TRANSPORT FOR LONDON

RIVER CROSSINGS: SILVERTOWN TUNNEL

SUPPORTING TECHNICAL DOCUMENTATION

NEW THAMES RIVER CROSSING: SILVERTOWN TUNNEL OPTION – ALIGNMENT DEVELOPMENT

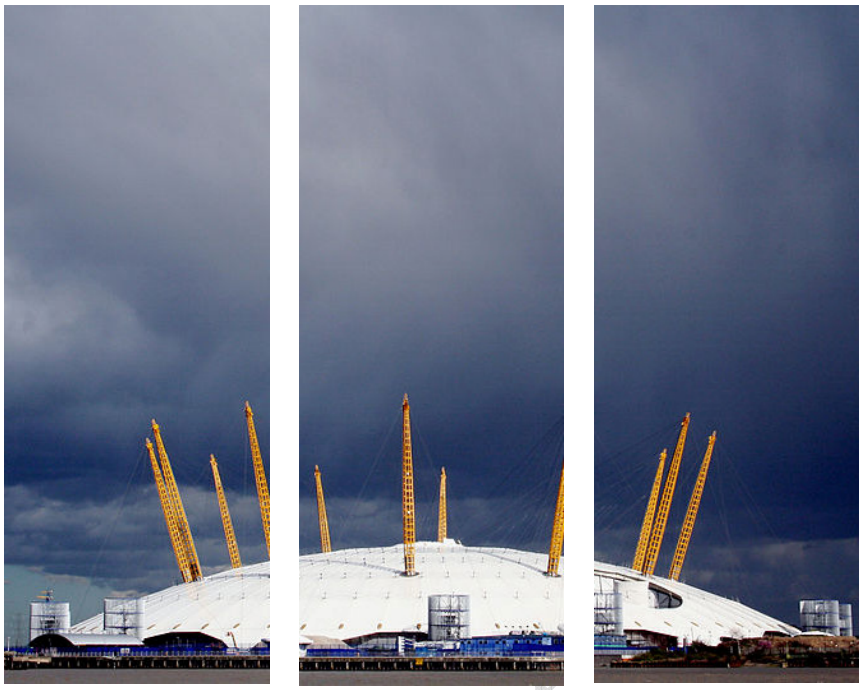
Mott MacDonald

January 2011

This report sets out the rationale behind the decision to progress the highway alignment criteria used and the way in which inter project risks between the proposed Silvertown Tunnel and London Cable Car have been mitigated through careful route selection.

This report is part of a wider suite of documents which outline our approach to traffic, environmental, optioneering and engineering disciplines, amongst others. We would like to know if you have any comments on our approach to this work. To give us your views, please respond to our consultation at www.tfl.gov.uk/silvertown-tunnel

Please note that consultation on the Silvertown Tunnel is running from October – December 2014.



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Windsor House, 42-50 Victoria Street, London, SW1H 0TL

Mott MacDonald, Mott MacDonald House, 8-10 Sydenham Road, Croydon CR0 2EE, United Kingdom
T +44(0) 20 8774 2000 F +44 (0) 20 8681 5706, W www.mottmac.com

Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
1.0	10/01/11	M Cooke	T Rock	R Bland	Draft – for comment only

Mott MacDonald, Mott MacDonald House, 8-10 Sydenham Road, Croydon CR0 2EE, United Kingdom
T +44(0) 20 8774 2000 F +44 (0) 20 8681 5706, W www.mottmac.com

Content

1. Introduction

1.1 Introduction

In order to facilitate the design and construction of the proposed London Cable Car across the Thames from the Greenwich Peninsula to the Royal Victoria Dock the design alignment of the proposed Silvertown Tunnel has been revisited. This realignment has been based on tunnelled Option 5 as described in report 281586/MNC/TUN/0001, principally a 12.8m external diameter twin bore two lane unidirectional road tunnel. The opportunity has been taken to develop the northern side of the proposed scheme in light of the historical records on the form and nature of the now backfilled Western Entrance to the Royal Victoria Dock.

The report sets out the rationale behind the decision to progress Option 5, the highway alignment criteria used and the way in which inter project risks between the proposed Silvertown Tunnel and London Cable Car have been mitigated through careful route selection.

In reading this report reference should be made to previous tunnel reports:

- 267759/MNC/TUN/01 Rev 001 – New Thames River Crossing – Silvertown Tunnel – Volume 1
- 281586/MNC/TUN/0001 Rev 1.0 – New Thames River Crossing – Silvertown Tunnel – Addendum to Volume 1
- 281586/MNC/TUN/0002 Rev 1.0 – New Thames River Crossing – Silvertown Tunnel – Design Guidance for Developers

2. Option 5

2.1 Scheme description

Option 5 consists of twin bore, uni-direction, two lane, 12.8m external tunnel diameter tunnels. A cross section of the bored tunnels is shown in drawing MMD-281586-TUN-4201. The tunnels are not accessible to pedestrians or cyclists, instead using the London Cable Car.

