Technical Note JACOBS AECOM

Project:	**Lower Thames Crossing**	Job No:	**60287784**
Subject:	**Module 4: Integration of Option A with the M25 and A282**		
	Revision 3		
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This document has been withdrawn as the preferred route for the Lower Thames Crossing has been announced.

1. Purpose and Scope

1.1 Purpose of Technical Note

1.1.1 In May 2013, the Department for Transport published the *Review of Lower Thames Crossing Options: Final Report (April 2013)* together with a suite of supporting reports. The Department used this Review report for the purposes of public consultation on the merits of three location options (Options A, B and C; a variant to Option C improving the A229 between the M2 and M20 was also consulted on) to provide additional highway capacity across the River Thames.

1.1.2 This technical note responds to part of a brief to Jacobs/AECOM provided by the Department for Transport entitled *Annex D: Lower Thames Crossing – further assessment of the respective cases for Options A and C*.

Module 4 of this brief required investigation of the following points in respect of Option A:

i. Whether traffic flows could be managed within existing capacity on the sections of the M25, A282 approaching the crossing, both during the construction period and following the opening of a new crossing, and if not, indicate the scale of costs of improvements needed.

ii. Potential operational issues at the crossing both during construction and following scheme opening and determine if and how these could be overcome.

1.1.3 The assessment and findings draw upon the collective knowledge of the DfT, Highways Agency and their suppliers, including the authors of this report. None of the assessments in this report represents a recommendation in any way on whether Option A is to be delivered or in what form.

1.1.4 Within this technical note, we refer to the Design and Costing report, which was produced for the 2012/13 AECOM/DfT review of options for the Lower Thames Crossing (LTC). The report is available on the DfT website https://www.gov.uk/government/publications/lower-thames-crossing-design-and-costing-report. Chapter 5 of that report contains details of Option A. The assessments made indicative assumption that a new crossing could be opened by about 2025.

1.1.5 Option A would provide additional capacity at the existing Dartford-Thurrock Crossing of the River Thames. An additional bridge or tunnels would be provided upstream of the existing bored tunnels, with northbound traffic using the additional four lanes provided by a new crossing and the existing west bore tunnel. Southbound traffic is assumed to continue to use the QEII Bridge and the existing east bore tunnel. This would offer a shorter crossing route than Option C and links the M25 J31 and M25 J1, and therefore directly ties in with the existing strategic road network. A general layout drawing of Option A (bridge) is included in Appendix 1.

1.1.6 Our analysis, documented in Module 3, has shown that if Option A was implemented M25 Junction 30 would need further investment beyond the M25 Junction 30/A13 Corridor Relieving Congestion Scheme which is due to be completed in 2016/17. In addition, this technical note addresses the additional investment required on the M25/ A282, south of the crossing. This package of investments is referred to as Option A+ and includes:

- Lower Thames Crossing Option A (bridge or tunnels, refer to the Design and Costing report)
- Improvements to Junction 30 and the A13 (referred to as Option E1+9, reported in a separate technical note 'LTC - Potential Additional Network Investment')
- Improvements to the M25/ A282 (reported in this technical note)

A summary of Option A+ is reported the Jacobs-AECOM Technical Note '*Overall Cost Information for Options A+ and C2"***.**

1.2 Scope

1.2.1 Based on the Module 4 brief, three specific subject areas concerning traffic management and capacity have been addressed in this note. These relate to:

i. The capacity, layout and ability to manage local and strategic traffic, particularly the southern (i.e. in northbound direction) A282/M25 approach to the crossing north of M25 J2

ii. Operation of the existing crossing during the construction period, particularly if part or all of the construction site could require part or all of the HA site used to marshal dangerous goods vehicles

iii. How the new and existing infrastructure could operate, with free-flow charging in operation, particularly in regard to present challenges posed by over-height vehicles. This note includes an assessment of the operational implications of the differing horizontal and vertical approaches to the crossing with each alternative crossing structure type.

1.3 **Methodology**

1.3.1 An initial assessment of the issues identified in the scope was undertaken by Jacobs/ AECOM, which provided the background information to inform an initial workshop.

1.3.2 The workshop was held on 18th October 2013 with DfT, the Highways Agency and its suppliers including consultants Jacobs/ AECOM and Connect Plus, the current operators of the crossing. The objective of the workshop was to obtain the professional opinions of attendees and reach a consensus view on the potential solutions in relation to the three subject areas listed in 1.2.1. The agreed outcomes and actions from the workshop are included in Appendix 2.

1.3.3 Following the workshop, further work was undertaken to produce potential investment solutions providing additional capacity on the A282 south of the crossing. Development work took account of high level engineering feasibility and risks as well as the limitations of the traffic model and basic lane capacity assumptions (refer 1.4.1)

1.3.4 The Highways Agency's cost consultant Benchmark, with support from AECOM's Cost Consultancy team, developed cost estimates for a range of potential solutions.

1.3.5 This note reports on the outcomes of the workshop and subsequent work. The remaining sections are structured as follows:

Section 2: The capacity of the A282 approaches to the crossing

Section 3: Operation of the crossing during construction of the new crossing structure and associated link connections

Section 4: Operation of the Option A crossing

Section 5: Summary and Conclusions

1.4 **Assumptions/Limitations**

1.4.1 The traffic demand on the A282 has been determined by using data from the LTC model outputs, which assume the existing number of lanes on the A282. This demand is effectively constrained by the assumed capacity (number of lanes). Further traffic modelling and assessment would be required to advise the forecast flows if more capacity was provided. This would also need to consider what improvements would be required at associated Junctions.

1.4.2 The Department for Transport's Design Manual for Roads and Bridges (DMRB) advises the design flow capacity for roads. Section 3 of DMRB Standard TD22/06: Layout of Grade Separated Junctions[1] advises the maximum traffic lane capacity of a motorway is 1800 vehicles per hour (vph), while for all-purpose roads it is 1600vph. DMRB advice note TA79/99: Traffic Capacity of Urban Roads[2] advises a maximum capacity of 1800 vph per lane for a dual 4 lane urban motorway[3].

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[1] http://www.dft.gov.uk/ha/standards/dmrb/vol6/section2/td2206.pdf

[2] http://www.dft.gov.uk/ha/standards/dmrb/vol5/section1/ta7999.pdf

[3] The April 2013 Review of Lower Thames Crossing Options assumed a lane capacity of 1800 PCUs per hour per lane (see 3.4.6 of Design and Cost Report) to test the level of service of the new crossing options and not to

1.4.3 Experience on Smart Motorways[4] (previously referred to as Managed or Controlled Motorways) suggests that a higher lane capacity value of 2000vph may be possible. However, further detailed assessment would be required to determine the maximum capacity and would need to consider the effect of short links, weaving and driver behaviour on approach to the crossing.

1.4.4 Taking into account the motorway characteristics of the A282, it is considered appropriate to assume a lane capacity of 1800vph in assessing lane requirements.

1.4.5 The engineering design concepts developed to inform the cost estimate for providing additional lanes on the A282 have drawn upon the collective knowledge of experienced highway engineers. They are of a simplistic level of detail that is sufficient to develop an order of magnitude cost. Detailed geometric design checks against DMRB standards were excluded from this exercise.

2. Capacity on Approach to the Crossing

2.1 Option A lane provision

2.1.1 Option A, in the Review report, would increase capacity by introducing an additional four lanes at the crossing, and provide six lanes in both the northbound and southbound directions.

