merge and A13 westbound to LTC southbound off slip	Proximity of the two junctions, not practicable to move this slip road elsewhere due to other slip roads and property constraints.	Currently less than 1km
1	4	Successive diverges. Required distance needs to be 3.75 x design speed (TD22/06 Paragraph 4.30). Required on A13 is 320m (85kph design speed), actually achieved is 110m.	**A13** Slip road from LTC northbound to A13 westbound and eastbound	Slip road required for all movement free flow junction. Due to proximity of properties not possible to separate these slip roads.	Proximity of properties restricts options at this junction.
2	4	Successive diverges. Required distance needs to be 3.75 x design speed (TD22/06 Paragraph 4.30). Required on A13 is 320m (85kph design speed), actually achieved is 110m.	**A13** Slip road A13 to LTC northbound and southbound	Slip road required for all movement free flow junction. Due to proximity of properties not possible to separate these slip roads.	Proximity of properties restricts options at this junction.
3	4	Weaving Length, merge to diverge less than desirable minimum of 1km for rural all-purpose roads (TD22/06 Paragraph 4.36). Actual weaving length is 740m.	**A13 westbound** Merge from A1014 junction to A13 diverge to LTC southbound.	The proximity of the two junctions results in substandard weaving length. LTC can not practically move further west due to properties and interaction with A1089 / A13 junction which would also create issues with weaving length.	No alternative without creating further departures on weaving length and possible geometry departures.
4	4	Weaving Length, merge to diverge less than desirable minimum of 1km for rural all-purpose roads (TD22/06 Paragraph 4.36). Actual weaving length is 679m.	**A13 westbound** Merge from LTC southbound to A13 eastbound to diverge for A1014 junction.	The proximity of the two junctions results in substandard weaving length. LTC can not practically move further west due to properties and interaction with A1089 / A13 junction which would also crate issues with weaving length.	No alternative without creating further departures on weaving length and possible geometry departures.
5	4	Successive merges. Required distance needs to be 3.75 x design speed (TD22/06 Paragraph 4.30). Required on interchange link is 320m (85kph design speed), actual achieved is 100m.	**A13** Slip road from A13 eastbound and westbound to LTC northbound	Insufficient space to separate these links and merge onto the A13 without additional property take.	
1	ESL	Weaving Length, merge to diverge less than desirable minimum of 2km for motorway (TD22/06 Paragraph 4.35). Actual weaving length is 1250m.	**M2 southbound** LTC southbound slip road to A228 diverge at 'dumbbell' junction	Proximity of the LTC merge and existing A228 junction.	No scope for altering the location of the merge, lane gain required through to A228 junction.
2	ESL	Weaving Length, diverge to merge less than desirable minimum of 2km for motorway (TD22/06 Paragraph 4.35). Actual weaving length is 1100m.	**M2 northbound** LTC northbound slip road from A228 diverge at 'dumbbell' junction	Proximity of the A228 merge with the LTC diverge.	No scope for altering the location of the merge, lane gain required from A228 junction.
3	ESL	Weaving Length, merge to diverge less than desirable minimum of 1km for rural all-purpose roads (TD22/06 Paragraph 4.36). Actual weaving length is 675m.	**A2 eastbound** Brewers Road merge to LTC northbound diverge.	Proximity of the two slip roads.	Potentially could close Brewers Road slip road, traffic would use westbound A2 and the return eastbound at existing junction at Hever Court Road.

Departure No.	Route Option	Departure Description	Location	Reason	Solutions
4	ESL	Successive diverges. Required distance needs to be 3.75 x design speed (TD22/06 Paragraph 4.30). Required on slip road is 320m (85kph design speed).	**A2 eastbound** A13 eastbound to LTC northbound slip road	Proximity of diverge from A2 and diverge on slip road to the A289 and A2.	Need to review traffic figures to determine if all slip roads are required.

Appendix 4.2
Geotechnical Drawings

Location A Geological Map Bedrock (Sheet 1 of 2)
Location A Geological Map Bedrock (Sheet 2 of 2)
Location A Geological Map Drift (Sheet 1 of 2)
Location A Geological Map Drift (Sheet 2 of 2)
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Route 1 River Crossing: Bridge Geological Long Section (Sheet 1 of 1)
Route 1 Geological Long Section
Location C Geological Map Bedrock (Sheet 1 of 2)
Location C Geological Map Bedrock (Sheet 2 of 2)
Location C Geological Map Drift (Sheet 1 of 2)
Location C Geological Map Drift (Sheet 2 of 2)
Route 2, 3 and 4 River Crossing: Bored Tunnel Geological Long Section (Sheet 1 of 1)
Route 2, 3 and 4 River Crossing: Bridge Geological Long Section (Sheet 1 of 1)
Route 2, 3 and 4 River Crossing: Immersed Tunnel Geological Long Section (Sheet 1 of 1)
Route 2 Eastern Southern Link Geological Long Section
Route 2 Western Southern Link Geological Long Section
Route 3 Eastern Southern Link Geological Long Section
Route 3 Western Southern Link Geological Long Section
Route 4 Eastern Southern Link Geological Long Section
Route 4 Western Southern Link Geological Long Section

Location A

ROUTE 1

Bedrock

- CHALK GROUP (CK-CHLK)
- HARWICH FORMATION (HWH-SANDU)
- LONDON CLAY FORMATION (LC-CLAY)
- LAMBETH GROUP (LMBE-SACL)
- LAMBETH GROUP (LMBE-SANCL)
- SEAFORD CHALK FORMATION (SECK-CHLK)
- THANET SAND FORMATION (TAB-SANDU)

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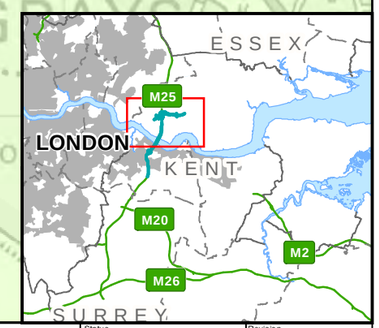

ILLUSTRATIVE DESIGN

THE DESIGN SHOWN ON THESE DRAWINGS IS ILLUSTRATIVE AND MAY BE SUBJECT TO CHANGE IN LATER STAGES OF THE SCHEME DEVELOPMENT

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-2016	SAR ISSUE	DD	CC	JB

Client: highways england

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Burderop Park
Swindon, SN4 0QD
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Project: LOWER THAMES CROSSING

Drawing title: Location A
Geological Map - Bedrock
Sheet 1 of 2

Status	S5	Revision P01
Scale	As Shown	Date - 18-01-2016
Drawn By	D Delgado	
Checked By	C Cooper	
Approved By	J Baple	
Project No. HA PIN	HA540039	Originator HHJ
Original Size	A3	

Drawing number: HA540039–HHJ–HGT –AZZZZZZZZZ–DR–GT–007

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Location A

ROUTE 1

Bedrock

- CHALK GROUP (CK-CHLK)
- LONDON CLAY FORMATION (LC-CLAY)
- LEWES NODULAR CHALK FORMATION (LECH-CHLK)
- LAMBETH GROUP (LMBE-SANCL)
- SEAFORD CHALK FORMATION (SECK-CHLK)
- THANET SAND FORMATION (TAB-SANDU)

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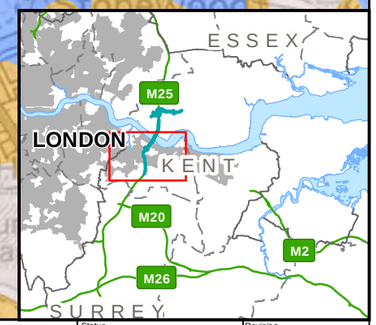

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Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-2016	SAR ISSUE	DD	CC	JB

Client: highways england

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Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Location A
Geological Map - Bedrock
Sheet 2 of 2

Status	S5	Revision P01
Scale	As Shown	Date - 18-01-2016
Drawn By	D Delgado	
Checked By	C Cooper	
Approved By	J Baple	
Project No. HA PIN	HA540039	Originator HHJ
Original Size	A3	

Drawing number: HA540039–HHJ–HGT –AZZZZZZZZZ–DR–GT–008

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Location A

ROUTE 1

Drift

- ALLUVIUM (ALV-Z)
- BOYN HILL GRAVEL MEMBER (BHT-XSV)
- BLACK PARK GRAVEL MEMBER (BPGR-XSV)
- HEAD (HEAD-C)
- HEAD (HEAD-XVSZ)
- ILFORD SILT MEMBER (ILSI-Z)
- LYNCH HILL GRAVEL MEMBER (LHGR-XSV)
- TAPLOW GRAVEL FORMATION (TPGR-XSV)
- TIDAL RIVER OR CREEK DEPOSITS (TRD-Z)
- MADE GROUND (MGR-ARTDP)
- MADE GROUND (MGR-UKNOWN)
- WORKED GROUND (WGR-UKNOWN)
- WORKED GROUND (WGR-VOID)
- INFILLED GROUND (WMGR-ARTDP)
- INFILLED GROUND (WMGR-UKNOWN)

0 100 200 300 400 500 600 700 800 900 1,000
SCALE 1:20,000 METRES

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-2016	SAR ISSUE	DD	CC	JB

ILLUSTRATIVE DESIGN
THE DESIGN SHOWN ON THESE DRAWINGS IS ILLUSTRATIVE AND MAY BE SUBJECT TO CHANGE IN LATER STAGES OF THE SCHEME DEVELOPMENT

Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Location A
Geological Map - Drift
Sheet 1 of 2

Status	S5	Revision	P01
Scale	As Shown	Date - 18-01-2016	
Drawn By	D Delgado		
Checked By	C Cooper		
Approved By	J Baple		
Project No. HA PIN	HA540039	Originator HHJ	
Original Size	A3		

Drawing number: HA540039–HHJ–HGT –AZZZZZZZZZ–DR–GT–005

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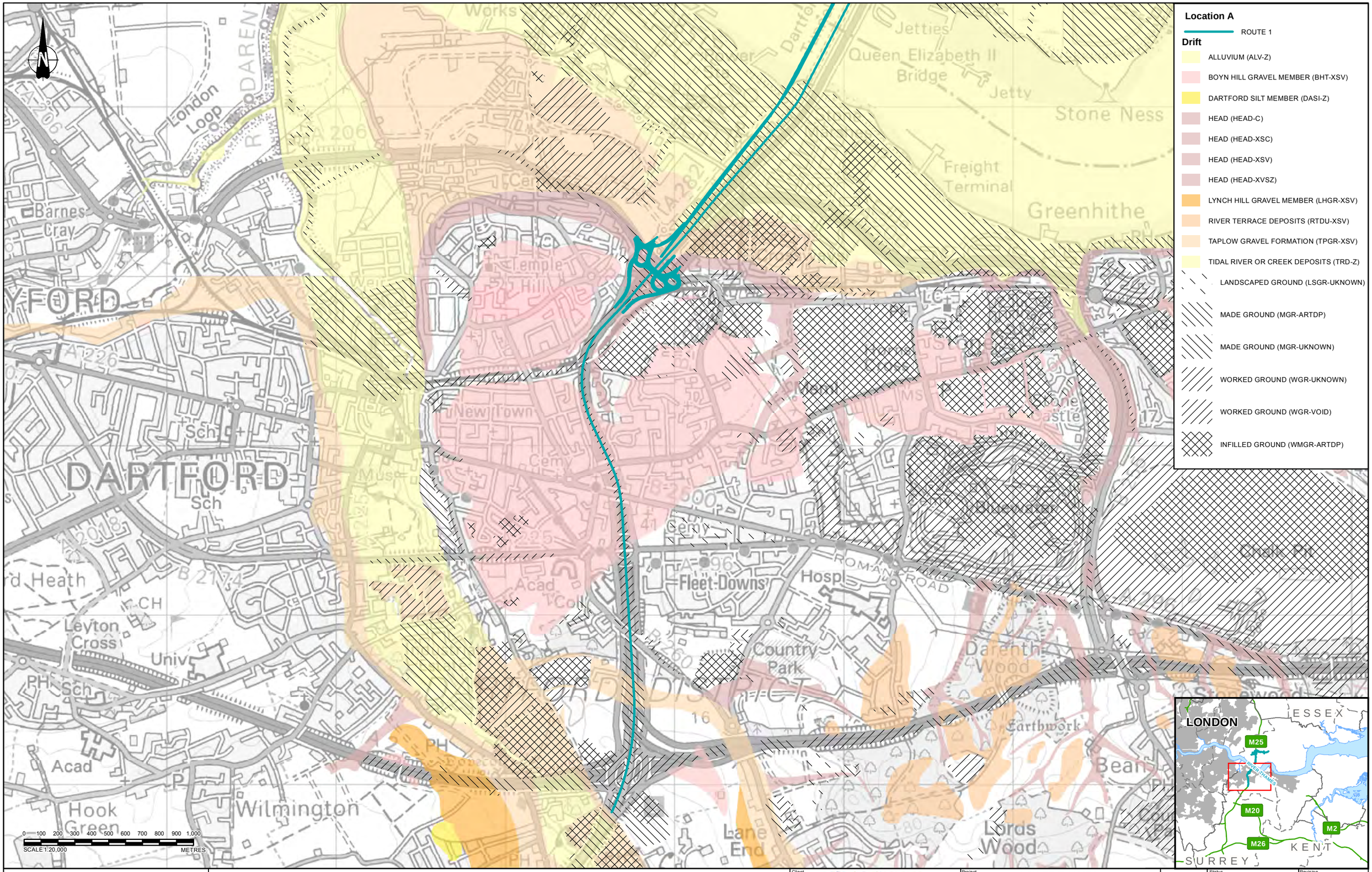

ILLUSTRATIVE DESIGN

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Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-2016	SAR ISSUE	DD	CC	JB

Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Location A Geological Map - Drift Sheet 2 of 2

Status	S5	Revision P01
Scale	As Shown	Date - 18-01-2016
Drawn By	D Delgado	
Checked By	C Cooper	
Approved By	J Baple	
Project No. HA PIN	HA540039	Originator HHJ
Original Size	A3	

Drawing number: HA540039–HHJ–HGT –AZZZZZZZZZ–DR–GT–006

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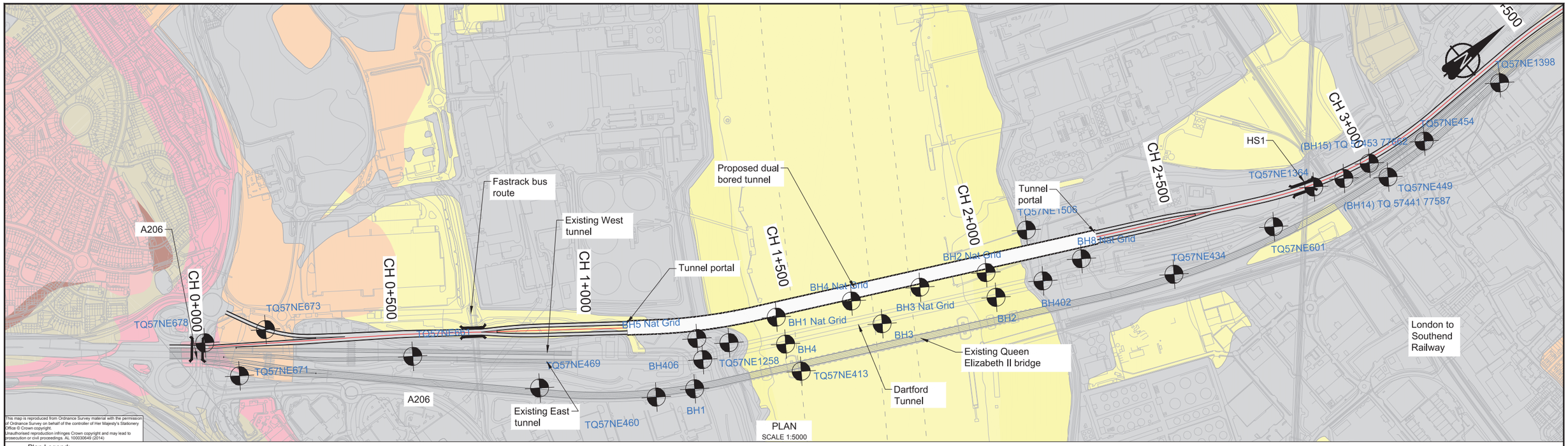


Plan Legend:

Superficial Geology Legend:

- Artificial Ground
- Alluvium
- Head
- Lynch Hill Gravel Member
- Taplow Gravel Formation

Bedrock Geology Legend:

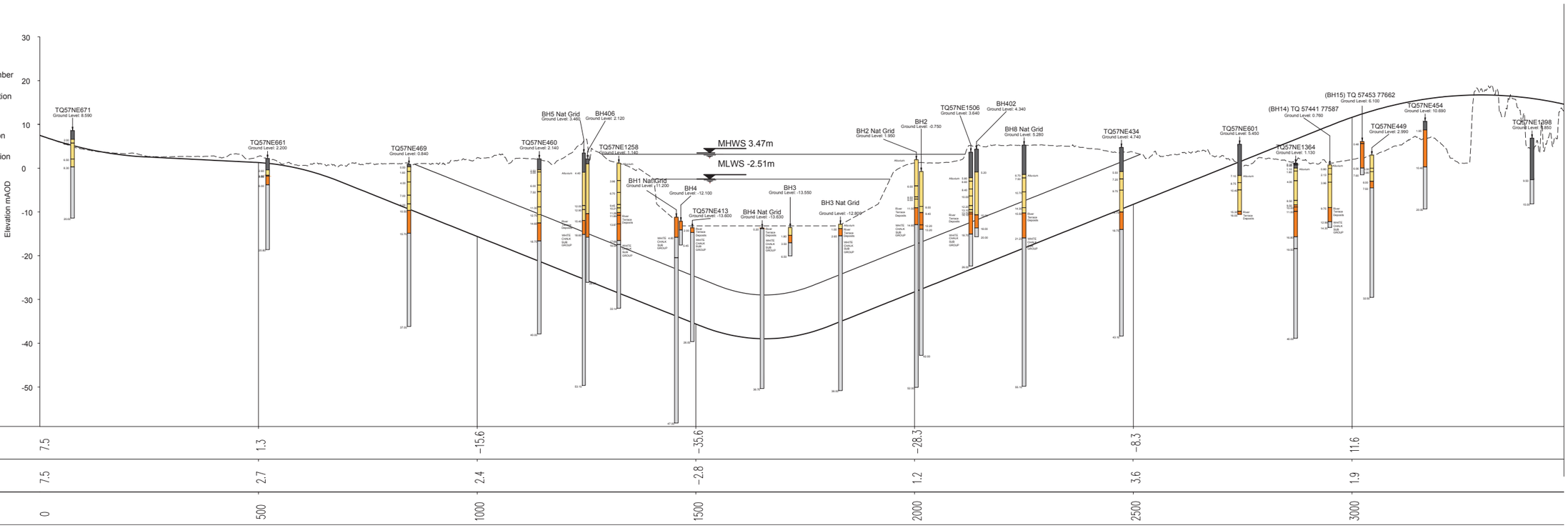
- Thanet Sand Formation
- Seaford Chalk Formation
- Lambeth Group

Profile Legend:

- LTC Vertical Alignment
- Existing Ground Profile

Borehole Geology Legend:

- Made Ground
- Topsoil
- Alluvium
- River Terrace Deposits
- Chalk



PROFILE
H:V SCALE 1:5000 - 1:500

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18/01/16	SAR Issue	MG	CC	JB

0 50 100 150 200 250 300 350 400 450 500
HORIZONTAL SCALE 1:5000 (A1) METRES
HORIZONTAL SCALE 1:10000 (A3)

0 10 20 30 40 50
VERTICAL SCALE 1:500 (A1) METRES
VERTICAL SCALE 1:1000 (A3)

ILLUSTRATIVE DESIGN
THE DESIGN SHOWN ON THESE DRAWINGS IS ILLUSTRATIVE AND MAY BE SUBJECT TO CHANGE IN LATER STAGES OF THE SCHEME DEVELOPMENT

Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

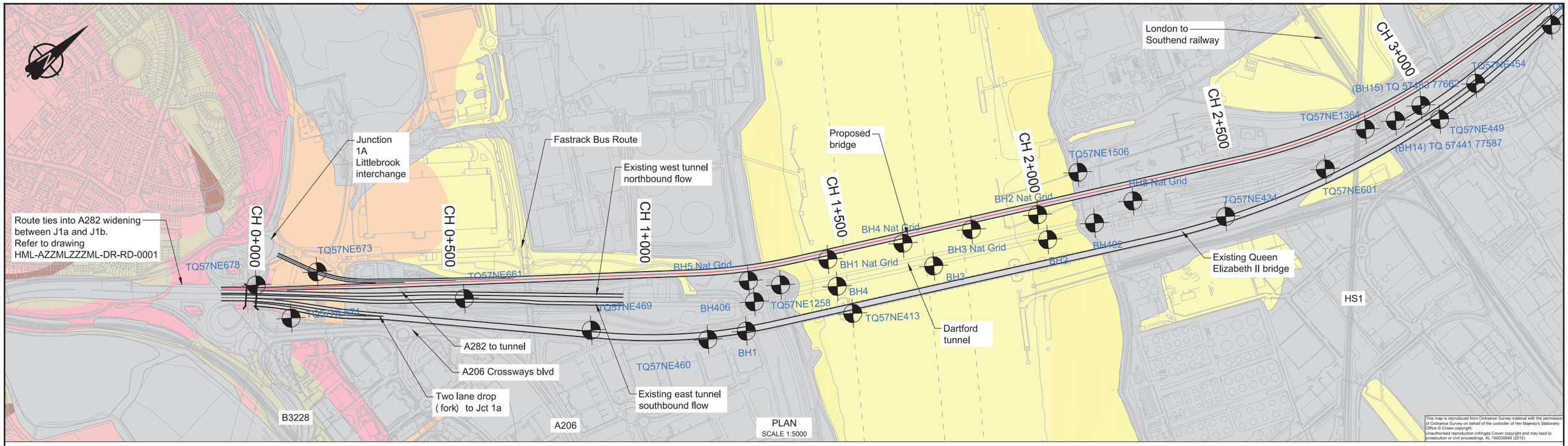
Project: LOWER THAMES CROSSING

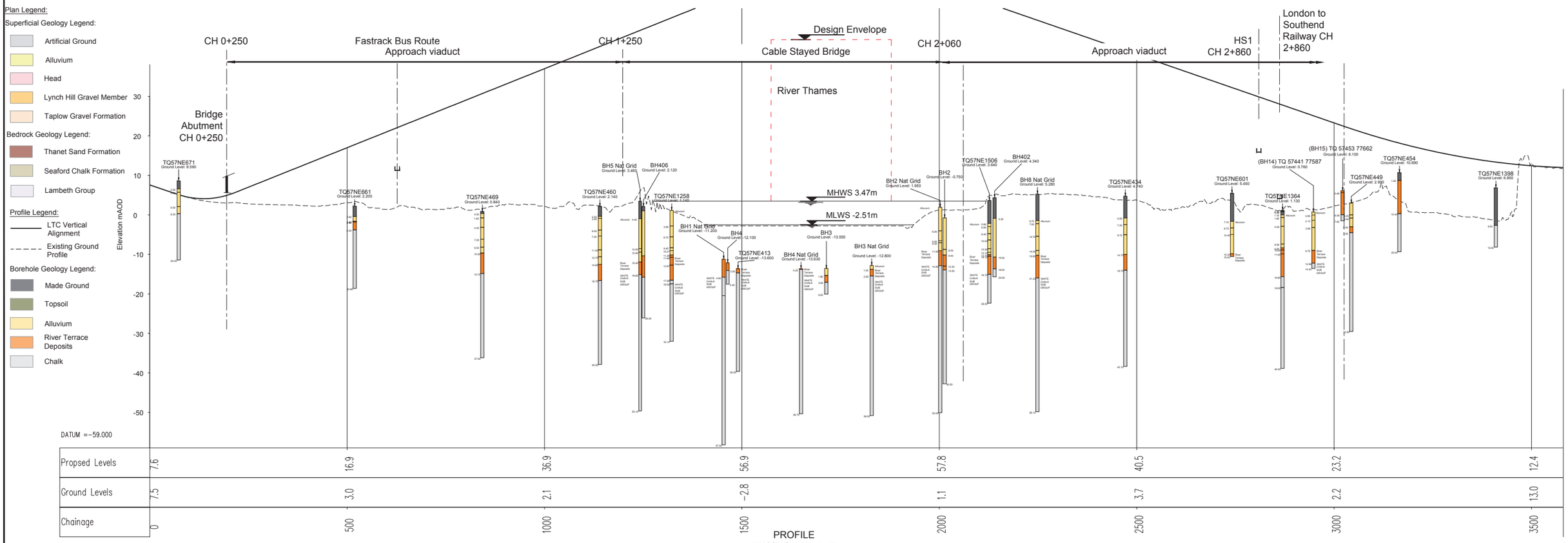
Drawing title: Route 1
River Crossing: Bored Tunnel
Geological Long Section
Sheet 1 of 1

Status	S5	Revision P01
Scale	AS SHOWN	Date - 18/01/16
Drawn By	M.GAMLIN	
Checked By	C.COOPER	
Approved By	J.BAPLE	
Project No. HA PIN	HA540039	Originator HHJ
Original Size	A1	

Drawing number: HA540039-HHJ-HGT-AD0MCZZZML-DR-GT-001

HA540039-HHJ-HGT-AD0MCZZZML-DR-GT-001.dwg





Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18/01/2016	SAR Issue	MG	CC	JB

0 50 100 150 200 250 300 350 400 450 500
SCALE 1:5000 (A1)
SCALE 1:10000 (A3)
METRES

0 10 20 30 40 50
SCALE 1:500 (A1)
SCALE 1:1000 (A3)
METRES

ILLUSTRATIVE DESIGN
THE DESIGN SHOWN ON THESE DRAWINGS IS ILLUSTRATIVE AND MAY BE SUBJECT TO CHANGE IN LATER STAGES OF THE SCHEME DEVELOPMENT

