Annex I List of Abbreviations and Glossary of Terms as Included in the ES

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List of Abbreviations and Glossary of Terms

Abstraction	The process of taking water from any source, either temporarily or permanently
AOD	Above Ordnance Datum
AQAP	Air Quality Action Plan
AQEG	Air Quality Expert Group
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
ATD	Above Tunnel Datum
bgl	Below Ground Level
BGS	British Geological Society
BREEAM	Building Research Establishment Environmental Assessment Method
BS	British Standard
CAZ	Central Activities Zone
CDM	Construction (Design Management)
CE	Church of England
CEEQUAL	Civil Engineering Environmental Quality Assessment and Award Scheme
CLEA	Contaminated Land Exposure Assessment
CMP	Construction Management Plan
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CoCP	Code of Construction Practice
CoPA	Control of Pollution Act 1974
COSHH	Control of Substances Hazardous to Health
CoW	City of Westminster Council
CPZ	Controlled Parking Zone
CSD	Corner Site Development
dB	Decibel
D&C line	District and Circle line
DCLG	Department of Communities and Local Government
DEFRA	Department for Environment Food and Rural Affairs
DfT	Department for Transport
DoE AL	Department of the Environment Advisory Leaflet
DTI	Department of Trade and Industry
EA	Environment Agency
EDM	Environmental Design Management
Effect	The consequence of the change to the baseline environment, or impact, on the environmental receptor or particular value or sensitivity.
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMMP	Environmental Management and Monitoring Plan

EPA	Environmental Protection Act
ES	Environmental Statement
FSC	Forest Stewardship Council
FTE	Full Time Equivalent
GDS	Geotechnical Desk Study
GLA	Greater London Authority
GLSMR	Greater London Scheduled Monument Register
GPDO	General Permitted Development Order
GPR	Ground Penetration Radar
HAZOP	Hazard and Operability Study
HFC	Hydrofluorocarbon
HSE	Health, Safety and Environment
HSG	Health Service Guidelines
IC	Interchange
ICE	Institution of Civil Engineers
IEMA	Institute of Environmental Management and Assessment
Impact	A predicted change to the baseline environment
ISO	International Standards Origination
KSPS	King's Scholars Pond Sewer
kW	Kilowatt
LAeq	The LAeq Index. [The equivalent continuous sound level LAeq is the level of a notional steady sound, which at a given position and over a defined period of time, would deliver the same A-weighted acoustic energy as the fluctuating noise.]
LBAP	Local Biodiversity Action Plan
LDC	London Development Corporation
LEZ	Low Emission Zone
LFCDA	London Fire and Civil Defence Authority
LFEPA	London Fire and Emergency Planning Authority
LLAU	Limits of Land to Acquired or Used
LNR	Local Nature Reserve
LP	London Plan
LPA	Local Planning Authority
LSF	Low Smoke and Fume
LSOH	Low Smoke and zero Halogen
LU	London Underground
M&E	Mechanical and Electrical
MM	Mott MacDonald
MoLAS	Museum of London Archaeology Service
NB	Northbound
NE	Natural England
NHS	National Health Service
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NOC	Network Operations Centre

NO_X	Nitrogen Oxides
NPV	Net Present Value
NR	National Rail
NRA	National Rivers Authority
NTH	North Ticket Hall
ODPM	Office of the Deputy Prime Minister
PAH	Polycyclic Aromatic Hydrocarbons
PAL	Paid Area Link
PCB	Polychlorinated biphenyls
pEMP	Project Environmental Management Plan
Piezometry	The science and practice of pressure measurement.
PM_{10}	Particulate Matter with a diameter less than 10 micrometers µ
PPE	Personal Protective Equipment
PPG	Planning Policy Guidance
PPP	Public Private Partnerships
PPS	Planning Policy Statement
PRM	Persons of Reduced Mobility
QUENSH	LU Standard Contract QUENSH Conditions
QUEST	Quantitative Engineering Sustainability Tool
Receptor	Recipient of an effect
RIBA	Royal Institute of British Architects
SA	Sustainability Appraisal
SAM	Scheduled Ancient Monument
SCL	Sprayed Concrete Lining
SEMP	Site Environmental Management Plan
SER	Signalling Equipment Room
SGI	Site Ground Investigation
SGV	Soil Guideline Values
SI	Site Investigation
SINC	Site of Importance for Nature Conservation
SMS	Short Messaging Service
SPG	Supplementary Planning Guidance
SQE	Safety, Quality and Environment
sq. m	Square metre
SRDF	Sub-Regional Development Framework
SSSI	Site of Special Scientific Interest
STH	South Ticket Hall
SWMP	Site Waste Management Plan
T2025	Transport 2025
TCP	Tunnel Cooling Programme
TfL	Transport for London
TPH	Total Petroleum Hydrocarbons
TWA	Transport and Works Act
TWAO	Transport and Works Act Order
TWUL	Thames Water Utilities Limited

UDP	Unitary Development Plan
US EPA	United States Environmental Protection Agency
UXO	Unexploded Ordnance
VAPB	Victoria Area Planning Brief
VBR	Vauxhall Bridge Road
VL	Victoria line
VLU	Victoria Line Upgrade
VPT	Victoria Palace Theatre
VSU	Victoria Station Upgrade
VTI	Victoria Transport Interchange
WAC	Waste Acceptance Criteria
WB	Westbound
WIS	Water Industry Specifications
ZoI	Zone of Influence
ZVI	Zone of Visual Influence

Annex II Matrix of Changes

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Table 1.1: The Main Changes Matrix

The main changes to the ES arise from the following information:

- The modifications to the scheme design;
- The updated construction methodology and phasing for the main works;
- The updated construction methodology and phasing for utilities diversions;
- The additional work that has been undertaken since the November 2007 Application;
- The development of London Underground's strategy for reinstatement of the sites of demolished buildings.

The Main Change Matrix presents the main changes as well as respective paragraph numbers and selected texts in the ES and the SES. This matrix identifies changes that have been removed or taken into account in the SES to present additional mitigation measures and the subsequent effects this has on the significant residual effects.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
1.1.4 of the ES	The development site lies within the administrative area of the City of Westminster (CoW). The works will require the demolition of buildings at the corner of Bressenden Place and Victoria Street and major construction activity above and below-ground for a period of approximately six years. However, once the works are complete the main changes will have been made to the below ground station layout with changes made to new and existing station entrances. The vacant land that will remain post-construction (where the existing buildings will be demolished) is the subject of a proposed development, known as the Corner Site Development (CSD), being promoted by London Underground (LU), for which a separate planning application for this scheme has been submitted to the CoW. Other buildings, as listed in paragraph 2.8.5, will also be demolished. In order to address the effects of their demolition a Site Reinstatement Strategy is currently being developed. This strategy will address the land use at these sites during the construction of the scheme and in the longer term.	1.1.3 2.5.2	The London Underground applications for planning permission and listed building consent to redevelop 120-124 Victoria Street and 3-11 Bressenden Place have now been withdrawn. The VSU Site Reinstatement Strategy explains how London Underground will deal with those sites where buildings will be demolished for the purposes of the works. Section 2.5 provides a description of the site reinstatement strategy. The strategy is included in Appendix D.
1.1.5 of the ES	London Underground considered it prudent to design a building to occupy the corner site that demonstrates how the successful integration of the above ground elements of VSU in this location could be achieved in a way that fully respects the setting of the VPT and the general location and which conforms to the Victoria Area Planning Brief.	1.1.3 2.5.2	The VSU Site Reinstatement Strategy explains how London Underground will deal with sites at 120-124 Victoria Street and 3-11 Bressenden Place where buildings will be demolished for the purposes of the works. Those sites have been assessed in this SES as a cumulative effect on the VSU scheme. Section 2.5 provides a description of the Site Reinstatement Strategy. The strategy is included in Appendix D.

Main Changes Matrix			
ES Para	**Original Text**	**SES Para**	**New Text**
1.2.3 of the ES	Paragraph 1.2.3 lists the works proposed for the VSU scheme. The application for the VSU scheme includes the following key components…	2.1.2 2.2	Paragraph 2.1.2 describes the main effects of changes. These include: • a reduction in the depth and footprint of the North Ticket Hall (NTH); • a reduction in the depth of the South Ticket Hall (STH); and • the removal of a tunnel that was required solely for CTP (tunnel #20). A summary of the changes made to the original scheme are provided in paragraph 2.2. Refer Figure 2-3 and Annex V for further details on the updated scheme.
1.2.6 of the ES	To enable construction of the VSU scheme, numbers 120 to 124 Victoria Street and 3 to 11 Bressenden Place will need to be demolished. Future consent for the CSD is the subject of a separate planning application submitted to CoW. If the CSD was built, it would house the new western entrance to the NTH of the Victoria Underground Station with a retail component and a 7/8 storey office development above.	2.5.2	The London Underground applications for planning permission and listed building consent to redevelop 120-124 Victoria Street and 3-11 Bressenden Place have now been withdrawn.
2.7.1 of the ES	The proposed works comprise the following: • a new subterranean North Ticket Hall (NTH) at the junction of Bressenden Place and Victoria Street improving access from the north and east of the station; • an enlarged existing Victoria line ticket hall (known as the South Ticket Hall (STH)) providing greater ease of passenger movements inside the station; • three new banks of escalators (each bank comprising three escalators); • a new interchange tunnel, referred to as the Paid Area Link (PAL). This new pedestrian tunnel will connect the NTH to the STH;	2.2	Section 2.2 – *Comparison with the scheme at November 2007* in the SES updates the proposed works to reflect design changes.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
	• new lifts providing step free access for persons of reduced mobility (PRM) between the street, ticket hall and platform levels, for the NTH and STH and for interchange between the District & Circle line and Victoria line platforms; • improved emergency services access and evacuation core in the NTH; • improved access between the National Rail and Underground stations through increased escalator and lift provision; • utilities diversions; and • demolition of some buildings for the purposes of the works.		
Table 2-3 of the ES	Table 2-3 - *Summary of Description of Tunnels and Shafts*	Table 1-1 in Annex V	Descriptions of clearances/interfaces with other structures for some of the tunnels and shafts in Table 2-3 of the ES is updated and superseded by Table 1-1 – *Summary of Description of Tunnels and Shafts* in Annex V. The other tunnels and shafts, which are not described in Table 1-1 have not been superseded.
Table 2-3 and Section 2.8 of the ES	Reference to the M & E services Tunnel South (#14) and Tunnel Cooling Programme Tunnel (#20) in Table 2-3 and Section 2.8.	1.1.5 in Annex V	The M & E services Tunnel South (#14) and Tunnel Cooling Programme Tunnel (#20) have been removed as part of the scheme changes.
2.8.39 of the ES	Paragraph 2.8.39 describes proposed locations of Spheroidal Graphite Iron linings	1.1.7 in Annex V	The structures in paragraph 2.8.39 of the ES, where they are still required, will be constructed using spray concrete lining techniques.
2.8.40 of the ES	The following tunnels are currently envisaged to be excavated as square work: • Connection adits from TCP (#20) and PAL invert (#4a) to crowns of Victoria line northbound and southbound tunnels; • Escalator 10-12 UMC access tunnel (#15); and • Cable link from NTH to D&C line (#23).	1.1.11 in Annex V	It is proposed that Cable link from NTH to D&C line (#23) will be constructed by drilling a core.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
2.8.41 of the ES	It is proposed to use pipe jacking and microtunnelling techniques for the following tunnels: • D&C Drainage Connection (#24); and • TCP Cooling Water Pipe (#25).	1.1.12 in Annex V	It is proposed to use microtunnelling or thrustbore and coring techniques for the following: • D&C Drainage Connection (#25); • Cable link from D&C to NTH (#23) and • Cable link connection from D&C to Sump (#34).
2.8.42 of the ES	The shaft for the new sump (#9) will be constructed with a pre-cast concrete segmental lining.	1.1.13 in Annex V	The sump pump shaft (#9) will be excavated from within a contiguous ring of secant piles, through the water-bearing granular deposits to full depth within the clay and subsequently lined with an in-situ concrete lining.
2.8.43 of the ES	The lower sections of the PRM lifts (#12a and #14) will be constructed using square work.	1.1.14 in Annex V	The lower section of PRM lift (#12a) will be constructed using square work.
2.8.44 of the ES	A detailed account of the works and construction methods associated with the development of the structural works associated with the scheme are provided in the Conceptual Design Statement for Structural Works	1.1.15 in Annex V	The Conceptual Design Statement for Structural Works (July 2007) is in the process of being updated and will provide an account of the works and construction methods associated with the development of the structural works required for the scheme.
2.8.45 – 2.8.70 of the ES	Paragraphs 2.8.45 – 2.8.70 describe proposed works, construction methodology and clearances/interfaces with other structures for NTH, STH and SER.	1.1.16 – 1.1.40 in Annex V	Paragraphs 2.8.45 – 2.8.70 of the ES are superseded by paragraphs 1.1.16 – 1.1.40 in Annex V.
2.8.71 – 2.8.73 Tables 2-4 and 2-5 of the ES	Paragraphs 2.8.71 – 2.8.73 and the respective tables discusses about phasing of utilities works, demolition and construction activities. Table 2-4 – *VSU Scheme Main Works Construction Phases* Table 2-5 – *VSU Scheme Utilities Works Phases*	1.1.41 – 1.1.44 Tables 1-2 and 1-3 in Annex V	Paragraphs 1.1.41 – 1.1.44 and Tables 1-2 and 1-3 in Annex V completely supersedes Paragraphs 2.8.71 – 2.8.73 and Tables 2-4 and 2-5 in the ES.
Section 2.9 of the ES	Section 2.9 describes key design assumptions.	Section 1.2 in Annex V	Section 1.2 in Annex V completely supersedes Section 2.9 of the ES.
3.5.12 of the ES	The Draft CoCP is provided as a supporting document and is being developed in consultation with City of Westminster.	Table 1-1	The Draft CoCP has been updated and is included as Technical Appendix E - The Draft Code of Construction Practice 2008 in Technical Appendices Volume 3 to the SES.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
4.2.9 of the ES	As TfL was unable to identify an acceptable business case for any schemes to improve the VTI, TfL decided not to progress the scheme. However, in early 2005, Land Securities proposed to the Mayor a major mixed-use development for Victoria and the VTI scheme was re-established within the TfL Major Projects Interchange team during the spring of 2005, to evaluate the opportunity presented by their proposals. Work continues on VTI in parallel with VSU.	4.1.4	The text in paragraph 4.2.9 in the ES states that "work continues on VTI in parallel with VSU". This text is superseded by "a planning application for the VTI scheme was submitted to the City of Westminster in August 2007".
4.2.14 - 4.2.19 of the ES	Entire paragraphs 4.2.14 – 4.2.19	4.2.1 – 4.7.3	Entire paragraphs 4.2.14 – 4.2.19 in the ES have been superseded by paragraphs 4.2.1 – 4.7.3.
Table 4-2 of the ES	Table 4-2 – *Initial Assessment Alternatives*	Table 4-1	Table 4-1 – *Phase 1 Options Assessment* in the SES supersedes Table 4-2 in the ES.
Table 4-3 of the ES	Table 4-3 – *Detailed assessment alternatives*	Tables 4-2 – 4-3 in Section 4	Table 4-2 – *Phase 2 Options Assessment* and Table 4-3 – *Phase 3 Options Assessment* in the SES supersedes Table 4-3 in the ES.
5.3.2 – 5.3.29 of the ES	Regional Planning Policy – The London Plan	Section 5	Since the submission of the application in November 2007 a revised version of the spatial development strategy for London, titled 'The London Plan 2008 (Consolidated with Alterations since 2004)' has been published. This replaces the previous version of the London Plan published in 2004 which was referred to in the ES. The regional policies discussed in paragraphs 5.3.2 to 5.3.29 of the ES have been superseded by Section 5 of the SES.
6.2 of the ES	Section 6-2 – Traffic and Transport	6.2	Section 6.2 of the ES has been completely superseded by Section 6.2 – Traffic and Transport of the SES. Overall the scheme changes have led to the removal of a number of significant residual adverse traffic and transport effects during construction, and one additional significant residual adverse effect, to those identified in the ES. Refer Section 6.2 of the SES for further details.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
6.3 of the ES	Section 6.3 – Noise and Vibration	6.3	Section 6.3 of the ES has been completely superseded by Section 6.3 – Noise and Vibration of the SES.
6.4.15 Table 6-7 of the ES 2.3.3 & Table 2-2 in Technical Appendix C	Urban background concentrations of NO_2 are continuously monitored at a site named 'Westminster' located approximately 1.5km from the proposed VSU scheme. The monitored concentrations of NO_2 are provided in Table 6-7 in the ES Main Report and Table 2-2 in the Air Quality Technical Appendix C.	6.4.20 6.4.21 Table 6.4-1	Additional information has become available on NO_2 levels, since the publication of the ES, for the years 2006 and 2007 from the automatic monitoring site in Westminster. Table 6.4-1 provides updated information on the monitored NO_2 concentrations in Westminster site.
6.4.20 of the ES 2.4.1-2.4.2 in Technical Appendix C	Plate 6.2: Extent of Study area	6.4.11	Local traffic routing during the construction phase has been revised to provide improved bus and taxi provisions. The traffic modelling has also been expanded to incorporate Allington Street, Eccleston Place and roads around the Warwick Way area. The air quality assessment study area has therefore been expanded accordingly to cover all traffic links potentially affected by the revised proposals. In the main the information feeding into the assessment has remained the same and there are no more significant predicted concentrations than those predicted in the ES.
6.4.29 of the ES 5.1.6, 5.1.19-5.1.22 in Technical Appendix C	The nature of the construction works means that there will be a number of different activities being undertaken concurrently which have differing dust-raising potential. These include demolition, piling, excavation, tunnelling and jet grouting.	6.4.24 – 6.4.26 6.4.28 – 6.4.30 Tables 6.4-2 – 6.4-4	The changes to the VSU scheme design will result in less excavation and a reduction in the footprint of the works. All of these changes lead to a reduction in the amount of materials or spoil that would be disturbed and consequently, a reduction in the risk of dust generation. Paragraphs 6.4.28 – 6.4.30 describe dust raising potential associated with utility works, and identify utilities worksites and its potential to lead to dust nuisance. Table 6.4-2 shows the key design changes and the sites which they affect, along with the change in dust raising potential. Table 6.4-4 identifies utilities worksites and potential to lead dust nuisance.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
6.4.30 of the ES 5.1.10, Tables 5-4 & 5.5 in Technical Appendix C	Air quality effects arise from both the construction work itself (i.e. emissions from onsite plant) and from the traffic relating to this construction work.	6.4.33 – 6.4.37 Tables 6.4-6 & 6.4-7	The air quality assessment has considered the changes in traffic flows at the following identified locations: • around Eccleston Place; • around Allington Street; and • around Gillingham Street and Warwick Way. Refer Tables 6-6 and 6-7 for modelled changes in pollutant concentrations of NO_2 and PM_{10}.
6.4.34 of the ES 6.1.2 in Technical Appendix C	The construction phase has an approximate duration of six years.	Annex V	Construction period is not mentioned in Section 6.4 of the SES. It is estimated that The main VSU scheme will take approximately seven years to construct. The construction methodology is substantially the same as given in the ES. Refer Annex V for details of phasing of utilities works, demolition and construction activities.
6.4.38 of the ES 6.1.4 in Technical Appendix C	Assessment of construction dust highlights that some construction sites will require a higher degree of mitigation from construction dust than others due to the combination of location, nature and duration of the construction activities.	6.4.40 6.4.27	ES identified no significant residual effects and this remains the position after the changes to the scheme have been taken into account. Monitoring of specific sensitive receptors (such as schools) will be undertaken during the main works, as outlined further in the CoCP to enable an assessment to be made of the dust levels in the vicinity of sensitive receptors. Monitoring of both PM10 and total suspended particles (TSP) will be undertaken. Monitoring will be undertaken using simple monitoring tools such as a 'directional dust gauge', to indicate the origin of the dust. Monitoring data should be compared with other monitoring data in the local area that cannot be directly affected by the works.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
6.4.52 6.1.19, 9.1.1 in Technical Appendix C	Traffic impacts from the construction phase and utilities works could potentially lead to some changes in ambient air quality around the area of Victoria Station. It is important however to stress that the changes identified are temporary and represent a 'worst-case' scenario for the construction traffic flows.	6.4.39	Predicted concentrations of PM_{10} from the changes to the road traffic are also, in the main, predicted to temporarily increase on the majority of the links considered. However the changes are mostly minor, and given that the background PM_{10} concentrations are well below the air quality objective of 40µgm^{-3}, they are considered to be of negligible significance.
Section 8 in Technical Appendix C	Section 8 - *Assessment of Cumulative Effects (Air quality)*	Sections 7.3 – 7.8 of the SES Table 1.1 in Annex VII	Information which has become available since the submission of the ES has been included in cumulative effects assessment in the SES. This information comprised the environmental effects resulting from the scheme changes ands design and construction information on other proposed schemes within the vicinity of the VSU scheme. Refer Sections 7.3 – 7.8 of the SES and Table 1.1 in Annex VII for the updated assessment of cumulative effects.
6.5.2 of the ES 3.2.10 – 3.2.11 and Table 6 in Technical Appendix D	Paragraph 6.5.2 describes baseline of the townscape character. The townscape character of the study area was assessed by analysing the following townscape elements: urban layout, land use, density and scale, appearance, legibility accessibility, public open space and existing trees.	6.5.18	There are two changes to the baseline: Abford House is currently being redeveloped: The new building will screen, during construction and operation, the main element of the VSU development visible from the high sensitivity visual receptors in Evelyn Mansions overlooking Vauxhall Bridge Road. The zone of visual influence (ZVI) and the study area has been revised to show both the Vauxhall Bridge Worksite and the advanced utility works.
6.5.3 Figure 6.5(2) of the ES 2.3.1 and Figure 3 in Technical Appendix D	The Zone of Visual Influence (ZVI) as illustrated on Figure 6.5(2), extends west of Terminus Place to Grosvenor Gardens, south down Wilton Road and Carlisle Place and north along Allington Court and Bressenden Place. It includes the section of Victoria Street that passes through the development area. High sensitivity receptors include residents of Carlisle Place and Evelyn Mansions. Medium sensitivity receptors include office workers in the office blocks within the ZVI, pedestrians and shoppers passing through the ZVI, theatre goers, users of Grosvenor Gardens, shoppers and visitors to the public houses	6.5.18	The zone of visual influence (ZVI) and the study area has been revised to show both the Vauxhall Bridge Worksite and the advanced utility works. This increases the number of high sensitivity visual receptors. These include: residents of Vauxhall Bridge Road, Wilton Road and the area immediately west of Bressenden Place. The number of medium sensitivity receptors, including local residents as they pass through the ZVI, also increases in these areas, which are considered as part of the Victoria Street and Bressenden Place Townscape Character Area for the purposes of this assessment. The townscape quality and sensitivity

