



RIVER CROSSINGS: SILVERTOWN TUNNEL

SUPPORTING TECHNICAL DOCUMENTATION

SILVERTOWN TUNNEL: HIGHWAY INFRASTRUCTURE CONCEPTUAL DESIGN RECOMMENDATIONS

Atkins

April 2013

This report builds upon previous studies undertaken to investigate the highway connections between the proposed Silvertown Tunnel and the existing highway networks to the north and south of the River Thames, in order to identify the preferred options.

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

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

(A2, A20) Lewisham A102 

Silvertown Tunnel:

Highway Infrastructure Conceptual
Design Recommendations

April, 2013

Notice

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Document History

JOB NUMBER: 5110309			DOCUMENT REF: 5110309-DOC-008			
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date
A	DRAFT ISSUE	MF	PRM	PRM	PRM	16/04/13
B	FORMAL ISSUE	MF	PRM	PRM	PRM	29/04/13
C	MINOR AMENDMENTS	MF	PRM	MF	PRM	20/05/13
D	MINOR AMENDMENTS	CH	MF	PRM	PRM	10/07/13
E	BUDGET ADJUSTMENT	CH	MF	PRM	PRM	24/07/13

Appendices

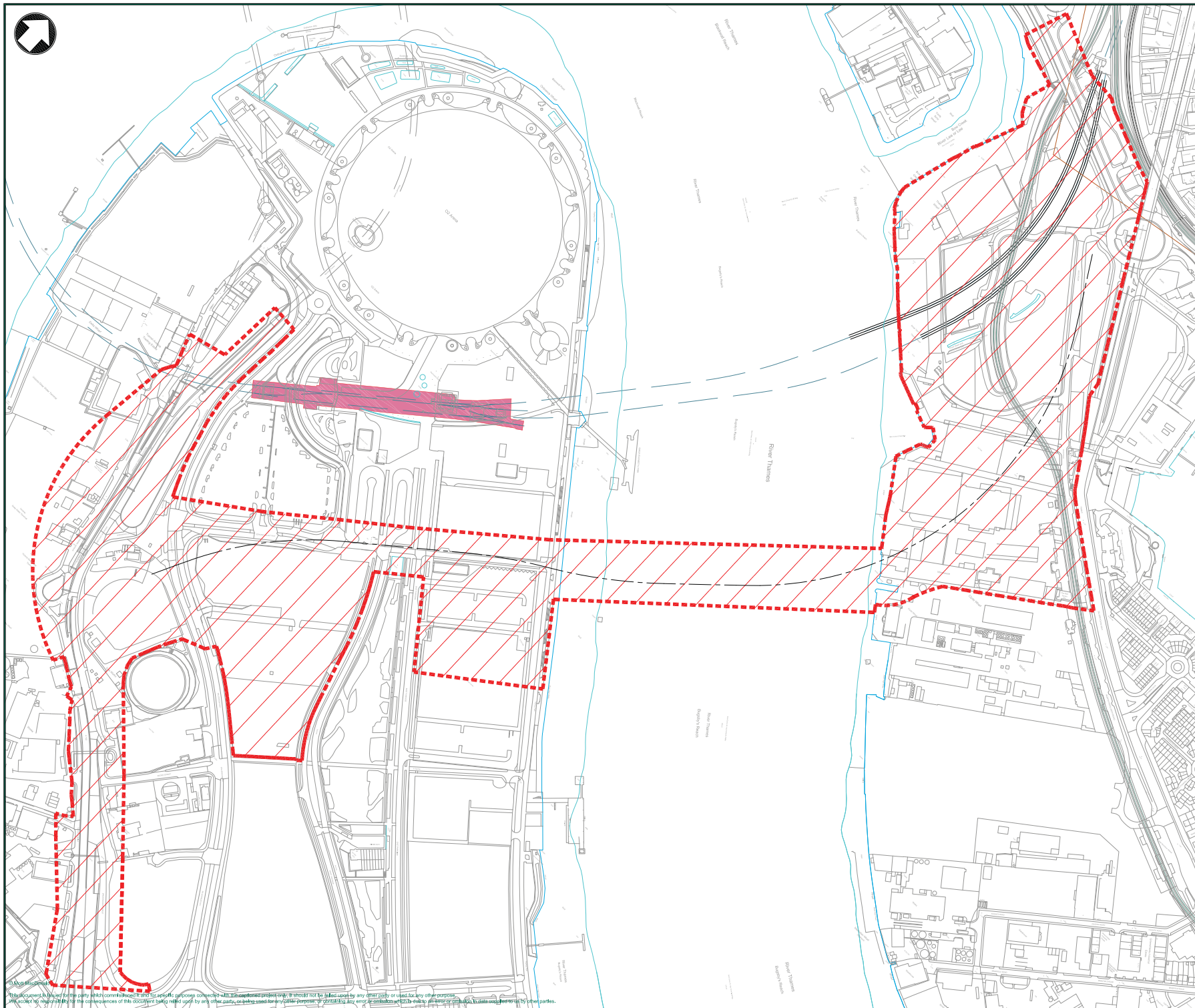
Appendix A: Previous Proposal Drawings

Appendix B: Current Proposal Drawings

Appendix C: Geotechnical Conceptual Design Report





Appendix A: Previous Proposal Drawings

Title	Reference
Silvertown Tunnel Crossing General Safeguard Area	MMD-267759-TUN-101
SOUTH4 - With Bus Link To Silvertown Tunnel Scheme Plan	5110309-HW-GA-0103
NORTH1 - Scheme Plan	5110309-HW-GA-0101
NORTH2 - Scheme Plan	5110309-HW-GA-0102
NORTH3 - Scheme Plan	5110309-HW-GA-0108
NORTH4A - Aborted Option Sketch	Sketch
NORTH5A - Scheme Plan	5110309-HW-GA-0207
NORTH5B - Scheme Plan	5110309-HW-GA-0208



Notes

Key to symbols

-  Safeguarded Area
-  Safeguarding Boundary
-  LUL North Greenwich Station Box
-  Tunnel centreline

Reference drawings


Safeguarded Area referenced from Mott MacDonald Drawing 36912/HWY/VIN/0204 P2 2002.

P1	17/02/12	RK	Preliminary Issue	AE	ML
Rev	Date	Drawn	Description	Chk'd	App'd

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Title

**Silvertown Tunnel Crossing
General
Safeguarded Area**

Designed	AE	Eng check	NT
Drawn	RK	Coordination	NT
Dwg check	AE	Approved	ML

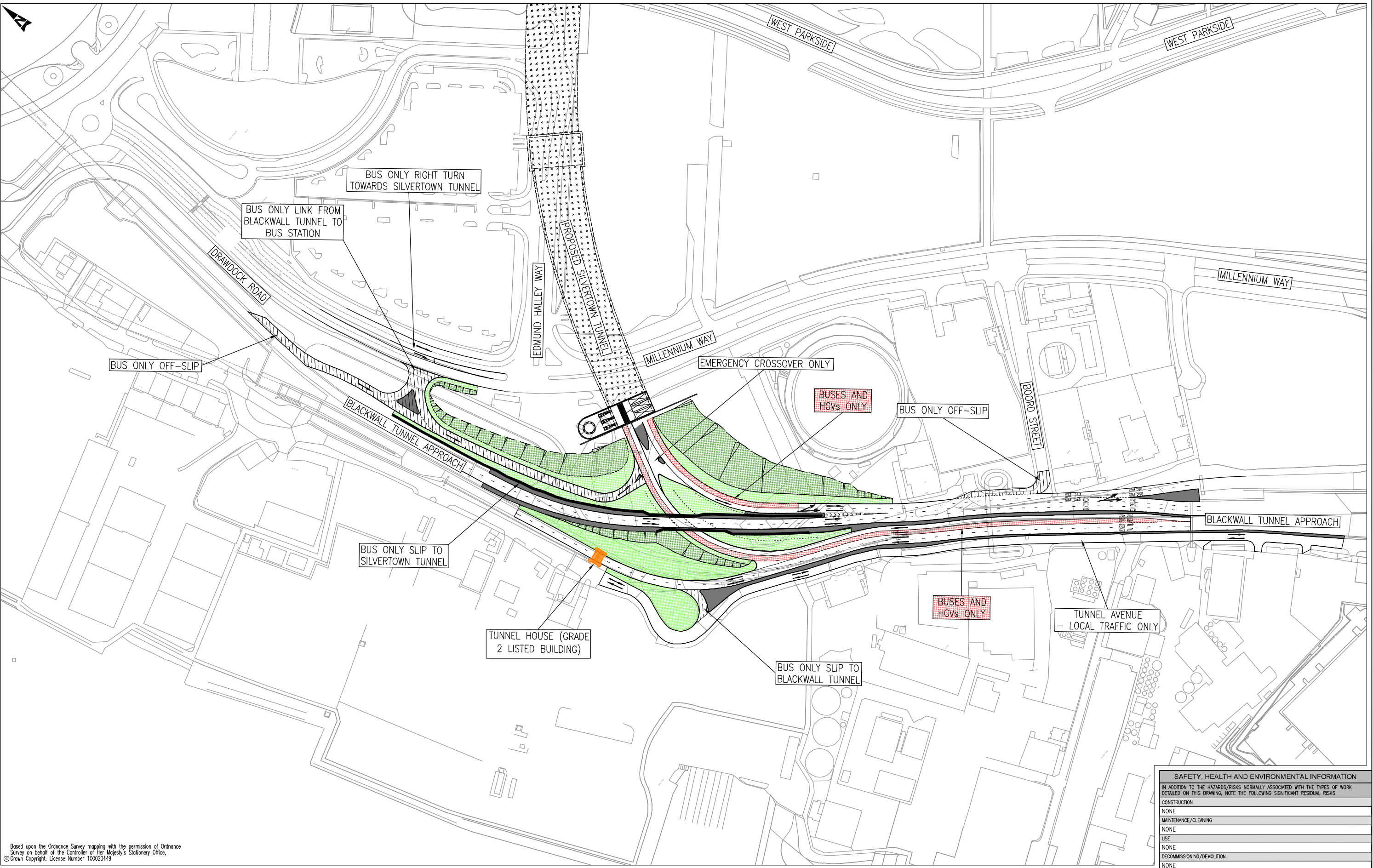
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Drawing Number: **MMD-298348-TUN-101**