2.1.2 North of the crossing, the illustrative design assumed a single lane drop at both Junctions 31 and 30 and in the southbound direction a single lane gain at Junctions 30 and 31. North of Junction 30, there would be no increase in capacity; the M25 would remain as existing - generally dual 4 lanes. A schematic layout is shown in Figure 2.1.

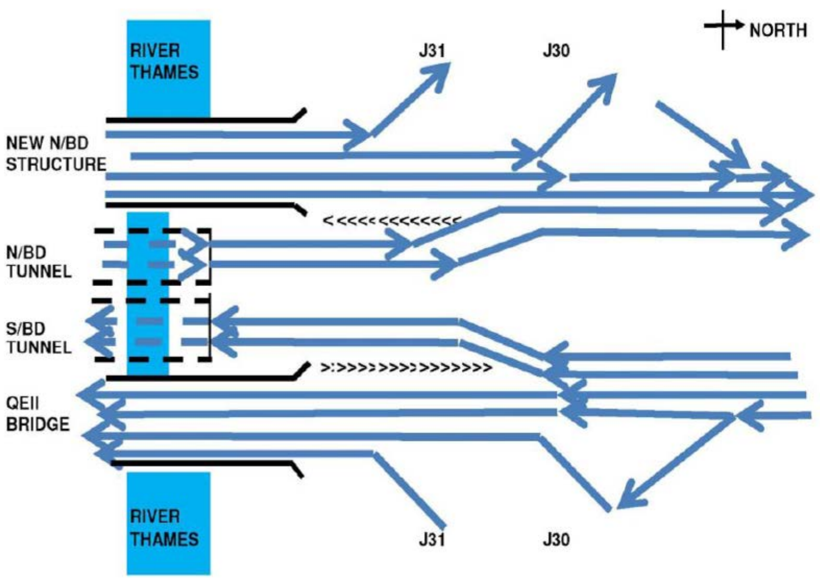

Figure 2.1 Schematic layout Junction 30 to the crossing

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determine adequacy of capacity. Based on DMRB guidelines and operational experience lane capacities of 1800 to 2000vph have been used in Module 4 to determine the need for additional capacity.

[4] For an explanation of Smart Motorways: http://www.highways.gov.uk/our-road-network/managing-our-roads/improving-our-network/smart-motorways/

2.1.3 Recent analysis has been undertaken which concluded that further investment beyond the scheme due to begin construction in 2015 would be needed at M25 Junction 30 if Option A were implemented. These improvements are referred to as Option E1+9 and reported in a separate technical note 'Module 3 LTC - Potential Additional Network Investment'. Option E1+9 will form a component of Option A+ (refer to Section 1.1.7 of this technical note)

2.1.4 South of the crossing, the illustrative design assumed that an additional two lanes were introduced at Junction 1A in the northbound direction and dropped at Junction 1A in the southbound direction. South of Junction 1B there would be no increase in the number of lanes, the M25 and A282 would remain as existing, generally dual 4 lanes to Junction 2. A schematic layout is shown in Figure 2.2.

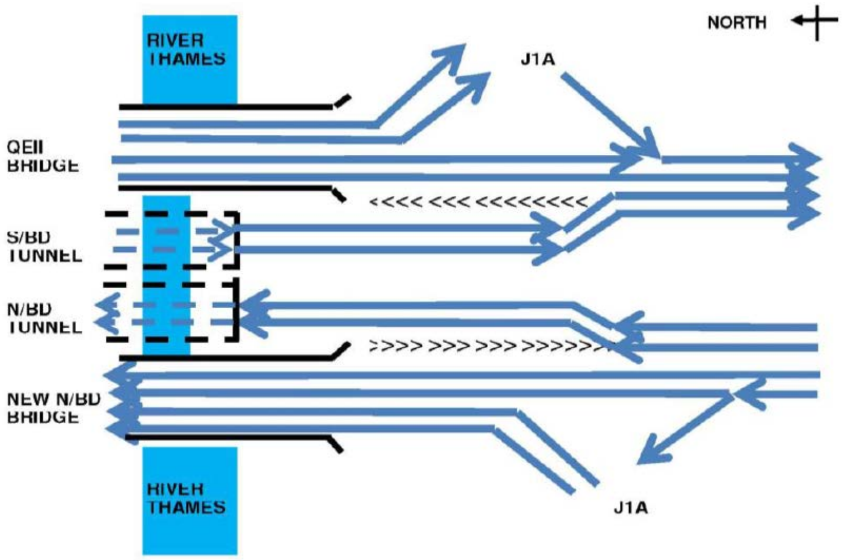


Figure 2.2 Schematic layout Junction 1A to the crossing

2.1.5 Based on available traffic data this lane arrangement south of the crossing could provide an overprovision for local traffic joining or leaving at Junction 1A and an underprovision for long distance strategic traffic on the A282 north of the A2 (M25/ A282 Junction 2). This layout may prevent acheivement of the full benefits of the new capacity at the crossing.

2.2 Forecast Traffic and assessment of Capacity

2.2.1 Forecast traffic flows on the A282, south of the crossing, are set out in Appendix 3 of the Central Forecast and Sensitivity Tests Report (May 2013). These show that this section of the network, particularly between Junctions 1B and 1A northbound, is operating near to or above capacity during peak periods in both the assumed opening year 2025 and design year 2041.

2.2.2 This assessment is based on a lane capacity 1800vph, as detailed in 1.4.4. A further detailed assessment would be required to determine with more certainty, the achievable lane capacity on this section. It would need to consider, in detail, the positive impact of technology such as mandatory variable speed limits and potential negative impact of the closely spaced junctions, weaving movements and lane selection decisions approaching the new crossing. It may consider that a higher lane capacity is achievable, accepting that it could reduce the level of service. If a lane capacity of 2000vph were assumed it is possible that no additional lanes would be required however new, technology infrastructure would be required to achieve the capacity.

2.2.3 The forecast flows modelled are based on retaining the existing number of lanes assumed on the A282 so the forecast demand is constrained by the existing road capacity. If the A282 were modelled with additional lanes and the required motorway junction improvements, for example, dual 5 lanes and motorway/A282 Junctions upgrade, the modelling may show demand for those additional lanes and higher flows.

2.2.4 The Final Review report produced for the LTC consultation notes that the existing network south of the crossing is stressed. Further modelling may show that the stress and congestion on the surrounding network also constrains the demand on the A282.

2.2.5 The capacity was discussed at the workshop (assuming a maximum lane capacity of 1600vph) and the consensus was an additional lane would be required on each carriageway of the A282 from J1A to J2 making this section dual 5 lanes. The workshop agreed the desirability of full width lanes for operational purposes.

2.2.6 Following the workshop, further review on lane capacity has been undertaken resulting in the assumed lane capacities being increased to 1800vph or potentially 2000vph. A range of potential solutions were developed:

i. Smart Motorway technology installed between Junction 1A and 2 with no additional lanes. It is assumed this design would deliver a lane capacity of 2000vph.

ii. Smart Motorway technology installed between Junction 1A and 2 with an additional lane on both carriageways between Junction 1A and 1B. For an 1800vph lane capacity scenario, the modelled flows indicate widening would only be required in the northbound direction. It is assumed both carriageways could need widening due to limitations of the traffic model and lane capacity assumptions.

iii. Smart Motorway technology installed between Junction 1A and 2 with an additional lane on both carriageways along the full length (Junction 1A to 2).