Main Changes Matrix			
ES Para	**Original Text**	**SES Para**	**New Text**
	in the ZVI. Lower sensitivity receptors include road users within the ZVI.		of this area, as assessed in Table 2 'Townscape Quality and Sensitivity Evaluation Criteria' in the Technical Appendix D, is lower. Figure 6.5(4) illustrates the revised ZVI.
6.5.4 of the ES 1.1.3 and Table 5 in Technical Appendix D	Units on the corner of Victoria Street North entrance and Bressenden Place Services have been identified as one of the key receptors in the ES.	6.5.9	The Victoria Street north entrance and associated stairs into the NTH and lift will not be built.
6.5.8 of the ES 1.2.2 in Technical Appendix D	The Corner Site entrance leads down to the NTH and is located on the corner of Bressenden Place and Victoria Street. The Cardinal Place entrance will also lead down to the NTH and is located on the opposite side of Bressenden Place.	6.5.9	The Victoria Street north entrance and associated stairs into the NTH and lift will not be built.
6.5.10 of the ES Table 11 in Technical Appendix D	The following significant residual effects during the construction period after mitigation: • deterioration in views for office workers in Portland House, Cardinal Place and Terminus Place, Victoria Palace Theatre goers, users of Victoria Station and pedestrians on Bressenden Place and Wilton Road; and • adverse effect on townscape character due to the erection of hoardings, the felling of three trees and the temporary removal of Little Ben clock tower.	6.5.20 – 6.5.24	ES identified no significant residual effects and this remains the position after the changes to the scheme have been taken into account. The effects arising from construction are minor in nature, temporary and will be mitigated: The Vauxhall Bridge Worksite has been substantially reduced in size from the one described in the ES. The magnitude of effects on visual receptors and townscape character is reduced from the effect assessed in the ES and is now minor negative. The significance of effect on visual receptors and townscape character has changed from moderate adverse to slight adverse. The utility enabling works will overlap with the main construction works for a short period. The effect of these works on the high sensitivity receptors who have a view of the works will be minor negative and the

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
			significance is slight adverse. The magnitude of effects on townscape character is minor negative and the significance of this effect is slight adverse. The structural support works will necessitate footway diversions and additional hoarding around the works. The significance of visual effects on the Victoria Station Character Area will remain as moderate adverse as assessed in the ES. The loss of three plane trees in Vauxhall Bridge Road will have an intermediate negative impact on townscape character as there are few street trees in this area and the existing trees help reduce the detrimental effect of the existing central traffic islands and railings. However the trees have not received regular formative pruning and consequently are of poor form and their roots have noticeably deformed the pavement surface. The trees are visible from north and south along the street. The significance of this effect is slight adverse.
6.5.12 of the ES 5.4.1 in Technical Appendix D	The mitigation measures include: • the use of high quality materials – glass, metal, concrete and stone – in the design of the structures to reflect the surrounding diversity of both contemporary and traditional materials; • the arrangement of the structures to complement the surrounding townscape and highlight landmark buildings; • the improvement of the arrangement of 'the Beach' to clarify the design of the area so that it can become an area of open space; and • the replanting of trees lost during construction to complement the new structures and surrounding townscape.	6.5.28 – 6.5.29	Mitigation measures as a result of design changes include: The trees in Vauxhall Bridge Road will be replaced with plane trees which have received careful formative pruning and will consequently be of an improved form. The structural support works will be carried out as quickly as possible with footpath diversions in place to maintain accessibility for pedestrians. Hoardings will be maintained in orderly condition.
6.5.13 of the ES Table 12 in Technical Appendix D	The scheme will result in the following significant residual beneficial effects during operation: • the high quality of the design of above-ground structures will enhance the townscape character; • the re-design of 'the Beach' will improve visual amenity for a number of visual receptors; and • the legibility of the study area will be improved with a reduction	6.5.25 – 6.5.27	Updated effects of the scheme on townscape and visual amenity during operation are described below: The omission of the Victoria Street North Entrance stairs will enable the area to be temporarily landscaped and so have an intermediate positive effect on visual amenity. The revised design of 'The Beach' reduces the number of structures.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
	in clutter on 'the Beach' and improved signage at the new station entrances.		There will be an intermediate positive effect on visual amenity from the changes. The structural support works required for the Duke of York public house will have a neutral impact on the Station Character Area. The significance of this effect is neutral.
6.6.4 of the ES	In addition, London Underground considered it prudent to design a building that could occupy the corner site in such a way that demonstrates successful integration of the above ground elements of VSU in this location, fully respects the setting of the VPT and the locality generally and which conforms to the Victoria area planning brief. This is subject to a separate planning application.	2.5.2	The London Underground applications for planning permission and listed building consent to redevelop 120-124 Victoria Street and 3-11 Bressenden Place have now been withdrawn. The VSU Site Reinstatement Strategy explains how London Underground will deal with those sites where buildings will be demolished for the purposes of the works. Section 2.5 provides a description of the site reinstatement strategy. The strategy is included in Appendix D.
6.6.11 of the ES	The works are not in a conservation area however, the Westminster Cathedral and Grosvenor Gardens Conservation Areas are nearby.	6.6.25 6.6.26	Paragraphs 6.6.25 – 6.6.26 discuss about built heritage baseline for the Cathedral Conservation Area. In the light of the changed proposals for the Bressenden Place site more information is given here on the character and appearance of the affected parts of the Cathedral Conservation Area.
6.6.26 of the ES 5.2.23, 5.2.25, 5.2.33-5.2.37, 5.3.12, 5.3.20, 5.6.4, 5.6.9, 7.2.1 in Technical Appendix E	Construction effects on the built heritage are discussed in this paragraph. Particularly significant (Psig) adverse settlement effects have been identified at the Victoria Palace Theatre and significant (Sig) potential settlement effects at the Apollo Theatre and Victoria National Rail Station (Eastern). Mitigation at the Apollo and National Rail station will be by robust construction methods to limit movements. Mitigation at the Victoria Palace Theatre will be primarily underpinning by ground improvement and additional tunnelling techniques to minimise volume loss such as pipe arches, grouted spiles, limiting advance length and sequential excavation. These actions will reduce ground movements to non-significant. However cautionary protective measures and	6.6.13 – 6.6.16	It is considered that mitigation measures should be provided at two locations within the footprint of the VPT: • at the junction of the theatre and the Duke of York public house, below the southwest corner of the auditorium, and • adjacent to the front wall abutting Victoria Street and in particular the delicate faience and the stone finishes of the interior. The reduction in building movement which is required is relatively small since without protective measures the potential damage category varies from 'slight' to 'negligible' (Engineering building damage classification). Several options have been considered for these mitigation measures. These options included underpinning of the affected areas of the building by either jet grout columns, or the creation of a reinforced concrete raft, the use of compaction grouting in the River Terrace

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
	strengthening works at the Victoria Palace Theatre will remain potentially significant (Sig) pending further development.	6.6.28 – 6.6.30	Deposits beneath the building foundations, or the reduction of ground movements at source by 'in-tunnel' mitigation measures. With the proposed mitigation measure above, the residual effects of settlement on the Victoria Palace Theatre will be non-significant. The reduction in the depths of the NTH and STH and the deletion of the CTP tunnel and associated air ducts in the PAL will all reduce ground movements. However these changes will not be of such a magnitude that similar mitigations to those described in ES Technical Appendix E Built Heritage to the ES will be changed and these will still apply. The impact on the VPT from ground movements will not be significant. The moving of Shaft #9 from out of Vauxhall Bridge Road to a location adjacent to the NTH will result in a beneficial change as it will reduce the effect on the Westminster Cathedral Conservation Area as the work will be within the NTH construction site. Additional construction effects on the built heritage due to design changes are discussed in paragraphs 6.6.29 and 6.6.30.
6.6.30 of the ES 5.2.32, 5.2.39, 6.2.2, 7.2.4 in Technical Appendix E	A potentially significant adverse effect on the setting of the Victoria Palace Theatre has been identified from demolition of numbers 120-124 Victoria Place and 3 to 11 Bressenden Place. The area will be occupied in part by the ventilation housing and the entrance of the North Ticket Hall. These structures will be designed to stand alone architecturally and structurally with no detriment to the setting of the area. Areas of the site not used by the ticket hall will be screened off or hard landscaped. The flank wall of the theatre exposed by demolition will be appropriately clad with an architectural finish. It is considered that with these actions the effect on the setting of the theatre compared to the baseline is non significant (Nsig).	6.6.18 – 6.6.19	An interim landscaping scheme has been developed for the sites of buildings to be demolished to the east of and behind the VPT. The interim landscaping scheme would be implemented pending a redevelopment on these sites individually or as part of a larger scheme. The Site Reinstatement Strategy indicates the form of a building that could be built in this location. Such a building will affect views from and of the upper part of Carlisle Place and the modern frontages along Victoria Street as far as Vauxhall Bridge Road, which are part of the Westminster Cathedral Conservation Area. It will also affect the setting of the Grade II listed VPT. It is not considered that there are any changes which will impact on the Grosvenor Gardens Conservation area. The Site Reinstatement Strategy outlines the proposals for the redevelopment and interim site restoration proposals of the site next to the VPT which will be a significant enhancement to the setting of the VPT.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
6.6.31 of the ES 5.2.32, 6.1.1, 7.3.1 in Technical Appendix E	The worksite for the North Ticket Hall and Corner Site Development will have an adverse significant residual temporary effect on the Victoria Palace Theatre.	6.6.21 6.6.32	There will be considerable utility diversions to enable the VSU project and these will occur in the streets around the listed buildings. The work will be carried out sequentially in small areas to allow traffic and pedestrian flow and the main construction works. The proposed utility works will not affect the setting of the VPT. They are to be located on part of the boundary of the Cathedral Conservation Area, also near to the Apollo Theatre and Victoria National Rail station. However, it is considered that there is sufficient vehicular and pedestrian activity as well as street furniture and other visual distractions in these areas, for the works not to have a significant effect on the settings of these heritage features. The newly exposed VPT flank and the rear walls of the VPT would be sympathetically clad. It is considered that the interim landscaping of this site will form an agreeable green backdrop to views from Carlisle Place and into Carlisle Place from Bressenden Place and will be a beneficial change. It will enable the clad return and sign on the first few metres of the flank wall of the VPT, to be clearly visible from further up Victoria Street. It will also extend the views of its cupola and help to soften the rest of the flank wall of the theatre, which was not intended to be seen when built. With a careful design, it is considered that the overall impact will be beneficial.
6.6.34 of the ES 5.3.19, 5.6.8, 6.2.1, 6.2.2, 7.4.1–7.4.3 in Technical Appendix E	An adverse significant (Sig) residual effect has been identified on the setting of Victoria National Rail Station (Eastern) from the two new air vents and the new Wilton Road entrance in the area of the forecourt known as ‘the Beach’ (area bounded by Wilton Road, the Victoria National Rail Station (Eastern) façade and Terminus Place). The same structures are considered to have a significant permanent residual effect on the setting of the Apollo Theatre.	6.6.31 6.6.35	As noted in the ES, an adverse significant effect had been identified on the setting of the National Rail station (eastern) and to a lesser extent of the Apollo Theatre from the air vents and the new Wilton Road entrance in the area of the forecourt known as ‘The Beach’. This was considered non-significant when considered relative to the existing situation. Since the ES development work has continued and the ventilation and the entrance have been combined into a single high quality structure. However the constraints below ground and the necessity for this entrance make its location unavoidable. Further explanation on the assessment of the effect on the setting of National Rail station is provided in paragraph 6.6.35.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
6.6.35 of the ES 5.2.23, 7.3.2, 7.4.4 in Technical Appendix E	At present, the residual effect from possible strengthening works to the Victoria Palace Theatre (potentially causing building settlement) is regarded as significant adverse (Sig). It is envisaged this will be reduced to non significant with further design development, and discussions and agreement with the relevant parties.	6.6.13 – 6.6.16 6.6.36 Table 6.6-1	It is considered that mitigation measures should be provided at two locations within the footprint of the VPT: • at the junction of the theatre and the Duke of York Public House, below the southwest corner of the auditorium, and • adjacent to the front wall abutting Victoria Street and in particular the delicate faience and the stone finishes of the interior. The reduction in building movement which is required is relatively small since without protective measures the potential damage category varies from 'slight' to 'negligible' (Engineering building damage classification). Several options have been considered for these mitigation measures. These options included underpinning of the affected areas of the building by either jet grout columns, or the creation of a reinforced concrete raft, the use of compaction grouting in the River Terrace Deposits beneath the building foundations, or the reduction of ground movements at source by 'in-tunnel' mitigation measures. With the proposed mitigation measure above, the residual effects of settlement on the Victoria Palace Theatre will be non-significant. The scheme changes have resulted in improvements to the effects on built heritage identified in the ES. This has led to the reduction of significant residual effects to non-significant, during both construction and operation. Refer Table 6.6-1 for further details.
Section 5 in Technical Appendix E	Reference to description of proposed works and construction activities in Section 5 of Technical Appendix E.	Annex V	Description of works and construction methodology have been updated. Refer Annex V – *Description of Works for Utilities Diversions and Main Construction Works* in the SES.
6.7.5 of the ES	The VSU scheme itself does not lie in a Conservation Area but lies adjacent to the Westminster Cathedral Conservation Area.	6.7.11	The archaeology and cultural heritage baseline remains the same as in the ES with one exception, the enabling works area for the advance utilities diversions now extends into the Westminster Cathedral Conservation Area.
6.7.19 of the ES	Some of the works affecting baseline include: Excavation for the cut and cover and piled box at the new NTH in Bressenden Place would completely remove potential	6.7.7	Some of the works affecting baseline as a result of design change include: The extent and depth of the excavation for cut and cover and piled box