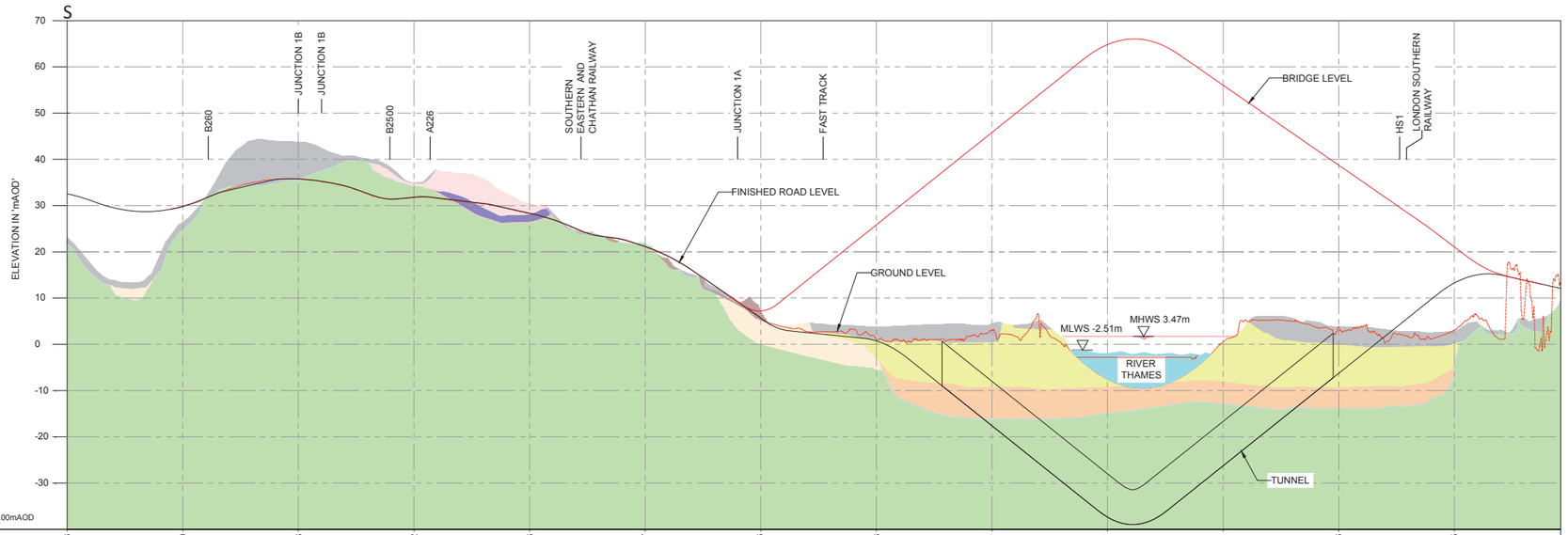
Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479
Halcrow Hyder

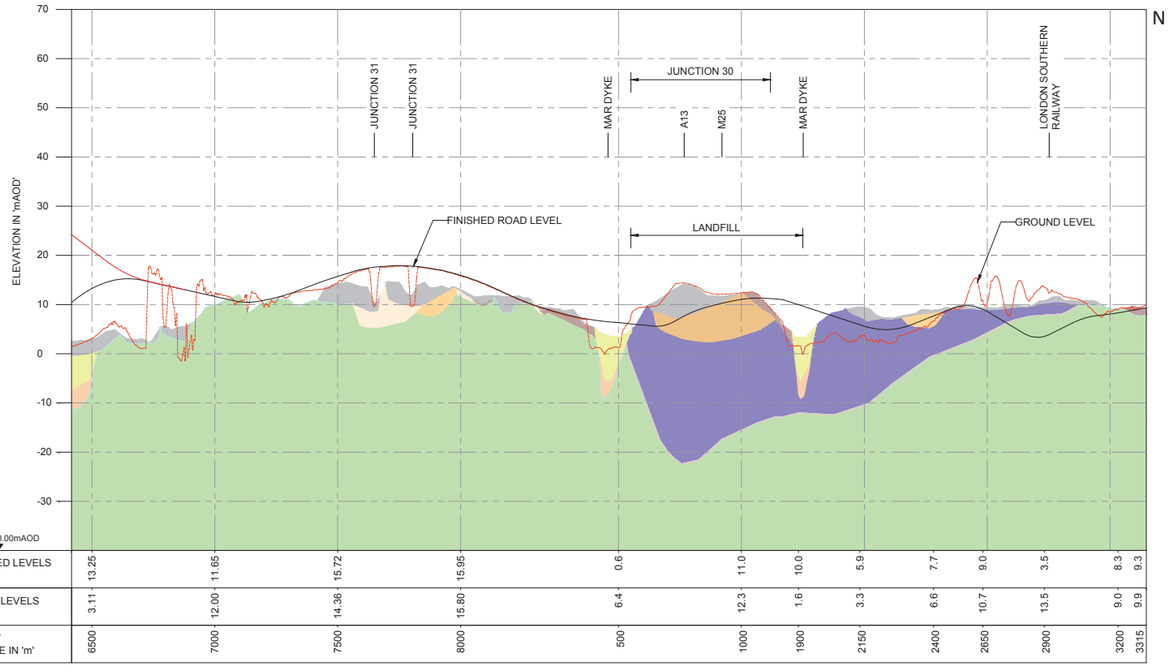
Project: LOWER THAMES CROSSING

Drawing title: Route 1 River Crossing: Bridge Geological Long Section Sheet 1 of 1

	Status	Revision	
	S5	P01	
Scale	AS SHOWN	Date - 18/01/2016	
Drawn By	M. GAMLIN		
Checked By	C.COOPER		
Approved By	J.BAPLE		
Project No.	HA PIN: HA540039	Originator: HHJ	Original Size: A1
Drawing number	HA540039-HHJ-HGT-AA0MCZZZML-DR-GT-001		



PROPOSED LEVELS IN 'mAOD'	32.33	29.50	35.78	31.82	28.36	21.17	5.66	0.73	-17.59	-37.37	-26.26	-6.26	13.25	
GROUND LEVELS IN 'mAOD'	32.33	29.73	35.74	31.72	28.29	21.07	5.76	1.22	3.11	-2.80	1.20	3.84	3.11	
HIGHWAY CHAINAGE IN 'm'	0	100	500	1000	1110	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500



PROPOSED LEVELS IN 'mAOD'	13.25	11.65	15.72	15.95	0.6	11.0	10.0	5.9	7.7	9.0	3.5	8.3	9.3
GROUND LEVELS IN 'mAOD'	3.11	12.00	14.36	15.80	6.4	12.3	1.6	3.3	6.6	10.7	13.5	9.0	9.9
HIGHWAY CHAINAGE IN 'm'	6500	7000	7500	8000	500	1000	1900	2150	2400	2650	2900	3200	3315

0 100 200 400 600 800 1000m

HORIZONTAL SCALE- 1 : 10000

0 5 10 20 30 40 50m

VERTICAL SCALE- 1 : 500

GEOLOGICAL LONG SECTION

1 : 10000 HORIZ. & 1 : 500 VERT.

ILLUSTRATIVE DESIGN

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Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18.01.16	SAR Issue	AA	CC	JB

NOTES:

1. ALL DIMENSIONS ARE IN METERS UNLESS STATED OTHERWISE.

LEGEND:

PATTERN	DETAIL
	HEAD
	LONDON CLAY
	LAMBETH GROUP
	THANET FORMATION
	CHALK GROUP
	TAPLOW GRAVEL

PATTERN	DETAIL
	ALLUVIUM
	RIVER TERRACE DEPOSITS
	LYNCH HILL GRAVEL
	HARWICH FORMATION
	BOYN HILL GRAVEL
	WORKING GROUND

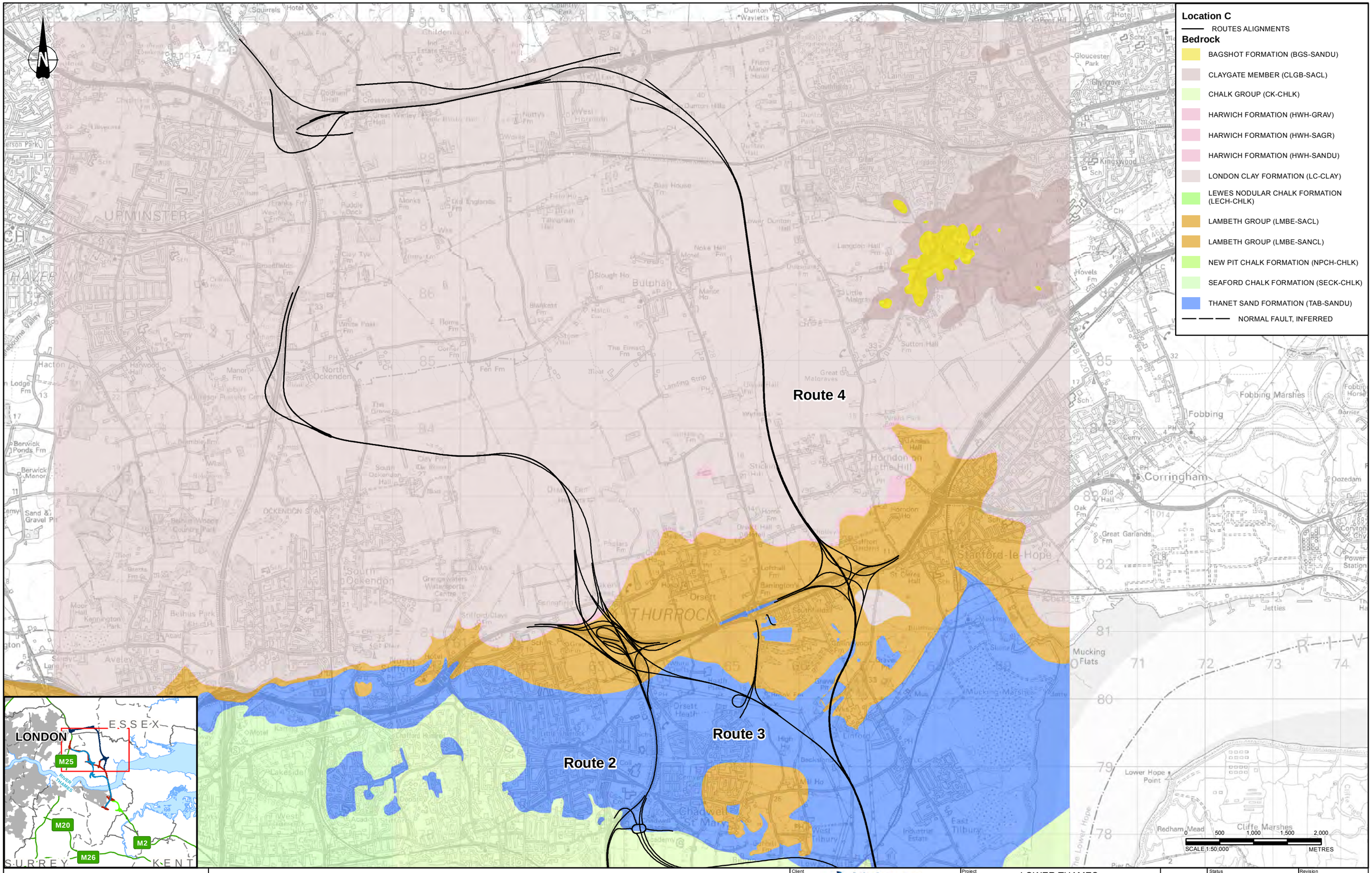
Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479
Halcrow Hyder

Project: LOWER THAMES CROSSING

Drawing title: Route 1 Geological Long Section

Status	S5
Revision	P01
Scale	1:1200 @ A1
Date -	18.01.16
Drawn By	Ashok A
Checked By	C Cooper
Approved By	J Baple
Project No. HA PIN / Originator	HA540039
Original Size	A1
Drawing number	HA540039-HHJ-HGT-AZZ ML ZZZ ML-DR-GT-001



P01 S5 18-01-2016 SAR ISSUE DD CC JB

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd

ILLUSTRATIVE DESIGN
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Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479
Halcrow Hyder

Project: LOWER THAMES CROSSING

Drawing title:
Location C
Geological Map - Bedrock
Sheet 1 of 2

	Status: S5	Revision: P01
Scale	As Shown	Date - 18-01-2016
Drawn By	D Delgado	
Checked By	C Cooper	
Approved By	J Baple	
Project No. HA PIN HA540039	Originator HHJ	Original Size A3
Drawing number	HA540039–HHJ–HGT –CZZZZZZZZZ–DR–GT–007	

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Route 2

Route 3

Western Southern Link

Eastern Southern Link

Location C

ROUTES ALIGNMENTS

Bedrock

- BAGSHOT FORMATION (BGS-SANDU)
- CLAYGATE MEMBER (CLGB-SACL)
- CHALK GROUP (CK-CHLK)
- HARWICH FORMATION (HWH-GRAV)
- HARWICH FORMATION (HWH-SAGR)
- HARWICH FORMATION (HWH-SANDU)
- LONDON CLAY FORMATION (LC-CLAY)
- LEWES NODULAR CHALK FORMATION (LECH-CHLK)
- LAMBETH GROUP (LMBE-SACL)
- LAMBETH GROUP (LMBE-SANCL)
- NEW PIT CHALK FORMATION (NPCH-CHLK)
- SEAFORD CHALK FORMATION (SECK-CHLK)
- THANET SAND FORMATION (TAB-SANDU)
- NORMAL FAULT, INFERRED

LONDON
ESSEX
SURREY
KENT
RIVER THAMES
M25
M20
M26
M2

0 500 1,000 1,500 2,000
SCALE 1:50,000 METRES

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-2016	SAR ISSUE	DD	CC	JB

ILLUSTRATIVE DESIGN
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Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Location C
Geological Map - Bedrock
Sheet 2 of 2

	Status: S5		Revision: P01
Scale: As Shown			Date - 18-01-2016
Drawn By: D Delgado			
Checked By: C Cooper			
Approved By: J Baple			
Project No.: HA PIN HA540039	Originator: HHJ	Original Size: A3	

Drawing number: HA540039–HHJ–HGT –CZZZZZZZZZ–DR–GT–008

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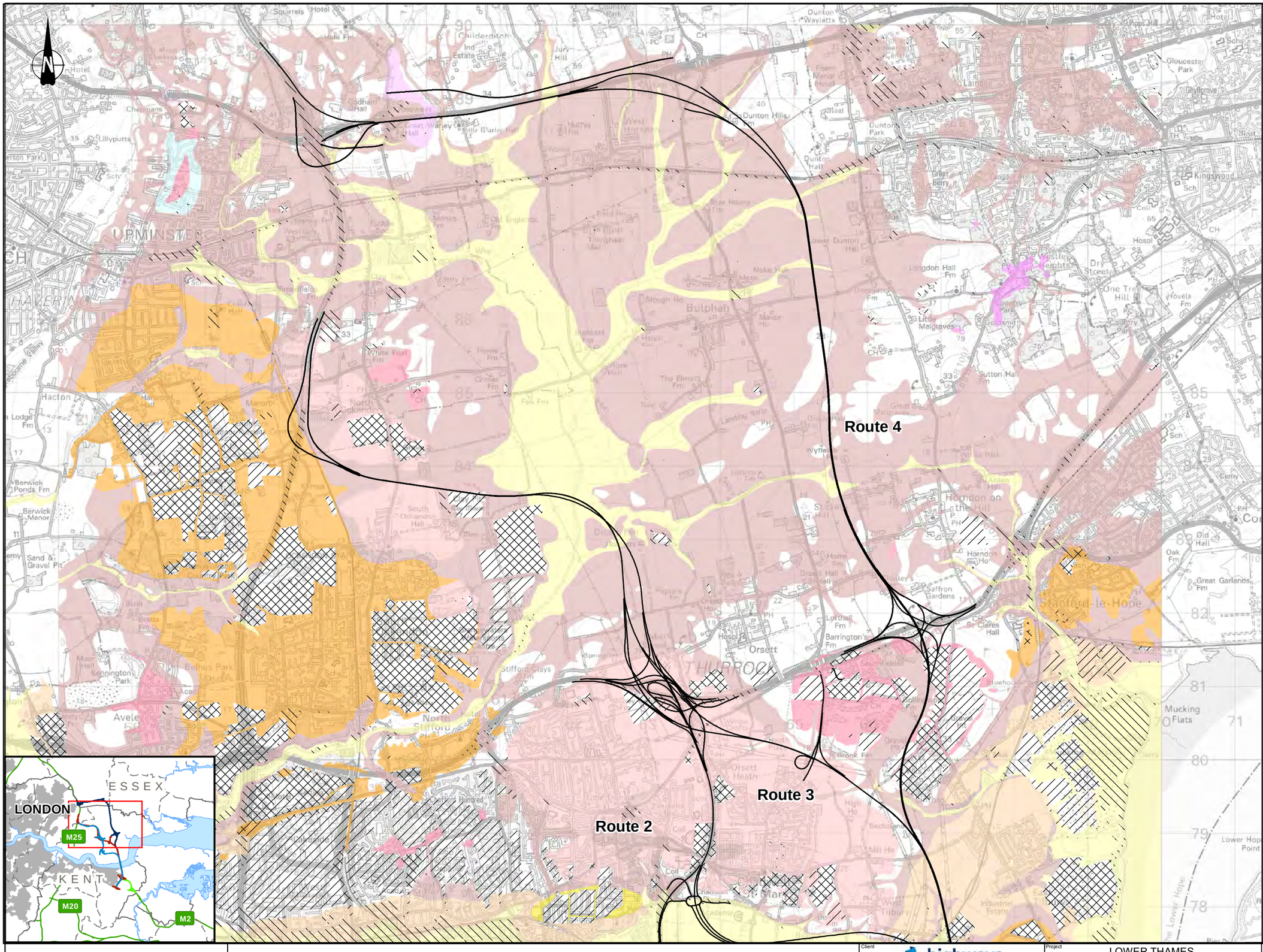

Location C

ROUTES ALIGNMENTS

Drift

- ALLUVIUM (ALV-Z)
- BOYN HILL GRAVEL MEMBER (BHT-XSV)
- BLACK PARK GRAVEL MEMBER (BPGR-XSV)
- GLACIOFLUVIAL DEPOSITS (GFDU-XSV)
- GLACIOLACUSTRINE DEPOSITS (GLLD-XSC)
- HEAD (HEAD-C)
- HEAD (HEAD-XVSZ)
- ILFORD SILT MEMBER (ILSI-Z)
- KEMPTON PARK GRAVEL FORMATION (KPGR-XSV)
- LYNCH HILL GRAVEL MEMBER (LHGR-XSV)
- RIVER TERRACE DEPOSITS (RTDU-XSV)
- STANMORE GRAVEL FORMATION (STGR-XSV)
- TILL (TILL-DMTN)
- TAPLOW GRAVEL FORMATION (TPGR-XSV)
- TIDAL RIVER OR CREEK DEPOSITS (TRD-Z)
- MADE GROUND (MGR-ARTDP)
- MADE GROUND (MGR-UKNOWN)
- WORKED GROUND (WGR-UKNOWN)
- WORKED GROUND (WGR-VOID)
- INFILLED GROUND (WMGR-ARTDP)
- INFILLED GROUND (WMGR-UKNOWN)

0 500 1,000 1,500 2,000

SCALE 1:50,000 METRES

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-2016	SAR ISSUE	DD	CC	JB

ILLUSTRATIVE DESIGN

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Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479
Halcrow Hyder

Project: LOWER THAMES CROSSING

Drawing title: Location C
Geological Map - Drift
Sheet 1 of 2

	Status: S5	Revision: P01
Scale: As Shown		Date - 18-01-2016
Drawn By: D Delgado		
Checked By: C Cooper		
Approved By: J Baple		
Project No. HA PIN: HA540039	Originator: HHJ	Original Size: A3

Drawing number: HA540039–HHJ–HGT –CZZZZZZZZZ–DR–GT–005

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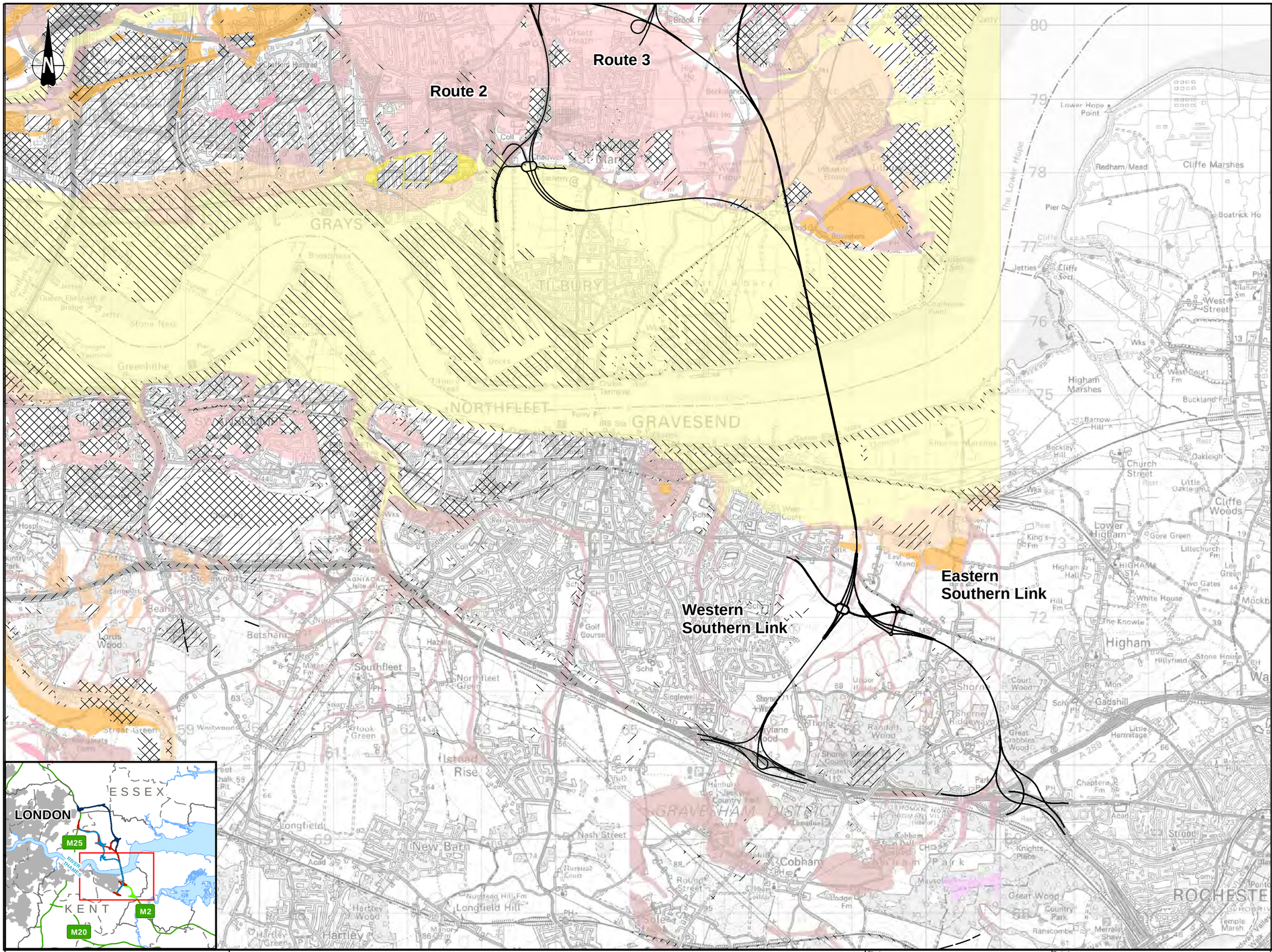

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Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-2016	SAR ISSUE	DD	CC	JB

Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Location C Geological Map - Drift Sheet 2 of 2

Status	S5	Revision P01
Scale	As Shown	Date - 18-01-2016
Drawn By	D Delgado	
Checked By	C Cooper	
Approved By	J Baple	
Project No. HA PIN	HA540039	Originator HHJ
Original Size	A3	

Drawing number: HA540039–HHJ–HGT –CZZZZZZZZZ–DR–GT–006

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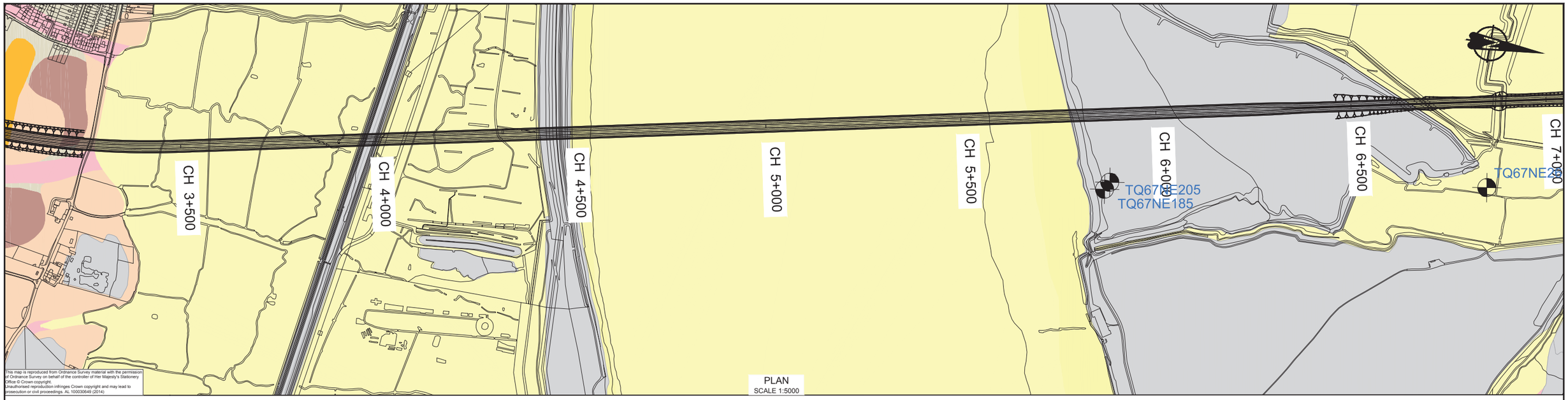


PLAN
SCALE 1:5000

Plan Legend:

Superficial Geology Legend:

- Artificial Ground
- Alluvium
- Head
- Lynch Hill Gravel Member
- Taplow Gravel Formation

Bedrock Geology Legend:

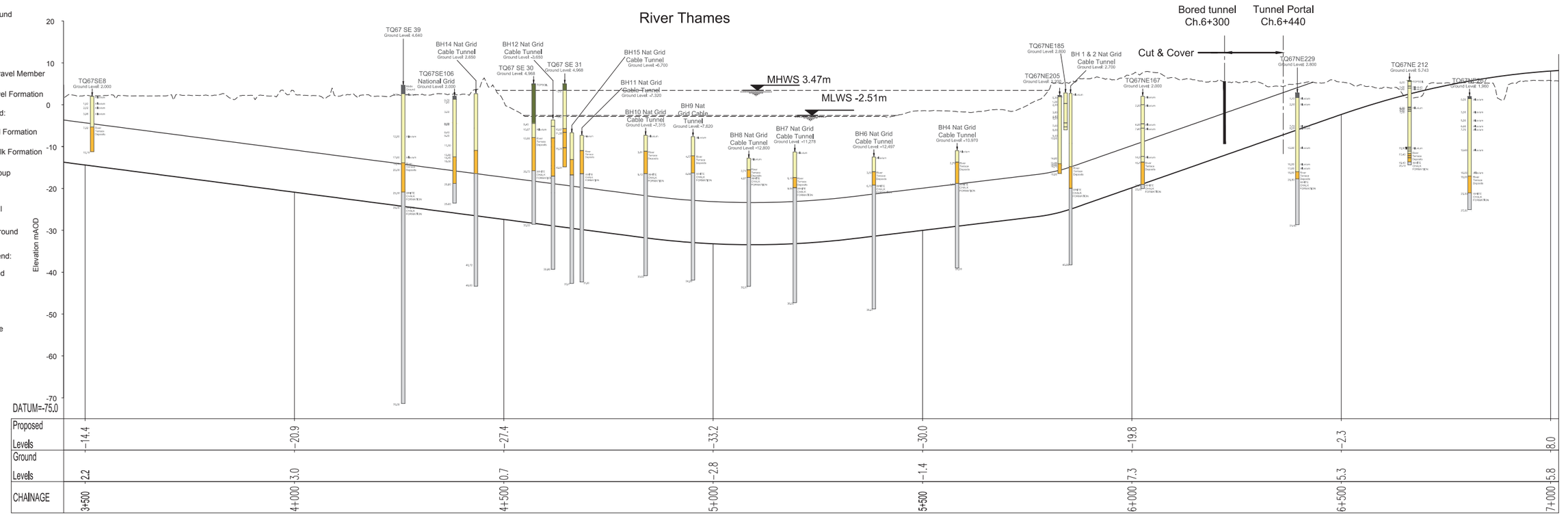
- Thanet Sand Formation
- Seaford Chalk Formation
- Lambeth Group