The escape principle is similar to that for options 2 & 3. In the event of an incident users would escape into a fire hardened housing at road level and walk to the nearest portal where they would escape to ground surface through the open cut sections. This strategy is similar in principle to that which is being employed on the New Tyne Crossing now under construction. A 1200mm wide escape passage is provided, fully accessible to persons of restricted mobility with man accessible cable duct above.

The reduction in diameter from 14.0m to 12.8m, combined with cut and cover construction through the old dock structure allows for the minor realignment of the tunnel. This new alignment is referred to as 'des road opt5'.

3. Alignment criteria

3.1 Alignment development

In response to the continuing advancement of the London Cable Car (LCC) project a new alignment for the Silvertown Tunnel has been developed. The alignment meets the following requirements:

- Maximising the land available to developers on the Greenwich Peninsula, by keeping the alignment as far south as possible, without encroaching closer than 6.5m to the South Cable Car Station Piles.
- Maximising the clear horizontal distance to the South Main Tower and ship impact protection foundations, keeping the minimum distance to extrados of the tunnel at 6.5m
- Maintaining a separation between the tunnel bores of 12.8m (external diameter), except at portals where separation is reduced to 70% of tunnel diameter.
- Maximising cover to the river bed at the tunnel low point
- Maintaining a minimum clear distance to the DLR piers foundation piles of 3.0m
- Use of cut and cover techniques through the redundant Western Entrance to the Royal Victoria Dock.
- Avoiding encroachment into lands south of the dock entrance, currently occupied by a drinks distribution warehouse.
- Minimum TBM radius of curvature of 400m.

3.2 Design criteria

The alignment developed is based upon standards published by the Highways Agency, principally:

- TD 27/05 – Cross-Sections and Headrooms
- BD 78/77 – Design of Road Tunnels
- TD 9/93 – Highway Link Design

The tunnel has been designed to the desirable minimum requirements as set out in the standards. One step and two step relaxations are allowable for some criteria.

3.2.1 Design speed and stopping site distance

The speed limit within the tunnel and on the approach roads is 30mph, giving a design speed according to BD78/99 Table 4.3 of 60km/h. At this speed the desirable stopping site distance (SSD) is 90m, no relaxation is necessary for the alignment proposed.

3.2.2 Carriageway dimensions

Table 3.1: Carriageway dimensions

Description	Dimension	Standard	Note
Carriageway width	7.3m	TD 27/05 Figure 4-4a	
Hardstrip	Not required	BD 78/99 Clause 4.28	
Verge width	1.0m	BD 78/99 Table 4.5	
Maintained headroom	5.03m + S	TD 27/05 Table 6-1	New headroom not required – see explanation below *
Sag curve compensation	0.07m	TD 27/05 Table 6-2	Sag radius 1300m
Additional clearance	0.25m	BD 78/99 Clause 4.25	
Walkway headroom	2.3m	BD 78/99 Table 4.5	

* The 'maintained headroom' is provided as opposed to the 'new construction headroom' due to the special requirements of road tunnels. Due to difficulties associated with movement services and alteration of walkway levels, relaying of the road surface will be achieved through removal of the old surface, before placement of the new, and as such the additional 270mm allocated for this purpose within the new construction headroom is not required.

3.2.3 Super elevation

To avoid unnecessary complication with drainage, service ducting and to minimise the tunnel diameter to reduce cost it is recommended that super elevation is maintained at 2.5% throughout the tunnel (BD 78/99 Clause 4.23 & 4.24). Further, to avoid transition zones and flipping of super elevation it is proposed to keep the horizontal radius of curvature to greater than 720m on adverse curves.

3.2.4 Gradient

Longitudinal gradients above 5% are not permitted in new tunnels, unless no other solution is geographically possible (Clause 2.2.2, Directive 2004/54/EC of the European Parliament and of the Council of 29 April 2004 on minimum safety requirements for tunnels in the Trans-European Road Network). However, for this exercise as noted in BD 78/99 Clause 4.22, gradient has been limited to 4% in order to reduce the impact on ventilation costs and traffic speeds.

4. Obstructions

4.1 London Cable Car & ship impact protection

The proposed London Cable Car (LCC) and ship impact protection (SIP) foundation structures significantly influence the alignment of the tunnel, which has been altered to maintain a minimum clear distance of 6.5m between any LCC & SIP foundation piles and the extrados of the tunnel.

The minimum clear distances to the tunnel alignment described herein are as follows:

- North Intermediate Tower – 14.0m
- South Main Tower – 14.9m
- South Cable Car Station & South Compression Tower– 6.5m
- Ship impact protection – 19.0m

The LCC foundations are based upon the Expedition drawings listed below, issued on 17/12/10:

- 284/310 – North Intermediate Tower Foundation Plan
- 284/320 – North Main Tower Foundation Plan
- 284/330 – North Main Tower Foundation Plan
- 284/340 – South Station and Compression Tower Foundation Plan

The SIP foundations are based upon the drawing below, issued on 10/12/10:

- 284196-SK02 – Floating Boom Restraint – Future Tunnel Interaction Diagram

The specification provided to the prospective Cable Car contractors stipulates maximum permissible loads and ground movements that can be imposed by the Cable Car onto the tunnel. This should ensure that no extraordinary design measures need to be implemented to protect the tunnel. It is required that the Cable Car be designed to accommodate predicted ground movements associated with the construction of the tunnel. As such no further Cable Car mitigation measures, apart from standard structural monitoring during tunnel construction should be necessary.