Main Changes Matrix			
ES Para	**Original Text**	**SES Para**	**New Text**
6.1.1 in Technical Appendix F	archaeological remains within its footprint; Excavation for a crane base currently proposed to the west of north ticket hall box that requires piled foundations would partially or completely remove potential archaeological remains within its footprint Excavation for a pump shaft in Vauxhall Bridge Road would completely remove potential archaeological remains within its footprint; Jet grouting in Allington Street, Wilton Road, Vauxhall Bridge Road and Victoria Street although not removing archaeological remains would have a major effect on archaeological remains as the information value of any archaeological features would be lost by consolidating the deposits to a degree which prevents future access and investigation. Any organic remains could also be affected by grouting depending upon the chemical composition of the material used. Closely spaced injection positions could lead to extensive near surface disturbance (Davis et al 2004). Service diversions and new service trenches are likely to partially or completely remove potential archaeological remains.	6.7.9	for the NTH has been reduced. Although this is within the footprint of the NTH as proposed in the ES. Excavation for a crane base to the west of NTH box that required piled foundations is no longer needed Excavation for a pump shaft in Vauxhall Bridge Road is no longer needed. Additional areas identified for jet grouting Enabling works areas for service diversions and new service trenches have altered.
6.7.21 – 6.7.26 of the ES 7.1, 7.3.7-7.3.8 in Technical Appendix F	Mitigation and residual effects – construction	6.7.14 – 6.7.15	Additional location (i.e. Bressenden Place) for significant residual effect on archaeology and cultural heritage from jet grouting has been identified. The supplementary mitigation identified for this effect is the archaeological evaluation prior to grouting and dissemination of results to enhance public appreciation through publication or seminar.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
Section 9 in Technical Appendix F	Section 9 - *Assessment of Cumulative Effects (Archaeology and Cultural Heritage)*	Sections 7.3 – 7.8 of the SES Table 1.1 in Annex VII	Information which has become available since the submission of the ES has been included in cumulative effects assessment in the SES. This information comprised the environmental effects resulting from the scheme changes ands design and construction information on other proposed schemes within the vicinity of the VSU scheme. Refer Sections 7.3 – 7.8 of the SES and Table 1.1 in Annex VII for the updated assessment of cumulative effects.
6.8.14 of the ES 4.1.1 in Technical Appendix G	One of the buildings to be demolished include the electricity Substation in Allington Street.	2.2.6	The buildings to be demolished as part of the development of the scheme are those mentioned in Section 2 of the ES with the exception of the electricity substation in Allington Street which will now be retained.
6.8.16 of the ES 4.2.4 in Technical Appendix G	The overall volume of excavated material from the tunnels and station boxes during the construction phase will be approximately 171,500m^3.	6.8.4 – 6.8.6	The anticipated overall volume of excavated material from the tunnels and station boxes during the construction phase has reduced from approximately 171,500 m^3 (as outlined in the ES) to approximately 159,471m^3. The overall volume of excavated material from utility works is also calculated in the SES.
6.9.8 of the ES 3.3.1 in Technical Appendix H	Made ground: (Source cut and cover spoil from the Circle and District line, Grosvenor Canal basin infilling): The made ground was noted to contain clinker and ash;	6.9.7 – 6.9.12	Since the publication of the ES, further ground investigations have been carried out. The results of this investigation appear to broadly concur with the published geology and the findings of the previous intrusive site investigations as described in the ES. • Made ground was encountered in all exploratory holes. The composition of the made ground varied at each location and comprised mixtures of sandy gravel, gravely sand and gravely sandy clay, where the gravel size fragments comprised brick, flint, concrete and clinker. Refer paragraphs 6.9.7 – 6.9.12 for further details of the ground investigation.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
6.10.17-6.10.22 of the ES 6.1.1-6.2.5 in Technical Appendix I	Mitigation and residual effects – construction and operation	6.10.7 – 6.10.9	There are no changes to the prediction of impacts and effects on Water Resources arising from the scheme changes. The utilities diversions will increase the amount of open trenching taking place with the attendant risks of wash off of material from spoil in the event of heavy rain or the possible need for some short term local dewatering if any perched groundwater or leaking services are encountered. These potential impacts are standard for this type of work and application of the CoCP will result in there being no significant impacts during the construction phase. The basement of the Apollo Theatre will have additional pumping capacity installed to ensure that there is no residual effect**.**
6.11.4 of the ES	The ZoI for the development covered in this assessment is a maximum of 2ha, this includes direct land take of less than 1hectare (ha) at Bressenden Place.	6.11.3	The Zone of Influence (ZoI) as described in the ES has been widened to include scheme changes.
Table 6-12 of the ES	Table 6-12 – Valued Ecological Resources within ZoI	6.11.6	In addition to the VERs already identified within the ZoI in the ES, the following trees likely to be affected by the utility works are also considered VERs. • Three plane trees *Platanus x acerifolia* in Vauxhall Bridge Road, and; • One plane tree in Warwick Row.
6.11.21 of the ES	The design of the VSU will include as a minimum the replacement of the three trees which will be removed as part of the works. The potential for further tree planting will be investigated to promote ecological enhancement and allow for potential failure of newly planted trees.	6.11.8	The changes brought about by the new construction programme are not likely to significantly change the VER assessment in the ES. However, an additional three plane trees are likely to be affected through the utility programme of works and may potentially be lost. It is however noted that there will be no significant residual effects, or corresponding supplementary mitigation required for ecology from the scheme changes.
N/A	N/A	6.12.11	Potential effects of structural support works were not previously assessed in the ES, however, they have been assessed in the SES. Further information on the structural support works since the submission of the ES has resulted in certain buildings being deemed unusable. The process for calculating employment loss in this SES is

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
			repeated, to include these buildings. A list of these buildings is shown in Table 6.12-1.
6.12.16 – 6.12.18 of the ES 7.1.2-7.1.9, Table 10 and Section 7.4, 8.2.1-8.2.2 in Technical Appendix J	Mitigation and residual effects – construction The total direct impact on jobs is an overall loss of 203. , Further, there is a total of 292 jobs created (195 direct through the construction process and a further 97 indirect).	6.12.12 – 6.12.18	The total direct impact on jobs is an overall loss of 425. The numbers have increased from the ES because of the inclusion of the buildings to be underpinned and more detailed information on the footprints of buildings being demolished. However, this is not considered to be significant in the context of the local economy, which supports over 500,000 jobs. Table 6-8 compares the numbers of job losses/gains as a result of the construction between the ES and the SES. Refer paragraphs 6.12.12 – 6.12.18 for further details of construction effects.
6.12.21 of the ES 7.2.2-7.2.4, 7.2.8, Table 11 and Section 7.4, 8.3.1-8.3.2 in Technical Appendix J	Mitigation and residual effects – operation There will be a total of 964 jobs created as a result of the VSU. This will be a slight residual positive benefit to the VSU project. However, it is not considered significant. This is set against the context of the Westminster economy that already is home to over 500,000 jobs.	6.12.22 6.12.23	Total numbers of jobs created in the operational phase will be 762. This is not considered to be particularly significant in the context of the local economy, which supports over 500,000 jobs. Initial passenger flow and passenger use calculations had included two ticket windows in the new NTH. However, design changes have now removed those ticket windows from the NTH. It is unlikely that there will be any additional socio-economic impact resulting from these design changes.
6.12.22 of the ES 7.2.5, 7.2.7, 7.5.4, Table 15 in Technical	In addition there may also be new employment opportunities created directly by the construction of the proposed Corner Site Development over the new north ticket hall. Using the information available on floor area, we calculate that 398 jobs may be created. Applying a multiplier indicates that a further 199 jobs will be created. However, this will be the subject of a separate planning application. This has been documented here to explain cumulative effects following the proposed demolition	7.7.6	Employment opportunities created directly by the construction of the CSD were not considered in the socio-economic assessment in the SES. The assessment of cumulative effects in paragraph 7.7.6 of the SES concludes that the job creation in the area will be significantly boosted by the VSU and the VTI or Bressenden Place Redevelopment schemes.

Main Changes Matrix			
ES Para	**Original Text**	**SES Para**	**New Text**
Appendix J	of the existing offices on site.		Refer Sections 7.3 – 7.7 for the updated assessment of cumulative effects.
Table 6-17 of the ES Table 4 in Technical Appendix K	Table 6-17 – Key Residential Areas	6.13.12 Table 6.12-1	Table 6.12-1 updates residential areas to reflect the permeable community boundary for indirect effects.
6.13.17 – 6.13.19 of the ES 6.1.2 & Table 6 in Technical Appendix K	Mitigation and residual effects – construction	6.13.15 – 6.13.24	The ES identified no significant residual direct community effects and this remains the position after the changes to the scheme have been taken into account. The significant residual positive and negative indirect effects on the community are all included under the relevant sections of the SES. The utilities works may result in service outages at certain times. This is expected to be localised and infrequent in any one particular area. Although facilities at the underground station will be affected, the community will still be able to use it. Therefore, there are no significant effects in terms of service provision to the community. Refer paragraphs 6.13.15 – 6.13.24 for further details on direct and indirect effects during construction.
6.13.21 of the ES 6.3.1 & Table 7 in Technical Appendix K	The operational scheme will result in the closure of the pedestrian subway at the south end of Bressenden Place at its junction with Victoria Street. However, this closure of a public right of way will not result in any significant negative impacts for the community as the street level pedestrian crossing will be retained. Additionally, the original subway did not provide step free access so was not suitable for all community receptors, for example PRM.	6.13.25 6.13.29	There will be no loss of permanent residential accommodation; no permanent closure or loss of key community facilities and the road and pedestrian access network will be retained as per pre-construction. Therefore there are no direct effects on the community of the scheme in the operational phase. It is also noted that the local community should benefit from the operation of the scheme. Reduced pedestrian congestion in the local area that should result will make it easier to move round and access local facilities.
Tables 9 and10 in	Table 9 – *Summary of Construction Effects on the Community*	Table 8-1	Tables 9 and 10 in Technical Appendix K have been updated.

Main Changes Matrix

ES Para	Original Text	SES Para	New Text
Technical Appendix K	Table 10 – *Summary of Operational Effects on the Community*	Table 8-2	Tables 8-1 and 8-2 identify the significant residual adverse and beneficial effects from both the construction and operation of the VSU scheme incorporating the design changes.
Table 7-1 of the ES	Table 7-1 – *Summary of Combined Residual Effects from Construction*	Table 8-1	Table 8-1 in the SES supersedes Table 7-1 in the original ES which summarises the combined residual effects during construction.
Table 7-2 of the ES	Table 7-2 – *Summary of Combined Residual Effects during Operation*	Table 8-2	Table 8-2 in the SES supersedes Table 7-2 in the original ES which summarises the combined residual effects during operation.
7.2.6-7.2.8 of the ES	Paragraphs 7.2.6 – 7.2.8 describe combined effects during construction.	7.2.5	Paragraph 7.2.5 supersedes paragraphs 7.2.6-7.2.8 of the ES in its entirety
7.2.11-7.2.12 of the ES	Paragraphs 7.2.11 – 7.212 describe combined effects during operation.	7.2.8	Paragraph 7.2.8 supersedes paragraphs 7.2.11-7.2.12 of the ES in its entirety.
7.3.3 -7.3.4 of the ES	The planning team undertook a comprehensive review of the above schemes. Table 7-3 summarises the planning review and explains which schemes have actually been assessed with reasoned justification. It should be noted that based on the review the District and Circle line Upgrade was itemised as a separate entity and not part of the VTI project and Victoria Coach Station was deleted as there are currently no planned works. The review also added Abford House, Pimlico School redevelopment and the planning brief for Victoria Street, Buckingham Gate and Palace Street.	7.5.3 – 7.5.4	Paragraphs 7.3.3 – 7.3.4 of the ES have been superseded by paragraph 7.5.3 – 7.5.4 in the SES. Programme information has been received on Wilton Piazza, Howick Place, Abford House, Pimlico School Development and the Victoria Street, Buckingham Gate and Palace Street schemes since the submission of the ES. This information identifies that these schemes will become operational prior to commencement of the VSU construction works. As this information was not available at the time of the ES, they were included as schemes for potential inclusion in the cumulative assessment with the VSU scheme. They have therefore been included in the baseline of the main assessments for the SES and excluded from the cumulative effects assessment.
Table 7-3 of the ES	Table 7-3 – *Planning Review of Projects*	Table 1.1 of Annex VII	Table 1.1 of Annex VII in the SES supersede Tables 7-3 in the ES.

Main Changes Matrix			
ES Para	**Original Text**	**SES Para**	**New Text**
7.3.5 7.3.7 of the ES	The review conducted by the planning team set the remit for the cumulative effects assessment. The assessment has focused on the interaction between the VSU and the VTI projects. The other projects are considered to either be in the early planning stages or are programmed for completion before the commencement of the VSU works. The VSU is proposed for construction from 2009 to 2015 and the VTI from 2010 to 2019. They are both major construction projects within a similar area. The VTI focuses on above ground works and the VSU on below ground works.	7.6	Section 7.6 of the SES supersedes paragraph 7.3.5 and 7.3.7 of the ES.
Table 8-1 Table 8-2 of the ES	Table 8-1 – *Summary of Construction Effects* Table 8-2 – *Summary of Operational Effects*	Table 8-1 Table 8-2	Tables 8-1 and 8-2 in the SES supersedes Tables 8-1 and 8-2 in the ES
Technical Appendix A	Traffic and Transport Technical Appendix A in Technical Appendices Volume 1 to the ES	Technical Appendix A	Traffic and Transport Technical Appendix A in Technical Appendix Volume 1 to the SES supersedes the Traffic and Transport Technical Appendix A in Technical Appendices Volume 1 to the ES
Technical Appendix B	Noise and Vibration Technical Appendix B in Technical Appendices Volume 2 to the ES	Technical Appendix B	Noise Technical Appendix B in Technical Appendix Volume 2 to the SES supersedes the Noise and Vibration Technical Appendix B in Technical Appendices Volume 2 to the ES.
Figures			
Figure 1.1	Figure 1.1 – Site Location Plan	Figure 1.1	This figure in the ES is superseded by Figure 1.1 - Site Location Plan – replacement.
Figure 1.2	Figure 1.2 – Plan of Proposals	Figure 2.1	This figure in the ES is superseded by Figure 2.1 - Scope of works.
Figure 1.3	Figure 1.3 – 3D Visualisation of the VSU Scheme	Figure 2.4	This figure in the ES is superseded by Figure 2.4 - 3D visualisation.
Figure 2.2	Figure 2.2 – Developments within Proximity of VSU Scheme	Figure 2.2	This figure in the ES is superseded by ES 2.2 – emendation.
Figure 2.3	Figure 2.3 – Buildings to be Demolished or Underpinned	Figure 2.3	This figure in the ES is superseded by ES 2.3 – emendation.

Main Changes Matrix			
ES Para	**Original Text**	**SES Para**	**New Text**
Figure 2.4(1) – 2.4(6)	Figure 2.4(1) to 2.4(6)– Construction Worksites (Phase 1)	Figure 6.2(14) – 6.2(40)	This figure in the ES is superseded by Traffic management plans 6.2(14) to 6.2(40).
Figure 2.5(A1-1) - 2.5(A6)	Figure 2.5(A1-1) to Figure 2.5(A6) Utilities Worksites	Figure 6.2(14) – 6.2(40)	This figure in the ES is superseded by Traffic management plans 6.2(14) to 6.2(40).
Figure 6.2(5)	Figure 6.2(5) – Existing Taxi Provisions	Figure 6.2(6)	This figure in the ES is superseded by Figure 6.2(6) in the SES.
Figure 6.2(6)	Figure 6.2(6) – Main Pedestrian Routes, Existing Pedestrian Crossings and Subway Locations	Figure 6.2(2)	This figure in the ES is superseded by Figure 6.2(2) in the SES.
Figure 6.2(7)	Figure 6.2(7) – Existing Parking and Loading Provisions	Figure 6.2(11)	This figure in the ES is superseded by Figure 6.2(11) in the SES.
Figure 6.5(2)	Figure 6.5(2) – Key Visual Receptors	Figure 6.5(4)	This figure in the ES is superseded by Figure 6.5(4) in the SES.
Figure 6.5(3)	Figure 6.5(3) – Listed Buildings and Zones of Visual Influence	Figure 6.5(4)	This figure in the ES is superseded by Figure 6.5(4) in the SES. (Fig 6.5(4) in the SES is a combination of ES Fig 6.5(2) and Fig 6.5(3) included in the ES)
Figure 6.6(1)	Figure 6.6(1) – Location of Listed Buildings and Settlement Contours	Figure 6.6(5)	This figure in the ES is superseded by Figure 6.6(5) in the SES.
Figure 6.7(3)	Figure 6.7(3) – Potential Impacts on Archaeological and Cultural Heritage	Figure 6.7(1)	This figure in the ES is superseded by Figure 6.7(1) in the SES.
Figure 7.1	Figure 7.1 – Combined Residual Effects during Construction	Figure 7(1)	This figure in the ES is superseded by Figure 7(1) in the SES.
Plate 2.1	Plate 2.1 – *Tunnels and Shafts Reference Plan*	Figure 2.3	Plate 2.1 of the ES is superseded by Figure 2.3 – VSU Project Naming Convention of the SES.

Annex III Consultation Terms of Reference

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CONSTRUCTION COMMUNITY LIAISON GROUP
INDICATIVE TERMS OF REFERENCE

Introduction

This document provides indicative Terms of Reference for the VSU construction Community Liaison Group (CLG). The CLG, which will be formally inaugurated if and when the Project obtains TWAO Powers and the preferred contractor is appointed, is intended to operate throughout the duration of the construction works and will provide an opportunity for Interested Parties to address issues of mutual interest regarding the construction of the VSU. *It should be noted that the terms of reference outlined below are indicative only at this stage, but will be firmed up and agreed following the appointment of the main contractor for the proposed works.*

Purpose

The CLG will be convened to provide a forum through which:

- Interested Parties can raise matters of interest or concern regarding the construction works with the intent, where reasonably practicable, of resolving them in an open and transparent manner;
- VSU can provide Interested Parties with information on the progress of the project, including where practical, the provision of advance notice of any changes to work schedules or applications for consents (including those associated with management of construction noise under Section 61 of the Control of Pollution Act 1974);
- VSU can demonstrate the extent of compliance with any conditions imposed on the construction works, details of any complaints registered (e.g. through the project 'Helpdesk" service) and actions taken in respect of them.
- Interested Parties can report back on the perceived effectiveness (or otherwise) of implementation of the Project Code of Construction Practice (CoCP) and any other associated conditions.

Whilst the Group will not have any legal enforcement or decision-making role *per se*, it will provide a mechanism whereby relevant issues can be brought to the attention of the primary parties to the consents and agreements that govern the construction works, namely London Underground Limited (LUL), the City of Westminster (CoW) and the main contractor for the works.

Should any non-compliance with the CoCP or associated notices or consents be recorded (or perceived), the Group will provide a structured forum for addressing these issues, and identifying measures necessary for the contractor to remedy such non-compliance as soon as reasonably practicable. The Group therefore provides a key element of the governance process that allows such controls to function effectively.

In the event that the CLG (having particular regard to the CoCP) agrees to make a recommendation to LUL or the contractor in respect of the management of the Construction Phase, the responsible party will be expected to use reasonable endeavours to implement any reasonable recommendation in a timely manner. Should the project team decide that it could or should not adopt any such recommendation they shall notify the next CLG meeting of this fact, together with written reasons as to why this is the case.

Membership

Membership of the CLG will include, but may not be restricted to:

- The LUL Project Manager and/or Construction Manager and/or their representatives;
- One or more representatives of the main contractor
- One or more representatives of the Council of the City of Westminster
- Up to four representatives of local residents or residents associations,

Additional representatives of the above groups may be invited to participate from time to time where the CLG agrees that this would be beneficial. In addition consideration may be given to the involvement of representatives of other local organisations such as business organisations, schools etc who have an interest in the construction works.

The Victoria Interchange Group (VIG) shall have the primary responsibility for the selection of the residents' representatives and shall ensure as far as reasonably possible that the views of the whole of the residential community are represented. In the event that LUL concludes that a significant section of the residential community is not properly represented it reserves the right to co-opt additional representatives following consultation with all CLG members.

Administration

The Group will meet on a monthly basis from inauguration and then throughout the Construction Phase, or as otherwise agreed as work progresses. Members of the Group will be given a minimum of seven (7) days written notice of each meeting. Any member of the Group will also be entitled to request an extraordinary meeting on reasonable grounds by giving written notice of not less than 10 days to the Liaison Officer (except in an emergency in which case such notice can specify a shorter period).

Meetings will be chaired on a basis to be agreed by the CLG. A Liaison Officer appointed by the Project Team will attend all meetings and will be responsible for both organising the meetings and liaising with Interested Parties.