Profile Legend:

- LTC Vertical Alignment
- Existing Ground Profile

Borehole Geology Legend:

- Made Ground
- Topsoil
- Alluvium
- River Terrace Deposits
- Chalk



PROFILE
H:V SCALE 1:5000 - 1:500

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18/01/16	SAR Issue	MG	CC	JB

0 50 100 150 200 250 300 350 400 450 500
HORIZONTAL SCALE 1:5000 (A1) METRES
HORIZONTAL SCALE 1:10000 (A3)

0 10 20 30 40 50
VERTICAL SCALE 1:500 (A1) METRES
VERTICAL SCALE 1:1000 (A3)

ILLUSTRATIVE DESIGN
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Client: highways england

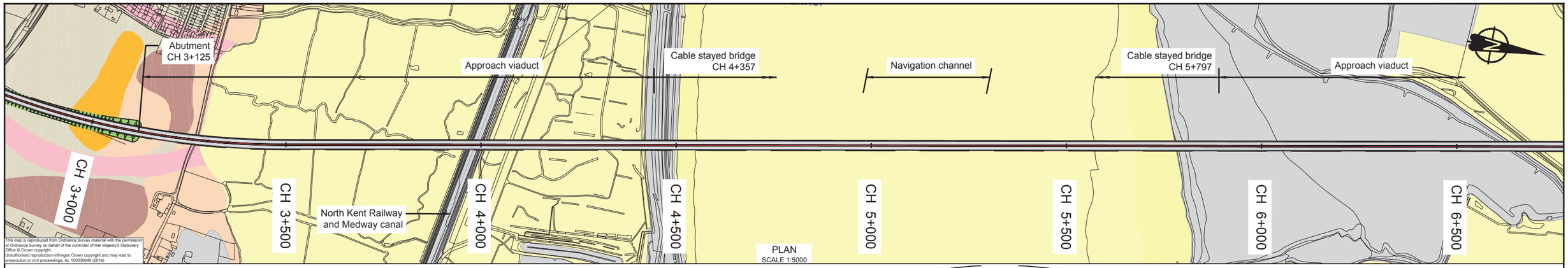
Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479
Halcrow Hyder

Project: LOWER THAMES CROSSING

Drawing title: Route 2, 3 and 4 River Crossing: Bored Tunnel Geological Long Section Sheet 1 of 1

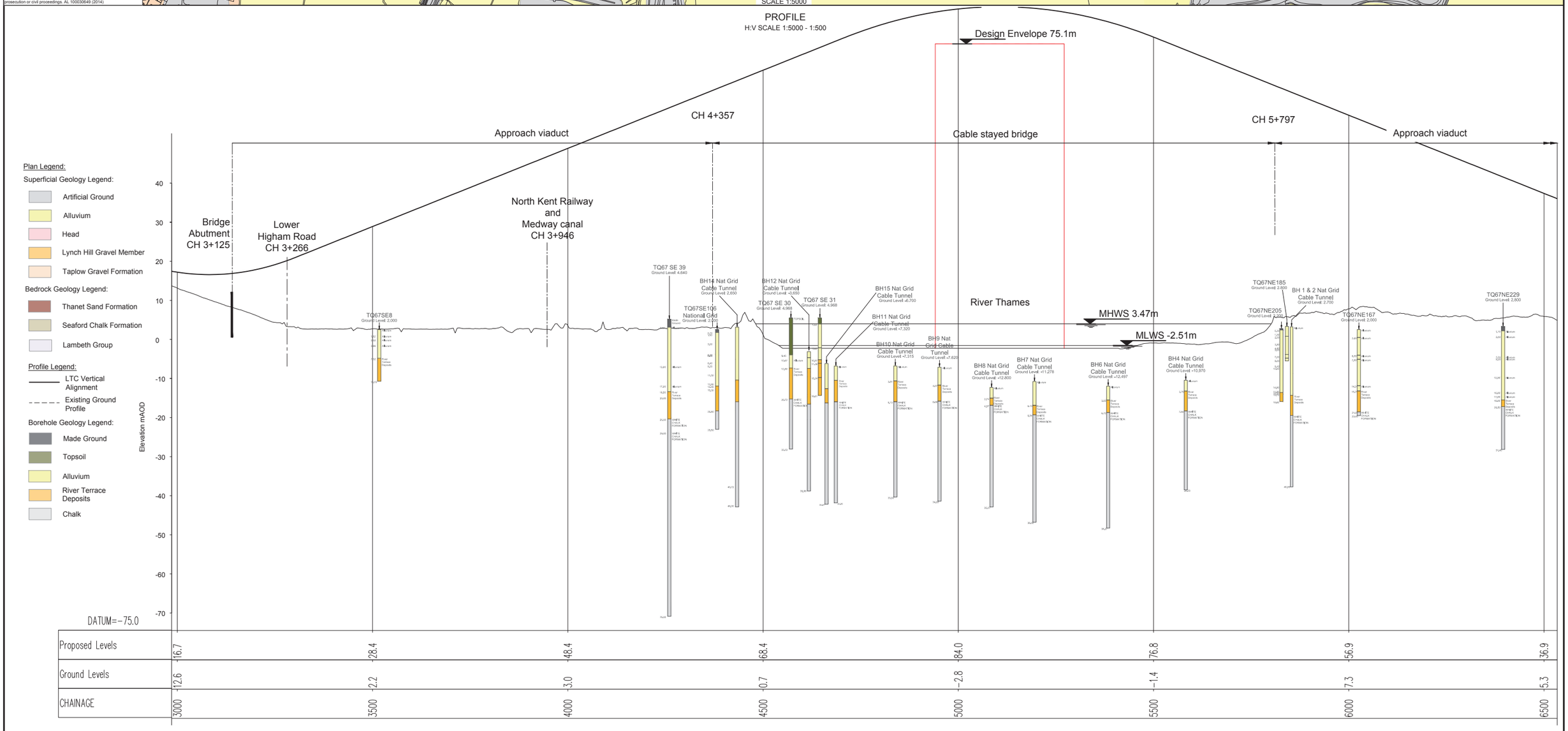
	Status: S5	Revision: P01
Scale	As shown	Date - 18/01/16
Drawn By	M.GAMLIN	
Checked By	C.COOPER	
Approved By	J.BAPLE	
Project No. HA PIN: HA540039	Originator: HHJ	Original Size: A1
Drawing number	HA540039-HHJ-HGT-CZZMCZZZML-DR-GT-002	

HA540039-HHJ-HGT-CZZMCZZZML-DR-GT-002



PLAN
SCALE 1:5000

PROFILE
H:V SCALE 1:5000 - 1:500



Plan Legend:

Superficial Geology Legend:
- Artificial Ground
- Alluvium
- Head
- Lynch Hill Gravel Member
- Taplow Gravel Formation

Bedrock Geology Legend:
- Thanet Sand Formation
- Seaford Chalk Formation
- Lambeth Group

Profile Legend:
- LTC Vertical Alignment
- Existing Ground Profile

Borehole Geology Legend:
- Made Ground
- Topsoil
- Alluvium
- River Terrace Deposits
- Chalk

DATUM=-75.0

Proposed Levels	16.7		28.4		48.4		68.4		84.0		76.8		56.9		36.9
Ground Levels	12.6		2.2		3.0		-0.7		-2.8		-1.4		7.3		5.3
CHAINAGE	3000		3500		4000		4500		5000		5500		6000		6500

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18/01/16	SAR Issue	MG	CC	JB

0 50 100 150 200 250 300 350 400 450 500
SCALE 1:5000 (A1) METRES
SCALE 1:10000 (A3)

0 10 20 30 40 50
SCALE 1:500 (A1) METRES
SCALE 1:1000 (A3)

ILLUSTRATIVE DESIGN
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Client: highways england

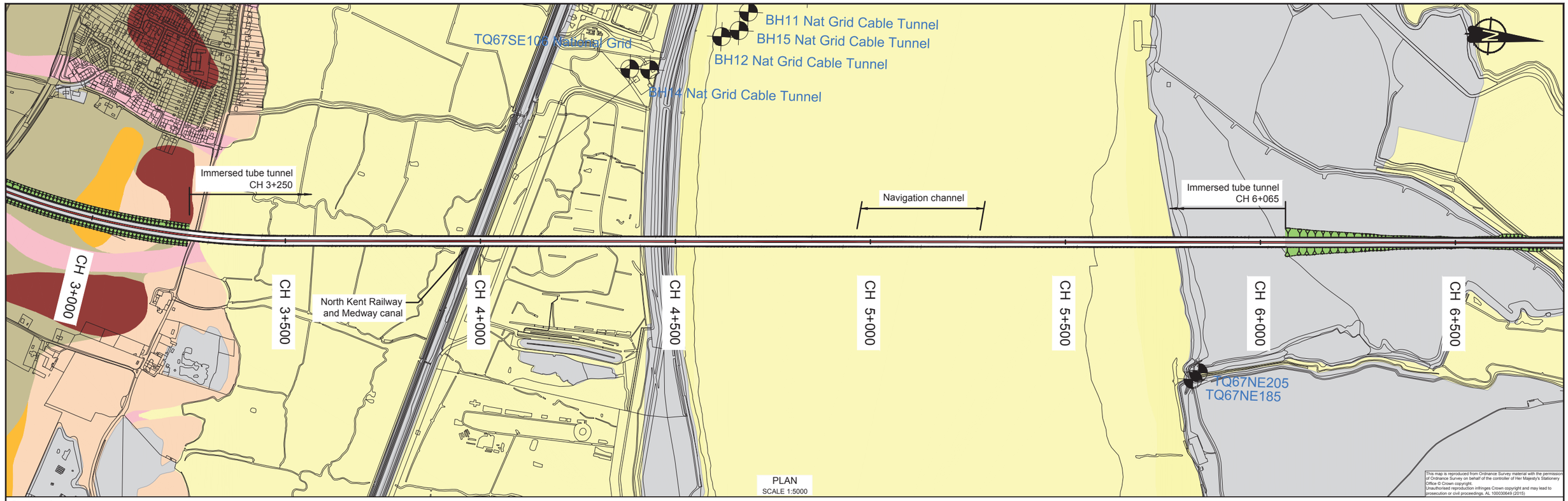
Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479
Halcrow Hyder

Project: LOWER THAMES CROSSING

Drawing title: Route 2, 3 and 4 River Crossing: Bridge Geological Long Section Sheet 1 of 1

	Status: S5		Revision: P01
Scale	As Shown	Date -	18/01/16
Drawn By	M.GAMLIN		
Checked By	C.COOPER		
Approved By	J.BAPLE		
Project No. HA PIN: HA540039	Originator: HHJ	Original Size	A1
Drawing number	HA540039-HHJ-HGT-CZZMCZZZML-DR-GT-001		

HA540039-HHJ-HGT-CZZMCZZZML-DR-GT-001



Plan Legend:

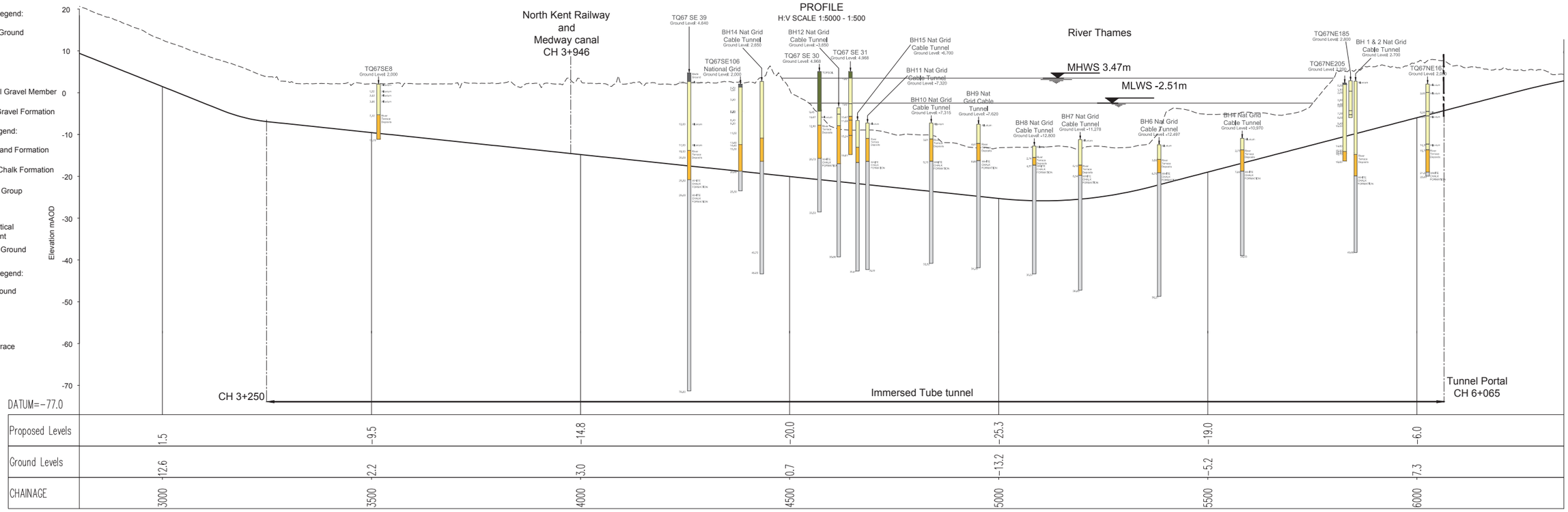
Superficial Geology Legend:
- Artificial Ground
- Alluvium
- Head
- Lynch Hill Gravel Member
- Taplow Gravel Formation

Bedrock Geology Legend:
- Thanet Sand Formation
- Seaford Chalk Formation
- Lambeth Group

Profile Legend:
- LTC Vertical Alignment
- Existing Ground Profile

Borehole Geology Legend:
- Made Ground
- Topsoil
- Alluvium
- River Terrace Deposits
- Chalk

PROFILE
H:V SCALE 1:5000 - 1:500



NOTES

0 50 100 150 200 250 300 350 400 450 500
SCALE 1:5000 (A1)
SCALE 1:10000 (A3)
METRES

0 10 20 30 40 50
SCALE 1:500 (A1)
SCALE 1:1000 (A3)
METRES

ILLUSTRATIVE DESIGN
THE DESIGN SHOWN ON THESE DRAWINGS IS ILLUSTRATIVE AND MAY BE SUBJECT TO CHANGE IN LATER STAGES OF THE SCHEME DEVELOPMENT

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18/01/16	SAR Issue	MG	CC	JB

Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

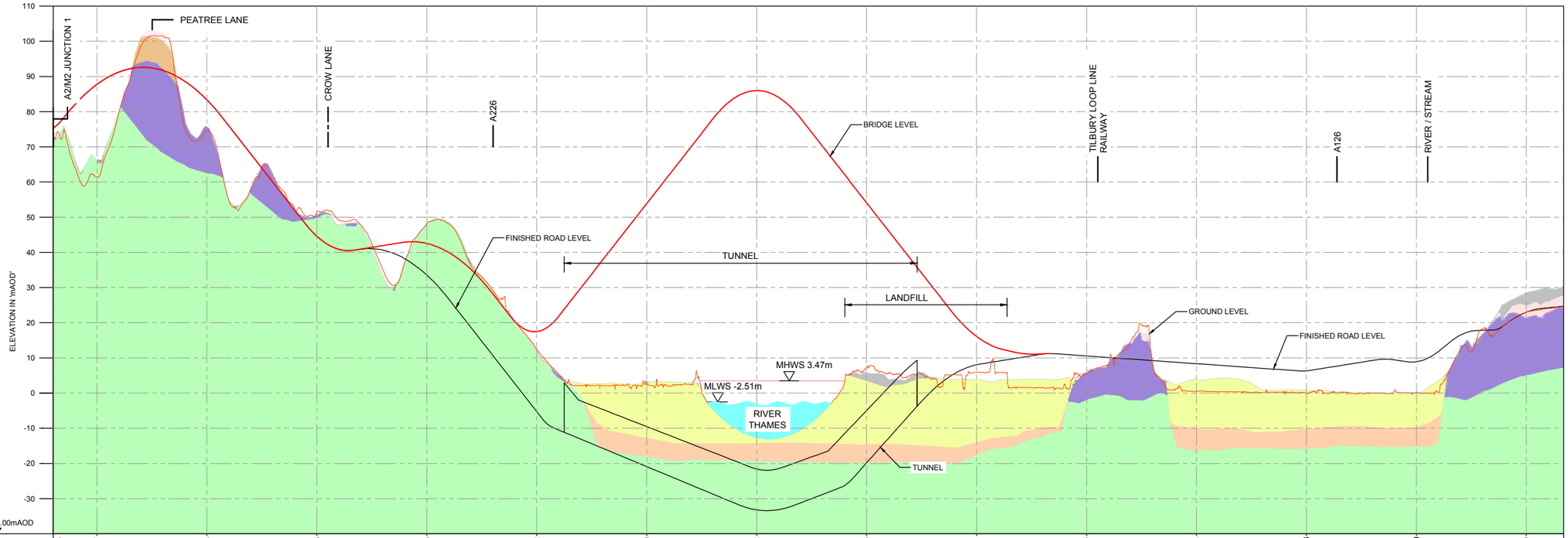
Project: LOWER THAMES CROSSING

Drawing title: Route 2, 3 and 4
River Crossing: Immersed Tunnel
Geological Long Section
Sheet 1 of 1

	Status: S5		Revision: P01
Scale	As Shown		Date - 18/01/16
Drawn By	M.GAMLIN		
Checked By	C.COOPER		
Approved By	J.BAPLE		
Project No.	HA PIN: HA540039	Originator: HHJ	Original Size: A1
Drawing number	HA540039-HHJ-HGT-CZZMCZZZML-DR-GT-003		

HA540039-HHJ-HGT-CZZMCZZZML-DR-GT-003.dwg

S



DATUM -40.00mAOD

PROPOSED LEVELS IN 'mAOD'	75.3	87.7	83.3	44.5	33.5	5.2	20.9	33.2	19.8	8.1	10.6	8.4	6.3	8.9	23.0										
GROUND LEVELS IN 'mAOD'	72.0	61.4	74.8	51.4	48.1	12.3	3.0	13.0	7.3	5.9	5.5	0.5	0.0	0.2	23.0										
HIGHWAY CHAINAGE IN 'm'	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000											

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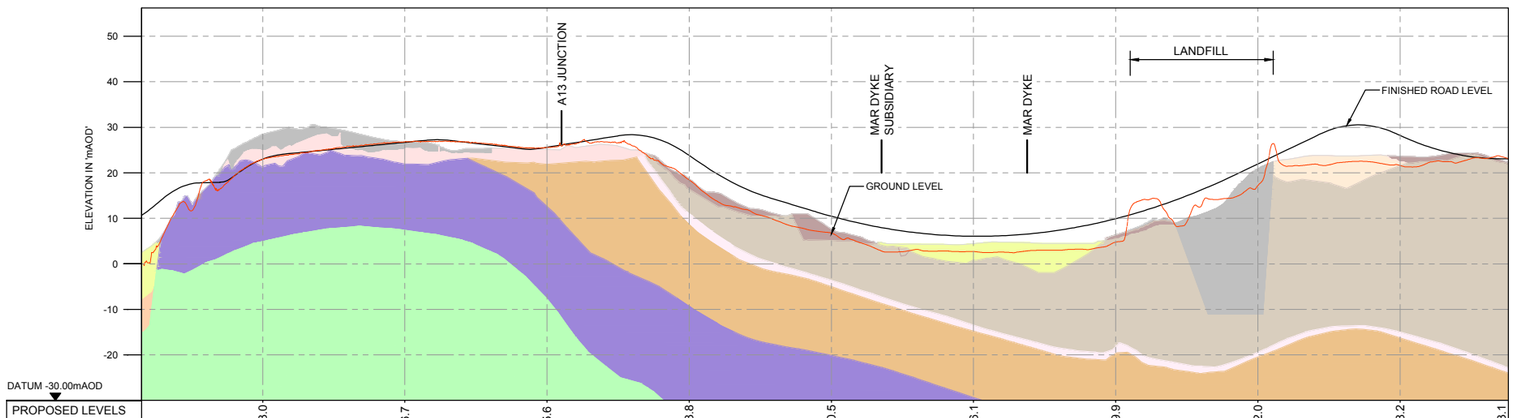


DATUM -30.00mAOD

PROPOSED LEVELS IN 'mAOD'	23.0	26.7	25.6	23.8	10.5	6.1	9.9	22.0	28.2	23.1			
GROUND LEVELS IN 'mAOD'	23.0	26.8	25.6	18.4	6.8	2.7	4.8	17.2	21.6	23.1			
HIGHWAY CHAINAGE IN 'm'	13000	14000	15000	16000	17000	18000	19000	20000	21000	22000	22166		

GEOLOGICAL LONG SECTION

1 : 20000 HORIZ. & 1 : 625 VERT.

ILLUSTRATIVE DESIGN

THE DESIGN SHOWN ON THESE DRAWINGS IS ILLUSTRATIVE AND MAY BE SUBJECT TO CHANGE IN LATER STAGES OF THE SCHEME DEVELOPMENT

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18.01.16	SAR Issue	AA	CC	JB

NOTES:

1. ALL DIMENSIONS ARE IN METERS UNLESS STATED OTHERWISE.

LEGEND:

PATTERN	DETAIL	PATTERN	DETAIL
	HEAD		ALLUVIUM
	LONDON CLAY		RIVER TERRACE DEPOSITS
	LAMBETH GROUP		LYNCH HILL GRAVEL
	THANET FORMATION		HARWICH FORMATION
	CHALK GROUP		BOYN HILL GRAVEL
	TAPLOW GRAVEL		WORKING GROUND

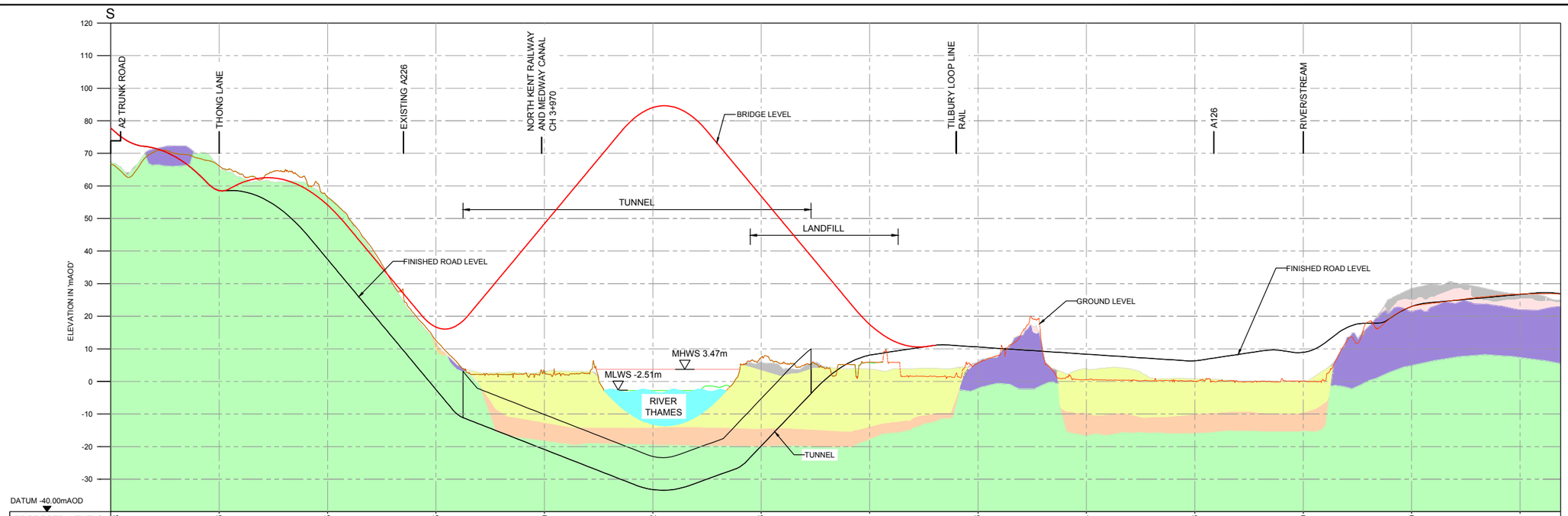
Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

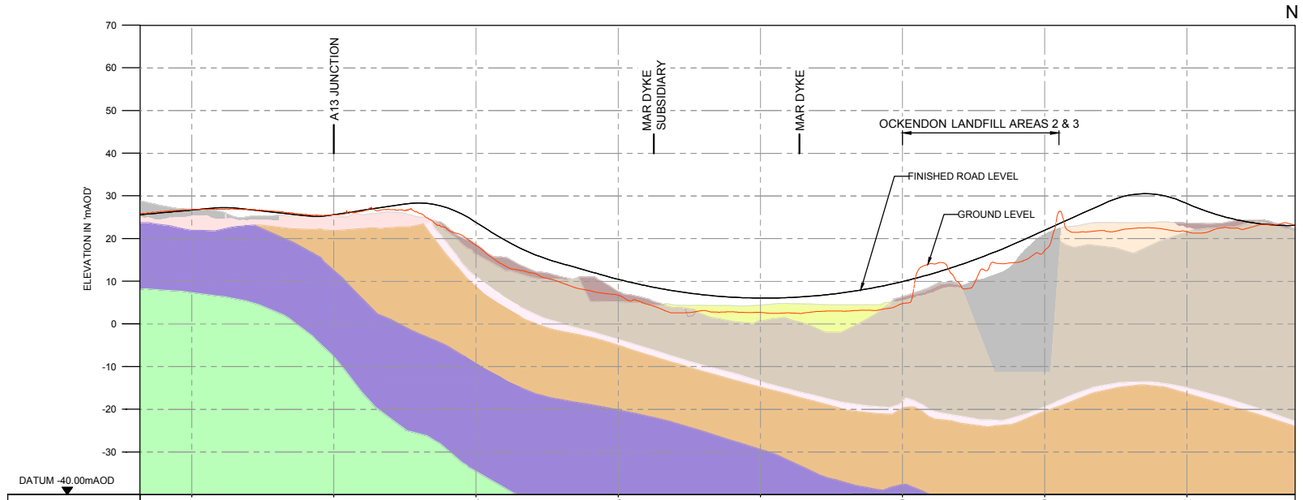
Project: LOWER THAMES CROSSING

Drawing title: Route 2 Eastern Southern Link Geological Long Section

	Status: S5	Revision: P01
Scale	1:1200 @ A1	Date - 18.01.16
Drawn By	Ashok A	
Checked By	C Cooper	
Approved By	J Baple	
Project No. HA PIN / Originator	HA540039	Original Size: A1
Drawing number	HA540039-HHJ-HGT-CD2MLZZZML-DR-GT-001	



PROPOSED LEVELS IN 'mAOD'	77.8	58.6	37.5	-2.5	-20.9	-33.2	-19.8	8.1	10.6	8.4	6.3	8.9	23.0	26.7										
GROUND LEVELS IN 'mAOD'	66.8	66.2	56.5	12.6	3.0	-13.0	7.3	5.9	5.5	0.5	0.0	0.2	23.0	26.8										
HIGHWAY CHAINAGE IN 'm'	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000										



PROPOSED LEVELS IN 'mAOD'	26.7	25.6	23.8	10.5	6.1	9.9	22.0	28.2	23.1
GROUND LEVELS IN 'mAOD'	26.8	25.6	18.4	6.8	2.7	4.8	17.2	21.6	23.1
HIGHWAY CHAINAGE IN 'm'	13000	14000	15000	16000	17000	18000	19000	20000	20769

GEOLOGICAL LONG SECTION

1 : 20000 HORIZ. & 1 : 625 VERT.

