



RIVER CROSSINGS: SILVERTOWN TUNNEL

SUPPORTING TECHNICAL DOCUMENTATION

TUNNEL ENGINEERING: ADDENDUM A OPTION REPORT

Mott MacDonald

October 2013

This report focuses on three of the potential adaptations to determine the impact on the scheme in terms of construction cost and the impact that these adaptations would have on the Greenwich Peninsular Masterplan developments.

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.



Silvertown Tunnel

Tunnel Engineering - Addendum A

October 2013

Silvertown Tunnel

Tunnel Engineering - Addendum A

October 2013

Issue and revision record

Revision	Date	Originator	Checker	Approver	Description	Standard
Revision 1	14/10/2013	A.Evans	J.Baber	J.Baber	First Issue	
Revision 2	07/11/2013	A.Evans	J.Baber	J.Baber	TfL comments incorporated	
Revision 3	20/11/2013	A.Evans	J.Baber	J.Baber	Additional TfL comments incorporated, QRA costs in Appendix A	
Revision 4	26/11/2013	A.Evans	J.Baber	J.Baber	Additional TfL comments incorporated,	
Revision 5	10/12/2013	A.Evans	J.Baber	J.Baber	Amendments to QRA values	



This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

Contents

Chapter	Title	Page
1	Introduction	8
1.1	Immersed tunnel Options _____	8
1.1.1	Option A _____	8
1.1.2	Option B _____	8
1.1.3	Option A + B _____	8
1.2	Bored Tunnel Options _____	8
1.2.1	Option C _____	8
1.3	Cross passage spacing _____	8
1.3.1	100m spacing options _____	8
1.4	Summary of options investigated _____	9
2	Immersed Tube Tunnel – Options A & B	10
2.1	Offsite Casting Basin – Option A _____	10
2.1.1	Potential locations _____	10
2.1.2	Construction Programme _____	10
2.1.3	Cost Estimate _____	11
2.1.4	Quantified Risk Assessment _____	11
2.2	Portal Location – Option B _____	12
2.2.1	Alignment _____	12
2.2.2	Construction Programme _____	14
2.2.3	Cost Estimate _____	14
2.2.4	Quantified Risk Assessment _____	14
3	Bored Tunnel Option C	16
3.1	Portal Location – Option C _____	16
3.1.1	Alignment _____	16
3.1.2	Construction Programme _____	17
3.1.3	Cost Estimate _____	18
3.1.4	Quantified Risk Assessment _____	18
4	Summary and conclusions	20
4.1	Option A _____	20
4.2	Option B _____	20
4.3	Option A + B _____	20
4.4	Option C _____	20
4.5	Cross passages _____	21
4.6	Summary of costs _____	21
Appendices		22
Appendix A. Summary of Option costs _____		23
Appendix B. Drawings _____		31

1 Introduction

The purpose of this Addendum is to explore in greater detail some of the potential project opportunities outlined in the June 2012 Silvertown Crossing Study. This addendum focuses on three of potential adaptations to determine the impact on the scheme both in terms of construction cost but also on the impact these adaptations would have on the Greenwich Peninsular Masterplan developments.

1.1 Immersed tunnel Options

1.1.1 Option A

Update the cost estimate from the 2012 report to be comparable with the 2013 bored tunnel cost estimate and incorporate the off-site casting basin option identified in the 2012 report.

1.1.2 Option B

Update the cost estimate from the 2012 report to be comparable with the 2013 bored tunnel cost estimate and incorporate the reduced length of cut and cover tunnel option at Greenwich that was identified in the 2012 report.

1.1.3 Option A + B

Update the cost estimate from the 2012 report to be comparable with the 2013 bored tunnel cost estimate and incorporate both the offsite casting basin and the reduced length of cut and cover tunnel options at Greenwich that were identified in the 2012 report.

1.2 Bored Tunnel Options

1.2.1 Option C

Develop a bored tunnel scheme that follows the same principles as Option B for the immersed tunnel and locates the western tunnel portal at the closest possible location to the river, and provide an amended cost estimate.

1.3 Cross passage spacing

1.3.1 100m spacing options

TfL have also requested comparison cost estimates for the original scheme with cross passages at 100m spacing as per BD78/99 and the scheme developed using a risk based approach that resulted in cross passages at a maximum spacing of 350m. These are not discussed in this report, but costs are presented in Appendix A.

At this stage the programme has not been reassessed for the increased number of cross passages. It is expected the overall durations do not alter although there could be some change to the critical path within the programme.

1.4 Summary of options investigated

The options investigated are summarised in table 1.1

Table 1.1: Summary of options investigated

Tunnel Type	Option No.	Variant
Immersed Tube	Base	Original long option with on-site casting
Immersed Tube	A	Original long option with off-site casting
Immersed Tube	B	Shortened option with on-site casting
Immersed Tube	A + B	Shortened option with off-site casting
Bored	Base	Original long option with cross-passages at 350m spacing
Bored	C	Shortened option with cross-passages at 350m spacing
Bored	D	Shortened option with cross-passages at 100m spacing
Bored	E	Original long option with cross-passages at 100m spacing

2 Immersed Tube Tunnel – Options A & B

The geometry and alignment of the immersed tunnel element has not been addressed in this report. The immersed tunnel structure is a three cell reinforced concrete box structure. The total immersed length between the approach cut and cover tunnels is 488m. This length is subdivided into four tunnel elements, each with an equal length of 122m. All design parameters with respect to sizing and vertical/horizontal alignment restrictions are in accordance with the July 2012 Study.

2.1 Offsite Casting Basin – Option A

2.1.1 Potential locations

As reported in the June 2012 report, securing a dry dock for construction of the elements requires a considerable amount of research and negotiation. However, the contractors who are familiar with building immersed tunnels generally are able to locate suitable facilities.

When the Medway Tunnel was built in the 1990's in Kent the client did not specify a location for building the elements, and the contractors that tendered considered solutions on the north coast of France and Belgium as well as in the north-east of the UK. Similarly the South Hampshire rapid transit project that was tendered in the early 2000's left this decision to the contractors and use of a dock with Portsmouth harbour was negotiated by at least one of the bidders.

In TfL's studies for Gallions Reach crossing the possible use of a disused dock at Tilbury was considered. The depth of the dock appears to be just deep enough but it is narrow and so would only accommodate the construction of one tunnel element at a time which is not ideal for the construction programme.

It is most likely that docks in the north-east of the UK would be investigated. Alternatively docks in Belgium or the Netherlands may be available that have been used for a number of immersed tunnel projects. Although a sea tow across the English Channel or around the east coast of the Britain is required this is not considered to be high risk or cost prohibitive.

As discussed in the 2012 Silvertown Crossing Study, river closures whilst undesirable are deemed possible by the Port of London Planning Authority. River closures would be held over the weekends preferably during the winter season, and require 6 months advance warning to river stakeholders. There were no significant difficulties identified with towing the tunnel elements down the Thames however float would be required within the construction programme to facilitate any delays caused by weather conditions which may halt the towing or immersion process.

2.1.2 Construction Programme

The construction programme in the June 2012 report allows approximately 10 months to create an on-site casting basin. Set-up of an existing dock would take less time than this, provided there were no extended planning issues to overcome for the chosen site. Tunnel elements could be ready perhaps 5-6 months earlier in the programme. If a dock is used that can accommodate all four tunnel elements this saving should have a knock-on effect and reduce the overall construction period. However with this approach to construction a closure joint needs to be formed between the last placed elements and this will add a small amount of time back in. Therefore a reduction of 4-5 months might be realised.

It should be noted that if a dock is used that cannot accommodate all four tunnel elements then there would be no significant change to the programme.

2.1.3 Cost Estimate

The costs used to evaluate the set-up of a dry dock assume there is a certain amount of basic infrastructure required to be installed such as access roads, as well as site security, offices, welfare facilities etc. It is assumed that basic services such as power supply, water supply, sewerage and communications systems would be available in the area and require relatively simple connections to be made.

Costs have been included for the towing operations assuming a lengthy sea tow of several days and for temporary berths along the River Thames in the event that a staged tow is required to fit with other shipping movements as well as tidal and current restrictions that would only allow a short period for towing each day. A fit-out station has also been allowed for at the tunnel crossing site for making the element ready for immersion.

Outline engineering schemes have not been developed for the offsite casting facility or temporary mooring facilities and broad-brush sums have been allowed for based on experience and, to a limited degree, past projects.

Costs associated with programme reduction have not been allowed for at this time as it is by no means certain that the time saving would be realised.

The total cost estimate for Option A excluding risk is £426,620,530 a cost summary can be found in Appendix A.

2.1.4 Quantified Risk Assessment

A re-run of the QRA modelling has not been carried out for the amended scheme but the risk profile reviewed to assess whether there is any substantial change arising from the amendments to the engineering solution. The primary risks that are affected by the change to an off-site casting basin are:

E04 - Uncertainty in estimate for casting basin. This was assessed as -10% to +15% of the £48.9m cost for the basin. This equates to -£5m to + £7.5m. Depending on the type of dry dock the contractor can find this level of risk is considered to remain appropriate as it caters for a saving for a dock that is fully functioning or an additional expense for dock that requires extensive renovation.

Risks associated with remote construction and the sea towing aspects will need to be managed but are not considered significant in terms of the QRA modelling.

Stakeholder risks are already covered in the QRA for the EA and PLA and although the works change because of the towing operation, the allowances in the QRA modelling are considered sufficient.

As a result of the above it is considered that the previous percentage costs arising from the previous QRA modelling remain valid. The P50% cost was 15.0% of the base cost. The further engineering study for the

bored tunnel incorporated the approach works to tie the scheme into the highway and the result was a minor decrease to the risk allowances. It is considered appropriate to apply the same level of decrease to the immersed tunnel and so it is recommended to take a P50% cost of 14.2%, which would be applied to the base cost without risk or other costs included.

2.2 Portal Location – Option B

2.2.1 Alignment

The location of the portal in the original report was set to the west of the proposed Greenwich Peninsular development to tie in with the development masterplan and its objectives for free pedestrian movement between the residential and commercial and retail areas.. However, this incurred a significant increase in the length of the cut and cover tunnelling required on the Greenwich peninsular. This study has located the minimum practical length of cut and cover tunnel and the impact upon the future developments.