2.2.7 Taking into account the uncertainties of the traffic modelling, we consider that if Option A was implemented Smart Motorway technology installed between Junction 1A and 2 with an additional lane on both carriageways between Junction 1A and 1B could be the most appropriate investment solution. This is based on 1800vph lane capacity for the higher flow section between Junctions 1a and 1b. When developing the solution for the section between Junction 2 and the north side of Junction 1b, the merits of a solution maintaining existing physical capacity, utilising Smart Motorway technology, traffic management measures, and, possibly, accepting lower level of service standards should be considered against the high capital cost and delivery risk of widening the A282.

2.3 **Providing additional capacity (lanes)**

2.3.1 The A282 between Junctions 1a and 2 is approximately 3km long and includes various constraints such as existing bridges, retaining walls and close land boundaries. Providing additional lanes would involve significant works in a constrained environment on one of the UK's busiest sections of road.

2.3.2 It was noted that there is potential for the upgraded section to be a Smart Motorway arrangement with a 1.0m hard strip rather than a hard shoulder. There is a risk a hard shoulder would be required for operation and safety reasons, similar to other dual five lane sections on the strategic road network. It is possible the use of a narrower cross section could be investigated. The cost estimates assume full lane widths with a 1.0m hard strip would be provided.

2.3.4 Allowance would need to be made for improvements to Junctions 1a and 1b to allow for the A282 widening and to provide additional capacity.

2.3.5 To accommodate additional lanes the major works would need to include:

i. Demolishing and replacing overbridges and widening underbridges to allow the widened A282 carriageway to pass through.

ii. Demolishing some lengths of retaining wall and constructing new walls

iii. Improvements to Junctions 1B and 1A to accommodate the additional lanes and capacity at merges and diverges

iv. Purchase of land to accommodate the widening and potentially temporary works.

v. Significant traffic management and temporary works to enable the existing local and strategic network to continue operating.

vi. Pavement, technology, environmental mitigation and other works associated with a widening scheme.

2.3.6 A schematic of the options is included in Appendix 4 and images of the A282 in Appendix 5. These illustrate some of the existing constraints along this section of the network.

2.3.7 The major risks identified with the delivery of additional lanes:

i. The safety and operation of dual five lane carriageway needs careful consideration and approvals

ii. Significant traffic management and other temporary works would be required to operate the strategic and local road networks during construction.

iii. Land purchase and a development consent order would be required, likely in conjunction with Option A that would increase the risk to delivery.

iv. There is limited scope to increase capacity at this location in the future.

2.4 Cost of providing additional capacity

2.4.1 The Highways Agency's cost consultant Benchmark produced estimates for two options which represent the potential lower and upper bounds of the potential investment scenario:

i. Smart Motorway between Junctions 1A and 2. The outturn cost ranged between £22.6M and £34.9M with a most likely outturn cost of £27.9M.

ii. Widening to provide an additional lane (dual five lanes) and smart motorway technology both carriageways between Junction 1A and 2. The outturn cost ranged between £362M and £563M with a most likely outturn cost of £439M.

2.4.2 AECOM's cost consultancy team developed an estimate the investment solution – widening to provide an additional lane (dual five lanes) for both carriageways between Junction 1A and 1B with Smart Motorway technology installed between Junctions 1A and 2. The most likely outturn cost of this option was £351M. This cost is closer to the upper bound solution because widening between Junction 1A and 1B constitutes a large portion of the scheme, both in length and complexity of the physical works.

2.4.3 A breakdown of the most likely outturn cost for each scenario is included in Appendix 6 of this technical note.

2.4.4 The outturn cost estimates are based on Q2 2011 prices with a price inflation profile, as shown in Table 2.1.

Financial Year	13/ 14	14/ 15	15/ 16	16/ 17	17/ 18	18/ 19	19/ 20	20/ 21	21/ 22	22/ 23	23/ 24	24/ 25
Inflation (%)	4.5	4.4	4.3	4.2	4.1	3.8	3.8	3.5	3.5	3.5	3.5	3.5

Table 2.1: Inflation Profile

2.4.5 The estimate for the investment solution has been used to build up the total cost of Option A+ (refer to Section 1.1.7 of this technical note). The original Option A estimate has been reviewed and adjusted to ensure there is no double counting between the component parts of Option A+.

3. Operation During Construction

3.1 Potential Issues

3.1.1 The new crossing structure(s) would be located to the west of the existing tunnel bores. South of the Thames, the new approach to the structure(s) would be located on the strip of land between the existing crossing and the private industrial land to the west. The construction footprint would impact on the existing Dartford Control centre and dangerous goods marshalling areas. On the north, side of the Thames the new approach would be constructed through the existing private industrial aggregate site.

3.1.2 The key issues that have been considered in this assessment are:

i. The potential construction footprint how it would impact the existing control centre and dangerous goods and non-compliant vehicle marshalling area.

ii. The ability to maintain traffic flows and free-flow tolling during construction

3.2 Dartford Free Flow Charging (DFFC) Operation

3.2.1 The Dartford Free Flow Charging (DFFC) scheme has been developed to reduce congestion by allowing motorists to use the Crossing without having to stop at traffic barriers to hand over payment. The scheme will be operation in Autumn 2014. It is important to understand the operation of the DFFC scheme as Option A would require similar operational for Non-compliant and dangerous good vehicles.

3.2.2 Introduction of a DFFC scheme at the Crossing involves the removal of the Charging Plazas and associated traffic barriers and reducing the carriageway width through the existing Plaza areas.

3.2.3 The revised northbound carriageway configuration will bifurcate with the nearside two lanes dedicated to the West tunnel and the offside two lanes dedicated to the East tunnel. The Junction 1A on-slip will merge with the approach to the West tunnel.

3.2.4 The two tunnels, West and East, impose a number of safety constraints on the Crossing, which the Northbound Charging Plaza is currently used to either mitigate or manage to some extent. The main safety constraints on the tunnels are, the substandard headroom in the West tunnel, restrictions on passage of vehicles carrying dangerous goods, abnormal loads (as defined by the Dartford-Thurrock Crossing Regulations 1998 (and amendments) and the need to avoid queuing traffic in the tunnels.

3.2.5 The design for DFFC has developed a system of traffic light signals, traffic barriers and Variable Message Signs (VMS) to replicate the vehicle management that the Northbound Charging Plaza is currently used to provide. This system is referred to as the Traffic Management Cell (TM Cell).

3.2.6 The main use of the TM Cell is to stop and redirect non-compliant vehicles from the carriageway. A vehicle is considered to be 'non-compliant' when it has failed to respond correctly to fixed signing and is proceeding towards the tunnels. The TM Cell will primarily be automatically activated when non-compliant vehicles are detected by technology on the approaching carriageway. This technology will include vehicle height detection, dangerous goods orange plate detection and vehicle profiling for length and width. The TM Cell may also be manually activated by the Highways Agency Traffic Officer Service.

3.2.7 The TM Cell will also be utilised to stop traffic for the purpose of allowing vehicle convoys into the tunnels, regulating traffic flows to prevent queuing in the tunnels and for emergency tunnel closures.

3.3 Impact of bridge construction

3.3.1 The alignment of the main approach viaducts is governed by the air draught requirements above the Thames and would follow a similar vertical alignment to the existing QEII bridge on both the north and south sides of Thames. It would involve construction of individual bridge piers, topped with bearings on which steel beam are placed. The construction footprint would be localised around each pier. Viaduct deck beams are likely to be launched linearly so saving on space required for construction, as there would be no large cranes needed.