ILLUSTRATIVE DESIGN

THE DESIGN SHOWN ON THESE DRAWINGS IS ILLUSTRATIVE AND MAY BE SUBJECT TO CHANGE IN LATER STAGES OF THE SCHEME DEVELOPMENT

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18.01.16	SAR Issue	AA	CC	JB

NOTES:

1. ALL DIMENSIONS ARE IN METERS UNLESS STATED OTHERWISE.

LEGEND:

PATTERN	DETAIL
	HEAD
	LONDON CLAY
	LAMBETH GROUP
	THANET FORMATION
	CHALK GROUP
	TAPLOW GRAVEL

PATTERN	DETAIL
	ALLUVIUM
	RIVER TERRACE DEPOSITS
	LYNCH HILL GRAVEL
	HARWICH FORMATION
	BOYN HILL GRAVEL
	WORKING GROUND

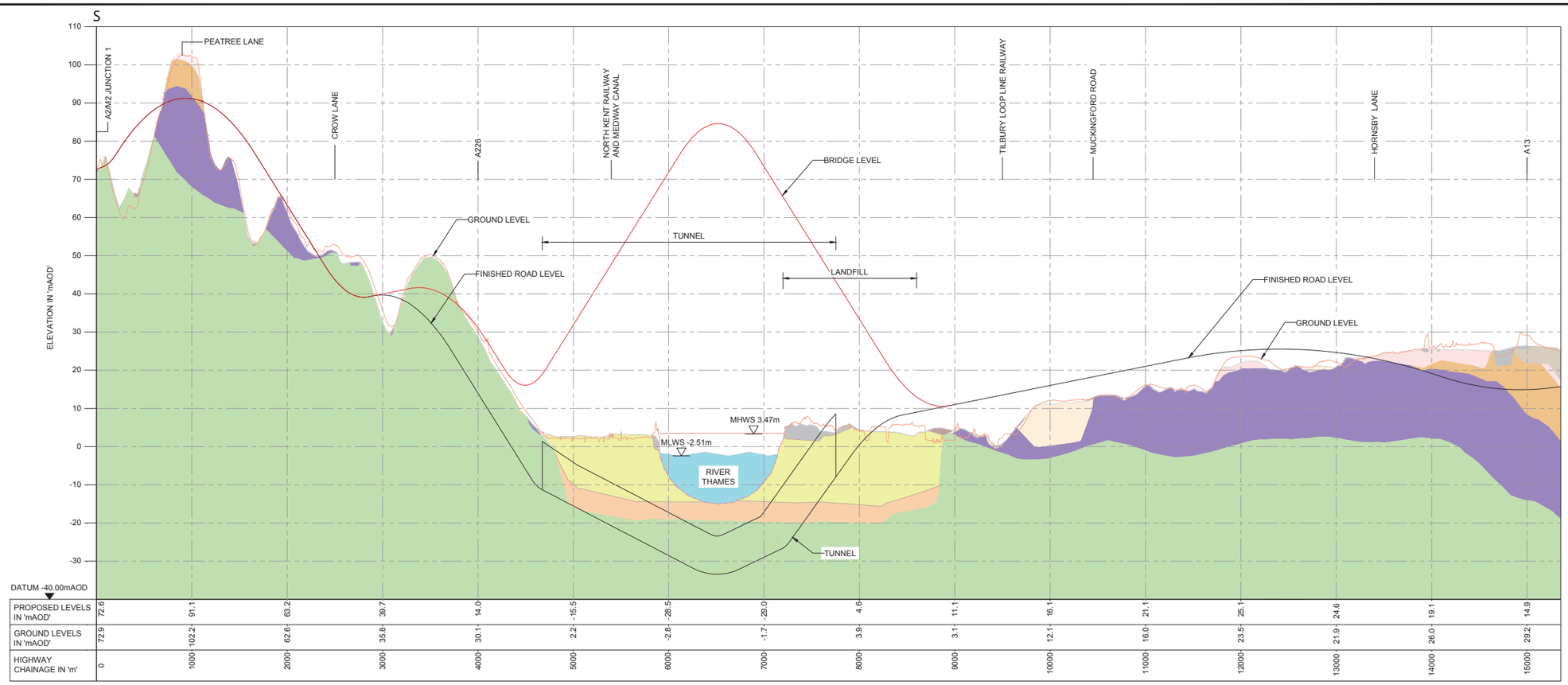
Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Route 2 Western Southern Link Geological Long Section

Status	S5
Revision	P01
Scale	1:1200 @ A1
Date -	18.01.16
Drawn By	Ashok A
Checked By	C Cooper
Approved By	J Baple
Project No. HA PIN / Originator	HA540039
Original Size	A1
Drawing number	HA540039-HHJ-HGT-CB1MLZZZML-DR-GT-001



GEOLOGICAL LONG SECTION

1 : 20000 HORIZ. & 1 : 500 VERT.

1 : 500

1 : 20000

ILLUSTRATIVE DESIGN

THE DESIGN SHOWN ON THESE DRAWINGS IS ILLUSTRATIVE AND MAY BE SUBJECT TO CHANGE IN LATER STAGES OF THE SCHEME DEVELOPMENT

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18.01.16	SAR Issue	AA	CC	JB

NOTES:

1. ALL DIMENSIONS ARE IN METERS UNLESS STATED OTHERWISE

LEGEND:

PATTERN	DETAIL
	HEAD
	LONDON CLAY
	LAMBETH GROUP
	THANET FORMATION
	CHALK GROUP
	TAPLOW GRAVEL

PATTERN	DETAIL
	ALLUVIUM
	RIVER TERRACE DEPOSITS
	LYNCH HILL GRAVEL
	HARWICH FORMATION
	BOYN HILL GRAVEL
	WORKING GROUND

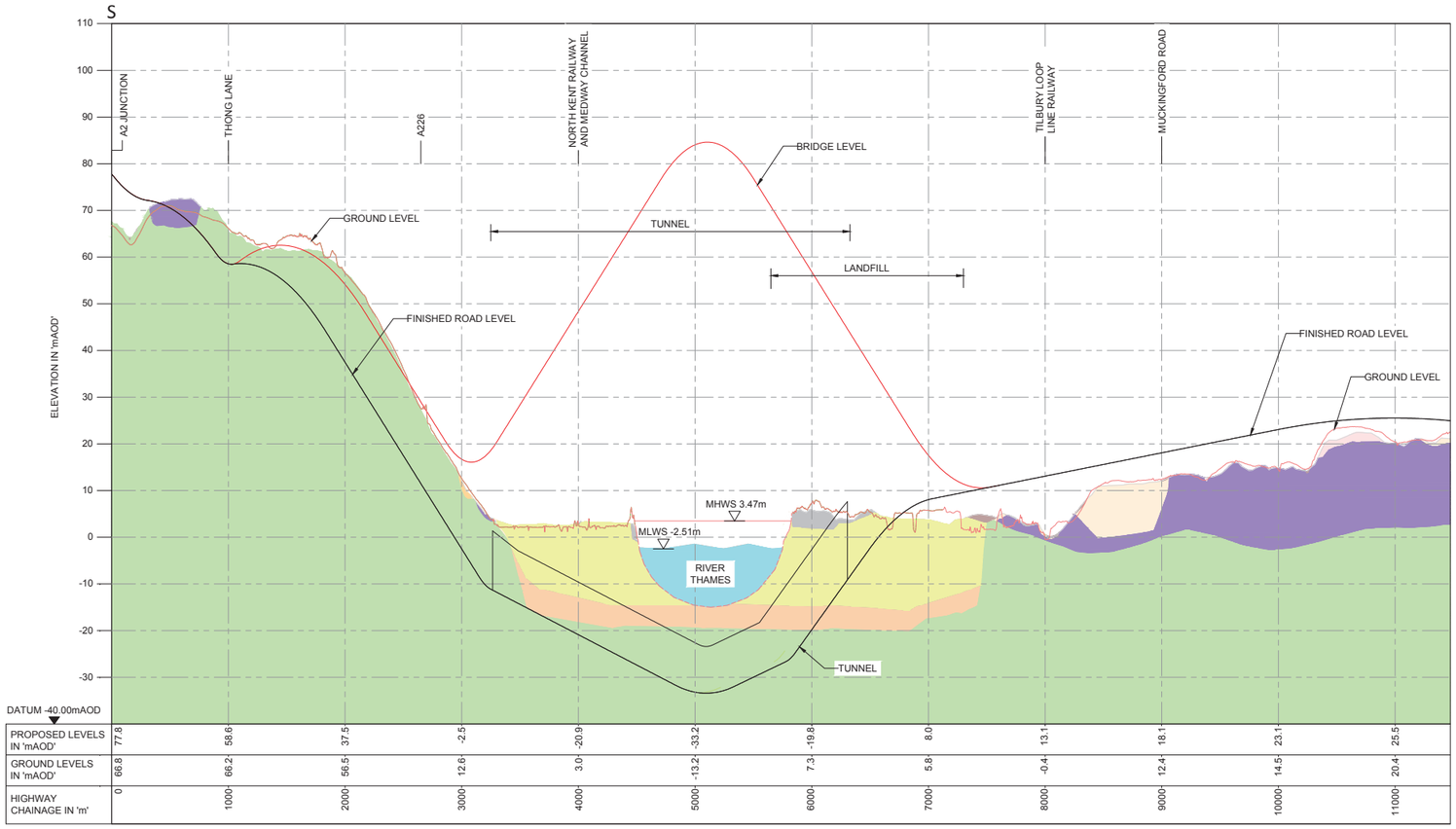
Client: highways england

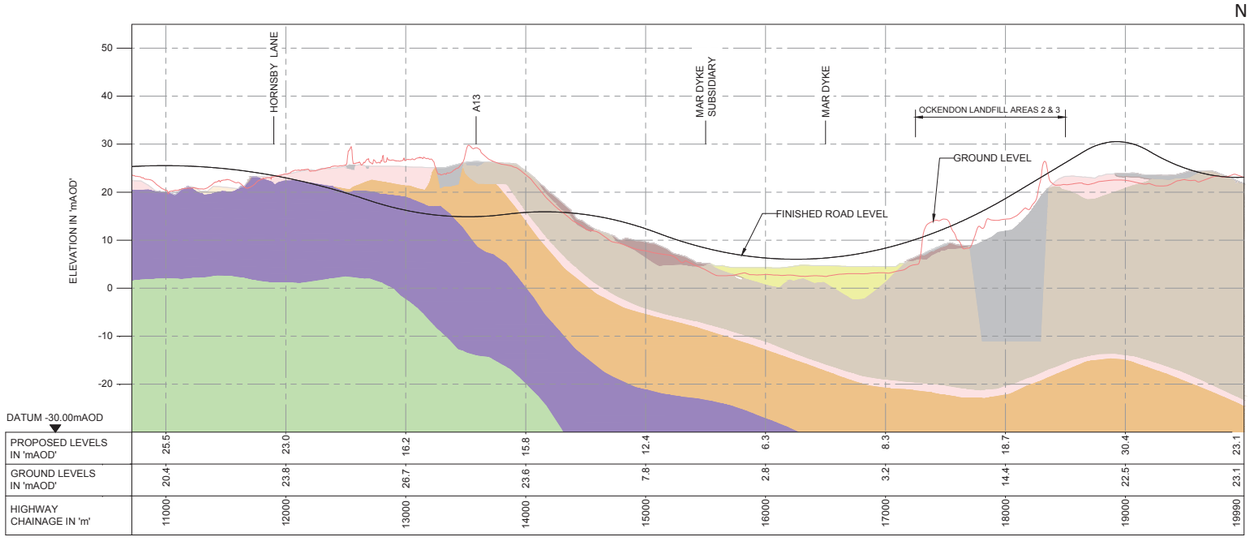
Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Route 3 Eastern Southern Link Geological Long Section

Status	S5
Revision	P01
Scale	1 : 1200 @ A1
Date	18.01.16
Drawn By	Ashok A
Checked By	C Cooper
Approved By	J Baple
Project No.	HA PIN / Originator: HA540039
Original Size	A1
Drawing number	HA540039-HHJ-HGT-CD3MLZZZML-DR-GT-001





GEOLOGICAL LONG SECTION

1 : 20000 HORIZ. & 1 : 500 VERT.

VERTICAL SCALE 1 : 500

HORIZONTAL SCALE 1 : 20000

ILLUSTRATIVE DESIGN

THE DESIGN SHOWN ON THESE DRAWINGS IS ILLUSTRATIVE AND MAY BE SUBJECT TO CHANGE IN LATER STAGES OF THE SCHEME DEVELOPMENT

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18.01.16	SAR Issue	AA	CC	JB

NOTES:

1. ALL DIMENSIONS ARE IN METERS UNLESS STATED OTHERWISE

LEGEND:

PATTERN	DETAIL
	HEAD
	LONDON CLAY
	LAMBETH GROUP
	THANET FORMATION
	CHALK GROUP
	TAPLOW GRAVEL

PATTERN	DETAIL
	ALLUVIUM
	RIVER TERRACE DEPOSITS
	LYNCH HILL GRAVEL
	HARWICH FORMATION
	BOYN HILL GRAVEL
	WORKING GROUND

Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Halcrow Hyder

Project: LOWER THAMES CROSSING

Drawing title: Route 3 Western Southern Link Geological Long Section

Status	S5
Revision	P01
Scale	1 : 1200 @ A1
Date -	18.01.16
Drawn By	Ashok A
Checked By	C Cooper
Approved By	J Baple
Project No. HA PIN / Originator	HA540039
Original Size	A1
Drawing number	HA540039-HHJ-HGT-CB1MLZZZML-DR-GT-002

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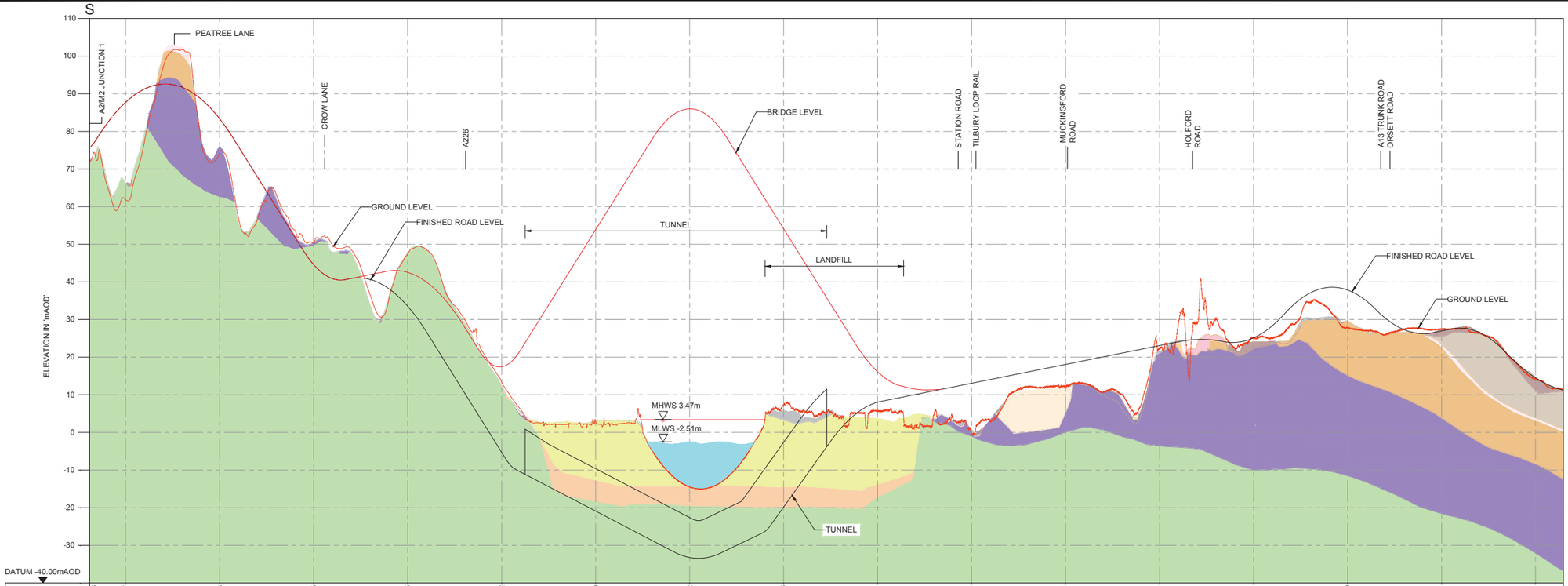

PROPOSED LEVELS IN 'mAOD'	75.6	87.7	83.3	44.5	33.6	-5.2	3.0	-20.9	-15.0	-33.2	7.3	-19.8	5.8	8.0	-0.4	13.1	12.3	18.1	22.2	23.1	25.1	25.1	27.9	37.9	27.4	27.0	14.2	14.5		
GROUND LEVELS IN 'mAOD'	72.1	61.8	74.3	50.2	47.4	13.3																								
HIGHWAY CHAINAGE IN 'm'	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000	14000	15000														

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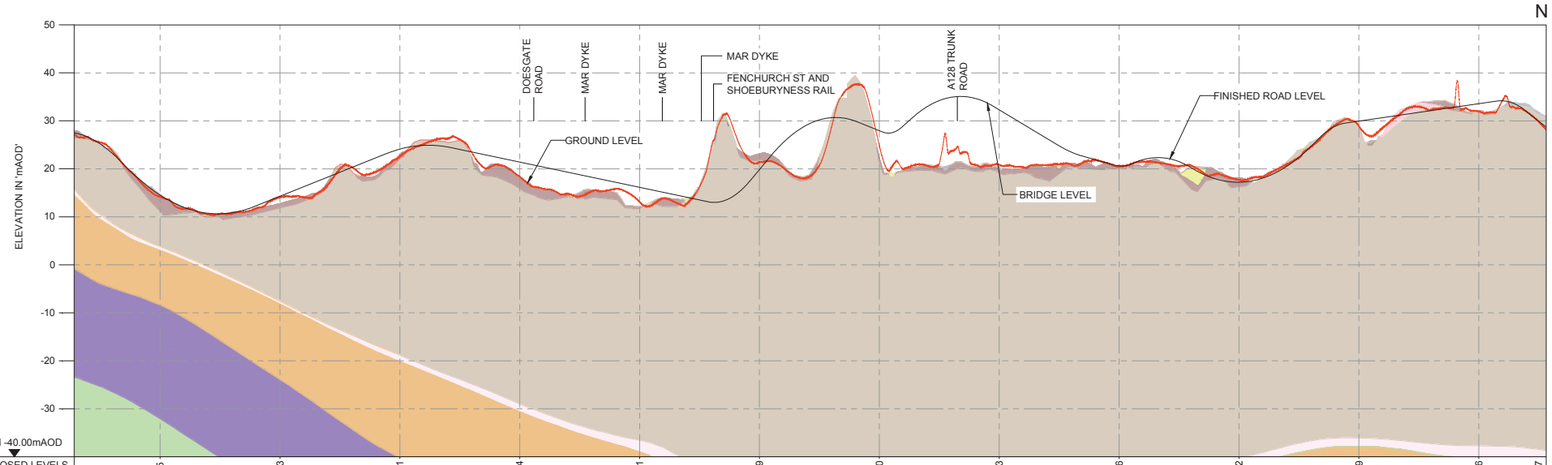

PROPOSED LEVELS IN 'mAOD'	14.5	14.3	24.1	21.4	16.1	19.9	28.0	32.3	20.6	17.2	29.9	33.6	28.7																	
GROUND LEVELS IN 'mAOD'	14.2	14.1	22.6	18.4	13.1	21.3	24.8	20.8	20.6	17.7	28.9	32.0	28.1																	
HIGHWAY CHAINAGE IN 'm'	15000	16000	17000	18000	19000	20000	21000	22000	23000	24000	25000	26000	26945																	

0 500 1000 1500 2000m

HORIZONTAL SCALE- 1 : 20000

0 5 10 20 30 40 50m

VERTICAL SCALE- 1 : 500

GEOLOGICAL LONG SECTION

1 : 20000 HORIZ. & 1 : 500 VERT.

ILLUSTRATIVE DESIGN

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Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18.01.16	SAR Issue	AA	CC	JB

NOTES:

1. ALL DIMENSIONS ARE IN METERS UNLESS STATED OTHERWISE.

LEGEND:

PATTERN	DETAIL
	HEAD
	LONDON CLAY
	LAMBETH GROUP
	THANET FORMATION
	CHALK GROUP
	TAPLOW GRAVEL

PATTERN	DETAIL
	ALLUVIUM
	RIVER TERRACE DEPOSITS
	LYNCH HILL GRAVEL
	HARWICH FORMATION
	BOYN HILL GRAVEL
	WORKING GROUND

Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Route 4 Eastern Southern Link Geological Long Section

	Status: S5		Revision: P01
Scale	1:1200 @ A1	Date -	18.01.16
Drawn By	Ashok A		
Checked By	C Cooper		
Approved By	J Baple		
Project No. HA PIN / Originator	HA540039	Original Size	A1
Drawing number	HA540039-HHJ-HGT-CD4MLZZZML-DR-GT-001		

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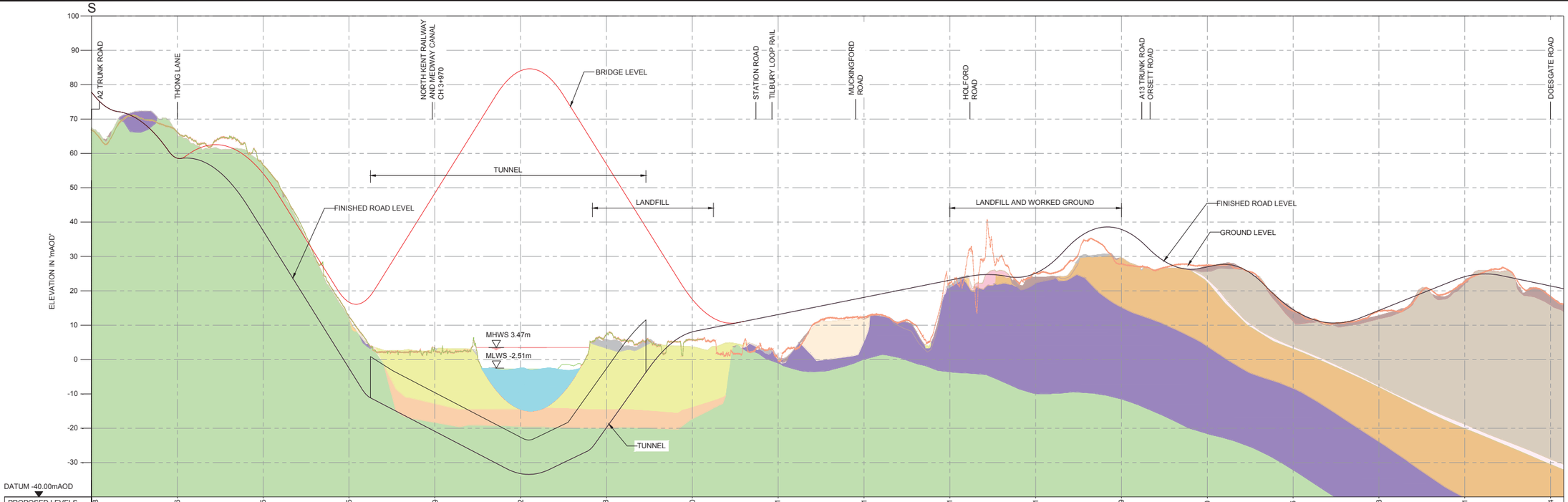
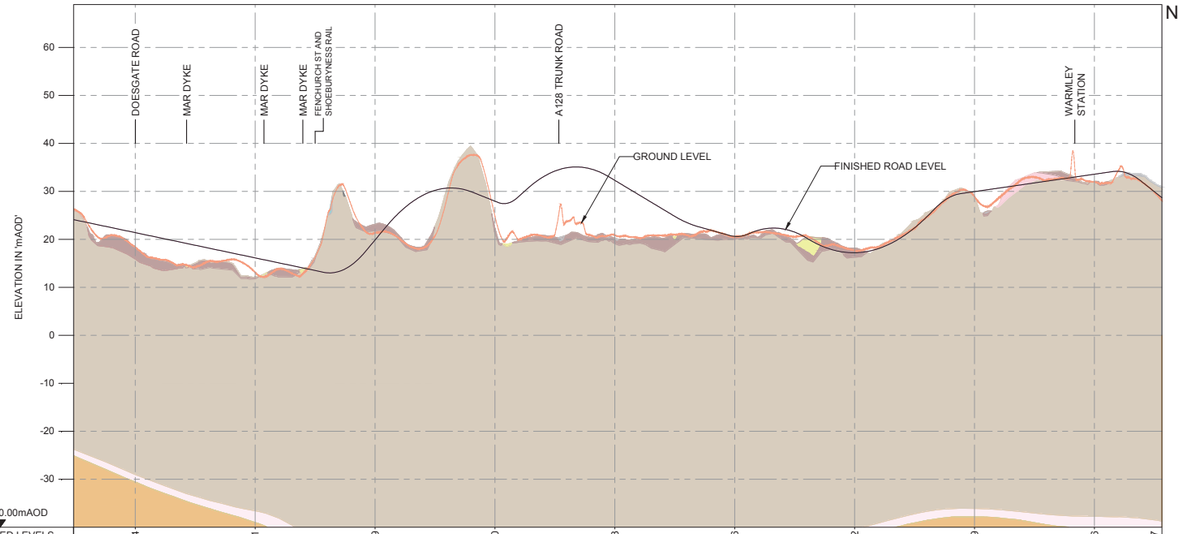


HIGHWAY CHAINAGE IN 'm'	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000	14000	15000	16000	17000
PROPOSED LEVELS IN 'mAOD'	77.8	58.6	37.5	-2.5	-20.9	-33.2	-19.8	8.0	13.1	18.1	23.1	25.1	37.9	27.0	14.5	14.3	24.1	21.4
GROUND LEVELS IN 'mAOD'	66.8	66.2	56.5	12.6	3.0	-15.0	7.3	5.8	-0.4	12.3	22.2	25.1	27.9	27.4	14.2	14.1	22.6	18.4

N



HIGHWAY CHAINAGE IN 'm'	17000	18000	19000	20000	21000	22000	23000	24000	25000	25563
PROPOSED LEVELS IN 'mAOD'	21.4	16.1	19.9	28.0	32.3	20.6	17.2	29.9	33.6	28.7
GROUND LEVELS IN 'mAOD'	18.4	13.1	21.3	24.8	20.8	20.6	17.7	28.9	32.0	28.1

0 500 1000 1500 2000m

1 : 20000

0 5 10 20 30 40 50m

1 : 500

GEOLOGICAL LONG SECTION

1 : 20000 HORIZ. & 1 : 500 VERT.

