

Infrastructure Investment Thameslink Programme

CCMS NUMBER

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Project Code	Contract Code	Originator Code	Document ID Code	Discipline Code	Sequential Number	
N231	0104733	NR	REF	PC	000001	2

Thameslink Programme London Bridge Station

GRIP Deliverable: Technical Option Definition & Feasibility - Part A

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Issue record

Issue	Date	Comments
DRAFT	29.05.09	Issued for review and comment
Version 1.0	04.06.09	Final for distribution
Version 1.1	13.08.09	Updated with details of Passenger Demand Analyses for review
Version 2	17.08.09	Final version for approval.

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1. Scope

- 1.0.1 The principal objective of the Network Rail Thameslink Programme (TLP) is to increase accessibility to, from and through the heart of London by improving and expanding the existing Thameslink service. The programme will provide the infrastructure to allow a major expansion of Thameslink services. The capacity increase is to be achieved by increasing the length of trains that can be accommodated and the frequency at which they can travel.
- 1.0.2 The Thameslink Programme creates a greater number of train paths between London Bridge and St Pancras International "Low Level". Otherwise the Thameslink Programme involves substituting existing services and creating only a small number of new services. The Thameslink Programme services will be created by joining services that currently terminate at London Bridge, Cannon Street and Blackfriars in the south with services that currently terminate at Kings Cross and, up to March 2009, terminated at Moorgate via Farringdon in the north.
- 1.0.3 As part of these works, London Bridge Station is to be substantially rebuilt, changing the station from 9 terminating platforms and 6 through platforms to 6 terminating platforms and 9 through platforms. Planning Approval has been granted for a scheme collectively known as 'Masterplan', which is permitted to incorporate a below track retail development and an above track commercial office development.

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2. Purpose

- 2.0.1 The purpose of this Technical Option Feasibility & Definition Assessment document is to articulate and evaluate the (detailed) technical solution options for delivering the requirements set out in the Thameslink Functional Specification [2].
- 2.0.2 The document further develops the outline option definition included within the London Bridge Station (N231) High Level Option Selection Report [1], forming GRIP 3 development works for London Bridge Station.
- 2.0.3 The Technical Option Feasibility & Definition Assessment for the redevelopment of London Bridge will be presented in two parts.

PART A (this document):

This document is to be used as guidance on the development requirement of selected High Level Options and identified sub options that are to be developed during GRIP stage 3 by various parties for the redevelopment of London Bridge Station.

- It should be noted that: during the early stages of the feasibility development period following issue of Part A, the Sponsors' high level requirements related to Station Performance, Maintenance and Operations & Control will be defined to establish inputs into the development process. These inputs will be required in order to produce Part B of the Technical Option Feasibility & Definition Assessment.

PART B:

Proposed Part B (future document): section contents are:

- Description of the project
- CAD drawings, plans and sections / preliminary designs articulating each option together with analysis report
- Operational facilities diagrams for each option
- Analysis from feasibility development outputs to be assessed against Sponsor Requirements re Station Performance, Maintenance and Operations & Control
- Outputs from operational modelling and calculations. [Results of Timetable Feasibility/ capacity assessments undertaken to confirm or otherwise, the robustness of the train service requirements to be incorporated into the Functional requirements for the station. Operational resilience for principal passenger flow routes in peak operational times to be assessed for each option against agreed passenger forecasts for 2026 and beyond.] The performance impact of the business requirements (retail and commercial returns) must be demonstrated.
- Evaluation of application of novel technology, considering the requirements of the approvals process.
 - Package escalators

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- MIP lifts
- CIS
- Other
- Interface issues with existing assets and mitigations
 - 84 Tooley Street
 - Shard of Glass (SOG) development (concourse and Retail servicing arrangements)
 - Signal box
 - Station Control Room
 - LU station entrance
 - Bus station
 - Station approach viaduct
 - Key tenancies
 - London Bridge Quarter
- Evaluation of technical options
- Construction and staging options
- Identification of risk and hazards (including Town Planning and other consents)
- Estimated costs of each option
- Outline project programme for each option
- Statement of exclusions and assumptions, agreed by Sponsor
- Recommendations for further analysis
- Recommended input/changes to hazard assessment
- Validation of Technical Option Feasibility against input documents
- Recommended solution covering scope, construction and staging approvals and consents required (see ENH03)

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3. Technical Option Definition & Feasibility – Part A

3.0 Overview

In PART A the following contents are presented to enable GRIP 3 option development:

- Description of the project
- High Level Options and identified sub option schematics.
- Development focus for each identified option
- Operational working assumptions
- Description of required output deliverables to enable option selection analysis.

3.1 Description

- 3.1.1 As highlighted in section 2 of this document the purpose of Part A of this Technical Option Feasibility & Definition Assessment is to provide directional guidance and a measure of clarity for the GRIP 3 options feasibility development.
- 3.1.2 The HLOSRS. Identified 5no principal options for the redevelopment of London Bridge Station together with areas of further study that are to be undertaken

4. High Level Options and identified further development focus

4.0 Option descriptions

- 4.0.1 **OPTION 1 – Consented Masterplan** [*HLOSRS ref The Consented Masterplan Scheme*]
- 4.0.2 **OPTION 2 – Updated Masterplan** [*HLOSRS ref An Upgraded Masterplan Scheme*]
- 4.0.3 **OPTION 3 – High Level Station Works** [*HLOSRS ref Providing Functionality to 2035*]
- 4.0.4 **OPTION 4 – As option 2 without ‘air rights’** [*HLOSRS ref Providing Functionality to 2076*]
- 4.0.5 **OPTION 5 – Core Scheme** [*HLOSRS ref Minimum Infrastructure to support 18tph through the High Level Station*]

4.1 GRIP 3 Development Focus

The project emphasis is:

- that Thameslink functionality of up to 18tph at peak times must be achieved by the December 2015 timetable change date and be within the Cost Plan.
- that the projected passenger capacity is projected to increase in line with the data included in section 4.9 of this report. To date these are figures that have not been

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agreed with the DfT. However, they represent a common bench line to make comparisons between the various options

- that the preferred option to be taken forward for recommendation is likely to be a hybrid scheme consisting of a combination of the best sub options
- that the preferred option is likely to be capable of being delivered in an incremental fashion
- that the preferred option to be taken forward for recommendation is likely to be a simplified scheme in terms of construction complexity and resultant time required on site
- to minimise passenger disruption and consequential TOC compensation resulting from the redevelopment works

4.2 Passenger Capacity Analysis and Modelling Requirements

- To carry out pedestrian flow capacity studies for the assessment of each Option, the following summary outputs (at both 2016 + 5% and 2016 + 35% levels) are required:
 - Flow diagrams demonstrating the internal pattern of movements and their magnitude within the station
 - Identify the external (to the station) critical attractors
 - Flow diagrams highlighting the external patterns and magnitude of movements (on the street landscape adjacent to the station) for am and pm peak hour
 - Identify the emergency evacuation routes – flow diagrams and capacities
 - Identify the routes - flow diagrams and capacities that would feature in Abnormal Operating Conditions during am and pm peak hour
 - Identify the routes - flow diagrams and capacities that would feature in Degraded Operating Conditions during am and pm peak hour
 - Static analysis for am and pm peak hour in Normal, Abnormal and Degraded operating conditions for Options 1, 2, 3 and 5 at all bottlenecks within the station and adjacent street pavements (escalators, gate lines, stairs (widths), corridors, waiting areas etc.) Static analysis to be undertaken following LUL Good practice guide station planning standards and guidelines (SPSG) and NR standards.
 - Produce diagrams and or graphs for the principle pedestrian flows for Options 1, 2, 3 and 5 representing
 - Walking distance (see note 2 below)
 - Journey times (time spent during each journey sector i.e. time on escalators, lifts, stairs and walking between vertical circulation facilities)
 - Accessibility (i.e number of changes in direction both vertically and horizontally)
 - Produce fire safety assessments for Options 1,2,3 and 5
- Dynamic (Legion) modelling shall be carried out on each option at 2016 + 5%, 2016 + 20% and 2016 + 35%

Note 1: Operational scenarios to be used in Abnormal and Degraded conditions to be determined in a future workshop session that will be attended by the Client Sponsor, NR Managed Station advisor and the pedestrian flow modeller. The workshop will be held as soon as practicably possible following appointment of the pedestrian flow modeller.

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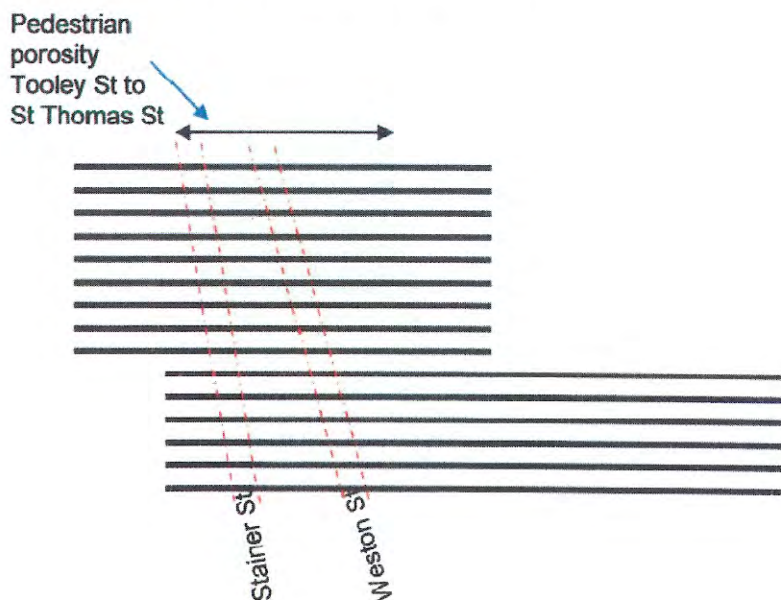
Note 2: The number of identified passenger flows within and through the station to external destinations will be agreed in a future workshop session once the external (to the station) critical attractors have been determined. It is anticipated that note 1 and note 2 outputs can be achieved in one combined workshop session.

Note 3: A statement to be included as an output of the GRIP 3 development process for OPTIONS 1, 2, 3 and 5 on Planning implications of each OPTION including a recommended outline Planning Strategy that may be adopted to achieve any additional approvals that are likely to be required for the options.

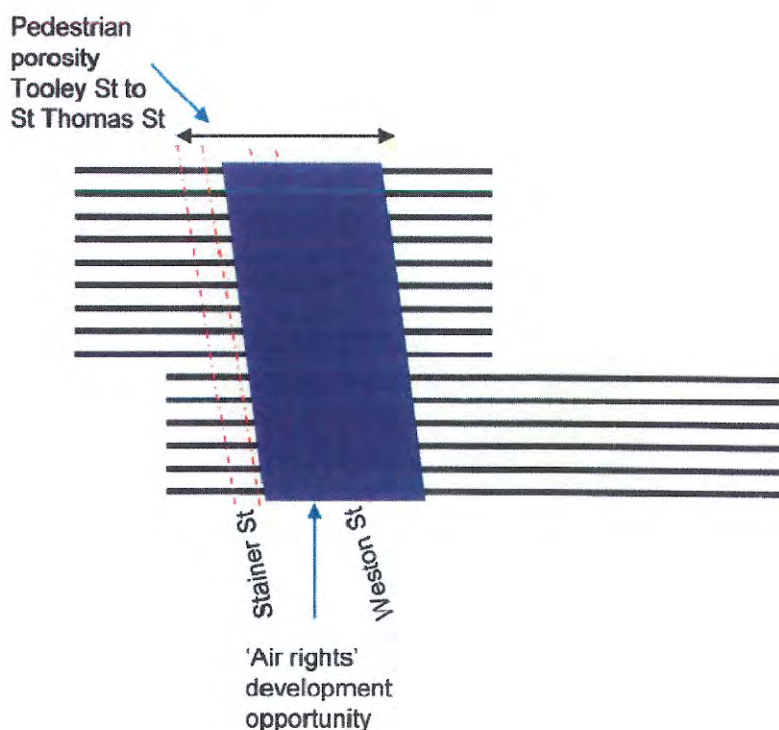
4.3 OPTION 1 – The Consented Masterplan Scheme

Original scheme to deliver SRA 2003 Client Requirements.

- Street level - extensive cut through / demolition



- 'Air rights' - Outline approval granted for across station development spanning North to South between Tooley St and St Thomas St.



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4.3.1 KEY ELEMENTS

- Significant cut through between Stainer St and Weston St providing pedestrian porosity between Tooley St and St Thomas St
- All new tracks and platforms
- Circa 750,000 sq ft of potential 'air rights'

4.3.2 GRIP 3 DEVELOPMENT REQUIREMENT

- Confirmation of passenger capacities that can be accommodated compliant with the specified FRUIN levels of service (see section 4.8). (This will be determined using the same passenger analysis and safety methodology that will be used on all options)
- Confirmation on the cost of the scheme (the same baseline information is to be used to cost all scheme options)
- No further works to be undertaken at this stage

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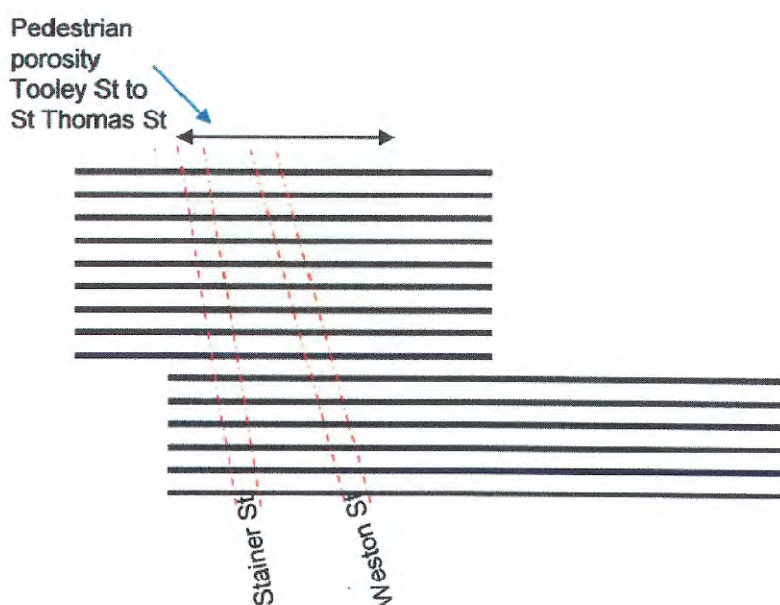
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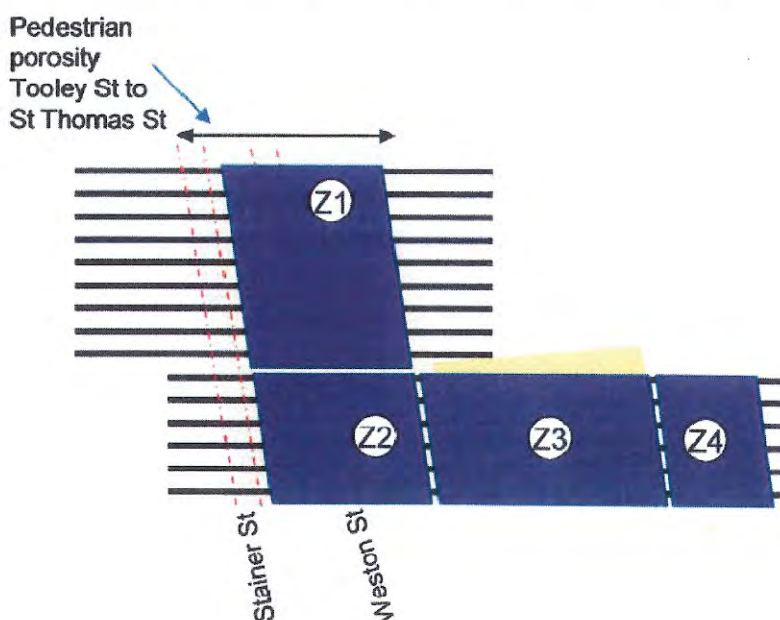
4.4 OPTION 2 – An Updated Masterplan Scheme

Scheme to deliver DfT, TLP functionality to satisfy DfT Client Requirements Brief issue 4 with a 60 year capacity design life. Design Brief set capacity at projected 2016 passenger numbers + 35% .

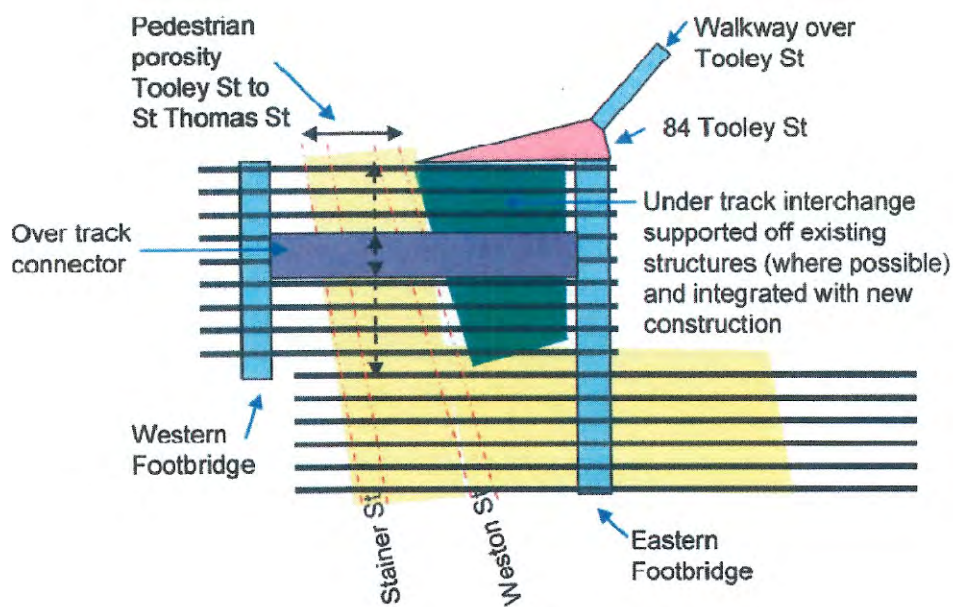
- Street level - extensive cut through / demolition



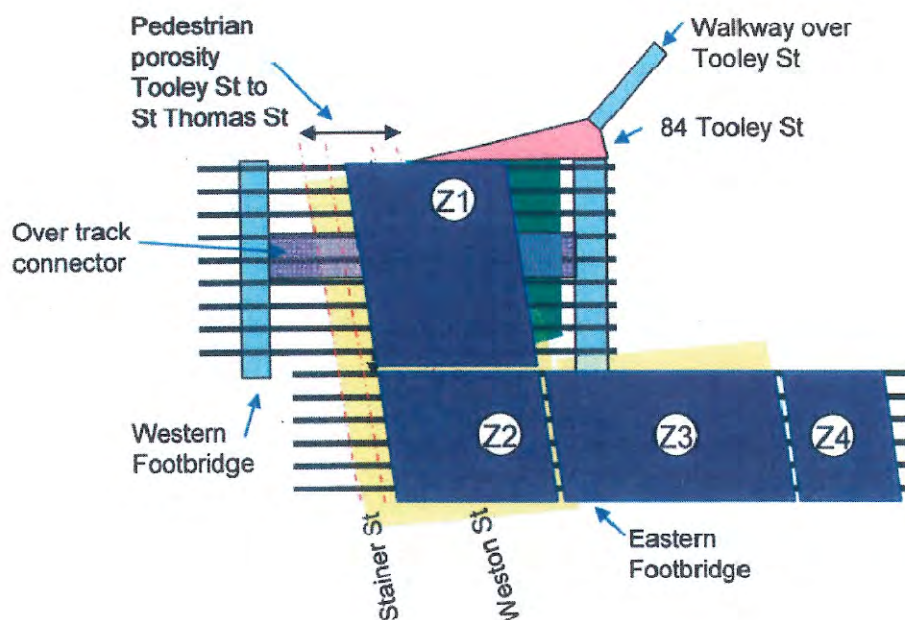
- 'Air rights' – Potential for across station development spanning North to South between Tooley St and St Thomas St (zones Z1 and Z2) and spanning West to East over terminating station tracks bordering St Thomas St (zones Z3 and Z4)



- Under and over track interchange opportunities to reduce construction complexity and improve station functionality



- Under and over track interchange opportunities to reduce construction complexity and improve station functionality with maximised 'air rights'



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4.4.1 KEY ELEMENTS

- Significant cut through between Stainer St and Weston St providing pedestrian porosity between Tooley St and St Thomas St
- All new tracks and platforms
- Opportunity to accommodate track layout for LL station as illustrated in 4.7 of this document
- Circa 1,500,000 sq ft of potential 'air rights'

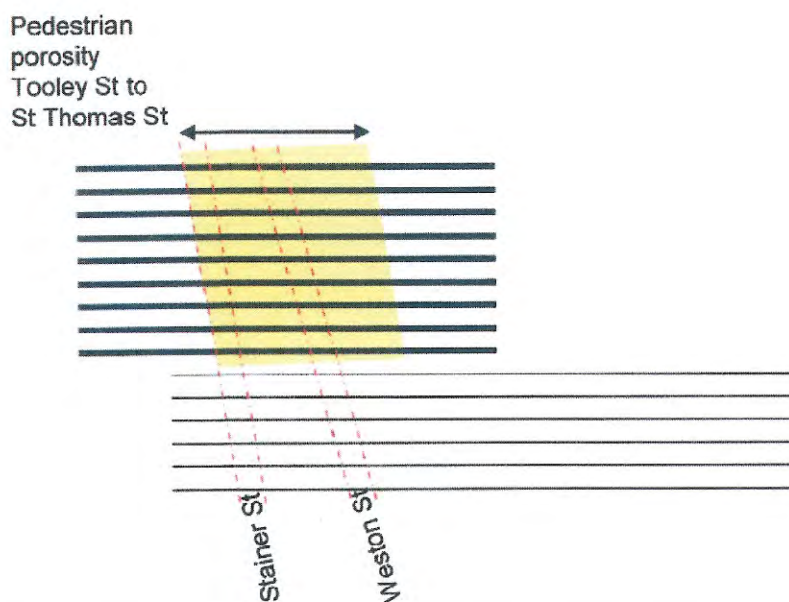
4.4.2 GRIP 3 DEVELOPMENT REQUIREMENT

- Confirmation of passenger capacities to 2016 + 35%, inclusive of SOG and 25LBP impacts, that can be accommodated compliant with the specified FRUIN levels of service
- Investigate provision of footbridges and over track connector to enable resilient passenger flows
- Investigate opportunity to accommodate track layout for LL station as illustrated in 4.7 of this document within the limits of deviation of the TWA and without the need to remove the existing signal box structure.
- Investigate retention of 84 Tooley St to achieve vertical access to Zone Z1 'air rights', to under track interchange and to eastern footbridge.
- Investigate provision of walkway over Tooley St
- Consider 'air rights' options:
 - no 'air rights',
 - Z1+Z2,
 - Z2+Z3,
 - Z1-4,
 - Z3+Z4

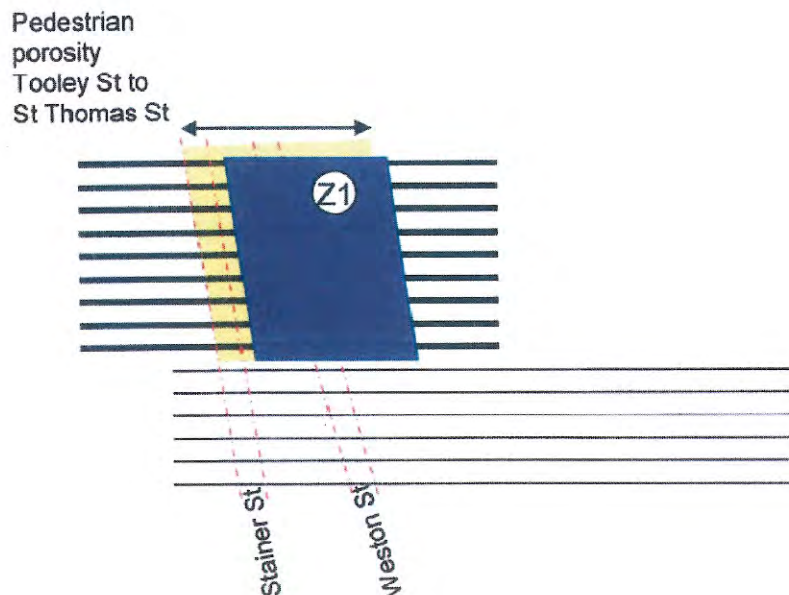
4.5 OPTION 3 – High Level Station Works

This scheme is effectively the Updated Masterplan scheme for the high level station only.

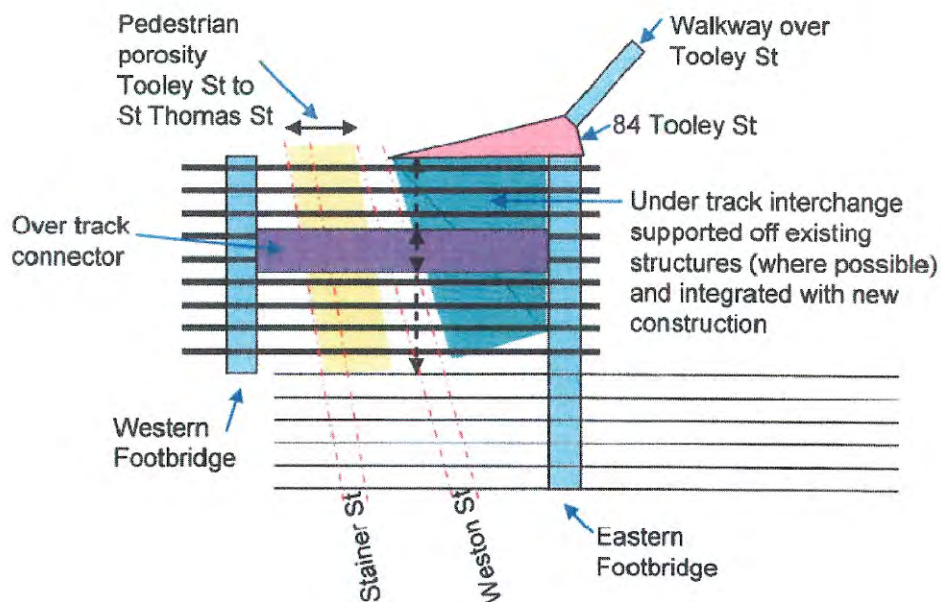
- Street level - reduced cut through / demolition under high level station.



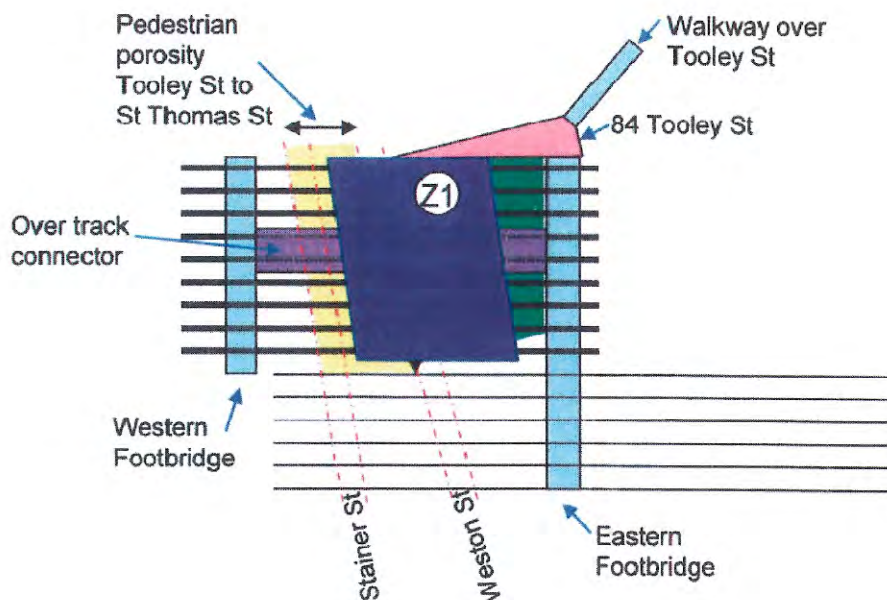
- 'Air rights' – Potential for across station development spanning North to South over HL station only (zone Z1)



- Under and over track interchange opportunities to reduce construction complexity and improve station functionality. Potential for reducing extent of cut through / demolition under high level station.



- Under and over track interchange opportunities to reduce construction complexity and improve station functionality with maximised 'air rights' (zone Z1) over high level station.



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4.5.1 KEY ELEMENTS

- Pedestrian porosity between Tooley St and St Thomas St
- Potentially all new tracks and platforms in high level station
- Circa 450,000 sq ft of potential 'air rights' over high level station. Air rights over low level station safeguarded.

4.5.2 GRIP 3 DEVELOPMENT REQUIREMENT

- Confirmation of passenger capacities inclusive of SOG and 25LBP impacts, that can be accommodated compliant with the specified FRUIN levels of service
- Identify extent of minimum work that needs to be undertaken in the low level station to enable London Bridge to operate fully.
- Investigate provision of footbridges and over track connector to enable resilient passenger flows
- Investigate retention of 84 Tooley St to achieve vertical access to Zone Z1 'air rights', to under track interchange and to eastern footbridge.
- Investigate provision of walkway over Tooley St
- Identify minimum requirements to achieve pedestrian access to provide north / south cut through between Tooley St and St Thomas St to satisfy London Borough of Southwark.
- Consider 'air rights' options:
 - no 'air rights',
 - Z1
 - Z1 and safeguarding for Z2, Z3 and Z4

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4.6 OPTION 4 – Updated Masterplan without ‘air rights’

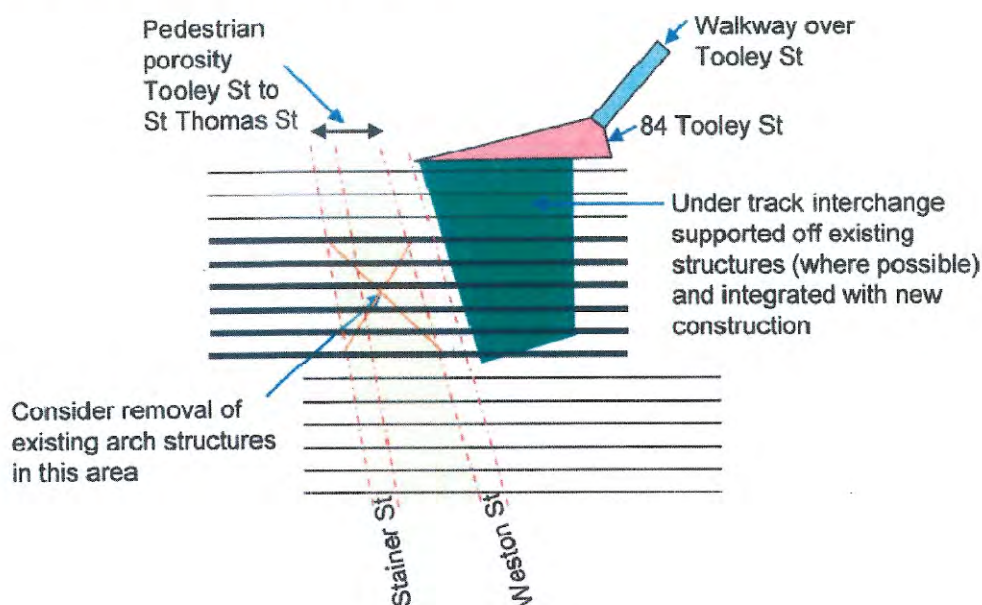
4.6.1 GRIP 3 DEVELOPMENT REQUIREMENT

- This option is now superseded as it is effectively Option 2 without ‘air rights’
- No further development work required at this stage on this option

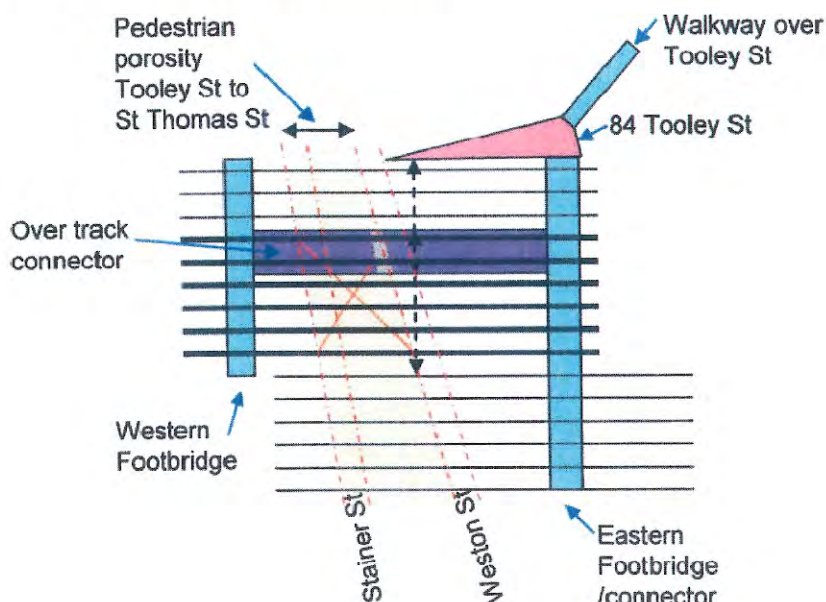
4.7 OPTION 5 – Core Scheme

The concept of this scheme is to reduce the extent of demolition of the existing structures to a minimum and to utilise existing structures, where possible to support infrastructure in the station design. Two versions of this scheme are to be worked up, one to accommodate passenger capacities to 2016 + 5% and another to accommodate passenger capacities to 2016 + 35%

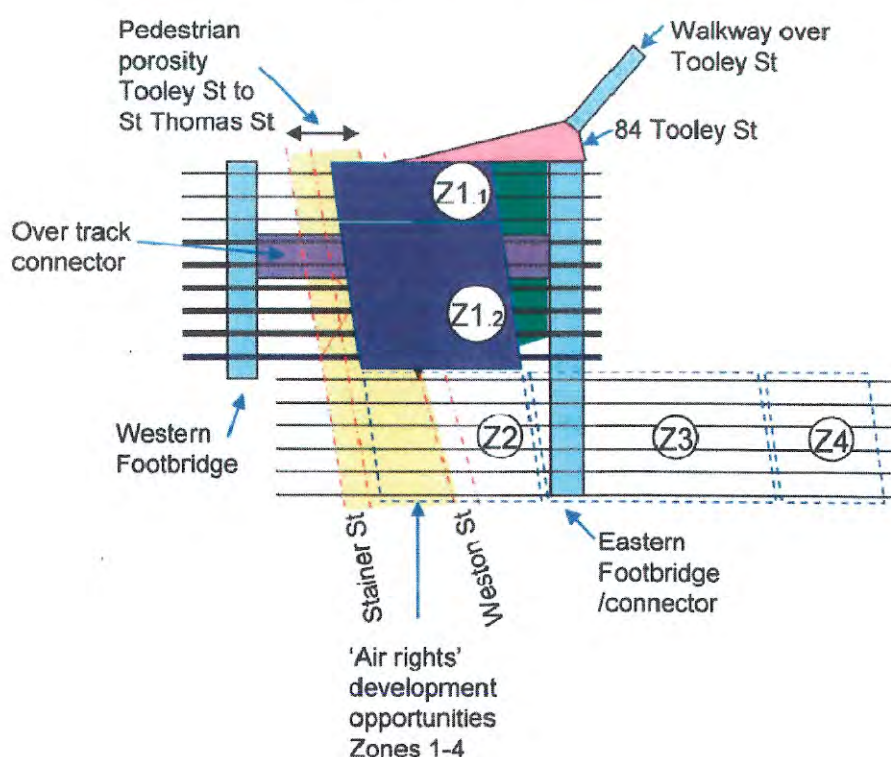
- Under track interchange opportunities



- Over track interchange opportunities



- Under and over track interchange opportunities to reduce construction complexity and improve station functionality. Potential for reducing extent of cut through / demolition with maximised 'air rights' over high level station (may result in sub zoning to reflect available foundation solutions, (zones Z1.1 and Z1.2). 'Air rights' opportunities over low level station safeguarded (zones Z2, Z3 and Z4)



4.7.1 KEY ELEMENTS

- Pedestrian porosity between Tooley St and St Thomas St
- Opportunity to retain tracks 1,2 and 3 HL station and 11-16 LL station with possible extension of tracks 14-16
- Opportunity to accommodate track layout for LL station as illustrated in 4.7 of this document
- Circa 450,000 sq ft of potential 'air rights' over high level station. Air rights over low level station safeguarded.