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	RETAINING WALL

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Project: **SILVERTOWN CROSSING - HIGHWAYS**

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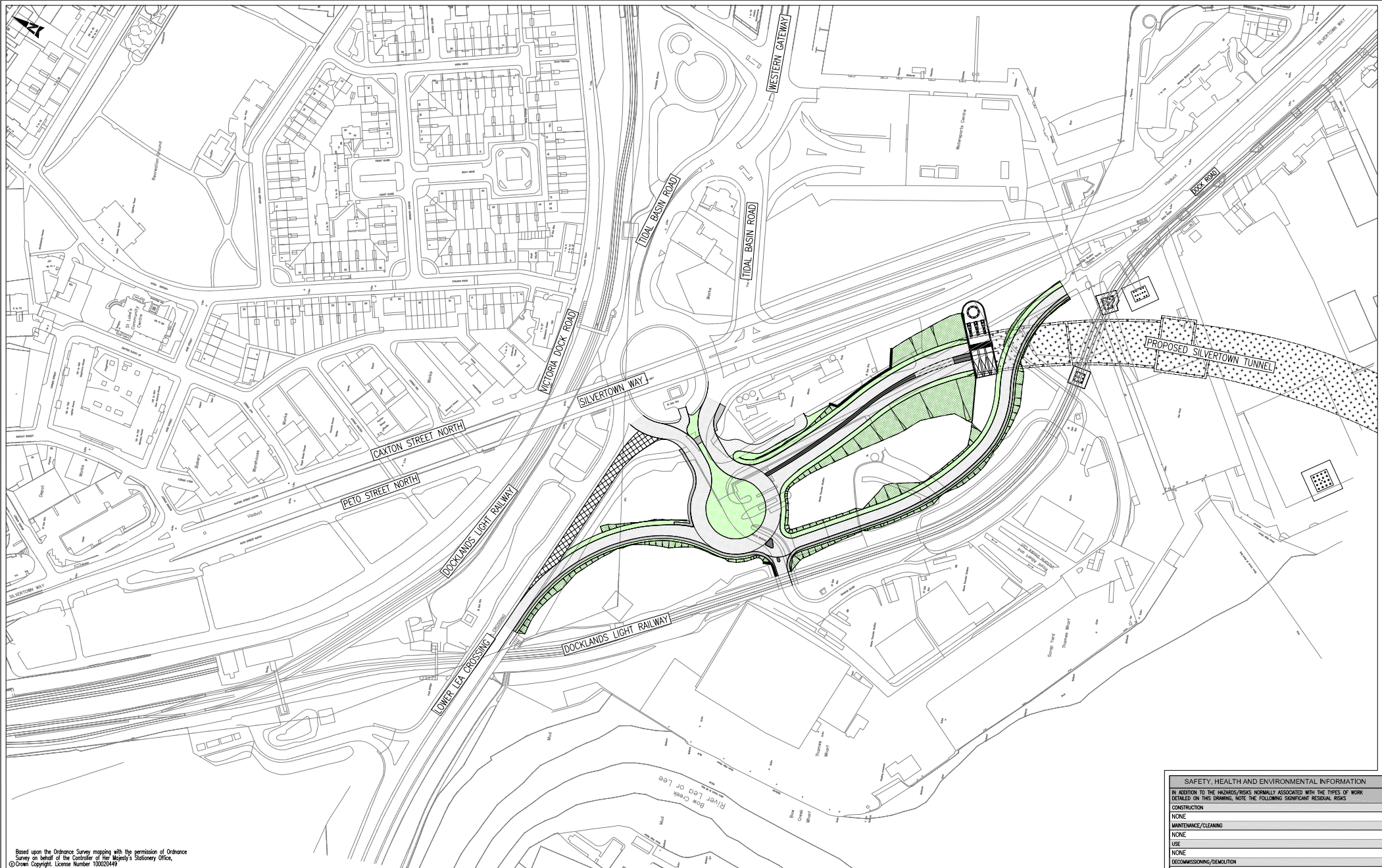
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Rev: B				

Rev A
 Drawing Number 5110309/HW/GA0101
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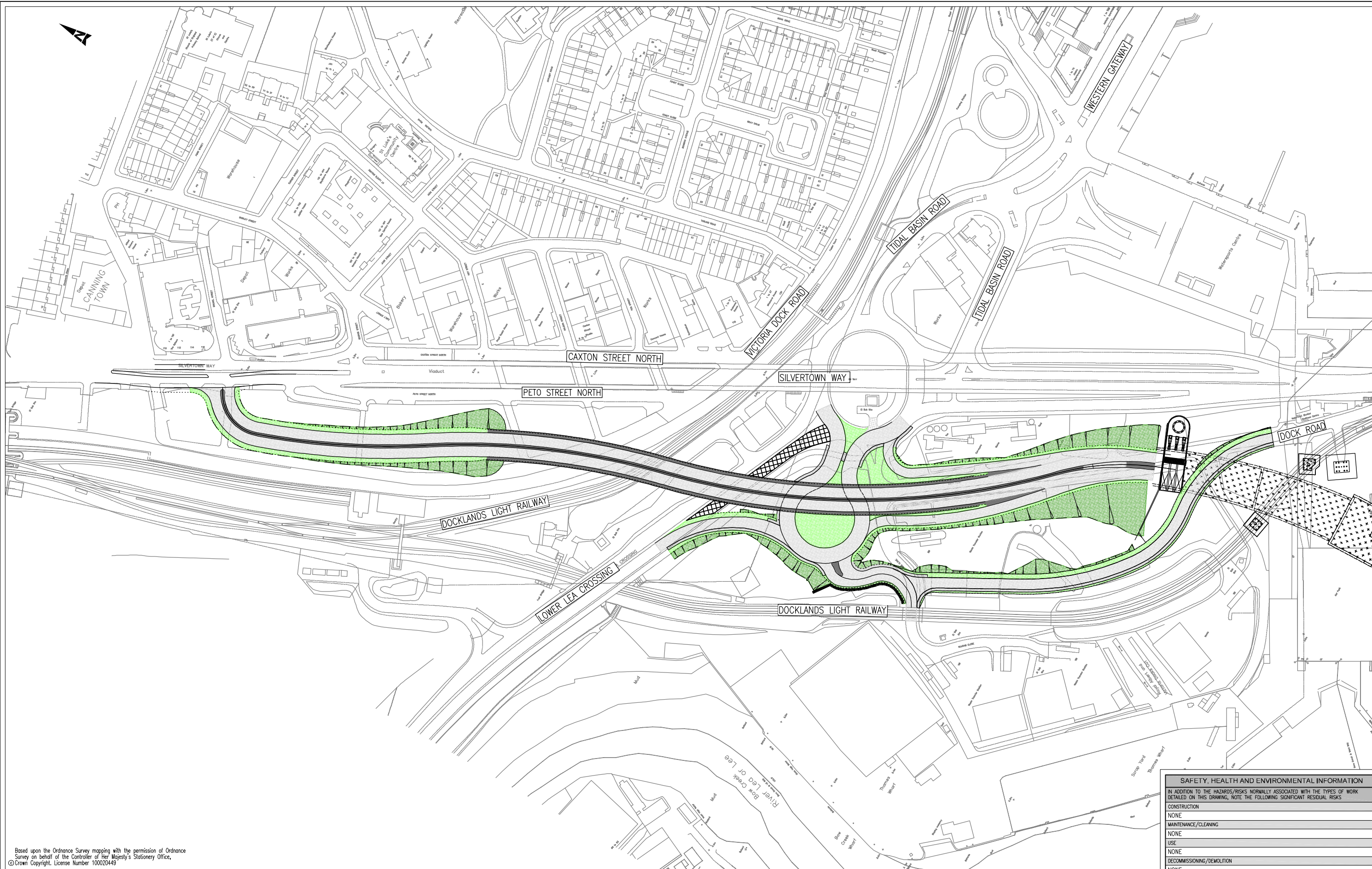
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