The original cut and cover length was 552m and the portal to the approach ramps was located to the West of all future developments and Millennium Way. From either side of the low point of the tunnel alignment beneath the Thames a 4% vertical gradient was used to locate the minimum length required to bring the tunnel to the surface. If this approach is used there is a potential to reduce the required cut and cover tunnel length by over 350m, bringing the portal location up in the middle of East Parkside Road. There would then be a requirement to construct an overpass structure for East Parkside Road and West Parkside Road immediately over the approach ramp and tunnel portal. The decision was therefore taken to move the location of the tunnel portal just west of West Parkside Road, resulting in a reduction of 300m for the cut and cover structure. The gradient was therefore relaxed down from 4% to achieve a smooth alignment down to the mid-river low point. This alignment allows East Parkside Road and West Parkside Road to pass over the cut and cover section of the tunnel without the need for any additional support structures.

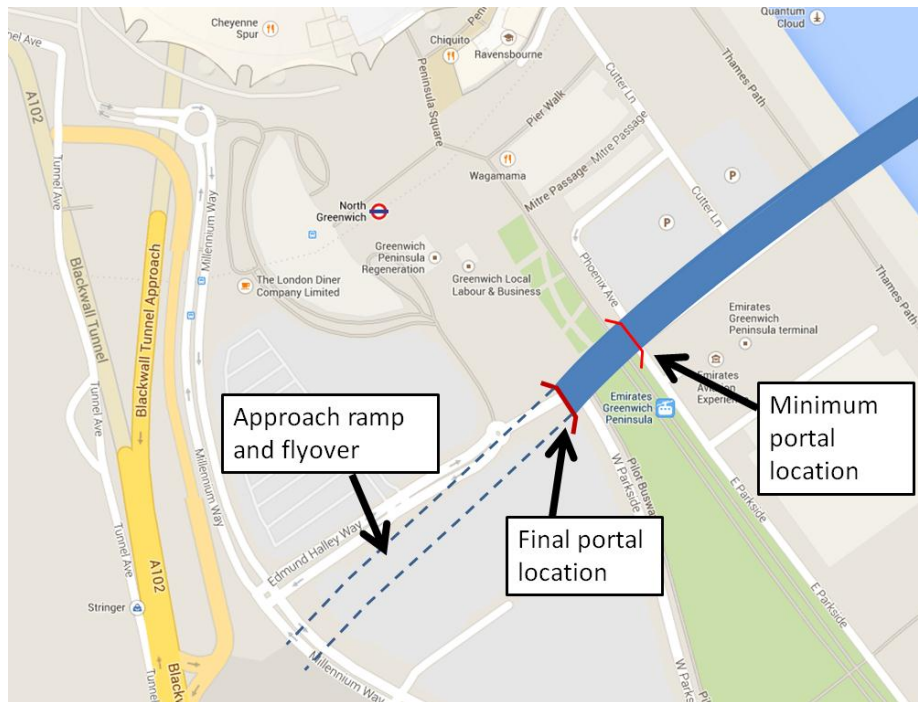


Figure 1: Portal location - Option B

From the cut and cover portal the incline of the ramp structure was set at the maximum permissible 6% gradient and continues into a ramp for a flyover structure above Millennium Way. Minor earthworks and lowering of Millennium Way may be required in order to ensure the required clearance is achieved beneath the flyover. The flyover splits after passing Millennium Way with the Silvertown south-bound carriageway re-joining the Blackwall south-bound road system. The Silvertown Approach north-bound carriageway continues at a high level to fly over the A102 Blackwall Tunnel Approach south-bound carriageway before looping down to join the A102 Blackwall Tunnel Approach north-bound road system. This arrangement was selected as it was deemed to cause the least disruption to the existing infrastructure meaning the length of any road closures as part of the new construction would be minimised. Other arrangements which would allow the Silvertown approach to remain at ground level would require extensive excavation or additional flyovers which would not only disrupt the current infrastructure dramatically but also negate the relocation of the portal as an alternative option. For example, bringing the alignment to surface and then lowering it beneath the A102 and Millennium Way would make the option similar to the original scheme.

The new portal location will require amendments to the ancillary road network as shown on the Greenwich Peninsular Masterplan. Widening of the road corridor along Edmund Halley Way will be required to facilitate the approach ramp for the Silvertown tunnel as well as a local road network between Millennium Way and East and West Parkside Road. A pedestrian footbridge is also likely to be required to connect over the top of both Edmund Halley Way and the Silvertown approach ramps.

The Silvertown tunnel principal service buildings will also require re-locating next to the tunnel portal. The vent building will require positioning directly adjacent to the portal and has a height of 25m and a footprint of approximately 60m by 20m. It is possible that this vent tower could be incorporated within one of the new developments and disguised behind a façade in order to minimise visual impact. The principal tunnel

services building has a footprint of approximately 38m by 25m, again this could be partially incorporated within the ground floor of a new development to minimise the impact on the masterplan. At present the degree to which this could be realised is uncertain and so a worst case solution is presented on the drawings in Appendix B.

2.2.2 Construction Programme

The Greenwich cut and cover construction was not critical on the construction programme for the immersed tunnel. A reduction in the quantity of this work will therefore not realise any time savings to the construction programme. Within the Greenwich approach area the reduction of cut and cover works is balanced by the need for additional bridge works for the flyover connections to the A102 Blackwall Tunnel Approach, pedestrian footbridge and additional ancillary roadworks. Although a detailed programme has not been developed for the new arrangements at this stage it is considered there should be sufficient time to accommodate these works in the overall programme of 48months.

2.2.3 Cost Estimate

The cost estimate is based upon the same principles as the June 2012 report and the subsequent updates in the July 2013 report.

The cost of tying in the ramps and flyovers to the existing A102 Blackwall Tunnel Approach past Ch0.00 has been assumed as equal to that of Atkins' original tie in scheme in the absence of a more detailed assessment. The cost of the elevated ramps is deemed to be broadly equivalent to that of the trough structures and bridge in the original scheme.

The total cost estimate for Option B excluding risk is £433,551,810 which offers a £35.3m saving on the original base line Immersed Tunnel Option. The majority of this saving can be found through a £40.5m reduction in the costs of the Greenwich cut and cover and an £8.4m reduction in the tunnel mechanical and electrical works, These savings are then offset by the cost of the new £8m Greenwich open cut construction, and £10m for the flyover at Millennium Way. A full cost summary can be found in Appendix A. It should be noted that this cost saving does not account for the effect of land take on the proposed Greenwich masterplan, which is due to be assessed in another study.

2.2.4 Quantified Risk Assessment

A re-run of the QRA modelling has not been carried out for the amended scheme but the risk profile reviewed to assess whether there is any substantial change arising from the amendments to the engineering solution. The primary risks that are affected by the change to the extent of cut and cover tunnelling are:

E19 - Estimating uncertainty for Greenwich cut and cover. A +/-5% was applied to the cost of £69m. This equates to +/- £3.5m. With the substantial reduction in length this could reduce, but new construction activities are introduced through the same area, namely flyover, footbridge and the Millenium Way depressed trough construction. Although the capital cost of the new works is slightly less the risk allowance is considered appropriate given the variety of new construction works and because similar risks

will exist in relation to excavation and foundation piling works. Additionally cut was previously omitted in the immersed tunnel QRA (E20) and this allowance can partially cover those works.

37 – Unacceptable impact of vent stacks. This risk remains from the June 2012 report. Although it has been partially mitigated for the bored tunnel solution through further work, the relocation of the portal brings this risk back again.

19 – Contaminated land at North Greenwich. A 25% chance of additional cost of up to £2.5m was included. The amount of excavation reduces for Greenwich but other works partially replace this and so the allowance is considered to remain appropriate.

22- Visual impacts. A 25% chance of additional cost up to £2.5m was included. Visual intrusion will be more severe because of the road passing through the development at high level, increased highway works, the flyover viaduct.

The reduction in risk 19 is considered to balance the increase in risk 22 and so the overall allowance is considered to be appropriate.

Risks associated with changed land use and impact to the GRPL development are not evaluated in this report and need to be addressed separately by TfL.

In light of the above, similar to Option A it is considered that the overall risk profile has not substantially changed and the allowances from the previous QRA analysis can be applied with the same level of decrease as described for Option A. It is therefore recommended to take a P50% cost of 14.2%, which would be applied to the base cost without risk or other costs included.

3 Bored Tunnel Option C

The geometry and horizontal alignment have not been addressed in this study. The proposal is for a twin bore tunnel using a single TBM running first from Silvertown towards Greenwich and then back towards Silvertown.

3.1 Portal Location – Option C

3.1.1 Alignment

The existing vertical alignment beneath the river has remained untouched, however between approximately Ch130 and Ch650 the gradient was steepened from 2.6% to 4.0%. This shortens the length of the bored tunnel by approximately 200m and reduces the cut and cover length between the TBM reception shaft and the tunnel portal by 110m.

The new portal is located to the west of West Parkside Road slightly further West than Option B and connects to an approach ramp with 6% gradient and continues into a ramp for a flyover structure above Millennium Way. Earthworks and lowering of Millennium Way will be required in order to ensure the required clearance is achieved beneath the flyover. The flyover splits after passing Millennium Way with the Silvertown Tunnel Approach south-bound carriage re-joining A102 Blackwall Tunnel Approach south-bound road system. The Silvertown Tunnel Approach north-bound carriage continues at a high level to fly over the A102 Blackwall Tunnel Approach south-bound carriages before looping down to join the A102 Blackwall Tunnel Approach north-bound road system. This arrangement was selected as it was deemed to cause the least disruption to the existing infrastructure meaning the length of any road closures as part of the new construction would be minimised. Other arrangements which would allow the Silvertown approach to remain at ground level would require extensive excavation or additional flyovers which would not only disrupt the current infrastructure dramatically but also negate the relocation of the portal as an alternative option.