4.7.2 GRIP 3 DEVELOPMENT REQUIREMENT

- Confirmation of passenger capacities to 2016 + 5% and to 2016 + 35%, inclusive of SOG and 25LBP impacts, that can be accommodated compliant with the specified FRUIN levels of service

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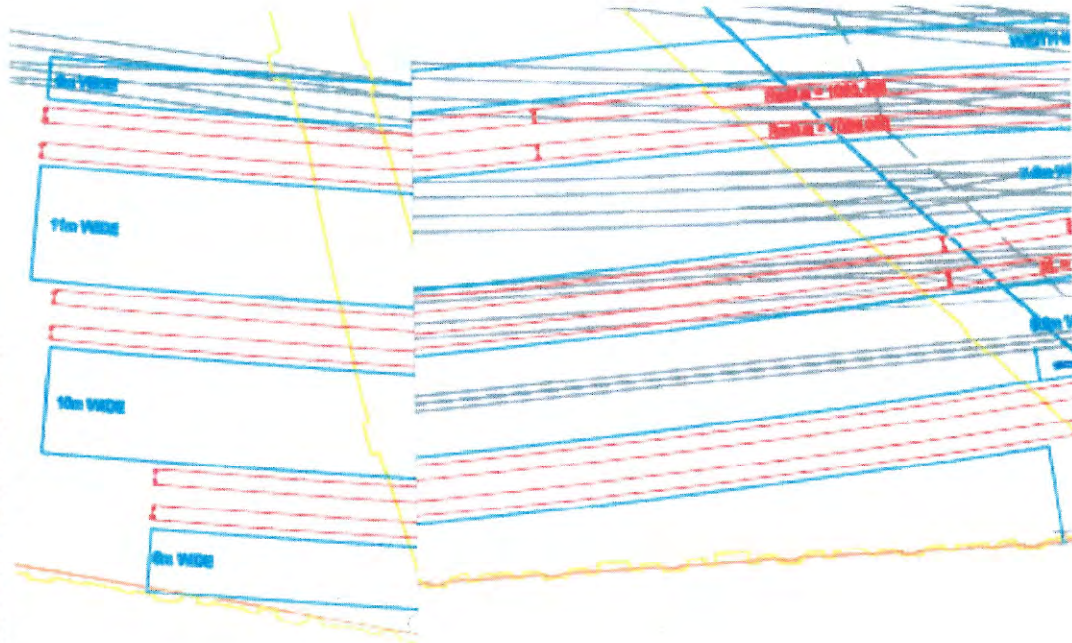
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- Investigate provision of footbridges and over track connector to enable resilient passenger flows
- Investigate retaining existing tracks 1,2 and 3 HL station and 11-16 LL station with possible extension of tracks 14-16
- Investigate opportunity to accommodate track layout for LL station as illustrated in 4.7 of this document within the limits of deviation of the TWA and without the need to remove the existing signal box structure.
- Investigate retention of 84 Tooley St to achieve vertical access to Zone Z1 'air rights', to under track interchange and to eastern footbridge.
- Investigate provision of walkway over Tooley St
- Consider 'air rights' options:
 - no 'air rights'
 - potential opportunity for Z1 'air rights' in one or two blocks (Z1.1 / Z1.2)
 - safeguarding for Z2, Z3 and Z4

4.8 LL station track layout for incorporating into OPTIONS 2 and 5.

(new track layout shown in red overlaid onto
existing track layouts shown in black)



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4.9 Fruin Levels for Passenger Service

4.9.1 The FRUIN levels of services for passenger service is to be as follows:

- As Open Concourses – Level of Service B
- Queuing for ticket hall facilities – Level of Service C
- Passageways: one-way – Level of Service D
- Passageways: two-way – Level of Service C
- Stairs: one-way – Level of Service D
- Stairs: two-way – Level of Service C
- Platforms – Level of Service C
- Escalators – 100 passengers / minute

4.9.2 FRUIN levels of Service

- A – Free circulation
- B – Free circulation with some conflicts
- C – Slightly restricted with cross flow difficulty
- D – Restricted circulation for most

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4.10 Projected Capacity - Passenger numbers

AM	2006 3 Hour Peak		DESTINATIONS			
			Terminating Platform	Through Platform	LUL	Street
ORIGINS	Terminating Platform		0	6991	8706	22867
	Through Platform		1836	8530	10805	19452
	LUL		2206	1057	7477	17557
	Street		2424	2475	7792	3057
			6466	19053	34780	62933
TOTAL			123232			

PM	2006 3 Hour Peak		DESTINATIONS			
			Terminating Platform	Through Platform	LUL	Street
ORIGINS	Terminating Platform		0	2430	2714	2888
	Through Platform		5522	8001	1524	3101
	LUL		6696	7503	7005	11286
	Street		17223	13854	17651	2645
			29441	31798	28894	19920
TOTAL			110053			

1. 2006 – origin destination matrices based on station surveys.
 2. 2016 – demand forecast deduced using TFL Railplan model
 3. 2026, 2046, 2076 – based upon 0.5% per annum growth (compound).
- Therefore, reflects 2016 + 5%, +20% and +35% growth respectively.

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5. Part A - Output Deliverables

5.0 Establishing Option Selection Criteria

- 5.0.1 The approach identified in section 4.0 is to be followed and further developed in conjunction with the Client Sponsor such that agreements are reached on selecting suitable option selection criteria. The Client Sponsor will be accountable for agreeing, with input from the KO2 Delivery team, the option selection criteria that will be used to select the preferred option.

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6. References

Ref	Document Title	Revision	Document Reference Number	CCMS/MOSS Reference
[1]	London Bridge Station High Level Option Selection Report	2.3	N231-NR-ASS-CL-000001	8104118
[2]	Thameslink Functional Specification	7.1	N000-01000-NRT-SPE-CL-000004	5997748

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7. Abbreviations

Abbreviation	Definition
CAD	Computer aided design
CCTV	Closed Circuit Television
CIS	Customer Information System
DfT	Department for Transport
ECR	Emergency Control Room
FRUIN	The Fruin scale of Levels of Service
GRIP	Guide to Railway Investment Projects
HL	High Level (station)
HLOSR	High Level Option Selection Report
LB	London Bridge
LBP	London Bridge Place
LL	Low Level (station)
LU	London Underground
LUL	London Underground Limited
MIP	Mobility Impaired
TLP	Thameslink Programme
TOC	Train Operating Company
TWA	Transport & Works Act
SCR	Station Control Room
SOG	Shard of Glass
SPSG	LUL – Station Planning Standards and Guidelines
SRA	Strategic Rail Authority

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KO2 Inner Areas – N231 London Bridge: Technical Option Definition & Feasibility Assessment – Part B

Prepared by:

– Design Integration Manager

Date:

Approved by:

– N231 Senior Programme Manager

Date:

Approved by:

– KO2 Scope & Development Manager

Date:

Approved by:

– KO2 Senior Estimating Manager

Date:

Authorised by:

– N231 London Bridge Station Sponsor

Date



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0.1	First Draft Issued for Comments	March 2010	Analysis of options 1, 2A, 2D, 3B, 5B, 5E, 5Z(5)
0.2	Second Draft Issued for Comments	June 2010	Addition of option 6B(3)
0.3	Third Draft Issued for Comments	July 2010	Addition of interim option selection description
1.0	First Issue		Document signed off for GRIP Stage 3

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References Documents

Section 1		
1/1	Technical Option Definition & Feasibility Assessment Part A	N231-0104733-NR-REP-PC-000001 v2
1/2	Thameslink Functional Specification	N000-01000-NRT-SPE-CL-000004 v7.1
1/3	London Bridge Project Design Specification	N231-01000-NRT-SPE-EG-000001 v1.0
1/4	London Bridge Station Historical Study	N231-104733-ALB-REP-ST-000001 v2.0
1/5	High Level Output Specification – Operational Station	TLP-N231-NR-REP-CL-000003
1/6	High Level Output Specification – Rail Systems	TLP-N000-NR-REP-CL-000001
1/7	High Level Output Specification – Construction Phasing	TLP-N231-NR-REP-CL-000002
1/8	High Level Output Specification – Air-rights Development	TLP-N231-NR-REP-CL-000004
1/9	N231 London Bridge Station – Grip 3 - ID25 Principal Project Options	N231-104733-TPB-REP-AR-000003
1/10	ID5 – GRIP 3 Design Status Report & GRIP 4 Design Activity Risk	N231-32110-TPB-REP-AR-000009 v1.2
1/11	London Bridge Station GRIP 3 Design Status Report	N231-32112-ALB-REP-ST-000016 v4.0
Section 2		
2/1	London Bridge Station Priority Task: Principal Project Options Draft ID25	N231-104733-ALB-REP-ST-000006 v1.4
2/2	London Bridge Station Structural Options Review Prepared for Network Rail Task ID40 (Incorporating ID64)	N231-32112-ALB-REP-ST-000001 v2.0
2/3	ID40.1 Existing Structures Appraisal Part 1 – Existing Viaduct & Station Structures	N231-104733-ALB-REP-ST-000016 v2.0
2/4	ID40.1 Existing Structures Appraisal Part 2 – Existing Structures & Supporting Information	N231-104733-ALB-REP-ST-000017 v2.0
2/5	ID40.1 Existing Structures Appraisal Part 3 – Impact of Alterations for the Selected Option	N231-104733-ALB-REP-ST-000018 v2.0
2/6	ID40.1 Existing Structures Appraisal Part 4 – Third Party Interfaces & Buried Services	N231-104733-ALB-REP-ST-000019 v1.0
2/7	GRIP 3 Fire Strategy Report	N231-32370-ARP-FR-000002 (Final Issue for 5Z)
2/8	Evacuation Assessment for Option 5Z	N231-32370-ARP-ASS-SQ-000000 Issue 1
2/9	Tenability Conditions Assessment of Option 5Z	N231-32370-ARP-RET-FR-000001 Issue April 2010
2/10	London Bridge Station – GRIP 3 Services Report	N231-32370-ARP-REP-ME-000002 Issue 1
2/11	SISS Telecoms Design Statement for London Bridge Station	N231-104733-NR-RET-TL-000001 v1.0
2/12	London Bridge Station Information and Surveillance Systems Migration Strategy	N231-104733-NR-COM-TL-000002 v1.0
2/13	Thameslink Programme – London Bridge Station – Town Planning Strategy and Policy Option 5Z5 Report	N231-32114-CGM-REP-CN-000001 v1.0



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2/14	Thameslink Programme – London Bridge Station – Town Planning Strategy and Policy Option 6B(3) Report	N231-32114-CGM-REP-CN-000002 v1.0
2/15	N231 London Bridge Station – ID25 Addendum	N231-104733-TPB-REP-AR-000212 v3
2/16	ID40 London Bridge Station - Option 6B(3) Structural Options Review	N231-32112-ALB-REP-ST-000010 v2.0
2/17	Site Specific Fire Strategy Requirements Statement and High Level Assessment Option 6B(3)	N231-32370-ARP-REP-FR-000005 Rev 3
2/18	Evacuation Assessment for Option 6B(3)3 Grip 3 Network	N231-32370-ARP-REP-FR-000006 Rev 3
2/19	Tenability Conditions Assessment for Option 6B(3)	N231-32370-ARP-REP-FR-000007 Rev 3
2/20	GRIP 3 Services Report Option 6B(3)	N231- 32370-ARP-REP-EG-000001 (Issue 1)
2/21	High Level Assessment Option 6B(3)	N231-32370-ARP-REP-EG-000002
2/22	Migration Strategy Report Option 6B(3)	N231-32370-ARP-REP-EG-000004

Section 3

3/1	London Bridge Station Operations & Control Concept	N231-01000-NRT-STR-OP-000001 v2.0
3/2	London Bridge Station – Accommodation Layout & Staging Strategy	N231-01000-NRT-GPH-PP-000001 v1.0
3/3	N231 London Bridge Station – Grip 3 ID19 Station Accommodation Summary Report	N231-104733-TPB-REP-AR-000005
3/4	London Bridge Station Redevelopment - Fourth Working Draft of the Proposed Station Room Schedule	N231-NR-SCH-AR-000001
3/5	Passenger Capacity Assessment – Masterplan & Derivatives	N231-01000-NRT-ASS-PD-000002
3/6	Passenger Capacity Assessment – Core Option & Derivatives	N231-01000-NRT-ASS-PD-000001
3/7	Passenger Capacity Assessment – Option 6B3	(N231-01000-NRT-ASS-PD-000008)

Section 4

4/1	GRIP 3 Construction Planning & Constructability Assessment	N231-104733-BBM-REV-CON-000007 v1.
4/2	London Bridge Station – ID60 Proposed Viaduct Extension Structures	N231-104733-ALB-REP-ST-000005 v1.0
4/3	Initial Review of Joiner Street Rail Under bridge (Bridge 54) (ID61)	N231-104733-ALB-REP-ST-000015 v2.0
4-4	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge – Arches Beneath the Station – Zone 1	N231 104733 RSL REV SU 000004 (Issue 30/10/2009)
4-5	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge – Arches Beneath the Station – Zone 2	N231 104733 RSL REV SU 000005 (Issue 30/10/2009)
4-6	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge – Arches Beneath the Station – Zone 3	N231 104733 RSL REV SU 000006 (Issue 30/10/2009)



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4-7	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge Station - Former Luggage Survey the Rat Run	N231-104733-RSL-REV-SU-000007 (Issue 30/10/2009)
4-8	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge Station – Arches Beneath the Station – Zone 4	N231 104733 RSL REV SU 000008 (Issue 30/10/2009)
4-9	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge Station – Arches Beneath the Station – Zone 5	N231 104733 RSL REV SU 000009 (Issue 30/10/2009)
4-10	Anthrax Survey London Bridge Station - Arch E951 (Zone 4) and 84 Tooley Street Basement	N231-104733-RSL-REV-SU-000010 (Issue 30/10/2009)
4-11	Analysis of Water Samples Taken from London Bridge – Arches E938 and E92	N231-104733-RSL-REV-SU-000011 (Issue 30/10/2009)
4-12	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge Station - Tenanted Areas within Station	N231-104733-RSL-REV-SU-000012 (Issue 20/11/2009)
4-13	Results of Asbestos Identification – Short Report B Block Accommodation, London Bridge Station	N231-104733-RSL-REV-SU-000014 (Issue 17/11/2009)
4-14	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge Station – A Block (Ground Floor), Ticket Office, Vaults, Subways & main Service Corridor Area	N231-104733-RSL-REV-SU-000015 (Issue 20/11/2009)
4-15	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge Station - Platforms and Associated Structures (Excluding Overbridge)	N231-104733-RSL-REV-SU-000016 (Issue 20/11/2009)
4-16	Analysis of water samples taken from the Shunt Theatre, arches above Zone 2, London Bridge	N231-104733-RSL-REV-SU-000018 (Issue 12/10/2009)
4-17	Analysis of Water and Sludge Samples Taken from the Rat Run, Former Luggage Subway at London Bridge Station	N231-104733-RSL-REV-SU-000019 (Issue 25/11/2009)
4-18	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge Station - Platform 7 Demolition Area	N231-104733-RSL-REV-SU-000020 (Issue 15/12/2009)
4-19	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge Station - Platform Overbridge	N231-104733-RSL-REV-SU-000022 (Issue 15/12/2009)
4-20	Results of Asbestos Identification - Short Report: Main Concourse Roof & Gate Line, London Bridge Station	N231-104733-RSL-REV-SU-000021 (Issue 15/12/2009)
4-21	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge Station - Annex E Accommodation Block	N231-104733-RSL-REV-SU-000025 (Issue 15/12/2009)
4-22	Health and Safety Surveys for Enabling Works Hazardous Materials Survey – Including Type II Asbestos Survey London Bridge Station – Accommodation Areas Blocks D,E & F	N231-104733-RSL-REV-SU-000026 (Issue 13/01/2010)
4-23	London Bridge Station Interim Bat Survey	(No Document Number)
4-24	N231 London Bridge Station Outline Monitoring Strategy	N231-104733-LBA-RET-SU-000002
4-25	Existing Services Layout	MCN-DN-NWR-09-291
4-26	London Bridge Station Multi-Utility Diversion C3 Consultancy Report	(no document number)
4-27	Environment Appraisal Action Plan	N231-01000-NRT-PLN-EN-000001
4-28	Sustainable Design Options Report	N231-3210-TEG-REP-EN-000001
4-29	Sustainability and Renewable Energy Options - Feasibility Study MEP	N231-32370-ARP-REF-EN-



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	Services	000001
4-30	CEEQUAL Pre-Assessment Score Sheet for LBS	(no document number)
4-31	Thameslink Programme N231 London Bridge GRIP 3 Survey Strategy	N231-01000-NRT-STR-SU-000001 v1.0

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Acronyms:

ATM	Automated Teller Machines
BTP	British Transport Police
CABE	Commission for Architecture and the Built Environment
ETFE	Ethylene Tetrafluoroethylene
KO2	Key Output 2
LUL	London Underground Limited
MIP	Mobility Impaired Persons
TfL	Transport for London
TOC	Train Operating Company
TODFA	Technical Option Definition and Feasibility Assessment
TLP	Thameslink Programme
TRANSEC	Transport Security and Contingencies
RSPG	Railway Safety Principles and Guidance
SAV	Station Approach Viaduct
SAVEX	Station Approach Viaduct Extension

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Section 1 – Design Development Overview

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1. Purpose

A Technical Options Development and Feasibility Assessment (TODFA) report is a requirement of ENH02 and GRIP 3 and the purpose of it is given as:

‘The purpose of a Technical Option Definition & Feasibility Assessment is to articulate and evaluate the (detailed) technical solution options for delivering the requirements set out in the Functional Specification. This process must cover all engineering disciplines.’

Early in the GRIP 3 stage a decision was made to produce the TODFA in two parts, A and B. The part A document REF[1/1] was produced by the Project Sponsor in order to guide the development of the designs through GRIP 3, it gave an overview of five concept option types for further development.

This document is the TODFA Part B report and it provides an analysis of the work done to date in developing the TODFA Part A options in order to aid the overall decision making process for the final option selection.

This document is split into four sections. This section gives an overview of the development history of the project highlighting the key milestones achieved and the decisions made to arrive at the preferred scheme Option 6B(3).

Section two provides a summary of each of the station layout options taken forward for development. In particular this section aims to highlight the key technical issues that differentiate between the options. For each of these options an analysis is undertaken which includes a review of:

- Architectural and structural overview
- Consents and planning
- Mechanical and electrical services

Section three explains the operational aspects of the station that essentially form a set of requirements to feed into the design process, against which the option can be assessed. This section covers:

- Station and train operations
- Accommodation requirements
- Passenger capacity

Section four covers the supplementary technical studies that have taken place, covering a range of subjects, which in general do not determine station option selection, but are required to understand the feasibility of the whole scheme. These areas are:

- Stakeholder interfaces
- Interfacing structures
- Site surveys
- Utilities investigations
- Environment and sustainability
- Railway systems design overview
- Construction phasing

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- Systems Engineering

In essence this report is intended as a technical guide to the main development work undertaken during the GRIP 3 stage by Network Rail and its suppliers. Throughout the text references are given to key source documents that should be read for an in depth understanding of each of the technical areas.

2. Scope

2.1. Overview

The Thameslink Programme, (TLP), is required to provide a significant increase in railway capacity through central London. To achieve this a programme of works will be completed in stages with Key Output 2 (KO2) being the final stage to be delivered to permit the introduction of the enhanced Thameslink services by December 2016.

To enable Thameslink requirements to be achieved, KO2 includes a proposed major reconstruction of London Bridge Station, changing the station from 9 terminating and 6 through platforms to 6 terminating and 9 through platforms. This will allow up to 18 trains per hour through the station and the associated increases in passengers using the station. Planning permission has been granted for a scheme known as Masterplan, which permits the required changes to the railway, below track retail developments and an above track 'air rights' commercial development.

Since the granting of the planning permission several new developments, most significantly the Shard of Glass, have happened that directly impact the station design. As a result of this, modified schemes have been developed for consideration within the current GRIP 3 stage.

The scope of this document is the development of London Bridge Station final scheme only.

2.2. Development Objectives

The objective of GRIP 3 design development of London Bridge Station is to select a single option that meets requirements and is technically feasible. Further to this the design must meet the high level requirements set out by the Department for Transport, who have set requirements for the Thameslink programme as a whole in the form of a Department for Transport Brief (currently a baseline at v4; negotiations are at v8) which is translated by Network Rail into a Functional Specification (currently a baseline at v7.1) REF[1/2]. These requirements are for the Thameslink programme overall, not specific to London Bridge Station, and a further set of London Bridge specific Department for Transport requirements have been derived, given in section 2.3 below.

There are many aspects of the development that have not been given as measurable requirements, nevertheless they have been considered through the design process. The station is to be a building fit for central London with the associated public realm benefits. This objective is enhanced when the station is viewed as a part of the London Bridge area, which now includes the Shard of Glass as a neighbour. Business drivers include the generation of funding opportunities through the inclusion of retail units and commercial developments, although there are no specific targets for either of these, there is a trade off between overall capital cost against future revenue potential which must be considered in the overall decision making process. There may also be future strategic property development opportunities in and around the station which enhance the overall value of the scheme, these ought to be identified and the potential for providing provision for these included in the

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designs. Within the GRIP 4 stage the Network Rail Commercial Property team will need to seek the relevant approval for any additional commercial facilities.

The functional performance of the station is largely around people movement, meeting train service capability and providing operational resilience. Pedestrian flow modelling has been undertaken for several options to prove the capacity of station options. In addition a Stations Project Working Group has been implemented as a stakeholder forum that includes representatives from the project team, the London Bridge station management team, and representatives from train operations companies. The work of this group has resulted in the production of an operational concept which will detail the way in which the future station is envisaged to operate.

The GRIP 3 document that captures the requirements is the London Bridge Project Design Specification REF[1/3]. This document has been written from all the available sources to as listed in the tables below:

Table 1 - Instructed Requirements for London Bridge Station used in the production of the PDS		
Instruction to Project	Document Reference Number	Version
TLP Functional Specification	N000-NRT-SPE-CL-000004	7.1
London Bridge Commitment Register	N231-01000-NRT-REG-CN-000001	1.0
London Bridge Environmental Mitigation Schedule	N231-01000-NRT-SCH-EN-000001	1.0
London Bridge Consent Schedule	N231-01000-NRT-REG-CN-000001	1.0
Train Control Specification	ON TREQS DATABASE	
Train Infrastructure Interface Specification	ON TREQS DATABASE	

In addition to the instructed requirements shown in Table 1 the project have, during the development of the Project Design Specification, also drawn upon the documents shown in Table 2 as guidance for requirements

Table 2 – Additional Guidance Sources for Requirements used in the production of the PDS	
Source of Requirements	Document Reference Number
Station Project Working Group Meetings (tranche 1)	ON TREQS DATABASE
Station Project Working Group Meetings (tranche 2)	N231-01000-NRT-MIN-PD-000001
London Bridge Station GRIP 3 Services Report	N231-32370-ARP-REP-EG-000001
Lift & Escalator Requirements Statement for Option 6B	N231-32150-BUY-STM-ME-000002
Evacuation Assessment for Option 6B	N231-32370-ARP-REP-FR-000003
Site Specific Fire Strategy Requirements Statement and High Level Assessment of Option 6B	N231-32370-ARP-REP-FR-000005
SISS Telecoms Design Statement for London Bridge Station	N231-104733-NR-RET-TL-000001
SISA Stations and Station Control	N000-01000-NRT-SAF-EA-000002
London Bridge Station Annexes	
Managed Station Design Guide	
'Railway Safety Principles and Guidance on Stations'	
Enhancement Engineering Programme Specification	

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2.3. Department for Transport Requirements

The requirements in table 1 were confirmed in consultation with Network Rail and Department for Transport at a meeting on the 3rd September 2009.

<u>Table 3: Department for Transport Requirements for London Bridge Station</u>	
Train Services	<ul style="list-style-type: none"> • Timetable version 1e (train service capability) • 18 tph for Thameslink services • 20 tph for Cannon Street services • 28 tph for Charring Cross services • 20 tph terminating at the Low Level • A total of 86 tph through London Bridge Station
Platform Lengths	<ul style="list-style-type: none"> • High level platforms: all 12 car • Low level platforms: 4x12; 1x10; 1x8 • Sufficient weather protection cover to disperse people along the platforms • All platforms to be DDA compliant
Passenger Routes	<ul style="list-style-type: none"> • Access from Tooley Street & St Thomas Street i.e. North & South • Retain Western access • "Unpaid" North-South route to be considered – identify separately cost & programme impact (non Department for Transport item)
Road Layout	<ul style="list-style-type: none"> • No requirement to close roads (Stainer & Weston) but need to consider how we service the station • Suitable access to the station to be maintained for servicing, maintaining, operations, emergency services)
Bus Station / Taxis	<ul style="list-style-type: none"> • Station solution to be appropriate for inter-modal flows
Streetscape	<ul style="list-style-type: none"> • Scheme has to work in the context of local streets and pedestrian movements.
Retail	<ul style="list-style-type: none"> • Sufficient retail provision to be provided. (Not a Department for Transport specific requirement)
Passenger Numbers	<ul style="list-style-type: none"> • 2016 figures + 35% (where 2016 = 2006 + 1.5% p.a)
Construction	<ul style="list-style-type: none"> • 3 year construction duration - To achieve 86 tph by Dec 2015 • During construction period, accommodate 24 tph in L – L

3. Development History

3.1. London Bridge Historically

The findings of historical research undertaken into the evolution of London Bridge Station are presented in the Alan Baxter's report REF[1/4], which presents a record of the understanding of the evolution of the station compiled from official historical records and observation of the



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station fabric. The historical understanding that has been captured will be a valuable resource for the subsequent design phases and for the construction process.

London Bridge Station was opened in December 1836 as the terminus of the London & Greenwich Railway comprising of only three tracks and two platforms. The station was subsequently expanded to provide an additional terminus for the London & Croydon Railway, and then altered to accommodate the traffic of the London & Brighton and South Eastern Railways. A Joint Station was opened in 1844, two separate stations being built following the amalgamation of the four railway companies into two – the South Eastern and the London, Brighton & South Coast in 1845 and 1846 respectively.

As the various companies operating out of London Bridge developed their railway networks, the station was altered to cope with increasing numbers of passengers. In the 1860s, the South Eastern terminus underwent major alteration as it became a through station, with trains to Charing Cross and Cannon Street.

The London, Brighton & South Coast Railway terminus was further extended southwards and the present train shed erected. The companies operating out of London Bridge were amalgamated into the Southern Railway in 1923, and some efforts were made to unify its two halves. The station suffered bomb damage during WW2, and was extensively remodelled in the late 1970s into its present format.

3.2. Pre-GRIP Development

In October 2006 the Secretary of State for Transport and the Secretary of State for Communities and Local Government granted legal powers and planning consents to Network Rail for the Thameslink Programme. Planning permission and statutory powers for the scheme have been granted, together with listed building and conservation area consents.

The original scheme for London Bridge Station (as part of Railtrack's Thameslink 2000 programme) was developed by Terry Farrell Architects with Scott Wilson. Between 1996 and 1999 the design team produced RIBA B, C & D development reports for this scheme; the stage 'D' reports are dated 23 September 1999.

The scheme was rejected in the 2000 Thameslink Public Inquiry. The Inspector included reasons that the scheme at London Bridge did not address adequately the issues and did not provide a station fit for a world class city.

In parallel, T.P. Bennett was tasked by Network Rail Commercial Property with working up an alternative scheme design for the station. This scheme, referred to as Masterplan, was submitted and gained planning consent from the London Borough of Southwark on 30th September 2003. Planning, Listed Building and Conservation Area consents for the London Bridge "Masterplan" design were granted by the London Borough of Southwark on 30th September 2003.

3.3. GRIP 2 Development

During the period when work on London Bridge Station design was suspended, Network Rail corporately introduced the Guide to Railway Investment Projects (GRIP).

When the Key Output 2 programme was resumed in January 2008, the project maturity was assessed to be in the GRIP 2 stage. During 2008, the London Bridge development project



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undertook a number of studies that examined various options for rail systems, station and above-station development designs.

Towards the end of 2008 the project team began the process of selecting design options, with the aim of maturing a selection of preferred solutions during GRIP 3. The result of the work was summarised in a suite of High Level Option Selection Reports REF[1/5, to 1/8].

In September 2008, the project hit a significant milestone when the completion of the Arch 77 works preserved the planning permission by demonstrating the start of construction at London Bridge. Listed Building consent was extended until 25th November 2011 by London Borough of Southwark on the 26th November 2008.

The N231 London Bridge Station project was successfully granted GRIP 3 status on the 27th March 2009.

3.4. GRIP 3 Development

The GRIP 2 Options were developed into a further set of options for development at GRIP 3. These were captured in the TODFA Part A REF[1/1] document and then reviewed by the project team and sponsor team to further refine the design direction. Amongst the key technical outcomes of this initial work was the decision that the proposed walkway over Tooley Street and retention of 84 Tooley Street were not feasible and that they should not be pursued. Other requirements presented in TODFA Part A were thought to be feasible with minor variations. The sub-options presented in the TODFA Part A are all variations of the following major layout options as follows:

- Option 1** The consented Masterplan scheme
- Option 2** An Updated Masterplan scheme
- Option 3** High level station works (a truncated Masterplan)
- Option 4** Updated Masterplan without 'air rights'
- Option 5** Core scheme (reduced demolition)

From an analysis of the TODFA Part A it was observed that all type 2 options are able to be derived by substitution or omission of elements between sub-options 2.1 and 2.4. Option type 3.1 is the same as 3.2 with omission of over-site development. Option 3.2 can be extracted from option 2 by omitting elements, option 3.3 is a copy of option 3.2 without implementation of over-site development in zones 2, 3 and 4. Option 4 was eliminated in the TODFA Part A document and no further work was instructed. All option 5 type schemes do not function well with over-site development and retention of track 1,2 and 3 as existing does not enhance the scheme. All options types required removal of the listed roof structure. In all option types the Low Level Station tracks will not meet the required functionality criteria and therefore the low level terminal requires remodelling. All option types require some demolition and strengthening to railway arches, in general more demolition will require less strengthening.

The appointed architect, TP Bennett developed a total of 15 sub-options based on the TODFA Part A options, the results of this study can be seen in the report REF[1/9]. These options were further narrowed down to five options, 2A, 2D, 3B, 5B and 5E. An analysis of these showed that there was a high risk that they would not fit into the available budget for

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the redevelopment. In response to this a further option was instructed to be developed that met the minimum requirements without the constraints of the existing planning consent and commercial development requirements. This work resulted in a substantially new option based on an over-deck providing the concourse space required for passenger capacity. In October 2009 following a review with the Department of Transport and further refining, this design became Option 5Z(5) as presented in this report.

In November 2009 a peer review of the design was conducted by Network Rail's Station Design Team. The key outcome of this review was the decision to develop in parallel a new Option 6. In January 2009 both options 5Z(5) and 6B(3) were taken forward for development to meet the requirements of the GRIP 3 Stage Gate. A full position statement for the status of the designs as of June 2010 can be found in reference documents for REF[1/10] for architectural and REF[1/11] for structural engineering.

4. GRIP 3 Design Options

Having considered the above analysis the KO2 Project and Sponsor teams agreed the following options to be taken forward to be developed.

Option 1 Masterplan with no changes or amendments to be used as benchmark against all other options.

Option 2A Masterplan layout, over-site development at zones 1 and 2, 84 Tooley Street demolished, no walkway over Tooley Street, Shard of Glass incorporated into design layout. Escape stairs at platform ends to ground level.

Option 2D Masterplan layout with reduced supermarket area, leisure, car park and loading bay, no over-site development, remainder as option 2A.

Option 3B High Level station as Masterplan, Low level station structure remains as existing – arches modified to allow for north-south permeability, Low level terminal remodelled on top of existing arches, no over-site development.

Option 5B High level station concourse area shifted east, reduced footprint and supported on remainder of the existing arches foundations. Low level station structure remains as existing – arches modified to allow for N-S permeability, Low level terminal remodelled on top of existing arches, no over-site development.

Option 5E Main vertical distribution area in the centre of the station within new build high level extension, arches demolished and rebuilt as mini concourse – archway to the north and south as to remain as existing refurbished to maintain N-S permeability. Over-Deck providing access to and from High Level platforms. Low and High level terminals remodelled on top of existing arches, no over-site

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development.

Option 5Z(5)

This option was defined as minimum scheme to meet the requirements. This option utilises the new track and platforms layout overlaid by structural Over-Deck to provide pedestrian access to all areas of the station and provide north-south permeability. There is no work to street level arches.

Option 6B(3)

This option is a Masterplan Derivative and can be described as a base engineering solution. The 6B(3) Option design is the development of a Network Rail Peer Group proposal for an under track concourse beneath standard modular NR bridge deck construction.

5. Option Costs Statement

This section will be completed when the estimates are available at the end of GRIP Stage 3

<u>Table 4: Department for Transport Requirements for London Bridge Station</u>	
Option	GRIP 3 Cost Estimate
Option 1	Not yet available
Option 2A	Not yet available
Option 2D	Not yet available
Option 3B	Not yet available
Option 5B	Not yet available
Option 5E	Not yet available
Option 5Z(5)	Not yet available
Option 6B(3)	Not yet available

6. GRIP 3 Interim Option Assessment

Table 2 below shows the qualitative analysis that was undertaken that resulted in taking forward Option 5Z(5) and Option 6B(3) for further GRIP 3 design development. A subsequent quantitative option analysis of Options 5Z(5) and 6B(3) has been undertaken and will be presented in the N231 GRIP 3 Value Management 2 report, not available at the time of writing.

During the Period June 2009 and October 2009, the 5 schemes identified in the TODFA Part A, REF[1/1] were developed to address concerns on scope and budget in to 15 sub-options. Within this analysis, Option 2A is the benchmark scheme as it is considered a derivative of Masterplan (Option 1) the scheme upon which Planning Approval was achieved.

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In October 2009 Option 5Z(5) was developed as the only option able to meet the budget, but requiring a new planning permission, which, therefore placed the Thameslink Programme delivery date at risk.

Option 6B(3) was developed with the intention of having a design to meet budget constraints and to be similar to the original planning conditions. Subsequently it was established 6B(3) would also require a full new planning application.

“Do Nothing” and “Do Minimum” Options were developed in high level detail in response to a request from the DfT. These options are not presented in this document, as they were developed for client information and inter-option comparative purposes – not proposed by the project as options that could meet the baseline functionality.

The options were assessed according to the following criteria:

Mandatory Criteria: Options must comply with these criteria to warrant further consideration

- | | | |
|----------|-------------------------------|--|
| A | Cost | Delivery capable within current budget assumptions |
| B | Station Capacity | Accommodation of 2016 + 35% base year passenger flows at London Bridge station |
| C | Thameslink Programme Delivery | Ability to achieve Thameslink support functionality 2015 timetable (v 1e) |

Additional Criteria: Options are ranked against whether or not they meet these criteria. Not meeting these criteria does not eliminate an option, but does make it less attractive for further development.

- | | | |
|----------|--|--|
| 1 | Complies with current planning application | North/South connectivity
Discharge of obligations
Overall compliance
Requirement for revised applications |
| 2 | Safety | Passenger, railway and construction safety impacts during construction phase
Security/major incidents/fire strategy impacts |
| 3 | Dec 2017 Construction Programme | Ability to achieve Thameslink Functionality (Note: Dec 2015 is the Functional Specification Date) |
| 4 | Facilities Requirements | End User Requirements at station
Passenger facilities
Ease of use of key routes e.g. to LUL
Revenue protection issues |
| 5 | Passenger impact during construction | Degree of disruption to train services
Passenger capacity and flows during |

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6 Early realisation of benefits

7 Future development opportunity

construction phases

Ability to bring new facilities and capacity into use earlier

Provision for further development in the future (e.g. air rights etc)

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Table 5 – Interim Selection Appraisal identifies assessment of each option relative to high level criteria proposed to the DfT in July 2009

Option	Mandatory Criteria			Additional Criteria							Appraisal Comments
	Meets TLP Budget	Meets 2016 + 5% PED Flow	TLP Delivery	Complies with Current Planning Application	Safety	2017 Construction Programme	Facilities Requirements	Passenger Impact During Construction	Early Realisation of Benefits	Future Development Opportunity	
1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Not Applicable for selection due to the Shard of Glass scheme.
2A	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	Costing threshold exceeded. This option has the costs and passenger flow / ops perceived capacity issues around utilising a Mezzanine interchange deck, including the principle of a 'single point of failure'.
2B1	x	✓	✓	x	✓	✓	✓	✓	✓	✓	Design extends beyond the Limit of Deviation requiring significant 3 rd Party land use agreements. By retaining the 84 Tooley Street building entrance the station concourse has little new street presence & little natural light into the new main concourse. Further costs above those of 2A, due to additional building over Tooley Street.
2B2	x	✓	✓	x	✓	✓	✓	✓	✓	✓	As 2B1 but with further costs above those of 2B1, due to additional footbridge.
2C	x	✓	✓	x	✓	✓	✓	✓	✓	✓	As 2B1, but further costs beyond 2B1 due to the increased extent of the main concourse's mezzanine area.

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Option	Mandatory Criteria			Additional Criteria							Appraisal Comments
	Meets TLP Budget	Meets 2016 + 5% PED Flow	TLP Delivery	Complies with Current Planning Application	Safety	2017 Construction Programme	Facilities Requirements	Passenger Impact During Construction	Early Realisation of Benefits	Future Development Opportunity	
											Structural technical concerns were expressed on extending the Mezzanine only level through the existing arches.
2D	x	✓	✓	x	✓	✓	✓	✓	✓	✓	As 2A (without the Over Site Development & Supermarket demise). This option retained the costs and passenger flow / ops issues around utilising a Mezzanine interchange deck. This option prompted further value engineering leading to option 6B(3).
3A	x	✓	✓	x	✓	✓	✓	✓	✓	✓	This option compromised the terminating train's operational functionality by not rebuilding the Southern half of the station which is needed to provide the necessary infrastructure.
3B	x	✓	✓	x	✓	✓	✓	✓	✓	✓	As 3A, but enhanced to address the passenger flow issues around interchanging between the Mezzanine and Terminating station.
3C	x	✓	✓	x	✓	✓	✓	✓	✓	✓	This option compromised the terminating train's operational functionality by not rebuilding the Southern half of the station which is needed to provide the necessary infrastructure.