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Rev				
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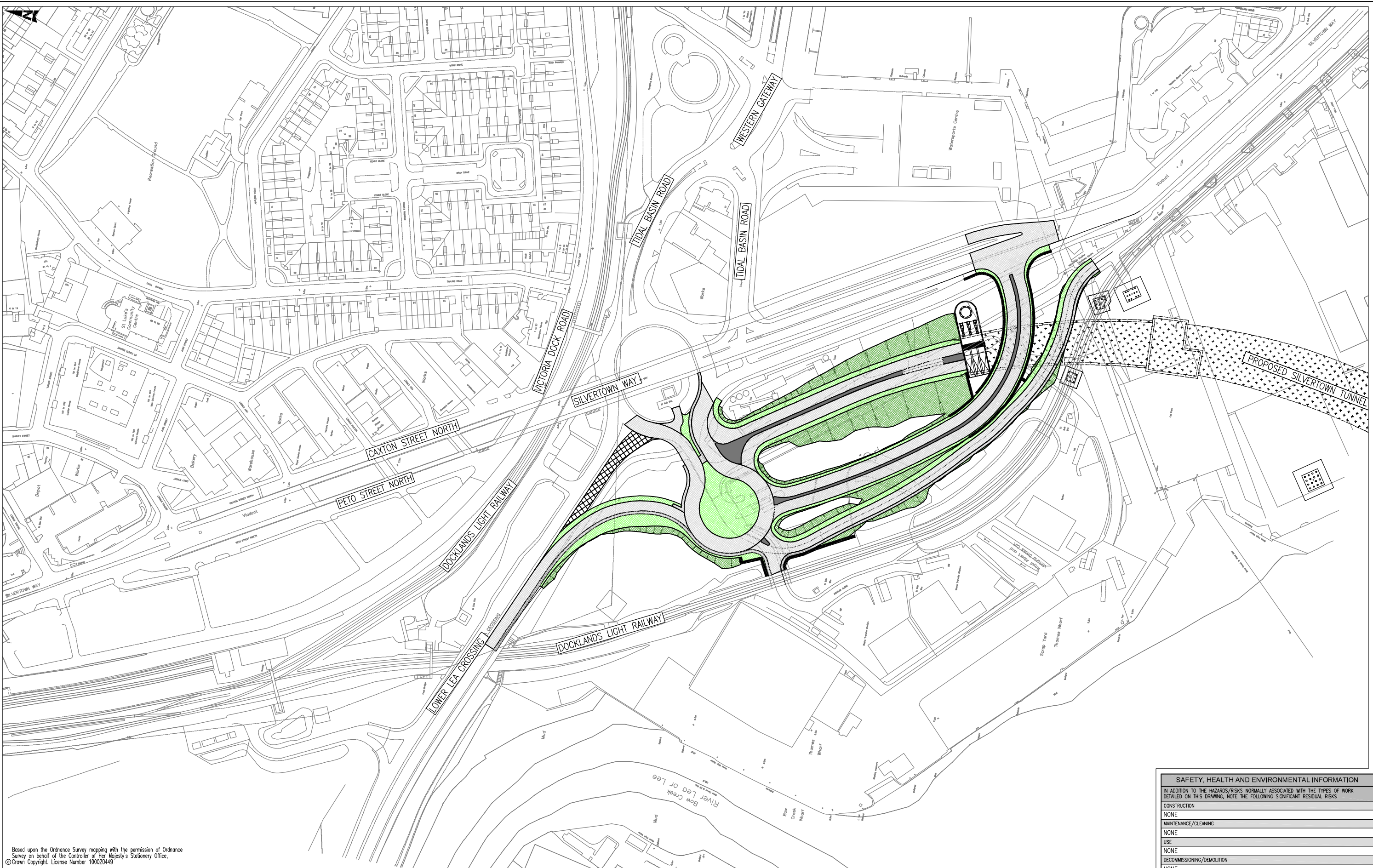
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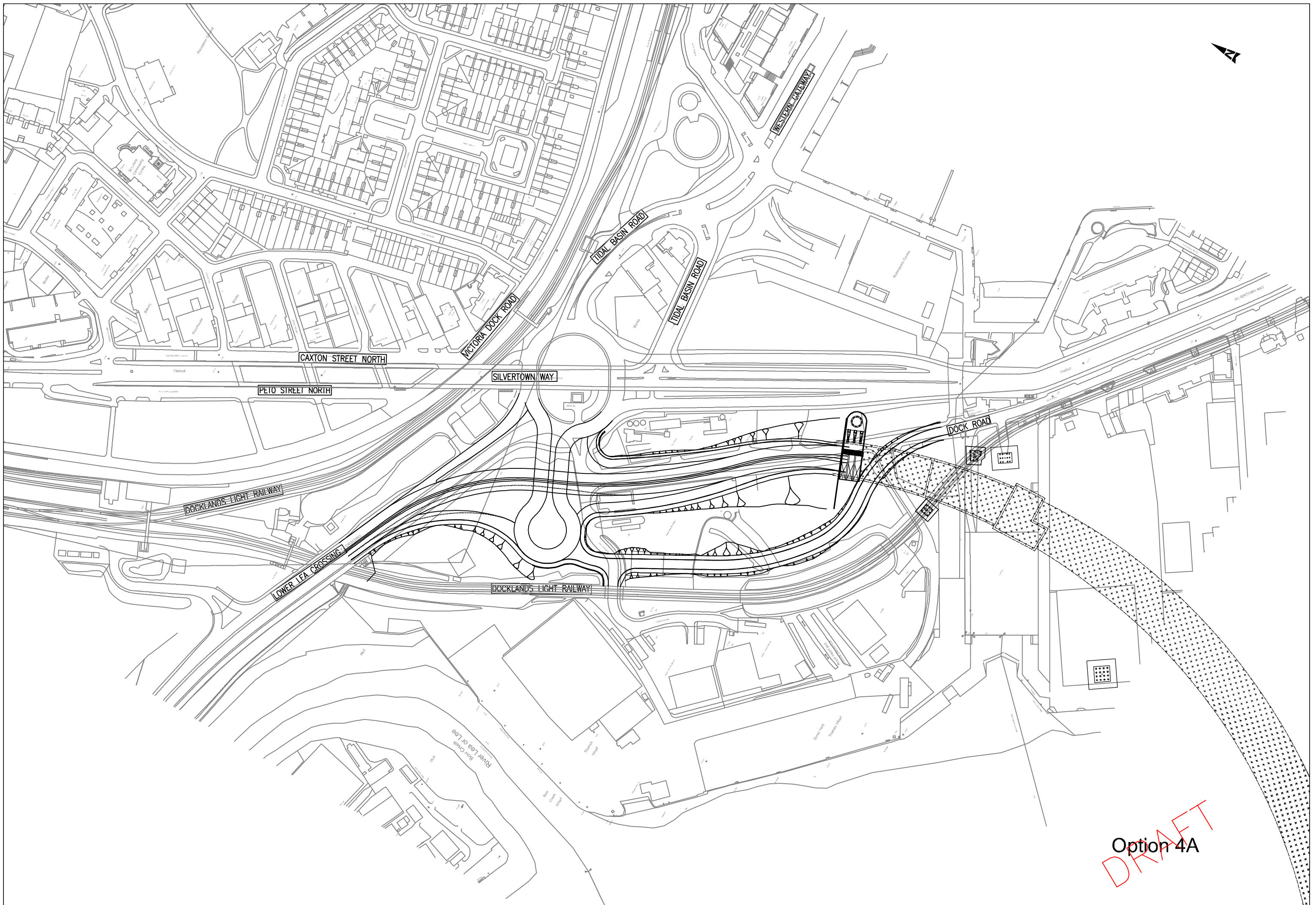
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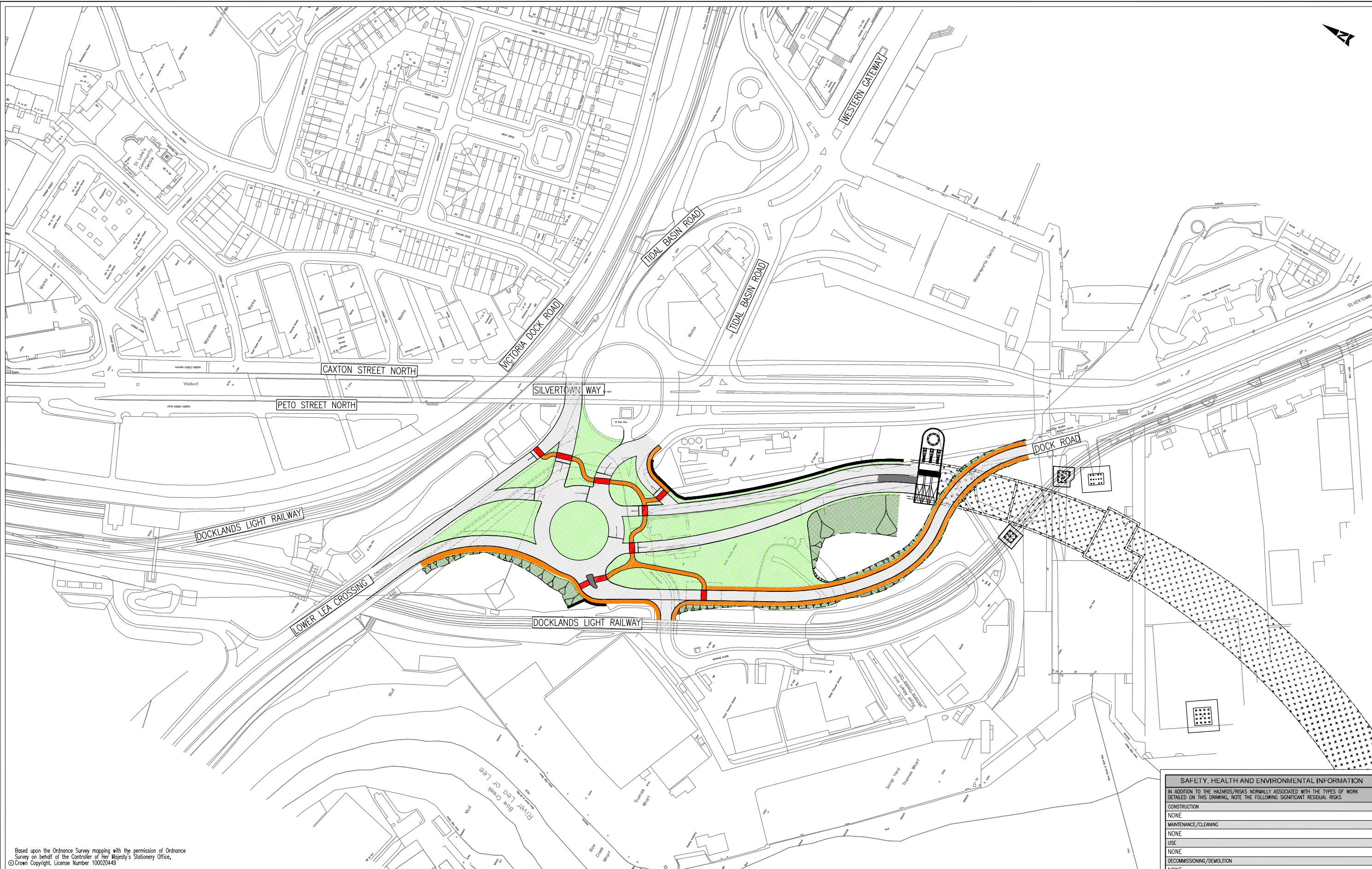
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Option 4A
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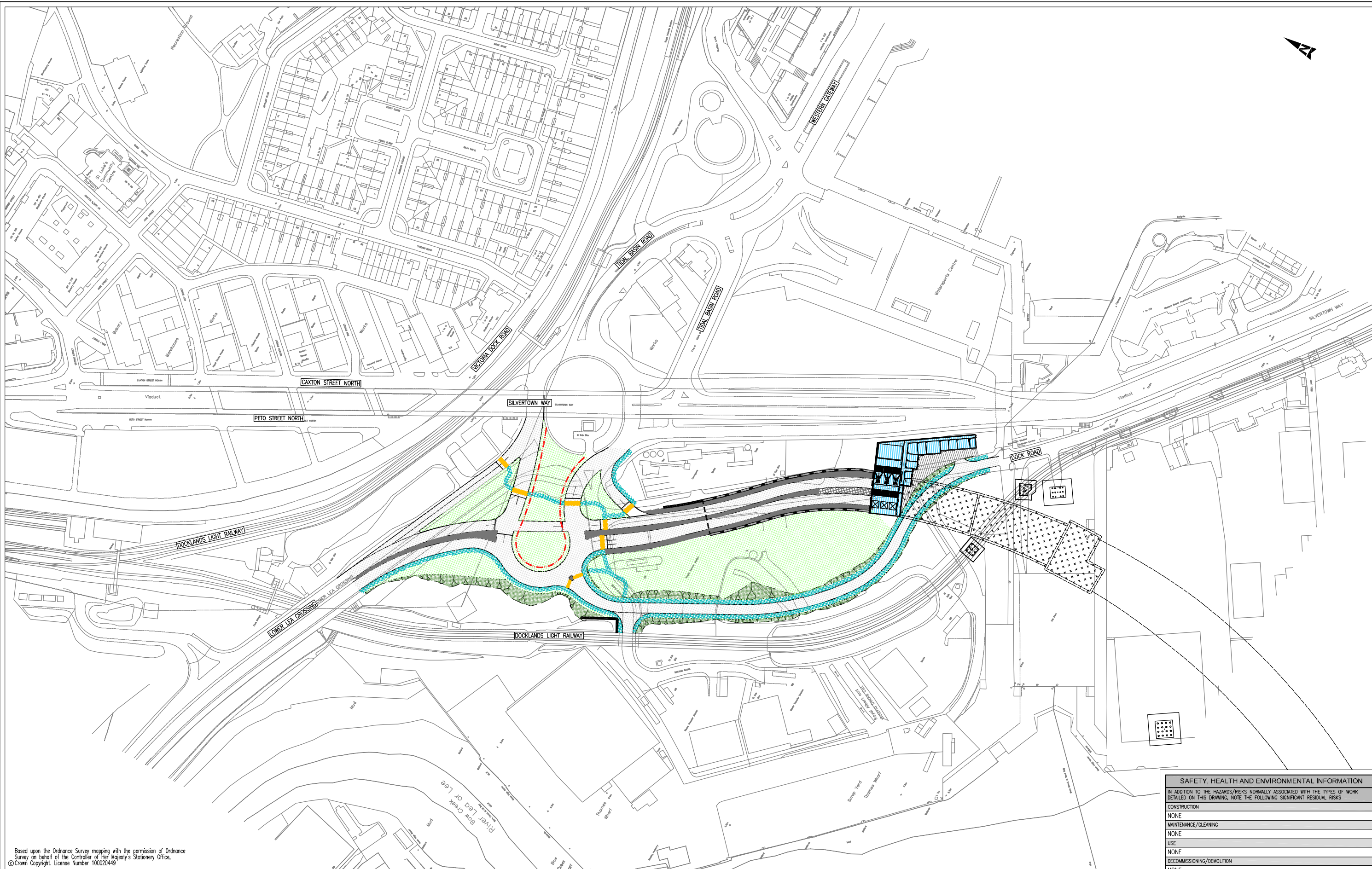
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Status P	Drawing Number 5110309/HW/GA/0208	Authorised M/F	Rev A