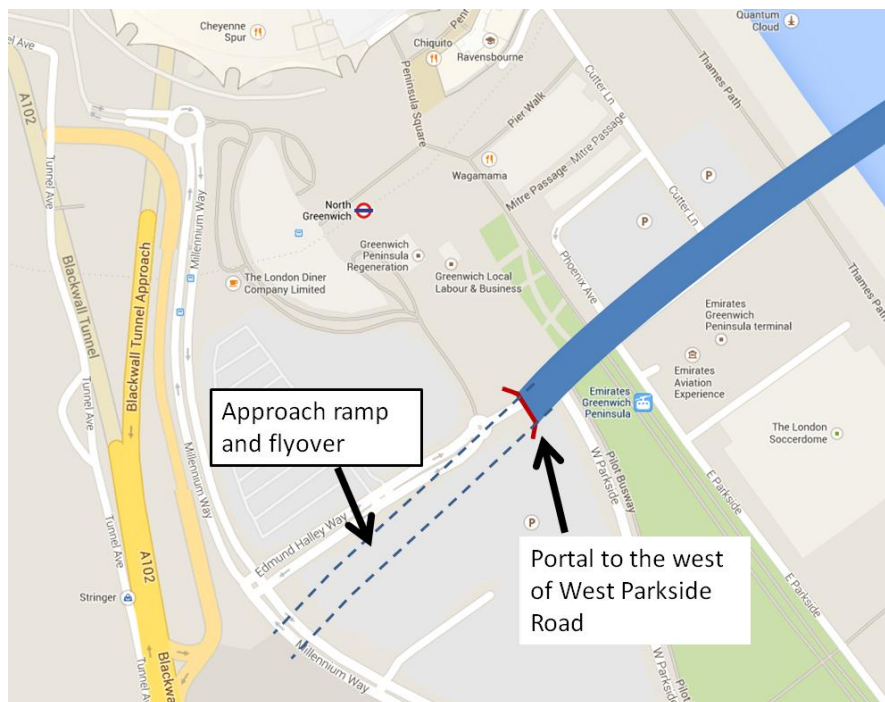


Figure 2: Portal location - Option C

As with the Immersed Tube option, the new portal location will require amendments to the ancillary road network as shown on the Greenwich Peninsular Masterplan. Widening of the road corridor along Edmund Halley Way will be required to facilitate the approach ramp for the Silvertown tunnel as well as a local road network between Millennium Way and East and West Parkside Road. A pedestrian footbridge is also likely to be required to connect over the top of both Edmund Halley Way and the Silvertown approach ramps.

The worksite layout for the Greenwich approach will move further west but can remain within the safeguarded land. Tunnelling operations are serviced from the Silvertown side and so only space for a gantry crane, vehicular access and a small amount of work space is needed. The TBM shaft has been located to the west of the cable car station to avoid any conflict. There is some flexibility in the final position that is chosen. It could move slightly to the East if preferred to keep the footprint out of the final highway footprint. Any such changes would not significantly alter the cost estimates.

3.1.2 Construction Programme

The reduction on bored tunnelling is in the order of 20% that could result in a saving of approximately 1-2 months on the construction programme.

The reduction in cut and cover tunnelling is approximately 50% but this is not on the critical path and so would have no effect on the overall construction programme.

New works are required for a flyover to connect to the A102 Blackwall Tunnel Approach, a pedestrian footbridge and the depressed trough for the Millennium Way underpass. Although a detailed programme

has not been developed for the new arrangements at this stage it is considered there should be sufficient time to accommodate these works in the overall programme.

3.1.3 Cost Estimate

The cost estimate is based upon the same principles as the June 2012 report and the subsequent updates in the July 2013 report.

The cost of tying in the ramps and flyovers to the existing A102 Blackwall Tunnel Approach past Ch0.00 has been assumed as equal to that of Atkins' original tie in scheme in the absence of a more detailed assessment. The cost of the elevated ramps is deemed to be broadly equivalent to that of the trough structures and bridge in the original scheme.

The total cost estimate for Option C excluding risk is £422,390,746 which offers an £11.7m saving on the original base line Bored Tunnel Option. The majority of this saving can be found through a £13.2m reduction in the costs of the Greenwich cut and cover, a £3.5m reduction in the TBM driving costs and a £1.8m reduction in tunnel fill and cladding, These savings are then offset by the £8.3m for the new flyover at Millennium Way A full cost summary can be found in Appendix A. It should be noted that this cost saving does not account for the effect of land take on the proposed Greenwich masterplan, which is due to be assessed in another study.

3.1.4 Quantified Risk Assessment

A re-run of the QRA modelling has not been carried out for the amended scheme but the risk profile reviewed to assess whether there is any substantial change arising from the amendments to the engineering solution. The primary risks that are affected by the change to the extent of cut and cover tunnelling are:

U9 – TBM driving costs. Although the tunnelling work has reduced by 20% the allowance for interventions and residual cost should remain the same. In principle, reductions associated with PC segments and spoil removal could be reduced by £3.5m but this is very small in monetary terms and can be offset by increased stakeholder risks (see below)

U20 – Estimate uncertainties for Greenwich cut and cover. +/-5% was included for a cost of £28m. the capital cost is now reduced by approximately 50% for the reduced length of cut and cover tunnel so there is a potential saving of £0.7m but it is considered prudent to retain this for the uncertainties in the new works for the flyover to connect to the A102 Blackwall Tunnel Approach, a pedestrian footbridge and the depressed trough for the Millenium Way underpass.

U21 – Uncertainty in estimate for Greenwich retained cut. Unchanged

046 – Additional works associated with gas works site. A 50% chance of up to £1m additional cost was included. Although the below-ground works alongside the gasworks are reduced we would consider it prudent to keep this allowance as there are piling works close by.

Stakeholders 049 – A 50% chance of up to £1.5m additional cost was included. This could be worsened given the visual intrusion of the viaducts and the presence of the road passing through the development. This risk has not been reassessed or remodelled at present.

As a result of the above it is considered that the previous percentage costs arising from the previous QRA modelling remain valid. The P50% cost was 13.8% of the base cost, which would be applied to the base cost without risk or other costs included.

4 Summary and conclusions

4.1 Option A

Casting the tunnel elements in an existing dry dock will reduce the cost of constructing an expensive casting basin in the centre of London. A cost reduction of £42.2m, when excluding risk, is estimated compared to the base scheme cost estimate that has been brought up to date to be on a comparable basis to the bored tunnel estimate.

4.2 Option B

The original immersed tunnel scheme had an alignment with a vertical gradient of 2.55% and a 552m cut and cover length beneath the Greenwich Peninsular. The tunnel portal was located to the west of the masterplan development and Millennium Way to avoid any impact upon the road network or new developments.

This study has looked into the relocation of the southern portal for the immersed tunnel option in order to minimise the length of cut and cover works required, by using a gradient of 4% for the vertical alignment. The new location of the portal was selected as just to the west of West Parkside Road in order to minimise the impact on the masterplan developments, and reduce the number of ancillary road adjustments required. This offers a reduction of 300m to the cut and cover length, however, there are additional works to be carried out to facilitate the shortening of the cut and cover length, including the widening of Edmund Halley Way, the creation of an over pass for the A102 Blackwall Tunnel Approach and the loss of development land next to the portal for tunnel services buildings. Taking into account these additional costs the overall reduction in cost excluding risk is £35.3m whilst the construction programme remains unaffected with works taking similar lengths / not being on critical paths.

4.3 Option A + B

The combined cost saving for option A + B from the base scheme cost of the immersed tube excluding risk is £77.6m.

4.4 Option C

As with the immersed tunnel scheme, the bored tunnel option had a portal to the west of the masterplan development just past Millennium Way.

As a direct comparison to Option B, the portal for the bored tunnel option was moved west in line with a 4% tunnel gradient from the low point beneath the river, whilst ensuring at least one tunnel diameter clearance above the tunnel whilst under the river. The new portal location was in a similar position to Option B, but slightly further west. Similar impacts with respect to additional works to the ancillary road network and masterplan development would be required with this adjusted portal location. Additionally, Millennium Way would require lowering to enable suitable headroom for the flyover approach.

This new layout would have an estimated £12m reduction in cost with a slight reduction in construction programme of 1-2 months. The overall reduction in cost from the base scheme for the bored tunnel solution excluding risk is £11.7m.

4.5 Cross passages

No engineering work has been carried out for the cross passage options as the solutions are described in the previous reports. The cross-passages had initially been set at 100m centres based on the initial starting point of BD 78/99. It was reported in the 2013 Silvertown Tunnel Study that new equipment has been developed in the field of Fire Life Safety, such that the same level of safety as proposed with BD78/99 is possible with an increase in cross-passage spacing. For the combination of shorter tunnels and cross-passages at 100m spacing the number of cross-passages has been adjusted to reflect the actual tunnel lengths, see Table 4.1. The adjusted costs are presented in the Table 4.2 and in Appendix A, these costs include potential ground treatment.

Table 4.1: Cross-passage spacing and number

Variant	Cross Passage Spacing (m)	No. Cross Passages
Original long option	350	3
Shortened option	350	3
Original long option	100	10
Shortened option	100	8

4.6 Summary of costs

The costs for all options are summarised in table 4.1 below

Table 4.2: Cost Estimate Summary

Tunnel Type	Option No.	Variant	Cost excluding QRA Risk at P50% (£)	Cost including QRA Risk at P50% (£)
Immersed Tube	Base	Original long option with on-site casting	468,864,833	535,443,639
Immersed Tube	A	Original long option with off-site casting	426,620,530	487,200,645
Immersed Tube	B	Shortened option with on-site casting	433,551,810	495,116,167
Immersed Tube	A +B	Shortened option with off-site casting	391,307,507	446,873,173
Bored	Base	Original long option with cross-passages at 350m spacing	423,204,676	481,606,922
Bored	C	Shortened option with cross-passages at 350m spacing	411,516,112	468,305,336
Bored	D	Shortened option with cross-passages at 100m spacing	422,390,746	480,680,668
Bored	E	Original long option with cross-passages at 100m spacing	436,900,607	497,192,891

*Note: these costs include risk allowances based on previous QRA. For shortened options no allowance has been made for additional land take or environmental mitigation with respect to the Greenwich Masterplan. No change has been made to any of the time related costs for any of the options, so all tabulated costs are based on programmes prepared as part of previous reports.