3.3.2 To the north side of the crossing, the bridge approach would be constructed through the industrial land, which would be acquired as part of the scheme. It is not foreseen that there would be any construction issues at this location that cannot be managed as part of the scheme.

3.3.3 To the south, the construction footprint of the approach viaduct and site compound and storage areas would directly impact on the existing control centre and dangerous goods vehicles (DGV) & non-conforming vehicles (NCV) marshalling area. Additional land would be required from the power station during construction and possibly for the permanent operation of the crossing.

3.3.4 The control centre would have to be relocated during construction and a suitable location for a permanent structure found. Both the temporary and permanent locations would need full sight of the northbound approach and TM cells. It was identified at the workshop that this could be achieved by the use of an elevated structure located within at a suitable location during construction within the existing site and the permanent structure may take a different form to the existing control centre but would likely be accommodated.

3.3.5 Management of DGVs and NCVs was identified as a potential issue. The NCVs are stopped at the TM Cells and marshalled across to a holding area near the control centre. During construction, space would be limited by construction activities and alternative temporary and permanent marshalling areas would need to be too identified. A possible location was mooted as area of vacant land adjacent to Junction 1a on the west side of the A282. This is earmarked for development and would need to be put in abeyance is Option A is progressed.

3.3.6 The vertical alignment of the bridge approach rises from around Junction 1a which means the carriageways separate from the tunnel approach alignment. Careful planning is required to ensure NCVs can be marshalled across and possibly underneath the approach structure both during construction and in the final scheme.

3.3.7 Junction 1A would need to be upgraded as part of the works, which would include constructing new offline overbridge(s) over the live carriageway. This junction is critical to the local road network and used by the operators of the crossing. It would need to remain open during construction, which could involve complex traffic management arrangements and temporary works.

3.4 Impact of a tunnel construction

3.4.1 The Design and Cost report considered two options for a tunnel, these being immersed tube and bored tunnel types. There are differences in the construction methodology but the construction footprint of both tunnel approach zones would be similar

3.4.2 The footprint of the tunnel approach would start further north of the bridge approach and would match the vertical alignment of the existing tunnels. This would potentially allow the retention of the control centre and more space to manage DGVs and NCVs during construction.

3.4.3 As with a bridge, the same issues with limited space and access for launch and reception locations would need to be dealt with on the south side. There would be potential to start a bored tunnel from the north side where land could potentially be more easily acquired to accommodate slurry and arisings areas to make best use of land available

3.4.4 There was a consensus from workshop attendees that there would be challenges with operating the crossing within a bridge or tunnel construction site. This was particularly relevant with the restricted space available to manage NCVs and DGVs. Management of these issues would be achievable but would add significantly to the complexity of construction activities and operation of the crossing during construction.

3.5 Maintaining capacity and Free-flow tolling during construction

3.5.1 For the tunnel option, the bulk of the construction work would occur off-line and the existing number of lanes would be maintained during construction. The bridge option would have more impact on the existing alignment due to the approach structure starting further south and closer to Junction 1A but it is envisaged the existing number of lanes could be maintained in each direction.

3.5.2 Access to construction sites along with constructing the connections to the existing alignments would need careful planning to ensure that impacts on the existing alignment and emergency access routes are managed.

3.5.3 The free-flow charging system would remain in place during construction; however, arrangements would need to be modified at numerous stages to allow for construction activities and transition to the new layout. The operation of the free-flow system is dependent on the ability to manage DGV & NCVs. The workshop noted there must be appropriate areas to manage traffic. The key consideration was to maintain access for emergency and operational vehicles in the event of congestion.

3.5.4 The consensus of workshop attendees was it would be complex but possible to maintain the four lanes and free-flow tolling in both directions. However, Jacobs/ AECOM are of the opinion that operation of the crossing would, inevitably, be vulnerable to some disruption through providing access to, and working alongside, a major construction site on both sides of the Thames.

4 Operation of Option A

4.1 Option A Layout

4.1.1 The proposed Option A layout either side of the crossing is described in Section 2.1 of this technical note. This section describes the operation of the new crossing in relation to the management of DGVs and NCVs and during bridge or tunnel closures.

4.1.2 The constraints affecting the passage of NCVs and DGVs through the crossing are described in Section 3.2. These constraints will still apply to the existing west and east tunnel bores which carry lanes 5 and 6 of the new layout in the north and southbound directions, respectively.

4.2 Managing DGVs and NCVs - New bridge option

4.2.1 Northbound NCVs and DGVs would be permitted to pass over the new bridge structure (lanes 1 to 4) unrestricted but would be restricted from using the west tunnel bore (lanes 5 and 6).

4.2.2 This would require a similar system to the TM Cells that will be implemented as part of the free-flow tolling scheme. This would detect the NCVs, stop them before entering the tunnels and across to a holding area.

4.2.3 Any future development of the design would need to consider how access to the holding area is provided. It could potentially allow lanes 1 to 4 to continue unimpeded over the bridge while the NCV is marshalled to the holding area via a route under the bridge approach structure.

4.2.4 In the southbound direction lanes 5 and 6 would be using the existing east bore this would also need a system similar to the TM Cells to detect and manage NCVs. There is an existing area known as 'Essex Point' on the north side of the crossing which can be used to marshal and manage NCVs.

4.2.5 There would be requirement to have provision to detect and manage NCVs in both directions through both tunnels in order to enable contra flow operation. This would mean having a means of operating a TM cell arrangement. This is logistically quite complex but the consensus at the workshop was that it would be achievable through careful planning and the use of technology.

4.3 Managing DGVs & NCVs - Tunnel Option

4.3.1 Subject to detailed design and risk analysis the new tunnel bores (lanes 1 to 4) would be constructed to accommodate DGV's but there would still be a need to restrict them from using the west tunnel bore (lanes 5 and 6). This would be a similar scenario to the bridge option and would require the use of a TM Cell arrangement to detect the NCVs, stop them before entering the tunnels and allow all lanes to be held while they are marshalled across to a holding area.

4.3.2 The same requirement to have a system to detect, stop and manage NCVs on both sides of both existing tunnels is required for the tunnel option.

4.4 Managing traffic during bridge and tunnel closures

4.4.1 At present, in the event of the QEII bridge being closed the southbound traffic is put into contraflow through the east bore. This allows two lanes to be maintained in either direction. We have assumed that in the face of increasing demand there would be a need to maintain four lanes in either direction to increase network resilience.

4.4.2 Both Bridges Closed (figure 4.1):

This is unlikely as the new bridge would be constructed with wind shielding and the existing QEII bridge is only closed for high winds 1 or 2 times a year on average. In the event of this scenario, there is no option but to maintain two lanes of traffic in each direction.

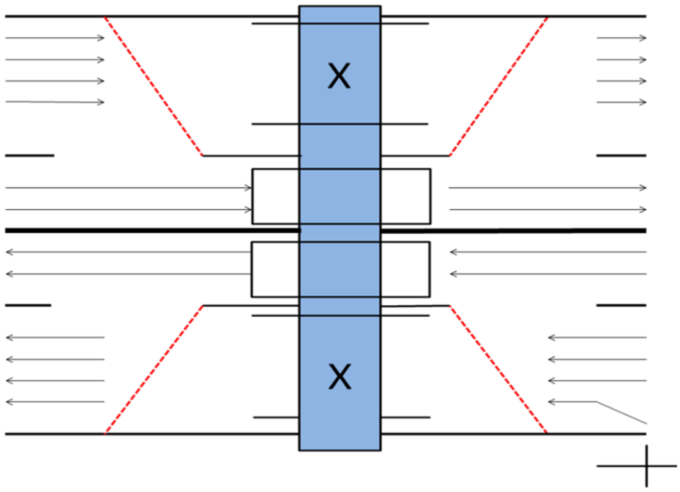


Figure 4.1: Both bridges closed.