Appendix B: Current Proposal Drawings

Title	Reference
NORTH5C - Scheme Plan	5110309-HW-GA-0218
NORTH5C – Long-Section Sheet 1 of 3	5110309-HW-GA-0230
NORTH5C – Long-Section Sheet 2 of 3	5110309-HW-GA-0231
NORTH5C – Long-Section Sheet 3 of 3	5110309-HW-GA-0232
NORTH5C – Cross-Sections	5110309-HW-GA-0233
NORTH5C – Scheme Footprint	5110309-HW-GA-0234
SOUTH4A - Scheme Plan	5110309-HW-GA-0219
SOUTH4A – Long-Section Sheet 1 of 4	5110309-HW-GA-0223
SOUTH4A – Long-Section Sheet 2 of 4	5110309-HW-GA-0224
SOUTH4A – Long-Section Sheet 3 of 4	5110309-HW-GA-0225
SOUTH4A – Long-Section Sheet 4 of 4	5110309-HW-GA-0226
SOUTH4A - Cross Section Sheet 1 of 2	5110309-HW-GA-0227
SOUTH4A - Cross Section Sheet 2 of 2	5110309-HW-GA-0228
SOUTH4A - Scheme Footprint	5110309-HW-GA-0229
Highway Bridge General Arrangement Option 1	5110309-ST-GA-0235
Highway Bridge General Arrangement Option 2	5110309-ST-GA-0236