ILLUSTRATIVE DESIGN

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Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18.01.16	SAR Issue	AA	CC	JB

NOTES:

1. ALL DIMENSIONS ARE IN METERS UNLESS STATED OTHERWISE.

LEGEND:

PATTERN	DETAIL
	HEAD
	LONDON CLAY
	LAMBETH GROUP
	THANET FORMATION
	CHALK GROUP
	TAPLOW GRAVEL

PATTERN	DETAIL
	ALLUVIUM
	RIVER TERRACE DEPOSITS
	LYNCH HILL GRAVEL
	HARWICH FORMATION
	BOYN HILL GRAVEL
	WORKING GROUND

Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Route 4 Western Southern Link Geological Long Section

Status	S5	Revision	P01
Scale	1:1200 @ A1	Date -	18.01.16
Drawn By	Ashok A		
Checked By	C Cooper		
Approved By	J Baple		
Project No. HA PIN	HA540039	Originator	
Original Size	A1		

Drawing number: HA540039-HHJ-HGT-CB1MLZZZML-DR-GT-003

Appendix 4.3
Major Utilities Affected

Route 1 Major Utilities Affected
Route 2 Major Utilities Affected
Route 3 Major Utilities Affected
Route 4 Major Utilities Affected
Eastern Souhern Link Major Utilities Affected

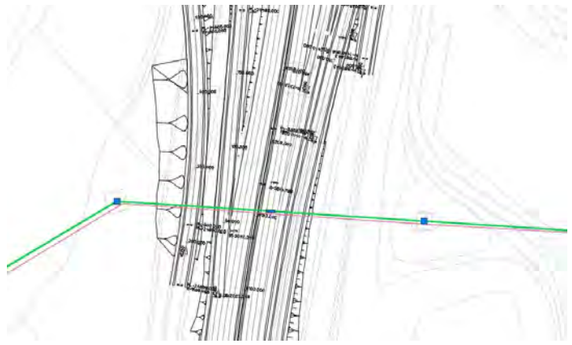
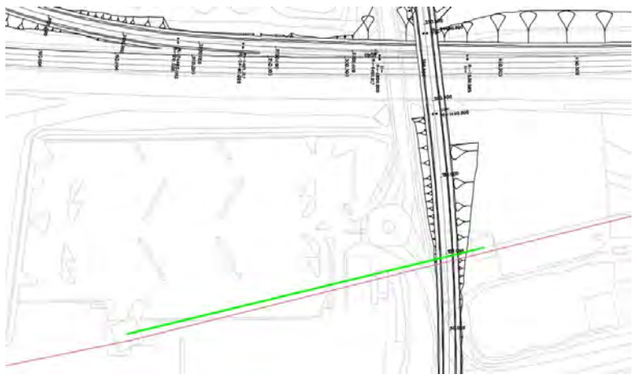
ROUTE 1 MAJOR UTILITIES AFFECTED

REF	SCHEME REF CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
Overhead Cables						
R1-OH03	3525	2 spans, 138m & 213m	Overhead conductors crossing the A282 roughly perpendicular to the line of the highway, continuing over the southern roundabout of Littlebrook interchange. Proposed widening and reconfiguration of A282 and southern Littlebrook Interchange roundabout anticipated to be at or near existing ground levels, requiring confirmation of safe clearance envelopes for both construction and operational phases. Presence of buried cables anticipated to north of terminal tower, passing beneath line of proposed northbound on slip. On slip is anticipated to be at or above existing ground. Data Source: OS Landline & Aerial Photography. Asset owner (UKTC) enquiries ongoing at time of writing.	BR,BT		Positive identification of line and level required to inform onward design development - Survey&sag/sway calculations and required safe clearance envelope required from Asset Owner. Positive identification of line and level of buried services required to inform onward design development - GPR/Trial pits. Proposed Lighting, signing and surface ancillary infrastructure to be designed/located to avoid impinging upon safe clearance envelopes of overhead conductors. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting buried services. Protection of buried services to be determined in consultation with the asset owner. Construction phasing and site control to comply with asset owner's requirements.
R1-OH04	3475	2 spans, 121m & 209m	Overhead conductors crossing the A282 roughly perpendicular to the line of the highway, continuing over the southern roundabout of Littlebrook interchange. Proposed widening and reconfiguration of A282 anticipated to be at or near existing ground levels, requiring confirmation of safe clearance envelopes for both construction and operational phases. Proposed realignment southern Littlebrook Interchange roundabout may incur a reduction in headroom of upto 650mm. Presence of buried cables anticipated to north of terminal tower, passing beneath line of proposed northbound on slip. On slip is anticipated to be at or above existing ground. Data Source: OS Landline & Aerial Photography. Asset owner (UKTC) enquiries ongoing at time of writing.	BR,BT		Positive identification of line and level required to inform onward design development - Survey&sag/sway calculations and required safe clearance envelope required from Asset Owner. Positive identification of line and level of buried services required to inform onward design development - GPR/Trial pits. Proposed Lighting, signing and surface ancillary infrastructure to be designed/located to avoid impinging upon safe clearance envelopes of overhead conductors. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting buried services. Protection of buried services to be determined in consultation with the asset owner. Should it be required, feasibility of raising the height of the intermediate tower to increase headroom at the southern Littlebrook Interchange roundabout to be investigated in consultation with the asset owner. Construction phasing and site control to comply with asset owner's requirements.
R1-OH05	4250	dual lines, 2 spans, 303&325m and 285&315m, 4 towers.	National Grid overheads transverse across the A282 at the northbound approach viaduct to the Proposed Bridge crossing (250m north from the end of the proposed northbound Junction 1a on slip). Prescribed clearance to the Thames Navigable channel and limitations on available longitudinal gradient (4%) places the proposed approach viaduct at conductor level with prospect of direct clash. Diversion will be required. Service data source: National Grid As-built records.	BR		Engagement and involvement of asset owner (National Grid) to be sought. Diversion design and costing to be determined by asset owner (National Grid). Diversion route (TBC) to take due cognisance of National Grid's headroom requirements from TS43-8 tbl 6.1) and preferences for lateral clearance between relocated towers and the proposed highway. Existing towers affected: YL022 to YL0023A and YL0022 to YL023B. Construction phasing and site control to comply with asset owner's requirements.

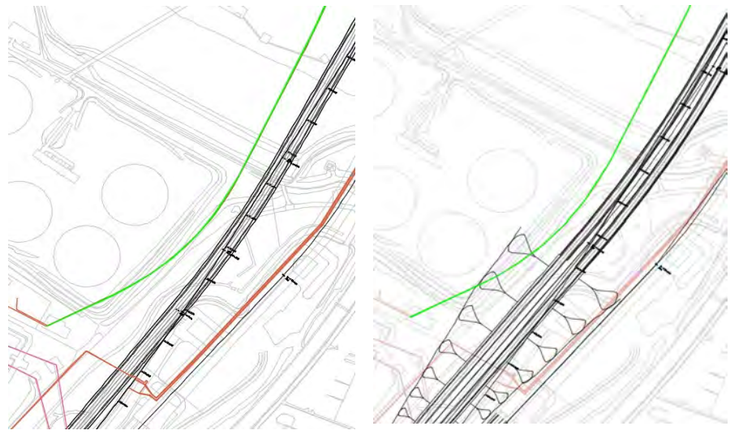
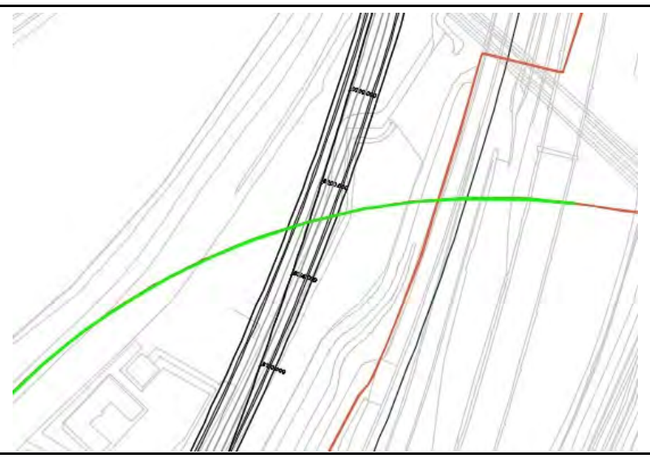
ROUTE 1 MAJOR UTILITIES AFFECTED

REF	SCHEME REF CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
R1-OH06	4250	dual lines, 2 spans, 303&325m and 285&315m, 4 towers.	National Grid overheads transverse across the A282 at the northbound approach to the Proposed Tunnel Crossing (250m north from the end of the proposed northbound Junction 1a on slip). Proposed highway alignment will be at or below exist ground levels, increasing the available safe clearance over the existing provision. Diversion is not anticipated. Cutting and/or retaining wall proposals in this are will require assessment to ensure compatibility with the tower foundations at towers YL0023A&B Service data source: National Grid As-built records.	BT		Engagement and approval of asset owner (National Grid) to be sought. Highway alignment design development to take due cognisance of National Grid's headroom requirements from TS43-8 tbl 6.1) and preferences for lateral clearance between relocated towers and the proposed highway.
R1-OH16	7875	single span, 235m	Proposed highway widening and partial realignment of existing A282 and National Grid High voltage overhead conductors intersect at a skew angle. Highway alignment changes anticipated to be predominantly at or near existing ground level, with potential for marginal reduction in clearance (c.200-300mm) where carriageway is raised for super elevation. Span affected:ZR026 to ZR027 Existing clearance c.17.3m. Anticipated clearance c.17.0 Data Source: National Grid 3D as-built records	BR,BT		Engagement, headroom requirements and approval of asset owner (National Grid) to be sought. Highway alignment design and ancillary feature development to take due cognisance of National Grid's headroom requirements from TS43-8 tbl 6.1) and preferences for lateral clearance between relocated towers and the proposed highway. Diversion currently considered to unlikely. Potential exists for re-tensioning of tower height increase. However, initial estimates of clearances to proposed highway exceed the most onerous requirements of TS43-8.

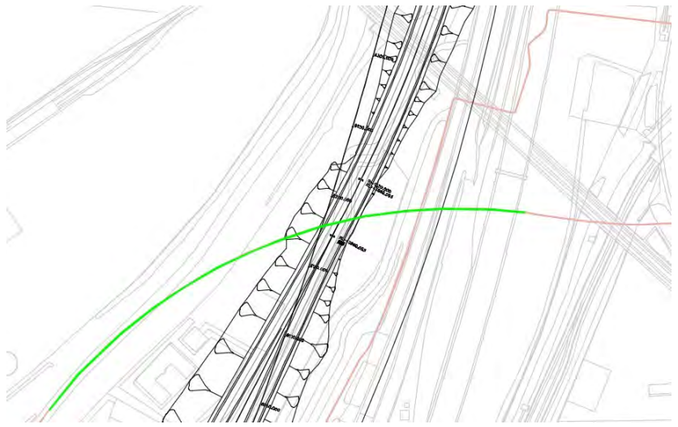
ROUTE 1 MAJOR UTILITIES AFFECTED

REF	SCHEME REF CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
R1-OH17	8150	single span, 210m	Proposed highway widening and partial realignment of existing A282 (and slips) and National Grid High voltage overhead conductors intersect approximately perpendicular to each other.. Highway alignment changes anticipated to be predominantly at or near existing ground level, with potential for marginal reduction in clearance (c.200-300mm) where carriageway is raised for super elevation. Span affected:ZBA012 to ZBA013 Anticipated clearance c.20.00m Data Source: National Grid 3D as-built records	BR,BT		Engagement, headroom requirements and approval of asset owner (National Grid) to be sought. Highway alignment design and ancillary feature development to take due cognisance of National Grid's headroom requirements from TS43-8 tbl 6.1) and preferences for lateral clearance between relocated towers and the proposed highway. Diversion currently considered to unlikely. Potential exists for re-tensioning of tower height increase. However, initial estimates of clearances to proposed highway exceed the most onerous requirements of TS43-8.
R1-OH18	A13 Eastbound ch450	single span, 240m	Proposed realignment of existing B186 Pilgrims Lane and National Grid High voltage overhead conductors intersect approximately perpendicular to each other.. Highway alignment changes anticipated to be predominantly at or near existing highway level, with potential for marginal reduction in clearance (c.100-200mm) where carriageway is raised for super elevation. Span affected: YYJ099 to YYJ100 Anticipated clearance c.30.00+m Due to existing topography, proposed highway is on embankment (c.2.5m height) the toe of which is found in close proximity with YYJ100 foundation fooprint. Lateral load transferral is possible. Data Source: National Grid 3D as-built records	BR,BT		Engagement, headroom requirements and approval of asset owner (National Grid) to be sought. Highway alignment design and ancillary feature development to take due cognisance of National Grid's headroom requirements from TS43-8 tbl 6.1) and preferences for lateral clearance between relocated towers and the proposed highway. Diversion currently considered to unlikely. Potential exists for re-tensioning of tower height increase. However, initial estimates of clearances to proposed highway exceed the most onerous requirements of TS43-8. Diversion or tower modification is considered unlikely. Potential exists for earthworks steepening or a localised low retaining structure to limit highway footprint encroachment towards tower base.
Gas Mains						
R1-GP01	2665	8m (to west) 8m (to east)	Sub-surface medium pressure gas pipeline crossing beneath existing A282 on approximate line of Bow Arrow Lane south footway. Widening to northbound and southbound A282 increases extent and depth of cover to east (approx. 1m increased cover depth) and west (approx. 2m increased cover depth). Existing depth of cover unknown. Data source: National Grid	BR,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Structure and foundation design for new bridges in the vicinity to be mindful of possible clash and/or sub-surface load distribution. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.

ROUTE 1 MAJOR UTILITIES AFFECTED

REF	SCHEME REF CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
Oil Pipeline						
R1-OP02	3500	TBC	Sub-surface Oil Pipeline(s) crossing the A282 roughly perpendicular to the carriageways. Existing depth unknown. Data Source: Linesearch. Supplied with indicated 100foot corridor - location within corridor is not definite. Proposed Northbound On slip crosses line of twin pipelines at or above existing ground level. Widening of southbound off-slip crosses the line of pipelines. Possible decrease in cover depth if pipelines deviate from midline of supplied 10 foot wide corridor information. Minor amendments to LIttlebrook Interchange roundabouts at or above existing ground.	BR,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Structure and foundation design for new bridges in the vicinity to be mindful of possible clash and/or sub-surface load distribution. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (Esso) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.
Cable Tunnel						
R1-UG07	4500-4700	200m (parallel)	Proposed Highway alignments to both Bridge and Tunnel variants run parallel to deep National Grid Cable Tunnel beneath the Thames. The proposed highway alignments have been positioned to maintain a minimum lateral clearances of 20m for the Bridge and 25m for the Tunnel options. There is potential for sub-surface load and/or vibration transmission. NB - The attached illustration for the tunnel option indicates earthworks cutting extents which are to be replaced by cut&cover and bored tunnel techniques. The earthworks extents shown are *not* the proposed solution, but merely indicate where the proposed highway is below ground.	BT, BR		Engagement and approval of asset owner (National Grid) to be sought. Development of structural solutions for bridge and tunnel to take due cogniscence of National Grid advice. Diversion requirement is not anticipated at this time. Construction phasing and site control to comply with asset owner's requirements.
R1-UG14	6180	50	Proposed footprint of northern approach viaduct intersects with the line of National Grid's Thames Crossing Cable Tunnel. Tunnel is expected to be encountered at considerable depth below existing ground. Potential clash or influence by bridge foundations. Data Source: National Grid As-built information	BR		Engagement and involvement of asset owner (National Grid) to be sought. Development of structural solutions for bridge to take due cogniscence of National Grid advice. If bridge pier spacing and foundation type and method of construction is developed to the asset owner's approval, diversion requirement is considered to be unlikely and technically unfeasible. Construction phasing and site control to comply with asset owner's requirements.

ROUTE 1 MAJOR UTILITIES AFFECTED

REF	SCHEME REF CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
R1-UG15	6180	50	Proposed footprint of northbound carriageway leaving the proposed tunnel portal structures intersects with the line of National Grid's Thames Crossing Cable Tunnel. Tunnel is expected to be encountered at considerable depth below existing ground. Potential influence by local retaining structures and ancillary surface infrastructure foundations Data Source: National Grid As-built information NB - attached illustration does not show approach structures found in the vicinity of the highway tunnel portal	BT		Engagement and involvement of asset owner (National Grid) to be sought. Development of solutions for tunnel approach structures, ancillary structures and highway cutting to take due cogniscence of National Grid advice. If Cable Tunnel is encountered at considerable depth, diversion is unlikely. Construction phasing and site control to comply with asset owner's requirements.
Underground Electric Cable						
R1-UG08	4385	110m	Sub surface National Grid conductors (issuing from the existing western tunnel bore) and approach viaduct for bridge crossing, intersect roughly perpendicular to each other. The proposed highway is on Viaduct approximately 30m above existing ground at this location. Data Source: Linesearch	BR		Engagement and involvement of asset owner (National Grid) to be sought. Development of structural solutions for bridge and tunnel to take due cogniscence of National Grid advice. Diversion requirement is not anticipated at this time. Likelihood of cable status (possible redundancy) to be explored fully. Anecdotally thought to have been replaced in part by the National Grid Thames cable tunnel. Construction phasing and site control to comply with asset owner's requirements.

ROUTE 1 MAJOR UTILITIES AFFECTED

REF	SCHEME REF CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
R1-UG09	4385	110m	Sub surface National Grid conductors (issuing from the existing western tunnel bore) and tunnel crossing, intersect roughly perpendicular to each other. The proposed highway is in retained cutting or tunnel approximately 10m below existing ground at this location. Data Source: Linesearch	BT		Engagement and involvement of asset owner (National Grid) to be sought. Development of diversion solutions to be developed in consultation with the asset owner. Likelihood of cable status (possible redundancy) to be explored fully. Anecdotally thought to have been replaced in part by the National Grid Thames cable tunnel. Construction phasing and site control to comply with asset owner's requirements.
R1-UG10	5800-5900	120m	Sub-surface high voltage National Grid cables found within 10m of northern approach viaduct footprint with partial encroachment beneath. Anecdotally thought to be redundant sub-surface of element of National Grid's Thames crossing subsequently diverted away from the line of HS1 into the new Thames Cable Tunnel. If residual function and asset value is confirmed, proximity with viaduct foundations is possible with associated risk of sub-surface load or vibration transmission.	BR		Engagement and involvement of asset owner (National Grid) to be sought. Development of diversion solutions to be developed in consultation with the asset owner. Likelihood of cable status (possible redundancy) to be explored fully. Anecdotally thought to have been replaced in part by the National Grid Thames cable tunnel. If found to be functional, diversion is unlikely, protection works more likely. Construction phasing and site control to comply with asset owner's requirements.

ROUTE 1 MAJOR UTILITIES AFFECTED

REF	SCHEME REF CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
R1-UG11	5800	150	Sub-surface high voltage National Grid cable route found within 25m of northern approach viaduct alignment. Route and highway footprint do not directly clash. However, possible lateral load or vibration transfer may occur. Data Source: Linesearch	BR		Engagement and approval of asset owner (National Grid) to be sought. Development of structural solutions for bridge and approach viaduct to take due cogniscence of National Grid advice. Diversion requirement is not anticipated at this time. Construction phasing and site control to comply with asset owner's requirements.
R1-UG12	5800-5900	120	Sub-surface high voltage National Grid cables found within 10m of northern approach cutting at the proposed east-bore tunnel northern portal, with partial encroachment beneath likely retaining structures. Anecdotally thought to be redundant sub-surface of element of National Gris's Thames crossing subsequently diverted away from the line of HS1 into the new Thames Cable Tunnel. If residual function and asset value is confirmed, diversion will be required. NB - attached illustration does not show approach structures: Shown cutting annotation is indicative of relative depth below existing ground *not* actual proposed earthworks footprint. Data Source: Linesearch	BT		Engagement and involvement of asset owner (National Grid) to be sought. Development of diversion solutions to be developed in consultation with the asset owner. Likelihood of cable status (possible redundancy) to be explored fully. Anecdotally thought to have been replaced in part by the National Grid Thames cable tunnel. If found to be functional, diversion will be required. Construction phasing and site control to comply with asset owner's requirements.

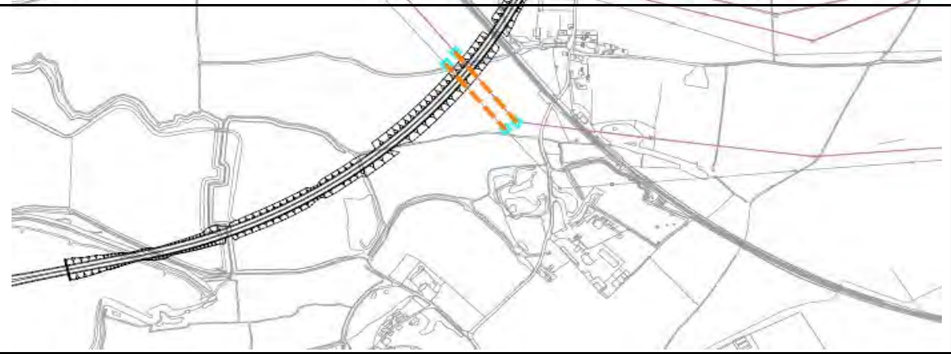
ROUTE 1 MAJOR UTILITIES AFFECTED

REF	SCHEME REF CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
R1-UG13	5800	150	Sub-surface high voltage National Grid cable route found within 25m of northern approach cutting alignment. Route and highway footprint do not directly clash. However, possible lateral load or vibration transfer may occur. NB - attached illustration does not show approach structures: Shown cutting annotation is indicative of relative depth below existing ground not actual proposed earthworks footprint.	BT		Engagement and approval of asset owner (National Grid) to be sought. Development of structural solutions for tunnel and approach structures to take due cogniscence of National Grid advice. Diversion requirement is not anticipated at this time. Construction phasing and site control to comply with asset owner's requirements.

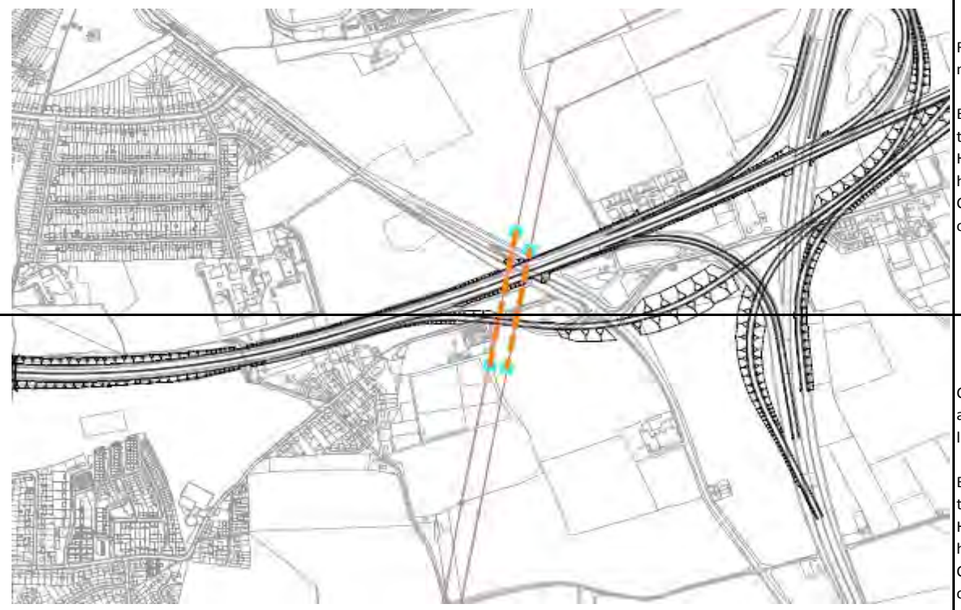
ROUTE 2 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
Overhead Cables						
C3-OH01	0+000 A2 Junction	415	Overhead Cable crossing roughly perpendicularly to A2 Realignment and A2 eastbound to LTC Slip road, continuing parallel to the LTC. Pylon AYN049A affected by A2 Realignment. Cable clearances to proposed levels: OHC z1=82.0m, z2= 80.6m, z3=77.5m LTC z1=69.3m, z2=72.9m, z3=69.8m	BR,IT,BT		Subject to lateral clearance requirements: - No action required - 415m underground diversion and pylon AYN049A removal. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Preferences for lateral clearance between towers and the proposed highway to be confirmed to determine if pylon AYN049A needs to be relocated/removed. Construction phasing and site control to comply with asset owner's requirements.
C3-OH02	2+500 A226 Realignment	362	Overhead Cable crossing perpendicularly to A226 Realignment, which at that point is at ground level. Cable clearances to proposed levels: OHC z=44.2m LTC z=31.3m	BR		Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C3-OH03	4+000	305	Overhead Cable located under LTC approach viaduct, parallel to the North Kent Railway. Cable clearances to proposed levels: OHC z=11.9m LTC z=50m	BR		300m underground diversion . Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner'srequirements.

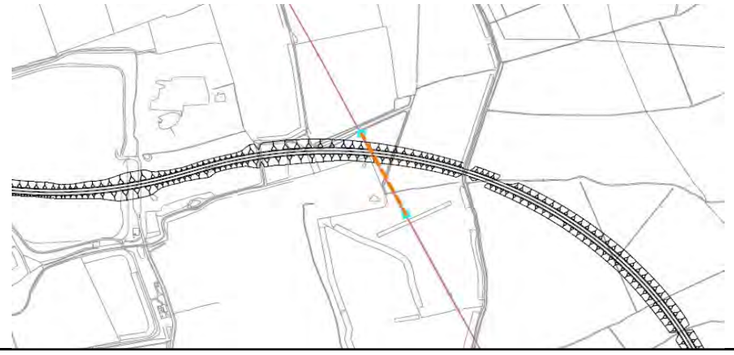
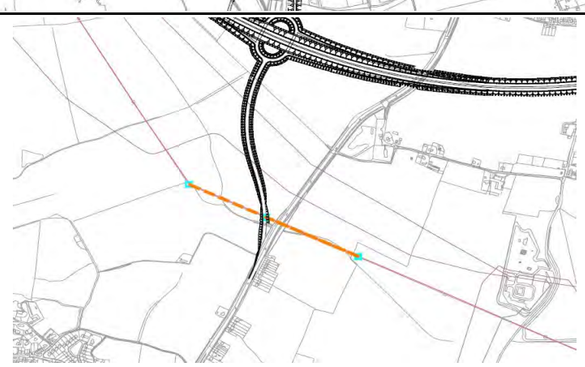
ROUTE 2 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C3-OH04	9+060	241	Overhead Cable crossing perpendicularly over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: OHC z=5.8m LTC z=5.7m	BR,IT,BT		241m underground diversion . Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Raise the pylon to achieve required clearance. Construction phasing and site control to comply with asset owner'srequirements.
C3-OH05	9+110	253	Overhead Cable crossing perpendicularly over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: OHC z=5.9m LTC z=5.8m	BR,IT,BT		253m underground diversion. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Raise the pylon to achieve required clearance. Construction phasing and site control to comply with asset owner'srequirements.
C3-OH06	9+1410	326	Overhead Cable crossing perpendicularly over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: OHC z=7.6m LTC z=7.6m	BR,IT,BT		326m underground diversion . Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Raise the pylon to achieve required clearance. Construction phasing and site control to comply with asset owner'srequirements.
C3-OH07	9+460	366	Overhead Cable crossing perpendicularly over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: OHC z=7.65m LTC z=7.6m	BR,IT,BT		366m underground diversion . Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Raise the pylon to achieve required clearance. Construction phasing and site control to comply with asset owner'srequirements.