Appendices

Appendix A. Summary of Option costs	23
Appendix B. Drawings	31

Appendix A. Summary of Option costs

Table A.1: Immersed Tunnel – Base, Original long option with on-site casting

Immersed Tunnel - Base		Cost (£)
INSURANCES		19,697,397
CONTRACTORS PRELIMS:		
SPECIFIED REQUIREMENTS		1,328,782
ALLOWANCE FOR STRUCUTRAL SURVEYS		135,000
ALLOWANCE FOR INSTRUMENTATION INSTALLATION		1,000,000
SUPERVISION		18,771,200
METHOD RELATED CHARGES		16,061,700
DIVERTING DRAIN	P.S.	10,000,000
CASTING BASIN and RIVER WORKS -SILVERTOWN		55,494,861
RIVER WORKS-GREENWICH		7,576,942
DREDGING		22,452,200
CONSTRUCTION OF SUBMERGED UNITS		24,049,553
FLOAT OUT AND POSITION SUBMERGED UNITS		4,618,437
TUNNEL INFILL AND CLADDING TO SUBMERGED UNITS		5,444,965
TUNNEL MECHANICAL AND ELECTRICAL WORKS		50,610,782
SILVERTOWN CUT AND COVER		39,577,819
SILVERTOWN OPEN CUT.		12,267,844
GREENWICH CUT AND COVER		74,984,891
GREENWICH OPEN CUT.		-
SUB STATIONS AND VENT BUILDINGS		12,562,500
Indicative saving for secondary lining in lieu of VE cladding		-1,657,408
Indicative price from Atkins for the approaches at both ends. Allowance for OH and P excluded		38,667,866
SUB TOTAL		413,645,329
Contractor's Design Costs	4%	16,545,813
Contractor's OH and P, <i>applied to design and construction costs</i>	10%	43,019,114
SUB TOTAL		473,210,257
Adjustment for escalation between Q1/2012 and Q1/2013	-1.0%	-4,163,420
SUB TOTAL		468,864,833
Contractor's RISK	Included in QRA	-
QRA, P50% RISK	14.2%	66,578,806
Immersed Tunnel – Base, inc P50%	TOTAL	535,443,639

Table A.2: Immersed Tunnel – Option A, Original long option with off-site casting

Immersed Tunnel - Option A		Cost (£)
INSURANCES		17,921,214
CONTRACTORS PRELIMS:		
SPECIFIED REQUIREMENTS		1,328,782
ALLOWANCE FOR STRUCUTRAL SURVEYS		135,000
ALLOWANCE FOR INSTRUMENTATION INSTALLATION		1,000,000
SUPERVISION		18,771,200
METHOD RELATED CHARGES		16,061,700
DIVERTING DRAIN	P.S.	10,000,000
CASTING BASIN and RIVER WORKS -SILVERTOWN		19,971,207
RIVER WORKS-GREENWICH		7,576,942
DREDGING		22,452,200
CONSTRUCTION OF SUBMERGED UNITS		24,049,553
FLOAT OUT AND POSITION SUBMERGED UNITS		4,618,437
TUNNEL INFILL AND CLADDING TO SUBMERGED UNITS		5,444,965
TUNNEL MECHANICAL AND ELECTRICAL WORKS		50,610,782
SILVERTOWN CUT AND COVER		39,577,819
SILVERTOWN OPEN CUT.		12,267,844
GREENWICH CUT AND COVER		74,984,891
GREENWICH OPEN CUT.		-
SUB STATIONS AND VENT BUILDINGS		12,562,500
Indicative saving for secondary lining in lieu of VE cladding		-1,657,408
Indicative price from Atkins for the approaches at both ends. Allowance for OH and P excluded		38,667,866
SUB TOTAL		376,345,493
Contractor's Design Costs	4%	15,053,820
Contractor's OH and P, <i>applied to design and construction costs</i>	10%	39,139,931
SUB TOTAL		430,539,244
Adjustment for escalation between Q1/2012 and Q1/2013	-1.0%	-3,918,714
SUB TOTAL		426,620,530
Contractor's RISK	Included in QRA	-
QRA, P50% RISK	14.2%	60,580,115
Immersed Tunnel – Option A, inc P50%	TOTAL	487,200,645

Table A.3: Immersed Tunnel – Option B, Shortened option with on-site casting

Immersed Tunnel - Option B		Cost (£)
INSURANCES		18,212,643
CONTRACTORS PRELIMS:		
SPECIFIED REQUIREMENTS		1,328,782
ALLOWANCE FOR STRUCTURAL SURVEYS		135,000
ALLOWANCE FOR INSTRUMENTATION INSTALLATION		1,000,000
SUPERVISION		18,771,200
METHOD RELATED CHARGES		16,561,700
DIVERTING DRAIN	P.S.	10,000,000
CASTING BASIN and RIVER WORKS -SILVERTOWN		55,494,861
RIVER WORKS-GREENWICH		7,576,942
DREDGING		22,452,200
CONSTRUCTION OF SUBMERGED UNITS		24,049,553
FLOAT OUT AND POSITION SUBMERGED UNITS		4,618,437
TUNNEL INFILL AND CLADDING TO SUBMERGED UNITS		5,444,965
TUNNEL MECHANICAL AND ELECTRICAL WORKS		42,264,048
SILVERTOWN CUT AND COVER		39,577,819
SILVERTOWN OPEN CUT.		12,267,844
GREENWICH CUT AND COVER		34,503,972
GREENWICH OPEN CUT.		8,082,931
GREENWICH FLYOVER AT MILLENIUM WAY		10,549,650
SUB STATIONS AND VENT BUILDINGS		12,562,500
Indicative saving for secondary lining in lieu of VE cladding		- 1,657,408
Indicative price from Atkins for the approaches at both ends. Allowance for OH and P excluded		38,667,866
SUB TOTAL		382,465,504
Contractor's Design Costs	4%	15,298,620
Contractor's OH and P, <i>applied to design and construction costs</i>	10%	39,776,412
SUB TOTAL		437,540,536
Adjustment for escalation between Q1/2012 and Q1/2013	-1.0%	-3,988,727
SUB TOTAL		433,551,810
Contractor's RISK	Included in QRA	-
QRA, P50% RISK	14.2%	61,564,357
Immersed Tunnel – Option B, inc P50%	TOTAL	495,116,167

Table A.5: Bored Tunnel – Base, Original long option with cross-passages at 350m spacing

Bored Tunnel - Base		Cost (£)
INSURANCES		17,777,593
CONTRACTORS PRELIMS:		
SPECIFIED REQUIREMENTS		1,481,124
ALLOWANCE FOR STRUCTURAL SURVEYS		135,000
ALLOWANCE FOR INSTRUMENTATION INSTALLATION		1,000,000
SUPERVISION		28,011,600
METHOD RELATED CHARGES		22,492,850
DIVERTING DRAIN P.S.		10,000,000
TBM SUPPLY,ERECT AND DISMANTLE		30,387,500
TBM DRIVING COSTS Including supply of PC segments.		51,607,556
INCREASED COST OF LARGER TUNNEL		-
SECANT PILE LAUNCH CHAMBER		6,836,415
CRANE MAT/HARDSTANDING FOR TBM ERECTION		250,000
TUNNEL PORTAL CONSTRUCTION		1,482,471
TUNNEL FILL AND CLADDING		12,781,783
TUNNEL MECHANICAL AND ELECTRICAL WORKS		49,164,015
CROSS PASSAGES		5,688,132
TBM RECEPTION CHAMBER		7,336,415
SUMP/ADDITIONAL GROUND TRTREATMENT		250,000
SILVERTOWN CUT AND COVER		20,644,884
SILVERTOWN RETAINED CUT.		11,273,095
GREENWICH CUT AND COVER		28,018,057
GREENWICH RETAINED CUT.		10,003,518
SUB STATIONS AND VENT BUILDINGS		19,360,000
Indicative saving for secondary lining in lieu of VE cladding		-1,320,429
Indicative price from Atkins for the approaches at both ends. Allowance for OH and P excluded		38,667,866
SUB TOTAL		373,329,446
Contractor's Design Costs 4%		14,933,178
Contractor's OH and P, <i>applied to design and construction costs</i> 10%		38,826,262
SUB TOTAL		427,088,887
Adjustment for escalation between Q1/2012 and Q1/2013 -1.0%		-3,884,210
SUB TOTAL		423,204,676
Contractor's RISK Included in QRA		-
QRA, P50% RISK 13.8%		58,402,245
Bored Tunnel – Base, inc P50%	TOTAL	481,606,922

Table A.6: Bored Tunnel - Option C, Shortened option with cross-passages at 350m spacing

Bored Tunnel – Option C		Cost (£)
INSURANCES		17,286,141
CONTRACTORS PRELIMS:		
SPECIFIED REQUIREMENTS		1,481,124
ALLOWANCE FOR STRUCTURAL SURVEYS		135,000
ALLOWANCE FOR INSTRUMENTATION INSTALLATION		1,000,000
SUPERVISION		28,011,600
METHOD RELATED CHARGES		22,492,850
DIVERTING DRAIN P.S.		10,000,000
TBM SUPPLY,ERECT AND DISMANTLE		30,387,500
TBM DRIVING COSTS Including supply of PC segments.		48,054,330
INCREASED COST OF LARGER TUNNEL		-
SECANT PILE LAUNCH CHAMBER		6,836,415
CRANE MAT/HARDSTANDING FOR TBM ERECTION		250,000
TUNNEL PORTAL CONSTRUCTION		1,482,471
TUNNEL FILL AND CLADDING		10,914,640
TUNNEL MECHANICAL AND ELECTRICAL WORKS		49,164,015
CROSS PASSAGES		5,688,132
TBM RECEPTION CHAMBER		7,336,415
SUMP/ADDITIONAL GROUND TRTREATMENT		250,000
SILVERTOWN CUT AND COVER		20,644,884
SILVERTOWN RETAINED CUT.		11,273,095
GREENWICH CUT AND COVER		14,746,346
GREENWICH RETAINED CUT.		10,541,719
FLYOVER/UNDERPASS AT MILLENIUM WAY		8,324,850
SUB STATIONS AND VENT BUILDINGS		19,360,000
Indicative saving for secondary lining in lieu of VE cladding		-1,320,429
Indicative price from Atkins for the approaches at both ends. Allowance for OH and P excluded		38,667,866
SUB TOTAL		363,008,965
Contractor's Design Costs 4%		14,520,359
Contractor's OH and P, <i>applied to design and construction costs</i> 10%		37,752,932
SUB TOTAL		415,282,256
Adjustment for escalation between Q1/2012 and Q1/2013 -1.0%		-3,776,144
SUB TOTAL		411,516,112
Contractor's RISK Included in QRA		-
QRA, P50% RISK 13.8%		56,789,223
Bored Tunnel – Option C, inc P50%	TOTAL	468,305,336