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KEY	
	RETAINING WALL
	LARGE DIAMETER SURFACE WATER ATTENUATION PIPE
	DIAPHRAGM WALL TO UNDERSIDE OF CARRIAGEWAY
	DIAPHRAGM WALL WITH VERTICAL UPSTAND
	CROSS OVER

Stat	Rev	Purpose of Issue	Date	Auth	Rev	Description	By	Date	Chk'd	Auth
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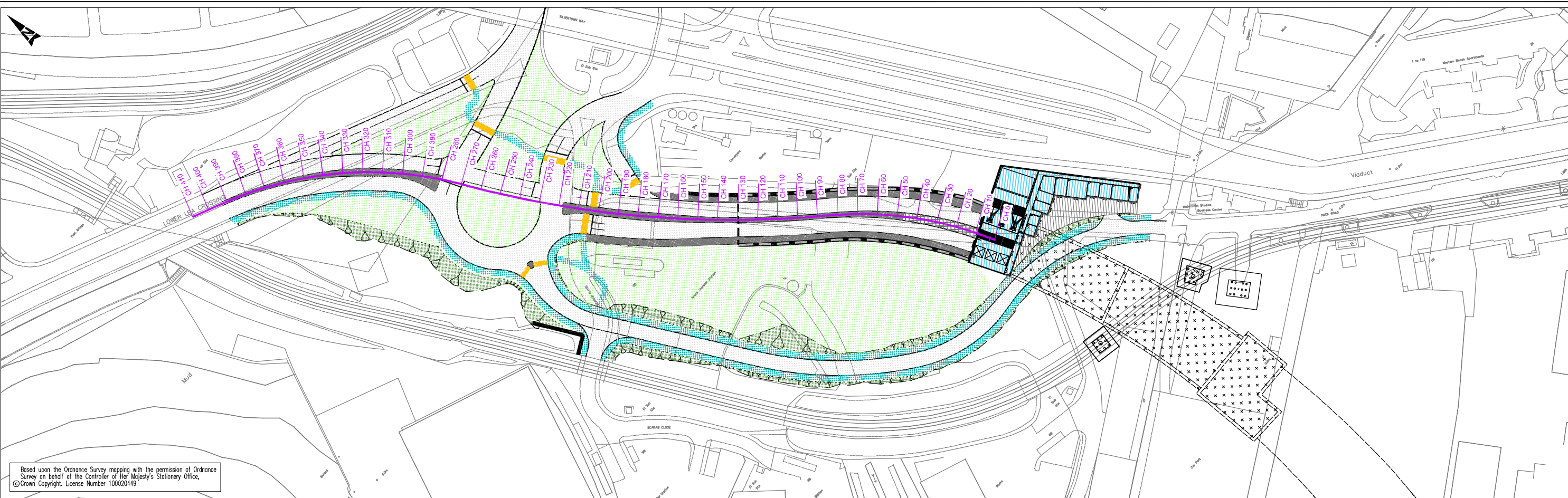
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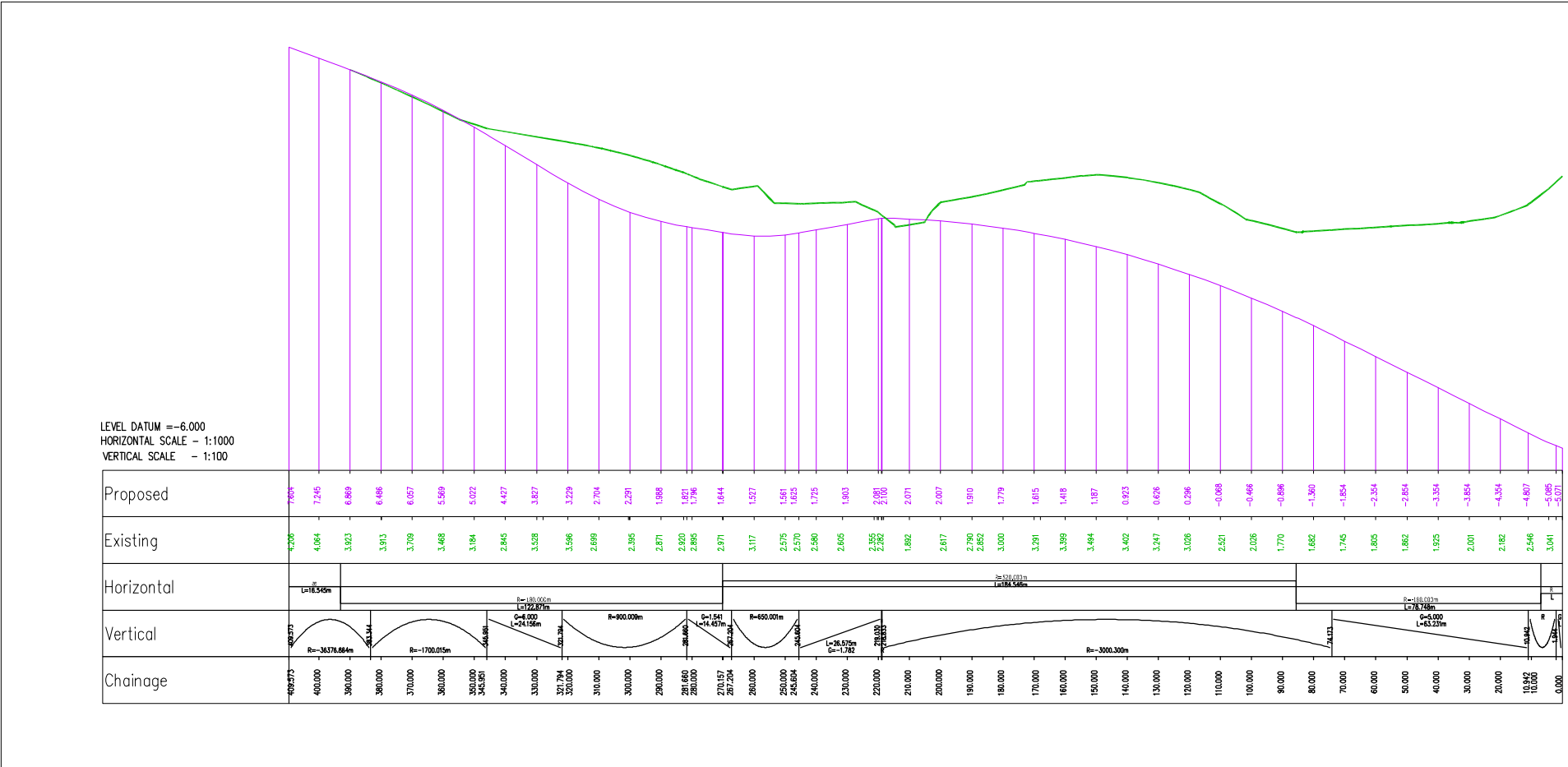
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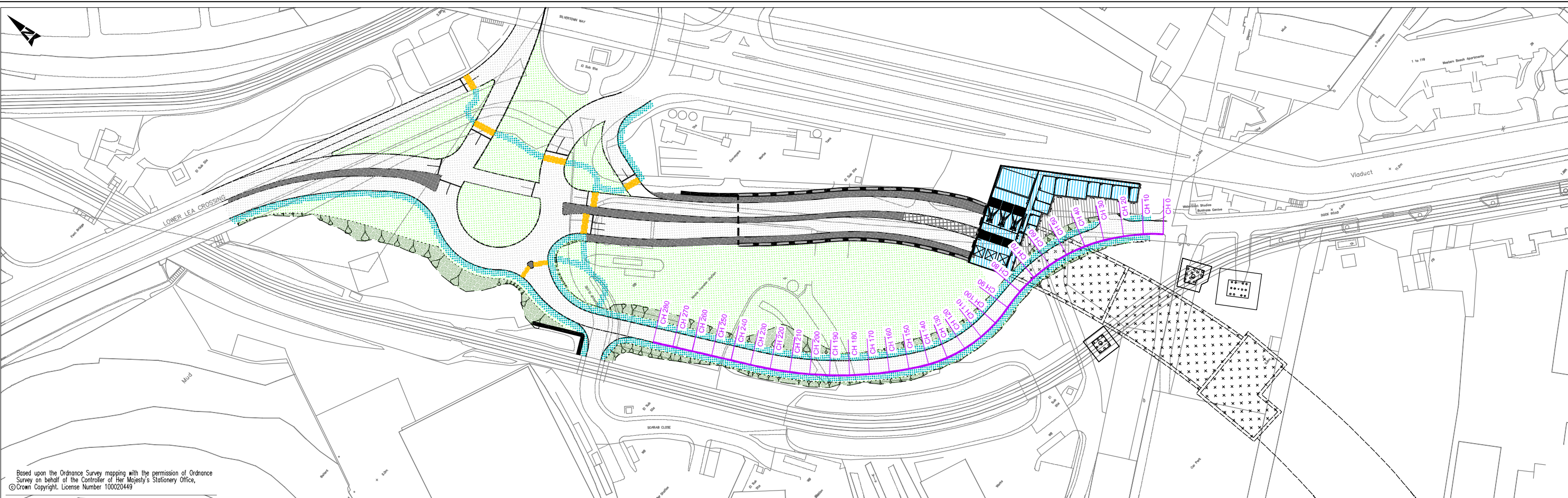
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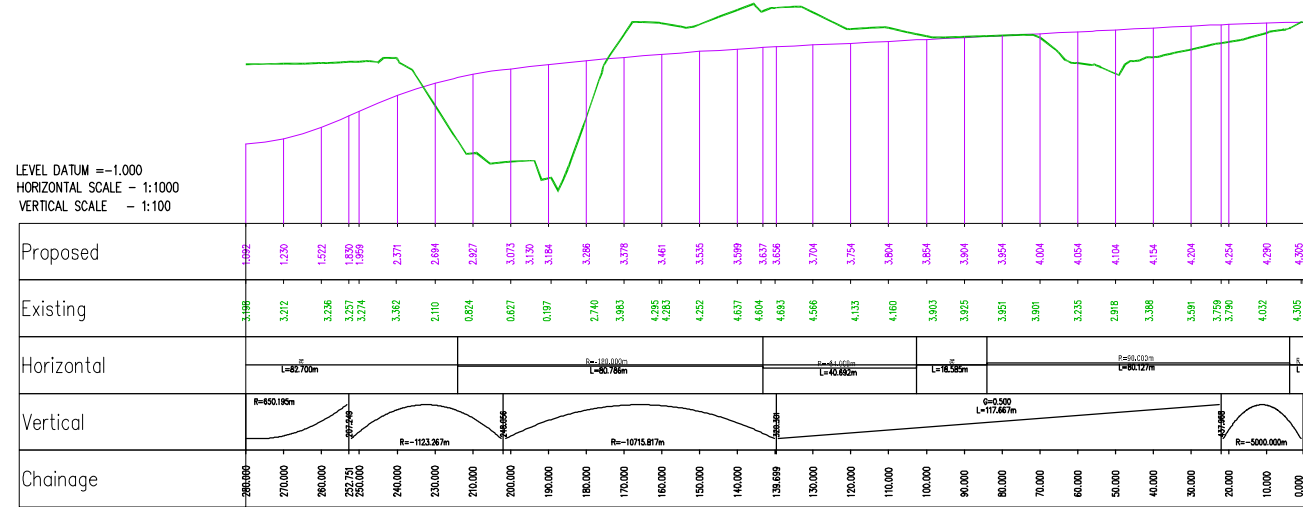