An agenda will be prepared for each meeting and agreed with the Chair, with all points to be raised at the meeting submitted in writing to the Liaison Officer 7 days before the meeting (at the discretion of the Chair), to allow time for all parties to prepare. Written minutes will be kept of each CLG meeting by the Liaison Officer which will record discussion and any decisions taken by the group. These will be circulated to all members of the Group within seven days of each meeting.

All meetings will be held at suitable facilities provided by the VSU project and within easy walking distance of the VSU Site.

Annex IV Design Changes Linked to Work, Shaft and Tunnel Numbers

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List of Contents

1 Introduction

This note summarises the VSU scheme footprint changes between the November 2007 TWAO application and the submission of the scheme's Supplementary Environmental Statement in August 2008.

The numbering system adopted for the various elements of the VSU project described below is consistent with the 'Proposed Works Project Naming Convention' shown in Figure 2.3 in the SES Volume of Figures.

2 South Ticket Hall

The third level basement is no longer required, and the STH will now therefore be constructed on two basement levels only. This change has been possible by rationalising the design (including mechanical and electrical elements) since November 2007, and relocating the interview / training room to the NTH.

A further change is the provision of a second lift providing step free access between the National Rail Station and the STH. This new second lift (A2) is located immediately adjacent to the previous single lift (A1).

The plan area of the STH has remained substantially unchanged since the November 2007 TWAO application.

3 North Ticket Hall

The following changes were made to the requirements of the NTH:

- ***Cooling the Tube Programme (CTP):*** Due to a change in the train braking strategy to be adopted for the future Victoria Line Upgrade (VLU) trains, the total cooling requirement at Victoria has been reduced by 50%. This has meant that a dedicated CTP plant room is no longer required within the NTH.

- ***EDF Powerlink D&C Traction Substation:*** Due to a requirement for the EDF Powerlink D&C Traction Substation to be upgraded to serve VLU trains, and therefore become operational before the NTH could be completed, EDF Powerlink will now upgrade the existing D&C Traction Substation. This is located immediately east of the existing Victoria D&C line ticket hall. The requirement to site a new traction substation within the NTH has therefore been removed.

- ***Compact Heavy Duty Escalators:*** LU instructed that the design of the NTH should now incorporate compact heavy duty escalators, rather than the standard heavy duty escalators that had been specified within the 2007 TWAO application. Compact heavy duty escalators have significantly reduced upper and lower machine chambers, thereby offering significant space savings.

- ***Removal of Ticket Windows:*** The ticket office suite has been removed together with its mess/kitchen, paper store and WC.

- ***Removal of NTH Entrance to the West of Bressenden Place***: Following LU consultation with Westminster City Council the stair and lift from the ticket hall up to the west side of Bressenden Place was removed from the design.

As a result of the above changed requirements, it has been possible to re plan the NTH to a significantly reduced footprint and depth.

The maximum internal width of the box has been reduced from 15.75 m to 14.66 m, and the lowest level of the station box has also been removed, giving a saving of 5.7 metres in depth.

The removal of the EDF Power link traction substation and the CTP plant room has also reduced ventilation requirements. This has allowed the mechanical plant room to be reduced in size by approximately 25%, and the ventilation core to be lowered by 7.5 metres.

The reduced ventilation core has been reconfigured and moved south by 12m at its north end and 16m at its south end. The core no longer accommodates the draught relief shaft which, above ground, will have a stand alone structure.

The previous design for the NTH had two parallel circulation routes - a plant area corridor and a fire-fighting corridor – at Level -2. These have now been combined into a single route. The relocation southwards of the ventilation core and fire-fighting stair within it lengthens the corridor, but this allows compliant 1:12 ramps along it, as opposed to the combination of ramps and stairs in the previous design.

The secondary firefighting/escape stair at the south west corner of the box has been deleted and the escape stairs now exit into the ticket hall, as opposed to street level in the previous design.

The redesign has now enabled a minimum 2.6m gap to be created for utilities between existing basements and the east side of the NTH box.

A pile exclusion zone of 5.6m has also been achieved from the extrados of the Western Deep Sewer (equivalent to twice the diameter of the sewer as required by Thames Water).

4 Paid Area Link

4.1 #8 (STH Escalator Shaft – (New Escalators 7-9)

This minor footprint change was required largely to allow an improved corridor for utilities to pass through the pinchpoint between the STH ‘cut and cover’ works and the basement of the adjacent Abford House.

This issue has been resolved by early provision of the north east corner of the cut and cover section, which provides a ‘trough’ to carry the utilities across the corner of #8 (cut and cover). The pile layout has changed slightly on the east side narrowing the foot print by about a metre.

4.2 Realignment of #29 (Allington Street Construction Shaft), #1b (Platform 3 Overpass) and #4b (PAL North)

This realignment followed the confirmation that it would be necessary to demolish Elliot House to construct #2 Fire Fighting Shaft, #10 NTH Escalator Shaft, and #1b Platform 3 Overpass.

Improved passenger flow, improved journey times, and reduced impact on stakeholders (including Land Securities and Thames Water) has been achieved by locally realigning the PAL by moving the junction between #1b (Platform 3 Overpass) and #4b (PAL North) marginally to the east.

4.3 Deletion of #15 (Escalators 10-12 UMC Access Tunnel)

This tunnel is no longer required as it has been confirmed that maintenance access to the Upper Machine Chamber of the new Heavy Duty compact escalators (10-12) can be achieved from within the floor of PAL#10 – NTH escalator shaft via an access door and stairway formed at the side of and in an enlarged section of PAL#10.

4.4 Height Reduced of #4a (PAL Centre) and #4b PAL North

Due to the changes to the CTP, there is no longer a requirement for cooling air to be transported through the invert of this section of the PAL. The enlarged invert of #4a and #4b has therefore been deleted.

The connections from the PAL invert into the crowns of the north and south Victoria Line platform tunnels have also been removed.

4.5 Marginal Realignment of #7(PAL Centre/IC Connection)

Development of the junction designs between PAL#7 and both the connecting existing Interchange Concourse and #4a (PAL Centre) has resulted in a minor realignment of this tunnel (due to the removal of the double curvature within the tunnel length).

4.6 Marginal Realignment of #13 (D&C WB PAL Interchange Stair)

Tunnel #13 has been reduced in cross-section to accommodate a maximum passenger area height of 2.4m at the tunnel walls. This has been done to reduce the extrados crown level of the upper part of #13 where a sewer has to cross. The tunnel meets with the D&C westbound connection (#31) which has restricted headroom due to the constraint of the sewers above which are gravity drains and so cannot be raised. The reduced cross-section has been maintained to the junction with PAL #5a as there is little point in changing half way down a staircase and the reduced cross-section will benefit the design of the complex #13/#5a junction.

This tunnel has also been reduced in length, giving the added benefit of increased clearance to the adjacent D&C line cut and cover tunnel.

4.7 Realignment of #31 (D&C WB Link Passage)

The D&C Westbound Link Passage (#31) has been reconfigured to facilitate the underpinning of 22 Terminus Place and 4 Victoria Buildings, reflect predicted passenger demand, and to allow a gravity sewer to traverse above.

4.8 PAL Vertical Alignment

The falls of the PAL tunnels have had to be amended because the internal sump was located in the now deleted small shaft connecting #20 (TCP-Tunnel) and #4b (PAL North). The PAL tunnel drainage is now directed to sumps in shaft #29 and a new sump off from #5b.

5 Other Shafts and Tunnels

5.1 Deletion of #20 (TCP Tunnel)

As described previously, due to a change in future train braking systems, the total cooling requirement at Victoria has been reduced significantly.

There is now no requirement to transport cooling air from a plant room housed within the NTH, and PAL#20 (TCP Tunnel) has therefore been deleted.

5.2 Addition of #35 (CTP Connection Pipe)

An approximately 150mm diameter pipe will be required between the NTH and the existing draft relief shaft. This is required to permit seepage water to pass from the NTH to the Cooling the Tube Programme (CTP) Air handling Units located on the Victoria Line platform tunnels.

5.3 Reduction in Size of #23 (D&C Cable Link)

As the existing D&C line Traction Substation will now be upgraded, and not relocated to the NTH, the direct current cabling to track section gaps has been removed from the project scope. This has resulted in the cable link tunnel from the NTH to the D&C line being significantly reduced in size.

5.4 Deletion of #14 (E&M Services Tunnel South)

This small E&M services tunnel has been deleted as an alternative service route has been incorporated within other existing elements of the design (principally through #11 (PAL/STH PRM Lift Shaft)

5.5 Changes Associated with the Relocation of #9 (New Sump)

5.5.1 Relocation of #9 (New Sump)

The reduction in plan footprint of the NTH has allowed Shaft #9 (New Sump) to be relocated to a position close to the reconfigured NTH with consequent rearrangement of links to the D&C drainage and the nearest street sewer. Traffic phasing plans will benefit from removing the shaft site from Vauxhall Bridge Road.

Sump #9 itself has been increased in plan area to allow its overflow capacity to be increased to 45 minutes, from the non compliant 15 minute capacity offered by the station's existing back sump, and the previously intended Sump #9 location in Vauxhall Bridge Road.

5.5.2 Deletion of #28 (Overflow to Western Deep Sewer), and Replacement with #32 Connection Pipe to Local Sewer System

In its new location adjacent to the NTH, the new sump #9 no longer overflows to the Western Deep Sewer. Connection #28 has therefore been deleted, and replaced with a connection to the local sewer system in Victoria Street (#32).

5.5.3 Deletion of #25 (TCP Cooling Water Pipe)

With the relocation of #9 (New Sump) and the change in CTP strategy, this connection is no longer required.

5.5.4 Relocation of #24 (D&C Drainage Connection)

This connection has been relocated to reflect the new position of #9 New Sump.

5.5.5 Addition of #34 (D&C Sump 9 / Cable Link)

Several sleeves of the order of 150mm diameter will be required for cabling, connecting #9 (New Sump) and the D&C Line running tunnel.

Rebuilding of Flexible Existing Tunnel Linings to North of Victoria Line Platform Tunnels

Preliminary analyses have shown that is unlikely that the existing flexible tunnel linings, which exist over an approximately 20m length at the immediate north end of the Victoria Line platform tunnels, will need to be rebuilt as a result of movements induced by construction of the VSU scheme.

Annex V Description of Works for Utilities Diversions and Main Construction works.

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1 Description of works for the utilities diversions and the main construction sites

1.1 Changes from ES

1.1.1 This Annex replaces and supplements subsection 2.8 and 2.9 of the ES

1.1.2 Paragraphs 2.8.1 – 2.8.14 remains and is not superseded by this Annex.

1.1.3 Plate 2.1 of the ES is superseded and replaced by Figure 2.3 of the SES.

1.1.4 Descriptions of clearances/interfaces with other structures for some of the tunnels and shafts in Table 2-3 of the ES is updated and superseded by Table 1-1 of this Annex. The other tunnels and shafts, which are not described in Table 1-1 of this Annex, have not been superseded and the description of their clearances and interfaces with other structures remain.

1.1.5 The M & E services Tunnel South (#14) and Tunnel Cooling Programme Tunnel (#20) have been removed as part of the scheme changes.

1.1.6 Paragraphs 2.8.15 – 2.8.38 of the ES are not replaced and remain.

1.1.7 The structures in paragraph 2.8.39 of the ES, where they are still required, will be constructed using spray concrete lining techniques.

1.1.8 Paragraph 2.8.40 – 2.8.43 of the ES is replaced and superseded by paragraphs 1.1 11 – 1.1.14 of this Annex respectively.

1.1.9 Paragraph 2.8.44 of the ES is superseded by paragraph 1.1.15.

1.1.10 Paragraphs 2.8.55 – 2.9.8, including Tables 2-4 and 2-5, of the ES are replaced and superseded by paragraphs 1.1.16 – 1.2.8, including Tables 1-2 and 1-3, of this Annex.

Table 1-1: Summary of Tunnels and Shafts		
Tunnel/Shaft Reference	**Description**	**Clearances/Interfaces with Other Structures**
NTH Escalator Shaft (#10)	The NTH escalator shaft (#10) houses the new bank of three heavy duty semi compact escalators that descend to the Victoria line platform level from the Victoria line overpass tunnel (#1) at the north end of the station. The shaft falls from a floor level of 92.98m at the Victoria line overpass tunnel (#1) to platform level. The NTH escalator shaft will consist of the upper machine chamber, inclined shaft and the lower machine chamber. Access to the UMC is provided via a stairs within an enlargement of the UMC tunnel.	**Victoria Line Platform Tunnels:** The escalator shaft is located between the two platform tunnels. The minimum clearance between the platform tunnels and the escalator shaft will be less than 0.5m. At the upper level of the shaft, a junction will be formed with the Victoria line overpass tunnel. At the lower level, the shaft will connect to the existing concourse tunnel leading passengers to both Victoria line platforms. The lower section of the shaft requires breakout of an existing cross passage and concourse tunnel, and the formation of a new cross passage.
New Sump (#9), D&C Drainage Connection (#25) and Cable Link (#34)	The new sump is required due to a clash between the new D&C westbound (WB) interchange stair (#13), the new D&C Underpass (#6) and the existing drainage pipes for the section of the D&C line to the east of the D&C underpass. The new sump (#9) will be located within a shaft adjacent to the NTH. Water from the D&C invert will be diverted through a drainage	**Victoria Street Sewer**: Existing D&C pumped wastewater discharges currently outfall to the Victoria Street Sewer. The proposed D&C pumped waste water outfall location, discharge rates and volumes will maintain a similar future drainage regime in the local sewer

Table 1-1: Summary of Tunnels and Shafts		
Tunnel/Shaft Reference	**Description**	**Clearances/Interfaces with Other Structures**
	pipe (#25) into the sump, with power and monitoring cabling fed through ducts cored between the D&C and shaft (#34). From the sump it will be pumped directly into the Victoria Street sewer (#32). The sump needs to be operational before construction of the D&C underpass, or construction of the D&C WB link passage piling works and the construction of the interchange tunnel (#13) begins. The M&E equipment will be located within the shaft above the sump with an access connection to the NTH. The shaft will be capped above the control room and backfilled to surface.	system.
D&C Eastbound Lift (#12a) and D&C Eastbound Stair Passage (#12b)	This lift shaft will allow step-free access from the Interchange Concourse level to the eastbound platform of the D&C line and down to Victoria line. The D&C eastbound stair passage	• **D&C Line:** The shaft will be located to the north of the D&C line platform. The large diameter upper section of the shaft will be constructed using sprayed concrete lining (SCL), using the wall of the D&C platform to prop the southern

Table 1-1: Summary of Tunnels and Shafts

Tunnel/Shaft Reference	Description	Clearances/Interfaces with Other Structures
	connects from the shaft to the eastbound platform of the D&C line.	side. The central section of the original passageway from the D&C eastbound to the Interchange Concourse will be removed to provide space for the lift and waiting area. The 1992 passageway from the D&C eastbound for the Interchange Concourse (passage 3/203) will be maintained as existing however passage movement along the tunnel will be restricted to suit the construction of the new link tunnel. • **Victoria Line:** At Victoria line platform level the lift will take up one of the existing cross-passages (5/216). • **Victoria Street Sewer:** The shaft will accommodate the existing sewer during and post construction. **Thames Water 30" Water Main:** The water main will be temporarily diverted during construction and will be reinstated

Table 1-1: Summary of Tunnels and Shafts		
Tunnel/Shaft Reference	**Description**	**Clearances/Interfaces with Other Structures**
		to its approximate existing location on completion of the shaft construction.
Cable Link from NTH to D&C (#23) & from Sump Shaft (#9) to D&C	A cable link is to be provided for the EDF power link cables from D&C line to the NTH and a separate supply to the sump pumps	The cable link connects between the D&C line and the North Ticket Hall and to the sump shaft.
D&C Westbound Link Passage (#31)	This tunnel provides a connection to the existing D&C platform from the new ticket hall.	• **D&C Line:** The D&C westbound link passage will interface with the westbound D&C platform tunnel. **Network Rail 30" Sewer/Thames Water Sewer:** The sewer will be diverted into a temporary location during construction and reinstated on completion of shaft construction.

Drilling a Core

1.1.11 It is proposed that Cable link from NTH to D&C line (#23) will be constructed by drilling a core.

Microtunnelling / thrustbore / coring

1.1.12 It is proposed to use microtunnelling or thrustbore and coring techniques for the following:

- D&C Drainage Connection (#25);
- Cable link from D&C to NTH (#23) and
- Cable link connection from D&C to Sump (#34).

Other Shaft Construction Methods

Secant Piles

1.1.13 The sump pump shaft (#9) will be excavated from within a contiguous ring of secant piles, through the water-bearing granular deposits to full depth within the clay and subsequently lined with an in-situ concrete lining.

Square Work

1.1.14 The lower section of PRM lift (#12a) will be constructed using square work.

Construction of Structural Elements

1.1.15 The Conceptual Design Statement for Structural Works (July 2007) is in the process of being updated and will provide an account of the works and construction methods associated with the development of the structural works required for the scheme.

North Ticket Hall

Description of Proposed Works

1.1.16 The proposed North Ticket Hall (NTH) is a 2-storey subsurface

structure located below Bressenden Place and the current location of Numbers 3-11 Bressenden Place and Numbers 120-124 Victoria Street which are to be demolished. The NTH is an irregular shape in plan with an approximate maximum length of 75m and 33m maximum width. It has a constant excavation depth of 13.9m from ground level (105.0mTD) to formation level (91.1mTD).

1.1.17 The proposed NTH is constrained on all sides by existing structures and the proposed future buildings of the Land Securities Commercial Development (LSCD). Portland House and the recently constructed Cardinal Place development lie along the eastside of the proposed NTH location and their basements are in close proximity to the proposed secant pile wall. VPT, Elliot House, the LU Draft Relief Shaft, Thames Water King's Scholar's Pond and Western Deep Level Sewers lie to the west side of the NTH.

1.1.18 Access to and from the NTH is proposed from a new entrance structure on the corner of Bressenden Place and Victoria Street adjacent to the Cardinal Place development. Access will be provided by stairs and PRM lift from existing street level (105.0mTD) to ticket hall level (99.8mTD).

1.1.19 A new ventilation shaft and fire and emergency access lift core is proposed along the western side of the NTH which will be accessed at street level. The new ventilation shaft will also be utilised for heavy plant access into the NTH.

1.1.20 The architectural design of the NTH aims to provide a large open space above the escalators between ticket hall and paid area link levels.