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Table 5 – Interim Selection Appraisal identifies assessment of each option relative to high level criteria proposed to the DfT in July 2009

	Mandatory Criteria			Additional Criteria							
Option	Meets TLP Budget	Meets 2016 + 5% PED Flow	TLP Delivery	Complies with Current Planning Application	Safety	2017 Construction Programme	Facilities Requirements	Passenger Impact During Construction	Early Realisation of Benefits	Future Development Opportunity	Appraisal Comments
											The option also extends beyond the Limit of Deviation requiring significant 3 rd Party land use agreements. By retaining the 84 Tooley Street building entrance the station concourse has little new street presence & little natural light into the new main concourse.
5A	x	✓	✓	x	✓	✓	✓	✓	✓	✓	This option has the costs and passenger flow / ops perceived capacity issues around utilising a Mezzanine interchange deck, including the principle of a 'single point of failure'. This option also had structural issues with engineering an under-concourse mezzanine deck by demolishing the top half only of the existing arches.
5B	x	✓	✓	x	✓	✓	✓	✓	✓	✓	As 5A, but with modified circulation elements (the main vertical central circulation core moved South)
5C	x	✓	✓	x	✓	✓	✓	✓	✓	✓	As 5A, but with modified circulation elements (reduced in area)

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Table 5 – Interim Selection Appraisal identifies assessment of each option relative to high level criteria proposed to the DfT in July 2009

Option	Mandatory Criteria			Additional Criteria							Appraisal Comments
	Meets TLP Budget	Meets 2016 + 5% PED Flow	TLP Delivery	Complies with Current Planning Application	Safety	2017 Construction Programme	Facilities Requirements	Passenger Impact During Construction	Early Realisation of Benefits	Future Development Opportunity	
5D	x	✓	✓	x	✓	✓	✓	✓	✓	✓	This option is a large single over-bridge type solution, without the benefit of the foot-bridge deck joining-down into the Western Vaults Mall. The option was assessed as inadequately addressing the passenger numbers or 'pressure' on the Terminating concourse (Shard).
5E	x	✓	✓	x	✓	✓	✓	✓	✓	✓	As 5D, but based on the option of providing two interconnected over-bridges.
5Z(5)	✓	✓	✓	x	✓	✓	✓	✓	✓	x	<p>The principle of passenger's going up around 11m to an over-bridge to go down 6m again to platform level is less acceptable. Overall passenger walking times are higher than those for Option 6B(3)</p> <p>The option has minimal Tooley & St.Thomas Street station entrances, the North-South connectivity is therefore not as prominent as Option 6B(3).</p>

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Table 5 – Interim Selection Appraisal identifies assessment of each option relative to high level criteria proposed to the DfT in July 2009

Option	Mandatory Criteria			Additional Criteria							Appraisal Comments
	Meets TLP Budget	Meets 2016 + 5% PED Flow	TLP Delivery	Complies with Current Planning Application	Safety	2017 Construction Programme	Facilities Requirements	Passenger Impact During Construction	Early Realisation of Benefits	Future Development Opportunity	
6B(3)	✓	✓	✓	x	✓	✓	✓	✓	✓	x	The two proposed St.Thomas Street station There is a major entrance on Tooley St and further entrances on St Thomas St, creating the desirable North - South connectivity, similar to the Master Plan solution. Intuitive design for passenger flow and overall reduced walking distances. Provides increased potential commercial property values when compared to Option 5Z.
Option 7 Do Min	✓	x	✓	✓	✓	✓	x	✓	x	✓	Passenger capacity requirements are not met.
Option 8 Do Nothing	✓	x	✓	✓	✓	✓	x	✓	x	✓	Passenger capacity requirements are not met.
No. Meeting Criteria	4	15	15	3	17	17	15	17	15	15	

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Section 2 – Station GRIP 3 Option Definitions

7. Option 1 – Consented Masterplan (baseline)

7.1. Option Description

The Masterplan design is as per the planning permission granted in September 2003 and is presented as an option to enable a baseline for comparison with the other options.

To achieve the required Thameslink functionality the station shall be converted to six terminating platforms in the low level station and nine through platforms in the high level. new tracks and platforms are provided in the low and high level stations.

The development includes a new north to south passenger concourse which allows for significant high quality retail development and the associated commercial opportunities that this would bring. Under the terminating platforms a new loading bay with the turning circle for an articulated lorry is proposed, thus providing significantly improved access for retail/station deliveries. A proposed (circa 750,000 ft²) development above the station would provide valuable commercial office accommodation.

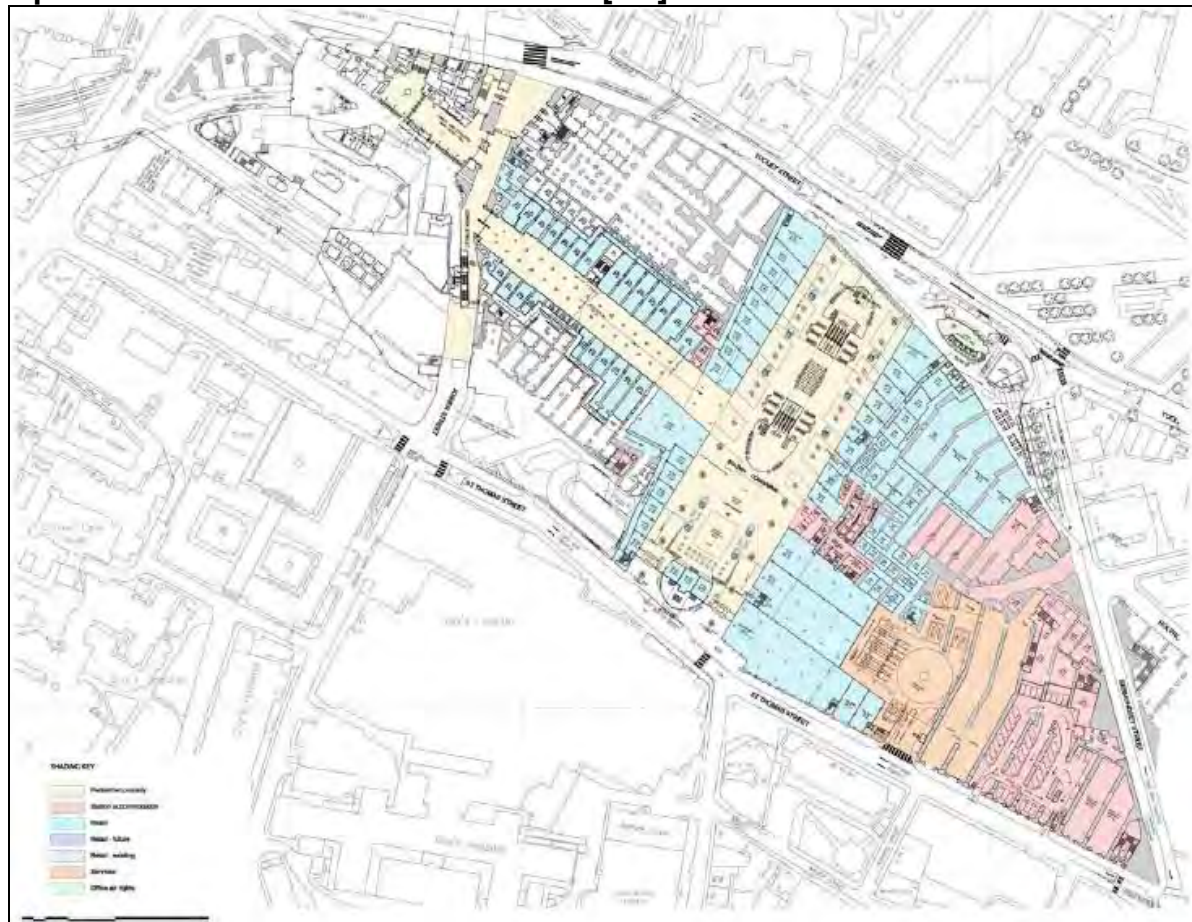
Increased pedestrian permeability through the station provides an important social gain by effectively opening up the areas around the station, in particular to the south, making them attractive for future residential and commercial developments. This is achieved by opening up of the western passage and the new concourse. Public realm improvements are achieved through a new piazza, widened pavement areas in front of concourse entrances and new pedestrian crossings for Tooley Street and St Thomas Street.

The Masterplan scheme does not take account of the Shard of Glass development which is now underway. This has a significant impact on the proposed track alignment and lower level concourse area. In addition, since the planning permission was achieved new railway signalling standards for location of signals on platforms have been introduced. The Masterplan platforms are too narrow to accommodate these requirements.

No station MEP services design was been undertaken for Option 1.

7.2. Station Layouts

Option 1 Concourse Level 00 from REF[1/9]

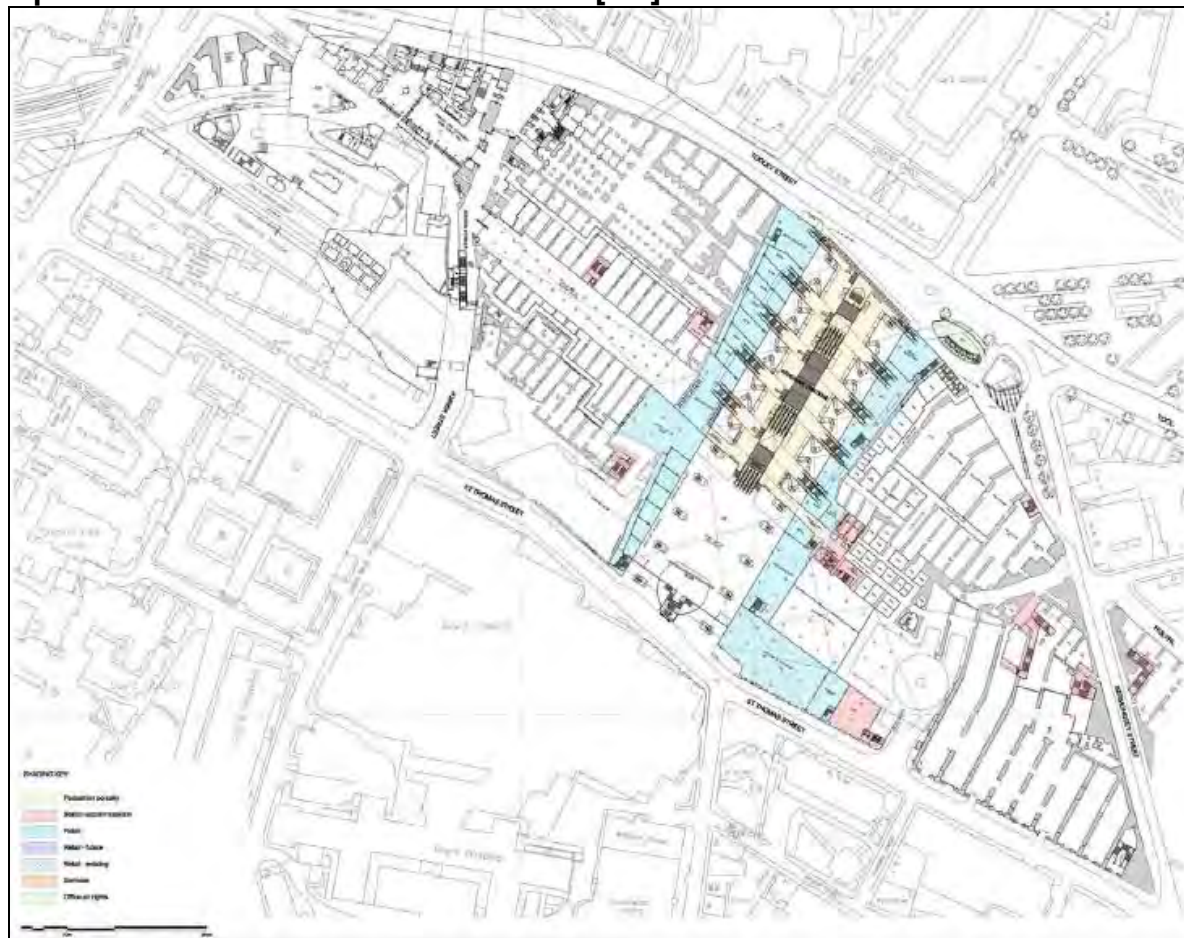


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Option 1 Mezzanine Level 01 from REF[1/9]

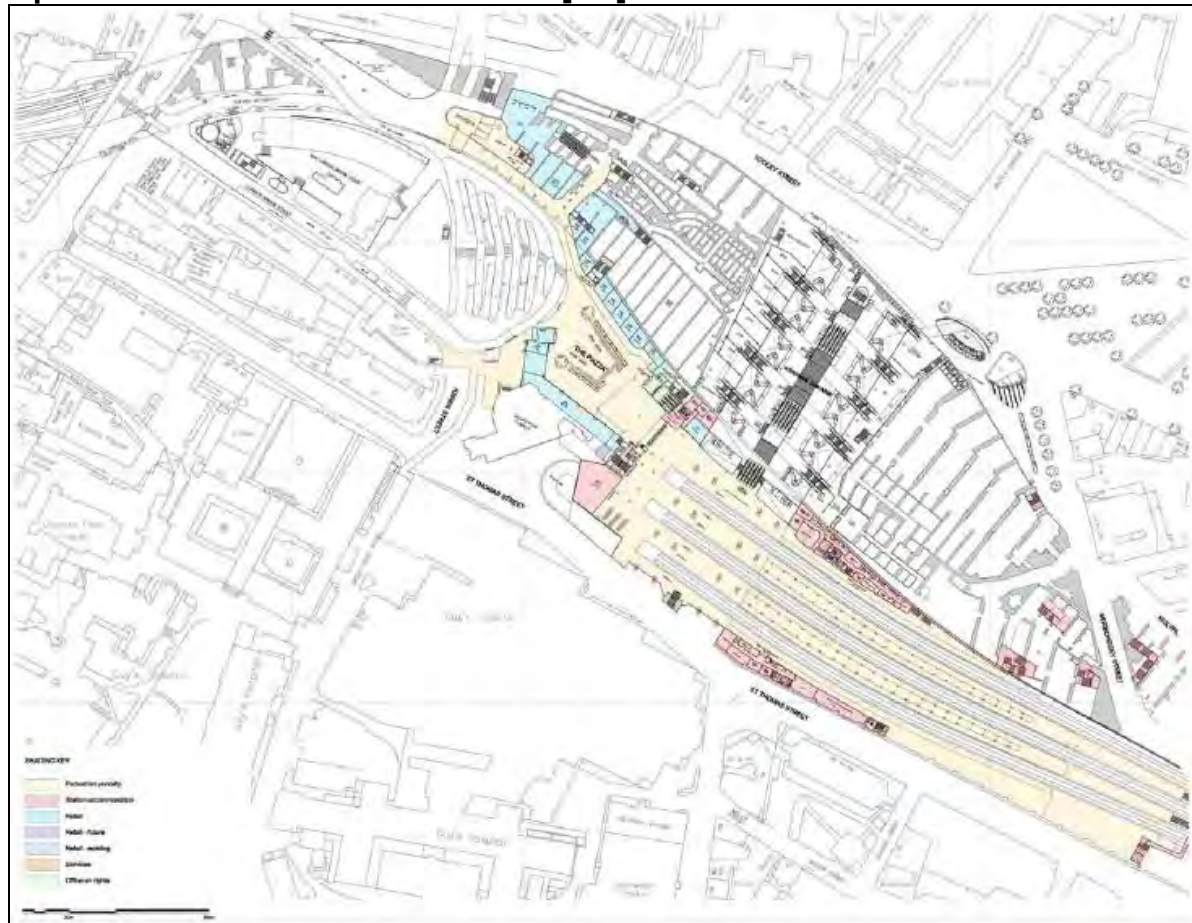


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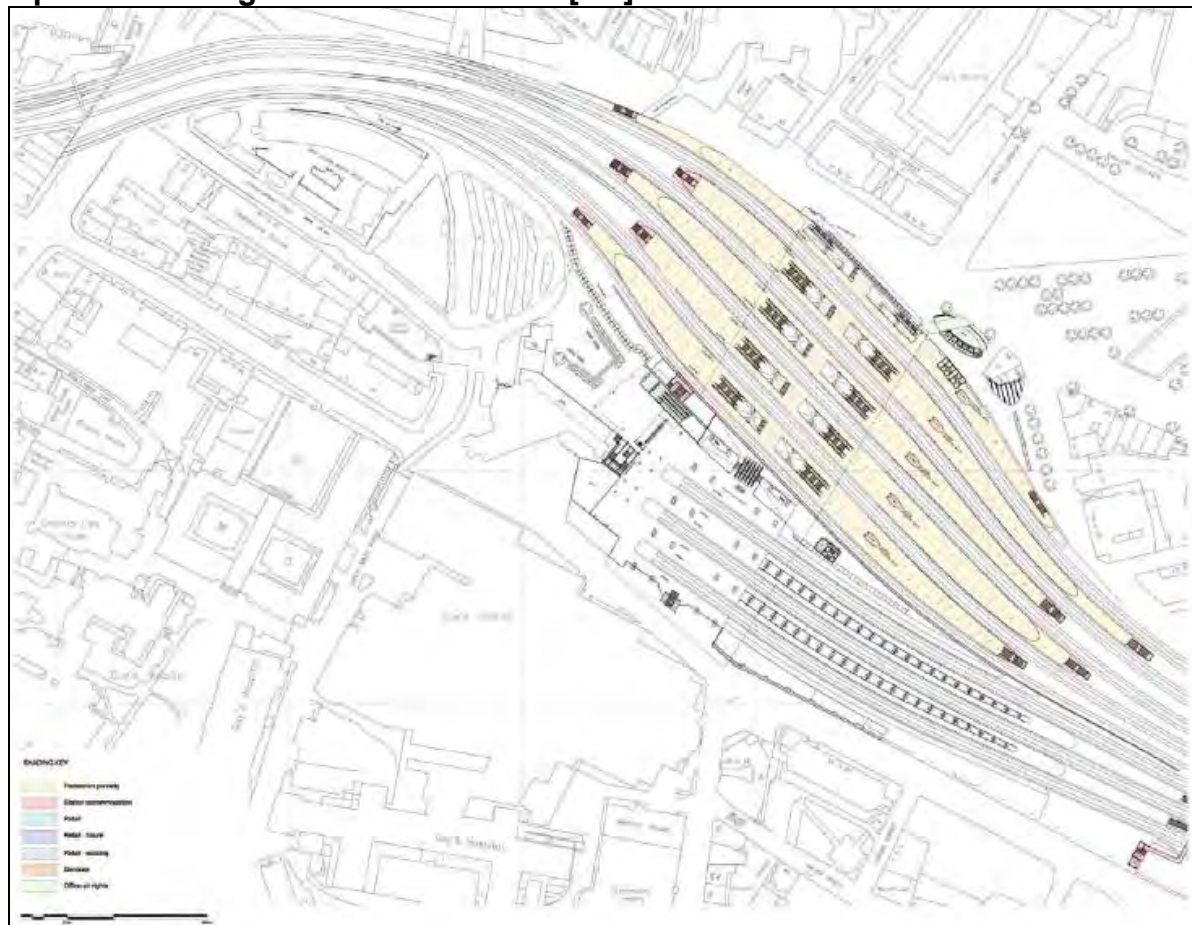
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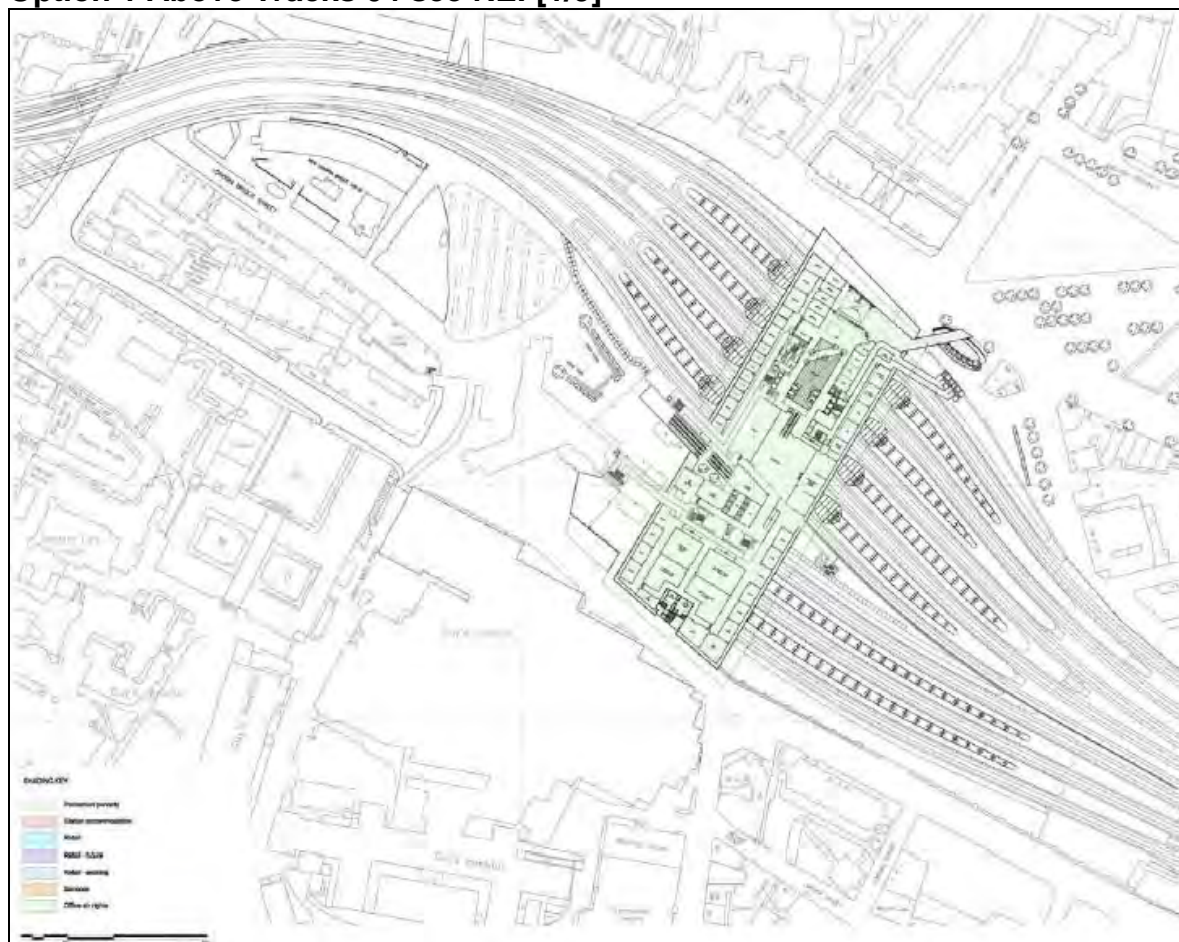
Option 1 Terminus Level 02 see REF[1/9]



Option 1 Through Tracks 03 see REF[1/9]



Option 1 Above Tracks 04 see REF[1/9]



7.3. Consents and planning

The Network Rail (Thameslink 2000) Order 2006 provides powers to construct and maintain the railway works at London Bridge station within the defined limits of deviation.

Planning Permission for the Masterplan scheme was granted in September 2003 and was accompanied by a Listed Building Consent for the demolition of the train shed roof and Conservation Area Consent for demolition of the viaduct wall between Weston Street and Stainer Street, the demolition of 64-84 Tooley Street and footbridge. The approval was also accompanied by a section 106 agreement relating principally to the implementation of highway works, dismantling and storage of the train shed roof and works to Guy's Hospital.

Subsequently, an application was submitted in April 2008 under S73 of the 1990 Planning Act to vary conditions attached to the original permission to allow phased discharge of details of each part of the development thus effectively creating a new planning permission. Approval was granted on 5 September 2008 and was subsequently implemented through submission of details relating to an initial enabling phase of the works which was confirmed by London Borough of Southwark in their letter of 23 October 2008. The permission is now effective in perpetuity.

For this option no further action would be required other than the discharge of planning conditions.

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7.4. Commercial Development Opportunities

7.4.1. Retail

The Consented Masterplan option is estimated to generate significant annual income (and Capital Value) from approximately 110,000 sq ft of new retail units

- Approximately 90,000 ft² of new retail units around and above the Station Concourse.
- Approximately 22,000 ft² of new retail units in the Western Arcade

The majority of the cost of providing this space has already been accounted for in the station re-development design and cost schedule as the units only need to be finished to sell standard with capped off services. Therefore the retail would be a big net win for Network Rail.

7.4.2. Over-Site Development (Offices)

This option includes an air rights slab designed to accommodate 750,000 ft² of office space. Planning permission for a 10 storey office development on this slab has already been granted. The sale to a third party property developer of the development rights to build off this slab is estimated to generate significant capital value (at the time of completion of the development). The slab would need to be incorporated in the station re-development design and cost.

7.4.3. Further Opportunities

The inclusion of rights for additional air rights space in zone 3 is estimated to have a potential to provide an additional 450,000 ft² of commercial (office) space. Currently this does not have planning permission. However, these additional air rights would not appear to conflict with the London View Management Framework, which currently regulates the development of tall buildings in the London Bridge area.

There is further but more difficult to achieve potential to add air rights to zone 4 (South side toward Bermondsey Street). At present this has been ruled out due to difficulties with track alignment.

It should be noted that there may also be an opportunity to add further storeys to the consented air rights building beyond 10 storeys and 750,000 ft² (subject to planning permission) because the London Borough of Southwark is currently developing a Supplementary Planning Document for the London Bridge area, which may result in new tall buildings being permissible in this locality. This would very likely increase the financial return for rights to build on the slab.

Given the large and optimal concourse floor space of this option, there are opportunities to create significant revenue streams through advertising

This option would draw many non-passengers to the station due to the strong presence of retail. Other commercial opportunities that would benefit from the increase in both passenger and non-passenger footfall, such Automated Teller Machines (ATM) and telephones, would also generate significant additional income.

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7.5. Structural Engineering Assessment

The structural scheme for this option is based on significant assumptions and on an architectural model only. Identification of the constraints and all the structural requirements for the proposed 'trees and trestles' support solution was not addressed at this stage of design development. The scheme makes conservative assumptions on the piling sizes, but does not offer similarly good insight into size and layout of pile caps, in-ground foundations, ground slab, associated staircases, and the Station Approach Viaduct Extension structure. Consequently the number of supporting structures for these elements and escalators, mezzanine slab supports, demolition perimeter area stability supports, etc is not clearly identified. Over site development deck (for a development in Zones Z1, Z2, Z3 and Z4) is well defined with proposed erection scheme incorporated and giving good insight to the future buildings to be erected. A more in depth statement of the structures for each option is given in the Alan Baxter's ID25 report REF[2/1]:

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8. Option 2A

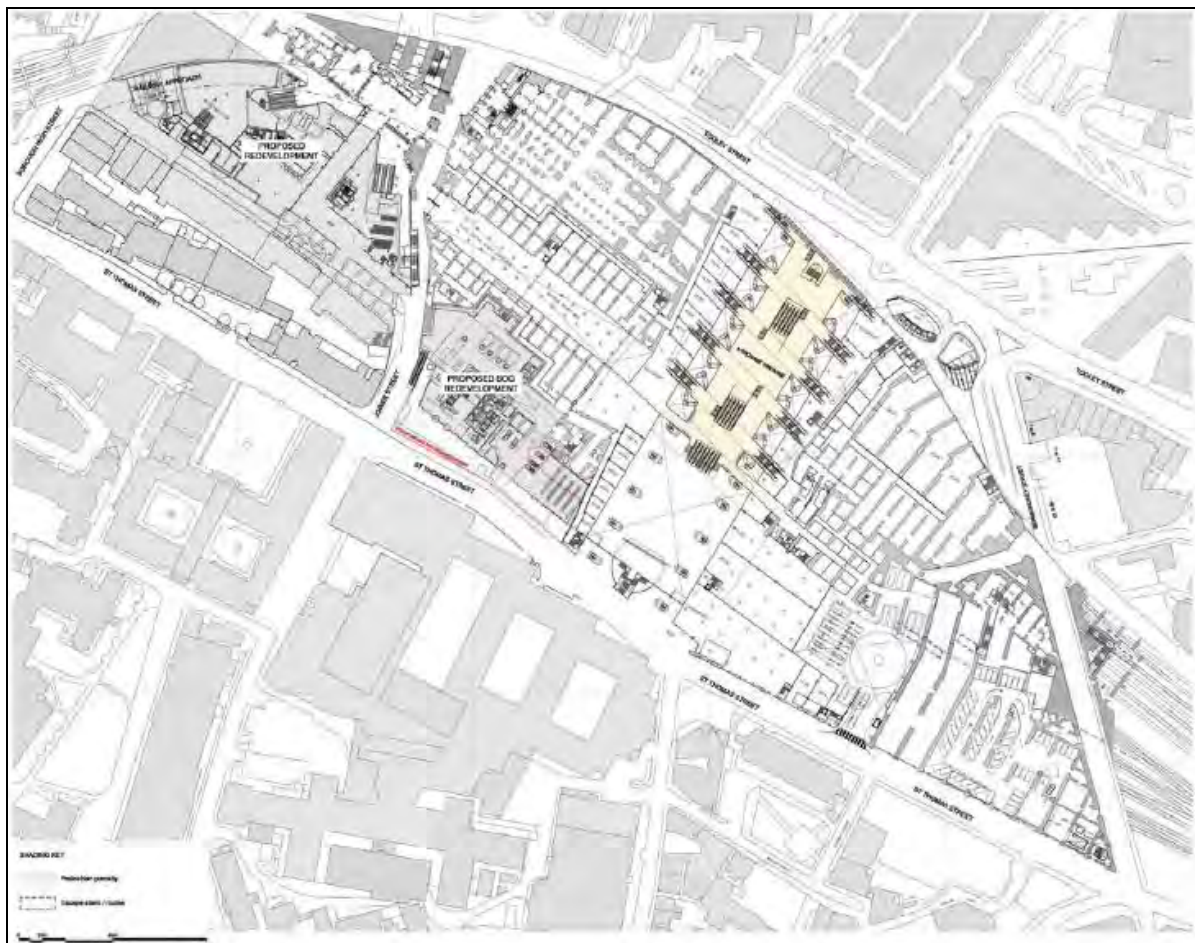
8.1. Option Description

Option 2A is a development of the Masterplan layout, modified to incorporate the Shard of Glass and retaining many of the key benefits. The train service requirements can be achieved by this scheme and the station layout is able to meet passenger capacity demands. Passenger flow and public realm improvements are similar to Masterplan, in particular from the north-south concourse and widened pavement areas in front of the Tooley St and Saint Thomas St entrances. The commercial opportunities are significant, extensive retail including a supermarket, a retail centre and an over-site office development in zones 1 and 2, are key benefits of this scheme. The scheme also retains a loading bay with sufficient space to allow for the turning circle of an articulated lorry.

No station MEP services design has been undertaken for Option 2A.

8.2. Station Layouts

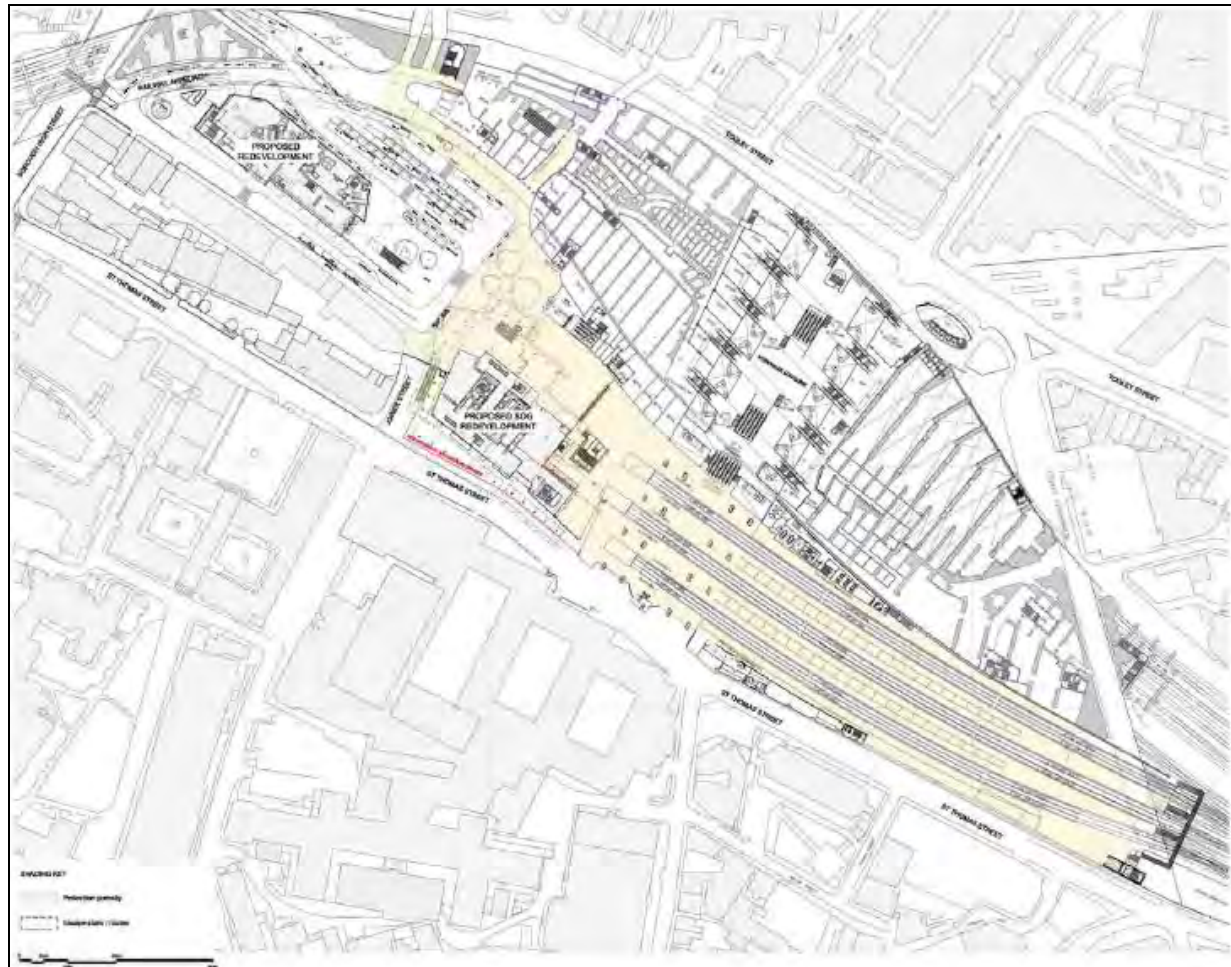
Option 2A Mezzanine Level 01 (see REF[1/9])



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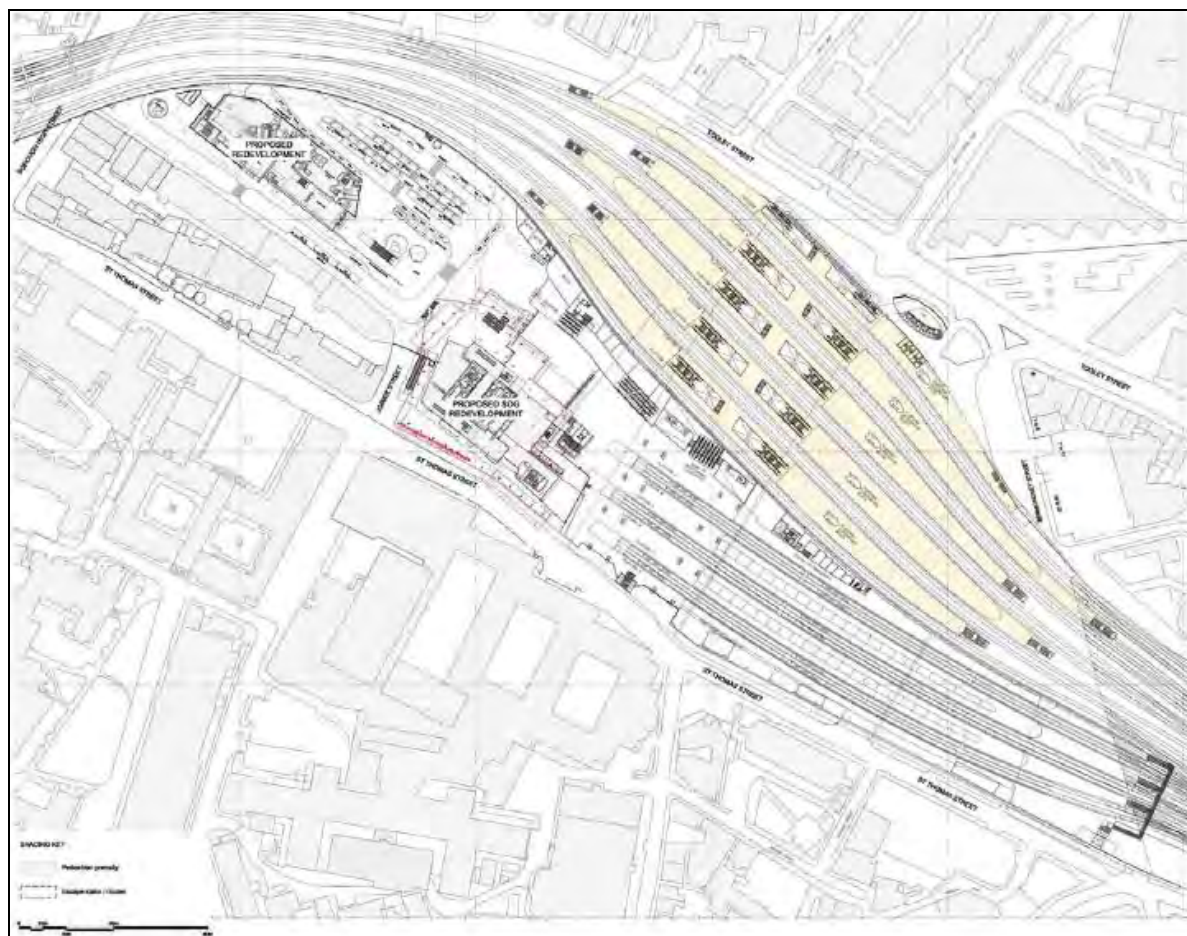
Option 2A Terminus Level 02 (see REF[1/9])



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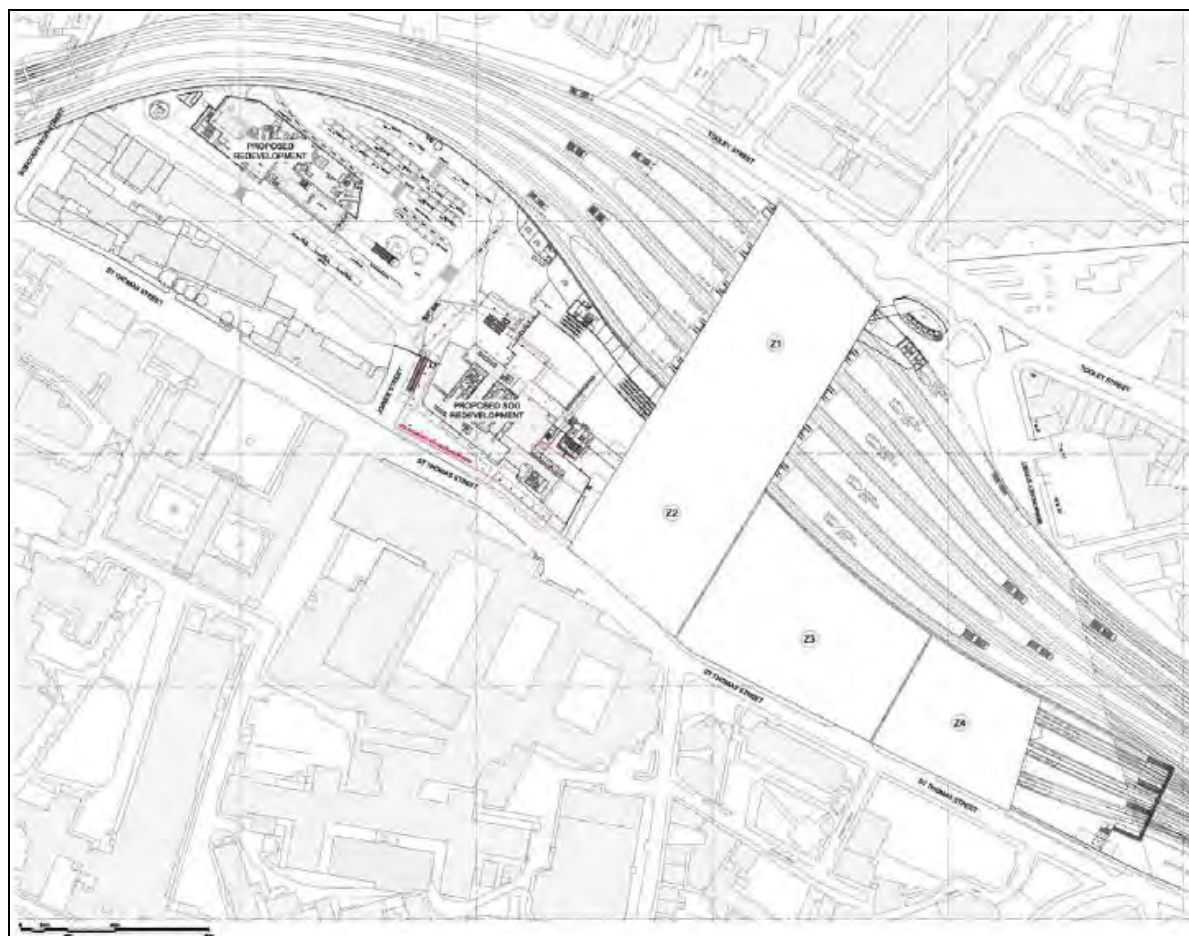
Option 2A Through Tracks Level 3 (see REF[1/9])



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Option 2A Air Right Level 04 (see REF[1/9])



8.3. Consents and planning

Option 2A is effectively the consented scheme and therefore no new consents are required to implement the work other than negotiation and discussion with London Borough of Southwark to discharge the planning conditions.