Table A.7: Bored Tunnel – Option D, Shortened option with cross-passages at 100m spacing

Bored Tunnel – Option D		Cost (£)
INSURANCES		17,743,371
CONTRACTORS PRELIMS:		
SPECIFIED REQUIREMENTS		1,481,124
ALLOWANCE FOR STRUCTURAL SURVEYS		135,000
ALLOWANCE FOR INSTRUMENTATION INSTALLATION		1,000,000
SUPERVISION		28,011,600
METHOD RELATED CHARGES		22,492,850
DIVERTING DRAIN	P.S.	10,000,000
TBM SUPPLY, ERECT AND DISMANTLE		30,387,500
TBM DRIVING COSTS	Including supply of PC segments.	48,054,330
INCREASED COST OF LARGER TUNNEL		-
SECANT PILE LAUNCH CHAMBER		6,836,415
CRANE MAT/HARDSTANDING FOR TBM ERECTION		250,000
TUNNEL PORTAL CONSTRUCTION		1,482,471
TUNNEL FILL AND CLADDING		10,914,640
TUNNEL MECHANICAL AND ELECTRICAL WORKS		49,164,015
CROSS PASSAGES		14,832,719
TBM RECEPTION CHAMBER		7,336,415
SUMP/ADDITIONAL GROUND TREATMENT		250,000
SILVERTOWN CUT AND COVER		20,644,884
SILVERTOWN RETAINED CUT.		11,273,095
GREENWICH CUT AND COVER		14,746,346
GREENWICH RETAINED CUT.		10,541,719
FLYOVER/UNDERPASS AT MILLENNIUM WAY		8,324,850
SUB STATIONS AND VENT BUILDINGS		19,360,000
Indicative saving for secondary lining in lieu of VE cladding		-1,320,429
Indicative price from Atkins for the approaches at both ends. Allowance for OH and P excluded		38,667,866
SUB TOTAL		372,610,782
Contractor's Design Costs	4%	14,904,431
Contractor's OH and P, <i>applied to design and construction costs</i>	10%	38,751,521
SUB TOTAL		426,266,734
Adjustment for escalation between Q1/2012 and Q1/2013	-1.0%	-3,875,989
SUB TOTAL		422,390,746
Contractor's RISK	Included in QRA	-
QRA, P50% RISK	13.8%	58,289,923
Bored Tunnel – Option D, inc P50%	TOTAL	480,680,668

Table A.8: Bored Tunnel – Option E, Original long option with cross-passages at 100m spacing

Bored Tunnel – Option E		Cost (£)
INSURANCES		18,353,445
CONTRACTORS PRELIMS:		
SPECIFIED REQUIREMENTS		1,481,124
ALLOWANCE FOR STRUCTURAL SURVEYS		135,000
ALLOWANCE FOR INSTRUMENTATION INSTALLATION		1,000,000
SUPERVISION		28,011,600
METHOD RELATED CHARGES		22,492,850
DIVERTING DRAIN	P.S.	10,000,000
TBM SUPPLY,ERECT AND DISMANTLE		30,387,500
TBM DRIVING COSTS	Including supply of PC segments.	51,607,556
INCREASED COST OF LARGER TUNNEL		-
SECANT PILE LAUNCH CHAMBER		6,836,415
CRANE MAT/HARDSTANDING FOR TBM ERECTION		250,000
TUNNEL PORTAL CONSTRUCTION		1,482,471
TUNNEL FILL AND CLADDING		12,781,783
TUNNEL MECHANICAL AND ELECTRICAL WORKS		49,164,015
CROSS PASSAGES		17,205,176
TBM RECEPTION CHAMBER		7,336,415
SUMP/ADDITIONAL GROUND TRTREATMENT		250,000
SILVERTOWN CUT AND COVER		20,644,884
SILVERTOWN RETAINED CUT.		11,273,095
GREENWICH CUT AND COVER		28,018,057
GREENWICH RETAINED CUT.		10,003,518
SUB STATIONS AND VENT BUILDINGS		19,360,000
Indicative saving for secondary lining in lieu of VE cladding		-1,320,429
Indicative price from Atkins for the approaches at both ends. Allowance for OH and P excluded		38,667,866
SUB TOTAL		385,422,343
Contractor's Design Costs	4%	15,416,894
Contractor's OH and P, <i>applied to design and construction costs</i>	10%	40,083,924
SUB TOTAL		440,923,160
Adjustment for escalation between Q1/2012 and Q1/2013	-1.0%	-4,022,553
SUB TOTAL		436,900,607
Contractor's RISK	Included in QRA	-
QRA, P50% RISK	13.8%	60,292,284
Bored Tunnel – Option E, inc P50%	TOTAL	497,192,891

Appendix B. Drawings

Table B.1: Silvertown Tunnel Engineering, Addendum A – Drawing list

Drawing Number	Drawing Title
MMD-298348-C-DR-00-ZZ-1050	Silvertown Tunnel Crossing, Twin Bore Tunnel, Option C, Tunnel Alignment Plan
MMD-298348-C-DR-00-ZZ-1051	Silvertown Tunnel Crossing, Twin Bore Tunnel, Option C, Tunnel Longitudinal Section
MMD-298348-C-DR-00-ZZ-1060	Silvertown Tunnel Crossing, Immersed Tunnel, Option B, Tunnel Alignment Plan
MMD-298348-C-DR-00-ZZ-1061	Silvertown Tunnel Crossing, Immersed Tunnel, Option B, Tunnel Longitudinal Section
MMD-298348-C-DR-00-ZZ-1070	Silvertown Tunnel Crossing, Twin Bore Tunnel and Immersed Tunnel, Longitudinal Section
MMD-298348-C-DR-00-ZZ-1071	Silvertown Tunnel Crossing, Twin Bore Tunnel and Immersed Tube Tunnel, Longitudinal Sections, Comparison.

Table B.2: Silvertown Crossing Study, Rev 02, June 2012 – Drawing List

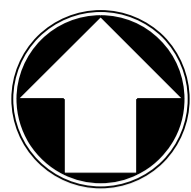
Drawing Number	Drawing title
MMD-298348-TUN-101	Silvertown Crossing, General, Safeguarded Area
MMD-298348-TUN-102	Silvertown Crossing, General, Constraints
MMD-298348-TUN-103	Silvertown Crossing, General, Borehole Data
MMD-298348-TUN-201	Silvertown Crossing, Bored Tunnel Option, Scheme Layout Plan
MMD-298348-TUN-202	Silvertown Crossing, Bored Tunnel Option, Geological Long Section
MMD-298348-TUN-203	Silvertown Crossing, Bored Tunnel Option, Plan and Longitudinal Section Sheet 1
MMD-298348-TUN-204	Silvertown Crossing, Bored Tunnel Option, Plan and Longitudinal Section Sheet 2
MMD-298348-TUN-205	Silvertown Crossing, Bored Tunnel Option, Plan and Longitudinal Section Sheet 3
MMD-298348-TUN-206	Silvertown Crossing, Bored Tunnel Option, Bored Tunnel Cross Section
MMD-298348-TUN-207	Silvertown Crossing, Bored Tunnel Option, Emergency Escape Cross Passages
MMD-298348-TUN-208	Silvertown Crossing, Bored Tunnel Option, Cross Passage & Sump
MMD-298348-TUN-209	Silvertown Crossing, Bored Tunnel Option, Precast Concrete Segmental Lining, Right Hand Taper Ring
MMD-298348-TUN-210	Silvertown Crossing, Bored Tunnel Option, Greenwich Approach Structures Plan
MMD-298348-TUN-211	Silvertown Crossing, Bored Tunnel Option, Greenwich Approach Structures Sections Sheet 1
MMD-298348-TUN-212	Silvertown Crossing, Bored Tunnel Option, Greenwich Approach Structures Sections Sheet 2
MMD-298348-TUN-213	Silvertown Crossing, Bored Tunnel Option, Silvertown Approach Structures Plan Layout
MMD-298348-TUN-214	Silvertown Crossing, Bored Tunnel Option, Silvertown Approach Structures Sections Sheet 1
MMD-298348-TUN-215	Silvertown Crossing, Bored Tunnel Option, Silvertown Approach Structures Sections Sheet 2
MMD-298348-TUN-216	Silvertown Crossing, Bored Tunnel Option, Greenwich Vent Station, GA, Sections and Details
MMD-298348-TUN-217	Silvertown Crossing, Bored Tunnel Option, Silvertown Vent Station, GA, Sections and Details
MMD-298348-TUN-218	Silvertown Crossing, Bored Tunnel Option, Tunnel Services Building Greenwich, Primary Substation
MMD-298348-TUN-219	Silvertown Crossing, Bored Tunnel Option, Tunnel Services Building Silvertown,