Construction Methodology

1.1.21 The proposed method of construction for the NTH is by top-down construction. The outline construction sequence is as follows:

i. Divert existing services in Bressenden Place to a temporary protectable location east of the NTH; some temporary diversions will be above ground level.

ii. Strengthen or install protection measures for adjacent buildings and sewers where required by the detailed deign.

iii. Install and commence instrumentation and monitoring of adjacent buildings and utilities. Some monitoring will have been installed as advanced works

iv. Demolish the existing 2-storey buildings located at 3-11 Bressenden Place, buildings at 120 and 124 Victoria Street, and the 6-storey building at 122 Victoria Street. Demolish and backfill

underpass and toilets under Bressenden Place.

v. Divert traffic to the east side of Bressenden Place.

vi. Install westside perimeter secant pile walls and western half of northside and southside perimeter secant pile walls.

vii. Install foundation (compression and tension) piles within westside of NTH with cut–off level at base slab level and steel columns (plunge piles) extending to roof slab level.

viii. Excavate to underside of roof slab level (approximately 102.8mATD).

ix. Construct the westside roof slab with connections to the secant pile walls and plunge columns and making provision for monolithic connection to the east side roof slab. Provide covered openings in roof slab for construction access.

x. Re-establish road and install permanent utility reinstatements above newly constructed west side roof slab and divert traffic to the west side of Bressenden Place.

xi. Repeat 6 to 9 for eastside temporary sheet pile wall, secant pile walls, foundation piles, plunge columns and roof slab forming monolithic connection with the west side roof slab.

xii. Re-establish road and install permanent utility reinstatements above newly constructed eastside roof slab and divert traffic back to the eastside of Bressenden Place.

xiii. Excavate beneath roof slab to Level -1 (ticket hall) slab formation level sealing any water ingress through the perimeter pile walls with shotcrete and/or grouting behind the wall.

xiv. Place Level -1 (ticket hall) slab and the diaphragm grillage and permanent steel props (at escalator position) with connections into the perimeter pile wall and internal plunge columns.

xv. Repeat 13 and 14 for Level -2 (station plant room).

xvi. Encase steel plunge columns with concrete to form permanent columns with necessary fire protection, form ventilated drainage cavity to all perimeter pile walls, construct internal non-load bearing walls and fit out station.

xvii. Construct new load bearing support wall within the existing Cardinal Place basement and demolish existing basement wall and roof slab within footprint of the Cardinal Place entrance stairs.

xviii. Install temporary sheet pile wall support system and excavate in bottom-up construction adjacent to the existing Cardinal Place basement to form the Cardinal Place entrance stairs and canopy above.

Clearances/Interfaces with Other Structures

1.1.22 Construction of the NTH will structurally impact the following existing structures:

- Cardinal Place (modification of part of the basement);
- LU Draft Relief Shaft (replacement superstructure); and
- Bressenden Place Public Subway (to be demolished).

Construction of the NTH is also likely to impact the following structures:

- VPT (Grade II Listed);
- Duke of York Public House (façade to be retained);
- Portland House;
- LU D&C line Brick Arch Tunnel;
- Thames Water Utilities King's Scholar's Pond Sewer; and
- Thames Water Utilities Western Deep Level Sewer.

NB: The design is based on the demolition of Elliot House to allow tunnelling of the Paid Area Link (PAL).

1.1.23 Impacts on the above structures are likely to occur due to ground movements, and noise and vibration associated with construction. Measures will be taken during construction to ensure that the works do not have a detrimental effect on the existing surrounding structures.

South Ticket Hall

Description of Proposed Works

1.1.24 The proposed STH is a 2 -storey subsurface structure located below 'the Beach' area of Terminus Place and partly below Wilton Road. The Beach is an area of public realm that lies in front of the National Rail Station. The STH extension is approximately triangular in plan with approximate maximum length of 38m and 40m maximum width. The station is a 2-storey substructure with an approximate excavation depth of 11.1m from ground level (104.5mATD) to formation level (93.4mATD).

1.1.25 The proposed STH is constrained on the southside by the existing mainline station building and on the eastside by traffic and utility requirements in Wilton Road. The STH will form an extension of the existing Victoria line ticket hall to the westside, part of which will be removed and replaced. Abford House and the Apollo Theatre lie along

the eastside of the proposed STH and their basements are in close proximity to the proposed secant pile wall. The Victoria line southbound running tunnel lies below the proposed STH.

1.1.26 Access to and from the new STH is proposed from the two existing staircases into the National Rail Station concourse - the 'Sussex' and 'Kent' Stairs – and relocated Wilton Road Stairs to street. The 'Sussex' Stairs will be widened and a new in-situ reinforced concrete wall provided. New PRM lifts will be constructed in reinforced concrete from the National Rail Station concourse to LU ticket hall level (100.18mTD) between the 'Sussex' and 'Kent' Stairs through the floor area currently occupied by Threshers. A new passageway from the STH to the D&C westbound platform level and the new Paid Area Link (PAL) tunnel level via a further PRM lift will also be provided.

1.1.27 The STH internal structure will be constructed with in-situ reinforced concrete throughout, with the exception of the roof which will be composite steel and reinforced concrete and the columns which are will be structural steel H-sections encased in concrete for the permanent works.

1.1.28 The new Wilton Road entrance will form an integral part of the STH between roof and ticket hall levels. The roof canopy structure is proposed to be constructed in structural steel, metal cladding and reinforced glass. The works will be phased to ensure that impact on the operation of the existing station will be minimised. New temporary stairs will be constructed from the current taxi lane, adjacent to the temporary ticket office on the NR station forecourt, down to the ticket hall to compensate for decommissioning of the Wilton Road stairs.

Construction Methodology

1.1.29 The proposed method of construction for the STH is a combination of bottom-up and top-down construction. The proposed outline construction sequence, incorporating construction of the cut-and-cover passageway connection to the westbound District and Circle line, is as follows:

i. Divert existing services in Wilton Road and Terminus Place to temporary and permanent locations and relocate mechanical and electrical (M&E) equipment within eastern rooms of existing ticket hall to be demolished.

ii. Construct temporary stairs from ground level to ticket hall adjacent to temporary ticket office. Relocate NR assets within NR basement forming part of the works. Form temporary NR entrance / exit through 'Boots' onto Wilton Road

iii. Strengthen or install protection measures for adjacent buildings and utilities (if necessary).

iv. Install and commence instrumentation and monitoring of Victoria line running tunnels, adjacent buildings and utilities. Some monitoring will have been installed as advanced works.

v. Underpin buildings in Terminus Place and construct section of link passage to westbound District and Circle line.

vi. Restrict Wilton Road to single lane and install perimeter secant pile wall to north east side of STH, together with tension piles/plunge columns where accessible. Construct part of roof slab adjacent to Wilton Road.

vii. Close Wilton Road install temporary sheet pile wall and complete perimeter secant piles to escalator collar and construct door frame slab. Start excavation and demolition to ticket hall level and reopen single lane of Wilton Road.

viii. Establish site in Terminus Place, install secant piles and construct northern section of link passage to westbound District and Circle line, including PRM lift shaft. Incorporate re-aligned sewer into roof slab, install remainder of new sewer line, connect to existing and commission, prior to reinstatement of road.

ix. Complete excavation to Level -1 (Ticket Hall Level), including demolition of the National Rail basement and existing ticket hall rooms, erecting a weatherproof barrier between the functioning area of the ticket hall and construction site.

x. Install perimeter secant pile wall to southern and western walls and tension piles/plunge columns, from Level -1 (Ticket Hall Level). Install and commission temporary deck in front of Network Rail arch.

xi. Install temporary beams on plunge columns just below ticket hall level. Cast RC slab at Level -1 (Ticket Hall Level), leaving escalator UMC open with appropriate propping.

xii. Excavate by top-down to Level -2 (Plant Room Level) and place RC floor/base slab. Install pipe arch for escalator shaft construction and cast columns at Plant Room level.

xiii. Reconfigure hoardings to incorporate southern section of link passage to westbound District and Circle line, install secant piles and construct passage.

xiv. Cast columns at Ticket Hall level and place roof slab. Construct new Wilton Road stairs and blockwork walls at both levels. Start architectural and Mechanical & electrical fit-out.

xv. Encase steel plunge columns with concrete to form permanent columns with necessary fire protection, form ventilated drainage cavity to all perimeter pile walls, construct internal non-load

bearing walls and fit out station.

xvi. Following completion of all major deliveries, close remaining openings in roof and ticket hall slabs and start waterproofing and reinstatement of ground level Beach area.

xvii. Approve, commission and open new Wilton Road stairs. Complete architectural and M&E fit out within ticket hall and surface features

xviii. Construct extension to 'Sussex' stairs.

Clearances/Interfaces with Other Structures

1.1.30 Construction of the STH will structurally impact the following existing structures:

- National Rail Station Building; and
- existing LU Victoria Line Ticket Hall
- Thames Water 30" trunk water main.
- Thames Water Wilton Road Sewer

1.1.31 Construction of the STH is also likely to impact the following structures:

- Apollo Theatre;
- Abford House;
- Southbound Victoria line running tunnel; and
- Northbound Victoria line running tunnel/ start of step plate junction.

1.1.32 Impacts on the above structures are likely to occur due to ground movements, and noise and vibration associated with construction. Measures will be taken during construction to ensure that the works do not have a detrimental effect on the existing surrounding structures.

Signalling Equipment Room

Description of Proposed Works

1.1.33 The proposed Signal Equipment Room (SER) is a single storey subsurface structure located in a new RC cut-and-cover structure above the Victoria line running tunnels north of the station platforms. The proposed SER will replace the existing SER located between the platform tunnels at the northern end of the station. The proposed SER is approximately rectangular in plan 12m long by 12m wide and an approximate excavation depth of 9.5m from ground level (104.5mTD) to formation level (95.0mTD).

1.1.34 The proposed SER location is constrained on the west side by the proposed Land Securities Commercial Development (LSCD), on the eastside by the existing King's Scholar Pond Sewer, and on the south side by the proposed London Fire and Emergency Planning Authority (LFEPA) shaft. The Stag Pub is adjacent to the proposed SER on the west side. The proposed SER is located above the Victoria line northbound running tunnel and in close proximity to the southbound running tunnel.

1.1.35 Permanent access to and from the proposed SER will be from access stairs within the proposed adjoining LFEPA shaft which will be accessed from a link tunnel to the NTH. As the SER is to be relocated at the start of the VSU scheme construction programme, ahead of completion of the NTH, temporary access to the SER will be provided from Victoria line platform level and up through the LFEPA shaft.

1.1.36 The location of the existing signal equipment room is currently a major constraint on the design of the proposed NTH Escalator Shaft (#10) for escalators 10-12 down to Victoria line platform level. The aim at detailed design stage is to optimise the design of this proposed escalator shaft to negate the need to relocate the SER.

Construction Methodology

1.1.37 The proposed method of construction for the SER is bottom-up construction. The proposed outline construction sequence is as follows:

i. Divert existing services in Bressenden Place and Allington Street.
ii. Strengthen or install protection measures to Victoria line running tunnels, adjacent buildings and utilities (if necessary).
iii. Install and commence instrumentation and monitoring of Victoria line running tunnels, adjacent buildings and utilities.
iv. Divert traffic in Allington Street and Bressenden Place as necessary.
v. Install perimeter secant pile walls.
vi. Dewater, excavate and install temporary props to formation level and install base slab.
vii. Install reinforced concrete columns and roof slab removing temporary props as necessary.
viii. Make connection into LFEPA shaft.
ix. Backfill over roof slab and reinstate ground/road surface above.
x. Form ventilated drainage cavity to all perimeter pile walls, construct internal non-load bearing walls and fit out room.

Clearances / Interfaces with Other Structures

1.1.38 Construction of the SER is likely to impact the following structures:

- LU Victoria line running tunnels;
- Thames Water King's Scholar Pond Sewer; and
- The Stag Public House.

1.1.39 The design is base on the demolition of Elliot House to allow tunnelling of the Paid Area Link (PAL).

1.1.40 Impacts on the above structures are likely to occur due to ground movements, and noise and vibration associated with construction. Measures will be taken during construction to ensure that the works do not have a detrimental effect on the existing surrounding structures.

Phasing of Utilities Works, Demolition and Construction Activities

1.1.41 Award of the main construction contract is planned for late 2009. Subject to this, main construction work would start in 2010. Utilities works are programmed to start in the spring/summer of 2009, with some advance traffic management works planned for spring/summer 2009. The main VSU scheme will take approximately seven years to construct. The works are proposed at a major London transport interchange. A complex (i.e. construction activities are not restricted to a single area of the site at any one time) and integrated construction methodology and programme has been prepared to ensure that the main transport function of the area can still operate in a safe and efficient manner. The major phases of the main works and target dates are listed and briefly explained below.

1.1.42 For the purpose of environmental assessment, the phasing of the utilities and main works has been simplified by apportioning construction activities into discrete phases (presented in Table 1-2 and Table 1-3). Note that in practice the main VSU works contractor may vary the way the works are implemented for practical, scheduling, environmental or financial purposes.

1.1.43 The phases relating to the main works together with the location of the respective worksites are illustrated on Figures 2.4(1) – 2.4(6) and therefore this table should be read in conjunction with these figures.

Table 1-2: VSU Scheme Main Works Construction Phases		
Work site	**Activities**	**Worksite Periods**
A	Erect hoardings	June ‘10
B	Erect hoardings	June ‘10
A1	Remove asbestos from properties to be demolished	July ‘10
B1	Remove asbestos from properties to be demolished	July ‘10
D1	STH enabling works & Boots entrance / exit	July ‘10
A1	Remove asbestos from properties to be demolished	Aug ‘10
B1	Remove asbestos from properties to be demolished	Aug ‘10
D1	STH enabling works & Boots entrance / exit	Aug ‘10
B1	Demolish 120-124 Victoria Street	Sept ’10 to Oct ’10
D1	STH enabling works & Boots entrance / exit	Sept ’10 to Oct ’10
A1	Demolition of Elliot House.	Nov ’10 to Dec ‘10
B1	Demolition of 3-11 Bressenden Place & complete demolition of 120-124 Victoria Street.	Nov ’10 to Dec ‘10
H	Remove asbestos from 175-179 Victoria Street & install crash deck over D&C line.	Nov ’10 to Dec ‘10
D1	STH enabling works & complete Boots entrance / exit	Nov ’10 to Dec ‘10
E1	Underpinning for westbound link passage to D&C.	Nov ’10 to Dec ‘10
F	Demolition/infilling of existing underpass and toilets in Bressenden Place.	Nov ’10 to Dec ‘10
A1	Demolition of Elliot House.	Jan ‘11

Table 1-2: VSU Scheme Main Works Construction Phases		
Work site	**Activities**	**Worksite Periods**
B1	Demolition of 3-11 Bressenden Place.	Jan ‘11
H	Install crash deck over D&C line.	Jan ‘11
D1	STH enabling works	Jan ‘11
E1	Underpinning for westbound link passage to D&C.	Jan ‘11
F	Demolition/infilling of existing underpass and toilets in Bressenden Place.	Jan ‘11
A1	Demolition of Elliot House.	Feb ’11 to Mar ‘11
B2	Piling & excavation to D&C Pump Sump shaft and piling to NTH west perimeter.	Feb ’11 to Mar ‘11
H	Demolish 175-179 Victoria Street.	Feb ’11 to Mar ‘11
D1	STH enabling works	Feb ’11 to Mar ‘11
E1	Underpinning for westbound link passage to D&C.	Feb ’11 to Mar ‘11
F	Demolition/infilling of existing underpass and toilets in Bressenden Place.	Feb ’11 to Mar ‘11
A1	Set up for jet grouting & jet grout within area + set up tunnel worksite & construct re-aligned Allington Street	Apr ’11 to July ‘11
B2	Lining, intermediate slabs & fit-out to D&C Pump Sump shaft. Complete internal piles to NTH west side, excavate, cast, waterproof & backfill roof slab	Apr ’11 to July ‘11
H	Demolish 175-179 Victoria Street & divert 760mm water main	Apr ’11 to July ‘11
D1	Complete STH enabling works within area	Apr ’11 to July ‘11
D2	STH enabling works – ventilation outlet	Apr ’11 to July ‘11
E1	Underpinning for westbound link passage to	Apr ’11 to July ‘11

Table 1-2: VSU Scheme Main Works Construction Phases		
Work site	**Activities**	**Worksite Periods**
	D&C.	
A2	Jet grouting mixer set up +start construction of LFEPA shaft & temporary construction access shaft	Aug '11
B2	Fit-out to D&C Pump Sump shaft. Construct temporary road to NTH west side	Aug '11
H	Divert 760mm water main	Aug '11
D2	STH enabling works – ventilation outlet	Aug '11
VPT	Underpinning work within basement of Victoria Palace theatre.	Aug '11
A2	Jet grouting mixer set up + construction of LFEPA shaft & temporary construction access shaft	Sept '11
B3	NTH – re-direct traffic to west side & establish east site	Sept '11
H	Divert 760mm water main	Sept '11
D2	STH enabling works – ventilation outlet	Sept '11
VPT	Underpinning work within basement of Victoria Palace theatre.	Sept '11
Allington Street	Jet grouting to east side of street.	Sept '11
J	Jet grouting.	Sept '11
A2	Jet grouting mixer set up + tunnelling via LFEPA shaft & temporary construction access shaft	Oct '11 to Nov '11
B3	NTH east side – obstruction removal, guide walls & piling to perimeter	Oct '11 to Nov '11
D2	STH enabling works – ventilation outlet	Oct '11 to Nov '11

Table 1-2: VSU Scheme Main Works Construction Phases		
Work site	**Activities**	**Worksite Periods**
Duke of York	Jet grouting	Oct '11 to Nov '11
Allington Street	Jet grouting to east followed by west side of street.	Oct '11 to Nov '11
A2	Jet grouting mixer set up + complete LFEPA shaft to Victoria line level & tunnelling via temporary construction access shaft	Dec '11
B3	NTH east side – complete piling to perimeter & start internal piles	Dec '11
D3	STH – PRM lifts A1 & A2	Dec '11
C1	Establish site	Dec '11
Duke of York	Jet grouting	Dec '11
Allington Street	Jet grouting to west side of street.	Dec '11
A2	Jet grouting mixer set up + tunnelling via LFEPA shaft & temporary construction access shaft	Jan '12 to Feb '12
B3	NTH east side – complete internal piles & breakdown for pile capping	Jan '12 to Feb '12
D3	STH – PRM lifts A1 & A2	Jan '12 to Feb '12
C1	Establish site & perimeter piles along Wilton Road	Jan '12 to Feb '12
Duke of York	Jet grouting	Jan '12 to Feb '12
Allington Street	Jet grouting to west side of street.	Jan '12 to Feb '12
M	Jet grouting	Jan '12 to Feb '12
A2	Jet grouting mixer set up + tunnelling via LFEPA shaft & temporary construction access shaft	Mar '12 to Apr '12