8.4. Commercial Development Opportunities

8.4.1. Retail

This option is estimated to generate incremental annual income of £7.8m from approximately 110,000 ft² of new retail units, which equates to a capital value of approximately £156m, whereby:

- Approximately 90,000 ft² of new retail units around and above the Station Concourse would generate about £6.4m of incremental income, which equates to a capital value of circa £130m
- Approximately 22,000 ft² of new retail units in the Western Arcade would generate about £1.4m of incremental income, which equates to a capital value of circa £26m

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8.4.2. Over-Site Development

This option includes an air rights slab designed to accommodate 750,000 ft² of office space. Planning permission for a 10 storey office development on this slab has already been granted. The sale to a third party property developer of the development rights to build on this slab is estimated to generate approximately £82m at time of completion.

8.4.3. Further Opportunities

The inclusion of rights for additional air rights space (zone 3, 450,000 ft², without planning permission) is estimated to have a capital value of £42m (net of slab construction costs) at time of completion. These additional air rights would not conflict with the London View Management Framework, which currently restricts the development of tall buildings in the London Bridge area.

There is potential to add air rights to zone 4 (South side toward Bermondsey Street). At present this has been ruled out due to difficulties with track alignment.

There may be an opportunity to add further storeys to the consented air rights building (subject to planning permission) because the London Borough of Southwark is currently developing a Supplementary Planning Document for the London Bridge area, which may result in new tall buildings being permissible. This would very likely increase the financial return for rights to build on the slab.

Given the large floor space of this option, there are opportunities to create significant revenue streams through advertising, with a yearly income of circa £450K, which equates to a capital value of £9m.

This option would draw many non-passengers to the station due to the strong presence of retail. Other commercial opportunities that would benefit from the increase in non-passenger footfall, such as ATM's and telephones, could generate additional income of circa £850,000, which equates to a capital value of £17m.

8.5. Structural Engineering Assessment

For the GRIP 3 design, demolition areas are identified outlining full demolition and arch strengthening areas separately. Identification of the areas of demolition and modification is defined well in the areas affected by the works and consequently sets out the scope for street level and 'jack arches' level interfaces.

Piling and foundation areas – The level of information has not changed significantly from Option 1 and remains conservative. More foundations and piling information is shown where demolition edge supporting structures are identified offering better definition to the scope of civil and structural works.

Structures – The edge of the demolition areas are now identified and structural support solutions in these areas are shown, thus increasing the level of definition to the scheme. Trees and trestles support structures supporting main escalators, rail beds, platforms and over site development do not appear more detailed than in Option 1 and integration of the edge support to the overall scheme is not provided. Platform escape stairs and other associated structures (Station Approach Viaduct Extension) are substantially better defined.

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The over site development deck is well described and not substantially changed form the Option 1 proposal.

Overall this scheme provides a significant increase in civil and structural elements' definition, enabling more detailed constructability and cost review. A more in depth statement of the structures for each option is given in Alan Baxter's ID25 report REF[2/1].

9. Option 2D

9.1. Option Description

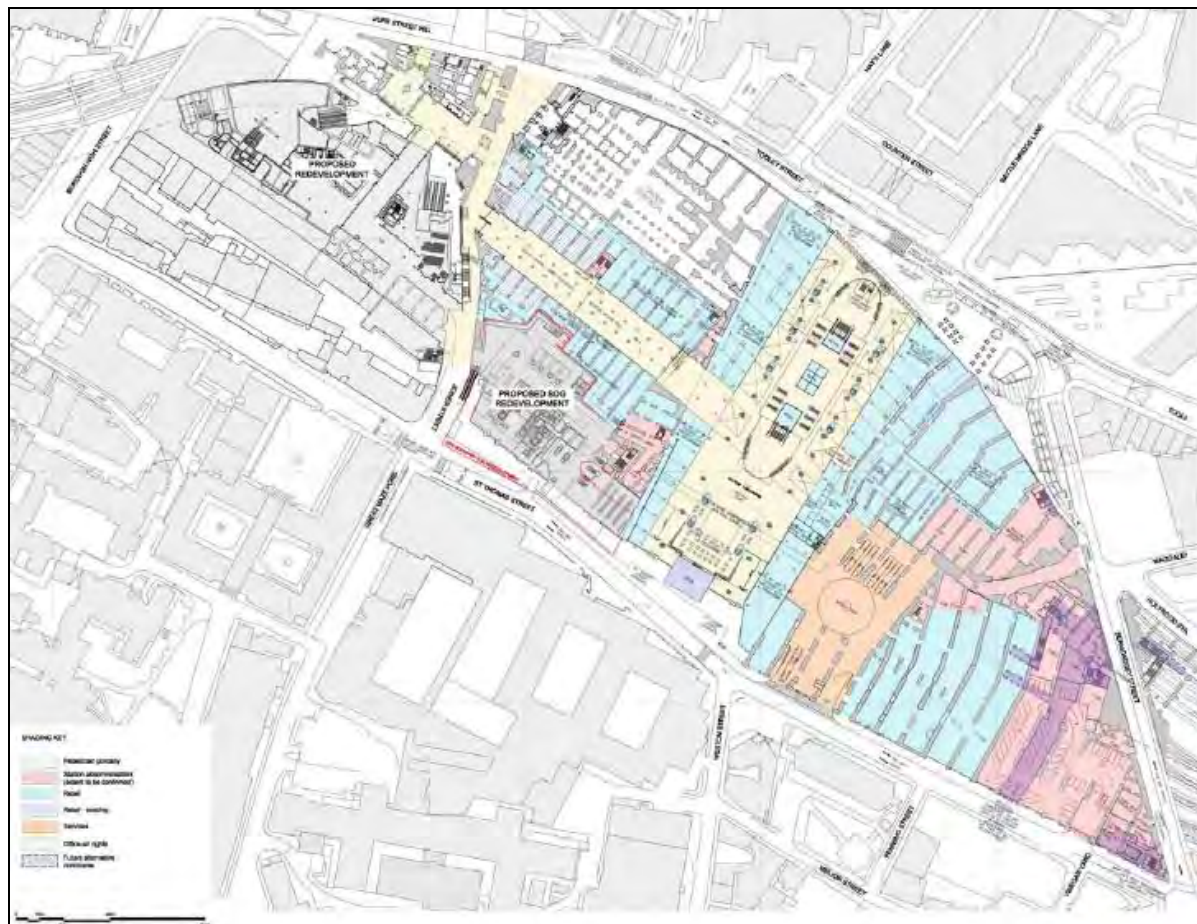
Option 2D is a development of the Masterplan layout, modified to incorporate the Shard of Glass. The train service requirements can be achieved by this scheme and the station layout is able to meet passenger capacity demands. The significant change over 2A and the Masterplan is the exclusion of air rights development, significantly reducing the commercial potential of the development. Passive provision is planned to be included for a development over zones 2 and 3, although this would require future investment. Retail units would be provided as shells to be fitted out by occupiers at a later date. Both gate lines and escalators would be provided to a minimum level, with the option to add more as passenger numbers increase over time. The option still provides for new platforms and tracks throughout the station.

This option has no provision for air rights and no detailed commercial assessments have been undertaken for this option. For GRIP 3 there was no station MEP services design undertaken for Option 2D.

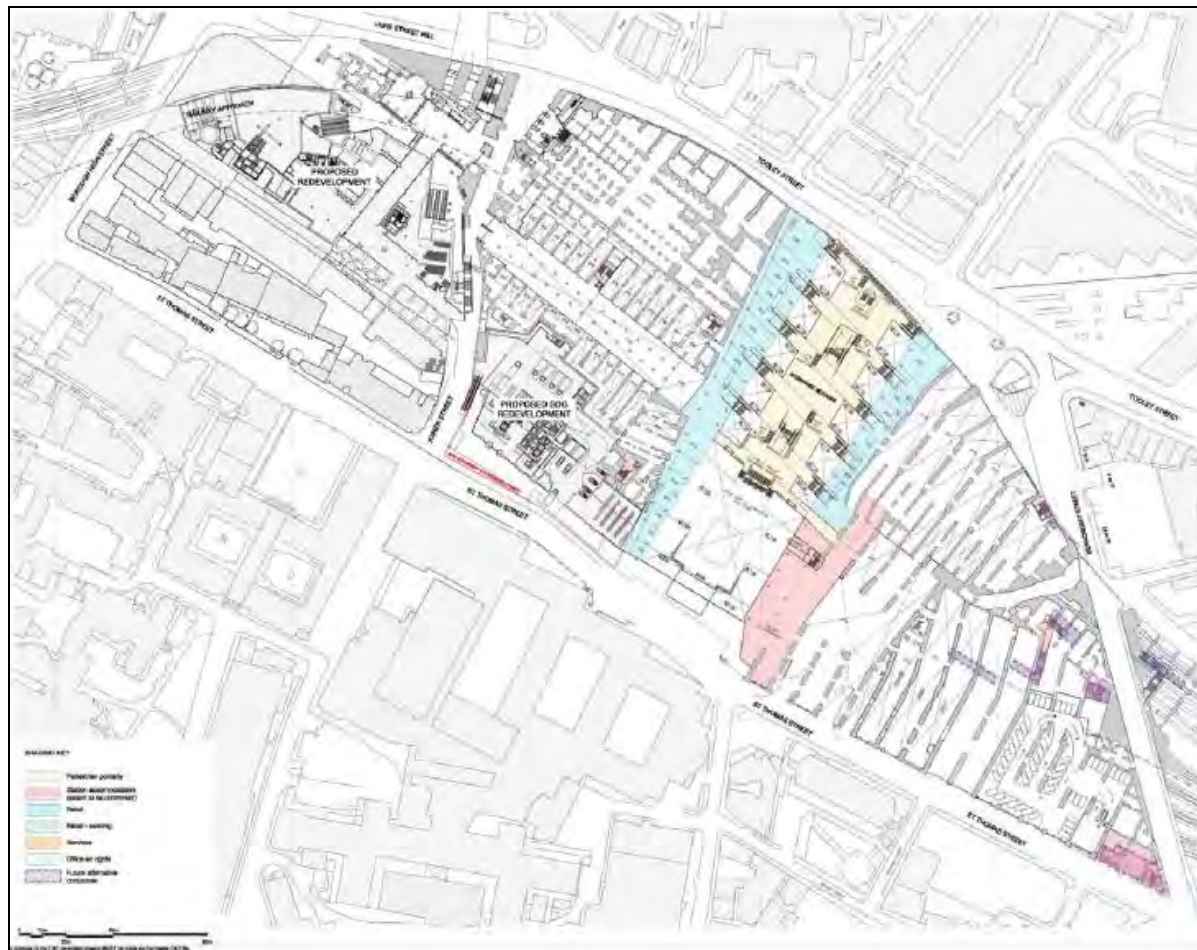
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9.2. Station Layouts

Option 2D Concourse Level 00 (see REF[1/9])



Option 2D Mezzanine Level 01 (see REF[1/9])

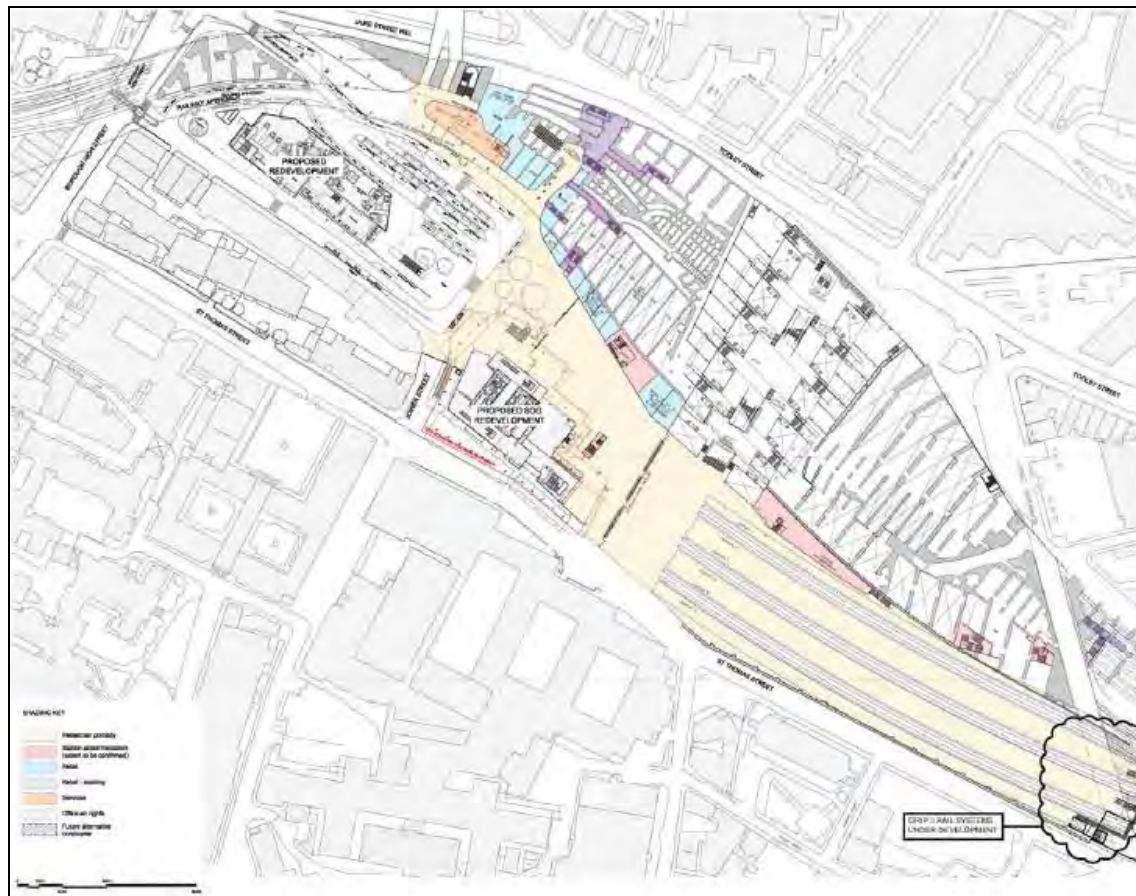


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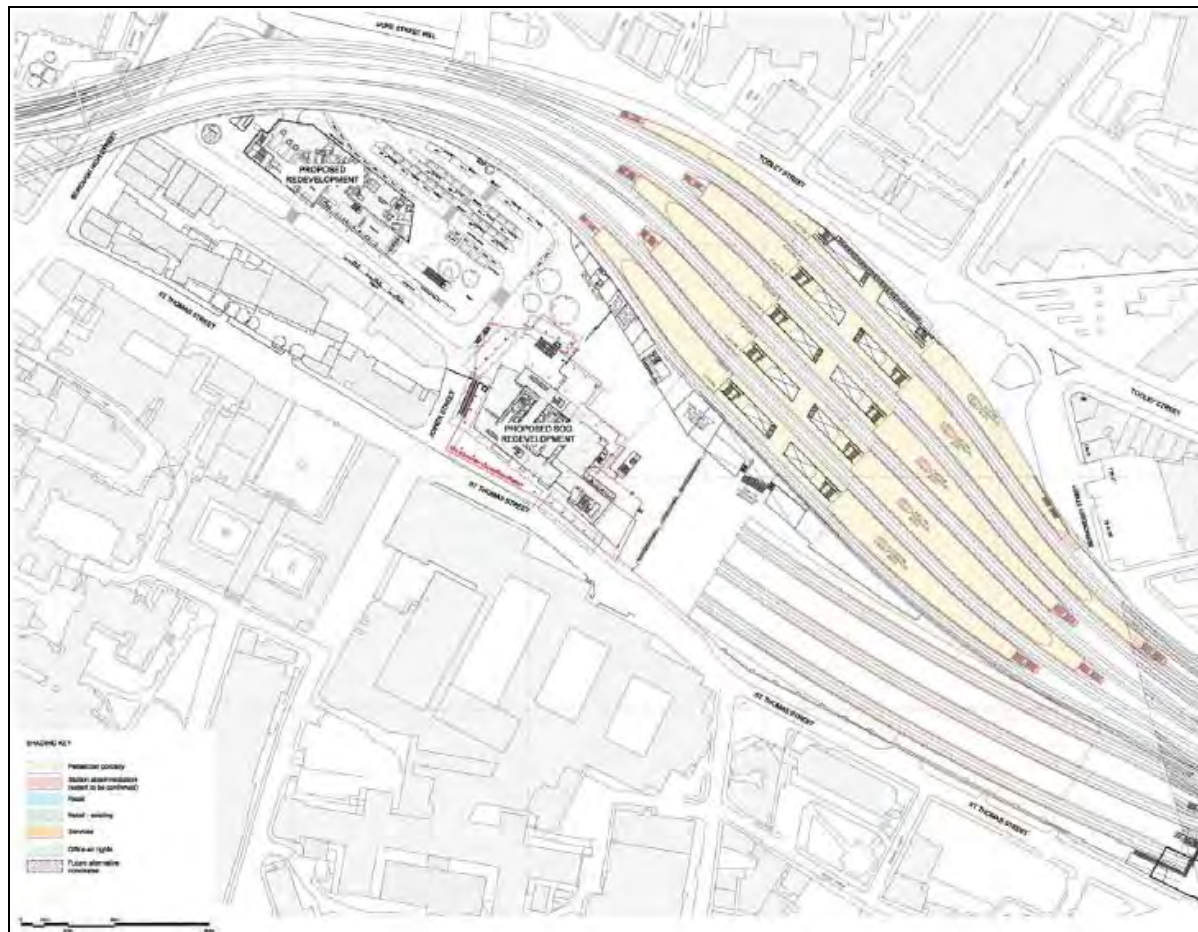
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Option 2D Terminus Track Level 02 (see REF[1/9])



Option 2D Through Track Level 03 (see REF[1/9])



9.3. Consents and planning

This is effectively the consented scheme and therefore no new consents are required to implement the work other than negotiation and discussion with LB Southwark to discharge the planning conditions.

9.4. Structural Engineering Assessment

The demolition areas are identified outlining full demolition and arch strengthening areas separately. Identification of the areas of demolition and modification works is defined well in areas affected by the works and consequently sets out scopes for street level and 'jack arches' level interfaces, which are now clearly visible. The demolition area is reduced below terminating platforms as the supermarket area is omitted, otherwise the areas and solutions are the same as option 2A

Piling and foundation areas – Sections showing reduced piling and pile-caps volume are introduced as a result of omission of the over site development deck and remain conservative. More foundations and piling information is shown where demolition edge supporting structures were identified.

Structures – The edge of the demolition areas are now identified and structural support solution in these areas are shown, increasing the level of definition to the scheme. Trees and

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trestles structures supporting main escalators, rail beds, and platforms are replaced by lighter V structures responding to omission of the over site development deck and introduction of much lighter roof structure in the area. Integration of the edge support to the overall structural scheme is not provided. Platform escape stairs and other associated structures (Station Approach Viaduct Extension) are substantially better defined. The roof structure is not defined sufficiently to comment on but it is expected to be a light weight steel structure.

Overall this scheme provides a significant increase in civil and structural elements' definition, enabling more detailed constructability and cost review. This option once implemented does not offer any future over site development investment opportunity without significant disruptive impact on station operation. A more in depth statement of the structures for each option is given in Alan Baxter's ID25 report REF[2/1].

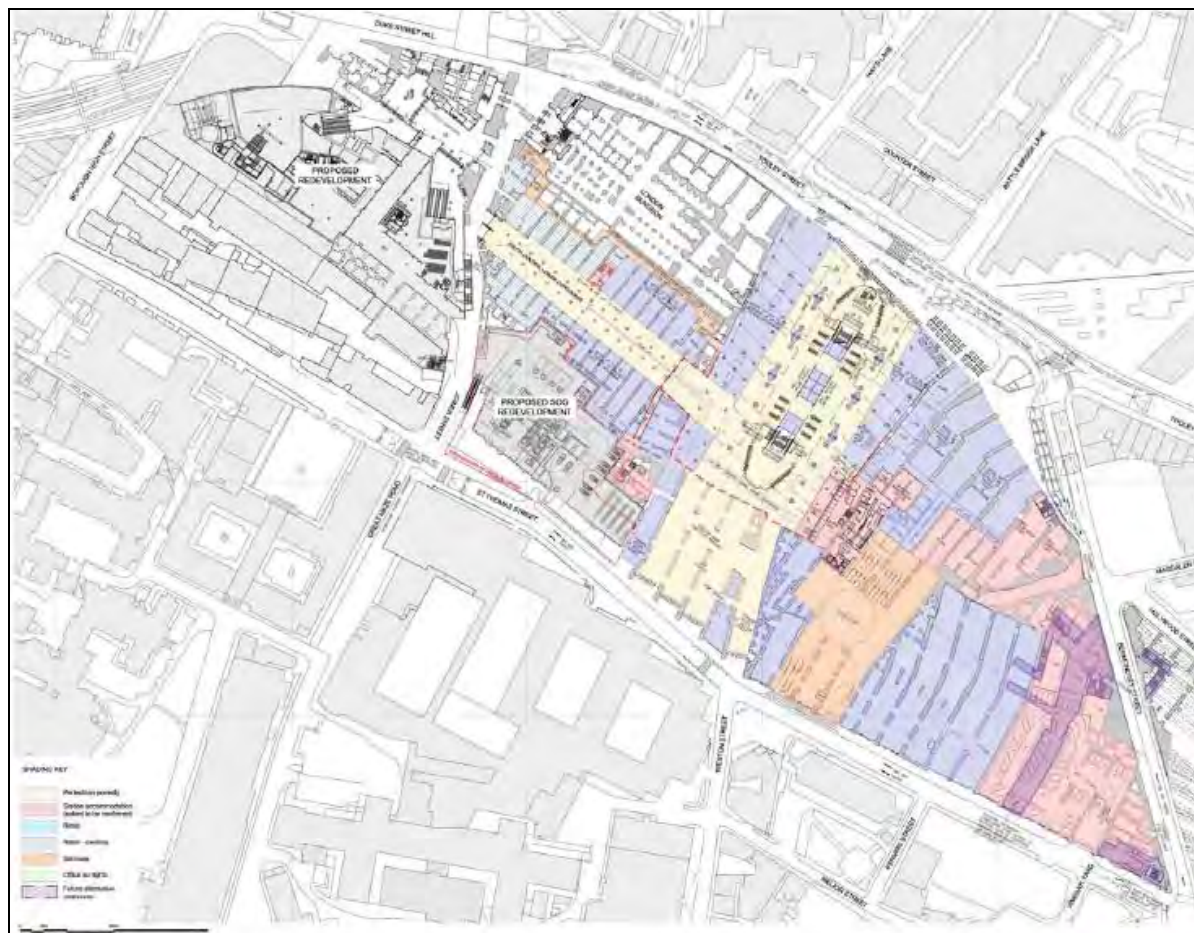
10. Option 3B

10.1. Option Description

Option 3B is a development of the Masterplan layout, modified to incorporate the Shard of Glass. The north south concourse is retained, albeit with simplified support structures and the south end formed of existing brick arches. There would be new entrances for both Tooley St and St Thomas St. Commercial opportunities are limited with this option, there is no air rights development and no passive provision provided for any future investment. There is also no allowance for a supermarket, resulting in lower potential revenue. This option allows for the retention of existing track and platforms on the lower level terminating platforms.

10.2. Station Layouts

Option 3B Concourse Level 00 (see REF[1/9])



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Option 3B Mezzanine Level 01 (see REF[1/9])

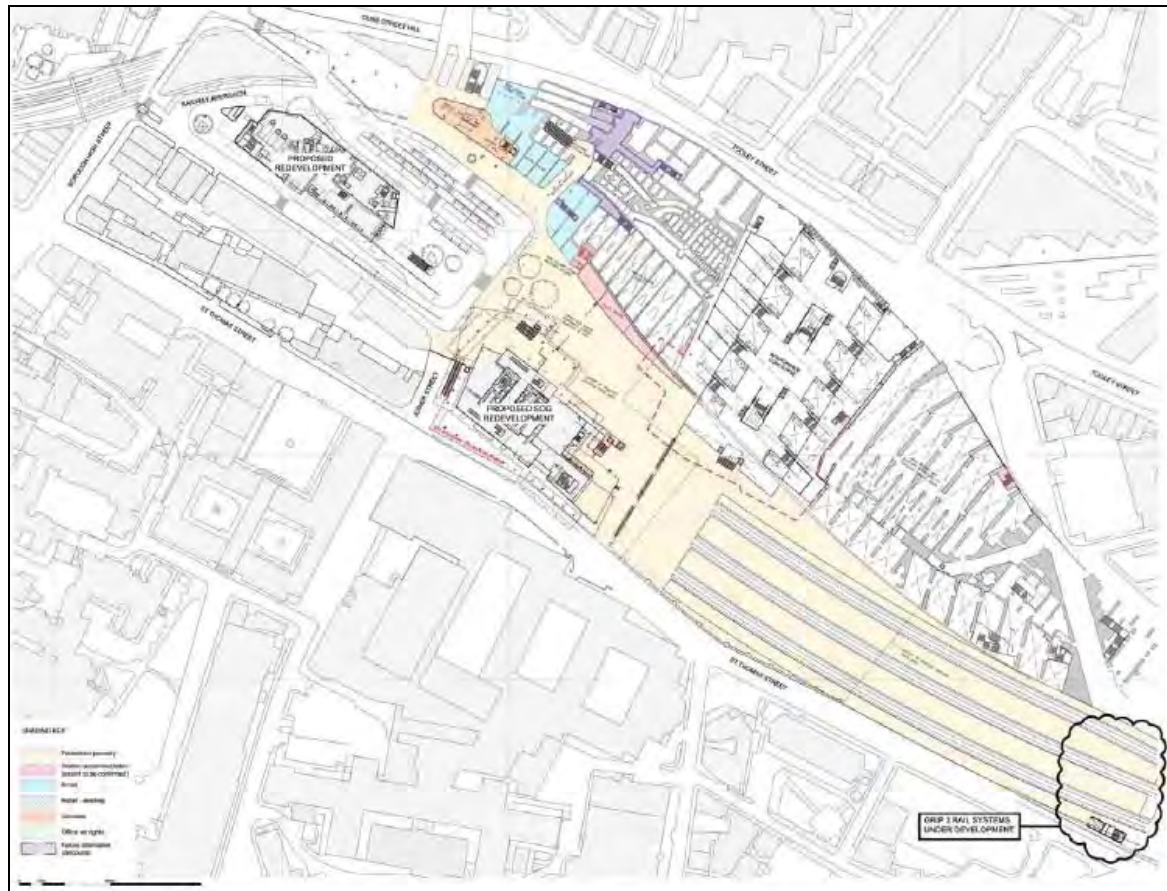


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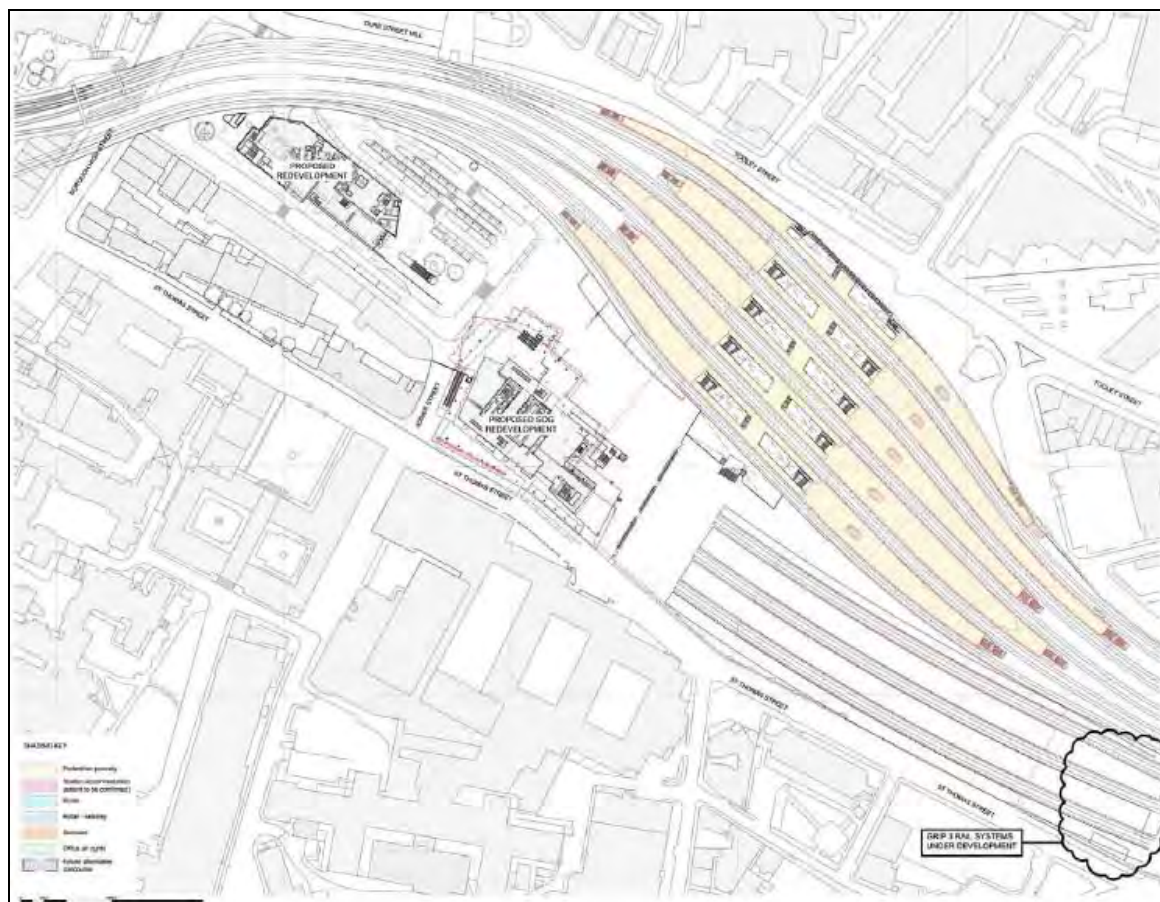
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Option 3B Terminus Platform Level 02 (see REF[1/9])



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10.4. Structural Engineering Assessment

This option shares the same structural solutions as Option 2D with the following exceptions:

- Demolition of low level terminus station arches is not within scope of this option, a serious strengthening and modification of arches in these areas is expected to replace demolition and rebuild.
- Piling and foundations areas are the same as Option 2D with significant (but not shown) foundations expected to cater for the new roof structure over the west end of the Low Level terminus station.
- Structures – same as 2D in the through station area. All low level terminus substantial remodelling is on top of the existing arches.
- This option once implemented does not offer any future over site development investment opportunity without significant disruptive impact on station operation.

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11. Option 5B

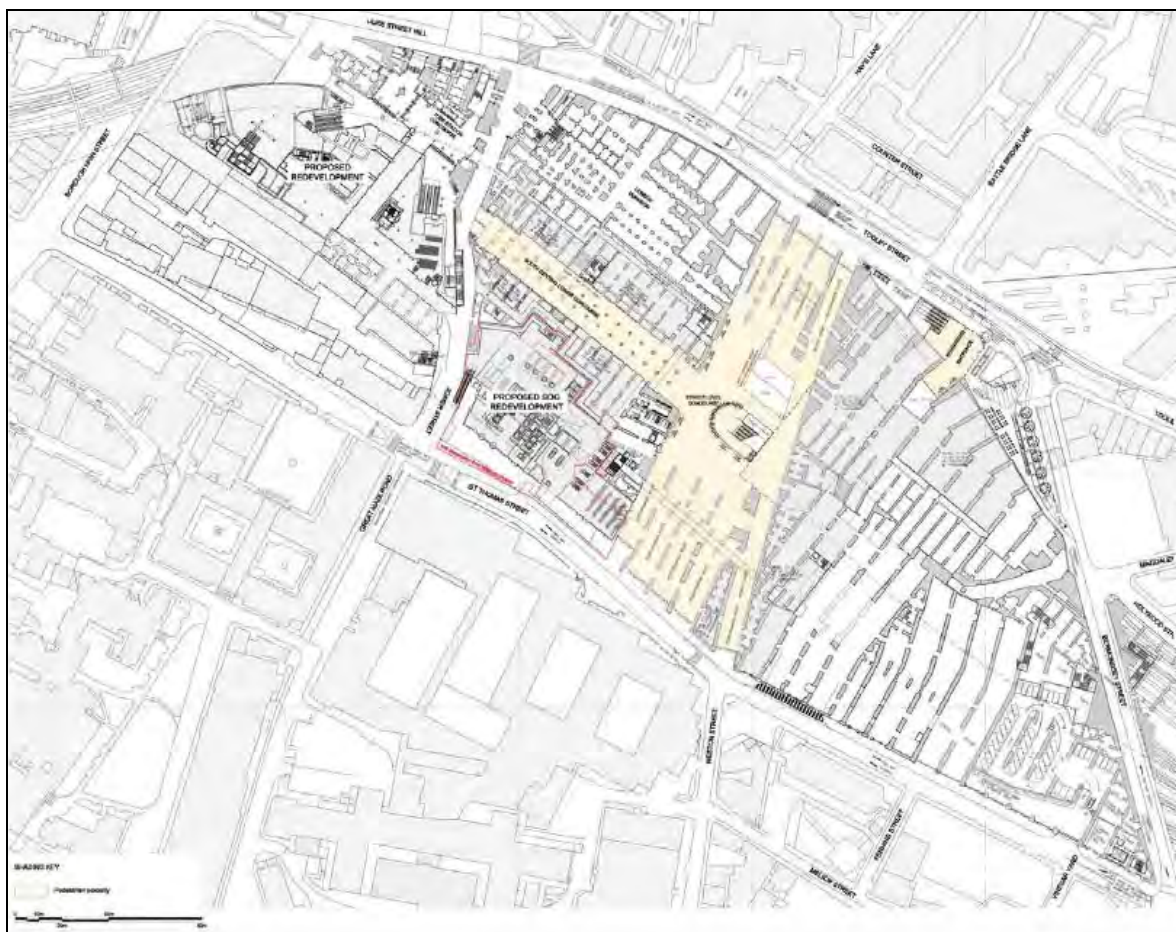
11.1. Option Description

This option is fundamentally different to the Masterplan. The north south concourse is formed from existing arches, with a new vertical circulation zone at the point where it meets the western mall. An interchange mezzanine level is formed on a part of the existing arches providing a connection to the position of the current 84 Tooley building. This option allows for the retention of existing track and platforms on the lower level terminating platforms. Commercial opportunities are significantly reduced with this option, there is no air rights development and no passive provision provided for any future investment. There is also no allowance for a supermarket, and retail units are in existing arches resulting in lower potential revenue. There is no loading bay provided within this option. This option would require new planning permission and environmental planning consent.