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Authorised	Authorised	Authorised	Authorised
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Rev	Rev	Rev	Rev
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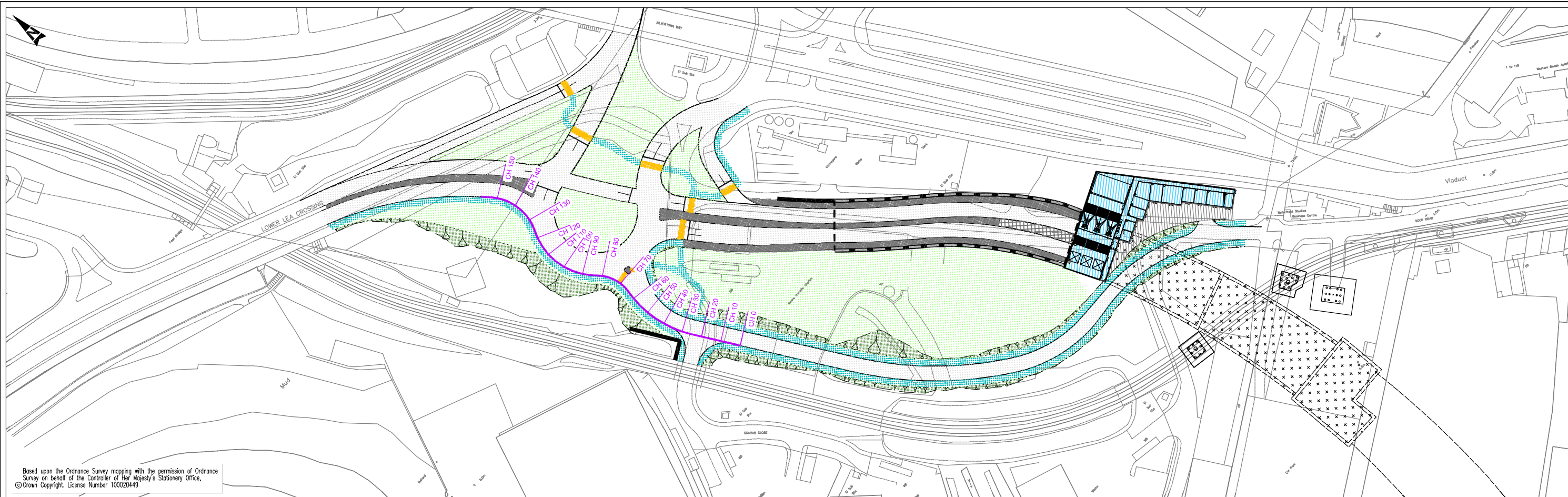
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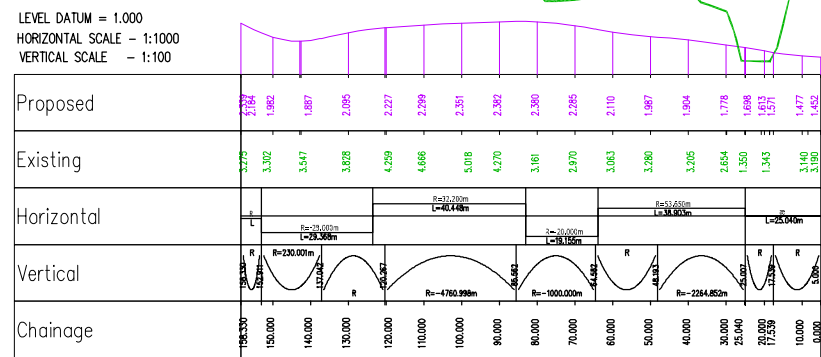
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Title
**NORTH 5C
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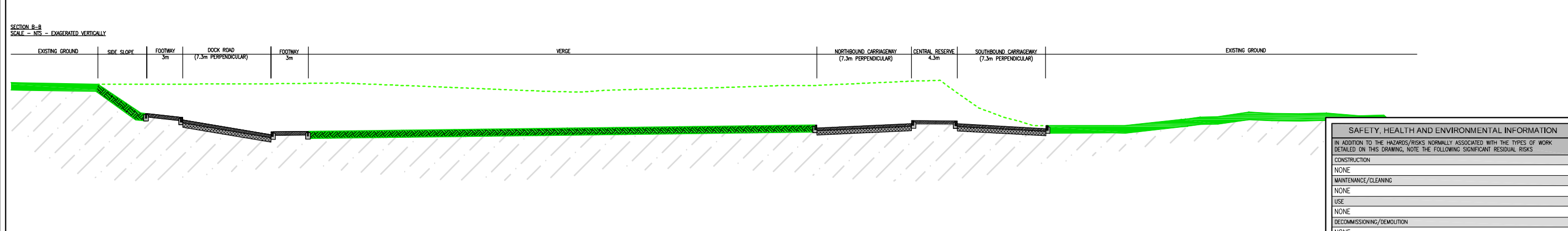
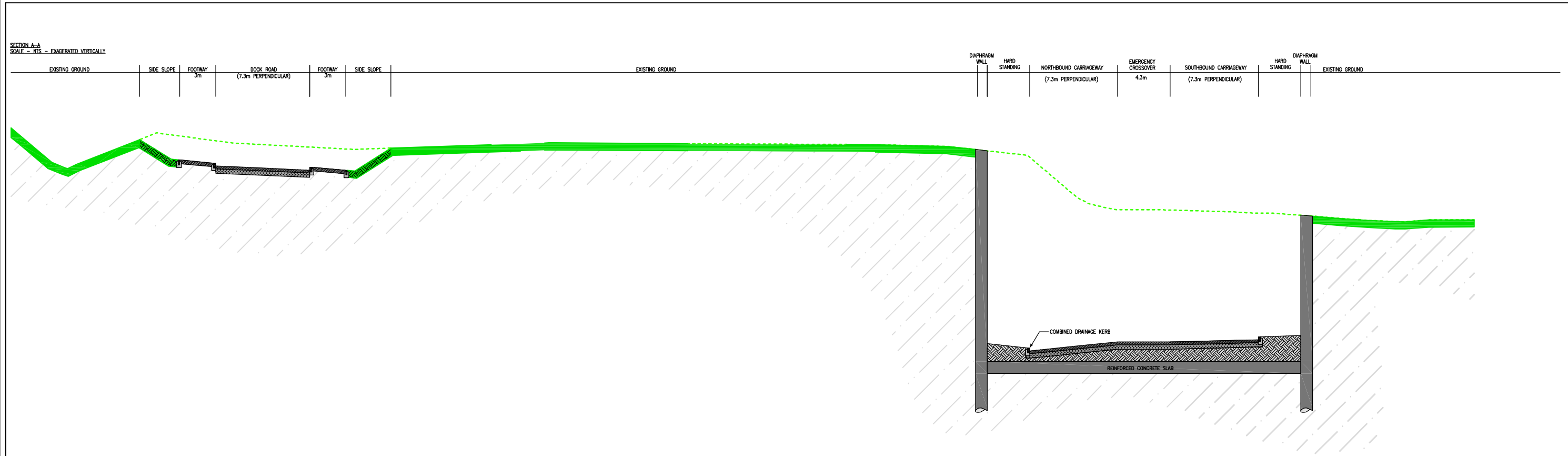
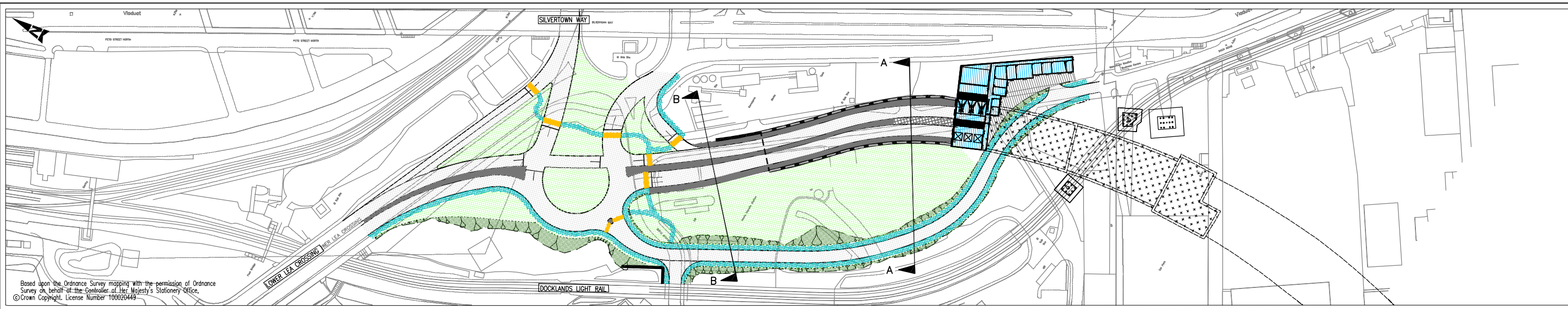
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				B