Drawing Number	Drawing title
	Secondary Substation
MMD-298348-TUN-220	Silvertown Crossing, Bored Tunnel Option, Greenwich Worksite Layout
MMD-298348-TUN-221	Silvertown Crossing, Bored Tunnel Option, Silvertown Worksite Layout
MMD-298348-TUN-222	Silvertown Crossing, Bored Tunnel Option, Greenwich Temporary Diversion
MMD-298348-TUN-301	Silvertown Crossing, Immersed Tunnel Option, Tunnel Alignment Plan
MMD-298348-TUN-302	Silvertown Crossing, Immersed Tunnel Option, Long Section
MMD-298348-TUN-303	Silvertown Crossing, Immersed Tunnel Option, Geological Long Section
MMD-298348-TUN-304	Silvertown Crossing, Immersed Tunnel Option, Typical Cross Sections
MMD-298348-TUN-305	Silvertown Crossing, Immersed Tunnel Option, Alternate Cross Sections
MMD-298348-TUN-306	Silvertown Crossing, Immersed Tunnel Option, Greenwich Approach Structures Plan
MMD-298348-TUN-307	Silvertown Crossing, Immersed Tunnel Option, Cut and Cover Cross Sections, Greenwich Approach
MMD-298348-TUN-308	Silvertown Crossing, Immersed Tunnel Option, Silvertown Approach Structures Plan
MMD-298348-TUN-309	Silvertown Crossing, Immersed Tunnel Option, Cut and Cover Cross Sections, Silvertown Approach
MMD-298348-TUN-310	Silvertown Crossing, Immersed Tunnel Option, Construction Sequence
MMD-298348-TUN-311	Silvertown Crossing, Immersed Tunnel Option, Construction Sequence, Greenwich Approach
MMD-298348-TUN-312	Silvertown Crossing, Immersed Tunnel Option, Greenwich Interface Detail
MMD-298348-TUN-313	Silvertown Crossing, Immersed Tunnel Option, Construction Sequence, Silvertown Approach
MMD-298348-TUN-314	Silvertown Crossing, Immersed Tunnel Option, Silvertown Interface Detail
MMD-298348-TUN-315	Silvertown Crossing, Immersed Tunnel Option, Silvertown Approach, Casting Basin Plan
MMD-298348-TUN-316	Silvertown Crossing, Immersed Tunnel Option, Casting Basin Cross Sections, Sheet 1
MMD-298348-TUN-317	Silvertown Crossing, Immersed Tunnel Option, Casting Basin Cross Sections, Sheet 2
MMD-298348-TUN-318	Silvertown Crossing, Immersed Tunnel Option, Dredging Profile Plan
MMD-298348-TUN-319	Silvertown Crossing, Immersed Tunnel Option, Dredging Profile Cross Sections, Sheet 1
MMD-298348-TUN-320	Silvertown Crossing, Immersed Tunnel Option, Dredging Profile Cross Sections, Sheet 2
MMD-298348-TUN-321	Silvertown Crossing, Immersed Tunnel Option, Tunnel Joint Details
MMD-298348-TUN-322	Silvertown Crossing, Immersed Tunnel Option, Greenwich Worksite Layout
MMD-298348-TUN-323	Silvertown Crossing, Immersed Tunnel Option, Silvertown Worksite Layout

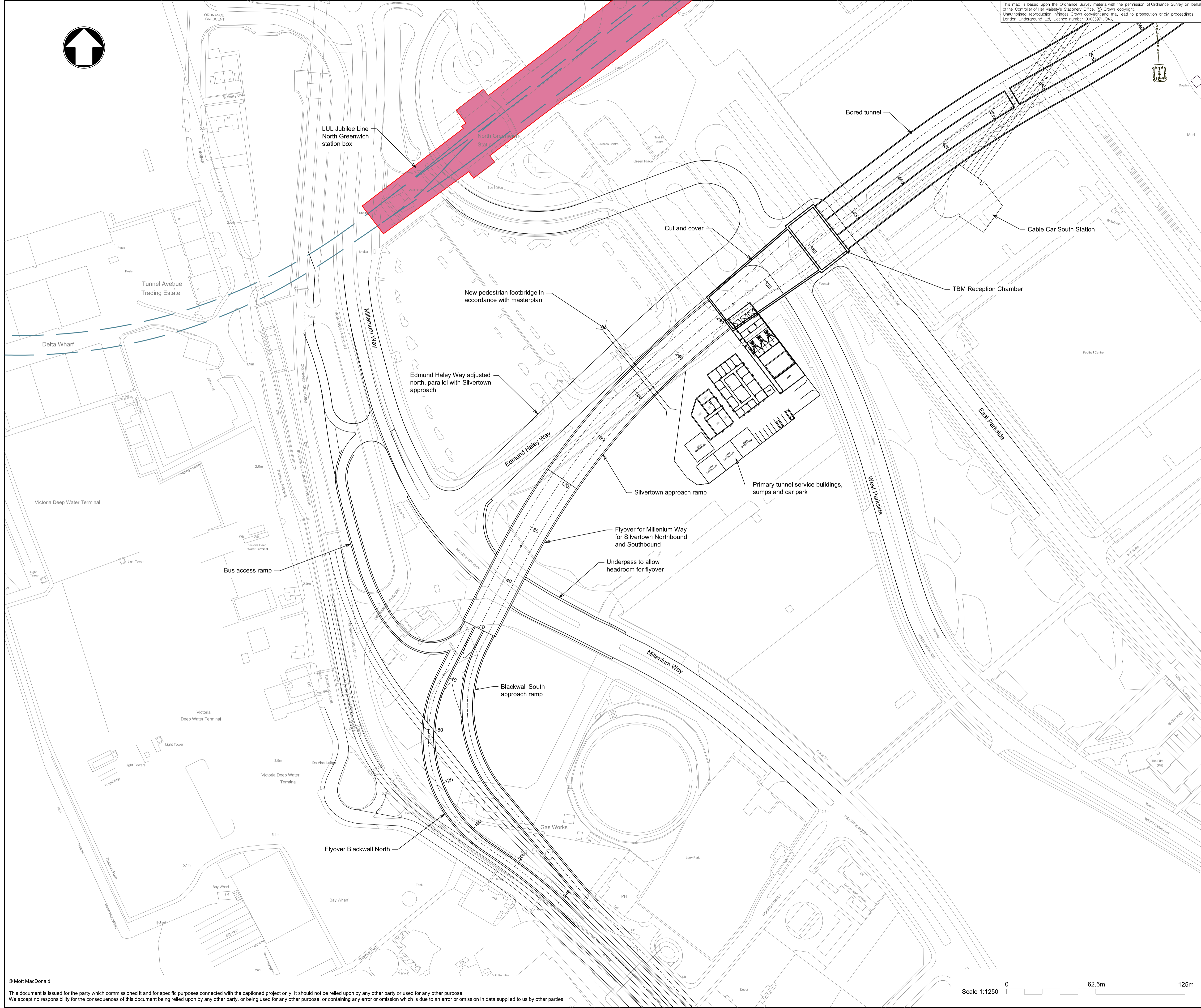
Table B.3: Silvertown Tunnel, Further development of Tunnel Engineering, Rev 4.1, July 2013 – Drawing List

Drawing Number	Drawing Title
MMD-298348-C-DR-00-ZZ-1001	Silvertown Tunnel Crossing General Safe Guarded Areas
MMD-298348-C-DR-00-ZZ-1002	Silvertown Tunnel Crossing General Constraints
MMD-298348-C-DR-00-ZZ-1003	Silvertown Tunnel Crossing Bore Hole Data
MMD-298348-C-DR-00-ZZ-1004	Silvertown Crossing Bored Tunnel Option Scheme Layout Plan
MMD-298348-C-DR-00-ZZ-1005	Silvertown Crossing Bored Tunnel Option Geological Long Section

Drawing Number	Drawing Title
MMD-298348-C-DR-00-ZZ-1006	Silvertown Crossing Bored Tunnel Option Plan and Longitudinal Section Sheet 1 of 3
MMD-298348-C-DR-00-ZZ-1007	Silvertown Crossing Bored Tunnel Option Plan and Longitudinal Section Sheet 2 of 3
MMD-298348-C-DR-00-ZZ-1008	Silvertown Crossing Bored Tunnel Option Plan and Longitudinal Section Sheet 3 of 3
MMD-298348-C-DR-00-ZZ-1009	Silvertown Crossing Bored Tunnel Cross Section
MMD-298348-C-DR-00-ZZ-1010	Silvertown Crossing Bored Tunnel Escape Cross Passages
MMD-298348-C-DR-00-ZZ-1011	Silvertown Crossing Bored Tunnel Escape Cross Passages and Sump
MMD-298348-C-DR-00-ZZ-1012	Silvertown Crossing Bored Precast Concrete Segmental Lining
MMD-298348-C-DR-00-ZZ-1013	Silvertown Crossing Bored Greenwich Cut and Cover Approach Structures Plan
MMD-298348-C-DR-00-ZZ-1014	Silvertown Crossing Bored Greenwich Cut and Cover Approach Structures Sections Sheet 1 of 2
MMD-298348-C-DR-00-ZZ-1015	Silvertown Crossing Bored Greenwich Cut and Cover Approach Structures Sections Sheet 2 of 2
MMD-298348-C-DR-00-ZZ-1016	Silvertown Crossing Bored Greenwich Open Cut Approach Structures Plan
MMD-298348-C-DR-00-ZZ-1017	Silvertown Crossing Bored Greenwich Open Cut Approach Structures Sections 1 of 2
MMD-298348-C-DR-00-ZZ-1021	Silvertown Tunnel Crossing Silvertown Worksite Layout Phase 1 Tunnel Cut and Cover Works
MMD-298348-C-DR-00-ZZ-1023	Silvertown Tunnel Crossing Greenwich Worksite Layout
MMD-298348-C-DR-00-ZZ-1024	Silvertown Tunnel Crossing Silvertown Worksite Layout Phase 1 Tunnel and Cut and Cover Works
MMD-298348-C-DR-00-ZZ-1025	Silvertown Tunnel Crossing Silvertown Worksite Layout Phase 2 Road Works & Fitout
MMD-298348-E-DR-00-ZZ-1001	Silvertown River Crossing Bored Tunnel Option Electrical Systems High Voltage Electrical Schematic Single Line Diagram
MMD-298348-H-DR-00-ZZ-1001	Silvertown River Crossing Bored Tunnel Option Greenwich Approach Principal Tunnel Services Building Compound Structures Plan
MMD-298348-H-DR-00-ZZ-1002	Silvertown River Crossing Bored Tunnel Option Silvertown Approach Secondary Tunnel Services Building Compound Structures Plan
MMD-298348-H-DR-00-ZZ-1003	Silvertown River Crossing Bored Tunnel Option Principal Tunnel Services Building - Building Plan
MMD-298348-H-DR-00-ZZ-1004	Silvertown River Crossing Bored Tunnel Option Fire Tanks and Pump Room Building - Building Plan
MMD-298348-H-DR-00-ZZ-1005	Silvertown River Crossing Bored Tunnel Option Secondary Tunnel Services Building - Building Plan
MMD-298348-H-DR-00-ZZ-1006	Silvertown River Crossing Bored Tunnel Option Greenwich Ventilation stack General Arrangement and Sections
MMD-298348-H-DR-00-ZZ-1007	Silvertown River Crossing Bored Tunnel Option Silvertown Ventilation stack General Arrangement and Sections
MMD-298348-H-DR-00-ZZ-1008	Silvertown River Crossing Bored Tunnel Option Greenwich Approach Compound and Portal Visualisation
MMD-298348-H-DR-00-ZZ-1009	Silvertown River Crossing Bored Tunnel Option Silvertown Approach Compound Visualisation
MMD-298348-H-DR-00-ZZ-1010	Silvertown River Crossing Bored Tunnel Option Silvertown Approach Portal Visualisation



This map is based upon the Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. © Crown copyright. Unauthorized reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. London Underground Ltd. Licence number 100035971/046.