4.4.3 A bridge closure (Figure 4.2) :

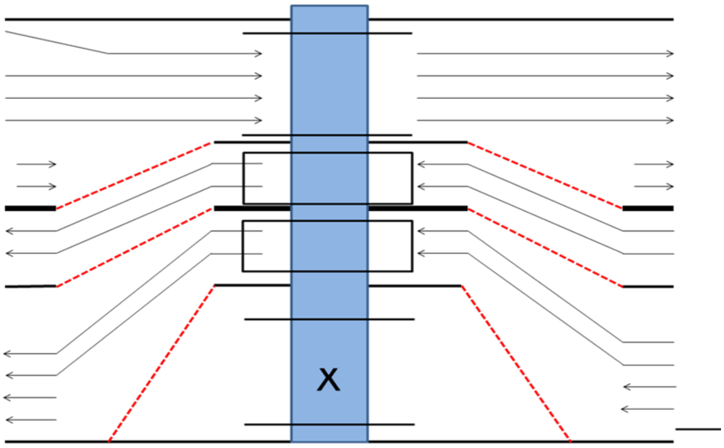


Figure 4.2: One bridge or tunnel closed, in this example the QEII bridge

4.4.4 This is a more likely scenario where a bridge is closed for maintenance or in an emergency. Four lanes would use the tunnels with lanes 5 and 6 being put into contraflow. The issues that have been identified in this situation are set out in Sections 4.4.5 and 4.4.6.

4.4.5 The proximity of the crossovers to J31 & J1A - the workshop identified that in the event of contra-flow being implemented Junction 31 south facing slips would be closed and traffic diverted to via Junction 30. Junction 1A would also be closed and traffic diverted via the local road network. This is consistent with the current operational procedures.

4.4.6 The traffic in contraflow would need to be physically separated from the opposing flows before being directed back out of contraflow. – The workshop identified that this could be achieved on both sides of the crossing without impeding the operation of the crossing. Northbound traffic in wishing to access Junction 31 would need to use lanes 1 and 2 and similarly southbound traffic wishing to access J1A would need to use lanes 1 and 2.

4.4.7 Any further design work would need to consider the location of crossovers and systems of operation in more detail. The workshop consensus was that it would be achievable to design and implement a contraflow system.

5 Summary and Conclusions

5.1 This technical note has reviewed the reviewed the illustrative design for Option A and assessed the operational issues that would potentially arise during the construction and operation of Option A.

5.2 A workshop was held on 18th October with the DfT, the Highways Agency and suppliers including consultants Jacobs/ AECOM and Connect Plus, the current operators of the crossing. The purpose of the workshop was to draw on the collective experience of the attendees and reach a consensus on the potential operational issues.

5.3 The Jacobs/ AECOM assessment and outcomes from the workshop have shown:

i. Based on available traffic forecasts the A282 between Junctions 1a and 1b would be operating above capacity in both the opening (2025) and design (2041) years. Due to limitations of the traffic model and lane capacity assumptions (refer to Sections 1.4.1 and 2.2.2 of this technical note) there is potential for a range of investment solutions to upgrade the A282 and meet traffic demand. The estimated most likely outturn cost of these solutions ranges from £27.9M to £439M.

ii. Smart motorway technology installed between Junction 1A and 2 with an additional lane on both carriageways between Junction 1A and 1B may provide sufficient capacity in the design years. The cost of this option is estimated to be £351M. Further assessment would be required to determine with more certainty the lane capacity, required lane provision and Junction improvements.

iii. Both the bridge and tunnel options would affect the operation of the crossing during construction particularly in relation to managing DGVs and NCVs. It is likely that these operations could be managed but it would add significantly to the complexity of construction. However, Jacobs/AECOM considers there remains some vulnerability to disruption through being part of a construction site. It is likely the existing number of lanes and a free-flow tolling system could be maintained during construction.

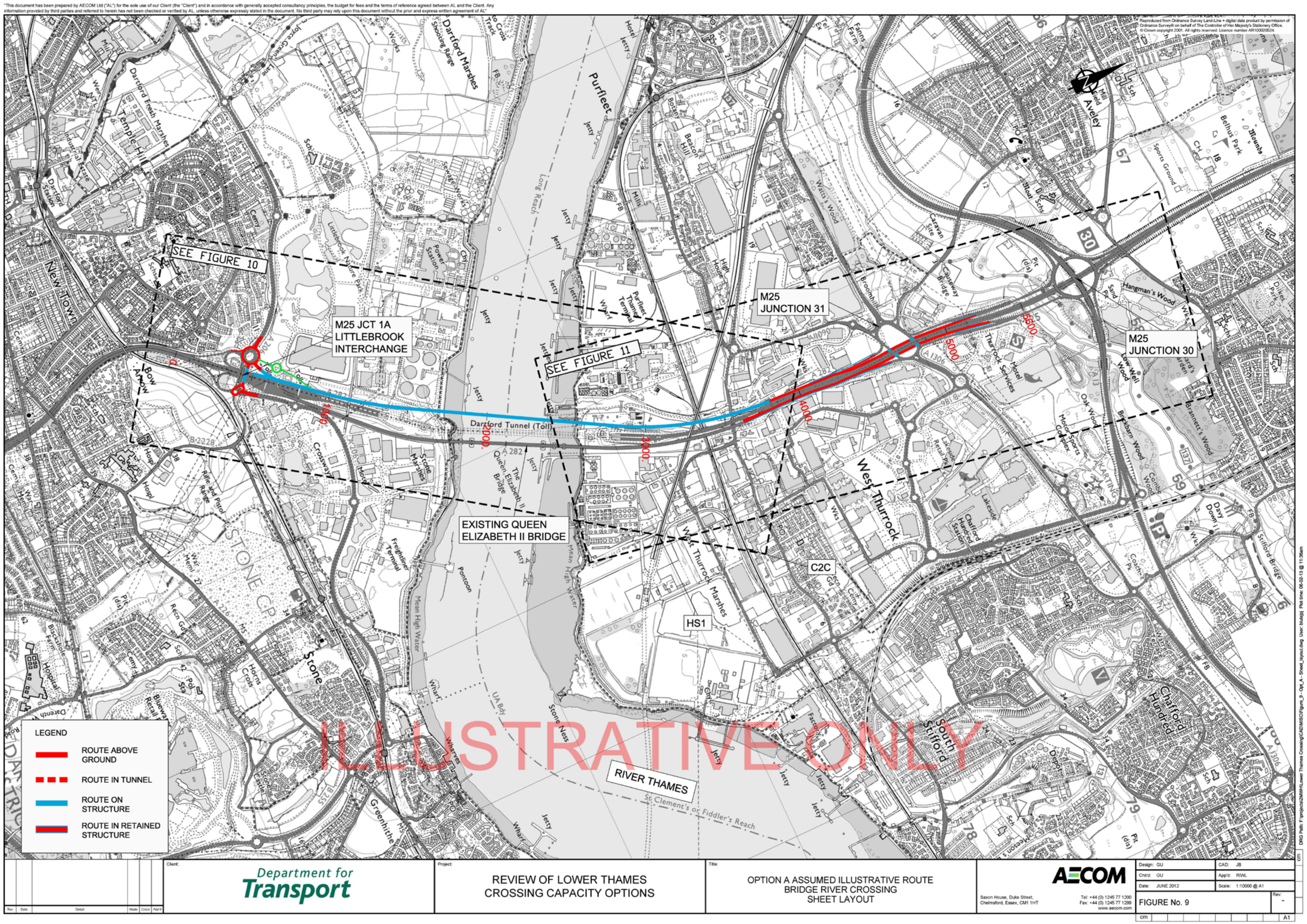
5.4 A new Option A crossing could operate with free flow tolling system. A system similar to the proposed DFFC method of managing DGVs and NCVs would need to be implemented. A system to implement contra-flow and allow four lanes to be maintained in either direction in the event of bridge or tunnel closures could be developed and implemented whilst still allowing the management of DGVs and NCVs.