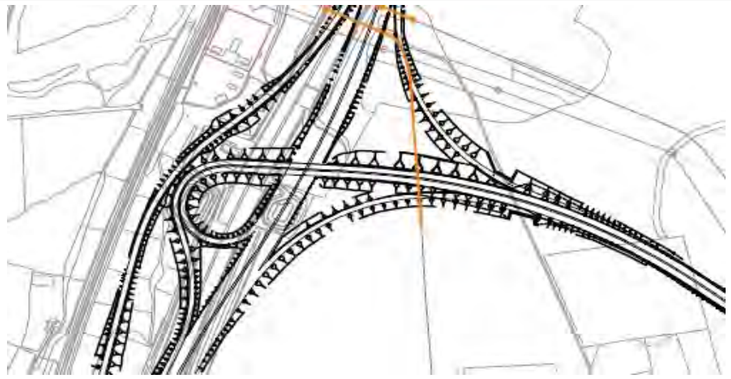
ROUTE 2 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C3-OH08	14+610	322	Overhead Cable crossing over the LTC mainline in embankment, and the A13 westbound to LTC southbound slip road, which is in a viaduct at this point. Cable clearances to proposed levels: OHC z=31.0m LTC z=26.4m	BR,IT,BT		Raise pylons 2m to achieve required clearance and divert 322 meters of overhead line. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner'srequirements.
C3-OH09	14+660	285	Overhead Cable crossing over the LTC mainline, which at that point is in viaduct over the A1013, and also crossing over the A13 westbound to LTC southbound slip road, which is in a viaduct at this point.	BR,IT,BT		Cable clearances not available. Assume raising pylons 2m to achieve required clearance and divert 285 meters of overhead line. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner'srequirements.
C3-OH10	A13 Junction	352	Overhead Cable crossing over the A13 westbound to LTC slip roads roughly perpendicular to the line of the slip at ground level, and over the A13 mainline. Cable clearances to proposed levels: OHC z1=31.0m, z2=24.8m LTC z1=27.7m, z2=25.8m	BR,IT,BT		352m underground diversion. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner'srequirements.

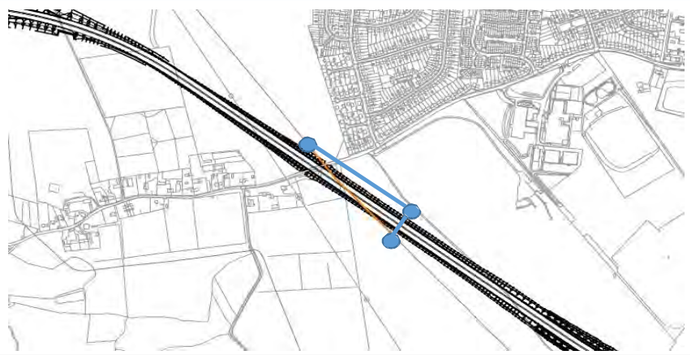
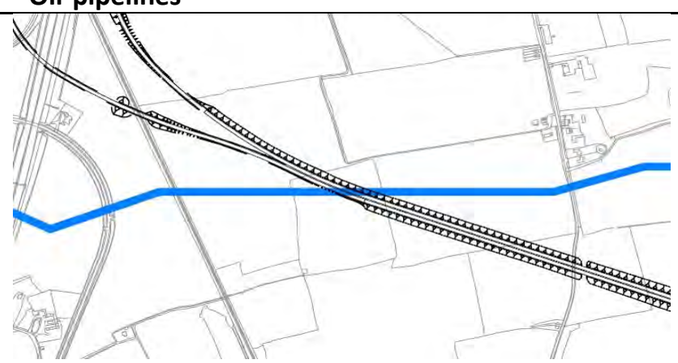
ROUTE 2 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C3-OH11	A13 Junction	355	Overhead Cable crossing over the A13 westbound to LTC slip roads roughly perpendicular to the line of the slip at ground level.	BR,IT,BT		Cable clearances not available. Assume 355m underground diversion. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner'srequirements.
C3-OH12	19+110	349	Overhead Cable crossing perpendicularly over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: OHC z=7.5m LTC z=10.1m	BR,IT,BT		349m underground diversion. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner'srequirements.
C3-OH13	M25 Junction	268	Overhead Cable crossing over the M25 mainline and over M25 - LTC Slip roads in embankment.	BR,IT,BT		Cable clearances not available. Assume raising pylons to achieve required clearance and divert 268 meters of overhead line. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner'srequirements.
C3-OH14	A226 Realignment	665	Overhead Cable crossing perpendicularly to A226 Realignment, which at that point is at ground level. Pylon AYN041 located in the new alignment of the A226. Cable clearances to proposed levels: OHC z=44.5m LTC z=32.0m	IT, BT		Subject to lateral clearance requirements: - No action required - 665m underground diversion and pylon AYN041 removal. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Preferences for lateral clearance between towers and the proposed highway to be confirmed to determine if pylon AYN041 needs to be relocated/removed. Construction phasing and site control to comply with asset owner's requirements.

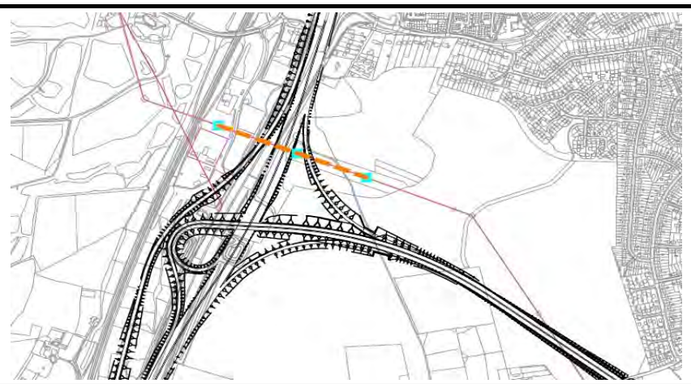
ROUTE 2 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
Gas mains						
C3-GM01	0+000 A2 Junction	125	Gas feeder affected by A2 and LTC Slip roads. Crossing under the new link road connecting Hever Ct Rd to Brewers road junction in cutting, under the A2 mainline at ground level, and under the A2 eastbound to LTC in embankment.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner'srequirements.
C3-GM02	0+000 A2 Junction	182	Gas feeder affected by A2 and LTC Slip roads. Crossing under the new link road connecting Hever Ct Rd to Brewers road junction in cutting, under the A2 mainline at ground level, and under the A2 eastbound to LTC in embankment.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner'srequirements.
C3-GM03	0+000 A2 Junction	430	Gas feeder affected by A2 and LTC Slip roads. Crossing under the A2 eastbound to LTC slip road, under the LTC mainline, and under the LTC to A2 eastbound slip, all of them in embankment.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner'srequirements.

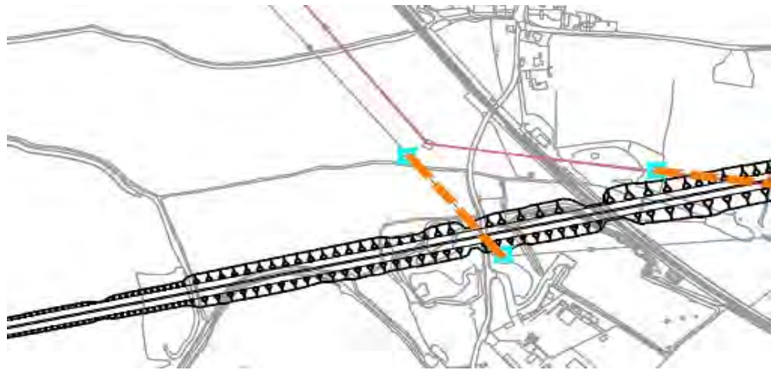
ROUTE 2 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C3-GM04	1+000	298	Gas feeder crossing under the LTC Mainline in cuttting	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Pipe likely to be affected, in which case a suitable diversion will need to be proposed and the pipe level lowered under the mainline level. Subject to Gas Feeder level and required clearance: - None - 380m underground diversion under LTC level Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner'srequirements.
				Oil pipelines		
C3-OP01	22+210	50m	Barking Power Station Fuel line crossing under the LTC mainline in embankment.			Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner'srequirements.

ROUTE 3 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
			Overhead Cables			
C2-OH01	0+000 A2 Junction	415	Overhead Cable crossing roughly perpendicularly to A2 Realignment and A2 eastbound to LTC Slip road, continuing parallel to the LTC. Pylon AYN049A affected by A2 Realignment. Cable clearances to proposed levels: OHC z1=82.0m, z2= 80.6m, z3=77.5m LTC z1=69.3m, z2=72.9m, z3=69.8m	BR,IT,BT		Subject to lateral clearance requirements: - No action required - 415m underground diversion and pylon AYN049A removal. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Preferences for lateral clearance between towers and the proposed highway to be confirmed to determine if pylon AYN049A needs to be relocated/removed. Construction phasing and site control to comply with asset owner's requirements.
C2-OH02	2+500 A226 Realignment	362	Overhead Cable crossing perpendicularly to A226 Realignment, which at that point is at ground level. Cable clearances to proposed levels: OHC z=44.2m LTC z=31.3m	BR		Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C2-OH03	4+000	305	Overhead Cable located under LTC approach viaduct, parallel to the North Kent Railway. Cable clearances to proposed levels: OHC z=11.9m LTC z=50m	BR		300m underground diversion . Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements.

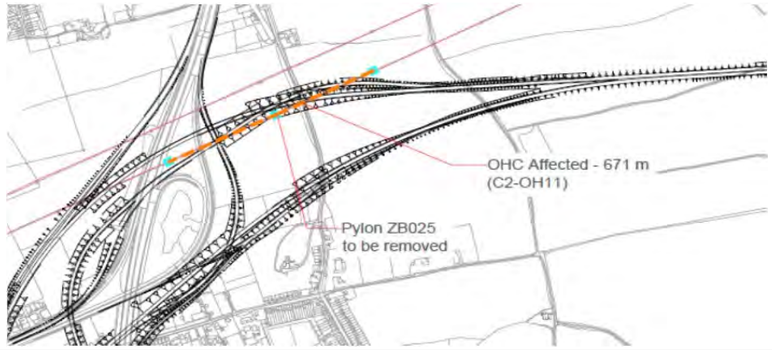
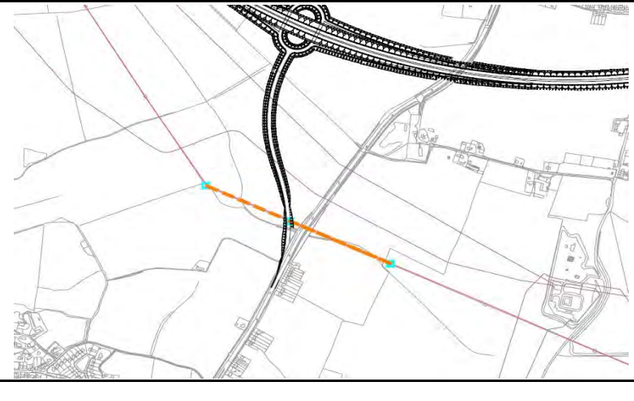
ROUTE 3 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C2-OH04	6+340	224	Overhead Cable crossing perpendicularly over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: OHC z=6.5m LTC z=13.7m	BR,IT,BT		Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C2-OH05	9+610	430	Overhead Cable crossing over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: Cable z=5.35m LTC z=13.9m	BR,IT,BT		Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C2-OH06	10+140	284	Overhead Cable crossing perpendicularly over the LTC mainline, which is in embankment at this point. Pylons affected by the LTC earthworks. Cable clearances to proposed levels not available.	BR,IT,BT		Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements. Cable clearances not available. Assume 284m underground diversion .

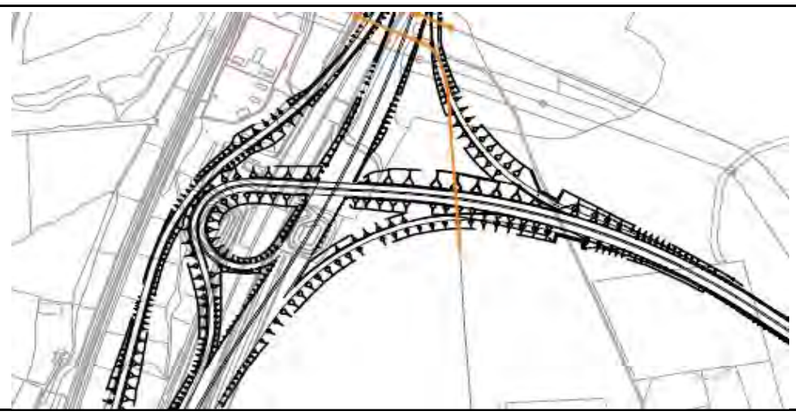
ROUTE 3 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C2-OH07	11+210	301	Overhead Cable crossing over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: Cable z=21.0m LTC z =22.0m	BR,IT,BT		Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements. 301m underground diversion .
C2-OH08	11+260	303	Overhead Cable crossing perpendicularly over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: Cable z=19.7m LTC z =22.4m	BR,IT,BT		Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements. 303m underground diversion .
C2-OH09	12+010	740	Overhead Cable crossing over the LTC mainline, which is in embankment at this point, and over the LTC to Brentwood road slip in cutting. Cable clearances to proposed levels: Cable z1=27.1m, z2=33.3m, z3=37.5m LTC z1=24.2m, z2=17.7m, z3=23.7m	BR,IT,BT		Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements. 500m underground diversion under LTC mainline. Clearances of existing cables adequate over junction slip road.
C2-OH10	12+110	739	Overhead Cable crossing over the LTC mainline, which is in embankment at this point, and over the LTC to Brentwood road slip in cutting. Cable clearances to proposed levels: Cable information missing, assume similar layout to C2-OH09	BR,IT,BT		Assuming similar layout to that of C2-OH09: - 425m underground diversion under LTC mainline. - Clearances of existing cables adequate over junction slip road. Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements.

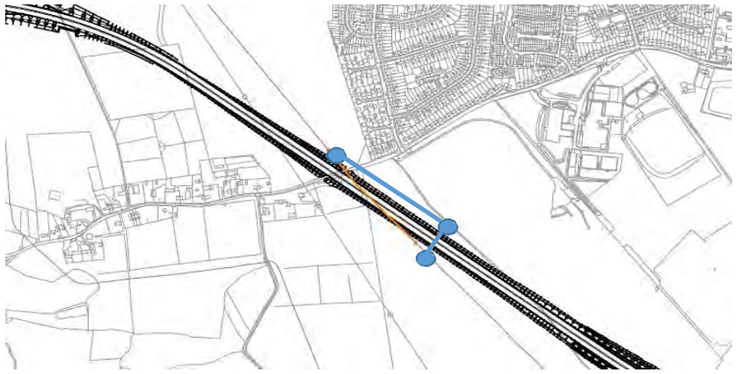
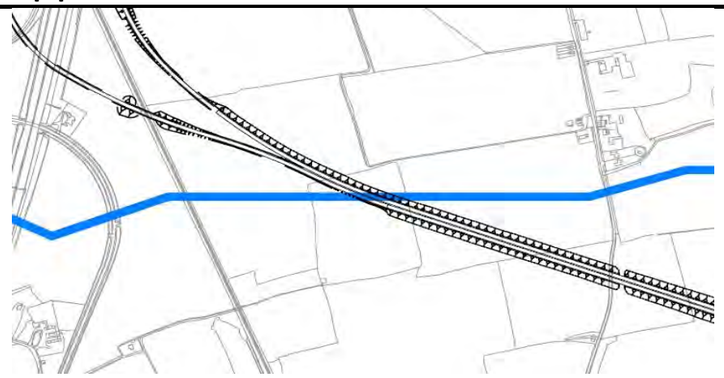
ROUTE 3 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C2-OH11	15+410	671	Overhead Cable crossing over the LTC mainline in cutting, over the A13 eastbound to LTC southbound slip at the ground level, over the A13 westbound to LTC northbound slip in embankment, and over the A1089 to A13 westbound slip in cutting. Cable clearances to proposed levels: OHC z=29.1m LTC z=15.15m	BR,IT,BT		Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C2-OH12	18+260	354	Overhead Cable crossing perpendicularly over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: OHC z=7.5m LTC z=10.1m	BR,IT,BT		349m underground diversion. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C2-OH13	M25 Junction	269	Overhead Cable crossing over the M25 mainline and over M25 - LTC Slip roads in embankment.	BR,IT,BT		Cable clearances not available. Assume raising pylons to achieve required clearance and divert 268 meters of overhead line. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements do not comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C2-OH14	A226 Realignment	665	Overhead Cable crossing perpendicularly to A226 Realignment, which at that point is at ground level. Pylon AYN041 located in the new alignment of the A226. Cable clearances to proposed levels: OHC z=44.5m LTC z=32.0m	IT, BT		Subject to lateral clearance requirements: - No action required - 665m underground diversion and pylon AYN041 removal. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Preferences for lateral clearance between towers and the proposed highway to be confirmed to determine if pylon AYN041 needs to be relocated/removed. Construction phasing and site control to comply with asset owner's requirements.

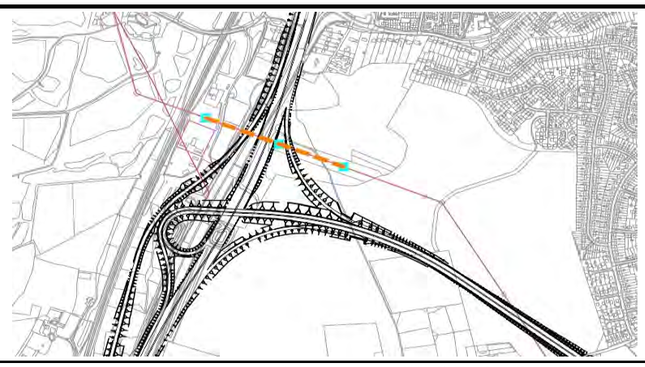
ROUTE 3 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
Gas mains						
C2-GM01	-	125	Gas feeder affected by A2 and LTC Slip roads. Crossing under the new link road connecting Hever Ct Rd to Brewers road junction in cutting, under the A2 mainline at ground level, and under the A2 eastbound to LTC in embankment.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.
C2-GM02	-	182	Gas feeder affected by A2 and LTC Slip roads. Crossing under the new link road connecting Hever Ct Rd to Brewers road junction in cutting, under the A2 mainline at ground level, and under the A2 eastbound to LTC in embankment.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.
C2-GM03	-	430	Gas feeder affected by A2 and LTC Slip roads. Crossing under the A2 eastbound to LTC slip road, under the LTC mainline, and under the LTC to A2 eastbound slip, all of them in embankment.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.

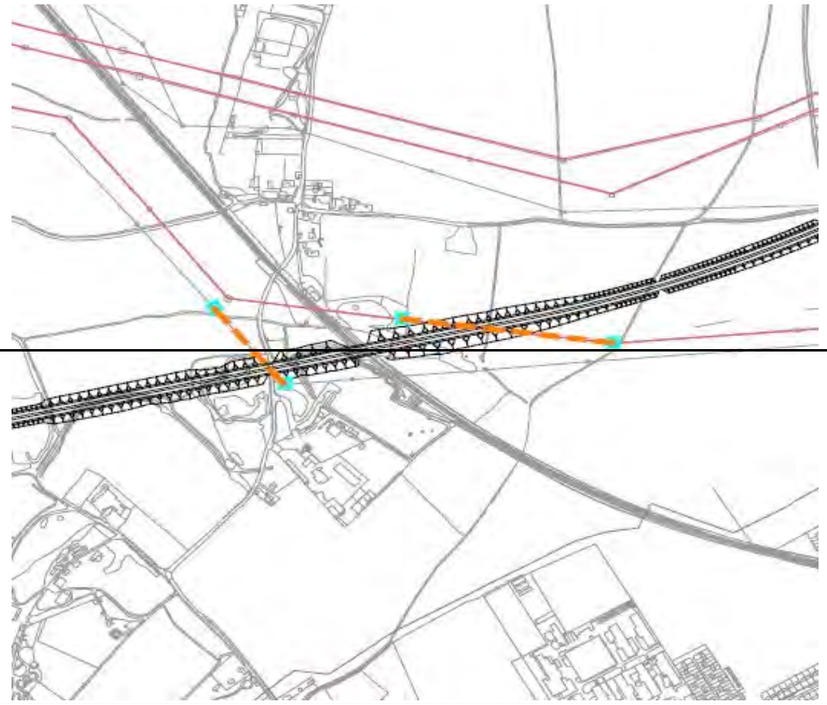
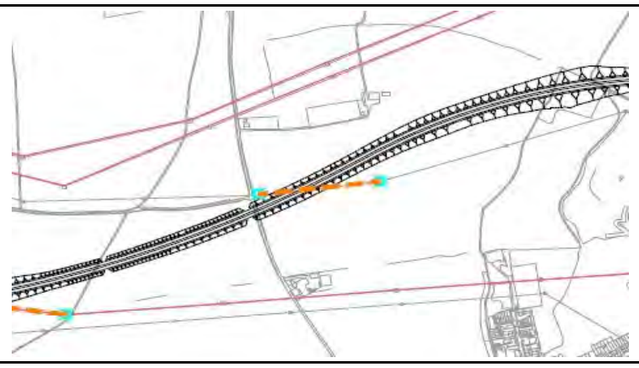
ROUTE 3 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C2-GM04	1+000	298	Gas feeder crossing under the LTC Mainline in cuttting	BR,IT,BT		Positive identification of line and level Required to inform onward design development - GPR/Trial pits. Pipe likely to be affected, in which case a suitable diversion will need to be proposed and the pipe level lowered under the mainline level. Subject to Gas Feeder level and required clearance: - None - 380m underground diversion under LTC level Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner.
Oil pipelines						
C2-OP01	20+910		Barking Power Station Fuel line crossing under the LTC mainline in embankment.			Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.

ROUTE 4 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
Overhead cables						
C9-OH01	-	415	Overhead Cable crossing roughly perpendicularly to A2 Realignment and A2 eastbound to LTC Slip road, continuing parallel to the LTC. Pylon AYN049A affected by A2 Realignment. Cable clearances to proposed levels: OHC z1=82.0m, z2= 80.6m, z3=77.5m LTC z1=69.3m, z2=72.9m, z3=69.8m	BR,IT,BT		Subject to lateral clearance requirements: - No action required - 415m underground diversion and pylon AYN049A removal. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Preferences for lateral clearance between towers and the proposed highway to be confirmed to determine if pylon AYN049A needs to be relocated/removed. Construction phasing and site control to comply with asset owner's requirements.
C9-OH02	-	362	Overhead Cable crossing perpendicularly to A226 Realignment, which at that point is at ground level. Cable clearances to proposed levels: OHC z=44.2m LTC z=31.3m	BR		Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C9-OH03	4+000	305	Overhead Cable located under LTC approach viaduct, parallel to the North Kent Railway. Cable clearances to proposed levels: OHC z=11.9m LTC z=50m	BR		300m underground diversion . Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements.

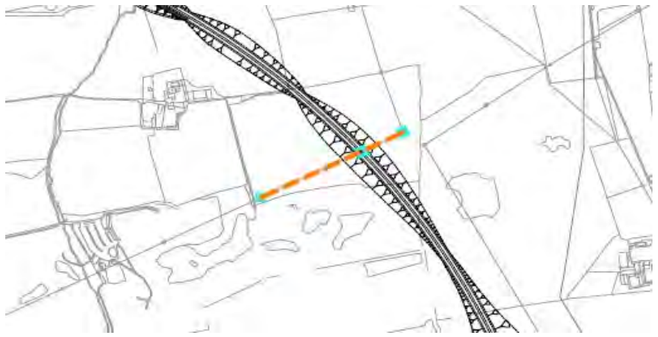
ROUTE 4 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C9-OH04	9+110	222	Overhead Cable crossing perpendicularly over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: OHC z=6.5m LTC z=13.7m	BR,IT,BT		Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C9-OH05	9+410	428	Overhead Cable crossing over the LTC mainline, which is in embankment at this point. Cable clearances to proposed levels: Cable z=5.35m LTC z=13.9m	BR,IT,BT		Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C9-OH06	10+310	285	Overhead Cable crossing over the LTC mainline, which is in embankment at this point. Pylon affected by LTC earthworks. Cable clearances to proposed levels not available.	BR,IT,BT		Cable clearances not available. Assume 285m underground diversion. Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements.

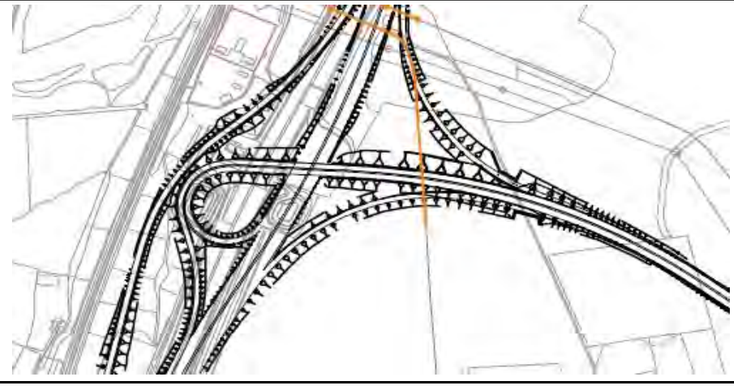
ROUTE 4 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C9-OH07	12+160	182	Overhead Cable crossing over the LTC mainline, in embankment, nearly at ground level. Cable clearances to proposed levels not available.	BR,IT,BT		Cable clearances not available. Assume 182m underground diversion. Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements.
C9-OH08	-	273	Overhead Cable crossing over the LTC - A13 slip roads and over the A1013 realignment at ground level. Cable clearances to proposed levels not available.	BR,IT,BT		Cable clearances not available. Assume 273m underground diversion. Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements.
C9-OH09	17+260	324	Overhead Cable crossing over the LTC mainline, in embankment, nearly at ground level. Cable clearances to proposed levels not available.	BR,IT,BT		Cable clearances not available. Assume 350m underground diversion. Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements.