Notes

Key to symbols

Reference drawings

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	24.10.13	GB	Preliminary issue	AE	MS



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

Client



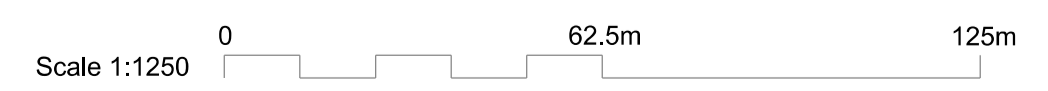
Transport for London
Transport for London
50 Victoria Street
London
SW1H 0TL

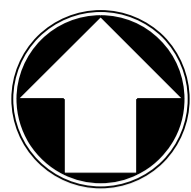
Title

**Silvertown Tunnel Crossing
Twin Bore Tunnel
Option C
Tunnel Alignment Plan**

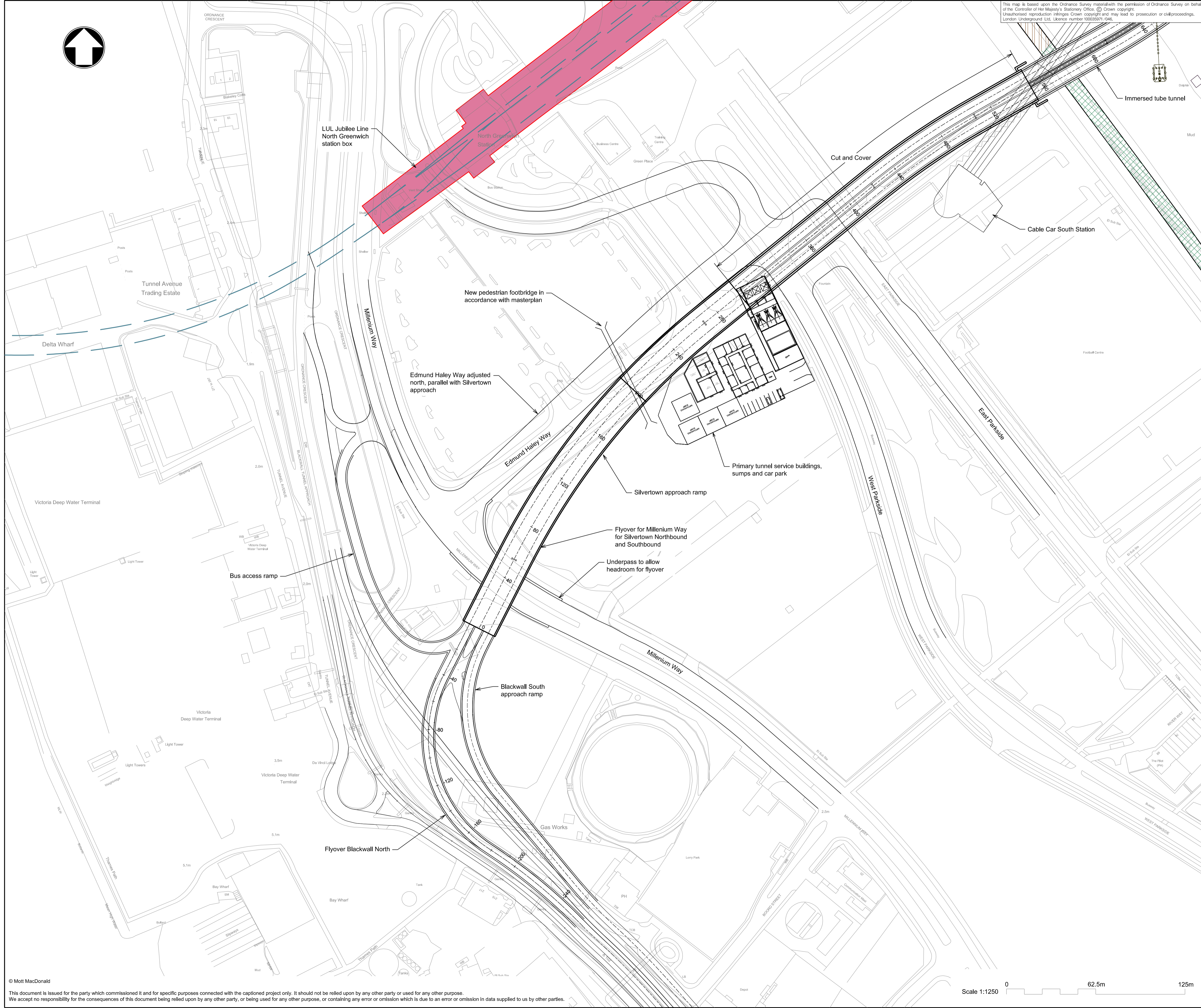
Designed	AE	24.10.13	Eng check	JB	24.10.13
Drawn	GB	18.10.13	Coordination	JB	24.10.13
Dwg check	AE	24.10.13	Approved	JB	24.10.13
Scale at A1 1:1250	Status	PRE	Rev	P1	
Drawing Number MMD-298348-C-DR-00-ZZ-1050					

© Mott MacDonald
This document is issued for the party which commissioned it and for specific purposes connected with the captioned project only. It should not be relied upon by any other party or used for any other purpose. We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.
Formerly Drawing No:- M1267759 New Thames River Crossing/H Reports and Drawings/H.03 Outgoing Drawings/working drawings/OPTIONS 2 & 3/DWG/Option 2/267759_TUN_1001.dwg — kn56149





This map is based upon the Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. © Crown copyright. Unauthorized reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. London Underground Ltd. Licence number 100035971/046.



Notes

Key to symbols

Reference drawings

P1	24.10.13	GB	Preliminary issue	AE	MS
Rev	Date	Drawn	Description	Ch'k'd	App'd



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

Client

Transport for London
50 Victoria Street
London
SW1H 0TL

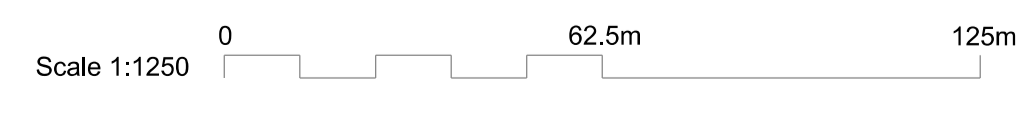
Title

**Silvertown Tunnel Crossing
Immersed Tunnel
Option B
Tunnel Alignment Plan**

Designed	AE	24.10.13	Eng check	JB	24.10.13
Drawn	GB	23.10.13	Coordination	JB	24.10.13
Dwg check	AE	24.10.13	Approved	JB	24.10.13
Scale at A1	1:1250		Status	PRE	Rev
					P1

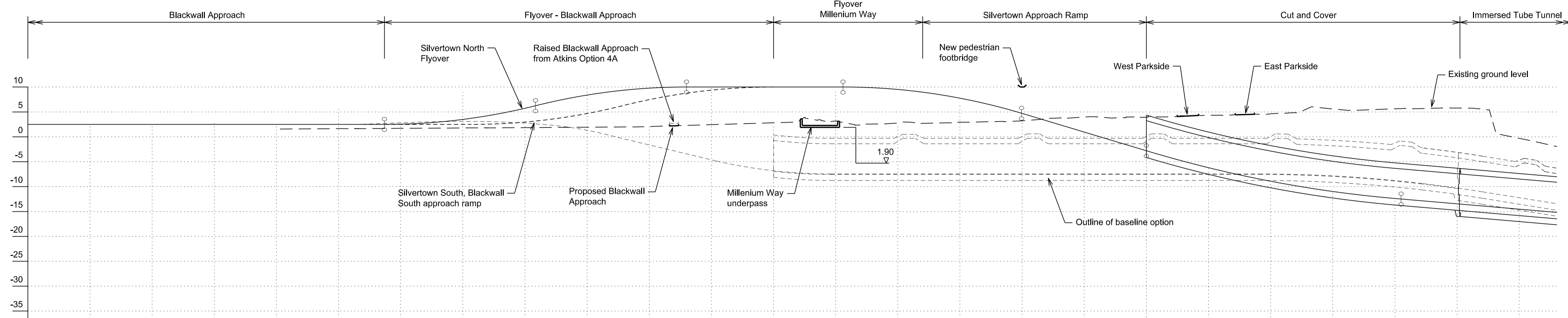
Drawing Number
MMD-298348-C-DR-00-ZZ-1060

© Mott MacDonald
This document is issued for the party which commissioned it and for specific purposes connected with the captioned project only. It should not be relied upon by any other party or used for any other purpose. We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.



This map is based upon the Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. © Crown copyright. Unauthorized reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. London Underground Ltd. Licence number 100235971/046.