There have been no commercial opportunity assessments or station mechanical, electrical and plant services designs undertaken for Option 3B.

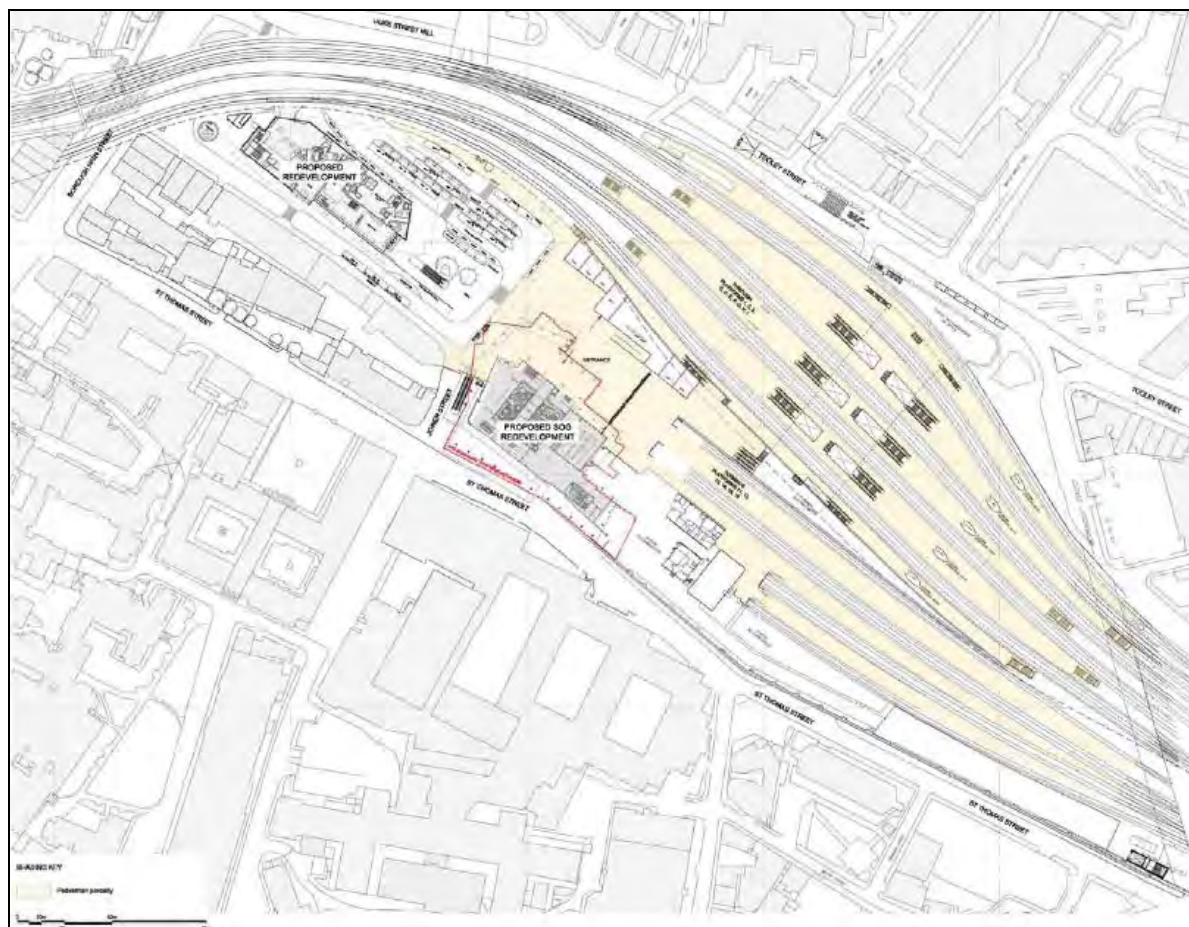
11.2. Station Layouts

Option 5B Street Level 00 (see REF[1/9])



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Option 5B Terminus & Through Tracks Level 02 (see REF[1/9])



11.3. Consents and planning

The Network Rail (Thameslink 2000) Order 2006 provides powers to construct and maintain the railway works at London Bridge station within the defined limits of deviation.

New applications for planning permission, listed building consent and conservation area consent would be required. In order to justify the loss of the listed train shed such applications would need to demonstrate achievement of planning and regeneration benefits equivalent to Masterplan. There would be very high risk that sufficient benefit could not be demonstrated.

11.4. Structural Engineering Assessment

This option explores the possibility of a reduced demolition area - central core distribution area (under new high level extension) and demolition of the top of the arches in line with 84 Tooley Street to found a new mezzanine passenger distribution area on top of existing arch foundations and brick columns.

The full demolition area is reduced to central core area only. Additional partial demolition of arches for mezzanine structure in NNE direction from the core is shown. Substantial strengthening and modifications of arches is expected in all other areas of the station affected by the new station layout to allow N-S permeability and new platforms.

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Piling and foundations are not explored in the same level of detail as other options but in the core demolition area these are expected to be identical in equivalent area of option 2D. Similar to option 2D all edges of demolition will have to receive strengthening structures, this also applies to the part-demolished area of mezzanine. The remainder of the station structures will be founded on top of existing arches.

Structures will be comparable to option 2D in the similar areas: the centre core area requires a bridging structure for the through trains, platforms and canopies, the mezzanine requires bridging structures for trains and platforms and the roof structure weatherproofing area over the escalators. Low level terminus will require new platforms, canopies and roof over the west end area. The option is a complex structural hybrid of full demolition and rebuild, partial demolition with rebuild modifications and strengthening in remainder of the areas. Creating a mezzanine on top of existing arches does not offer sufficient usable space under the mezzanine and would require extensive strengthening of the remaining brick structures to achieve fitness for purpose. This option once implemented does not offer any future over site development investment opportunity without significant disruptive impact on station operation. A more in depth statement of the structures for each option is given in Alan Baxter's ID25 report REF[2/1]:

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12. Option 5E

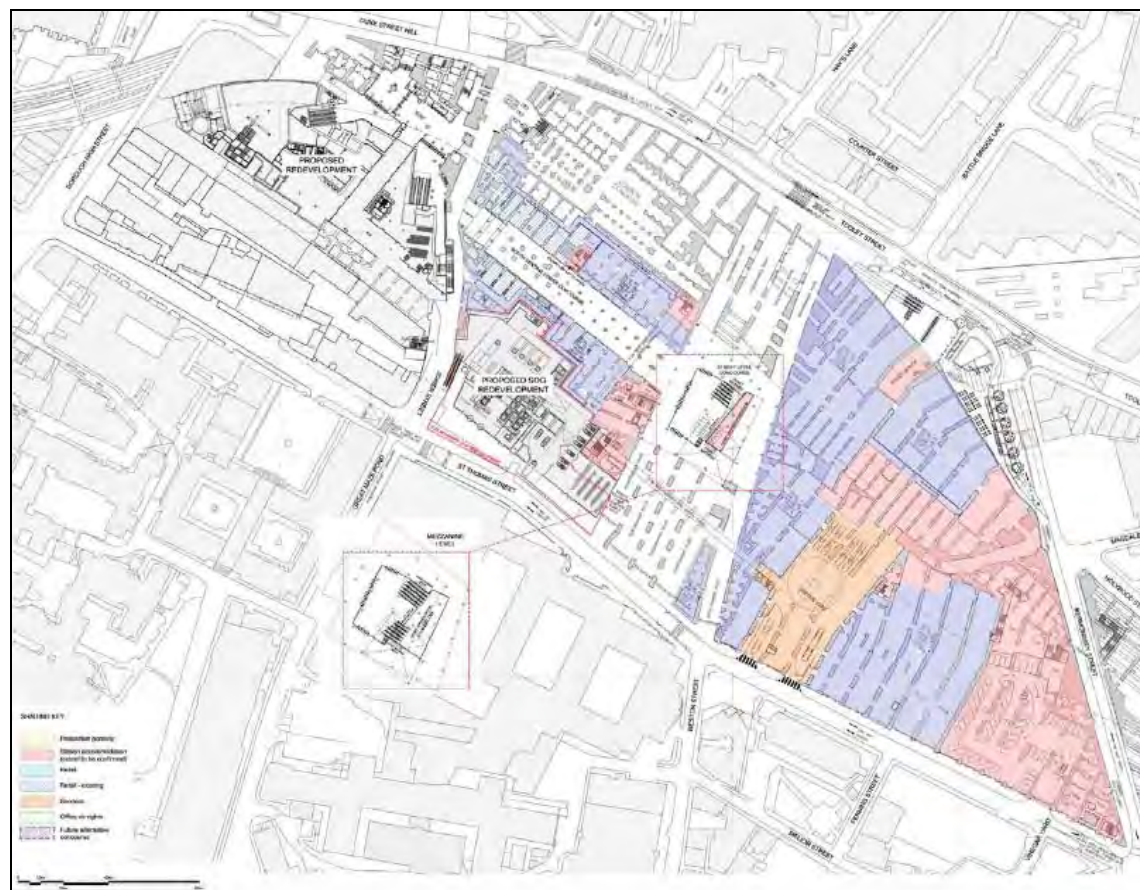
12.1. Option Description

This option is fundamentally different from the Masterplan. Passenger circulation is provided by footbridges spanning the station; horizontal cross track passenger routes are by a pair of over bridges over the high level tracks forming a loop, with a single over bridge over the low level tracks. This scheme requires the demolition of 84 Tooley St, the footprint being used as vertical circulation to the double over bridge. The north south concourse is formed from existing arches with a new central vertical circulation zone at the junction of the Western Mall and the north south concourse. Commercial opportunities are significantly reduced with this option, there is no air rights development and no passive provision provided for any future investment. There is also no allowance for a supermarket, and retail units are in existing arches resulting in lower potential revenue. There is no loading bay provided within this option. This option would require new planning permission and environmental planning consent.

There have been no commercial opportunity assessments or station mechanical, electrical and plant services designs undertaken for Option 5E.

12.2. Station Layouts

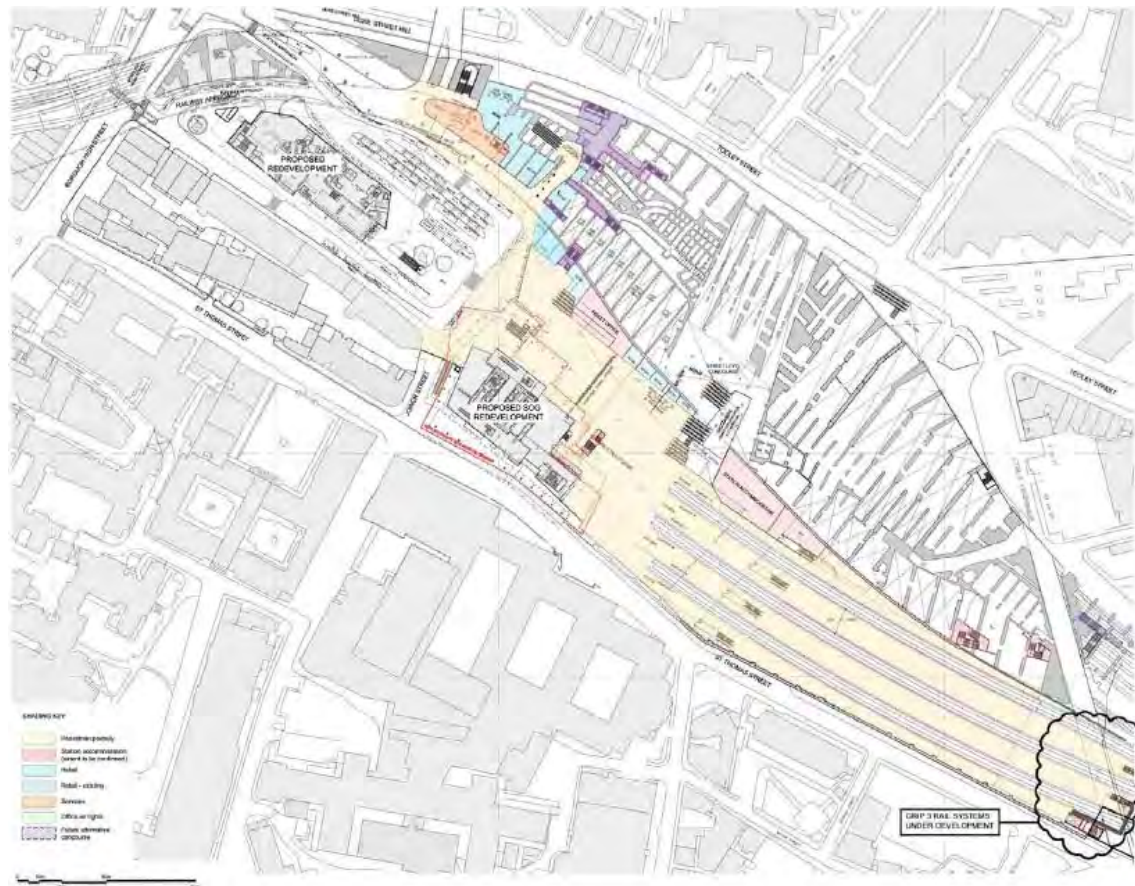
Option 5E Street Level 00 (see REF[1/9])



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Option 5E Terminus Track Level 01 (see REF[1/8])



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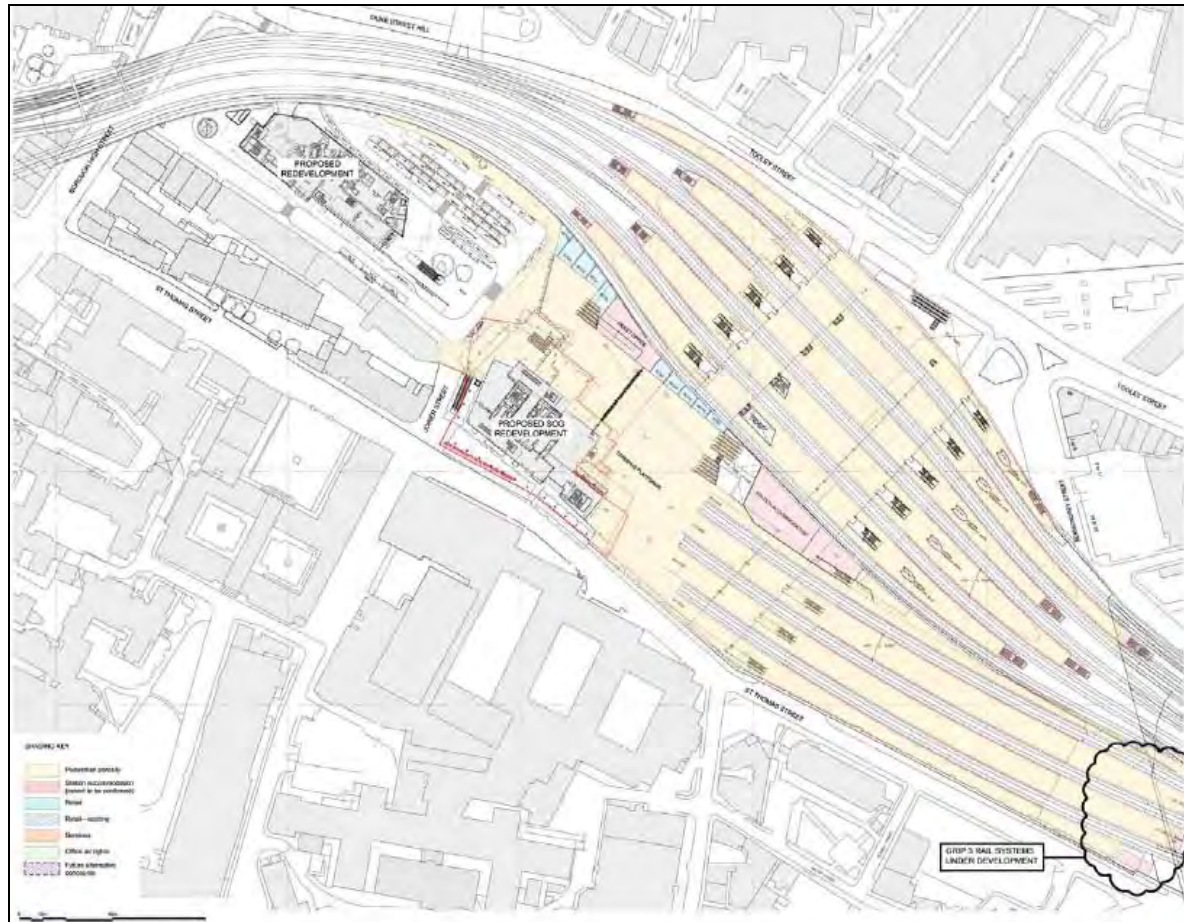
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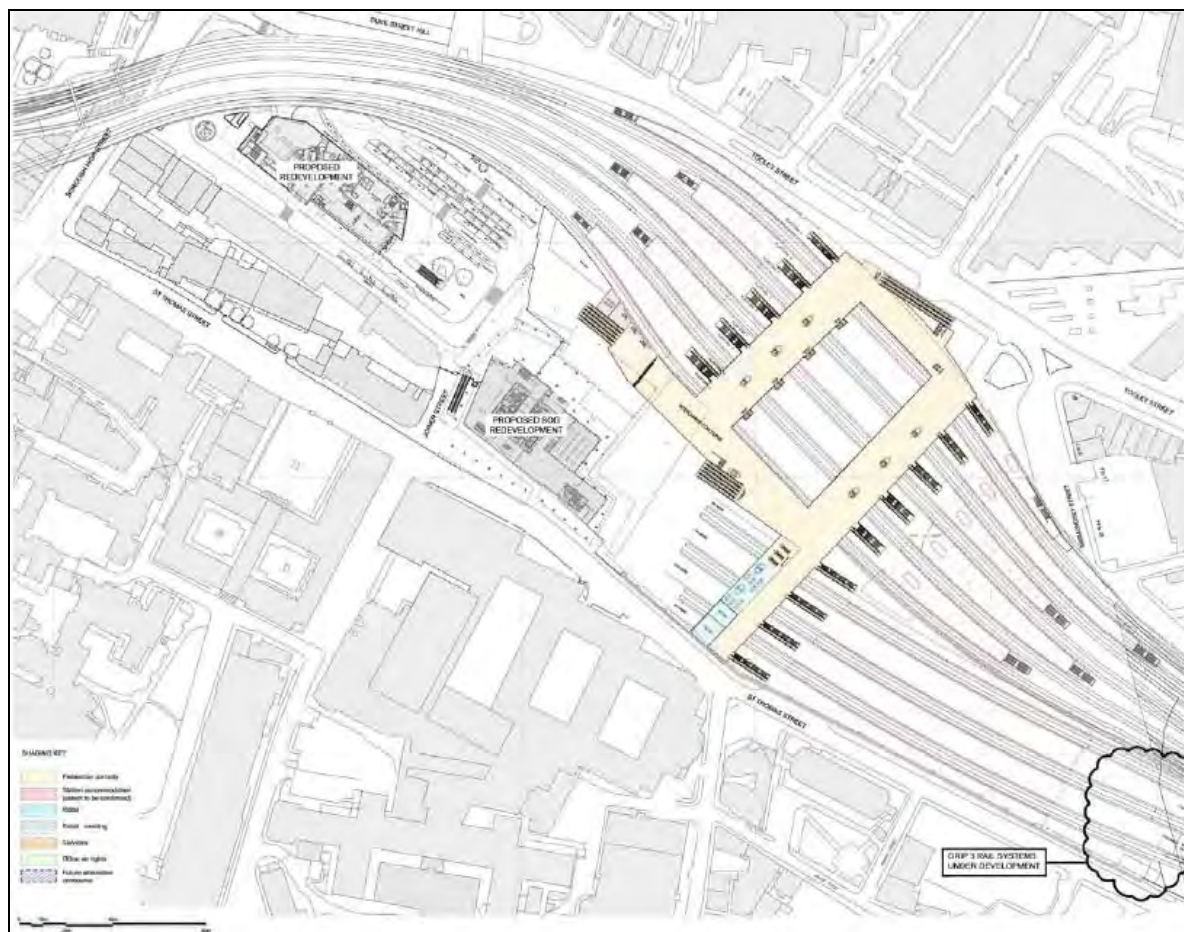
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Option 5E Through Track Level 02 (see REF[1/9])



Option 5E Over bridge Level 03 (see REF[1/9])



12.3. Consents and planning

The Network Rail (Thameslink 2000) Order 2006 provides powers to construct and maintain the railway works at London Bridge station within the defined limits of deviation.

New applications for planning permission, listed building consent and conservation area consent would be required. In order to justify the loss of the listed train shed such applications would need to demonstrate achievement of planning and regeneration benefits equivalent to Masterplan. There would be very high risk that sufficient benefit could not be demonstrated.

12.4. Structural Engineering Assessment

This option explores the possibility of a reduced demolition area - central core distribution area (under new high level extension) is demolished and remainder of the station is remodelled on top to existing structures. Main passenger distribution is via over-decks founded on the existing arches.

The full demolition area is reduced to central core area only, with remainder of the station requiring substantial strengthening and modifications to existing arches to accept the new

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loads. Perimeter of the demolition area will have to be strengthened in the same way as in Option 2A.

Foundations in the core area will be generally similar to Option 2D with likely increase of approximately 30% to cater for taller roof and over-deck structures. Foundations on top of the arches will have to cater for the double deck structure of passenger over-deck and roof, therefore will be substantial and through foundation to the ground level should not be ruled out at this stage.

Structures are not explored in great detail for this option but in general a double deck structure of over-deck and roof will substantially increase (comparing against Option 2D) the structural section requirements to cater for the loads. Over-deck (platforms and track) structures will be more complex above the demolition area, as the additional double storey bridge and roof structure must be accommodated in column loads and the complex arrangement of escalators will add to the volume of required foundations and structures.

The option is a complex structural hybrid of demolition and rebuild, modifications and strengthening in the remainder of the areas. An over-deck structure will be as complex to design and erect as the over site development deck. This option once implemented does not offer any future over site development investment opportunity without significant disruptive impact on station operation. A more in depth statement of the structures for each option is given in REF[2/1].

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13. Option 5Z

13.1. Option Description

The Option 5Z design has been developed to a much greater extent than the other TODFA Part A options presented above. This section provides an overview of the design and technical reports produced during GRIP 3.

This option is fundamentally different from Masterplan. Option 5Z is similar to Option 5E in that both options are “over-bridge type “ solutions. For Option 5Z passenger circulation is provided by a single wider over-deck spanning the High Level tracks with a narrower arm spanning the Low Level tracks. In order to make the station work efficiently in terms of pedestrian flow the passenger are encouraged to be separated between the High and Low level station. The over-deck is unpaid down the middle with gate lines left and right leading down to the through tracks / High Level station.

The scheme requires the demolition of 84 Tooley Street, the footprint being used as vertical circulation to the northern end of the over-deck. The north south concourse is formed using the existing arched Stainer Street which is to be pedestrianised with a new central vertical circulation bank of 3 flights of escalators directly to the unpaid side of the over-deck. This vertical circulation zone is located at the junction of the Western Mall and Stainer Street. Western Street remains open to vehicular traffic as today. Commercial opportunities are significantly reduced with this option, there is no air rights development and no passive provision provided for any future investment. There is also no allowance for a supermarket, and retail units are in existing arches resulting in the lower potential revenue. There is no loading bay provided within this option. This option would require new planning permission and environmental planning consent.

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13.2. Station Layouts

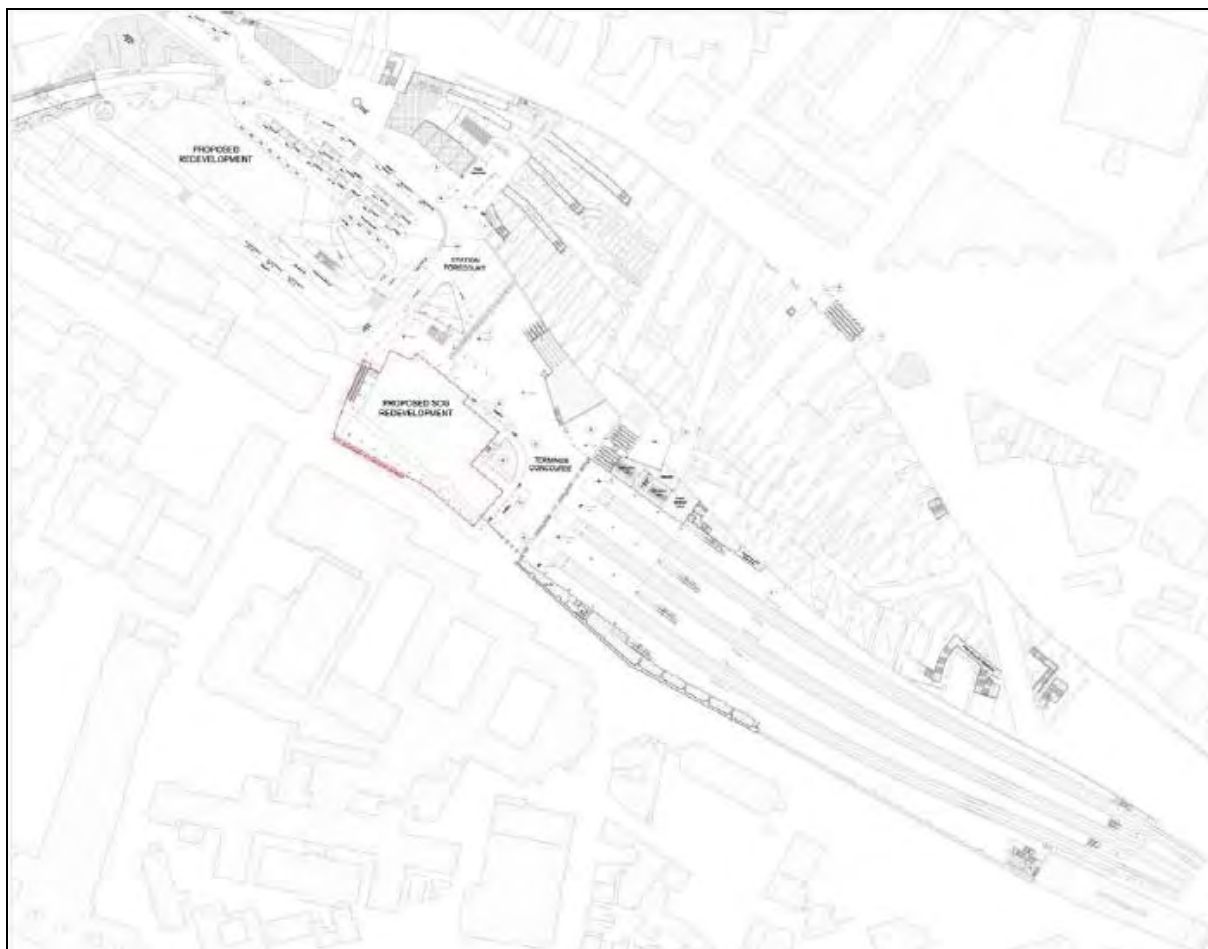
Option 5Z Street Level 00 REF[1/9]



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Option 5Z Terminus Level 01 REF[1/9]



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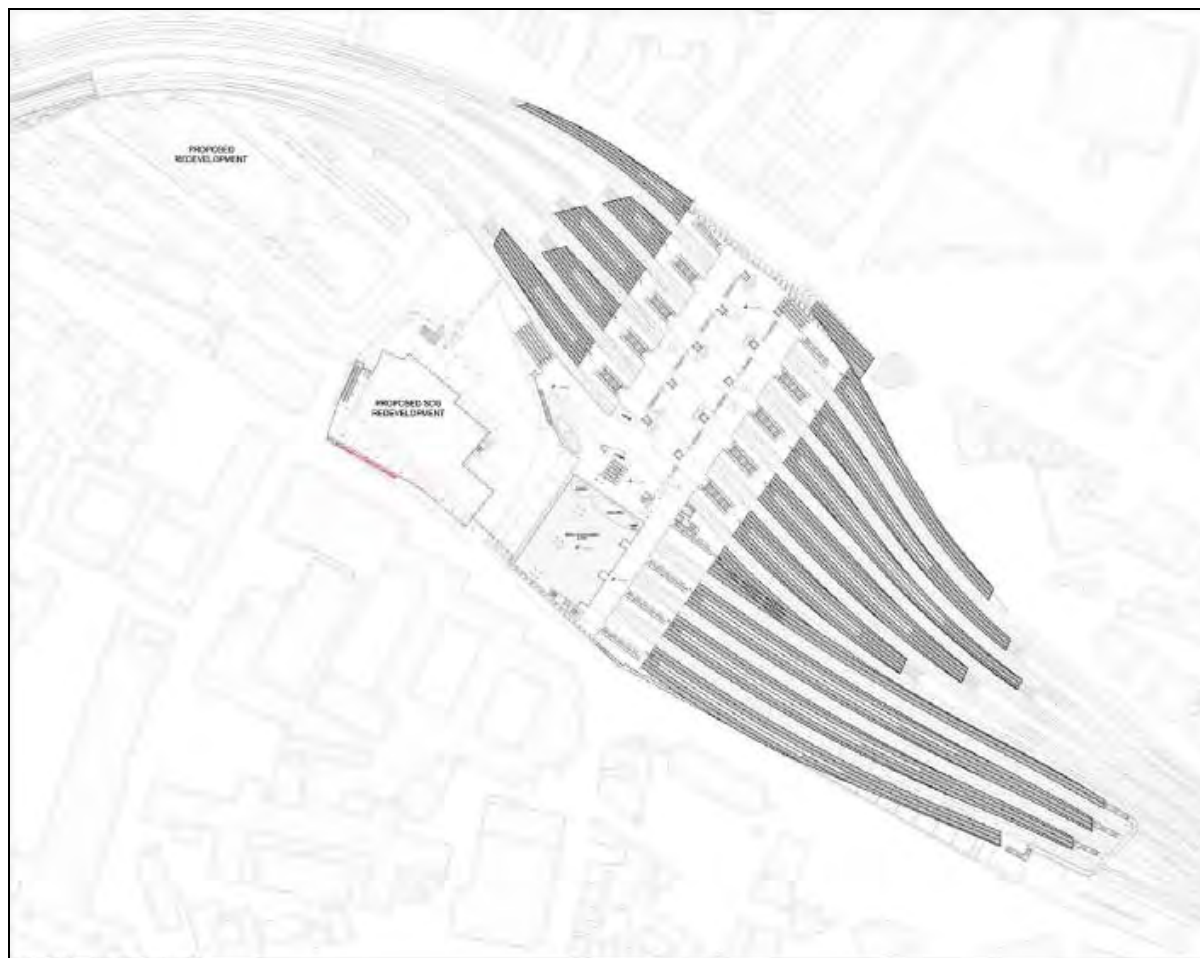
Option 5Z Through Tracks Level 02 REF[1/9]



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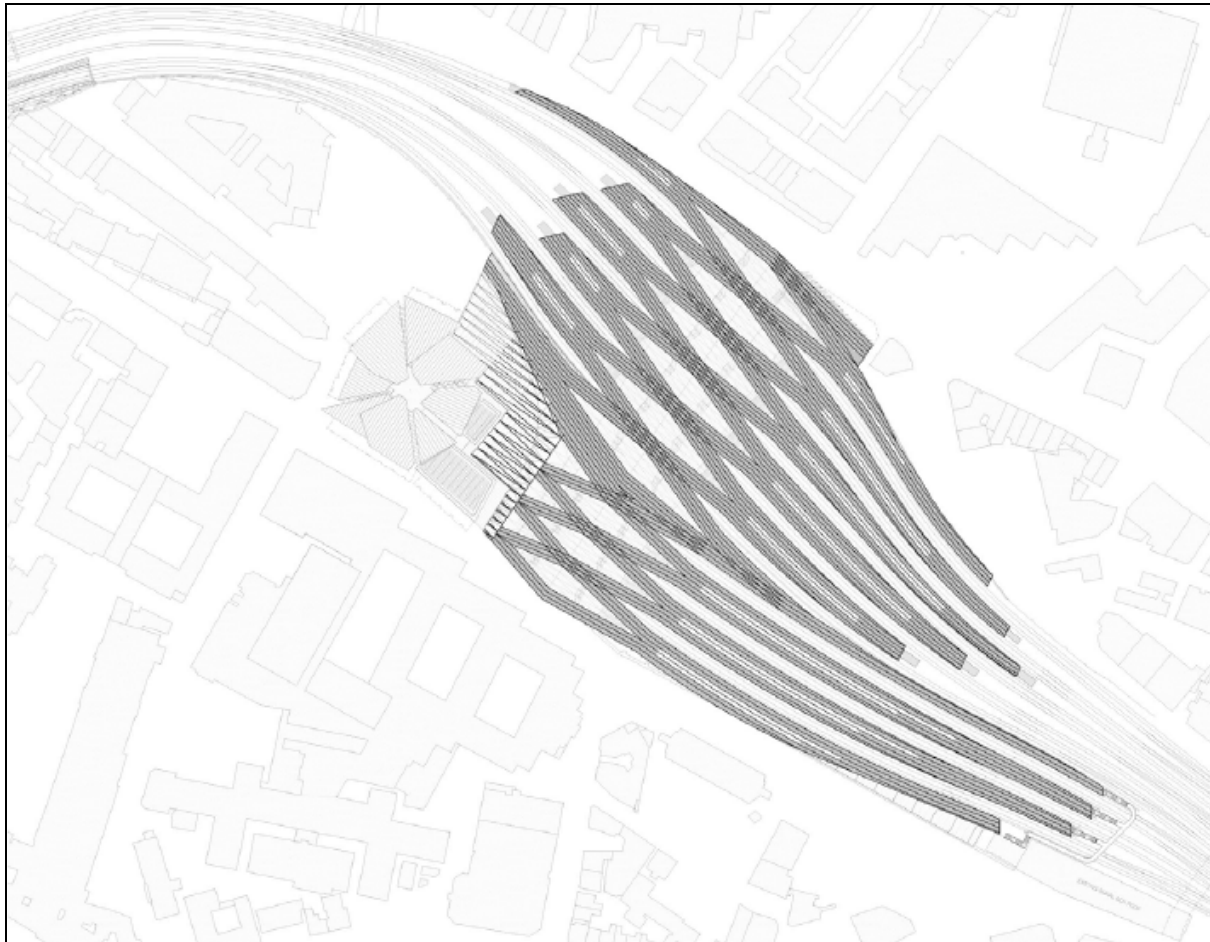
Option 5Z Over Deck Level 03 REF[1/9]



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Option 5Z Roof Level 04 REF[1/9]



13.3. Consents and planning

The Network Rail (Thameslink 2000) Order 2006 provides powers to construct and maintain the railway works at London Bridge station within the defined limits of deviation.

New applications for planning permission, listed building consent and conservation area consent would be required. In order to justify the loss of the listed train shed such applications would need to demonstrate achievement of planning and regeneration benefits equivalent to Masterplan. There would be very high risk that sufficient benefit could not be demonstrated.

Further details of the planning consent requirements for Option 5Z can be found in REF[2/13].

13.4. Commercial Opportunities

Due to cost reduction efficiencies this option did not initially consider any significant retail or over site development as an integral part of the scheme, so the commercial property opportunity or potential has not been considered in any great detail.

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Option 5Z is restricted in terms of over-site and retail development potential. Potentially offices could be developed above the terminating platform on St Thomas's Street. Retail potential is also restricted due to the over-deck configuration limiting the available concourse space. Minor "Grab and Go" retail, such as barrier and paid side kiosks (e.g. for snacks, coffee and news papers), may be possible. Significant retailing is therefore very limited under this option.

13.5. Structural Engineering Assessment

This option was selected to be developed to the level of definition suiting single option and therefore becomes the best defined representative of type 5 options. All type 5 options explore in varying degree of detail possibility of passenger distribution based on the over-deck above the main station platforms and small central core demolition area allowing installation of escalator links to terminus level, Western Arcade and street level. The option assumes minimum works to the street level arches and concentrates on providing the fully functioning station at and above existing rail levels. The main works at ground level involve breakthrough to link Western Mall to the core vertical link area, and the removal of bank of escalators in the middle of western arcade.

Demolitions: Full demolition to street level is reduced to central core area only and 84 Tooley Street, with the remainder of the station requiring substantial demolition of so called 'Jack arches' level and strengthening / modifications works to existing arches to accept the new loads. Perimeter of the core demolition area will have to be strengthened in a similar way to that described in Option 2A narrative. There is a suite of drawings defining the demolition areas to all structural works.