Table 1-2: VSU Scheme Main Works Construction Phases		
Work site	**Activities**	**Worksite Periods**
B3	NTH east side – excavate, cast & waterproof ground level roof slab and backfill	Mar ’12 to Apr ‘12
D3	STH – PRM lifts A1 & A2	Mar ’12 to Apr ‘12
C1	Internal piles & plunge columns, capping beam to perimeter piles & construct section of roof slab adjacent to Wilton Road	Mar ’12 to Apr ‘12
K	Jet grouting	Mar ’12 to Apr ‘12
N	Jet grouting	Mar ’12 to Apr ‘12
A2	Jet grouting mixer set up + tunnelling via LFEPA shaft & temporary construction access shaft	May ’12 to Jul ‘12
B4	NTH west side – excavate down to ticket hall level, complete concrete works and continue excavation to plant room level	May ’12 to Jul ‘12
D3	STH – complete PRM lifts A1 & A2	May ’12 to Jul ‘12
C2	Close Wilton Road. Pile for and construct slab over escalator. Start excavation & demolition to ticket hall level. Prepare for jet grouting.	May ’12 to Jul ‘12
L	Jet grouting	May ’12 to Jul ‘12
A2	Jet grouting mixer set up + secondary lining to LFEPA shaft & tunnelling via temporary construction access shaft	Aug ’12 to Sept ‘12
B4	NTH west side – excavate to plant room level and start concrete work	Aug ’12 to Sept ‘12
C2	Excavation & demolition to ticket hall level. Complete jet grouting.	Aug ’12 to Sept ‘12
G	Jet grouting	Aug ’12 to Sept ‘12
A2	Jet grouting mixer set up + cast capping slab & backfill LFEPA shaft + tunnelling &	Oct ’12 to Jan ‘13

Table 1-2: VSU Scheme Main Works Construction Phases		
Work site	**Activities**	**Worksite Periods**
	secondary lining via temporary construction access shaft	
B4	NTH west side – Complete excavation and concrete to plant room level and passageway level 2. Form junctions with passages #19, #1a & sump shaft #9	Oct ’12 to Jan ‘13
C3	Re-open Wilton Road. Complete excavation & demolition to ticket hall level, install perimeter piles to south & west walls and internal tension / plunge piles, plus capping beams. Erect temporary deck in front of Network Rail arch.	Oct ’12 to Jan ‘13
E2	Establish site, clear obstructions & form guide walls, pile north section of link passage to westbound District & Circle line, excavate and cast base slab.	
H	Jet grouting & start underpinning for eastbound passage to District & Circle line	Oct ’12 to Jan ‘13
A2	Jet grouting mixer set up + cast capping slab & backfill LFEPA shaft + tunnelling & secondary lining via temporary construction access shaft	Feb ’13 to Jul ‘13
B4	NTH west side – Architectural and M&E fit-out	Feb ’13 to Jul ‘13
C3	Complete ticket hall floor slab, excavate to plant room level & start concrete. Install pipe arch for escalator shaft and complete escalator walls, etc to bottom level.	Feb ’13 to Jul ‘13
E2	Complete construction of northern section of link passage to westbound District & Circle line, cast roof slab, install sewer diversion over roof & reinstate road	Feb ’13 to Jul ‘13
H	Continue underpinning for eastbound passage to District & Circle line	Feb ’13 to Jul ‘13
F	Construct Cardinal Place entrance to NTH.	Feb ’13 to Jul ‘13

Table 1-2: VSU Scheme Main Works Construction Phases		
Work site	**Activities**	**Worksite Periods**
A2	Tunnelling & secondary lining via temporary construction access shaft	Aug ’13 to Nov ‘13
B4	NTH west side – Architectural and M&E fit-out	Aug ’13 to Nov ‘13
C4	Complete plant room level concrete + columns to plant room & ticket hall levels. Perimeter walls, Wilton Road stairs & roof. Construct escalator shaft. Start Architectural and M&E fit-out.	Aug ’13 to Nov ‘13
E3	Pile & construct southern section of passage to westbound District & Circle line and reinstate road.	Aug ’13 to Nov ‘13
H	Continue underpinning for eastbound passage to District & Circle line and construct PRM shaft and passage.	Aug ’13 to Nov ‘13
F	Complete Architectural and M&E fit-out to Cardinal Place entrance to NTH.	Aug ’13 to Nov ‘13
A2	Complete tunnelling, secondary lining & internal concrete via temporary construction access shaft	Dec ’13 to Jul ‘14
B4	NTH west side – Architectural and M&E fit-out	Dec ’13 to Jul ‘14
C4	Complete waterproofing & surface reinstatement. Continue Architectural and M&E fit-out.	Dec ’13 to Jul ‘14
H	Complete construction of PRM shaft and passage.	Dec ’13 to Jul ‘14
A2	Clear temporary construction access shaft, cap, backfill & reinstate. General site use.	Aug ’14 to Mar ‘15
B4	NTH west side – Architectural and M&E fit-out and start testing & commissioning	Aug ’14 to Mar ‘15
C5	Open Wilton Road stairs. Continue Architectural and M&E fit-out and start testing & commissioning.	Aug ’14 to Mar ‘15

Table 1-2: VSU Scheme Main Works Construction Phases		
Work site	**Activities**	**Worksite Periods**
H	Cast capping slab & backfill shaft. Re-divert 760mm water main & reinstate site..	Aug ’14 to Mar ‘15
A2	General site use.	Apr ’15 to Jul ‘16
B4	NTH west side – Integrated testing & commissioning, final inspections and sign off.	Apr ’15 to Jul ‘16
C5	Complete Architectural and M&E fit-out, integrated testing & commissioning, final inspections and sign off.	Apr ’15 to Jul ‘16

1.1.44 The phases relating to the utilities works together with the location of the respective worksites are illustrated on Figures 2.5(A0) – 2.5(A6) and therefore this table should be read in conjunction with these figures.

Table 1-3: VSU Scheme Utilities Works Phases

Work site	Activities	Worksite Period
Eccles'n Bridge Road Junct'n	Highway enabling works to accommodate diverted traffic flows from Wilton Road during the advance utility diversion works and main works phases of the project and comprising alterations to kerbs, paved areas, traffic signals and street furniture.	Mar'09 to Aug'09
Wilton Road Junct'n	Highway enabling works to accommodate changes to traffic lane positions for the implementation of advance utility diversion phases and comprising alterations to kerbs, paved areas, traffic signals and street furniture.	
Little Ben Island Junct'n		
Bress'n Place Junct'n		
H1	Diversion of trunk telecommunications apparatus from Wilton Road to Vauxhall Bridge Road via Neathouse Place in shallow trench (less than 1200mm deep).	Aug'09 to Nov'09
H2	Diversion of trunk telecommunications apparatus from Wilton Road to Vauxhall Bridge Road via Neathouse Place in shallow trench (less than 1200mm deep).	
H3	Diversion of 315mm diameter gas main and trunk telecommunications apparatus from Wilton Road to Vauxhall Bridge Road via Neathouse Place in shallow trench (less than 1200mm deep).	
H4	Diversion of 315mm diameter gas main and trunk telecommunications apparatus from Wilton Road to Vauxhall Bridge Road via Neathouse Place in shallow trench (less than 1200mm deep).	

Table 1-3 VSU Scheme Utilities Works Phases		
Work site	**Activities**	**Worksite Period**
H5	Diversion of 315mm diameter gas main and trunk telecommunications apparatus from Wilton Road to Vauxhall Bridge Road via Neathouse Place in shallow trench (less than 1200mm deep).	
H6	Diversion of 315mm diameter gas main and trunk telecommunications apparatus from Wilton Road to Vauxhall Bridge Road via Neathouse Place in shallow trench (less than 1200mm deep).	
D1	760mm diameter water main diversion, diversion of brick egg sewer as 450mm diameter sewer (up to 3000mm deep) and small utilities diversions to eastern carriageway half-width.	Nov'09 to Jan'10
B3	760mm diameter sewer diversion from Terminus Place (up to 4500mm deep) to Wilton Road, small secondary utility diversions to eastern carriageway half-width.	
C1	Diversion of small water, electricity, gas and telecommunications apparatus to accommodate 10m diameter D&C EB PRM Shaft, all in footway, in shallow trench (less than 1200mm deep).	
E1 & G1	Diversion of small water, electricity, gas and telecommunications apparatus in new route to avoid LFEPA fire-fighting shaft, all in shallow trench (less than 1200mm deep).	
A1	New 1200mm diameter Bressenden Place combined drainage manhole and relief sewer (up to 4500mm deep), small secondary utilities diversions.	
A2	New 1200mm diameter Bressenden Place combined sewer (up to 4500mm deep) and small secondary utilities diversions.	
A6	Thames Water combined drainage system apparatus relocation.	

Table 1-3 VSU Scheme Utilities Works Phases

Work site	Activities	Worksite Period
A7	Diversion of small water, private sewers, highway drainage, electricity, gas and telecommunications apparatus to temporary and permanent locations on east footway of Bressenden Place; diversions in shallow trench (less than 1200mm deep).	
D1	760mm diameter water main diversion, diversion of brick egg sewer as 450mm diameter sewer (up to 3000mm deep) and small utilities diversions to eastern carriageway half-width.	Jan'10 to Mid Feb '10
B3	760mm diameter sewer diversion from Terminus Place (up to 4500mm deep) to Wilton Road, small secondary utility diversions to eastern carriageway half-width.	
C2	Diversion of small water, electricity, gas and telecommunications apparatus to accommodate 10m diameter D&C EB PRM Shaft, all in carriageway, in shallow trench (less than 1200mm deep).	
G2	Diversion of small water, electricity, gas and telecommunications apparatus in shallow trench, local diversion of Allington Street brick egg sewer to avoid temporary construction shaft (up to 3000mm deep).	
A3	New 1200mm diameter Bressenden Place combined sewer (up to 4500mm deep), small trunk route and secondary utilities diversions in carriageway and footway.	
A6	Thames Water combined drainage system apparatus relocation.	
A8	Diversion of small water, private sewers, highway drainage, electricity, gas and telecommunications apparatus to temporary and permanent locations on east footway of Bressenden Place; diversions in shallow trench (less than 1200mm deep).	

Table 1-3: VSU Scheme Utilities Works Phases

Work site	Activities	Worksite Period
D2	Installation of approximately 50m long permanent sheet pile wall adjacent to east side of STH as protection to utilities. 760mm diameter water main diversion, diversion of brick egg sewer as 450mm diameter sewer (up to 3000mm deep) and small utilities diversions to eastern carriageway half-width and footway.	Feb'10 to May'10
D3	760mm diameter water main diversion (up to 3000mm deep), small utilities diversions through eastern carriageway half-width and footway.	
G3	Diversion of small water, electricity, gas and telecommunications apparatus in shallow trench, local diversion of Allington Street brick egg sewer to avoid temporary construction shaft (up to 3000mm deep).	
A4	New 1200mm diameter Bressenden Place combined sewer (up to 4500mm deep), small trunk route and secondary utilities diversions in carriageway and footway.	
A5	Installation of approximately 60m long permanent sheet pile wall adjacent to east side of NTH as protection to utilities. Diversion of small water, private sewers, highway drainage, electricity, gas and telecommunications apparatus to temporary and permanent locations on east footway of Bressenden Place. Some temporary diversions will be within a temporary above ground enclosure.	
D1	Final tie-in works of 760mm diameter water main diversion and abandonment of existing.	May'10 to Aug'10

Table 1-3: VSU Scheme Utilities Works Phases		
Work site	**Activities**	**Worksite Period**
D5	760mm diameter water main diversion (up to 3000mm deep), small utilities diversions through eastern carriageway half-width.	
F2	Diversion and reconnection of diverted small water, electricity, gas and telecommunications apparatus, all in footway and carriageway, in shallow trench (less than 1200mm deep).	
A4	New 1200mm diameter Bressenden Place combined sewer (up to 4500mm deep) and new manhole, small trunk route and secondary utilities diversions in carriageway and footway.	
D4	Diversion to temporary locations of small water, electricity, gas and telecommunications apparatus, all in carriageway, in shallow trench (less than 1200mm deep).	Aug'10 to Nov'10
F1	Diversion and reconnection of diverted gas and small telecommunications apparatus, all in footway and carriageway, in shallow trench (less than 1200mm deep).	
A4	New 1200mm diameter Bressenden Place combined sewer (up to 4500mm deep) and new manhole, small trunk route and secondary utilities diversions in carriageway and footway.	
F3	Diversion and reconnection of diverted gas and small telecommunications apparatus, all in footway and carriageway, in shallow trench (less than 1200mm deep).	Nov'10 to Jan'11
C3	Reconstruction of existing telecommunications access chambers and installation of new apparatus.	
C4	Installation of new telecommunications ducts and apparatus.	

Table 1-3: VSU Scheme Utilities Works Phases		
Work site	**Activities**	**Worksite Period**
C5	Replacement and reconnection of diverted gas main in carriageway in trench (less than 2000mm deep).	Jan'11 to Mar'11

1.2 Key Design Assumptions

1.2.1 The assessment presented within Section 6 of this SES and within the detailed Technical Appendices has been based on the broad description of the scheme updates presented in Section 2 of this SES. Specific key design assumptions that have formed the basis of the assessment are discussed below.

Utilities

1.2.2 The Intrusive Slit Trench Investigation will be undertaken prior to the advance utility diversion works and not under the Powers to be obtained under TWAO. The slit trench investigation covers an extensive area around Victoria Station; the following assumptions have been made:

- Approximately 50 trenches/trial pits in carriageways, footways and other paved areas will be excavated, information recorded and the opening and surface reinstated
- The duration of each slit trench investigation in any location will be less than 10 days and would typically be 5 days for a simple trench
- Slit trench investigations will be phased over several months to minimise the impact on traffic
- Each slit trench/trial pit investigation would be undertaken in a manner designed to minimise the period of time of the investigation, the impact on traffic, pedestrians and adjacent residential and commercial property etc.
- The short duration of each slit trench/trial pit would not create a 'significant effect' at any single location or cumulatively

1.2.3 The works regarding the utilities diversions will be undertaken in advance of the main works. The assessment is based on the diversion of the utilities discussed in this SES. Further mitigation measures will be discussed with the relevant Utility companies during

the detailed design phase.

Demolition and Underpinning

1.2.4 The assessment in the ES considered the demolition and underpinning of various buildings.

Tunnels and Shafts

1.2.5 The assessment is based on the updates to the construction of the tunnels and shafts presented in Section of this SES.

Description of Works and Construction Methods

1.2.6 The assessment is based on the description of works of each element of the scheme and its associated construction methodology as presented throughout Paragraphs 1.1.29 – 1.1.44 and within any reference documents therein.

Construction Phasing

1.2.7 The assessment is based on the phased approach discussed throughout Paragraphs 1.1.41 -1.1.44 and demonstrated in Figures 2.5(A1.1) – 2.5(A.6). This is also discussed and presented within the construction programme which accompanies the Order application and forms part of the basis of this assessment.

Incorporated Mitigation

1.2.8 The assessment considers that the incorporated mitigation measures discussed in Paragraph 2.6.4 and throughout Section 6 have been included within the design.

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Annex VI Settlement Assessment on Buildings

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Figures and Tables

Summary

The Phase 2 potential damage assessment presented in this report has been undertaken to the RIBA Stage E scheme layouts current in December 2007. The 3-D settlement model has been created and analysed using the Mott MacDonald in-house software GRP (Version 1.2.5). With predicted ground movement contours calculated based on the parameters stated within this report.

Of the 37 buildings identified within the predicted 1 mm greenfield ground surface settlement contour line or 1:500 (or steeper) ground slope line during Phase 1 of the potential damage assessment process, 21 have been considered during Phase 2 of the assessment process. Of these buildings, 9 have been referred for Phase 3 level assessment/the development of protective measures.

The Phase 3 Assessment for the Victoria Palace Theatre has been completed and sent to English Heritage. It describes mitigation measures which, when implemented, will result in a very low risk of damage to the theatre.

1 Introduction

1.1 Scope

This document presents the results of the Phase 2 potential damage assessments for both the Listed and Non-Listed buildings within the zone of influence of excavation-induced ground subsidence associated with the VSU underground works. The impact on the surface structures of the implementation of the jet grouting ground treatment works is not addressed in this report. This impact will be addressed on completion of the jet grouting trial and associates monitoring. Consideration is also not given to the effect of long term ground movements at this stage of the assessment process.

The method of assessing the potential damage to buildings resulting from excavation-induced ground movements is a three-phase process, with an increasing level of detail and rigour being applied at each phase of assessment. It is a filtering process in which initially conservative assumptions are reviewed and refined at each phase. This approach is widely accepted in the UK and has been successfully adopted on various London tunnelling projects including the Jubilee Line Extension, the Channel Tunnel Rail Link and most recently Crossrail.

2 Potential Damage Assessment Methodology

At the VSU site ground movements may be induced by:

- Implementation of the ground improvement works, i.e. jet grouting;
- Excavation of shallow tunnels, shafts and boxes construction;
- Consolidation and equilibration of pore pressures in the long term following the change in boundary conditions induced by underground construction.

The following potential impacts are associated with the implementation of the jet grouting ground treatment measures at the VSU site:

a) Surface loading – from tracked drilling rigs and other heavy plant and equipment used during the ground treatment works;

b) Intrusion – drilling through/into existing sub-surface structures;

c) Ingress – ingress of grout during jet grouting operations into existing sub-surface structures, and

d) Ground movement associated with jet grouting operations.

The first three impacts detailed above are associated with the implementation of the construction process and as such shall be addressed as part of the jet grouting trial and final detailed design.

It is acknowledged that ground movement can be associated with the implementation of jet grouting ground treatment measures. Either settlement or heave could be generated by the jet grouting process.

Settlement is considered unlikely. The jet grout columns are to be isolated from the overlying Made Ground thus preventing any collapse settlement within this stratum. The underlying material, alluvium, is essentially cohesive in nature and consequently should not be subject to settlement during jet grouting operations.

Heave is primarily generated through spoil blockage. Spoil blockage may be generated by:

a) the presence of an inadequate annulus causing a restriction to the return flow of the spoil;

b) the viscosity of the spoil, and

c) lumps within the spoil accumulating at restrictions.

These aspects are to be addressed in detail during the jet grouting trial with appropriate techniques and procedures being formulated as well as the determination of suitable parameters that, through careful site control during jet grouting operations, will result in minimal movements.

A three-phase approach is adopted for assessing the damage caused to buildings by excavation-induced ground movements.

Phase 1 involves the determination of the 'greenfield' ground surface movements, presented as settlement contour drawings, resulting from the proposed underground construction works. Tunnelling-induced ground movements shall be determined adopting the well established and widely accepted empirical approach (for example O'Reilly & New, 1982, and Attewell & Woodman, 1982). For open excavations the generic ground movement assessment methods, including those for box excavations and shafts, derived from the Crossrail project shall be used. The principle of superposition shall be assumed valid for the analysis of multiple tunnels and shafts. All buildings located within the predicted 10mm (or greater) ground surface settlement contour or 1:500 (or steeper) ground slope line are referred for further consideration in Phase 2 of the potential damage assessment process. On the basis that they are likely to experience negligible damage all buildings located outwith these lines at Phase 1 are not considered further in the potential damage assessment process.

In Phase 2, consideration is given to individual buildings and likely modes of deformation, and the determination of the *'greenfield'* strains likely to result from the underground works, i.e. it is assumed that the building follows the *'greenfield'* surface settlement trough.

An integral part of this stage of the assessment process is damage categorisation. The damage classification system proposed by Burland et al (1977) and subsequently developed upon by Boscardin & Cording (1989) and Burland (1995) is to be used to assess the impact on the surface buildings. This classification system is summarised in Table 2.