Notes

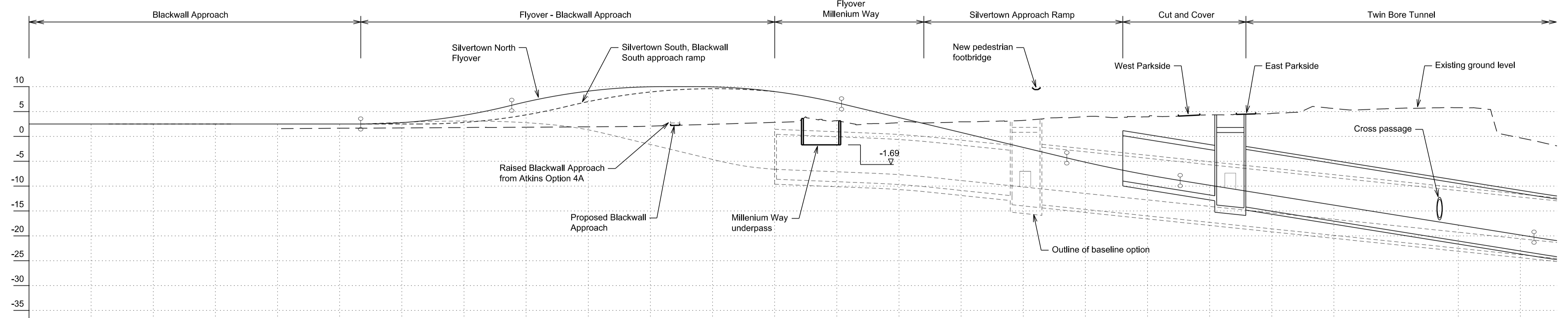


Key to symbols
 Legend:
 - - - Existing ground level
 - - - Outline of baseline option

CHAINAGE (M)	PROPOSED LEVEL (M)	EXISTING LEVEL (M)
-580.00	2.500	2.065
-560.00	2.500	2.216
-540.00	2.500	2.366
-520.00	2.530	2.517
-500.00	2.630	2.667
-480.00	2.814	2.818
-460.00	3.078	2.968
-440.00	3.424	3.622
-420.00	3.850	2.960
-400.00	4.358	2.538
-380.00	4.948	2.577
-360.00	5.622	2.714
-340.00	6.377	2.809
-320.00	7.106	2.782
-300.00	7.753	2.938
-280.00	8.316	3.045
-260.00	8.798	3.157
-240.00	9.198	3.507
-220.00	9.517	3.814
-200.00	9.755	3.933
-180.00	9.913	3.994
-160.00	9.991	3.970
-140.00	10.000	4.188
-120.00	10.000	4.309
-100.00	10.000	4.355
-80.00	10.000	4.544
-60.00	10.000	4.712
-40.00	10.000	5.709
-20.00	10.000	5.676
0.000	9.962	5.353
20.00	9.824	5.544
40.00	9.586	5.707
60.00	9.248	5.744
80.00	8.809	5.781
100.00	8.268	5.695
120.00	7.625	0.468
140.00	6.880	-0.551
160.00	6.030	
180.00	5.076	
200.00	4.015	
220.00	2.847	
240.00	1.569	
260.00	0.181	
280.00	-1.305	
300.00	-2.805	
320.00	-4.249	
340.00	-5.580	
360.00	-6.802	
380.00	-7.916	
400.00	-8.922	
420.00	-9.823	
440.00	-10.620	
460.00	-11.313	
480.00	-11.904	
500.00	-12.393	
520.00	-12.820	
540.00	-13.248	
560.00	-13.675	
580.00	-14.103	
600.00	-14.530	
620.00	-14.958	

Reference drawings

Immersed Tube Tunnel



CHAINAGE (M)	PROPOSED LEVEL (M)	EXISTING LEVEL (M)
-580.00	2.500	2.065
-560.00	2.500	2.216
-540.00	2.500	2.366
-520.00	2.526	2.517
-500.00	2.630	2.667
-480.00	2.814	2.818
-460.00	3.078	2.968
-440.00	3.424	3.622
-420.00	3.850	2.960
-400.00	4.358	2.538
-380.00	4.948	2.577
-360.00	5.622	2.714
-340.00	6.377	2.809
-320.00	7.106	2.782
-300.00	7.753	2.938
-280.00	8.316	3.045
-260.00	8.798	3.157
-240.00	9.198	3.507
-220.00	9.517	3.814
-200.00	9.755	3.933
-180.00	9.913	3.994
-160.00	9.991	3.970
-140.00	9.989	4.188
-120.00	9.907	4.309
-100.00	9.745	4.355
-80.00	9.502	4.544
-60.00	9.179	4.712
-40.00	8.775	5.709
-20.00	8.289	5.676
0.000	7.722	5.353
20.00	7.071	5.544
40.00	6.337	5.707
60.00	5.518	5.744
80.00	4.614	5.781
100.00	3.623	5.695
120.00	2.543	0.468
140.00	1.376	-0.551
160.00	0.176	
180.00	-1.020	
200.00	-2.224	
220.00	-3.424	
240.00	-4.622	
260.00	-5.754	
280.00	-6.797	
300.00	-7.753	
320.00	-8.623	
340.00	-9.427	
360.00	-10.227	
380.00	-11.027	
400.00	-11.827	
420.00	-12.627	
440.00	-13.427	
460.00	-14.227	
480.00	-15.027	
500.00	-15.827	
520.00	-16.627	
540.00	-17.427	
560.00	-18.227	
580.00	-19.027	
600.00	-19.827	
620.00	-20.618	

P1	07.11.13	GB	Preliminary issue	AE	MS
Rev	Date	Drawn	Description	Ch'k'd	App'd



Title
**Silvertown Tunnel Crossing
 Twin Bore Tunnel and
 Immersed Tube Tunnel
 Longitudinal Sections**

Designed	AE	07.11.13	Eng check	JB	07.11.13
Drawn	GB	06.11.13	Coordination	JB	07.11.13
Dwg check	AE	07.11.13	Approved	JB	07.11.13
Scale at A1	Status		Rev		
As shown	PRE		P1		
Drawing Number MMD-298348-C-DR-00-ZZ-1070					

Twin Bore Tunnel

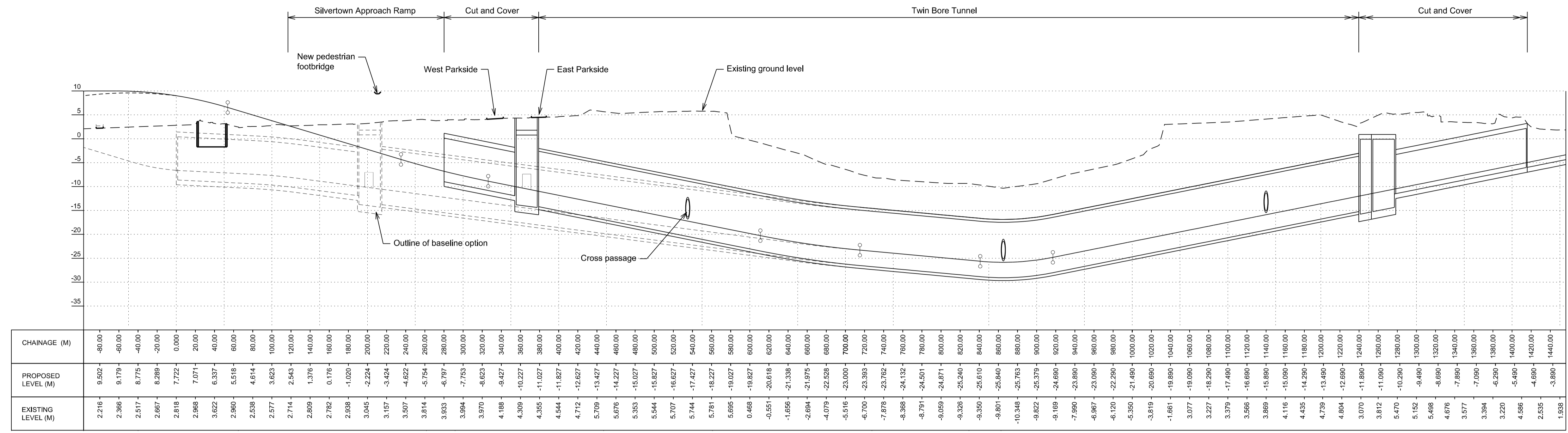
This map is based upon the Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. © Crown copyright. Unauthorized reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. London Underground Ltd, Licence number 100035971/046.

Notes

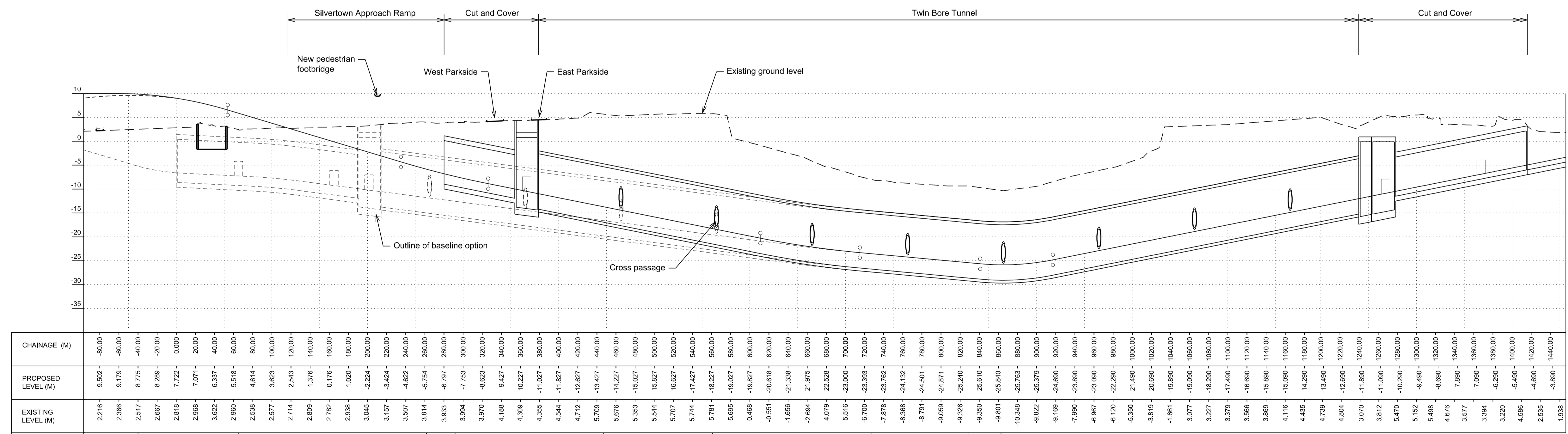
Key to symbols

Legend:
 - - - Existing ground level
 - - - Outline of baseline option

Reference drawings



Twin Bore Tunnel - 3 Cross Passages



Twin Bore Tunnel - 8 or 10 Cross Passages

P1	07.11.13	GB	Preliminary issue	AE	MS
Rev	Date	Drawn	Description	Ch'k'd	App'd

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

Client

Transport for London
 50 Victoria Street
 London
 SW1H 0TL

Title

**Silvertown Tunnel Crossing
 Twin Bore Tunnel and
 Immersed Tube Tunnel
 Longitudinal Sections
 Comparison**

Designed	AE	08.11.13	Eng check	JB	08.11.13
Drawn	GB	07.11.13	Coordination	JB	08.11.13
Dwg check	AE	08.11.13	Approved	JB	08.11.13
Scale at A1	Status	PRE	Rev	P1	

Drawing Number
MMD-298348-C-DR-00-ZZ-1071