Foundations: In the core area, foundations will be generally similar to those described in Option 2D narrative. Perimeter foundation will be piled strip type to allow restraining of adjacent arches and offer support to concourse and track structures in transition areas. The centre of the core area foundations will be of pile and pile cap type, likely to offer a fixed point to transfer horizontal forces from above. Foundations on top of the arches (installed within the footprint of the over-deck) are designed to be placed directly on primary arch piers and span the arch intrados to avoid placing direct load on the on the arch curve. Foundations for the escalator link at north of the station (footprint of 84 Tooley Street) will be substantial pile and pile cap type. The comprehensive set of design drawings and report ID40 details the design solutions and reasons for them.

Structures: Over-deck structure is well defined and comprises steel support structure with pre-cast / screed deck and architectural roof mixing steel and PTFE elements. The major structure at the north of the station (footprint of 84 Tooley Street) provides housing to the escalator link (over-deck to street level). This structure is same type as the over-deck (steel and pre-cast decks) and will have glass façade, which will require substantial structural support. Minor perimeter and ancillary structures such as station platforms, canopies escape staircases etc are now well defined and studies of potential structural solutions are also present.

The comprehensive set of design drawings and ID40 report REF[2/2] detail the design solutions and reasons for them.

Option 5Z is a complex hybrid of various civil and structural solutions. As such it will offer number of challenges to detail and construct. Its interface with Shard of Glass concourse will require serious modifications to the roof structure in this area. This option once implemented

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does not offer any future over site development investment opportunity without significant disruptive impact on station operation. Alan Baxter reports for ID40.1 REF[2/3, 2/4, 2/5 & 2/6] appraise the existing structures with respect to Option 5Z.

13.6. Fire Engineering

13.6.1. GRIP 3 Fire Strategy

Arup's report REF[2/7] presents the fire strategy for Option 5Z; this report demonstrated that an adequate level of fire safety can be achieved within the station, thus bringing the station in line with modern standards and codes. The proposed fire strategy for London Bridge Thameslink Station has been discussed with key stakeholders at a Qualitative Design Review on 8th February 2010.

With regards to the Fire Strategy ARUP are following (among other regulatory documents) the guidance outlined in the RSPG (HSE HMRI Railway Safety Principles and Guidance) on stations, Part 2 Section B Guidance on Stations; 1996. This requires that the public and non-public areas have a means of purging smoke post-evacuation.

A number of conclusions were drawn from the fire strategy study, a summary of items that need to be addressed as part of Grip 4 are given below:

- The steady state calculations carried out demonstrate that tenable conditions can be maintained on the platform and over-bridge (for the credible fire scenarios identified) allowing occupants to escape safely and fire fighters to carry out fire fighting operations safely. This approach is considered conservative and should additional retail facilities be provided then it may be necessary to carry out more detailed analysis such as computational fluid dynamics.
- Further investigations into the width of the evacuation bridge at the country end, the stair from the bridge to Platform 16 and the stair off Platform 16 to St Thomas' Street taking account of the egress analysis and physical restraints of the station.
- Consideration with regards to retaining the sprinkler tank and connecting the vaults sprinkler system to the sprinkler tank.
- The impact of retail will need further consideration and development.
- The use of intumescent materials as a form of fire protection to the steel structure.
- Full understanding of the interface between the Shard of Glass and London Bridge Station with regard to fire separation, sprinkler tank integration and smoke management.
- Explore the advantages and disadvantages of ETFE as a roof covering, with regard to smoke venting.

13.6.2. Fire Evacuation Assessment

Arup's report REF[2/8] presents the evacuation assessment for Option 5Z of London Bridge Station. Based on the 2016+35% passenger flow predictions and scenarios for train and station fires; the evacuation assessment verifies the:

- Population of passengers to be evacuated;
- Minimum stair capacity required for means of escape;
- Minimum escalator capacity required for means of escape.
- Minimum exit width required at street level

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The key findings from the evacuation are that all stairs within the station are permitted to be 1.1m in width and all escalators are permitted to be 1m in width. This is based upon an engineered solution that treats the end of the terminating platforms as a place of relative safety. These conclusions are based on the following design solutions:

- The terminating platforms are each provided with one stair at the end remote from the concourse;
- The terminating platforms are provided with a total of 30 UTS gates;
- The through platforms are each provided with one protected stair at either end of the platform;
- The through platforms are each provided with two escalators and two open stairs to the interchange concourse.

Mobility Impaired Persons (MIP)

Each end of platform stair is to be provided with an area dedicated to a disabled refuge. Flat or ramped access will be provided to enable wheelchair users to reach a final exit or a refuge. Each refuge space will be an area accessible to a wheelchair of minimum dimensions 900mm by 1400mm, in which a wheelchair user can await assistance. The refuges shall be designed as follows:

- Arranged so as not to impede the egress of others by maintaining a clear circulation path;
- Provided with a 2-way intercommunication device complying with BS 5839 Part 9 Fire detection and alarm systems for buildings, code of practice for system design, installation, commissioning and maintenance of emergency voice communication systems and consisting of Type B outstations to allow disabled users to communicate with the station management and the fire brigade at the fire alarm panel located within the SOR.

A management plan will be required to be developed to address the evacuation of Mobility Impaired Persons (MIPs). For a full understanding of the fire evacuation analysis REF[2/8] should be read.

13.6.3. Fire tenability assessment

The GRIP 3 fire tenability report REF[2/9] assesses the level of safety within the proposed design for Option 5Z(5) should a fire occur, identifying the additional fire safety measures required to enhance the means of escape provision if any are needed.

The tenability conditions assessment has been performed against the following Fire Safety objectives:

- Ensure the safe evacuation of the public and members of staff
- Ensure the safe intervention of fire brigade

The tenability assessment focuses solely on life safety issues during evacuation, and does not consider property protection. The assessment proposes a number of detailed recommendations, and overall the tenability requirements are thought to be achievable.

13.7. M&E Station services design



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13.7.1. GRIP 3 Fire Strategy

Arup's report REF[2/7] presents the fire strategy for Option 5Z(5); this report demonstrated that an adequate level of fire safety can be achieved within the station, thus bringing the station in line with modern standards and codes. The proposed fire strategy for London Bridge Thameslink Station has been discussed with key stakeholders at a Qualitative Design Review on 8th February 2010.

With regards to the Fire Strategy ARUP are following (among other regulatory documents) the guidance outlined in the RSPG (HSE HMRI Railway Safety Principles and Guidance) on stations, Part 2 Section B Guidance on Stations; 1996. This requires that the public and non-public areas have a means of purging smoke post-evacuation.

A number of conclusions were drawn from the fire strategy study, a summary of items that need to be addressed as part of Grip 4 are given below:

- The steady state calculations carried out demonstrate that tenable conditions can be maintained on the platform and over-bridge (for the credible fire scenarios identified) allowing occupants to escape safely and fire fighters to carry out fire fighting operations safely. This approach is considered conservative and should additional retail facilities be provided then it may be necessary to carry out more detailed analysis such as computational fluid dynamics.
- Further investigations into the width of the evacuation bridge at the country end, the stair from the bridge to Platform 16 and the stair off Platform 16 to St Thomas' Street taking account of the egress analysis and physical restraints of the station.
- Consideration with regards to retaining the sprinkler tank and connecting the vaults sprinkler system to the sprinkler tank.
- The impact of retail will need further consideration and development.
- The use of intumescent materials as a form of fire protection to the steel structure.
- Full understanding of the interface between the Shard of Glass and London Bridge Station with regard to fire separation, sprinkler tank integration and smoke management.
- Explore the advantages and disadvantages of ETFE as a roof covering, with regard to smoke venting.

13.7.2. Fire Evacuation Assessment

Arup's report REF[2/8] presents the evacuation assessment for Option 5Z(5) of London Bridge Station. Based on the 2016+35% passenger flow predictions and scenarios for train and station fires; the evacuation assessment verifies the:

- Population of passengers to be evacuated;
- Minimum stair capacity required for means of escape;
- Minimum escalator capacity required for means of escape.
- Minimum exit width required at street level

The key findings from the evacuation are that all stairs within the station are permitted to be 1.1m in width and all escalators are permitted to be 1m in width. This is based upon an engineered solution that treats the end of the terminating platforms as a place of relative safety. These conclusions are based on the following design solutions:

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- The terminating platforms are each provided with one stair at the end remote from the concourse;
- The terminating platforms are provided with a total of 30 UTS gates;
- The through platforms are each provided with one protected stair at either end of the platform;
- The through platforms are each provided with two escalators and two open stairs to the interchange concourse.

Mobility Impaired Persons (MIP)

Each end of platform stair is to be provided with an area dedicated to a disabled refuge. Flat or ramped access will be provided to enable wheelchair users to reach a final exit or a refuge. Each refuge space will be an area accessible to a wheelchair of minimum dimensions 900mm by 1400mm, in which a wheelchair user can await assistance. The refuges shall be designed as follows:

- Arranged so as not to impede the egress of others by maintaining a clear circulation path;
- Provided with a 2-way intercommunication device complying with BS 5839 Part 9 Fire detection and alarm systems for buildings, code of practice for system design, installation, commissioning and maintenance of emergency voice communication systems and consisting of Type B outstations to allow disabled users to communicate with the station management and the fire brigade at the fire alarm panel located within the SOR.

A management plan will be required to be developed to address the evacuation of Mobility Impaired Persons (MIPs). For a full understanding of the fire evacuation analysis REF[2/8] should be read.

13.7.3. Fire tenability assessment

The GRIP 3 fire tenability report REF[2/9] assesses the level of safety within the proposed design for Option 5Z should a fire occur, identifying the additional fire safety measures required to enhance the means of escape provision if any are needed.

The tenability conditions assessment has been performed against the following Fire Safety objectives:

- Ensure the safe evacuation of the public and members of staff
- Ensure the safe intervention of fire brigade

The tenability assessment focuses solely on life safety issues during evacuation, and does not consider property protection. The assessment proposes a number of detailed recommendations, and overall the tenability requirements are thought to be achievable.

13.8. M&E Station services design

13.8.1. Overview

The Arup M&E services design, report REF[2/10], is based on the architectural drawings and layouts for station option 5Z. The M&E design proposals at GRIP3 are mindful that the



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project is being undertaken under strict budgetary constraint, as far as possible the best economic solutions have been selected although operational costs have also been considered.

13.8.2. Electrical Engineering

The key features of the proposed electrical services design for Option 5Z(5) that impact the fundamental layout of the station design from REF[2/10] are summarised in this section. The GRIP 3 electrical services design covers: Power supply arrangements, plant access and maintenance, HV power supplies, back-up power supplies, LV power supplies and local back-up supplies.

The maximum demand for Option 5Z(5) is estimated to be 3.4MVA (approx 4600A), allowing for 20% spare capacity for future extension or enhancement of the station. This estimate does not include any capacity allowance for future commercial opportunities.

There are a number of existing low voltage intakes available at the station, a number of which may be retained through construction and for the final scheme. Existing available supplies provide only 2.1MVA and additional supplies are required to meet the estimated demands of Option 5Z(5).

A new Network Rail owned HV sub station is proposed as the solution to meet the additional power demand. The substation would provide a 2MVA supply and a separate 630kVA Network Rail owned substation will be required as a back up supply. The back up supply shall be supplied from an independent source to any normal supplies. It is anticipated that the capital cost of providing a new Network Rail owned HV substation would be greater than a DNO owned supply option. However, there is the potential for lifecycle benefits due to increased supply reliability and cost savings to the lower tariffs attracted by HV supplies.

Potential non-compliances have been identified against GT/TDINT100 Earthing and equipotential bonding of telecommunications equipment. At this stage it is not thought that this non-compliance can be resolved due to the restrictions of London Bridge Station and, therefore, a derogation will be required. Refer to section 3.3 of Ref [2/10] for further information. No other non-compliances have been identified.

No provision has been made in the electrical services design for future commercial opportunities. Spare capacity allowed for in the design is intended for future station upgrades and enhancements and not for third party use. It is recommended that at GRIP 4 the electrical services design is revisited and determine if appropriate commercial requirements are considered in electrical design to cover:

- Electrical load requirements
- Servicing strategy for electrical connections
- Provision of space for plant
- Provision of containment routes
- Provision of base build services to each retail unit e.g. fire alarms
- Renewable energy provisions

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13.8.3. Service Routes

A key element of the M&E design at GRIP 3 is to provide feasible service and cable routes. To summarise the service routes have been planned to:

- Be integrated with architectural and structural design;
- Provide secure routes across the station;
- Allow for easy access and maintenance;
- To be suitable for all services including M&E and communications and railway systems;
- Provide sufficient space for future upgrades.

13.8.4. Heating, Venting and Air Conditioning

At the GRIP 3 stage of design the mechanical engineering has been limited to an assessment of whether spaces are heated or unheated, mechanically or naturally ventilated and cooled or un-cooled. The report gives the appropriate design criteria for mechanical systems and the technology options available for meeting the station requirements. A high level assessment of suitability of technology is presented in REF[2/10] in the form of listed advantages and disadvantages.

No non-compliances have been identified as a result of the GRIP 3 design. At this stage allowances have not been made for mechanical services to retail units, it is recommended that at GRIP 4 the mechanical services design is revisited to include retail requirements if appropriate.

- It is assumed all mechanical services will be new
- The main focus will be to design accommodation using natural ventilation where possible
- Where the above is not possible, central CHW and LTHW will be used
- Technical rooms will incorporate CRAC units
- Plant rooms will incorporate local air cooled DX units
- Back of house areas such as cleaners rooms will be provided with central LTHW only
- Public and open areas will be naturally ventilated only

13.8.5. Public Health Engineering

The public health systems that are covered by REF[2/10] include incoming gas and water supplies, cold water storage, treatment and distribution, hot water, sanitary plumbing, rainwater management systems and fire protection systems. Key assumptions that have been made are:

- All foul and surface water drainage within the vaults, plant room gullies and underground drainage will be done by the structural engineers;
- No allowance has been made for requirements of retail franchises;
- All items of public health equipment are new except for the sprinkler tank.

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13.8.6. M&E Sustainability

The recommendations from REF[2/10] with regards to the sustainability options are presented in this section. In order to ensure that the project follows best practice, the following objectives have been set:

- Compliance with Part L2A of the Building Regulations 2010 (it is envisaged that this will represent a 25% reduction in CO2 emissions compared to Part L2A 2006).
- 20% CO2 emissions reduction from renewable energy. This is in line with the London Plan 2009.
- Achieve CEEQUAL Excellent.

Energy demand should be reduced by specification, installation and appropriate initial and seasonal commissioning of efficient building systems. Energy-in-use should be reduced by installation of energy monitoring and building management systems, as well as control systems for lighting and HVAC.

Existing utilities connections should be reused where practicable and reuse of existing building structure and materials should be considered. A preliminary study of low and zero carbon technologies suggests technologies suitable for the project include the following and these will have to be investigated in more detail in GRIP 4 along with others:

- Ground source heat pumps to provide space heating and cooling
- Solar thermal energy to generate domestic hot water
- Photovoltaic panels to generate electricity

A similar strategy of minimising usage for water conservation has been adopted. Water consumption will be minimised through water efficient measures (e.g. low flow fittings, automatic controls, etc). In addition, rainwater harvesting will be used to flush toilets and urinals.

Final decisions have not been made on any of the technologies mentioned above, due to the full requirements for sustainability not being clear at this stage. The choice of technologies could have significant impact on the station design.

During GRIP 4 a whole-life approach should be taken when considering the viability of low and zero technologies. In the timescales that London Bridge Station is due for completion by, significant advances in these technologies are expected, combined with increasingly stringent legislation.

13.8.7. Residual risks and issues from the M&E studies

Several risks to the mechanical services design have been identified that could have a significant impact on the station design going into GRIP 4. These can be summarised as follows:

1 - Full services surveys are not available: At the time of issue (July 2010), required station surveys results are not available, therefore designs have not been completed with knowledge of as-built information. It is strongly recommended that thorough survey results be examined as soon practicable as this critically informs the overall design and identifies areas of risk.

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2 - Sustainable solutions have not been determined: Final decisions have not been made on any of the technologies mentioned above, due to the full requirements for sustainability not being clear at this stage. The choice of technologies could have significant impact on the station design.

3 - Construction sequencing has not been agreed: Whilst the proposed design has been based on providing flexibility whatever construction sequence is followed, until this sequence is confirmed there is a risk to the feasibility of the proposed design.

4 - Commercial requirements are unknown: Addition of commercial / retail units to the scheme will mean an increase in the quantum of M&E services to be provided, within impacts on equipment, space and services routes.

13.9. Telecoms Design (Station Information & Security Systems)

A GRIP 3 level telecoms design statement is provided in REF[2/11]. In this document the high level systems architecture is developed to meet the Thameslink Functional Specification REF[1/2]. Elements of the final telecoms design shall be delivered as a part of the enabling works, the migration strategy for operational utilisation of existing and new equipment is given in REF[2/12].

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14. Option 6B(3)

14.1. Option Description

The 6B(3) Option design is the development of a Network Rail Peer Group proposal for an under track concourse beneath standard modular NR bridge deck construction.

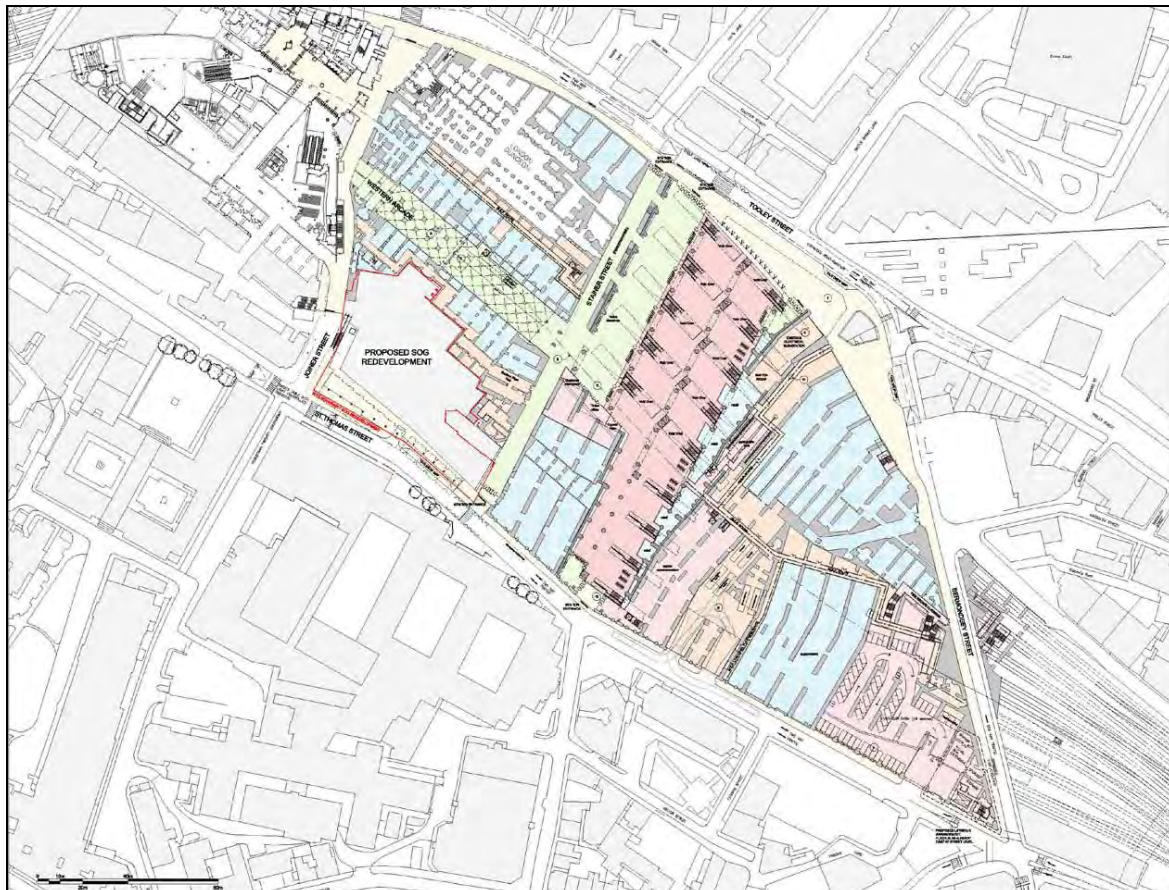
In this option the main entrance to the station (and in particular the through station) switches to Tooley Street at ground level. This reflects the change in size and importance of the through and terminus elements of the station, and allows the creation of a major, ground level connection between Tooley Street and St Thomas's Street mirroring the link proposed in the Masterplan planning consented scheme. The existing station entrance location, which extends the concourse provided by the Shard development, becomes a secondary entrance to the station primarily serving the London Bridge Quarter and Bus station egress and interchange. There is no over site development proposal and minimal commercial development. Platforms are covered for the most part by simple modular canopies based on an existing design. The key station accommodation aside from those elements directly serving the lower concourse is provided by on an over-bridge over the terminus gate-line.

This proposal replicates the approach of the Masterplan but with the cut for the under track concourse moved slightly to the east and with a reduced width concourse requiring less demolition beneath the terminus station. The key feature of the proposal is that the track bridges should become independent standard box sections supported on large concrete cross head structures with separate platform bridges rather than bespoke combined structures (the trees and trestles of Masterplan, for example). This approach requires no mezzanine interchange deck and the introduction of longer escalators direct to a larger ground level concourse from both the High and Low Level platforms.

The proposals have been reviewed against the proposed passenger flows and the proposal is supported by detailed reviews by planning, structural, services, and vertical circulation and fire studies.

14.2. Station Layouts

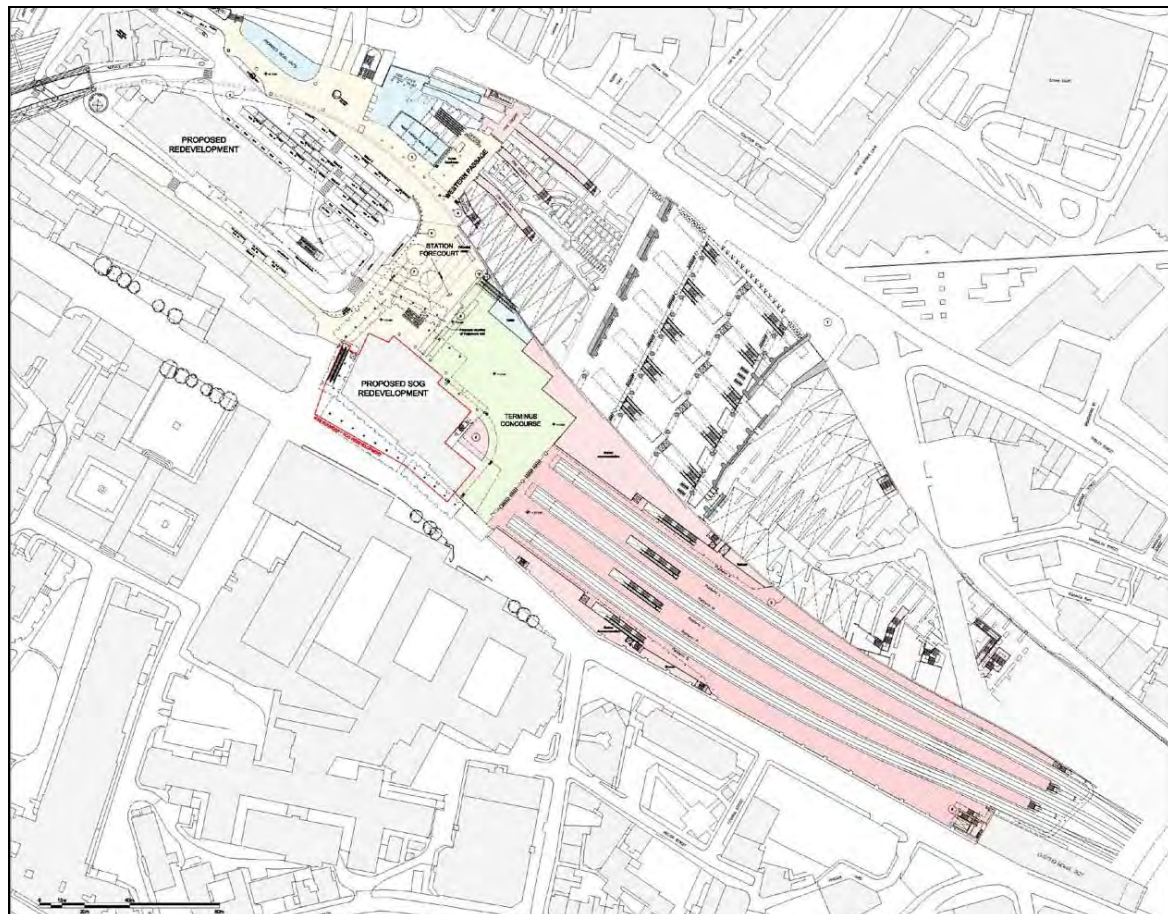
Option 6B(3) Street Level 00 (taken from REF [2/15])



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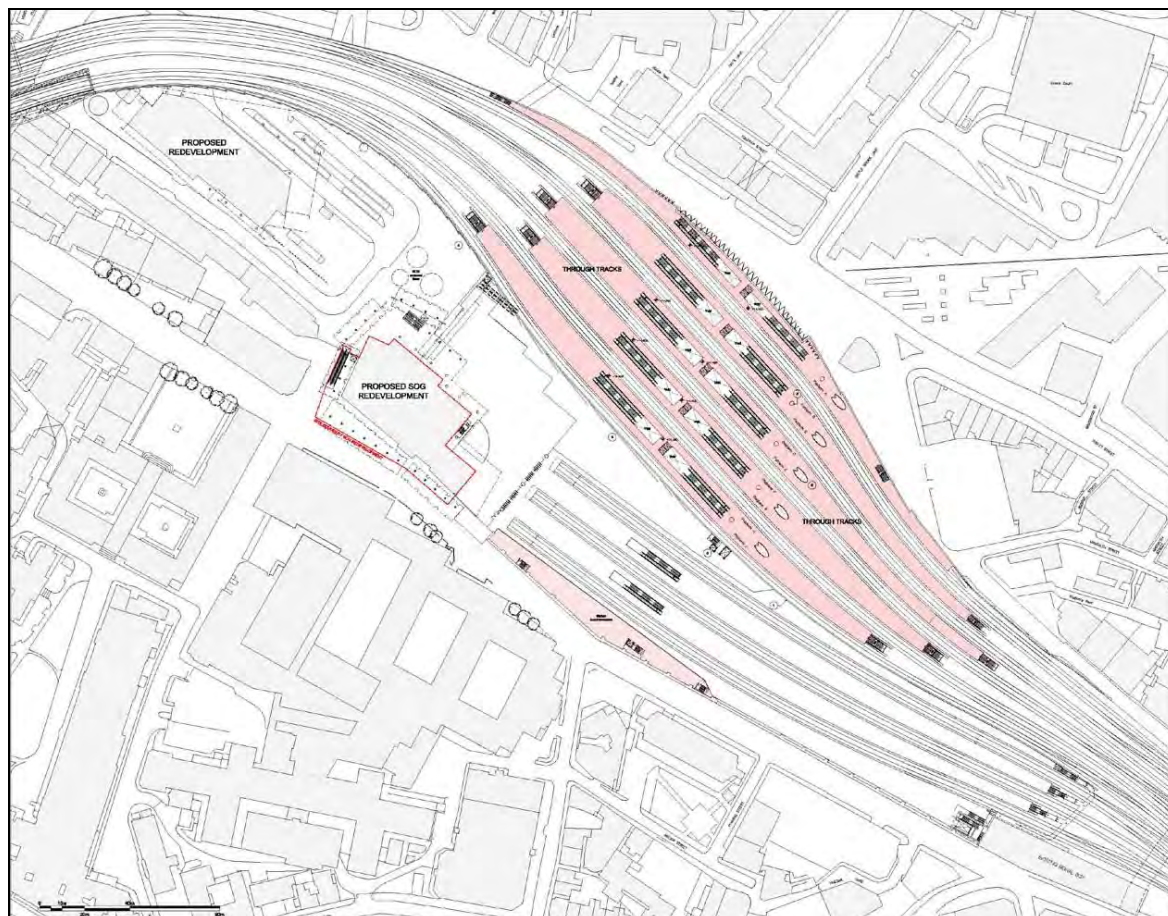
Option 6B(3) Terminus Level (taken from REF [2/15])



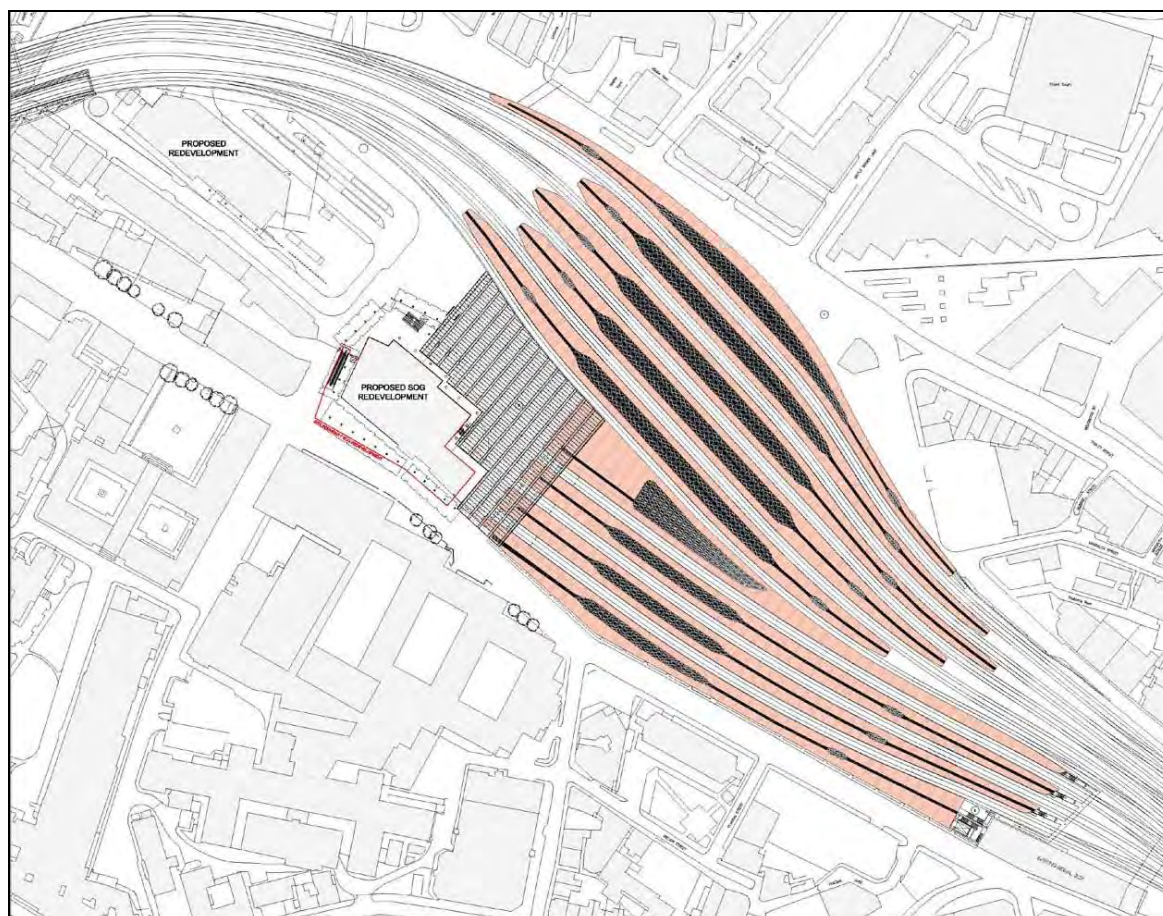
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Option 6B(3) – Through Track Level (taken from REF [2/15])



Option 6B(3) – Roof Plan (taken from REF [2/15])



14.3. Consents and Planning

For Option 6B(3) the Network Rail (Thameslink 2000) Order 2006 provides powers to construct and maintain the railway works at London Bridge station within the defined limits of deviation.

New applications for planning permission, listed building consent and conservation area consent would be required. In order to justify the loss of the listed train shed such applications would need to demonstrate achievement of planning and regeneration benefits equivalent to Masterplan. There is a high risk that the current design will need to be amended to achieve planning permission.

Further details of the planning consent requirements for Option 6B(3) can be found in [REF 2/14].

14.4. Commercial Opportunities

14.4.1. Retail

Option 6B(3) has only considered a retail provision of approximately 1000 m²/10,750 ft². The Department for Transport has instructed Network Rail that they are only prepared to fund

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replacement retail to the level of the present station on a like for like basis. This was interpreted as providing as “grab ‘n go” type retail only.

Using the front part of the extended vaults area provides 950 m², giving an estimated annual rent of £3.5m with a capital value of £66.5m (these figures have been provided by the Commercial Property team at Network Rail Head Quarters).

14.4.2. Over-site Development

The current planning permission allows for a 10 storey structure with 750,000 ft² (c70,000 m²) gross floor area. Consideration was made as to the possible opportunities provided by the provision of an air rights slab, recognising the impact on both construction and programme that this provision would bring. Involving representatives from the Project, Sponsor, Development and Commercial Property teams, each of the original four air rights zones was considered.

It was accepted that the levels of rent for an over site development over the tracks would not offset the cost and disruption to the Thameslink Programme to justify pursuing this further as an option.

Network Rail Commercial Property has accepted the GRIP 3 Position that an over site development of any kind is not included in the scope of work.

14.4.3. Further Opportunities

There is retailing opportunity over and above the 1000m² currently provided for in the design. Early analysis suggests that an additional 6700m² may be suitable for retail and available with an estimated potential annual rental value of c£7m, the capitalised value of rent being c£135m. There would be additional revenue streams available for advertising and ATMs with an initial estimate still to be confirmed.

14.5. Structural Engineering Assessment

Option 6B(3) explores further the concept initially set out in Masterplan version Option 2D, and relies on a large area of the railway arches to be demolished and rebuilt as a series of rail bridges and platform structures. This option explores passenger distribution directly from platform to street level without an intermediate mezzanine level redistribution area. Lack of mezzanine is the only major difference to the concept of 6B(3) and Options 2D variants.

- rail bridges over the demolished area to be standard 24m span box girder Network Rail design;
- canopies should be used to cover platforms, the design of these is to be based on a standard design used on the network;
- escalators to be full length from platform level to ground level;
- arches in south west corner between Weston and Stainer street to be retained;
- there should be escalators down to ground level embedded in terminating platforms;
- station accommodation to be placed on the over-bridge over terminating platforms;
- minimise the demolition area as far as possible;

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This option is developed to the single option level of definition and therefore becomes the best defined representative of options type 2 and 6.

Demolitions: Full North to South demolition; demolition line is well defined in the available set of design drawings and substantiated in the report REF[2/16].

Foundations: The piling / pile cap solutions were chosen as basis of the design for this option after considering two other options. The edge of demolition will require same type of strip piled foundations as defined in Option 2D to serve as support to the edge retention structures. The centre pairs of columns (2 rows) are supported on individual pile caps and piles. There are a large number of smaller foundations for escalators, lifts, façade supporting structures etc – these are likely to be founded on small piles or on soil depending on detailed design.

Structures: Main vertical support is designed as pairs of reinforced concrete columns with reinforced concrete crossheads supporting the structural steel railway bridge (box girders) of standard Network Rail design; a simply supported system was chosen. Platforms are supported off reinforced concrete crossheads and structurally separate from the railway bridges, also made of structural steel with continuous span across the opening, and of box girder and cantilever design. Spans and spacing of the structures is normalised as far as possible allowing more than 60% of the structure to be of standardised design.

Platform canopy design is a standard design used at several stations on the network but generally modified to fit the structures gauge and spans. The North façade to the station (Tooley St footprint) requires substantial structural supports and is designed to be of steel and glass construction. The structure of the station accommodation building is spanning over the terminating platforms and is designed as a sway frame on the rectangular grid. The interface zone between terminating and through stations contains a large light well set in concrete structure, which also contains link escalators structures.

Option 6B(3) is a structurally simplified version of options type 2, it maximises use of Network Rail standard designs to increase the cost accuracy and efficiency of the proposed scheme. The interface with the Shard of Glass concourse is less intrusive than Option 5Z(5) but is still significant.

The design of 6B(3) assumes the use of standard box girder bridge design. Due to the difference in live load between the platforms and bridges supporting track loads, the two structures have been separated. During GRIP 4 differential settlement between the two structures will need to be checked along with platform gauging.

It would be recommended prior to commencement of GRIP 4 to run a value engineering workshop and during such to consider alternative standard bridge designs. .

Further details of the options considered for the structural engineering of Option 6B(3) can be found in REF [2/16].