Rev B
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DECOMMISSIONING/DEMOLITION	NONE

NOTES :
 FOR DETAILS OF DIAPHRAGM WALL SEE THE MOTT MACDONALD REPORT - SILVERTOWN TUNNEL : FURTHER DEVELOPMENT OF TUNNEL ENGINEERING

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P	A	INFORMATION	SEE TITLEBLOCK	A	A	ORIGINAL ISSUE	SEE	TITLE BLOCK		

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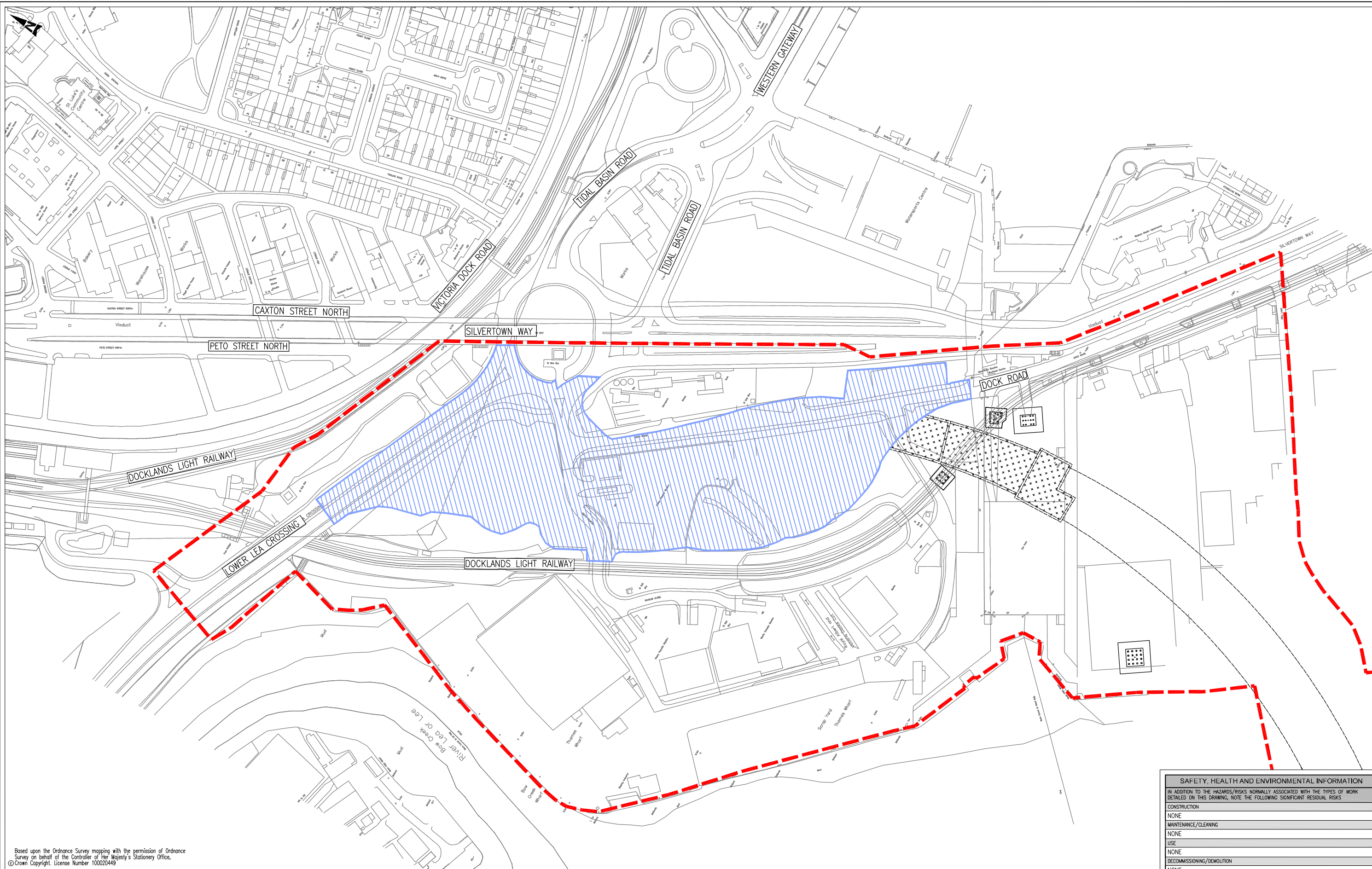
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Project
SILVERTOWN CROSSING - HIGHWAYS

Title NORTH 5C CROSS-SECTIONS	
Sheet Size A1	Original Scale 1:1250
Designed/Drawn DK	Checked SMC
Date 15/04/13	Date 15/04/13
Status P	Rev B
Drawing Number 5110309/HW/GA/0233	

DO NOT SCALE



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KEY	
	SAFEGUARDED CORRIDOR
	SCHEME FOOTPRINT INSIDE SAFEGUARDED CORRIDOR

Stat	Rev	Purpose of Issue	Date	By	Chk'd	Auth	Description
P	B	FOR INFORMATION	24/04/13	PRM	B		DESIGN AMENDED
P	A	INFORMATION	SEE TITLE BLOCK	A			ORIGINAL ISSUE