Depending upon the results of the Phase 2 analysis and the damage category assigned, a Phase 3 assessment may be undertaken. Generally, those buildings with an anticipated damage category of 3 (moderate) or greater are referred for further consideration during Phase 3 of the potential damage assessment process. The assumptions made and values assigned to the various input parameters shall be critically reviewed during Phase 3 of the assessment process. Sophisticated numerical analysis techniques may be employed during this stage of the assessment process.

In terms of protective measure provision, the category 2 (slight)/3 (moderate) threshold is the governing criterion. Under normal circumstances the provision of protective measures is not generally envisaged where a damage category of 2 or below is anticipated. For cases where damage categories of 3 or above are expected further more detailed analysis is usually undertaken to assess the requirements for mitigation measures.

It should be noted that the potential damage assessment process is intended to be conservative such that those structures at risk of sustaining unacceptable damage can be identified and thereby allow more detailed study to be concentrated in problematic areas (Mair et al., 1996). The greenfield surface/sub-surface settlement contours determined as part of this process are not intended to serve as a prediction of the expected effects but should be used as a filter to identify infrastructure that is potentially at risk (Bowers & Moss, 2005).

The potential damage assessment process described that this report is based on the construction sequence in Table 1. It should be noted that this 2007 construction sequence contains provision for the Cooling the Tube Programme on a tunnel which has subsequently been removed from the scheme. The assessment results are therefore conservative.

3 Settlement Estimation Methodology

The following sections outline the methodologies that are to be adopted for the determination of the ground movements resulting from tunnel, box and shaft excavation. The general notation that shall be used to define the ground response to excavation is as follows:

d_v is the vertical ground movement (settlement/heave) at any point.

S_h is the horizontal ground movement at any point. The horizontal ground movement has components in two orthogonal directions. The value of S_h is the vector sum resolved into the direction of the relevant analysis section line.

3.1 Settlement due to Tunnelling

The ground surface settlement induced by tunnel construction is commonly described by a Gaussian Error function in the transverse direction (O'Reilly & New, 1982) and a Cumulative Error function in the longitudinal direction (Attewell & Woodman, 1982). Figure 1 illustrates the assumed inverted normal probability distribution curve settlement profile and input parameters for determining tunnelling-induced settlement. For a single tunnel running between a starting point (x_i, y=0) and a finishing point (x_f, y=0) the corresponding surface settlement trough is defined by the following equation:

$$d_v = d_{\max} \cdot e^{\left(\frac{-y^2}{2i^2}\right)} \left[\varphi\left(\frac{x-x_i}{i}\right) - \varphi\left(\frac{x-x_f}{i}\right)\right]$$

where

$d_{v\,max}$ = maximum settlement at the centre of the trough due to a single tunnel (m).

The maximum settlement is calculated using the following expression:

$$d_{\max} = \frac{V_l \pi r^2}{i\sqrt{2\pi}}$$

where

V_l = volume loss expressed as a percentage of the tunnel excavated volume (%)

r = excavated radius of the tunnel (m)

i = horizontal offset to the point of inflexion of the Gaussian curve (m)

x, y = planar co-ordinates (m)

$\phi(\alpha)$ = normal cumulative distribution function

The Mott MacDonald in-house computer program *GRP* (Version 1.2.5) have been employed to determine these greenfield ground movements. This program has been fully validated through its extensive use on projects including Crossrail. The corresponding ground settlement contours have been prepared using Golden Softwares Surfer® (Version 8.06.39) software package. The various sub-surface tunnel structures forming the station have been modelled as equivalent circular tunnel sections. The centre of gravity of each particular excavated element has been determined and used to define the corresponding axis position of the equivalent circular section. Sub-surface settlements will be determined in *GRP* incorporating the empirical equation for the determination of the trough width parameter given by Mair et al (1993).

It should be noted that the greenfield ground movement contours thus determined relate to immediate volume loss movements only.

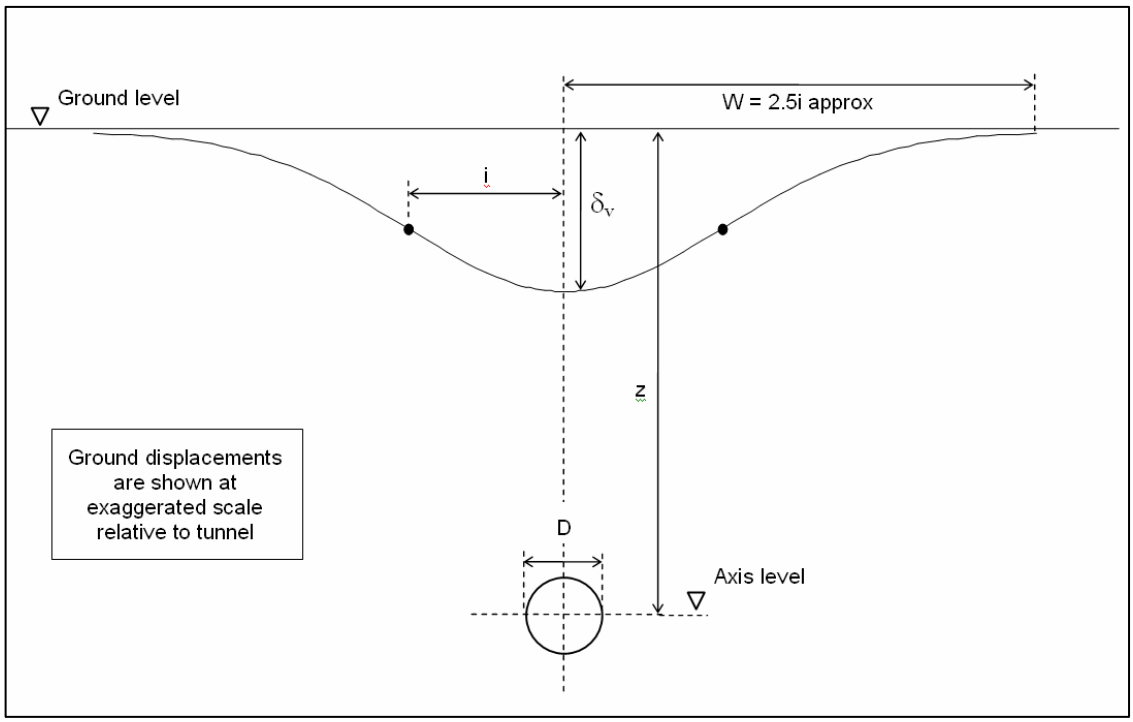

Figure 1: Settlement due to Tunnelling

3.1.1 Volume Loss

The volume loss parameter is assumed to be equal to the volume of the ground surface settlement trough per unit length. Volume loss in tunnelling results from the following four ground movement components:

- movement towards the unsupported excavated face

- movement prior to effective support of the tunnel heading
- movement associated with the passage of the shield (if applicable)
- movement associated with the deformation of the tunnel lining

These effects have been combined into a single parameter representing the volume loss expressed as a percentage of the assumed excavated volume:

$$V_s = V_l \frac{\pi D^2}{4}$$

3.1.2 Trough Width

The width of the ground surface settlement trough is directly proportional to the depth of the tunnel and the nature of the surrounding soils. The trough width is related to the depth to the tunnel axis by the trough width parameter, K, as follows:

$$i = Kz.$$

where

i = horizontal offset to the point of inflexion of the Gaussian curve (m)

K = trough width parameter (an empirical constant)

z = depth to tunnel axis (m)

The trough width parameter is dependent upon the ground conditions through which the tunnel will be constructed and those above the tunnel. The choice of an appropriate value of K requires interpretation of the ground conditions, and in particular whether the material is cohesive or granular, and in the latter case on whether the tunnel is above or below the water table.

3.2 Settlement due to Box and Shaft Construction

Settlement due to box and shaft excavations includes that arising from wall installation, movement and deflection of the excavation support system and groundwater changes outside the excavation. Wall movements vary with wall and propping layouts, soil parameters and groundwater regime, construction method and quality of workmanship. The shape of settlement trough due to wall deflection may be predicted from estimates of wall movements during excavation by making assumptions on wall stiffness, sequence of excavation and propping.

There is no widely accepted method for estimating the ground movements generated by the excavation of boxes and shafts. Settlement estimation procedures have been developed for use on the Crossrail project and it is proposed that these procedures are adopted on the VSU Project. The procedures are based on appropriate case studies of box and shaft excavations in stiff clays; most of the limited data available relates to excavations within the London Clay.

In the procedure the settlement trough is described by the hogging zone of the Gaussian settlement trough adopted for tunnels. The following equation is used to calculate the ground surface settlements anticipated from shaft and box construction, assuming a variation of settlement from a maximum at the wall to a minimum at a distance W from the wall:

where

$$S_v = \delta_v e^{\left(\frac{1}{2}-\frac{1}{2}\left(1+1.5\frac{y}{W}\right)^2\right)}$$

S_v = is the settlement from the shaft/box construction (m);

δ_v = is the settlement at the wall face (m);

y = is the distance from the shaft outer wall (m);

W = is the extent of the settlement trough (m).

3.2.1 Box Excavations

For box excavations, ground movement is dependent upon the depth of the excavation and stiffness of the support system provided. The magnitude of the displacement at the wall (δ_v) and the extent of the settlement trough (W) are expressed as functions of the support stiffness and the excavation depth (Z).

For the purposes of potential damage assessment, the retaining wall designs are classified as either high or low stiffness support systems.

Modelled box excavation elements are defined by the following parameters:

- 'E, N,' defines the coordinates of the start and finish of each wall element forming the box.
- 'Z' defines the excavation depth at either end of the particular wall.
- δv/Z defines the ratio of maximum settlement at the box wall to the excavation depth.
- W/Z is the ratio of settlement extent to excavation depth.
- δh/δv is the ratio of horizontal movement to vertical movement at the wall.

Figure 2 illustrates the assumed ground settlement profile (related to the hogging section of the normal probability curve) and input parameters for modelling box excavations.

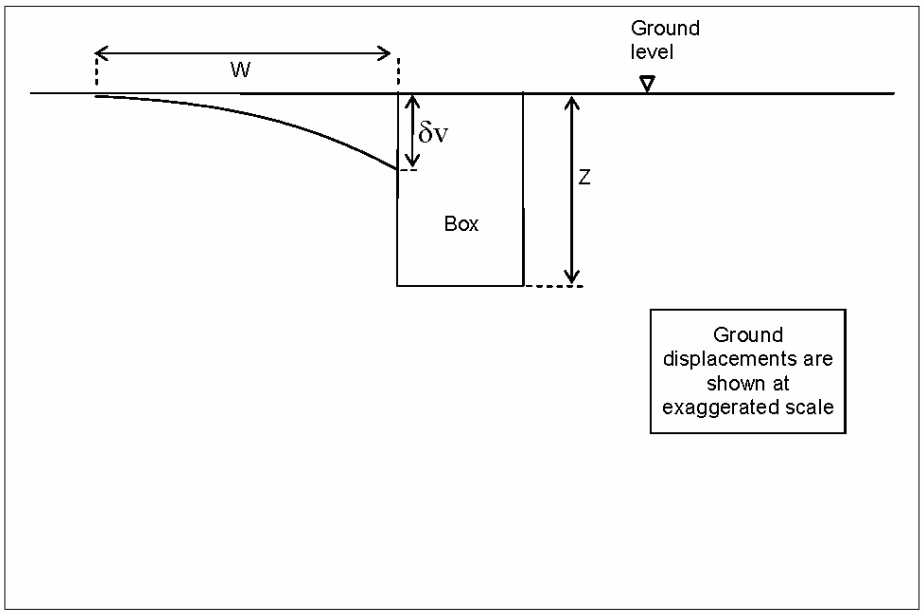

Figure 2: Settlement due to Box Excavation

3.2.2 Shaft Excavations

For shafts, the magnitude of settlement at the wall (δ_v) and the extent of the settlement trough (W) are expressed as functions of the shaft diameter (ϕ) and the shaft depth (Z). All circular shaft excavations are assumed to be inherently stiff structures working in hoop compression.

Modelled shaft excavation elements are defined by the following parameters:

E, N defines the spatial position of the shafts by their centreline axis.

R is the radius of the shaft.

Z is the modelled shaft excavation depth.

$\delta v/Z$ is the ratio of maximum settlement at the shaft wall to the excavation depth.

W/Z is the ratio of settlement trough width to the excavation depth.

$\delta h/\delta v$ is the ratio of horizontal movement to vertical movement at the wall.

Figure 3 illustrates the assumed ground settlement profile (related to the hogging section of the normal probability curve) and input parameters for modelling shaft excavations.

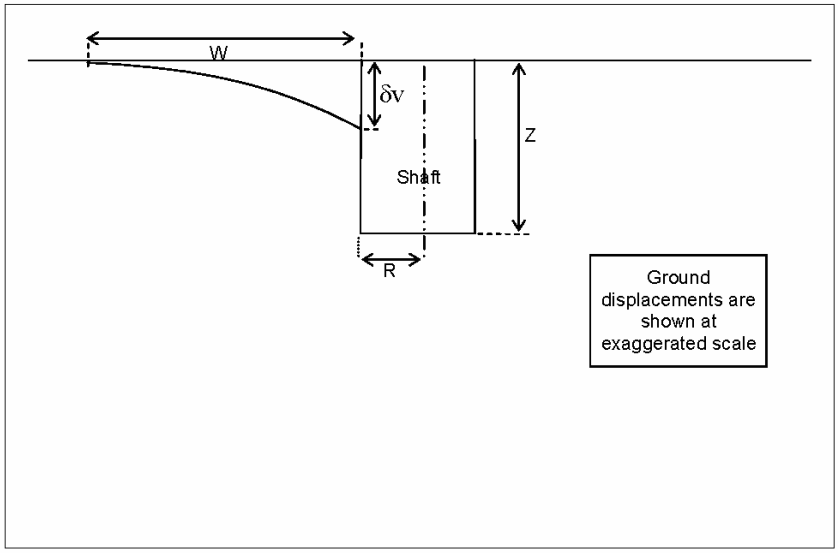

Figure 3: Settlement due to Shaft Excavation

The Mott MacDonald in-house computer program *GRP* (Version 1.2.5) has been employed to determine these greenfield ground movements. The corresponding ground settlement contours have been prepared using Surfer® (Version 8.06.39).

4 Input Parameters

4.1 Volume Loss

The volume losses assumed during Phase 1 of the potential damage assessment process have been critically reviewed in relation to various aspects of the proposed works, including the ground and groundwater conditions, ground treatment proposals and tunnelling techniques. Table 3 summarises the revised volume losses to be adopted in the determination of ground movements.

For the tunnels that are to be formed within the London Clay no specific ground treatment is proposed.

4.2 Trough Width

A trough width parameter of K=0.4 has been adopted for all tunnels except the TCP ventilation tunnel. This reflects the predominantly granular soil through and below which the tunnels are to be constructed. A trough width parameter of K=0.5 has been adopted for the TCP ventilation tunnel. This reflects the predominantly cohesive nature of the London Clay through which this tunnel is to be constructed.

4.3 Shaft Parameters

For shafts, the magnitude of settlement at the wall (δv) and the extent of the settlement (W) are expressed as functions of the shaft diameter (ϕ) and the shaft depth (Z). Table 4 presents the criteria to

be adopted when selecting the parameters to be used in the estimation of the ground movements induced by the construction of circular shafts.

4.4 Box Parameters

For box excavations, excavation-induced ground movement is dependent upon the depth of the excavation and support system stiffness employed. For the purposes of potential damage assessment, retaining wall designs are classified as either high or low stiffness support systems. Parameters for both types of wall support systems are presented in Table 5.

All shaft and box excavations for the proposed VSU works are assumed to have high stiffness support systems.

5 Results

The results of the Settlement Assessment are shown in Table 6. These indicate that, of the 37 buildings referred for the assessment, 28 are not expected to be significantly affected by settlement-related impacts. The following 9 properties, however, could be affected to some extent, namely:

- Victoria Palace Theatre, Victoria Street (Grade II listed)
- Duke of York Public House, Victoria Street
- Allington House (138 -140 Victoria Street) / 142 Victoria Street/ 175 – 179 Victoria Street
- 144-146 Victoria Street
- 181 Victoria Street
- 183Victoria Street
- 4-7 Victoria Buildings, Terminus Place
- 22 Terminus Place

Mitigation to reduce the severity of these impacts has been incorporated in the scheme design and will include both jet grouting and underpinning techniques as relevant. Phase 3 assessment will be carried out on potentially impacted properties to further refine such mitigation measures as the project develops.

The Phase 3 assessment has already been completed for the Grade II listed Victoria Palace Theatre and sent to English Heritage for comment. The text following summarises this assessment.

This assessment found that the unmitigated works would result in potential damage categories at the theatre ranging from ‘slight’ to ‘moderate’, but that only a relatively small reduction in building movement would be required to mitigate these. As a result, two locations within the footprint of the theatre have been identified for mitigation measures namely:

- at the junction of the theatre and the Duke of York Public House (and below the southwest corner of the auditorium); and
- adjacent to the front wall abutting Victoria Street and in particular near the delicate faience and the stone finishes of the interior.

Available mitigation for such sites includes:

- underpinning of the affected areas of the building by either jet grout columns, or the creation of a reinforced concrete raft;
- use of compaction grouting in the River Terrace Deposits beneath the building foundations; or
- reduction of ground movements at source by ‘in-tunnel’ mitigation measures.

In particular, creation of a solid jet-grouted block near these areas of the theatre would lead to significant reduction in ground movement and to a very low risk of damage to the theatre. Such a block would encompass the whole tunnel cross-section and associated pipe arch canopy, rather than the jet grout canopy/annulus used elsewhere, and the tunnel would subsequently be constructed through this block of treated ground.

The mitigated works would result in only a risk of some minor cracking to the less sensitive finishes in the theatre. In particular, the fibrous plaster finishes in the auditorium and the finishes to the wall at the rear of the stage could be affected, but these finishes are not considered particularly sensitive or noticeable, and are easily repairable using conventional restoration techniques.

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12. Building response to excavation-induced settlement. Boscardin, M.D. and Cording, E.J. ASCE, Journal of Geotechnical Engineering (1989)

13. Assessment of risk of damage to buildings due to tunnelling and excavations. Burland, J.B. Conference on Earthquake Geotechnical Engineering, Tokyo (1995)

14. The effect of new tunnel construction under existing metro tunnels. Moss, N.A. and Bowers, K.H. 5th International Symposium Geotechnical Aspects of Underground Construction in Soft Ground, Amsterdam (2005)

15. Subsurface Settlement Profiles above tunnels in clay. Mair, R.J., Taylor, R.N. and Bracegirdle, A. (1993)

Table 1: Simplified Construction Sequence for VSU Works.