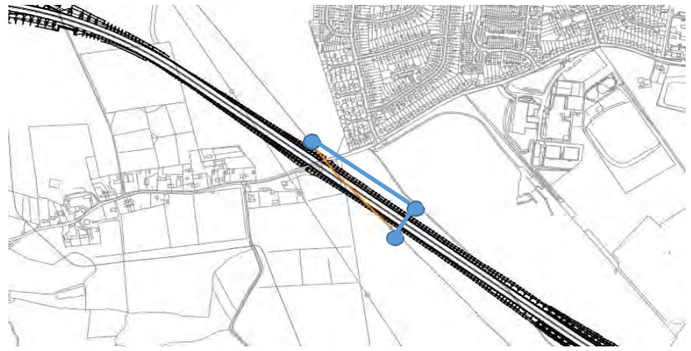
ROUTE 4 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C9-OH10	20+810	391	Overhead Cable crossing over the LTC mainline, which is in embankment at this point. Pylon located in the LTC main alignment. Cable clearances to proposed levels not available.	BR,IT,BT		Cable clearances not available. Assume 350m underground diversion and pylon removal. Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements.
C9-OH11	-	321	Overhead Cable crossing perpendicularly over the LTC to M25 Slip road in viaduct. Cable clearances to proposed levels: OHC Z=29.6 LTC Z=36.4	BR,IT,BT		Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Construction phasing and site control to comply with asset owner's requirements.
C9-OH12	-	393	Overhead Cable crossing perpendicularly over the LTC to M25 Slip road in viaduct. Cable clearances to proposed levels: OHC Z=39.1 LTC Z=39.2	BR,IT,BT		393m underground diversion. Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements.
C9-OH13	-	665	Overhead Cable crossing perpendicularly to A226 Realignment, which at that point is at ground level. Pylon AYN041 located in the new alignment of the A226. Cable clearances to proposed levels: OHC z=44.5m LTC z=32.0m	IT, BT		Subject to lateral clearance requirements: - No action required - 665m underground diversion and pylon AYN041 removal. Engagement and involvement of asset owner (National Grid) to be sought. Headroom requirements comply with National Grid's headroom requirements from TS43-8 tbl 6.1). Preferences for lateral clearance between towers and the proposed highway to be confirmed to determine if pylon AYN041 needs to be relocated/removed. Construction phasing and site control to comply with asset owner's requirements.

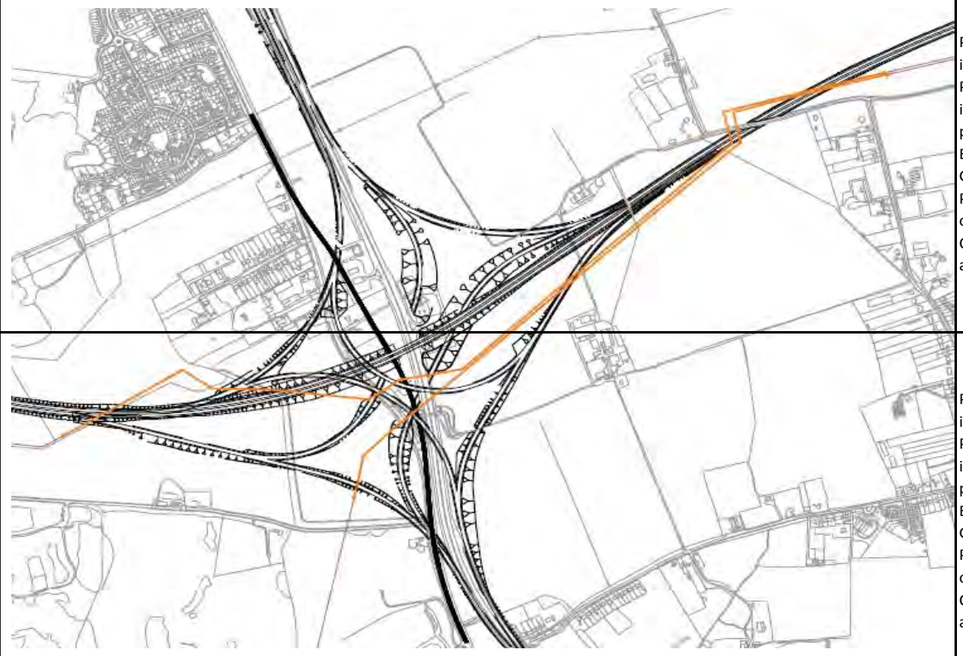
ROUTE 4 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
Gas mains						
C3-GM01	-	125	Gas feeder affected by A2 and LTC Slip roads. Crossing under the new link road connecting Hever Ct Rd to Brewers road junction in cutting, under the A2 mainline at ground level, and under the A2 eastbound to LTC in embankment.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.
C3-GM02	-	182	Gas feeder affected by A2 and LTC Slip roads. Crossing under the new link road connecting Hever Ct Rd to Brewers road junction in cutting, under the A2 mainline at ground level, and under the A2 eastbound to LTC in embankment.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.
C3-GM03	-	430	Gas feeder affected by A2 and LTC Slip roads. Crossing under the A2 eastbound to LTC slip road, under the LTC mainline, and under the LTC to A2 eastbound slip, all of them in embankment.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.

ROUTE 4 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C3-GM04	1+000	298	Gas feeder crossing under the LTC Mainline in cuttting	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Pipe likely to be affected, in which case a suitable diversion will need to be proposed and the pipe level lowered under the mainline level. Subject to Gas Feeder level and required clearance: - None - 380m underground diversion under LTC level Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.

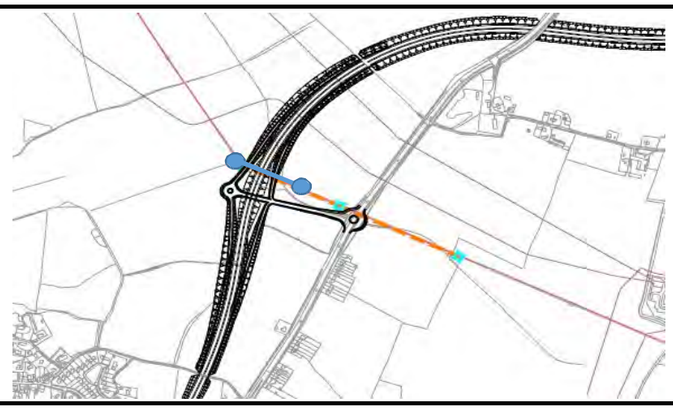
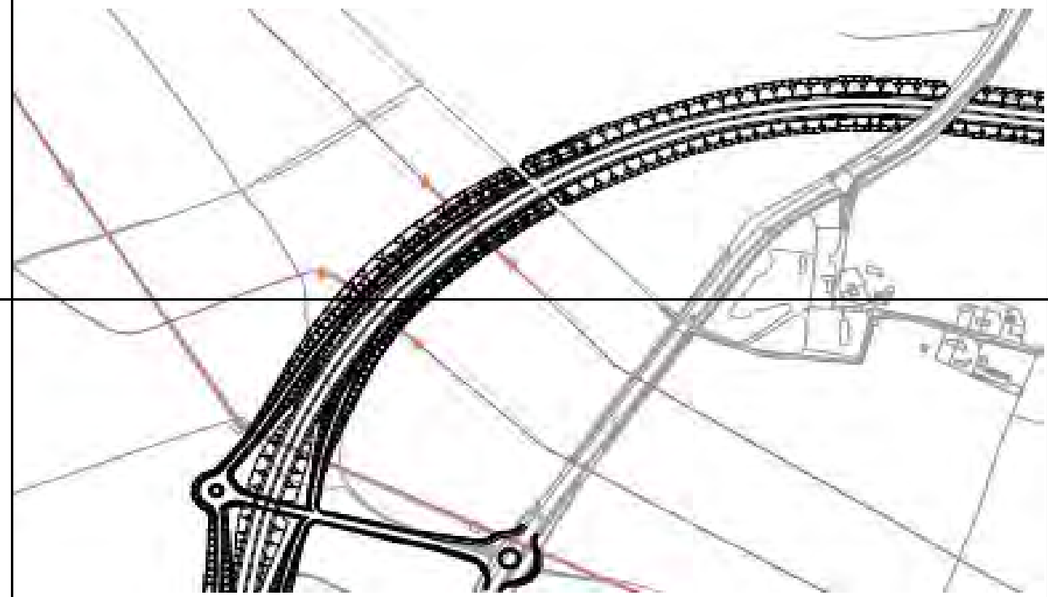
ROUTE 4 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C3-GM05	12+710	2450	Gas feeder affected by A13 and LTC Slip roads. Crossing under the LTC in embankment, under the LTC northbound to A13 westbound slip in embankment, under the A13 eastbound to LTC southbound slip in cutting, under the LTC northbound to A13 westbound slip in viaduct, under the LTC southbound to A13 westbound, under the A13 westbound to LTC northbound slip in cutting, and under the LTC southbound to A13 eastbound slip at ground level.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.
C3-GM06	13+410	1840	Gas feeder affected by A13 and LTC Slip roads. Crossing under the A13 westbound to LTC southbound slip in embankment, under the A13 westbound to LTC northbound slip in cutting, under the LTC northbound to A13 eastbound slip in viaduct, under the LTC southbound to A13 westbound slip in viaduct, and under the LTC southbound to A13 eastbound slip at ground level.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.
C3-GM07	26+410	45m	Gas feeder crossing under the link road between the B187 and the Junction 29 at ground level.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.

ROUTE 4 MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
C3-GM08	26+410	110	Gas feeder affected by A127 widening. Crossing under the LTC mainline in embankment, under the M25 to LTC slip at ground level, and under the M25 to LTC slip embankment.	BR,IT,BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.
C3-OP01	17+660	55	BPA Fuel line crossing under the LTC mainline in embankment, nearly at ground level.			Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.
C3-OP03	25+010	243	BPA Fuel line crossing under the A127 Widening at ground level.			Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements.

EASTERN SOUTHERN LINK MAJOR UTILITIES AFFECTED

REF	CHAINAGE	DISTANCE AFFECTED	DESCRIPTION	CROSSING OPTION AFFECTED	LOCATION PLAN	ACTION
Overhead cables						
C19-OH01	3+100	667	Overhead Cable crossing perpendicularly over the LTC mainline in embankment, over the A226 to LTC northbound slip in embankment, and over the LTC to A226 slip at ground level. Overhead Cable affecting A226 - LTC Slip roads. OHC z1=44.5m, z2= 39.9m, z3=37.1m LTC z1=29.9m, z2=39m, z3=32.9m	BR, IT, BT		Engagement and involvement of asset owner (National Grid) to be sought. Construction phasing and site control to comply with asset owner's requirements. 220m underground diversion under LTC mainline.
Gas mains						
C19-GM01	3+300	150	Gas feeder crossing under the LTC mainline, and the A226 - LTC slips in cutting.	BR, IT, BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements. Subject to pipe level confirmation: 150m diversion at a greater depth.
C19-GM01	3+500	150	Gas feeder crossing under the LTC mainline, and the A226 - LTC slips in cutting.	BR, IT, BT		Positive identification of line and level required to inform onward design development - GPR/Trial pits. Proposed drainage, comms and ancillary infrastructure to be designed to avoid affecting pipeline. Engagement and approval of asset owner (National Grid) to be sought. Protection works and/or diversion to be implemented on the advice of the asset owner. Construction phasing and site control to comply with asset owner's requirements. Subject to pipe level confirmation: 150m diversion at a greater depth.

Appendix 4.4
Affected Properties

Location A Route 1 (Bridge & Tunnel) Demolished Properties Plan
Route 2 Demolished Properties Plan
Route 3 Demolished Properties Plan
Route 4 Demolished Properties Plan

M25

Junction 30

A13

Refer to Inset A:
Bored Tunnel Option

Junction 31

1 No. Commercial
1 No. Commercial
London
Tilbury
Southend
railway
1 No. Commercial
1 No. Commercial
1 No. Commercial
HS1
1 No. Commercial
1 No. Commercial
Bridge Option
Existing Queen
Elizabeth II
bridge
1 No. Commercial
1 No. Commercial
1 No. Commercial
1 No. Commercial
5 No. Private
5 No. Private
5 No. Private
Junction 1A
1 No. Private
1 No. Private
1 No. Commercial
Junction 1B
Junction 2

Inset A: Bored Tunnel Option

1 No. Commercial
1 No. Commercial
1 No. Commercial
1 No. Commercial
1 No. Commercial
1 No. Commercial
1 No. Commercial
1 No. Commercial
1 No. Commercial
1 No. Commercial
1 No. Commercial
5 No. Private
5 No. Private
5 No. Private

NOTES
1. Drawing to be read in colour.
2. The design shown on these drawings is illustrative and may be subject to change in later stages of the scheme development.

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-16	SAR Issue	PMN	LG	KC

LEGEND:
Property demolished

ILLUSTRATIVE DESIGN

Client: highways england

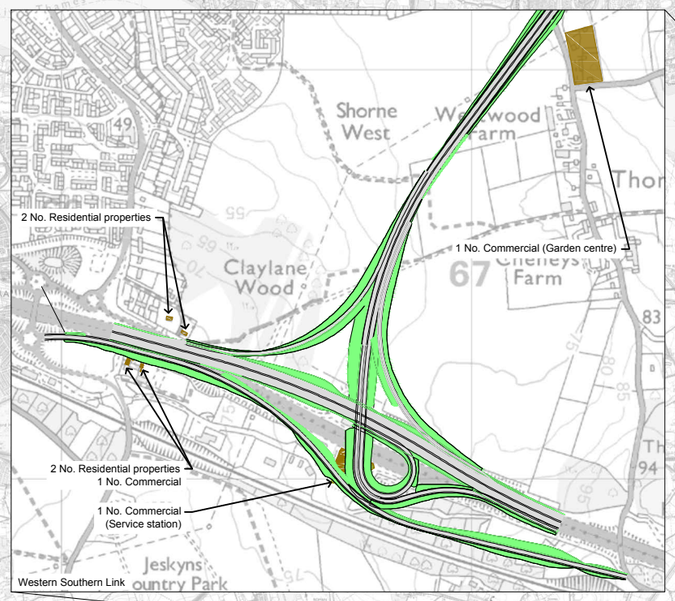
Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

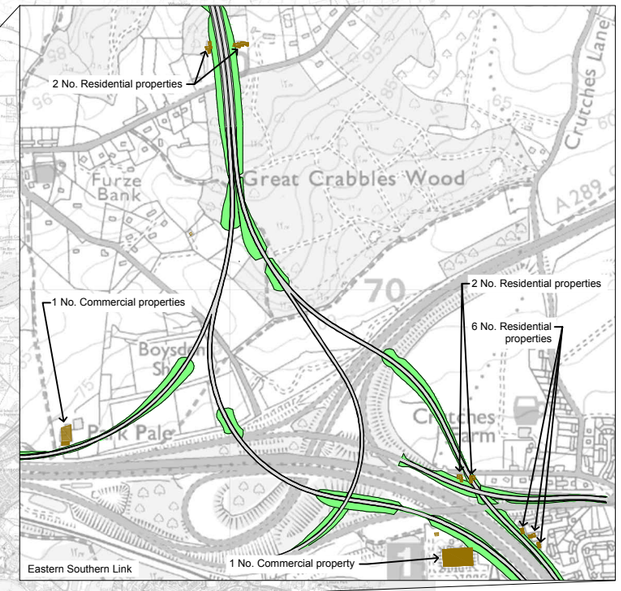
Project: LOWER THAMES CROSSING

Drawing title: Location A
Route 1 (Bridge & Tunnel)
Demolished Properties Plan

	Status: S5	Revision: P01
Scale: NTS		Date - 15-01-16
Drawn By: P. McNulty		
Checked By: L. Gocool		
Approved By: K. Chapman		
Project No. HA PIN: HA540039	Originator: HHJ	Original Size: A1
Drawing number: ZZZ-AZZMLZZZML-DR-SE-0001		

HA540039-HHJ-ZZZ-AZZMLZZZML-DR-SE-0001.dwg





Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-16	SAR ISSUE	MEC	MR	GH

LEGEND:

Property demolished

NOTES:

1. The design shown on these drawings is illustrative and may be subject to change in later stages of the scheme development.

ILLUSTRATIVE DESIGN

Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Route 2 Demolished Properties Plan

Status	S5	Revision	P01
Scale	As Shown	Date -	05-10-15
Drawn By	E Basketter		
Checked By	M Robinson		
Approved By	G Hodge		
Project No. HA PIN	HA540039	Originator HHJ	Original Size A1
Drawing number	HML-CD2MLZZZZZ-SK-SE-0001		

HA540039-HHJ-ZZZ-CD2MLZZZZZ-SK-SE-0001.dwg

LEGEND:

Property demolished

NOTES:

1. The design shown on these drawings is illustrative and may be subject to change in later stages of the scheme development.

ILLUSTRATIVE DESIGN

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-16	SAR ISSUE	MEC	MR	GH

Client: highways england

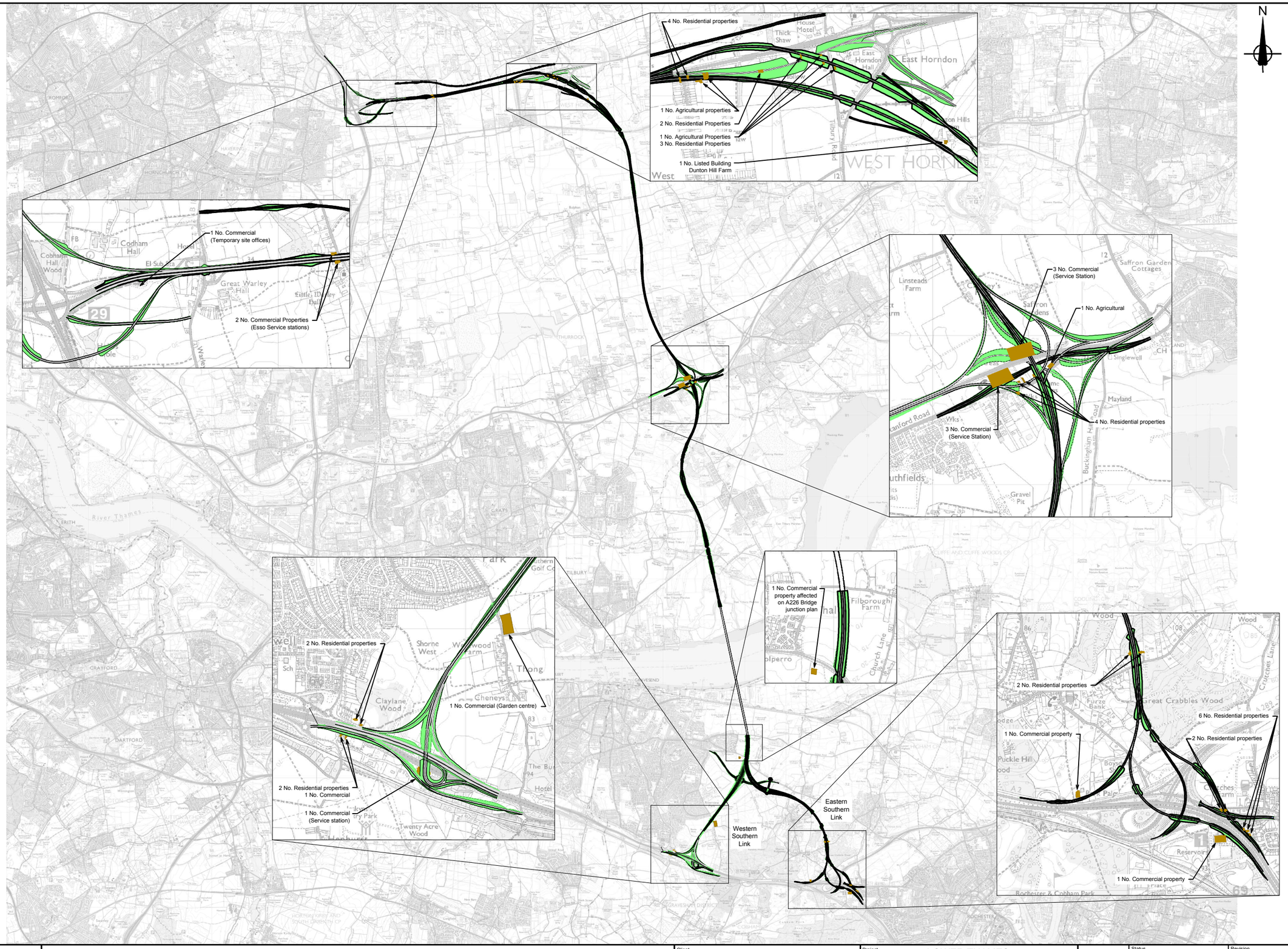
Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Route 3 Demolished Properties Plan

	Status: S5		Revision: P01
Scale	As Shown	Date -	05-10-15
Drawn By	E Basketter		
Checked By	M Robinson		
Approved By	G Hodge		
Project No. HA PIN: HA540039	Originator: HHJ	Original Size	A1
Drawing number: HML-CD3MLZZZZZ-SK-SE-0001			

HA540039-HHJ-ZZZ-CD3MLZZZZZ-SK-SE-0001.dwg



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01	S5	18-01-16	SAR ISSUE	MEC	MR	GH

LEGEND:

Property demolished

NOTES:

1. The design shown on these drawings is illustrative and may be subject to change in later stages of the scheme development.

ILLUSTRATIVE DESIGN

Client: highways england

Halcrow Hyder Joint Venture
Burderop Park
Swindon, SN4 0QD
Tel. +44(0)1793 812479

Project: LOWER THAMES CROSSING

Drawing title: Route 4 Demolished Properties Plan

	Status	Revision
	S5	P01
Scale	As Shown	Date - 05-10-15
Drawn By	E Basketter	
Checked By	M Robinson	
Approved By	G Hodge	
Project No. HA PIN	HA540039 HHJ	Originator / Original Size: A1
Drawing number	HML-CD4MLZZZZZ-SK-SE-0001	

HA540039-HHJ-ZZZ-CD4MLZZZZZ-SK-SE-0001.dwg

Appendix 4.5
Hydrodynamics Summary Report

Hydrodynamics Summary Report

Appraisal of hydrodynamics and sediment transport

Introduction

Numerical modelling was used to assess the potential impacts on estuary processes of a new crossing in the Lower Thames estuary. The modelling was intended in order to inform understanding of whether the potential changes, at a very course level, would be likely to be a problem or not. The modelling therefore focussed on a limited number of development scenarios chosen to represent worst case conditions.

A hydrodynamic model was set up to examine variations in water levels and current speeds. This information was used to infer likely areas of erosion and deposition. The development scenarios included restriction of channel cross section, due to the temporary caissons during the construction stage; and slimmer, but permanent, bridge piers that would support the bridge during its operational life.

Some stakeholders raised concerns about levels of increased suspended sediment arising from dredge operations during the construction stages. The hydrodynamic model was used to drive a sediment model which predicted the extent sediment plume and potential sedimentation rates on neighbouring designated intertidal areas during these dredging operations.

Hydrodynamic modelling

Model Set-up

A 2-D hydrodynamic model of the Thames Estuary (Figure 1) was constructed using the MIKE 21 Flow Model FM by DHI modelling software. The results of a calibration and validation exercise showed that the model was suitable for clarifying the differences in water levels and current speeds caused by the proposed crossing options.

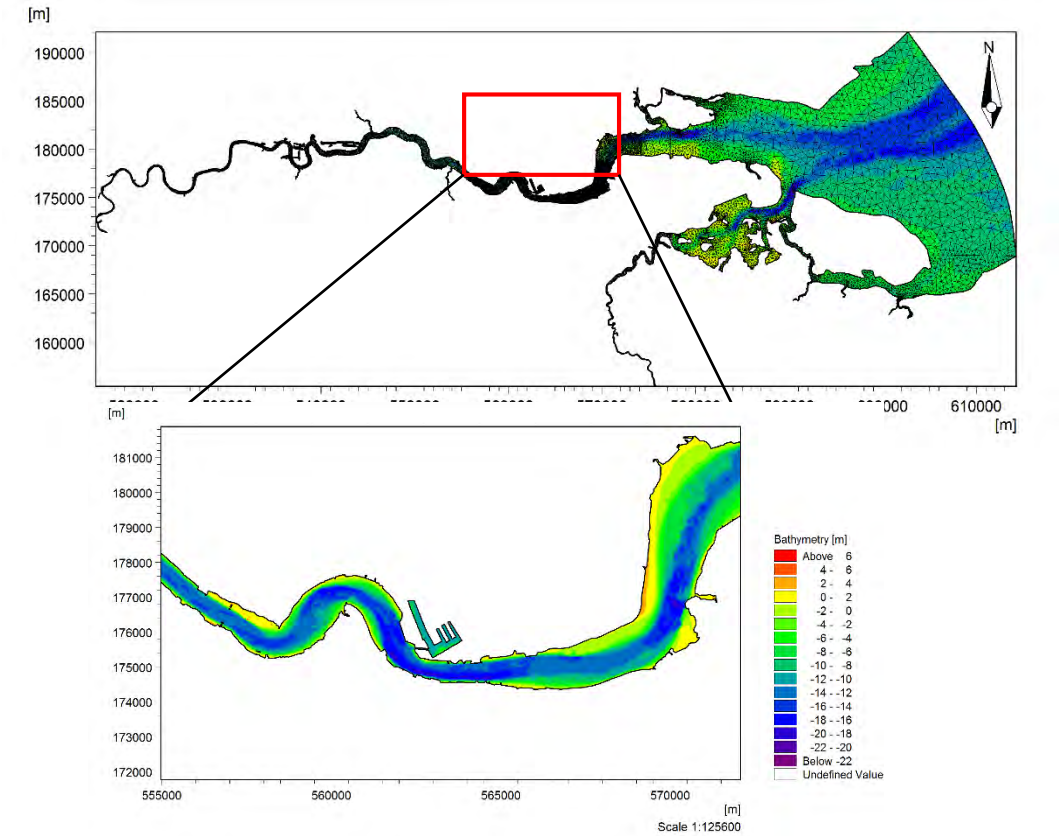


Figure 1 Hydrodynamic Model domain showing the finer grid resolution in the area associated with the two crossing routes

Scenarios examined

At Location A cofferdams and bridge piers were appraised. At Location C cofferdams, bridge piers and the immersed tunnel dredged trench were appraised. The impact of each of the developments was appraised under a spring tide, 1 in 20 year and 1 in 100 year event.

The bored tunnel option at Location A and C was not considered further since it was assumed that it would lie beneath the estuary bed level and thus not impinge on physical processes within the estuary.

The model results were analysed to determine both the near field (adjacent to the development) and the far-field (about 5 km or more away) effects of the crossing options on the baseline conditions.

Results

Baseline hydrodynamic conditions

The high water levels and peak current conditions for baseline hydrodynamic conditions in the proposed crossing locations are summarised in the Table 1.

Table 1: High water levels and peak current speeds at the proposed crossings.