4.2 Western Entrance to Royal Victoria Dock

The desk study has identified the Old Western Entrance to the Royal Victoria Dock as a major constraint. Contemporary drawings and papers indicate that the entrance structure comprises two lock gates and connecting channels. The walls are formed of concrete and brick walls in excess of 20 feet thick with the lock structures founded on brickwork with timber piles. Associated structures include lock gates, pipes, and miscellaneous mechanical and hydraulic equipment.

The lock has been back-filled and little is known about modifications to the structure before decommissioning or the extent to which the old structures were demolished. However, it is likely that the lock gates remain in-situ, probably closed.

The depth of this structure is such that it would present an unacceptable obstruction to a closed face TBM, thus a cut and cover box is necessary for safe removal the old structures. A secant pile box may be the favoured option as it provides greater flexibility in dealing with obstructions in the ground. The TBM launch and reception chamber will be moved to south of the dock entrance.

4.3 DLR viaduct foundations

North of the of the dock entrance the tunnel passes under the DLR viaduct, during construction of which provision was made for a 'Blackwall Third Crossing' under span 2. The following drawings identify the location and form of the pier foundations.

- HA-BRG-PWD-DRG-10020 Rev X0 – Viaduct Spans Layout Plan & Elevation Sheet - 1 of 10
- HA-BRG-PWD-DRG-15000 Rev X0 – Substructure Information Tables Piers Sheet 1 of 2
- HA-BRG-PWD-DRG-15005 Rev X0 – Viaduct Pilecaps General Arrangement Sheet 1 of 3
- HA-BRG-PWD-DRG-15006 Rev X0 – Viaduct Pilecaps General Arrangement Sheet 2 of 3
- HA-BRG-PWD-DRG-15200 Rev X0 – Substructures Pile Reinforcement 30m CFA Pile Option

Previous alignments showed a bored tunnel under the DLR viaduct, however this is now not an economical option due to the relocation of the portal southwards. Clearance under span 2 of the viaduct is less than 6m, limiting the use of traditional piling equipment employed on the other cut and cover sections. Alternative techniques to form the tunnel under the viaduct include:

- Low headroom piling
- SCL mined tunnel
- Jacked box

For the purpose of this exercise a continuation of the piled wall using low headroom techniques is indicated as the preferred option.

4.4 Royal dock drainage

Two large diameter (approximately 1800mm) rising mains, forming part of the Royal Victoria Dock drainage discharge into the Thames, traverse the alignment of the tunnel in the vicinity of the DLR viaduct. It will be necessary to divert these mains or provide alternative drainage measures for the duration of the cut and cover works. It will be possible to reinstate/relocate the current drainage system after completion of the tunnel works.

5. Worksite layouts

5.1 Silvertown worksite

Refinement of the worksite layout due to clarification of land ownership and extension of cut and cover structures is taking place. A modified worksite layout is shown on drawing MMD-281586-TUN-4602. This drawing is currently under development and will be modified in a subsequent revision of this document.

5.2 Greenwich worksite

Further discussion with the owners have indicated that the gas holder currently occupying part of the Greenwich Peninsula site will be present for the foreseeable future. Alterations to the worksite layout have taken place accordingly and are shown on drawing MMD-281586-TUN-4601. This drawing is currently under development and will be modified in a subsequent revision of this document.

Appendices

Appendix A. Drawings

Number		Rev	Title
MMD-281586-TUN-	4001	P1	Option 5 - Scheme Layout - Plan
MMD-281586-TUN-	4002	P1	Option 5 - Scheme Layout - Long Section
MMD-281586-TUN-	4003	P1	Option 5 – Long Section and Plan - Sheet 1 of 3
MMD-281586-TUN-	4004	P1	Option 5 – Long Section and Plan - Sheet 2 of 3
MMD-281586-TUN-	4005	P1	Option 5 – Long Section and Plan - Sheet 3 of 3
MMD-281586-TUN-	4201	P2	Option 5 – Bored Tunnel - Cross Sections
MMD-281586-TUN-	4301	P1	Option 5 - Silvertown Approach - Plan
MMD-281586-TUN-	4302	P1	Option 5 - Silvertown Approach - Long Section
MMD-281586-TUN-	4303	P1	Option 5 - Silvertown Approach - Cross Sections
MMD-281586-TUN-	4601	P1	Option 5 - Greenwich Worksite - Layout
MMD-281586-TUN-	4602	P1	Option 5 - Silvertown Worksite - Layout