Stage	Proposed Works
1	LFEPA shaft 4b-PAL north Temporary construction shaft 19-E&M Services Tunnel North 9-New Sump and sump adit 1b- Platform 3 overpass 1a- Platform 4 overpass
2	22- PAL/ D&C EB connection 4a-PAL centre Passageway to STH PRM Lift D&C WB Link Passage 6-D&C Underpass 5a-PAL/STH Escalator Connection 5b-PAL South 7-PAL Centre/IC Connection
3	Northern Ticket Hall (NTH) Southern Ticket Hall (STH) 12a-D&C EB PRM Shaft 20-TCP Tunnel TCP Launch Tunnel
4	12b-New D&C EB Stair Passage 13-D&C WB PAL Interchange Stair 8-STH Escalator Shaft
5	TCP Shaft from PAL North

Table 2: Building Damage Classification

Building Damage Classification (after Burland et al, 1977, Boscardin and Cording, 1989 and Burland, Mair and Standing, 2004)				
Category of Damage	Normal Degree of Severity	Description of Typical Damage (Ease or repair is underlined)	Crack Width[1] (mm)	Max Tensile Strain (%)
0	Negligible	Hairline cracks	< 0.1	0 to 0.05
1	Very Slight	Fine cracks which are easily treated during normal decoration. Damage generally restricted to internal wall finishes. Close inspection may reveal some cracks in external brickwork or masonry.	0.1 to 1	0.05 to 0.075
2	Slight	Cracks easily filled. Re-decoration probably required. Recurrent cracks can be masked by suitable linings. Cracks may be visible externally and some repointing may be required to ensure weathertightness. Doors and windows may stick slightly.	1 to 5	0.075 to 0.15
3	Moderate	The cracks require some opening up and can be patched by a mason. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5 to 15 or a number of cracks greater than 3	0.15 to 0.3
4	Severe	Extensive repair work involving breaking-out and replacing sections of wall, especially over doors and windows. Windows and door frames distorted, floor sloping noticably[2]. Walls leaning[2] or bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15 to 25 but also depends on number of cracks	Greater than 0.3

Building Damage Classification (after Burland et al, 1977, Boscardin and Cording, 1989 and Burland, Mair and Standing, 2004)				
Category of Damage	Normal Degree of Severity	Description of Typical Damage (Ease or repair is underlined)	Crack Width[1] (mm)	Max Tensile Strain (%)
5	Very Severe	This requires a major repair job involving partial or complete rebuilding. Beams lose bearing, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	Usually greater than 25 but depends on number of cracks	

[1] Note: Crack width is only one aspect of damage and should not be used on its own as a direct measure of it.

[2] Note: Local deviation of slope, from the horizontal or vertical, of more than 1/100 will normally be clearly visible. Overall deviations of more than 1/150 are undesirable.

Table 3: Phase 2 Volume Loss Input Parameters

Element	Tunnelling Medium	Construction Method	More Probable	Worst Credible
Tunnels	RTD/Treated Ground	SCL/SGI	0.5	1.0
Escalators	RTD/Treated Ground	SCL	0.5	1.0
Connections to Existing (i.e. adjacent 2-3m)	RTD (with dewatering only)	SCL	2	3
Connections to New Work	RTD/Treated Ground	SCL/SGI	0.5	1.0

Element	Tunnelling Medium	Construction Method	More Probable	Worst Credible
Tunnels	London Clay	SCL	1.25	1.5
Escalators	London Clay	SCL	1.5	1.75
Connections to Existing (i.e. adjacent 2-3m)	London Clay	SGI	2	3
Connections to New Work	London Clay	SCL/SGI	1.25	1.5

Table 4: Phase 2 Shaft Excavation Input Parameters

Shaft Size	δv/Z (%)	W/Z	δh/δv
OD < 10m	0.006*OD	1.0	1.0
10m < OD < 25m		1.0 + (OD-10)/15	1.0
OD > 25m	0.15	2.0	1.0

Table 5: Phase 2 Box Excavation Input Parameters

Support stiffness category	δ_v/Z	W/Z	δh/δv
High support system (propped)	0.18%	2.5	1.0
Low support system (cantilever)	0.36%	2.5	1.0

Table 6: Phase 2 Results Summary - Buildings

ID	Structure	Maximum anticipated ground settlement (mm)	Limiting Tensile Strain (%)	Damage Category	Phase 3 Assessment requirement
B01	Network Rail Mainline Station Building (Grade II listed)	8	0.07	1	No
B02	Victoria Palace Theatre, Victoria Street (Grade II listed)	31	0.187	3	**Yes**
B03	Apollo Theatre, Wilton Road (Grade II* listed)	4	0.027	0	No
B04	Portland House, Bressenden Place	Not applicable	Not applicable	Not applicable	Not applicable
B05	The Stag Public House, Bressenden Place	5	0.055	1	No
B06	Eland House, Bressenden Place	Phase 1 assessment indicated that Phase 2 assessment not required.			
B07	5 Allington Street (Section A-A)	8	0.042	0	No
B08	5a Allington Street (Section B-B)	8	0.038	0	No
B09	7 Allington Street (Section C-C)	6	0.030	0	No
B10	7a Allington Street (Section D-D)	5	0.022	0	No
B11	9 Allington Street (Section E-E)	3	0.012	0	No
B12	The Stage Door Public House, Allington Street	6	0.036	0	No
B13	Cardinal Place, Victoria Street	Not applicable	Not applicable	Not applicable	Not applicable
B14	Duke of York Public House, Victoria Street	26	0.187	3	**Yes**
B15	Allington House, 138-140 Victoria Street	22	0.130	2	**Yes**
B16	142 Victoria Street	As B15	As B15	As B15	**Yes**
B17	144-146 Victoria Street	As B15	As B15	As B15	**Yes**
B18	175-179 Victoria Street	Building to be demolished.			
B19	181 Victoria Street	64	0.556	5	**Yes**

ID	Structure	Maximum anticipated ground settlement (mm)	Limiting Tensile Strain (%)	Damage Category	Phase 3 Assessment requirement
B20	183 Victoria Street	64	0.556	5	**Yes**
B21	185 Victoria Street	Phase 1 assessment indicated that Phase 2 assessment not required.			
B22	Abford House, Wilton Road	Not applicable	Not applicable	Not applicable	Not applicable
B23	4-7 Victoria Buildings, Terminus Place	8	0.084	2	**Yes**
B24	1-20 Allington Street (Section E-E)	3	0.012	0	No
B25	13 Allington Street	Phase 1 assessment indicated that Phase 2 assessment not required.			
B26	15 Allington Street	Phase 1 assessment indicated that Phase 2 assessment not required.			
B27	Carrier House, Allington Street	3	0.028	0	No
B28	173 Victoria Street	5	0.041	0	No
B29	1-14 Carlisle Place (Evelyn Mansions)	Phase 1 assessment indicated that Phase 2 assessment not required.			
B30	326-330 Vauxhall Bridge Road	Phase 1 assessment indicated that Phase 2 assessment not required.			
B31	171 Victoria Street	4	0.021	0	No
B32	169 Victoria Street	Phase 1 assessment indicated that Phase 2 assessment not required.			
B33	167 Victoria Street	Phase 1 assessment indicated that Phase 2 assessment not required.			
B34	165 Victoria Street	Phase 1 assessment indicated that Phase 2 assessment not required.			
B35	18 Terminus Place	Phase 1 assessment indicated that Phase 2 assessment not required.			
B36	20 Terminus Place	11	0.069	1	No
B37	22 Terminus Place	8	0.101	2	**Yes**

Notes:

1. It has been assumed that 3-11 Bressenden Place, 120-124 Victoria Street and Elliot House are to be demolished prior to construction of the VSU works and therefore do not require a potential damage assessment.

2. Little Ben Clocktower (Grade II listed) will be temporarily removed during the VSU works and therefore does not require a potential damage assessment.

3. Allington House building footprint covers buildings B15, B16 and B17.

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Annex VII Tables for Assessment of Cumulative Effects

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Table 1.1: Developments for inclusion in the cumulative effects assessment

Scheme Name	Applicant	Agent	Status	Details	High Level Review of Effects
(a) Schemes for which there has been no further information since the submission of the ES					
Victoria National Rail Station Upgrade	N/A	N/A	N/A	Station refurbishment.	There is currently no indication as to the extent of works or when these are due to commence. The most likely effects should the construction be concurrent with VSU, are related to traffic.
Victoria Coach Station (VCS)	N/A	N/A	A planning brief is due to be submitted on this scheme	A review by TfL concluded that a substantial upgrade of VCS, through expansion and redevelopment, would provide the most cost effective means of providing suitable coach station facilities for the Capital, which could be operational in 2010. A planning brief for this site is now being prepared by the City Council.	There is insufficient information on the works required and construction programme for this scheme. With this uncertainty over the works, it was not included for further assessment.

Scheme Name	Applicant	Agent	Status	Details	High Level Review of Effects
Refurbishment of Chelsea Barracks	DTZ Pieda Consulting	MoD	An application made on 6 Jan 03 for a screening opinion for a redevelopment of site for smaller military use and residential units. 21 Feb '03 CoW stated EIA not required. Planning application made for engineering works and demolition on 2 May 2008. The site is now due for sale and CoW has adopted a planning brief for the site. Planning application lodged on 2 April 2008 (08/02889/FULL). Application currently being assessed and has not been determined to date.	Chelsea Barracks is a 5.18ha site, occupying a significant length of the City's boundary with the Royal Borough of Kensington and Chelsea. The MoD proposes to dispose of the site in 2008 and relocate to Woolwich. The planning brief outlines a comprehensive development for the site combining major residential development with substantial affordable housing, and associated community uses, and in particular, an area of open space.	The Planning Application is currently being assessed for the site. Information on programme, phasing and extent of works is unavailable. From the information available, there will be no material effect on the environmental effects predicted from the VSU works. This scheme is too remote from the direct works and the diversionary route. In addition the construction works are incidental within the context of the VSU works.
District & Circle Line: Station refurbishment	N/A	N/A	Scheme is currently in the planning stages.	Basic station modernisation currently at the planning stage.	Normal refurbishment works comprising telecoms, PA system upgrade and retiling works. The majority of these works will be done from the tunnel and it is

Scheme Name	Applicant	Agent	Status	Details	High Level Review of Effects
					unlikely to generate construction traffic.
Victoria Transport Interchange (VTI)	Land Securities	Moseley & Webb	Application for full planning permission received by CoW 17/08/07. Planning Application Ref: 07/07296/FULL was considered by the Planning and City Development Committee on 6th December 2007	Demolition of the existing buildings on site with the exception of the Victoria Palace Theatre, Duke of York pub and the Little Ben Clock and the comprehensive redevelopment of the site for transport works above and below ground, new public spaces and pedestrian routes and a mixed use development comprising offices (Class B1/A1-A5), art gallery/cinema space (Class D1/D2), retained Victoria Palace Theatre (Sui Generis) and residential development (Class C3) and associated highways, utilities and other ancillary works. Little Ben Clock is temporarily relocated and replaced in its current position. This will include the redevelopment of an entire	This scheme is programmed to commence in 2010 and finish in 2019, the extent of works will be large and it would be in close proximity to the VSU scheme. An ES was submitted with the VTI planning application in August 2007. This document provided sufficient information on which to carry out a cumulative effects assessment with the VSU scheme, for the VSU ES. Principle effects were related to noise and traffic. The cumulative effects assessment for the VSU ES was reviewed in light of the design changes.

Scheme Name	Applicant	Agent	Status	Details	High Level Review of Effects
				block of buildings, of which 175-179 Victoria street will form part.	
(b) : Schemes for which further information has been provided since they were assessed in the ES					
Corner Site Development (CSD)	LU	TfL Group Properties and Facilities	Application for full planning permission was withdrawn by LU. Planning Application Ref: 07/07416/FULL	Erection of new 8/9-storey building (plus basement) to be built in association with a new entrance to an enlarged Victoria Underground station and comprising 7,665m^2 of office (Class B1) space, 335m^2 of Class A uses and ancillary accommodation. (Site includes 120-124 Victoria Street and 3-11 Bressenden Place).	The planning application for this scheme has been withdrawn since the submission of the ES, accordingly it is not included for further assessment of cumulative effects.
Proposed Expansion of Victoria Palace Theatre (VPT)	Victoria Palace	N/A	Application submitted May 2008.	A new and extended stagehouse, incorporating a six metre strip of land at the rear of the stage, and two passenger lifts adjacent to the front of house facilities (also to be extended and improved) at the side of the theatre.	An application for this development has been submitted since the publication of the ES. The works are assumed to be minor in nature from the scheme description provided in the application. There is insufficient information in the extent of works and the programme. It was not therefore possible to assess whether there is a cumulative

Scheme Name	Applicant	Agent	Status	Details	High Level Review of Effects
					effect with this scheme.
Parliament Square Improvement Project	TfL	Montagu Evans	Project to be reviewed by the new Mayor of London. If the project is to go ahead, a planning application would be lodged in 2008.	Aims to create a high-quality urban space at Parliament Square to include enhanced and expanded public space by closing the south side of the square.	The likely effects of this scheme are related to traffic. Since the submission of the original ES there has been liaison with Parliament Square project team with the aim of identifying any potential cumulative transport effects. However, there is currently no confirmation of the programming of the project nor is there any information regarding construction methodology or temporary traffic management. This scheme was not assessed for cumulative effects with the VSU scheme due to insufficient information being available.
(c): Additional schemes within the vicinity of the VSU works to those assessed in the ES					
Bressenden Place redevelopment as part of the Site Reinstatement Strategy	N/A	N/A	Design stage	It will cover the area of the demolished buildings at 3-11 (odd) Bressenden place, 120-124 (even) Victoria Street, and Elliot House. For further information on this scheme, refer to the re-	Whilst the conceptual design is known, and is in the process of being agreed with CoW, the programme of construction is unknown. This building cannot be built concurrently with the VSU as it is proposed to be sited within the NTH construction envelope.

Scheme Name	Applicant	Agent	Status	Details	High Level Review of Effects
				instatement strategy (See SES technical Appendices Volume 3, Technical Appendix D).	Therefore it was not possible to assess this scheme for cumulative effects with the VSU scheme during construction. This building could be operational with the VSU scheme and will enhance the visual setting and socio-economic status of the area.
Land Securities Commercial Development (LSCD) also known as VTI 2	Land Securities	Gerald Eve	Land Securities are preparing an alternative scheme to the VTI for the site bounded by Victoria Street, Buckingham Palace Road and Bressenden Place.	A comprehensive redevelopment of the site bounded by Victoria Street, Buckingham Palace Road and Bressenden Place. The development is likely to comprise a mixed use development including offices and retail (Class B1/A1-A5), community and/or leisure uses, the retained Victoria Palace Theatre and residential development (Class C3) and associated highways, new public spaces and pedestrian routes, utilities and other ancillary works.	The scheme is currently being considered and future development is shown in Revision C of a programme dated 28 April 2008. Work intended to start in September 2010 to May 2013. The information received shows that compared to the VTI scheme, the extent of works is less and the construction programme is shorter for the LSCD scheme. Due to the locations required for development of the VTI and LSCD projects only one of them can be developed. As the VTI scheme will be assessed further and has a longer construction programme, it will represent a worst-case scenario compared to the LSCD. Refer to the assessment of the VTI scheme cumulative effects for predicted cumulative effects from

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					the LSCD scheme.
Subsurface Line Power Upgrade (District & Circle Line): Victoria traction substation upgrade	London Underground Ltd	N/A	Conceptual design stage	Substation relevant to VSU is located within Victoria Station, above the District & Circle railway lines. Entrance (pedestrian and vehicular) located on Terminus Place. Upgrade to substation power output with some possible expansion of substation.	Upgrading the sub-surface line (SSL) is planned to begin in 2009 with the introduction of new rolling stock on the Metropolitan line, and is to be completed in 2016, when the last of the present rolling stock on the District line will be removed from service. These works are incidental in the scale of the VSU and therefore have not been included in the cumulative effects assessment.
Network Rail Roof Replacement, Hammerson's Development.	Network Rail	White Young Green Consulting Ltd	Design Stage	Project awarded for Design Services (Structural and M&E) - Victoria Station roof renewal	Network Rail roof replacement will be undertaken from Hudson's place, and is anticipated to be concurrent with VSU programme. Works will be too remote from the VSU works to result in any cumulative effects. The taxi mitigation for the VSU will be affected by this scheme but as there is currently no indication as to the extent of works or any details of the proposed traffic management, an assessment of cumulative effects between this scheme and the VSU scheme

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					could not be made.
Cross River Tram	TfL scheme.	N/K	Not known whether the new Mayor of London will support the scheme.	Preferred route alignment is through Kingsway and via Waterloo Bridge.	Preferred route alignment is more than 1km distant from the Victoria Station area, although traffic diversions through Westminster Bridge and Victoria Street may have some effects. It has been determined that the scheme generally is too remote from the VSU scheme to contribute. Any pertinent effects relate to traffic.
Removal of Congestion Charge Zones including effect of the Western Extension (CCWEZ)	TfL	N/K	Consultations and discussions with stakeholders.	The new London Mayor of London has pledged to undertake consultation regarding the possible removal of the CCWEZ and will outline the new priorities after consultation with key stakeholders.	There is no available information of the programme of the consultation and the outcome is unknown. With the considerable uncertainty over the programme for this consultation, it has not been assessed within this cumulative effects assessment.
Olympic Route Network (ORN)	TfL	N/K	N/K	The Olympic Route Network (ORN) will consist of roads within England that will be used for travel to and from events, venues and accommodation.	The ORN in the Victoria area uses the A4/ Hyde Park Corner/ Park Lane/ Constitution Hill/ Bird Cage Walk/ Great George Street/ Parliament Square. There is insufficient information to assess cumulative effects between the ORN scheme and the VSU scheme. It is anticipated that there will be an impact on

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					traffic but only in the short term over a 6 week period during the Olympics and Paralympics Games.
Wellington House, Buckingham Gate	Waterman Environmental	Waterman Environmental	Application received on 1st May 2008 for a screening opinion (08/03926/EIAOP) to determine if an Environmental Impact Assessment is required. Decision made 22nd May 2008. No planning application submitted for the redevelopment of the site to date.	Redevelopment of the site to provide a nine storey building for residential and retail use with ancillary parking.	On a normal development programme it is likely that this development will coincide with the VSU construction programme. As there is no information on the programme however, or scope of works it has not been included. Likely effects will be noise, traffic and air quality.
Crossrail	Network Rail	N/K	Design Stage. Received Royal Assent July 2008.	New railway proposal for London and the South-East from 2017. The route goes from Maidenhead and Heathrow in the west right across the capital into Essex and Kent in the east. It travels underground through the city centre between Paddington and east	The preferred route alignment is more than 1km distance from the Victoria Station area, in the Tottenham Court Road/Bond Street area. There will not be any deep tunnels or vent shafts in the vicinity of VSU. It has been determined that the scheme is too remote from the VSU scheme to contribute to cumulative effects and therefore has not been

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				London. Preferred route alignment is through Kingsway and via Waterloo Bridge.	considered in the cumulative effects assessment.
Thameslink	Network Rail	N/A	Design Stage	North-south route will be built from St Pancras/Kings Cross to Brixton	The works associated with Thameslink may result in the rescheduling of trains to Victoria beyond the construction phase. This is likely to increase the flow of passengers through Victoria and result in increased passenger congestion. The traffic and transport assessment has allowed for a 20% increase in demand for use of the underground due to re-directing of passengers to Victoria station from construction of other transport schemes. An increase in congestion from redirecting of trains due to Thameslink construction works has been accounted for in the VSU traffic and transport assessment, predicted effects and mitigation measures.