Taken from REF [1/11] the key issues and recommendation with respect to structural engineering at the close of GRIP 3 are as follows:

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- a) Further appraisal and assessment of the existing viaduct structures should be undertaken prior to GRIP 4 following the topographical survey, structural investigations and ground investigations currently being undertaken. This will inform the GRIP 4 design and help identify further investigations likely to be required during GRIP 4 and 5.
- b) Whilst significant demolition is to be undertaken for the new concourse, the majority of the station remains on the existing viaduct structures with necessary alteration, strengthening and buttressing. There is a risk that more extensive works to the retained existing structure will be required than is currently anticipated and allowed for in the cost plan. This risk can be better quantified following the proposed structural investigations, but residual risks relating to unknowns within the existing structures and their foundations will remain.
- c) Further consideration should be given to increasing the extent of demolition to include the isolated arches currently intended to be retained below the terminus as considerable structural works are required to maintain their stability, support the additional rail loads, and the proposed over-track station accommodation building, and accommodate openings in the supporting walls to suit their proposed use.
- d) Foundations to the new concourse structures including the buttressing walls to the retained arches need to minimise the risk of ground movements or surcharging of the soils below the retained arch foundations leading to potential foundation movements. Piled foundations have been proposed as the selected option for the GRIP 3 designs.
- e) There are issues to be fully resolved during GRIP 4 in relation to having independent track bridge and platform structures, in relation to the relative stiffness of the structures to maintain required track to platform clearances under different loading arrangements, accommodation of movement joints, maintenance access for internal and external inspection of the box girders and acoustic treatment. Other structural solutions for the decks could be explored to simplify some of these issues.
- f) The construction phasing and staging strategy is still being developed. A further review of the GRIP 3 design should be undertaken to highlight any new issues arising from the phasing that could impact upon the GRIP 4 design.
- g) There is a risk that the Shard of Glass design could compromise aspects of the GRIP 3 station design for the terminus concourse and piazza. It is likely that some elements of the Shard works will need to be altered as part of the station development. There is an important unresolved issue with concourse levels which need to be lowered to suit the new station concourse, to provide adequate headroom for access below Station Approach Viaduct Extension into the Western Passage and to provide level access with the bus station to avoid steps. Other key interface issues to be addressed include the works required to the Shard of Glass concourse roof to suit Station Approach Viaduct Extension and proposed extension of the roof over the terminus concourse, and any works the Shard of Glass team may be proposing to undertake within the arches adjacent to the western arcade. Temporary station layouts and construction worksite requirements need to be properly considered in reviewing the Shard of Glass concourse proposals.
- h) SAVEX is a key element of the overall station design and needs to be fully integrated within the selected design option with its key interfaces with the piazza concourse,

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Western Passage, Western Arcade and main concourse structures at Stainer Street, as well as other interfaces with the Shard, bus station and SAV.

It is noted that at GRIP4 the SAVEX design will be an integrated within the Station design remit.

- i) The interface between SAVEX and SAV is not fully resolved, with further studies required on the SAV support structure at Joiner Street to avoid a permanent new structure within Joiner Street and to address pedestrian flow requirement adjacent to the bus station. The articulation of SAV and potential transmission of traction and braking loads via lock-up devices to SAVEX needs to be confirmed.
- j) There are significant risks associated with unknown services, both within the station and statutory services in the highway and potential clashes with the proposed structural works. Some limited information on services within the station is available but the results of a comprehensive survey of existing services currently being undertaken has not been available to inform the GRIP 3 design.
- k) The current planning consent and listed building consent for removal of the train shed relates to Masterplan. Option 6B(3) is different to Masterplan and will require new planning, listed building and conservation area consent applications. Consultations with London Borough of Southwark, CABE and English Heritage need to be undertaken, and the GRIP 3 design developed as required for submission for planning. Obtaining necessary consents is a very significant risk in the deliverability of Option 6B(3). The overall quality of the street level concourse in Masterplan and the wider regeneration benefits associated with it were central to the current listed building consent for taking down the train shed roof.
- l) A detailed study is required of the necessary streetscape works to Tooley Street to accommodate the predicted passenger flows from the new station concourse.
- m) The GRIP 3 design has been developed on the basis of 1000m² retail provision. Any inclusion of further retail is subject to business case justification and funding.

The following table is a structural scope comparison for Option 5Z(5) and Option 6B(3).

Table 6: Structural Scope Comparison for 5Z(5) and 6B(3)		
Area for consideration	5Z(5) SCOPE	6B(3) SCOPE
East of Joiner Street to west of Stainer Street in through level	New platform layout and escape corridors same in both options	New platform layout and escape corridors same in both options
East of Joiner Street to west of Stainer Street in SAVEX construction area	SAVEX construction and new platform layout with escape stairs same in both options	SAVEX construction and new platform layout with escape stairs same in both options
Shard / Terminus concourse	Removal of the escalator bank from western arcade. Modifications to Shard roof, Construction of high level walkway and escalator bank to terminus level station entrance. Modifications to western arcade enabling connection to the central escalator bank	Removal of the escalator bank from western arcade. Extension of Shard roof, Modifications to western arcade enabling connection to the central distribution area
East of Stainer Street to N-S line at east end of 84 Tooley Street	Minor strengthening works at ground level in arches. Erection of	Demolition of arches. Construction of the ground level concourse and

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building North of SAVEX structure line	foundation and pedestrian over bridge superstructure and platforms at track level	supports to the platform and track above. Construction of railway bridges and platforms
East of Stainer Street to N-S line at east end of 84 Tooley Street building South of SAVEX structure line	Minor strengthening works at ground level in arches. Erection of foundation and station offices over bridge superstructure and platforms at track level	Minor strengthening works at ground level in arches. Erection of foundation and station offices over bridge superstructure and platforms at track level. Demolition of arches. Construction of the ground level concourse and supports to the platform and track above. Construction of railway bridges and platforms
East of N-S line at east end of 84 Tooley Street to East boundary of London Bridge works	New platform layout and escape corridors same in both options	New platform layout and escape corridors same in both options

14.6. Fire Engineering

Grip 3 Fire Strategy

Arup's reports REF[2/17] presents the fire strategy for Option 6B(3); these reports demonstrate that an adequate level of fire safety can be achieved with the station, thus bringing the station in line with modern standards and codes. The fire strategy has been carried out to the same standards as that for Option 5Z(5) and is similar in most respects apart from impacts driven by the street level interchange concourse.

For London Bridge station the proposal is to provide, in both the terminus and interchange concourses, small retail kiosks. Smoke from a fire in a kiosk could impact on the evacuation of the concourse areas themselves. It is proposed to adopt a fire engineered solution whereby it is demonstrated that provision of natural ventilation will be sufficient to maintain tenable conditions within the concourse areas.

As with Option 5Z(5), there is the potential for retail in the Western Arcade, subject to separate business case. However, since Stainer Street forms part of the new interchange concourse in 6B(3), there will be a need to review the fire strategy to include smoke extract and sprinklers protection and to examine escape distances which may exceed 18m should this provision be made.

In addition at terminus concourse level one side is open to the external platform areas and the other side is provided with glazed façade. The large openings to the platforms provide a means for smoke to discharge. To improve the purging of smoke and achieve cross-ventilation from the concourse, the doors to the glazed façade may be opened post-evacuation.

ARUP do not currently envisage any fire loads within the concourse. The station accommodation will be fire separated from the concourse.

Fire fighting stairs are not required to be lobbied, since it is very unlikely for smoke to enter the stairs and fire fighting access is therefore not considered to be compromised.

Terminating platforms are to be provided with an end stair which leads to the escape bridge and then onto a single common stair to discharge to street level to St Thomas Street, or

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alternatively to platform Q should the evacuation route be clear. The single escape stair is the limiting factor in terms of exit width which may result in people queuing at this location. This is considered acceptable as people can be considered to be in a place of relative safety.

As in Option 5Z(5), a further fire strategy study will need to be addressed as part of GRIP 4 into the width of the evacuation bridge at the country end, the stair from the bridge to platform Q and the stair off platform Q to St Thomas Street taking account of the egress analysis and physical restraints of the station.

In addition at the terminating platform London end, the means of escape is via automatic ticket gates onto the main concourse, to escape to outside into bus station/taxi area at level 01, or, down escalators / stairs to level 00 and escape to St Thomas Street.

Through platforms are served by stairs at each end of the platform with stairs leading to Joiner Street and Bermondsey Street. In addition, there is the means of escape from the through platforms down via the escalators and stairs to the main interchange concourse, to escape directly into Tooley Street. Should the escape route be restricted, further escape can be obtained across interchange concourse to St Thomas Street or escape via Stainer Street.

14.6.1. Fire Evacuation Assessment

The evacuation assessment REF[2/18] verifies the following:

- Population of passengers to be evacuated
- Minimum stair capacity required for means of escape
- Minimum escalator capacity required for means of escape
- Minimum exit width required at street level

The design year is taken as 2016 with 35% increase passenger flow as required by Network Rail. The key findings from the evacuation are that all stairs within the station are permitted to be 1.1m in width and all escalators are permitted to be 1m width. This is based upon an engineered solution that treats the end of the terminating platforms as a place of relative safety. These conclusions are based on the following design solutions:

- The terminating platforms are each provided with one stair at the end remote from the concourse;
- The terminating platforms are provided with a total of 30 UTS gates;
- The through platforms are each provided with one protected stair at either end of the platform;
- The through platforms are each provided with vertical means of escape from the platforms to interchange concourse via two pair of escalators and two open stairs in each bank.
- The staircase design shall enable their removal at an agreed later date for replacement with escalators to cater for expected increased passenger flow.

For a fire within the station structure scenario, the RSPG requires evacuation to be modelled as if the exit route with the greatest capacity were blocked by fire. The remaining routes should then have sufficient capacity to evacuate the passengers in 8 minutes from the platforms and 12 minutes to a fire protected route. The evacuation study confirms these criteria are satisfied.

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Flow rates are as section 4.16 of the Network Rail Managed Station design guide 2007 as outlined below.

- Flow rate along passageways: 80 people per minute per metre width
- Flow rate on stairs/ramps: 56 people per minute per metre width between handrails
- Flow rate on working escalators (direction of escape route only): 120 people per minute per metre width
- Flow rate through automatic ticket gates: 50 people per UTS and wide aisle gates (additional capacity to be provided by the use of manually operable equipment or emergency gates).

For mobility Impaired Persons (MIPs), the provision is the same as Option 5Z(5).

14.6.2. Fire Tenability Assessment

The GRIP 3 fire tenability report REF[2/19] assess the level of safety within the proposed design for Option 6B(3) should a fire occur, identifying the additional fire safety measures required to enhance the means of escape provision if any are needed.

The tenability conditions assessment has been performed against the following Fire Safety objectives:

- Ensure the safe evacuation of the public and members of staff
- Ensure the safe intervention of fire brigade

The tenability assessment focuses solely on life safety issues during evacuation and does not consider property protection. The assessment proposes a number of detailed recommendations and overall the tenability is requirements are thought to be achievable.

The assessment concludes that tenability is acceptable in:

- fire situations with regard to heat generation
- spread of smoke/toxic gases requires local smoke extract or natural ventilation in retail areas
- structural failure conditions are acceptable provided the requirements of Approved Document B are implemented

14.7. Mechanical & Electrical Services Design

14.7.1. Overview

The ARUP M&E services design, report [2/20] is based on the architectural drawings and layout for station option 6B(3). For the services, the most economic solutions have been selected from the perspective of their capital cost, although operational costs have also been considered.

14.7.2. Electrical Engineering

The key features of the proposed electrical services design for option 6B(3) that impact the fundamental layout of the station design from REF [2/20] are summarised in this section. The

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GRIP 3 electrical services design covers: Power supply arrangements, plant access and maintenance, HV power supplies, back-up power supplies, LV power supplies and local back-up supplies.

The maximum demand for Option 6B(3) is estimated to be 3.9 MVA (approx 4600A), allowing for 20% spare capacity for future extension or enhancement of the station. This estimate does not include any capacity allowance for future commercial opportunities.

There are a number of existing low voltage intakes available at the station, a number of which may be retained through construction and for the final scheme. Existing supplies available provide only 2.1MVA and additional supplies are required to meet the estimated demands of Option 6B(3).

At this stage, a new Network Rail owned HV sub station is proposed as the solution to meet the additional power demand. The sub station would provide a 2MVA supply and a separate 630kVA NR owned substation will be required as a back up supply. The back up supply shall be supplied from an independent source to any normal supplies. It is anticipated that the capital of providing a new Network Rail owned high voltage substation would be greater than a distribution network operator owned supply option. However there is the potential for lifecycle benefits due to increased supply reliability and cost savings to the lower tariffs attracted by high voltage supplies.

Potential non-compliances have been identified against GT/TDINT100 Earthing and equipotential bonding of telecommunications equipment. At this stage it is not thought that this non-compliance can be resolved due to the restrictions of London Bridge Station and therefore, derogation will be required.

As with Option 5Z(5), no provision has been made in the electrical services design for future commercial opportunities. Spare capacity allowed for in design is intended for future station upgrades and enhancements and not for third party use. It is recommended that at GRIP 4 the electrical services design is revisited and if appropriate commercial requirements are considered in electrical design to cover:

- Electrical load requirements
- Servicing strategy for electrical connections
- Provision of space for plant
- Provision of containment routes
- Provision of base build services to each retail unit e.g. fire alarms
- Renewable Energy provisions

14.7.2. Heating, Venting and Air Conditioning

At the GRIP 3 stage of design the mechanical engineering is the same as for Option 5Z(5). The report gives the appropriate design criteria for mechanical systems and the technology options available for meeting the station requirements. A high level assessment of suitability of technology is presented in REF[2/20] in the form of listed advantages and disadvantages.

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14.7.3. Public Health Engineering

- The public health systems are covered by REF[2/20] include incoming gas and water supplies, cold water storage, treatment and distribution, hot water, sanitary plumbing, rainwater management systems and fire protection systems. At this stage, the design is the same as Option 5Z(5).

14.7.4. M&E Sustainability

The recommendations from REF[2/20] with regards to the sustainability options at this stage of design are the same as Option 5Z(5):

12.8.3 Cable & Service Routes

A key element of the M&E design at GRIP 3 is to provide feasible service and cable routes. To summarise the services routes have been planned to:

- Be integrated with architectural and structural design;
- Provide secure routes across the station;
- Allow for easy access and maintenance;
- To be suitable for all services including M&E and communications and railway systems;
- Provide sufficient space for future upgrade.

12.8.4 Residual MEP risks and issues

The risks to the mechanical services design are the largely same as those for Option 5Z(5), these are summarised as follows:

- 1- Full service station surveys:** ARUP have undertaken a review of the WSP full services surveys. ARUP examination has identified areas of risk to be addressed in GRIP 4.
- 2 - Sustainable solutions have not been determined:** Final decisions have not been made on any of the technologies mentioned previously, due to the full requirements for sustainability not being clear at this stage. The choice of technologies could have significant impact on the station design.
- 3 - Construction sequencing has not been agreed:** whilst the proposed design has been based on providing flexibility whatever construction sequence is followed, until this sequence is confirmed there is a risk to the feasibility of the proposed design.
- 4 - Commercial requirements are unknown:** Addition of commercial / retail units to the scheme will mean an increase in the quantum of M&E services to be provided, within impacts on equipment, space and services routes.

14.8. Telecoms Design

The Option 6B(3) GRIP 3 Telecoms design strategy is essentially as for Option 5Z(5) and is provided in REF[2/11 & 2/12]. The table below gives a comparison of telecom, design for Option 5Z(5) and 6B(3).

<i>Table 7: Comparison of Telecoms Design for 5Z(5) and 6B(3)</i>		
Area for consideration	Option 5Z(5)	Option 6B(3)
Choice of equipment room locations	Main equipment room locations to the East of Weston Street in the arches. No change between two options	Main equipment room locations to the East of Weston Street in the arches. No change between two options
General Station cabling distribution arrangements	5Z(5) – Principle design choice was around a through station (North to South / East to West) utility service route with interface to the 3 rd party Telecoms providers on the Tooley Street side. Platforms are serviced by vertical risers into the platforms. Services to the station over bridge concourse use the lift risers.	<p>The 6B(3) design concourse at low street level will require an alternative approach to the East to West route. Options exist for through concourse floor in ducts, or within the ceiling voids. Both options have some limitations for access / maintenance.</p> <p>Concern with routes through ceiling is how maintenance and provisioning access will be possible above a ceiling designed for acoustics and ascetics purposes.</p> <p>The proposal discussed at the M&E workshop on 5/5/2010 proposed a walk through route beneath the station concourse to a depth level within the pile caps (2 metres). Whilst this represents a reasonable final solution, it would be very difficult to construct during the enabling works as utility services in Weston and Stainer Street will not have been moved.</p> <p>A through station E-W route will be required as the new TER equipment locations will constructed and equipment moved as part of the enabling works.</p> <p>Enabling work options</p> <ol style="list-style-type: none"> 1. Utilise a temporary route along the inside of the south side train shed roof. Some bracing structures need to be added (refer Alan Fleet) during the first phases of construction so any choice of route will need to be carefully planned and flexibility designed to allow work around the route to take place. 2. North Wall of Platform 1 3. Through the deck of Platform 1&2 <p>See separate enabling works 6B(3) report and drawings.</p>
3 rd party diversion works	BT / GX Works to new equipment rooms	<p>BT / GX Works to new equipment rooms.</p> <p>No change between two options.</p> <p>Weston Street impacted by excavation works so services will need to be moved. Telecoms services diversion part of Utility works not station enabling works.</p>
Choice of control room	5Z(5) Station accommodation	6B(3) Station accommodation, there are two

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location	on footbridge extension on low level station side.	suggested locations which are adjacent to Platforms 10 and 15 on the low level station. Although different physical location no design impact.
General Accommodation	5Z(5) Station accommodation on footbridge extension on low level station side. Also adjacent to Platforms 10 and 15 on the low level station	Suggested locations are adjacent to Platforms 10 and 15 on the low level station and in areas beneath the arches. Although different physical location no design impact.
Construction staging strategy	5Z(5) option was to construct from the South (P16) to the North. The operational Telecoms cable diversions for the footbridge assume this.	Assumed similar to 5Z(5), enabling works impacted, see report.
Asset area – PA / VA, including Acoustics – CIS – Help Points – Station Management System – CCTV – Station Radio – 3 rd party services	On low level station side, CIS decision point for passengers to the high level needed to be made at the main entrance as the escalators were positioned just inside the front doors. This would necessitate the positioning of screens in the outer concourse. Opportunities for a CIS main board in the over bridge were possible but limited by the availability of vertical space.	Potential changes in quantities to reflect different concourse design (and area). High definition CCTV options for the low level concourse may bring about savings in the physical numbers of cameras needed. Opportunity for NTIs above escalators on the High level station. A range of vertical surfaces suitable for a CIS main board on the paid / unpaid side. On the low level, the escalator transit route to the high level station has moved towards the gate-line, this moves the passenger decision point within the station and opportunities for a CIS main board exist in this area (pedestrian flow considerations for positioning to avoid blocking route to gate line) Consider static signage and CIS for escalators by London Dungeon area.
Maintenance access	Architectural choice recommends SISS equipment will be bottom fed, reduce the requirement for working at height.	Architectural choice recommends SISS equipment will be bottom fed, reduce the requirement for working at height.

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Section 3 – Operations & Requirements Summary

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15. Station Operations

15.1. Stations Project Working Group (SPWG)

Key to the systems integration of the London Bridge scheme is a thorough understanding of the station operational requirements. These requirements have been developed working with Network Rail station managers, Train Operating Company managers and members of the KO2 delivery team, collectively termed the Stations Project Working Group (SPWG). Establishment of this group, with members from all key stakeholders, ensures an appropriate level of engagement during the GRIP 3 design process.

A series of workshops have been held through GRIP 3 to date to determine the proposed requirements. The sessions were structured in such a way as to fully understand the concept of operations for London Bridge as it is today and to capture potential future operating requirements. At this stage there have been no specific commitments to any of the stakeholders as to what will be delivered in the final scheme.

At the SPWG sessions each stakeholder organisation is represented by nominated individuals in the different aspects of station operations. This level of participation has ensured that future aspirations, knowledge of operations and potential technical solutions are well understood and incorporated into the conceptual design as far as practicable.

The outputs of all the SPWG meetings are issued to the design team to ensure requirements are captured in the London Bridge Project Design Specification and used to inform the design process. An in depth description of the station operations has been captured in the GRIP stations operational concept report REF[3/1].

15.2. Current station operations

London Bridge station is a major transport interchange. The over ground commuter station is a Network Rail managed station, and is effectively two interconnected stations. The high level station currently consists of seven through tracks with six platforms at a raised level to the north of the site and a second station with nine terminating platforms at a lower level to the south of the site. Below the site is the London Bridge London Underground station serving the Jubilee Line and the Northern Line, with access points within the Network Rail station. To the front of the station there is a bus station and taxi rank.

The high level through station provides services to Cannon Street, Charing Cross and to Kent, Sussex and Surrey. Specific platforms serve Cannon Street and Charing Cross. The Charing Cross platforms also serve Thameslink Services between Bedford and the Brighton Main Line. The terminus (low level) station provides train services to Croydon / Sussex and South London suburban stations.

London Bridge station is used by approximately 88,000 people during each daily am peak (between 07:00 and 10:00 Monday to Friday) and 72,000 people during each daily pm peak (between 16:00 and 19:00).

London Bridge as an interchange hub is used by approximately 120,000 people during the daily am peak and 110,000 people during each daily pm peak. These numbers include the underground and bus terminal users, and are represented graphically in the two figures below.

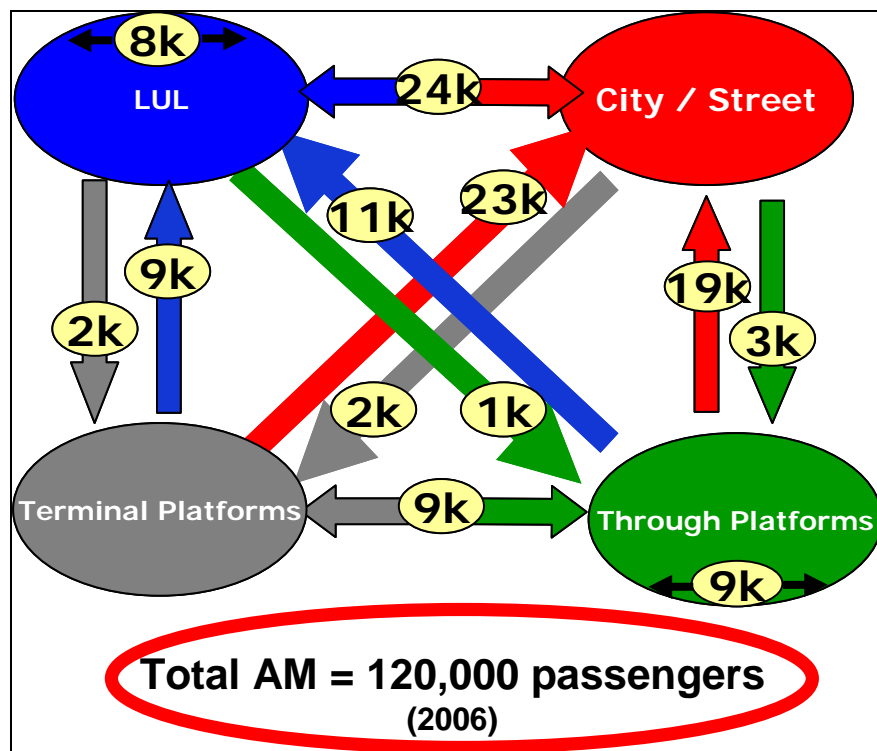


Figure 1 – AM Passenger Flows for the London Bridge Interchange

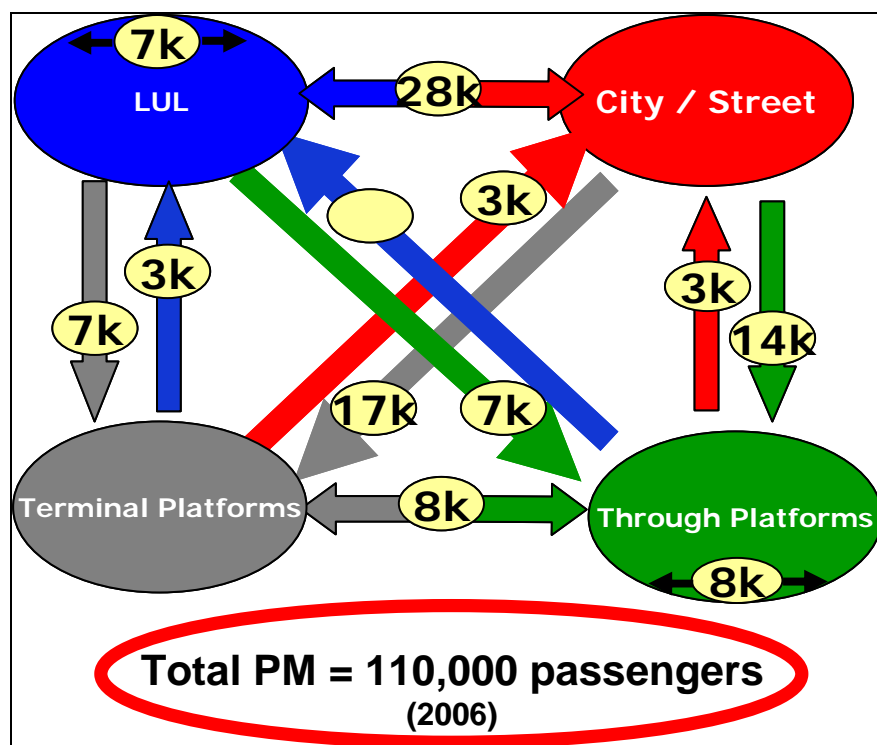


Figure 2 – PM Passenger Flows for the London Bridge Interchange

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15.3. Future station operations

The Department for Transport business case indicates that on the introduction of the new Thameslink Service London Bridge Station will be used by approximately 155, 000 people during the AM peak period and 132, 000 people during the PM peak period.

Using the 2016 forecast and applying a 35% uplift it is projected that the redeveloped London Bridge as an interchange hub will be used by approximately 200,000 people during the am peak and 182,000 during the pm peak. These figures include the underground and bus terminal users.

The new London Bridge Station will provide for a seven day railway. The station will be staffed 24 hours per day 365 days per year, though staffing levels will vary during the day in line with operational requirements.

Network Rail TLP recognises the benefits brought to communication and efficiency through providing a joint location for operational control of the railway, and wishes to consider this as the right way to operate a station. Joint location also offers the possibility of joint operation and subsequent efficiencies. However, for the purposes of Grip 3 at London Bridge this is considered purely as joint location.

It is envisaged that each operator (Train Operating Company and Network Rail) places its senior role in an enlarged joint control room where they are supported by necessary junior roles. The area will also house the traditional station control functions such as CCTV, fire panel and station announcing. This functional area would be placed at one end of the control area. Additional room will be available for the Train Operating Companies, and others, to run their normal functions that are company specific or of a confidential nature etc.

16. Train Operating Service

16.1. Current Train Service

The existing frequency of train services through London Bridge during the high peak hour is as follows:

Southeastern:	58 tph (29 Charing Cross and 29 Cannon Street)
Southern:	30 tph
Thameslink Services:	0 tph

Although the December 2009 timetable contains 29 Charing Cross trains in the high peak hour, there is currently insufficient platform capacity for all these trains to call at London Bridge Station.

In the morning peak 14 of the 29 peak direction services currently pass straight through the station utilising line 7, the Up Passenger Loop. In the off-peak period there are four Thameslink trains per hour through London Bridge.

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16.2. Planned Train Service

The Thameslink Programme has been developed to deliver a major expansion of the cross-London Thameslink Service. Provision of longer, more frequent trains, serving a more extensive network will deliver a substantial increase in passenger capacity through the centre of London. The majority of service improvements delivered by the Thameslink Programme will be created by joining services that currently terminate in London Bridge, Blackfriars and Cannon Street (in the south) with services that terminate at Moorgate and Kings Cross (in the north). The new train paths will be created between London Bridge and St Pancras International (Low Level).

The planned frequency of train services at London Bridge during the high hour peak will be as follows:

Southeastern:	48 tph (28 Charing Cross and 20 Cannon Street)
Southern:	20 tph
Thameslink Services:	18 tph

The operation of passenger services will commence at 05.30am and finish at 01.00. The time outside these hours is designated “Engineering Hours”, and the station will be staffed through this period.

Thameslink passenger services will operate:

- Up to 24 trains per peak hour in both directions.
- 18 tph will call at London Bridge Station in both directions during peak hours.
- Morning and evening peak train service for up to 3 hours (0700 to 0959 and 1600 to 1859).
- A comparable level of night time service between 0100 and 0530 as currently operates.

To allow passengers to experience the ongoing benefits of the Thameslink Programme, incremental improvements will be made to the train service at each of the Key Output stages.

The full Thameslink KO2 will be implemented upon completion of the KO2 infrastructure works. The KO2 timetable is designed to provide up to 24 train paths through the core area, in each direction during peak periods. Once supported by the instillation of Automatic Train Operation [ATO] systems the timetable will possess the potential ability to recover the service in 30 minutes by providing up to 30 tph, in each direction.

The final Thameslink service patterns remain subject to a collaborative development process between Network Rail, the effected Train Operating Companies and the Department for Transport. The final timetable specification will be confirmed 2 years prior to the service implementation date in accordance with the industry timescales for timetable development.

Thameslink KO2 services will be operated by new build 8 car (162m) or 12 car (243m) fixed formation rolling stock.

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17. Accommodation Requirements

17.1. Summary

Based on the understanding of the current accommodation, shown in REF[3/2], the technical definition of the station's accommodation was developed principally by TP Bennett, as an architecturally led activity, with secondary endorsement by Arup for services and fire inputs. The GRIP 3 design development work was primarily an accommodation placement or 'zoning' activity, for the fully completed station. No interim or construction phasing arrangements were considered under this task or work-stream.

As the existing station occupies two main horizontal levels; ground and platform, assessments were undertaken exploring the use of these levels within the overall redeveloped scheme. As the Option 5Z(5) proposal incorporates an over-deck this was additionally assessed as a third potential level. The aim was to establish a preferred single (sub) option for the main front-of-house station areas. Back-of-house 'zoning' was then considered. Reference was made to the consented 'Masterplan' scheme where helpful. The working assumption applied to these areas was that the existing station's existing back-of-house areas should be generally carried over into the Option 5Z(5) proposal.

Accommodation option selection considerations were generally advanced as part of the overall design development co-ordination meetings. The TP Bennett Task ID 19 REF[3/3] report included taking account of factors such as:

- Non utilisation, where possible, of prime concourse areas.
- Non utilisation, where possible, of prime retail / commercial areas.
- Safety & Accessibility as relevant
- Zoning for an Integrated Management & Station Control Suite
- Overall Flexibility of Layout for future needs
- Environmental / Sustainability
- Other Location Suitability factors

17.2. Option 5Z(5)

For option 5Z(5) the above criteria guided against primary use of the platform level areas and guided for the minimum use of the ground level for front-of-house accommodation; given that the concourse over-deck is some 16m over-head. The working consensus was that the main front-of-house zone of accommodation, meeting the above criteria, would be best placed sitting at deck-level on an extended section of deck-structure, on the far south side with vertical connection down to the arches beneath for supporting back-of-house areas.

17.3. Option 6B(3)

The GRIP 3 accommodation design development work was primarily an accommodation placement or 'zoning' activity, for the completed station. Interim or construction phased arrangements were not considered under the 6B(3) final design tasks / work-stream. Accommodation has been positioned to meet the following requirements:

- Co-location of operating staff;
- No increase to train crew diagram walking times

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- Use of natural light providing a suitable working environment

It was agreed that the main operational 'office' accommodation would be best placed sitting at deck-level on a bespoke area of deck-structure, with vertical connections down to the available level(s) beneath. The principle of an accommodation over-deck was then adopted, with its inherent flexibility to be designed to suit future defined requirements and to be generally located at a suitable position above.

Given the 'centre of gravity' of 6B(3) is at ground level the ticket office suite was placed at this level within an area of retained (south) arch structures, facing the primary public circulation axis. Additionally a station access entrance on St. Thomas Street was included. The primary over deck accommodation 'block' then incorporates the integrated station control / management suite and sufficient potential floor area for both essential operational and non-operational staff (i.e. those currently working in 84 Tooley Street).

A more in depth study of the accommodation proposals are provided in REF[3/4].

18. Station Passenger Capacity Assessment

18.1. Summary

A key functional requirement of the remodelled station is to provide enough capacity for the station to meet the forecast passenger demands.

Options 1, 5E, 5Z(5) and 6B(3) have been assessed using Legion dynamic pedestrian modelling software. The Legion models aim at demonstrating the likely results, in terms of passenger experience and flow, as a projection on the forecast capacity growth, for three scenarios defined as passenger numbers in 2016 +5%, +20% and +35%. These passenger demand forecasts were developed in conjunction with Department for Transport, London Underground Limited, Transport for London and are based on 2016 Railplan projection (which includes the South London Route Utilisation Strategy). Options have been modelled for, as a minimum, the AM period under normal operation and also reviewed for passenger capacity issues from a qualitative perspective. Options which demonstrated an ability to accommodate the anticipated flows have been further assessed to varying degrees to review PM peak performance, the impact of degraded conditions and train service perturbations and the average journey times within the station. The results of this work are reported in reference document REF[3/5, 3/6 & 3/7]

Being able to operate effectively (not necessarily in line with NR standards, but safely and without ongoing station management) for normal operations at demand levels of 2016+35% is a core requirement for all stations. Pedestrian flow modelling for the public areas that surround and interface with the station has not been undertaken at GRIP 3.

Table 8 below summarises the ability of the options to satisfy the core requirements, for each requirement performance has been evaluated as one of four levels:

	No Legion quantitative assessment undertaken
	Acceptable – station fully meets relevant standards/criteria
	Minor Issues – standards not met, minor impact on station operations
	Significant Issues – standards not met, noticeable impact on station operations and customer experience
	Unacceptable – station cannot meet requirements in proposed configuration

Further investigation has assessed in more detail the relative performance of the options meeting this base requirement in terms of resilience to degraded and perturbed operations, adherence to NR managed station guidelines and passenger journey times.

Note – Result interpretation

- 1) The qualitative assessment is a review of the Legion quantitative study with an expert interpretation. These qualitative results are adjusted for software limitations, biased, modelling assumptions and issues that could be straightforwardly address during further design development stage (e.g. gate line arrangements/layout).
- 2) *Assessing degraded conditions* – The degraded performance is assessed using the same scale than for normal operation; a noticeable decline in performance is indicative of low level design resilience.

Table 8: Option performance for pedestrian flow (all options considered)							
Design Options	Normal Operations				Degraded Operations		Journey Time
	Legion			Qualitative	Legion	Qualitative	Legion
	2016+5%	2016+20%	2016+35%	2016+35%	2016+35%	2016+35%	2016+5%
Masterplan (1) & derivatives (2A, 2D & 3B)							3 mins 50 seconds
5E							
5Z(5)							4 mins 20 seconds
6B(3)							3 mins 25 seconds

18.2. Station Capacity Assessment – Technical Note

18.2.1. Scope of the study

For all options the trains are modelled as 12-car trains in the through platforms and a combination of (1x) 8-car train, (1x) 10-car train & (4x) 12-car trains in the terminating platforms. The train service is modelled on a frequency basis as follows:

- Cannon St (2 x10) tph – Platform A, B, C
- Thameslink (18 tph) – Platform D, E

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- Charing Cross (2 x14) tph – Platform F, G, H, I
- Low Level 20 tph – Platform J, K, L, M, N, O

18.2.2. Pedestrian flow modelling assumptions

- Passenger route choice has been set up to reflect an optimum usage of the available capacities on stairs and escalators at each level (e.g. high level, concourse, street level etc.) to mimic behavioural response to congestion. In practice we have observed that passengers generally make informed choices consistent with the above assumption
- No operational intervention implemented at this stage. The modelling study does not attempt to incorporate any signage or managerial station control during this design stage.
- All passengers are modelled as UK commuters, no tourists or passengers with restricted mobility have been factored in at this stage
- Usage of Non-critical facilities (ticketing, retail, lifts, toilets etc) has not been included in the models at this stage
- The operational concept will be developed in collaboration with the Train Operating Company during GRIP 4 detailed design stage
- A basic boarding & alighting dynamics has been implemented in all current models.
 - A fixed proportion of the waiting platform population boards each service
 - No train-stayers or passengers left behind on the platform due to train overcrowding are represented
 - Passengers on platforms and trains are uniformly distributed
- Train service is modelled in terms of trains per hour
- No detailed timetable or perturbation of service is factored into calculations at this stage

18.3. Option 1 – Consented Masterplan Station Capacity (baseline)

The results of the Passenger Capacity Assessment are reported in REF[3/5]. The consented Masterplan was assessed solely in terms of normal operations and passenger journey times. Performance was reviewed for the AM and PM peak and is summarised in the Table below by station area.

The worst performing area of the station is taken as determining the overall performance level which informs the comparative assessment of the options.

Overall the option performs acceptably with performance being largely consistent with NR Managed station guidelines when assessed against the 2016 +35% demand forecasts.

Minor congestion issues are highlighted at the ground level area (associated with the gate line arrangements and the overall operational configuration of the paid/unpaid concourse) and more significantly at the mezzanine level where the combination of high

levels of interchange and passengers dwelling to view customer information systems results in congestion.

Further work would also be required to gain further confidence in the capability of the terminating concourse to accommodate through platforms passenger flows to/from the London Bridge Walk via the station forecourt and terminating concourse. There remain some significant concerns regarding the effective size and operational capability of the terminating concourse and station forecourt.