5.5 The construction and operation of Option A would be complex but is feasible. Further work would be required to develop the infrastructure and operational regimes in more detail.

5.6 If Option A were to be implemented the A282 may need to be widened to provide the additional capacity required to fully realise the capacity benefits of a new crossing.

Further work to develop solutions at Option A may also show other network improvements are necessary.

Appendix 1: Option A (Bridge) General Layout
(further figures are available in the Design and Costing Report)


SEE FIGURE 10
SEE FIGURE 11
M25 JCT 1A
LITTLEBROOK
INTERCHANGE
M25
JUNCTION 31
M25
JUNCTION 30
EXISTING QUEEN
ELIZABETH II BRIDGE
Dartford Tunnel (Toll)
C2C
HS1
RIVER THAMES
1000
2000
3000
4000
5000
5600
ILLUSTRATIVE ONLY
LEGEND
ROUTE ABOVE GROUND
ROUTE IN TUNNEL
ROUTE ON STRUCTURE
ROUTE IN RETAINED STRUCTURE
Department for Transport
REVIEW OF LOWER THAMES
CROSSING CAPACITY OPTIONS
OPTION A ASSUMED ILLUSTRATIVE ROUTE
BRIDGE RIVER CROSSING
SHEET LAYOUT
AECOM
Saxon House, Duke Street, Chelmsford, Essex, CM1 1HT
FIGURE No. 9
Date: JUNE 2012
Scale: 1:10000 @ A1
A1

Appendix 2: Workshop Notes

Project:	**Lower Thames crossing**	Job No/Ref:	60287784 - 900
Purpose:	**Module 4 Workshop – Option A Further Assessment Work**	Date held:	18/10/2 013
Held at:	Highway Agency Dorking	Made by:	M. Hastie

Present:

Name	Organisation	Speciality/Role
James Hooson (JH)	DFT	Project Lead
Eamonn Colgan (EC)	Highways Agency	Main LTC contact
Francis Cluett (FC)	Highways Agency	Asset Delivery Manager
Gary Bacon (GB)	Highways Agency	DFFC Project Manager
Dan Blackburn (DB)	Highways Agency	DFFC Project Sponsor (Technology)
Keith Davies (KD)	Highways Agency	HA Traffic Officers
Chris Rose (CR)	Highways Agency	Traffic Officer Service, Operations Manager (Dartford)
Derek Hughes	Connect Plus	Connect Plus Network Operations
Wairimu Wainaina (WW)	Connect Plus	Third Party Additional Works Team
David Jenner (DJ)		
Daren Cook (DC)	Jacobs	Jacobs AECOM Project Manager
David Riley (DR)	Jacobs	Jacobs AECOM Project Director
Richard Lyon (RL)	AECOM	Associate Director (Highways)
Maclean Hastie (MH)	AECOM	Principal Engineer (Highways)

Apologies:

Paul Robinson	Highways Agency	
Rob Gibson	Highways Agency	
Shaleen Srivastava (SS)	Jacobs	Transport Planning

Distribution: Those present + apologies

No.	Item	Action By
1	**Workshop Objectives**	
1.1	JH introduced the overall objectives of the workshop.	
1.2	MH said it was necessary to reach a consensus view on the likely practicality of potential solutions for Option A in relation to: ▪ The required lane provision on M25/A282 south of the crossing, particularly northbound between Junction 2 and the crossing. Without changes to the approach roads there would potentially be dual four lane roads on each side of a dual six lane crossing. ▪ The operation of the existing crossing during construction ▪ The operation of any new crossing particularly in relation to managing Non-compliant vehicles (NCV), Dangerous Goods Vehicles (DGV), and contra flow during bridge or tunnel closures.	
2	**Background**	
2.1	Existing layout - MH explained the existing layout.	
2.2	Dartford Free Flow Charging (DFFC) – DB presented the proposed layout and explained the key operational aspects of the scheme ▪ 4 lanes northbound would bifurcate into two lanes ▪ To manage NCVs and DGVs northbound DFFC would use a system of signs, traffic signals, traffic barriers and VMS to replicate the function of the existing tollbooths. This system was referred to as the traffic management cell (TM	

	Cell) and would be used to stop NCVs and hold traffic to allow stacked DGVs to proceed through the tunnel in convoy. Option A – RL explained the key aspects of Option A, a new bridge or tunnels to adjacent and west of the existing tunnels, which would provide an additional 4 lanes at the crossing. Refer to the design and cost report https://www.gov.uk/government/publications/lower-thames-crossing-design-and-costing-report.	
2.3	CR – noted that further work at the scheme design stage, should Option A become the chosen location, would need to consider capacity at J1a & J31 to avoid congestion on both the local networks and A282.	
3	**Capacity on Approach to the Crossing (northbound)**	
3.1	MH noted that the assessment had been carried out to determine the improvements required north of the crossing at J30 and A13 if Option A was implemented. This work has been documented separately and not considered further at the workshop.	
3.2	MH presented a table showing design year (2041) flows on the A282 between J2 and the crossing. Flows indicated the A282 would be at or over capacity in both the assumed opening (2025) and design years during peak periods. It was also noted that the flows modelled are restricted by the number of lanes assumed on the A282 (i.e. the forecast demand is constrained by the capacity).	
3.3	The consensus of workshop attendees was ▪ that an additional lane would be required on each carriageway of the A282 from J2 to the crossing. full width lanes should be provided to provide a safer layout (emergency access) operation in an incident. ▪ It is likely a hard shoulder would also be required – similar to other D5M sections on the network. ▪ Allowance would need to be made for improvements to Junctions 1a and 1b to allow for the A282 widening and to provide additional capacity.	
3.4	MH described the works and major risks and significant risks that would be involved in delivering a scheme to provide an additional lane – replacing and widening structures, retaining walls, improving Junctions, operating the network during construction and CPO of land. The safety and operation of dual five and six lane motorways is outside of HA standards and guidance and would require careful consideration.	
3.5	AECOM to liaise with DfT & HA Commercial to develop a range of cost magnitude for the works. PMN – for the purposes of costing it assumed D5M with full width lanes and no hard shoulder would be required with a risk that D5M with hard shoulder and possibly six lanes from J1B & D6M could be required – further modelling work would be required to determine lane provision. Significant Junction upgrades would also be required.	AECOM
4	**Operation during Construction**	
4.1	RL explained the construction issues involved in both the bridge and tunnel options. The key points being ▪ The site is narrow and constrained on the south side, land could be required from the power station ▪ A temporary area to manage NCVs & DGVs would be required and would need further consideration. There is vacant land near J1b earmarked for development that could potentially be used.	