	Location A			**Location C (mODN)**		
	High water level (m ODN)	**Max Ebb current speed (m/s)**	**Max flood current speed (m/s)**	**High water level (m ODN)**	**Max Ebb current speed (m/s)**	**Max flood current speed (m/s)**
RP = 100 years	5.2	1.49	1.70	4.9	1.41	1.34
RP = 20 years	4.9	1.50	1.66	4.6	1.43	1.34
Spring tide	MHWS=3.6	1.38	1.64	3.4	1.42	1.40
Neap tide	MHWN=2.2	1.07	1.04	2.1	1.01	0.79

For mean spring tides at Location A and C water levels ranged from 3.4 to 3.6m AOD, whilst maximum flood and ebb current speeds were 1.4-1.6m/s. The maximum flood and ebb current speeds were similar for the different return period events.

Impacts of crossings

The modelling showed that the impact of the developments on high water levels was negligible, whilst impact on current speeds was significant only in the vicinity of the crossings themselves (Table 2).

Table 2: Summary of impacts of developments on current speeds

	Description of impact	Maximum linear extent of estuary section impacted from the crossing** (km)
Trench at Location C	Peak flood/ebb current across the trench is reduced by about 0.5m/s in most parts of the trench. The reduction is however greater than 1 m/s at the northern and southern ends of the trench.	1.0
Cofferdams at Location C	Peak flood/ebb current adjacent to the cofferdams is increased by up to about 0.8m/s. Peak flood/ebb current in the region between the north and south cofferdams is increased by 0.1 to 0.2m/s over a distance of about 1000m in the direction of flow. Peak flood/ebb current in the in the inter-tidal flats is reduced.	2.5
Bridge Piers at Location C	Peak flood/ebb current adjacent to the bridge piers is increased by up to about 0.5m/s. Peak flood/ebb current in the region between the north and south piers is increased by 0.05 to 0.1m/s over a distance of about 1000m to 2000m in the direction of flow. Peak flood/ebb current in the in the inter-tidal flats is reduced.	2.0
Cofferdams at Location A	Peak flood/ebb current adjacent to the cofferdams is increased by up to about 0.8m/s. Peak flood/ebb current in the region between the cofferdams is increased by 0.1 to 0.2m/s over a distance of about 1000m in the direction of flow. Peak flood/ebb current in the in the inter-tidal flats is reduced.	1.0
Bridge Piers at Location A	Peak flood/ebb adjacent to the bridge piers is increased by up to about 0.5m/s. Peak flood/ebb current in the region between the north and south piers is increased by 0.05 to 0.1m/s over a distance of about 500m to 1000m in the direction of flow. Peak flood/ebb current in the in the inter-tidal flats is reduced in the direction of flow from the pier.	1.0
**Extent of impact estimated based on areas where changes to current speed is greater than 0.1m/s.		

Figure 2 shows the impacts of the temporary coffer dams for a bridge at Location A. Currents are observed to increase between the coffer dams. Flow speeds are generally decreased over the intertidal although there are some localised increases. These results suggest that erosion could occur near to the structures whilst increased accretion could occur over the intertidal areas.

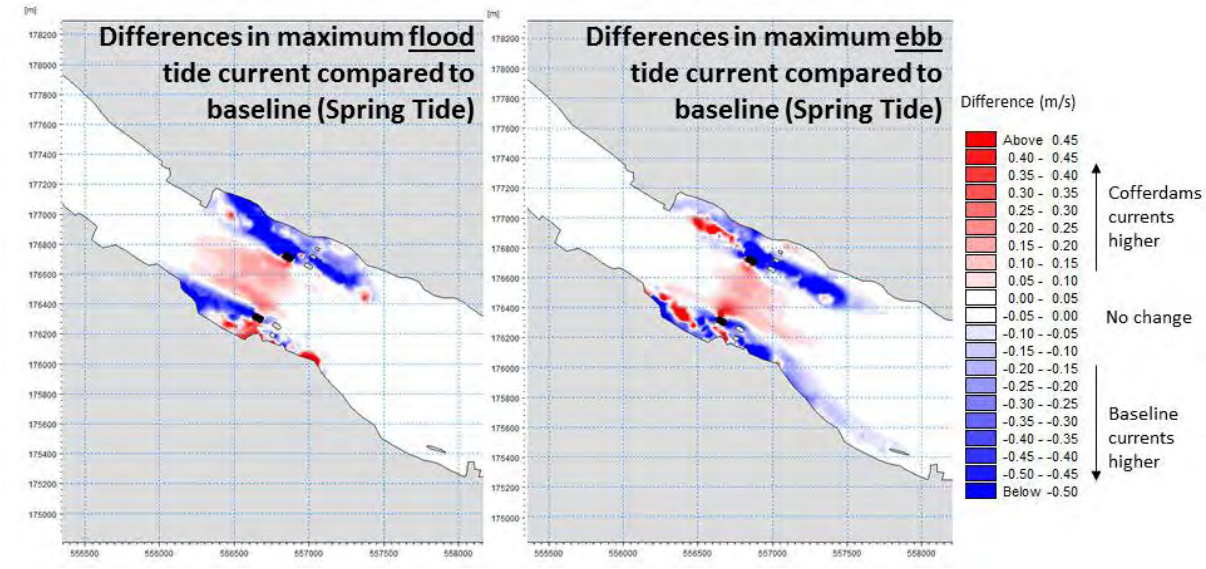


Figure 2 Impact on Tidal Currents for cofferdams at Location

Sediment Plume Modelling

The MIKE 21 FM (Flow Model) and the decoupled MT (Mud Transport) model were used to assess the impact of the dredging operations for the immersed tunnel at Location C and the bridge at Location A. More specifically, the model was used to:

- Quantify the extent of the sediment plume due to dredging operations at Location A and C
- Estimate the fate of the sediment plume – identify areas experiencing sedimentation
- Determine the effect of dredging on protected areas
- Estimate the amount of sedimentation into the dredged trench due to background SSC

Scenarios examined

Details of the required dredging operations for each option are shown in Table 3. Table 3 shows the total estimated volume of material to be dredged for each of the crossing options, along with the volume of that total made up by fine grained alluvium which was assumed to be the source of any dredge plumes. It was assumed that the alluvium occupies the surface layer and any spilt coarse sediment will fall back into the bed near the dredger.

The immersed tunnel trench at Location C requires the greatest volume of dredging whilst the bridge at Location A requires the least. These two options therefore cover the range of potential crossing options.

Table 3 also shows the dredge rate, required duration, spill rate and total spill volume for the two dredger types (Backhoe and Cutter suction) at each crossing option. Compared to the cutter suction dredger the back hoe dredger can be seen to spill a greater amount of sediment over a longer duration.

Table 3 *Estimated dredging quantities required for the crossing options*

Crossing Option	**C – Immersed tunnel**	**C – Bridge Crossing**	**A – Bridge Crossing**

Estimated Dredger quantities (m^3)	**Total**	769,073	110,000	28,000
	Alluvium (fine)	303,784	43,450	11,060
Estimated Backhoe	**Dredge rate (m^3/hr)**	350	350	350
	Spill rate (%)	3	3	3
	Required dredge duration (hrs)	868	124	32
	Spill volume (m^3)	9114	1302	336
Estimated Cutter Suction	**Dredge rate (m^3/hr)**	3500	3500	3500
	Spill rate (%)	1	1	1
	Required dredge duration (hrs)	87	12	3
	Spill volume (m^3)	3045	420	105

Results

A number of model runs were carried out to determine the plume extents and areas of sedimentation due to dredging operations (Table 4). In all cases the hydrodynamics within the model were allowed to warm up for at least 12 hours prior to the start of the dredging operations and continued to run for at least 12 hours after the dredging ceased, to allow the sediment to reach areas of potential sedimentation.

Figure 3 is an example output for the sediment plume model showing the maximum suspended sediment concentration.

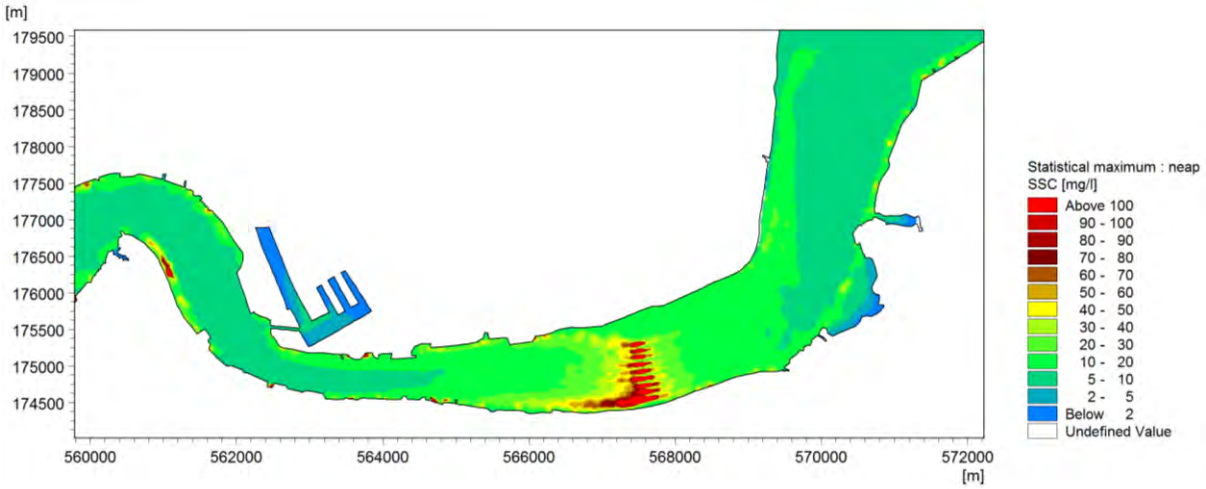


Figure 3 Sediment plume model showing maximum suspended sediment concentration during a spring tide with a cutter suction dredger operating at Location C.

Table 4 Summary of sediment plume simulations

	Crossing Option	Location C – Immersed trench			Location A – Bridge	
	Simulation period	Spring tide	Neap tide	15 day spring neap cycle	Spring tide	Neap tide
Dredger	**Type**	Cutter Suction	Cutter Suction	Backhoe	Cutter Suction	Cutter Suction
	Start time	27/09/2004 12:00	20/09/2004 12:00	19/09/2004 12:00	30/09/2004 00:00	22/09/2004 12:00
	End time	04/10/2004 12:00	27/09/2004 12:00	04/10/2004 12:00	01/10/2004 00:00	23/09/2004 12:00
	Duration (hours)	168	168	360	24	24
	Location	Transect along channel moving south to north at 100m intervals from (**Error! Reference source not found.**)	Transect along channel moving south to north at 100m intervals (**Error! Reference source not found.**)	Transect along channel moving constantly south to north from (567661.043, 174553.432) to (567488.14, 175400.48) (**Error! Reference source not found.**)	Point locations North pier (556854, 176720) and south pier (556657, 176311) separate runs for each pier (Figure 2c)	Point locations North pier (556854, 176720) and south pier (556657, 176311) separate runs for each pier (Figure 2c)
	Dredge rate (kg/s)*	486.1	486.1	48.6	486.1	486.1
	Modelled spill rate	1	1	3	1	1
	Total modelled spill volume (m^3)	5880	5880	3780	840	840
	Total modelled spill volume as percentage of estimated spill volume ** **during proposed dredging operations (%)**	193	193	41	800	800

* dredge rate in kg/s was calculated assuming the sediment in the hoppers and barges to have a dry density of around 500 kg/m^3, thus a dredge rate of 350m^3/hr = 350*500 kg/hr = 175000/3600 kg/s = 48.6 kg/s

**based on estimated total volume of dredge needed, volume of alluvium and assumed spill rates – see Table 3

Location A

The results show that the impacts of dredging for the bridge piers at Location A were minimal. Maximum sediment concentrations of 20 mg/l did not extend more than 1.5 km up or downstream of the dredger. Predicted sedimentation rates in the protected areas and the port of Tilbury were 2mm or less.

In reality the impacts of the dredging operations will be even smaller than modelled, as the duration of the dredging extended beyond that required to remove the calculated volumes associated with the works. The extended dredging duration results in modelled spill volume that is 800% of the estimated spill volume for the cutter suction dredger, or 250% of the estimated total spill volume for the backhoe dredger.

Location C

The results show that at Location C the ebb dominance of the tide (shorter duration of the ebb tide versus the flood) leads to a greater increase in SSC upstream of the dredgers. Higher SSC also extend further up/downstream in shallower water near to the shore. The maximum SSC was seen with the cutter suction dredging over a neap tide. The backhoe dredger produces lower SSC due to the lower spill rate. However, the higher total spill volume of the backhoe dredger means that sedimentation is worse for this case. The maximum volume of material deposited in the Port of Tilbury was 2630 m^3 after 36 days of dredging with the backhoe dredger. This represents 3.1% of the average annual volume currently dredged from the port. The smallest increase in the average annual sedimentation volume in the Port of Tilbury was predicted using the cutter suction dredger during neap tide (less than 1% of the annual sedimentation volume).

Deposition of more than 2mm in protected areas occurs at very few locations using the cutter suction dredging operation. The amount of deposition is greater during spring tides than neap tides. The worst case is the backhoe dredger, which leads to deposition of up to 6 mm in the Holehaven Creek SSSI site and up to 12 mm on the South Thames Estuary SSSI, Ramsar and SPA site.

Sedimentation in the immersed tunnel trench due to background concentration was estimated to be between 0.7m in the centre of the channel to 3m in the intertidal areas over a period of two weeks. Therefore, maintenance dredging will be required if the trench is left for an extended period of time.

An example output for the sediment plume model is shown in Figure 4.

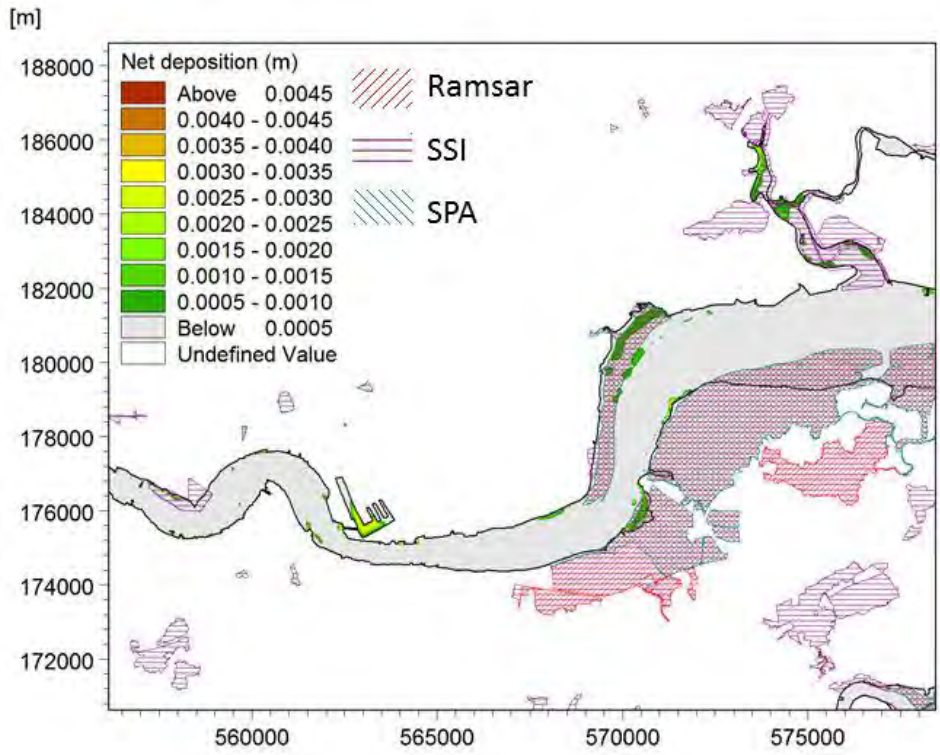


Figure 4 Deposition in protected areas due to dredging operations using a cutter suction dredger for the immersed tunnel trench option at C over a neap tide.

Conclusions

- Overall no unacceptable changes to the river hydrodynamics/sediment transport were found
- None of the options tested – bridge piers and coffer dams at A and C, immersed tunnel dredged trench at C, have significant impacts on water levels.
- The impacts of the bridge piers (which would be permanent) and coffer dams (which would be temporary) on flow speeds is similar. There are localised increases in flow speeds either side of the structures and between structures in the centre of the channel. There are more extensive changes in the shallower water closer to the shoreline. In these areas generally there is a decrease in flow up and downstream of the structures with some localised increases. These results suggest that erosion could occur near to the structures whilst increased accretion could occur over the intertidal areas. Further modelling would be needed to quantify these changes.
- The immersed tunnel trench (which would be temporary) generally has less impact on flow speeds than a bridge options. Flows are decreased over the trench and this effect is largest in the shallow water nearer the shore. Sedimentation in the trench over two week period is considerable (0.7-3m) suggesting that maintenance dredging might be necessary to keep the trench open.
- Preliminary modelling for the dispersal of sediment from the dredging has been carried out for the construction of the trench for the immersed tunnel. This scenario represents the worst case development scenario. On a spring tide this shows a distinguishable plume of sediment (where sediment concentrations are raised some 40-50mg/l) above background concentrations and extends up and downstream of the dredge operation on the flood and ebb tide. The plume has a greater extent when the dredging operation take place in shallow water nearer to the shore. Nevertheless predicted deposition rates over designated sites and the Port of Tilbury are small (2mm or less when using a cutter suction dredger).

Appendix 4.6
Cost Estimating Methodology

A4.6.1 Capital Cost Estimates

Capital cost range estimates have been developed in accordance with Highways England Commercial Services Division's standard practice for the Project Control Framework (PCF) *Options Phase* for each of the following Shortlisted Options:

- Route 1 Bored tunnel
- Route 1 Cable-stayed bridge
- Route 2 Bored tunnel with Western Southern Link
- Route 2 Cable-stayed bridge with Western Southern Link
- Route 2 Immersed tunnel with Western Southern Link
- Route 3 Bored tunnel with Western Southern Link
- Route 3 Cable-stayed bridge with Western Southern Link
- Route 3 Immersed tunnel with Western Southern Link
- Route 4 Bored tunnel with Western Southern Link
- Route 4 Cable-stayed bridge with Western Southern Link
- Route 4 Immersed tunnel with Western Southern Link
- Route 3 Bored tunnel with Eastern Southern Link

Estimates for Location C options with the Eastern Southern Link (ESL) have been derived by manually adding an estimated extra-over cost of the ESL to the relevant assured cost estimate for the route option with Western Southern Link (WSL). The extra cost of the ESL is calculated from the difference in assured Route 3 costs with ESL and with WSL for the bored tunnel crossing option.

Range estimates have been prepared using three point estimating techniques with outputs based on 10% (P10), Most Likely (Mode) and 90% (P90) levels of probability. The cost estimate structure consists of the following components:

- Base cost estimate
- Project-level risk and residual uncertainty assessment
- Roads Portfolio-level risk assessment
- Inflation to out-turn prices (nominal terms)

All costs have been estimated in real terms at a price base of Q1, 2014 prior to the application of inflation to the forecast year of expenditure to produce out-turn cost estimates in nominal terms.

Cost estimates are based on the engineering solutions shown in Volume 3 Appendices. Construction methodology and planning assumptions were agreed in consultation with the design team for the basis of estimates.

The estimates have adopted a work breakdown structure aligned to the Project Control Framework as follows:

- Historical costs based on recorded spend to date;
- Options Phase costs based on current forecast of expenditure to the planned completion of the Options Phase and identification of preferred option;
- Development Phase based on an assessment of costs for the Development Phase workstreams covering Preliminary Design, Statutory Process, Procurement and Construction Preparation. Estimates for the Development Phase assume development of a single preferred scheme and delivery of consents through a DCO process;
- Indicative estimates of land purchase and compensation costs have been based on an assessment of affected land by the District Valuer. Close reference has been made to rates used for the HS2 project;
- Lands Costs based on reports and estimates prepared by the District Valuer;
- Costs of construction including direct costs, preliminaries and contractor's overheads and profit:
    - Cost estimate rates for standard highways works are based on Highways England Commercial Services Division current rate database with a price base date for the capital cost estimates is January 2014. A specific assessment of rates for non-standard works items with rates rebased to Q1, 2014 prices. Indicative construction programmes and preliminary construction methodology assumptions for the river crossing options were provided for the basis of the estimates;
    - It was assumed that the construction of each route option would be delivered through three works packages advised by the Delivery Planning workstream:
        - Northern links and junctions;
        - Crossing;
        - Southern links and junctions.
    - Procurement and Construction Phase estimates assume the crossing works are procured on a design and build basis.
- Statutory Undertakers' costs of protecting and diverting utilities services were based on a schedule of utilities works setting out assumed requirements developed from C2 enquiry responses and data received from the utility companies.
- Works supervision, third party fees and ancillary costs including Non-Recoverable VAT based on an assessment of forecast expenditure outside the existing highway boundaries to calculate VAT at current rates.

Project Risk has been assessed based on assessment of the project risk register and risk workshops to identify risks for each route and crossing solution.

The estimates also include an assessment of Portfolio-level risk, i.e. risks that act across the Roads Portfolio rather than specific project risks.

Inflation has been applied using the Commercial Services Division's inflation profile previously set with the Department for Transport. This has been compared with the most recent Infrastructure UK forecast which is broadly similar up to 2020/21 (the extent of the Infrastructure UK forecast).

A comparison with costs reported from other recent bridge and tunnel projects of comparable scale and nature, including projects in Europe and elsewhere in the world, was carried out as part of the review of the assured costs.

A4.6.2 Operation and Maintenance Cost Estimates

Operation and Maintenance (O&M) cost estimates have been prepared for each Shortlisted Route considered in the SAR. The O&M estimates costs are for the incremental costs of operation and maintenance post-implementation of each scheme compared with do-minimum base case of the existing road network layout.

The assessment period for O&M costs has been set at 60 years across the project, as described in HM Treasury Green Book and WebTAG, with Year 1 being the year of road opening.

O&M estimates have been produced in real terms at a price base of Q2, 2025, reflecting the typical planned date of completion of construction across the options. Discounting factors have been applied as set out in HM Treasury's *Green Book: Appraisal and Evaluation in Central Government*, i.e. discount factors of 3.5% for years 1-30 and 3.0% for years 31-60 of the assessment period.

O&M estimates were prepared net of relative price growth and risk/ optimism bias so that the economic assessment could apply these as necessary for consistency with the treatment of these factors in Volume 5 and elsewhere.

O&M estimates have been calculated based on assessment of incremental cost for each of the following scope categories:

- Routine operation and maintenance activities (e.g. winter maintenance, road sweeping, litter picking, grass cutting, routine inspection programmes, energy costs and core operation and incident response capability, etc…). Note vehicle operating costs and the costs of traffic delays at roadworks are excluded and assessed elsewhere through the scheme's traffic modelling and economic assessment work;

- Asset renewals, e.g. such as pavement resurfacing, replacement of safety barriers, bridge bearing replacement, tunnel electrical and control system replacements, etc;

- Betterment that may result from the scheme's replacement of ageing infrastructure with new assets and improved efficiency of future operation and maintenance working practices. This is limited for the Lower Thames Crossing scheme as the vast majority of works are to establish new assets, however,

there are minor areas of resurfacing of the existing network and removal of some assets from the existing maintenance burden.

The difference in complexity of operation and maintenance for the crossing sections compared with the more standard highways works to the north and south of the River Thames has been reflected in the estimating methodology for each of these categories.

O&M estimates for the standard complexity highways works to the north and south of the River Thames are based on a take-off of principal quantities for each Shortlisted Option. Annual routine operation and maintenance costs have been estimated based on applying a unit rate per square metre of carriageway derived from annual lump sum charges from existing Highways England Area maintenance contracts. This includes an uplift of 25% for location factors.

The estimates of routine operation and maintenance for standard highways works assume that the scope of these activities will be similar to existing operation and maintenance regimes. Similarly, it is assumed that required asset condition, service levels, deterioration profiles and maintenance strategies will be similar to existing requirements.

Periodic asset renewal costs for standard highways assets have been estimated based on the incremental quantities of assets and set renewal frequencies over the assessment period. Percentage allowances for preliminaries and traffic management have been applied based on current practice.

There are numerous highway structures required north and south of the Thames crossing for each shortlist route. Structures' O&M requirements are variable and O&M costs sums have been allowed for structures (other than the main crossing) on the basis of a conservative fixed percentage of capital cost pending design development.

For the complex crossing structures, O&M estimates are based on specific assessment of routine activities and asset renewal frequencies for each asset type.

Conservatively, year-on-year efficiency improvements over the assessment period with a gradual reduction in rates have not been assumed. This is naturally difficult to assess with confidence and no allowance for efficiencies is proposed at this stage.

Reference was made to costs for operating and maintaining the existing Dartford Crossing where relevant but it is noted these costs are significantly affected by the age of the existing Dartford Crossing tunnels and care needs to be taken in comparing with costs for operating and maintaining a new tunnel designed to modern standards and reflective of latest industry best practice.

Appendix 4.7
Provision of a Tunnel Emergency Lane at Location C

4.7.1 The illustrative design for Location C tunnel options is based on a D2AP scheme, without emergency lanes. An alternative tunnel cross section with emergency lanes has also been considered.

Regulations and TERN Requirements

4.7.2 The minimum safety requirements for road tunnels on the Trans European Road Network (TERN) throughout Europe are set out in the EU Directive 2004/54/EC[1] (EUD). The Road Tunnel Safety Regulations (RTSR) implement the EUD under UK legislation. The EUD requirements apply to tunnels over 500m long and which are located on the TERN. The existing crossing at Location A is on a designated TERN route. No decision has been made with regards designating routes at Location C as part of the TERN.

Design Requirements

4.7.3 The bored tunnel at Location C would be 3.2km long, and the immersed tunnel 2.8km long. Based on the safety requirements for road tunnels, the tunnel would be classified as Category AA, the most stringent category under BD78, requiring that emergency stopping lanes and emergency walkways are provided as a "normal provision" for tunnel safety. However, whilst BD78 notes this as a “normal provision”, cost benefit grounds may be used to omit the emergency lane provision due to the high cost and instead the standard allows consideration of enhanced monitoring and recovery as a way to mitigate risk from accidents and breakdowns.

Emergency Lane cross section

4.7.4 The proposed alternative tunnel cross section with emergency lanes would increase the tunnel diameter from 12.1m (illustrative design) to 15.4m. For the immersed tube tunnel scheme, the width of the tunnel section would increase from 26m to 31m.

Capital Cost Estimates

4.7.5 The additional cost for the provision of an emergency lane would be similar to the cost of D3AP.

Conclusion

4.7.6 Provision of an emergency lane in the tunnels would provide benefits in terms of safety, resilience and user experience. The extra over out-turn cost to provide a tunnel emergency lane is estimated to be in the range of £0.17bn to £0.50bn.

4.7.7 More detailed traffic, economic, environmental and operational appraisal will be required in the next stage of development of the scheme, in order to determine the final scheme for the tunnel cross-section. The Tunnel Design and Safety Consultation Group (TDSCG) (see DMRB BD78[2)] will be established in the next stage of the scheme. This group will play a key role in reviewing the needs and benefits of providing an emergency lane.

1 Directive 2004/54/EC Minimum Safety Requirements for Tunnels in the Trans-European Road Network

2 DMRB BD 78/99 Design of Road Tunnels

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The Pre-Consultation Scheme Assessment Report details the assessment of options leading up to consultation. A final Scheme Assessment Report will be published post consultation.