<u>Table 9: Option 1 Pedestrian Flow Performance</u>								
Station Area		Normal Operations				Degraded Operations		Journey Time
		Legion			Qualitative	Legion	Qualitative	Legion
		2016+5%	2016+20%	2016+35%	2016+5%	2016+35%	2016+35%	2016+5%
Ground level & North/South concourse	A M							
	P M							
Interchange mezzanine	A M							
	P M							
Terminating concourse and platforms	A M							
	P M							
Through platform level	A M							
	P M							
Overall								3 Mins 50 Secs

Pedestrian Flow Recommendations

- Developing the operational concept for this option would benefit from modelling certain scenarios for service perturbations in abnormal and degraded and emergency conditions to illustrate likely outcomes to compare against the Client Sponsor station performance requirements.
- Going forward, dynamic modelling will be able to aid decision making on how to communicate the effects of each construction phase to various stakeholders, including TOCs, TfL, LUL, passengers and to those bodies responsible for ensuring safety (Fire officers, TRANSEC and BTP, etc)

De-scoping opportunities

- Assessing the difference and opportunity between 2016 +5%, +20% and +35% growth levels is a important piece of modelling work, which has not been undertaken yet.
- It is believed that there should be an opportunity for the reduction in the number of escalators. It may also be possible to substitute stairs for escalators in a

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number of locations. Stairs will provide approx 70% of the capacity of escalators for the same width required.

18.4. Option 2A, 2D, 3B and 5B Station Capacity

In terms of station capacity and pedestrian flow analysis Option 2A, 2D and 3B do not vary significantly from the Masterplan option therefore for further information refer to the Masterplan station capacity assessment.

From a pedestrian flow perspective Option 5B is fundamentally different to the Masterplan. The north south concourse is formed from existing arches, with a new vertical circulation zone at the point where it meets the western mall. An interchange mezzanine level is formed on a part of the existing arches providing a connection to the position of the current 84 Tooley building. No pedestrian modelling assessment was completed for the Option 5B.

18.5. Option 5E Capacity Assessment

From a pedestrian flow perspective this option is fundamentally different from the Masterplan. Passenger circulation is provided by footbridges spanning the station; horizontal cross track passenger routes are by a pair of over bridges over the high level tracks forming a loop, with a single over bridge over lower level tracks. This scheme requires the demolition of 84 Tooley St, the footprint being used as vertical circulation to the double over bridge. The north south concourse is formed from existing arches with a new central vertical circulation zone at the junction of the Western mall and the North-South concourse.

The results of the Passenger Capacity Assessment are reported in REF[3/5]. The Option 5E was assessed solely in terms of normal operations. Performance was modelled for the AM peak only and is summarised below by station area.

The worst performing area of the station is taken as determining the overall performance level which informs the comparative assessment of the options.

Overall while the station can operate safely in the AM peak when assessed against the 2016 +35% demand forecasts, congestion levels exceed levels from the NR Managed station guidelines in various areas. It is also a strong concern that the station would perform poorly in the evening peak due to space restrictions in the terminating concourse.

Problems in the AM peak are most obvious in the sustained congestion on the various access routes to the over bridge, particularly the northern route. The popularity of this route also results in crowding at the top of the western passage escalators providing access from the terminating concourse to the LUL station.

The alternative route to LUL via the under-platform interchange from the terminating concourse is also significantly congested.

While minor congestion is observed for users accessing the eastern leg of the footbridge this design offers improved access capacity for passengers using the through platforms and crowding in this area is not anticipated to be a significant problem.

Table 10: Option 5E Pedestrian Flow Performance

		Normal Operations				Degraded Operations		Journey Time
		Legion			Qualitative	Legion	Qualitative	Legion
Station Area		2016+5%	2016+20%	2016+35%	2016+5%	2016+20%	2016+35%	2016+5%
Ground level, North/South concourse & interchange	A M							
	P M							
Overbridge	A M							
	P M							
Terminating concourse & platforms	A M							
	P M							
Through platform level	A M							
	P M							
Overall								

Pedestrian Flow Recommendations

- PM peak model to be developed to gain further confidence in the ability of Option 5E in accommodating passenger growth up to 2016 +35%
- Developing the operational concept for each option would benefit from modelling certain scenarios for service perturbations in abnormal and degraded and emergency conditions to illustrate likely outcomes to compare against the Client Sponsor station performance requirements (see the Project Design Specifications)
- Going forwards dynamic modelling will be able to aid decision making on how to communicate the effects of each construction phase to various stakeholders, including TOCs, TfL, LUL, passengers and to those bodies responsible for ensuring safety (Fire officers, TRANSEC and BTP, etc)

De-scoping opportunities

- To assess the difference and opportunity between 2016 +35% and 5% growth levels is a significant piece of modelling work, which has not been undertaken yet.
- It is believed that there should be an opportunity for a reduction in the number of escalators. It may also be possible to substitute stairs for escalators in a number of locations. Stairs will provide approx 70% of the capacity of escalators for the same width required.

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18.6. Option 5Z(5) Capacity Assessment

This option is fundamentally different from Masterplan from a pedestrian flow perspective. Option 5Z(5) is similar to Option 5E in that both options are ‘over-bridge type’ solutions. However, Option 5Z(5) has been fully designed and optimised in terms of passenger circulation, which is provided by a single wider footbridge spanning the High Level tracks with a narrower arm spanning the low level tracks. In order to maximise passenger capacity the passengers are encouraged to segregate between the High and Low level stations. The over-bridge is unpaid down the middle with gate lines left and right leading down to the through or High Level station.

The scheme requires the demolition of 84 Tooley Street, the footprint being used as vertical circulation to the northern end of the over-bridge. The north south concourse is formed using the existing arched Stainer Street which is to be pedestrianised with a new central vertical circulation bank of 3 flights of escalators directly to the unpaid side of the over-bridge. This vertical circulation zone is located at the junction of the Western Mall and Stainer Street.

The results of the Passenger Capacity Assessment are reported in REF[3/6]. Option 5Z(5) was assessed for both normal and degraded station operations and passenger journey times were also evaluated. Performance was reviewed for the AM and PM peak and is summarised in the Table below by station area.

The worst performing area of the station during normal operations is taken as determining the overall performance level which informs the comparative assessment of the options.

Overall the option performs acceptably with performance being largely consistent with NR Managed station guidelines when assessed against the 2016 +35% demand forecasts.

The terminating concourse area is operational whilst experiencing significant level of congestion. The location of CIS and ticketing facilities will be critical to maximise space and optimise passenger flows and experience. With regards to the PM peak, further work is required to better understand the impact of outdoor CIS provision on passenger flow, and the capability of the inner concourse to accommodate all passengers. This question will take on particular relevance during winter months and unfavourable weather conditions. It is of paramount importance that further design development takes place during detailed design stage.

Some concerns still exist regarding the capability of the proposed steps to the Western Passage to accommodate passenger flow during the morning peak.

The over-bridge design has been optimised to cope with 2016 +35% demand level and to provide an adequate passenger experience and sufficient resilience to operate the station. Analysis of the degraded station operation tests shows that the design has sufficient resilience to effectively accommodate reduced escalator availability, whether planned or unplanned, on various key routes to and from the over-bridge and in the western passage to Joiner Street.

Journey time analysis however indicates extended average journey times in comparison with the Masterplan, this is largely driven by increases in the vertical journey times

between most key interchange facilities (through/terminating platforms to and from LUL/street).

This is most obvious in access from the through platforms to LUL via the proposed escalator arrangement between the over-bridge and vaults. Further development is required to address this constraints and improving performance in this area is a key priority during the next design stage.

Table 11: Option 5Z(5) Pedestrian Flow Performance

		Normal Operations				Degraded Operations		Journey Time
		Legion			Qualitative	Legion		Legion
Station Area		2016+5%	2016+20%	2016+35%	2016+5%	2016+35%	2016+35%	2016+5%
Vaults and LUL station interface	A M							
	P M							
Overbridge and LUL Interchange escalators	A M							
	P M							
Terminating concourse and platforms	A M							
	P M							
Through platform level	A M							
	P M							
Overall								4 mins 20 sec

Pedestrian Flow Recommendations

- Developing the operational concept for this option would benefit from modelling additional scenarios for service perturbations in abnormal and degraded and emergency conditions to illustrate likely outcomes to compare against the Client Sponsor station performance requirements (see the Project Design Specifications).
- Going forwards dynamic modelling will be able to aid decision making on how to communicate the effects of each construction phase to various stakeholders, including TOCs, TfL, LUL, passengers and to those bodies responsible for ensuring safety (Fire officers, TRANSEC and BTP, etc)

De-scoping opportunities

- Assessing the difference and opportunity between 2016 +5%, +20% and +35% growth levels is an important piece of modelling work, which has not been undertaken yet.
- The number and location of gate lines has been design led to date, offering scope for value engineering. Further work is required to quantify gate line provision for key demand growth thresholds (refer to the PDS for detailed requirements). In addition, work is required to better understand the integration of the gate line, ticketing, CIS and waiting zones.
- There is also a need to quantify the level of retail available within the over-bridge for key demand growth thresholds (see PDS for detailed requirements).
- It is believed that there should be an opportunity for a reduction in the number of escalators. It may also be possible to substitute stairs for escalators in a number of locations. Stairs will provide approx 70% of the capacity of escalators for the same width required.

18.7. Option 6B(3) Capacity Assessment

London Bridge Option 6B(3) provides a legible design (i.e. easy for commuters to navigate) with direct/shortest routes for all major interchange flows.

Most commuters will move through the North-South link. This in turn will move the "centre of gravity" of the station and alter the dynamic in the London Bridge wider area. This should also help for planning purposes/development and regeneration. The design is in the spirit of the Master plan but with more people at street level. It will provide good North-South connectivity.

The design routes all through platform passengers via the North-South concourse at street level. This will ease pressure on the upper level terminating concourse compared to Option 5Z(5) and the Master Plan options. The connection from the through platforms to the terminating platforms will now be via the North-South link at street level.

The configuration of the design intrinsically limits the number of passengers using the terminating concourse, resulting in greater flexibility for the provision of accommodation and retail opportunities.

The through platforms provide direct access to the north-south link at street level via (x2) banks of escalators located at the western and eastern ends. The banks of escalators have been re-centred to optimise the distribution of passengers on the through platforms. This will improve the egress performance of the platform and positively support the short station dwell times allowed for in the train service specification.

The design provides a good level of resilience during degraded conditions at the station. During construction, the provision of a direct link from the through platforms to the street level will considerably help the movement of passengers.

The street landscape adjacent to the station will need to be adjusted to ease pedestrian flow/access. (It is anticipated that this would not be more than that which is already permitted under the Master Plan, and most similar to as it was adapted in Option 2D).

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The results of the Passenger Capacity Assessment are reported in REF[3/7]. Option 6B(3) was assessed for both normal and degraded station operations and passenger journey times were also evaluated. Performance was reviewed for the AM and PM peak and is summarised below by station area.

The worst performing area of the station during normal operations is taken as determining the overall performance level which informs the comparative assessment of the options.

Overall the option performs well with performance being largely consistent with NR Managed station guidelines when assessed against the 2016 +35% demand forecasts.

The North-South concourse is the main concourse and the station's 'centre of gravity' in this option and provides both a significant unpaid thoroughfare, in addition to the paid side holding areas.

Localised areas of congestion are highlighted on the terminating platforms associated with the stairs and escalator routes to the North-South concourse and within the terminating concourse following the redesign of the terminating track layout.

It should be noted that the terminating tracks have moved west to accommodate the 20m over-run pit required by safety standards. The implication of this new layout is that the terminating gate line has moved back to the line of the east wall of the Shard of Glass.

The reduced area of the concourse impacts the ability of the station to cope in not only perturbation, but also impacting the passenger flow across the concourse under normal operation, where passengers are waiting, particularly at 2016+35% provision. Further work to develop solutions for addressing these constraints is recommended at the next stage of design development.

Analysis of the degraded (facilities not available) and perturbed (train service disruption) station operation tests shows that the design has sufficient resilience to effectively accommodate reduced escalator availability, whether planned or unplanned, on various key routes and can also be managed effectively in the event of a service disruption, enabling the impacts of service disruptions on interfaces with the bus and underground stations to be minimised.

Journey time analysis shows that average journey times compare favourably with that achieved by the Master Plan design, confirming the lack of severe congestion problems and the straightforward layout of the station.

Table 12: Option 6B(3) Pedestrian Flow Performance

		Normal Operations				Degraded Operations		Journey Time
		Legion			Qualitative	Legion	Qualitative	Legion
Station Area		2016+5%	2016+20%	2016+35%	2016+35%	2016+35%	2016+35%	2016+5%
Ground level & North/South concourse	A M							
	P M							
Terminating concourse & platforms	A M							
	P M							
Through platform level	A M							
	P M							
Overall								03 mins 25 sec

Pedestrian Flow Recommendations

- Developing the operational concept for this option would benefit from modelling additional scenarios for service perturbations in abnormal, degraded and emergency conditions to illustrate likely outcomes to compare against the Client Sponsor station performance requirements (see the Project Design Specification).
- Going forwards dynamic modelling will be able to aid decision making on how to communicate the effects of each construction phase to various stakeholders, including TOCs, TfL, LUL, passengers and to those bodies responsible for ensuring safety (Fire officers, TRANSEC and BTP, etc)

De-scoping opportunities

- Assessing the difference and opportunity between 2016 +5%, +20% and +35% growth levels is an important piece of modelling work, which has not been undertaken yet.
- Some de-scoping has already been incorporated into the design development of Option 6B(3), as a previous iteration had demolition of the entire area between Weston and Stainer St. Pedestrian flow modelling demonstrated that this level of circulation space was excessive even at the 2016+35% level of demand anticipated, and so an 'island' of retained arches on the southern side of the station (beneath the terminating concourse) has been retained, the demolition costs saved, and now forms the proposed location for the ticket office.

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Section 4 – GRIP 3

Supplementary Technical Information

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19. Construction Planning and Constructability

The proposed staging has been developed within the requirements to maintain a minimum level of train service through London Bridge Station during construction. This has been developed in discussions between KO2 sponsor, Network Rail, DfT and TOC's during the GRIP 2 and GRIP 3 development process.

The defined level of train service to be accommodated from these discussions is as follows;

- In the Low Level 6 platforms open at all times to enable a service of 24 tph.
- In the High Level station either Charing Cross operating a non-stopping service (0 platforms / 2 tracks) with Cannon Street Stopping a tidal flow service (3 platforms / tracks) or,
- Charing Cross operating a tidal flow service (3 platforms / tracks) with Cannon street operating a non stopping service (0 platforms / 2 tracks)

The proposed construction staging is deemed the most effective strategy, based on making available the construction worksites required to construct the station and minimising the duration of impact on the operational railway.

The staging essentially only has 3 railway operational modes / timetables in operation during the entire re-construction of the station.

- Low Level on 6 changing platforms with the High Level unaffected
- Low Level on the final 6 platforms with Charing Cross Non Stopping and Canon Street Stopping
- Low Level on the final 6 platforms with Charing Cross Stopping and Canon Street Non Stopping

The development of the staging of the reconstruction of London Bridge station has been developed to accommodate all the options proposed for the station. At the GRIP 3 level of design all options are constructible within the staging that has been developed and is defined in REF[4/1].

20. Stakeholder Interfaces

20.1. London Borough of Southwark (Planning Application)

New detailed planning consent, Listed Building consent and Conservation area consent applications are necessary. This will require exhaustive discussions on the proposals with the London Borough of Southwark, English Heritage and the GLA. The resulting approvals will include new planning conditions and a section 106 agreement.

20.2. Shard of Glass development (concourse and retail)

The concourse is to be re-configured due to the track re-alignment and new Bus Station layout. It is also being re-fitted and provided with a new glass roof. These works are being undertaken by Sellers'/ Shard of Glass (Teighmore) in satisfaction of their S106 (planning

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gain) obligations in relation to the Shard of Glass planning permission and commercial agreements with NR under the lease sale agreement. Works will start in 2010 and be complete by the Olympics, concurrent with completion of the Shard. Retail provision in the new Concourse is nominal.

20.3. Transport for London Bus Station

Obligation on the Bus Station is with Sellars under a Section 106 Agreement for 25 London Bridge Place. However should the redevelopment of 25 London Bridge Place not proceed for a number of years then the obligation to resolve and provide the Bus Station could revert back to Network Rail as per the original obligation under the Master Plan planning permission. At present, works to 25 LBP have commenced, and the developers are committed to completing the works both to their own redevelopment building, and meeting the associated s106 commitments to build the bus station.

20.4. 84 Tooley Street

Under Master Plan 84 Tooley Street is demolished to make way for the new entrance and access to the over site development. A developer may choose to reconfigure the access and perhaps retain 84 Tooley Street but this would be a change to the planning permission and require approval from the London Borough of Southwark. In the interim, the building is being refurbished to provide temporary accommodation for the Train Operating Companies. The Train Operating Companies are being displaced due to the demolition of the existing station accommodation on the concourse, to enable Sellars (owners of the Shard of Glass development) to complete the new finishes and roof to the reconfigured concourse.

20.5. LU Station Entrance

No significant changes are proposed to London Underground Station Entrance interchange with London Bridge Station. Any significant works would result in the requirement for full DDA compliance and compensation issues. Master Plan has deliberately tried to avoid significant impact on London Underground and its Station entrance

20.6. Station Approach Viaduct

This is a post-Olympic activity and enabling works have already commenced (closure of Railway Approach). There is a Memorandum of Understanding between the three main parties (Network Rail, London Underground & Sellars) to facilitate co-operation and co-ordination. Programme visibility and coordination between all the schemes in the same locale remains critical to managing this interface.

20.7. Key tenancies

All tenants, other than those noted below, do not have security of tenure so are subject to standard Landlord and Tenant terms and conditions of Lease – mostly with a maximum 6-month break clause.

Marks and Spencer -

Six month break clause, with compensation.

London Dungeon -

Have security of tenure. MP requires access to LD to build SAVEX and Network Rail have no



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rights of access to build so compensation will need to be negotiated and paid.

Train Operating Companies -

Relocated and compensated during the course of the works

21. Interfacing Structures

21.1. Station Approach Viaduct Extension (SAVEX)

Station Approach Viaduct Extension viaduct provides a structure of eastern part of the high level (through) tracks widening of the London Bridge Station. The widening is required to accommodate additional train capacity and the new tracks required by new Thameslink service proposed to pass through London Bridge station. The western part of the widening structure is provided by the main London Bridge Station Remodelling project.

The Station Approach Viaduct Extension viaduct structure is interfacing with London Bridge Station Remodelling project along all boundaries and forms integral part of future station functional requirements. Externally this structure interfaces with Shard of Glass concourse, Station Approach Viaduct and new bus station layout. In turn all these interfaces affect the London Bridge Station remodelling and will influence functionality of the integrated final product. Internal and external interfaces create a 'circular' cause / effect scenarios, i.e.: change in one area will affect the other areas directly and / or indirectly as effect of change in one area will carry over via number of interfaces. The Station Approach Viaduct Extension structure should not be designed in 'stand alone' mode and careful interfaces controls should be placed on the design.

1. South edge of high level station becomes an interface from Joiner Street to Stainer Street. Station Approach Viaduct Extension structure is expected to align in plan and level with that edge. Some modifications to the high level station boundary are expected.
2. East boundary of Station Approach Viaduct Extension is aligned with eastern line of Stainer Street. It is recognised that in this area the structure of Station Approach Viaduct Extension will change to railway bridge carrying the track and platform over the vertical circulation area beneath. This boundary must form an abutment for the bridge and therefore interface with the station design.
3. South edge of Station Approach Viaduct Extension is forming the north boundary of the terminating station concourse (also Shard of Glass concourse and roof). There are numerous interfaces with Shard of Glass including roof foundations, existing western mall escalators (will have to be removed in current station design), concourse levels and headroom.
4. West boundary of Station Approach Viaduct Extension forms the east abutment for Station Approach Viaduct structure where the horizontal forces from Station Approach Viaduct are transferred into Station Approach Viaduct Extension. Local headroom and levels need to be addressed and interfacing with concourses, bus station and other station areas requires resolution in conjunction with station design.

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5. Top of Station Approach Viaduct Extension serves as track beds for new tracks and therefore forms important interface with track and railway systems (signals, cables, power etc.) it also carries large part of the station platform, contain escape stairs from platform level to concourse level, canopy structures and its foundations. All these interfaces have to be considered for full integration of designs.
6. Station Approach Viaduct Extension foundations are placed on the existing station structures and overlay a mix of existing tenures (including London Dungeon) and unoccupied arches. Build-ability and future plans for the fully functioning station (including retail plan) should be considered interfaces.

Alan Baxter associates have provided a comprehensive report ID60 REF[4/2] for the Station Approach Viaduct Extension structure design to GRIP 3 level and its interfaces with other. It is planned to include the design if SAVEX within the London Bridge Station design remit for the GRIP 4 design.

21.2. Joiner Street Bridge

The Thameslink project requirements for the London Bridge area result in extensive track realignments. In relation to Joiner Street bridge track realignment resulted in the centre girder of the bridge clashing with the new track position. Subsequent review concluded that there is no possibility to change track alignment to accommodate the centre girder and therefore the centre girder has to be removed.

Responding to the consequential requirement stated above the report by Alan Baxter Associates in December 2009 concluded that there are two feasible solutions, which can be adopted. Option 1 recommends replacing the whole bridge as the structure is approaching its design life limit. Option 2 recommends replacing the existing centre girder with the girder installed under the bridge and provide some upgrading refurbishment works to the remainder of the structure.

Consultation with the permanent way team and construction planning team concluded that the Joiner Street bridge will be in use by operational railway during all phases of London Bridge remodelling. This leads to conclusion that all activities involved in repairing or replacing the bridge would have to be performed during a string of possessions and daytime working arrangements (for refurbishment) or a full 12 – 14 days blockade (for replacement).

Works to the bridge have to be performed prior to track alignment change allowing for Cannon Street service not stopping at London Bridge. The centre girder cannot be in its current position in time for this changeover. It is therefore assumed that works will be performed during phase 1 or 2 of London Bridge works during Christmas blockade.

The bridge overlays two operational levels of the London Bridge station – ground level where entrance to LUL station and ticket gate line to access paid side of through station (via escalator bank) are situated and concourse level where through route to pedestrian bridge (off western passage) and gate line to access paid side of through station are situated.

Concourse level under the Joiner Street bridge is supported by series of Warren trusses – a type of structure which is listed grade II by National Heritage and is showing signs of structural failures, which in turn indicates very low load bearing capacity.

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The recent Network Rail structural assessment report indicates that north girder of Joiner Street bridge is not achieving an adequate railway load criteria and will have to be extensively repaired.

It is assumed that bus station and main concourse area will not be allowed to be used for construction materials' delivery, offloading and construction traffic. Furthermore it is expected that this area may clash in timing with erection of SAV / SAVEX structures and this timing issue must be resolved in construction planning.

This constructability study is assuming that London Bridge Station will be remodelled in accordance with design as Option 6B(3) and is not applicable to any Option 7 'do minimum' or and Option 8 'do nothing' options. An initial report by Alan Baxter Associates on the options for Joiner Street Bridge can be found in REF[4/3]. Detailed appraisal, design and construction planning work are now required to progress this issue.

22. Site Surveys

The Survey Strategy document REF[4/31] details the progress and status of surveys completed during GRIP 3 and the strategy and requirements for surveys going forward in GRIP 4 and beyond.

22.1. Health and Safety Surveys

4 Rail Services were appointed in September 2009 to carry out a hazardous materials survey of London Bridge Station including street level arches and all station managed areas and was recently completed in March 2010. The remit included surveying and testing for asbestos (type 2 and 3 surveys), lead paint, oils, chemicals, anthrax, stagnant water, polychlorinated Biphenyls and rodent/avian investigations.

As expected in a station of this age and size a number of hazardous materials were discovered including asbestos containing materials at various locations. In particular there were a number of fire breaks in the ceiling voids of blocks A and B containing asbestos.

The level of hazardous materials discovered does not give undue concern with regards to implications to potential cost and programme issues to the enabling and main works. A suitable contingency allowance should be allocated for the risk of discovering hazardous materials in excess of those expected and known.

Full details of all findings are detailed in the technical reports REF[4/4 to 4/22] all surveys have now been completed.

Key Issues & recommendations

- Ground contamination at street and track level will be surveyed and tested as part of the Geotechnical and Structural Investigations (planned completion September 2010).
- Ballast sampling and contamination is part of the Railway Systems scope.
- Annex E - Type 3 Asbestos survey not completed due to structure type and high level of occupancy.

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Type 3 asbestos surveys for Annex E and the Train Shed Roof will need to be arranged and completed during GRIP 4. During this stage requirements for any additional hazardous materials surveys should be considered to accommodate any gaps or change in scope to the main works.

22.2. Topographical Surveys

Plowman Craven Limited was appointed in October 2009 to carry out a full topographical survey of the entire station, the surrounding streets and buildings, due to be completed in July 2010. The full suite of topographical survey deliverables will form the key base information from which all design, plans and drawings will be derived from and will be used for all suppliers and internal teams going forward. The key outputs are as summarised below:

- 3D Scans of all areas within scope (viewed via Trueview)
- Plans covering the full footprint and surrounding areas (at all of the levels)
- Sections at locations stipulated by Alan Baxters & TP Bennett

The tracks and permanent way are generally excluded from this scope as they had been recently surveyed by ABA Limited. To ensure the two sets of survey data are compatible and can be tied together to give a homogenous survey the Plowman Craven remit includes for a verification of the track survey carried out by ABA Limited.

Key Issues & recommendations

Rights of Light – the façades of the surrounding buildings have been surveyed but internal surveys to ascertain floor and sill levels have not been yet been carried out as exact requirements are to be determined in GRIP 4 based on the single option design development..

London Dungeons – Due to not being able to remove the false ceilings and various obstructions at arch level in this tenant's area there are a number of gaps in the survey where the profile of the brick arches has not yet been able to be obtained. Given the additional structural loading and likely need for strengthening these arches will need to be revisited when suitable tenant access is agreed through implementation of the stakeholder communications strategy.

Additional Surveys – Over time a number of changes will occur in and around the station environment which may need to be surveyed or validated (depending on the level of interface) to ensure our information is current and accurate. This may include the new bus station, concourse constructed by the Shard and highway reconfiguration. There is also likely to be other small additional elements and areas that will require surveying as the scheme design develops.

3D Model – The scan data collated provides the opportunity to allow a 3D model to be produced to aid the design. Due to the size of the survey and quantity of data is unlikely that a 3D model of the entire station would be practical but areas of particular complexity and importance could be modelled. The type of 3D model (wire frame, solid etc) that best suits the needs of the project will need to be agreed between the GRIP 4 designer, Thameslink Surveyor and Plowman Craven.

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22.3. Station Services Surveys

White Young Green was appointed in September 2009 to carry out surveys of station services (generally a non-intrusive) which is due to be completed in July 2010 and includes:

- Electrical Systems
- Electrical Load Surveys
- Fire Systems
- Mechanical Systems
- Telecommunications
- Drainage and piped services
- Lifts and Escalators
- Street level arches (incoming supplies only)

Noted Exclusions from the scope is detailed below:

- Majority of trackside services
- Internal Services of arches at street level occupied by commercial tenants (incoming supplies to meters have been surveyed but nothing beyond these points)
- Public Utilities in the highway (this is included in the utilities package)
- Integrity testing of services

The key deliverables are as follows:

- Plans detailing service routes (by discipline)
- Cable and service schedules (by discipline)
- Equipment Schedules
- Schematics for all systems
- Electrical Load data taken from key distribution boards
- Tagging of equipment and cables (uniquely referenced)

22.4. Geotechnical and Structural Investigations (including Archaeology)

Norwest Holst was appointed in January 2010 for geotechnical and structural investigations, and works commenced at street level in early July in the Shunt and the public highway. The scope is currently based around Option 2A and generally includes the following:

- A large number of cores into the brick arches across the footprint of the scheme at various positions on the arch (wall, foundation level & crown)
- Trial pit investigations at street level, terminus level and high level. There are also 6 deep bore holes at street level to confirm the geology
- Brick samples
- Associated sampling and testing for SI works

It is likely that further Geotechnical and Structural Investigations works will need to be carried out during GRIP 4 to supplement the current scope once a final option has been selected.

22.5. Bats & Birds Surveys

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RSK Carter has completed surveys to record any activity of bats in the area at different times in the year. This was due to be completed in June 2010, and the report REF[4/23] has been issued. No bats were recorded emerging or returning to the building complex during the surveys some further minor surveys may be required in 2011 to check survey findings still hold.

Aecom have been appointed under Consents, Environment & Planning framework contract to carry out a bird survey (Black Redstarts) which has now been completed. Some Black Redstarts have been recorded around with territories around the perimeter of the site of, further details and potential implications will be included in the final report, due to be issued August 2010.

22.6. Structural Monitoring

The movement monitoring strategy had been progressing on the basis that a number of enabling works would be commencing pre-Olympics and suitable monitoring would need to be designed, installed and baselined prior to these works commencing. With the recent developments of 5Z(5) and 6B(3) options and confirmation that enabling works will now commence post Olympics the monitoring requirements and strategy has been put on hold whilst GRIP 3 is completed.

London Bridge Associates have produced a monitoring strategy REF[4/24] (based on Option 2A) which details the likely technical requirements for each of the main elements of works.

22.6.1. Shared Monitoring System

There are a number of large projects in close proximity to London Bridge Station (Borough Viaduct, KO2 London Bridge & the Shard of Glass) that have the potential to cause ground movements that could adversely affect London Underground assets and some of the settlement contours overlap and may have a cumulative effect. This could cause issues regarding which party is responsible for any consequential damage and general confusion regarding interpretation of movement data. It is for this reason that London Underground is keen to see a co-ordinated approach to managing the Ground Movement Assessments across all projects that will be working concurrently in the area.

A tri-partite agreement may be entered into between Network Rail / London Underground /Sellers' contractors to share data, unify the engineering control & response, and avoid duplication of monitoring equipment. Currently a "heads of terms" agreement is being reviewed by the parties and Network Rail (Borough Viaduct TLP) is seeking a commercial and legal agreement with Teighmore (Sellers contractors).

This shared co-ordinated approach is based on a single specialist monitoring company carrying out all ground and structure monitoring around London Bridge for which Sol Data have been nominated as they have installed all infrastructure and systems which are in operation for the Shard.

If agreement is reached between Network Rail and Teighmore for this shared approach it would seem sensible for K02 London Bridge to integrate and become part of this team. Subject to consideration being given to the following:

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- The extents of the monitoring required for KO2 London Bridge derived by the GRIP 4 designer may lend to all, parts or no monitoring falling under this umbrella.
- Network Rail is satisfied that the agreement and shared process is working successfully and continues to be in the best interest of the project.
- Single tender action to Sol Data for all or some of the works (approx £5million over the duration of the project) being acceptable commercially.
- London Bridge programme may be such that the other projects monitoring requirements are nearly complete. This may mean that the monitoring contract in place to employ Sol Data (with Teighmore) may need to be taken over by Network Rail or an alternative arrangement negotiated.

If it were decided to be party to this agreement it likely the projects interaction initially will be quite low and increasing to a point potentially leading the group when the London Bridge commences in earnest.

Depending on the final foundation option chosen the following surveys to the London Underground assets listed below may be required:

- Topographical Tunnel Survey
- Tunnel Gauging Survey
- Track Survey
- Escalator Survey
- Condition Surveys

It is worth noting that the biggest likely cause of potential movement for the London Bridge Project was associated with the main deep piles or the foundations of Option 2A in close proximity to the Jubilee line tunnels. Option 6B(3) has shallower CFA piles that will have less potential impact to the Jubilee line tunnels which should reduce the monitoring requirements.

22.6.2. Recommendations for future work and GRIP 4 design

The Grip 4 designer's remit will include the preparation of the relevant monitoring documents to suit their structural design solution. The key documents will be the ground movement assessment and a specification for the monitoring requirements.

These documents in conjunction with the remit will form the key information to allow a monitoring specialist(s) to be procured. This will need to be reviewed in conjunction with considering whether/how to integrate these works with any shared approach and systems with others.

The procurement and installation may need to be phased to allow suitable monitoring systems to be in place to suit the programme of early enabling works.

23. Utility Services Investigations

23.1. Overview

McNicholas limited was appointed as the Utilities Services Manager in May 2009, tasked with managing the utilities diversions through the initial stages (C2 to C4) of the New Roads and Street Works Act (NRSWA). Their remit was based on planning for the diversion of services



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to enable the construction of Option 2A, which involved the diversion or abandonment of all services within the footprint of the permanent works.

The introduction of Option 5Z(5) has potentially reduced the requirements for diversion of services due to the over-deck solution which means large scale demolition of the street level arches between Stainer and Weston Streets is no longer required. Option 5Z(5) would still require services in Stainer Street to be diverted as a result of the core construction required for the main bank of escalators providing connectivity between street level and the upper levels. This would provide significant savings on the original scope compared to Option 2A, mainly attributable to not having to divert the deep Thames Water sewer and other services in Weston Street.

Due to this change in direction it was agreed in November 2009 to formally suspend McNicholas's contract at a suitable juncture (completion of Stage C3) due to the uncertainty regarding the option selection.

23.2. Outputs to date

NRSA Stage C2 - All Statutory Undertakers with apparatus in the vicinity of the works likely to be affected have been contacted and provided plans detailing the locations of their apparatus. From the above information a services plan has been produced REF[4/25] showing all known apparatus in the area.

NRSA Stage C3 (Budget Estimate and Outline Scheme) - All Statutory Undertakers with apparatus affected by the proposed works have provided a budget estimate and an Outline scheme design. A C3 report REF[4/26] has been produced which covers all of the works carried out by McNicholas including issues with regards to critical services, proposals to co-ordinate the work (shared trenches etc) procurement & Value Engineering and estimates costs.

23.3. Recommendations for future work and GRIP 4 design

The works and studies completed to date provide a valuable database of information to inform design and cost estimates for GRIP 3. A supplier to carry out the role Utilities Delivery Team (UDT) is currently being procured due to be appointed August 2010. Their initial priority will be to commence the C4 process of obtaining detailed estimates and design

1. C3 Notices Review and Assessed;
2. C4 (Detailed Design and Estimate) - Notices Issued accompanied with advance payments;
3. Detailed design discussions and Value Engineering with Utility Companies;
4. C4 Submissions Returned and reviewed;
5. C5 and C6 Advance Order and Payment by Network Rail;
8. C7 Site Works – Managed by Principal Contractor.

A procurement strategy for obtaining a designer to complete a multi-utilities design and a Principal Contractor to manage and execute the physical works will need to be confirmed early during the C4 stage to allow a timely start on site (Stage C7).

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23.4. Key issues and recommendations

- Diversion of Thames Water sewer from in Weston Street (if required) is the most complicated diversion, high risk and a high capital cost (£5million approx). Current solution involves enlarging existing sewer by tunnel boring from between Stainer Street and Bermondsey Street;
- Any diversions required for enabling works, particularly in St Thomas Street, such as for the foundations for temporary supports for the south train shed wall and any tower crane foundations have not been planned for to date. The scope for any enabling work diversions needs to be ascertained as early as possible as these will need to be carried out and co-ordinated with the main works due to the limited physical space in the road and traffic management constraints.
- There is a large private sewer that runs between Stainer and Weston Street that has yet to be surveyed and currently with limited details available. It is proposed that White Young Green under their current station services remit carry out surveys as far as possible from lifting manholes and that a detailed topographical survey and walk through is carried out early in GRIP 4.
- The existing HV supplies for the station will not have sufficient capacity for the new station loadings and as such new HV supply(s) and upgrades will be required. The requirements for new supplies including retail and upgrades will need to be co-ordinated with any diversion requirements.

24. Environment and Sustainability Analysis

24.1. Environmental Management Activities

Environmental Management activities ensure appropriate controls are established for the project activities commensurate with the environmental risks as they become more defined.

Prior to the start of GRIP 3 environmental assessments had already been carried out and the following documents were produced:

- Project Environmental Strategy,
- Environmental Impact Assessment/Statement (EIA/ES)
- Thameslink Programme Environment Statement
- Sustainability Report (2004) and the Environmental Risk Assessment/Risk Register.

These documents remain active, however, due to the need for a new Planning Application the above documents may require updating during GRIP 4.

The most notable environmental risks to the London Bridge project include:

- new planning application (time, cost, and station appearance),
- English Heritage (replacement for train shed roof),

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- issues relating to construction (noise and vibration, air pollution, working hours etc),
- station appearance (vastly different to Master Plan)
- socio economic (lack of improvements to surrounding communities)

These issues and others are addressed in the REF[4/27] which has been completed during GRIP 3.

24.2. Sustainability

The broad aims for sustainability at London Bridge redevelopment have been established by several bodies which include:

- National Government,
- the Greater London Authority,
- London Borough of Southwark,
- Network Rail and Thameslink Programme.

These organisations have published plans/guidance notes in which they set sustainability criteria and targets developments such as London Bridge are expected to achieve. The term frequently used is for new structures to be 'lean, green and clean' this is achieved by:

- Demand Minimisation – reduce demand for resources especially energy through environmentally considerate design.
- Demand Efficiency – reduce energy consumption/losses by deploying efficient systems
- Supply Renewable – deliver through renewable resources
- Supply Alternatives – deliver energy through alternative sources where possible use of high efficiency technologies which reduce the environmental impact to minimum by servicing any residual demand.

This environmental design approach is to devise low carbon developments/buildings which naturally respond to the dynamics of the local external environment whilst providing an internal environment that is comfortable for end users.

Environmental Consultants Temple REF[4/28] and ARUP REF[4/29] have drafted separate technical reports which draw on the influences of the aforementioned bodies published works to ensure Option 5Z(5) and Option 6B(3) designs meet the necessary requirements. The reports also assess and make recommendations as to opportunities for London Bridge Station Design to achieve an environmental rating from either BREEAM or CEEQUAL.

During GRIP 3 we have also completed an initial CEEQUAL Assessment REF[4/30]. A target of CEEQUAL rating 'Excellent' has been set for the London Bridge Development.

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It is strongly recommended these technical reports are read to fully appreciate their impact on Option 6B(3) development through GRIP 4.

The reports do not highlight any major risks which at this stage would prevent required targets by and Statutory being unable to be met.