- Junctions 1a and 1b would be reconstructed with off-line bridges to allow it to remain open during construction works.

4.2 The construction footprint would have an impact on existing operations at the control centre and adjacent operational areas such as DGV holding areas.
The key points raised in the workshop were
- CR noted a temp control centre needs to have sight of the crossing & the TM cell
- A temporary area to manage NCVs & DGVs is required and would need further consideration. There is vacant land near J1b earmarked for development that could potentially be used.
- Junction 1b would be reconstructed with an off-line bridge to allow J1a to remain open during construction.

There was consensus from workshop attendees that there would be challenges with operating the crossing within a bridge or tunnel construction site. This was particularly relevant with the restricted space available to manage NCVs and DGVs. Management of these issues could be achievable but would add significantly to the complexity of construction activities and operation of the crossing during construction.

4.3 In relation to maintaining the free-flow charging system and four lanes either direction:
- CR noted that the key consideration was to maintain access for emergency and operational vehicles in the event of congestion.
- It was also noted that the space to manage NCV & DGVs was required to maintain the free-flow system

The consensus of workshop attendees was it would be practical to maintain the four lanes in both directions.

5 Operation of Option A (closures and managing NCVs & DGVs)

5.1 MH explained the potential scenarios with the bridge and tunnel options in the event of closures and in normal operational scenarios.

5.2 Tunnel Option Northbound:
- New tunnel may be able to take hazardous goods vehicles but it is likely a system similar to the DFFC TM Cells would be required to manage NCVs & DGVs.
- The new tunnels would be on a similar vertical alignment to the existing tunnels, which could enable NCVs to be directed across to a holding area. A TMC or equivalent will still need to exist to manage any over-sized or dangerous good vehicles in the future lanes 5 &6 and that lanes 1,2,3, and 4, traffic flow could be interrupted to intercept and remove such vehicles from lanes 5 & 6.

5.3 Bridge Option Northbound:
- DGVs would be able to use lanes 1 to 4
- NCVs and DGVs in lanes 5 & 6 would need to be managed using a similar system to the DFFC TM Cells.
- Directing these vehicles to a holding area would need careful consideration as the bridge vertical alignment may make if difficult to access the control centre area if it remained in a similar location.

5.4 Bridge & Tunnel Option Southbound:
- A method of managing NCVs and DGVs would be required on the north side for both southbound lanes 5 & 6 and northbound Lanes 5&6, for southbound traffic during a QE2 bridge closure. This mode would be a similar system to

	the currently proposed DFFC TM Cells. ▪ It would be important to have similar signage and systems on approach both north and south of the crossing.	
5.5	Bridge and tunnel closures: The workshop discussed various scenarios with the assumption that four trafficked lanes would need to remain open in both directions. This would enable traffic to operate in contra-flow mode in both existing tunnels depending on the closure type. A key point made was HATOs would need full accessibility when congestion / incidents occurred to implement contra-flow arrangements.	
5.6	The consensus of workshop attendees was that ▪ Solutions were available to manage NCVs & DGVs with Option A. ▪ The workshop acknowledged that the bridge option might present challenges in managing NCVs & DGVs in lanes 5 and 6. This is due to the to the vertical alignment of lanes 1 to 4 on the bridge approach structure potentially not allowing the necessary clearance to escort NCVs under the approach structure. ▪ It would be practical to include provision to manage traffic in contra-flow during bridge or tunnel closures.	
6.0	**Other issues raised**	
6.1	Segregation into six lanes and the various decisions approaching the tunnels is an issue that is unique to Option A. The designer of the crossing would need to explore these matters in more detail to determine and resolve safety and operational issues.	
6.2	The workshop noted that Operation & Maintenance costs were included in the Option A business case.	
6.3	It was suggested that the additional crossing capacity could promote an opportunity to improve the current tunnels.	
6.4	A commercial point made around the significant potential cost of adding or removing the whole crossing, to/from the current long term M25 DBFO PFI contract.	
7.0	**Next Steps** 1. Notes from the workshop will be distributed to attendees 2. Jacobs/AECOM will produce a technical note for DfT, which will enhance the evidence base for a final decision between the locations for the new Lower Thames crossing.	

Appendix 3: M25/ A282 Peak hour flows

Design Year:

2041 AM Peak Period

	Northbound			Southbound		
Link	**VPH**	**Existing Lanes**	**Req. Lanes**	**VPH**	**Existing Lanes**	**Req. Lanes**
J1a to the crossing	6881	4	3.8	6067	4	3.4
J1a to 1b	7344	4	4.1	6282	4	3.5
J1b to 2	5624	4	3.1	5716	4	3.2
J2-3	6301	4	3.5	6478	4	3.6

2041 PM Peak Period

	Northbound			Southbound		
Link	**VPH**	**Existing Lanes**	**Req. Lanes**	**VPH**	**Existing Lanes**	**Req. Lanes**
J1a to the crossing	7020	4	3.9	6336	4	3.5
J1a to 1b	7710	4	4.3	6467	4	3.6
J1b to 2	6269	4	3.5	5972	4	3.3
J2-3	6481	4	3.6	5281	4	2.9

req. Number of lanes based on 1800 vph/ lane

Opening Year:

2025 AM Peak Period

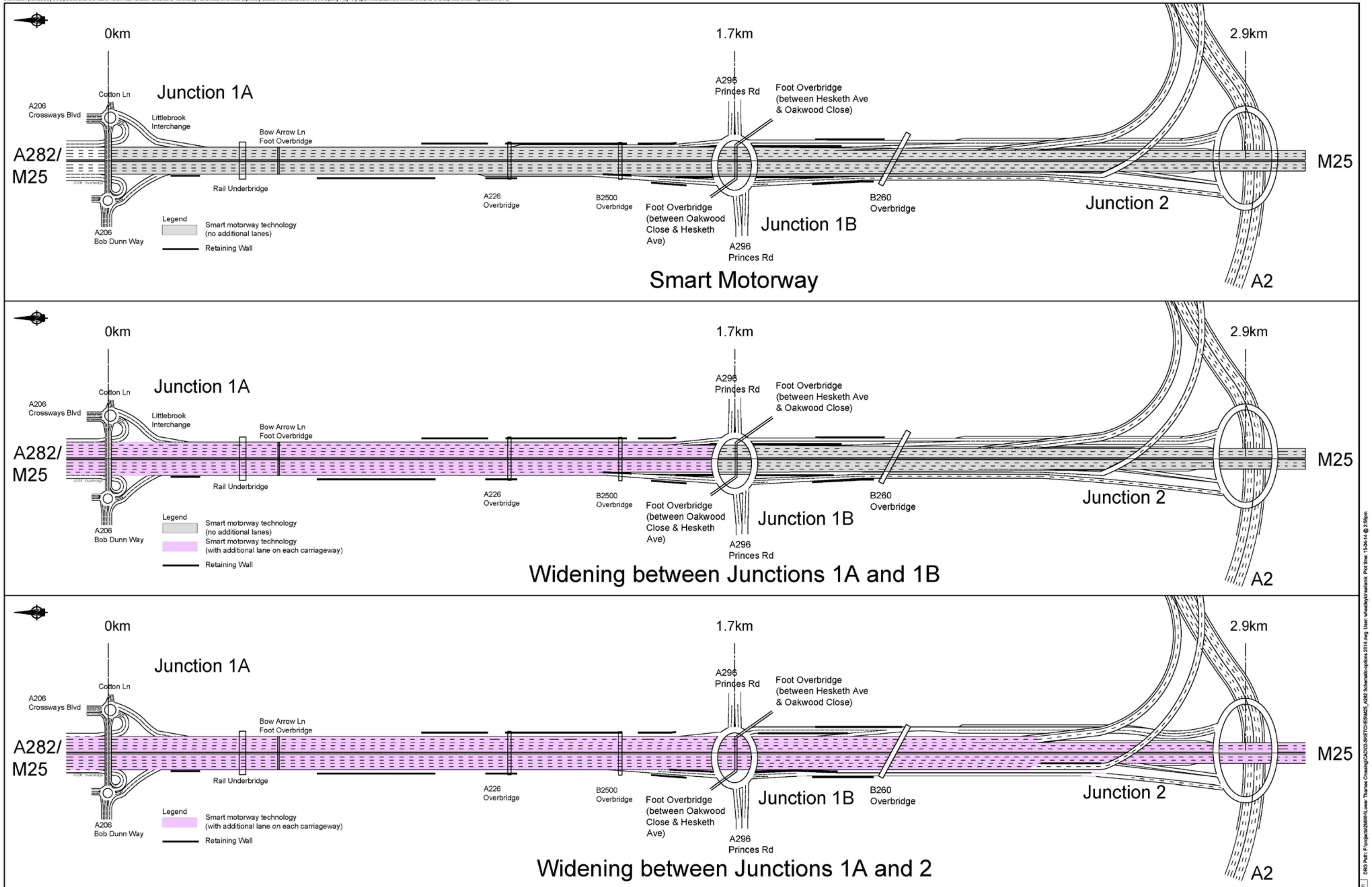
	Northbound			Southbound		
Link	**VPH**	**Existing Lanes**	**Req. Lanes**	**VPH**	**Existing Lanes**	**Req. Lanes**
J1a to the crossing	6321	4	3.5	5356	4	3.0
J1a to 1b	6828	4	3.8	5603	4	3.1
J1b to 2	5309	4	2.9	5119	4	2.8
J2-3	6138	4	3.4	6121	4	3.4

2025 PM Peak Period

	Northbound			Southbound		
Link	**VPH**	**Existing Lanes**	**Req. Lanes**	**VPH**	**Existing Lanes**	**Req. Lanes**
J1a to the crossing	6560	4	3.6	6025	4	3.3
J1a to 1b	7584	4	4.2	6051	4	3.4
J1b to 2	6222	4	3.5	5532	4	3.1
J2-3	6590	4	3.7	5044	4	2.8

req. Number of lanes based on 1800 vph/ lane

Appendix 4: M25/ A282 Improvement Options

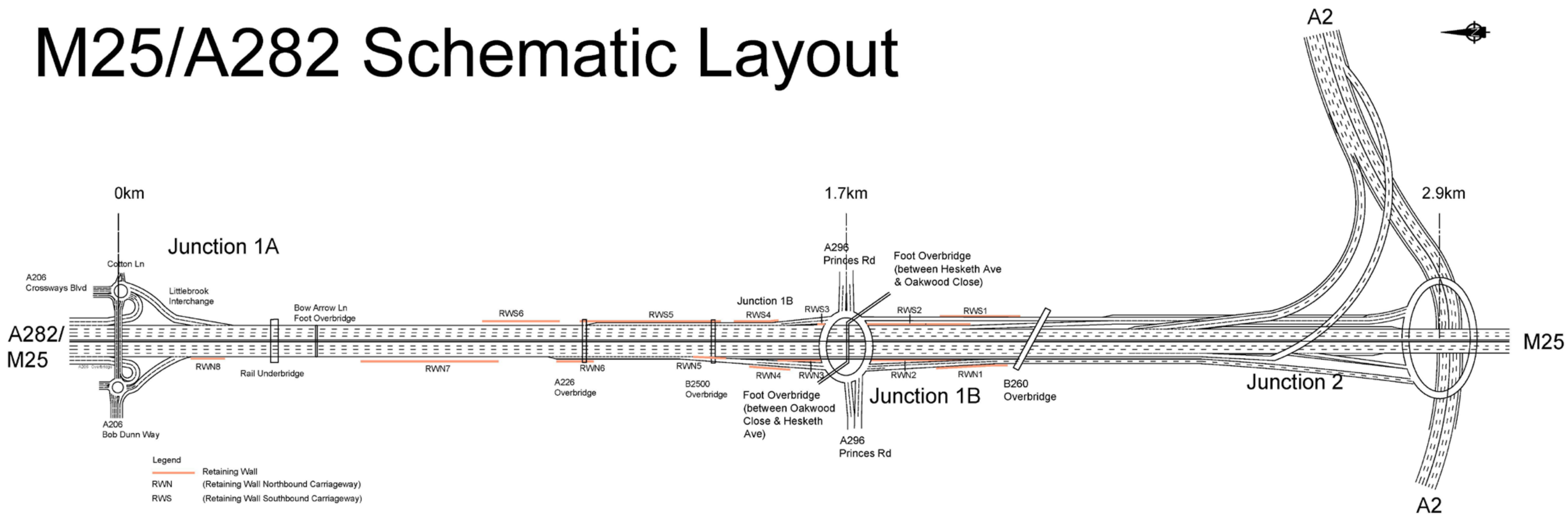


Client: Department for Transport	Project: LOWER THAMES CROSSING OPTION A	Title: M25/A282 IMPROVEMENTS	JACOBS AECOM

Design: -	CAD: JB
Chk'd: MH	App'd: RIWL
Date: APR 14	Scale: N.T.S
FIGURE No. 1	Rev: -

A1

M25/A282 Schematic Layout



Appendix 5: A282 Constraints (Junction 1a to 2)

The images are examples to demonstrate the existing constraints to widening along the route.

Image 1 – A282 northbound approaching Junction 1b showing examples of retaining walls, bridges and constrained carriageway

Image 2 – A282 southbound approaching Junction 1b showing retaining walls and adjacent private land

Appendix 6: Cost Estimates - M25/ A282 Improvement Options

	Module 4: A282 Improvements Most Likely Outturn cost		
	Upgrade to Smart Motorway	Upgrade to Smart Motorway with dual five lanes J1b to 1a*	Upgrade to dual five lane Smart Motorway J1b to 2
Options Phase	0.3	6.5	8.1
Development Phase (i) Land	0.5	11.5	14.3
Development Phase (ii) Preliminary Design & Procedures	0.0	13.9	17.4
Project Overheads & Method Related	4.3	57.5	71.9
Roadworks	4.6	36.4	45.5
Structures	1.0	37.1	46.3
Contractor Fee	0.9	13.1	16.4
Statutory Undertakers	0.1	11.2	14.0
Construction Overheads	3.6	5.0	6.2
Non Recoverable VAT	0.0	15.5	19.4
Sub-total	15.3	207.6	259.6
Range Narrowing Inflation Programme Risk	0.0 10.0 2.6	0.0 123.5 19.9	0.0 154.5 24.8
Grand Total	28.0	351	438.8

* indicative breakdown of total cost