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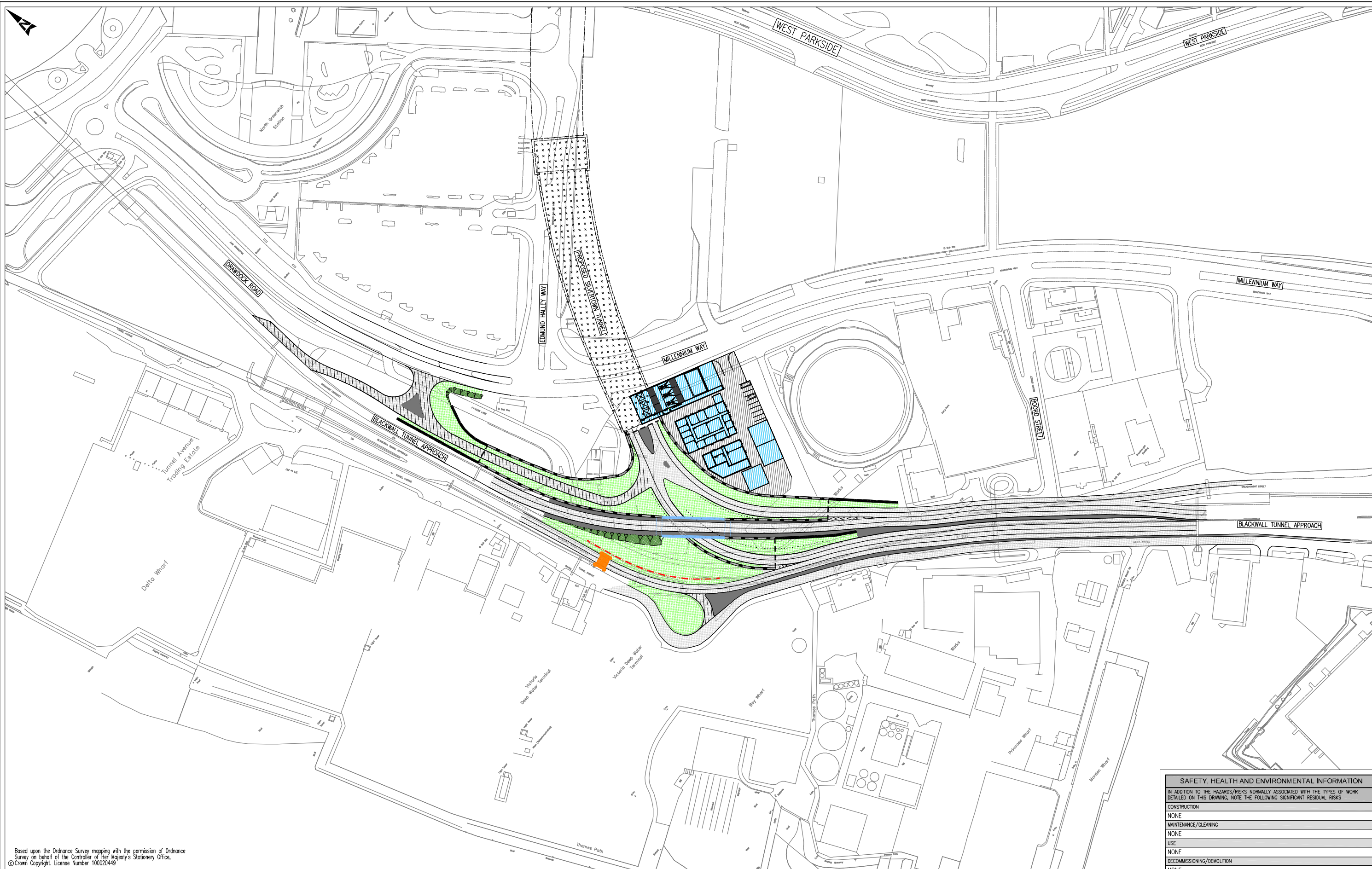
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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION				
IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS				
CONSTRUCTION	NONE			
MAINTENANCE/CLEANING	NONE			
USE	NONE			
DECOMMISSIONING/DEMOLITION	NONE			

Title				
NORTH 5C SCHEME FOOTPRINT				
Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
A1	1:1250	DK	MF	PRM
Status	Drawing Number	Date	Date	Date
P	5110309/HW/GA/0234	15/04/13	15/04/13	15/04/13
				Rev
				B

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KEY	
	RETAINING WALL
	BRIDGE PARAPET
	DIAPHRAGM WALL TO UNDERSIDE OF CARRIAGEWAY
	DIAPHRAGM WALL WITH VERTICAL UPSTAND
	BUSES ONLY
	LARGE DIAMETER SURFACE WATER ATTENUATION PIPE

Stat	Rev	Purpose of Issue	Date	Auth	Rev	Description	By	Date	Chk'd	Auth
P	B	FOR INFORMATION	24/04/13	PRM	B	DESIGN AMENDED	DK	24/04/13	MF	PRM
P	A	FOR INFORMATION	SEE TITLE BLOCK	A	ORIGINAL ISSUE		SEE	TITLE	BLOCK	

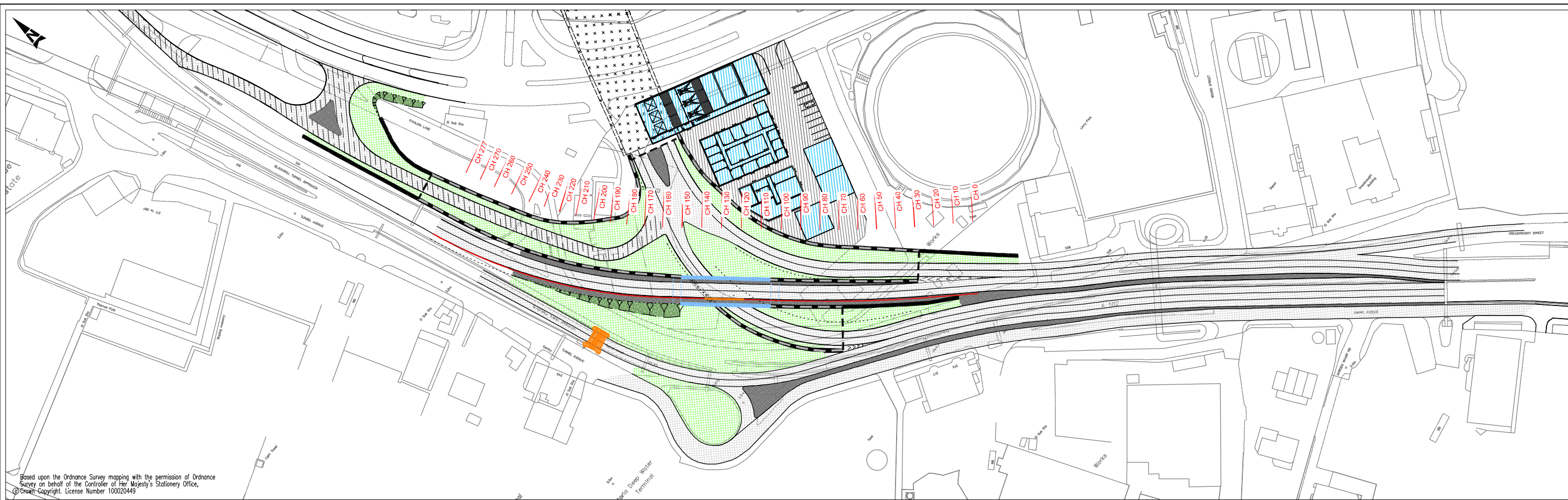
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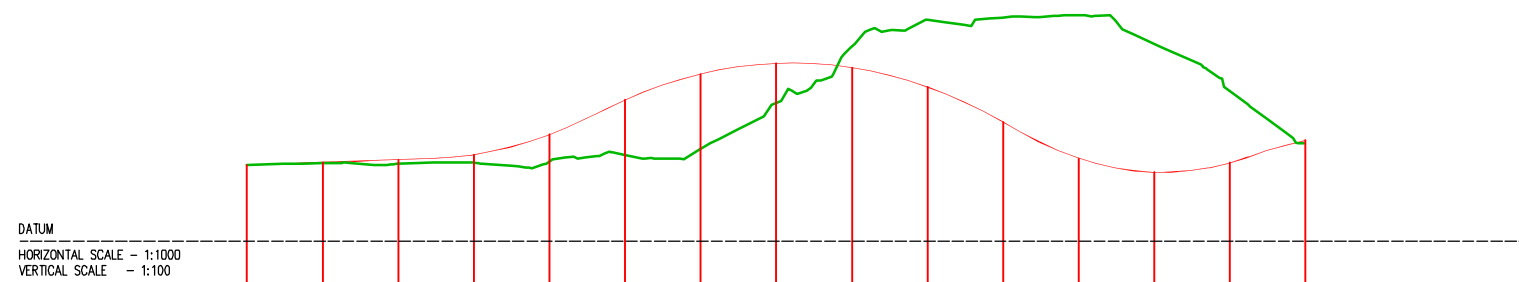
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION				
IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS				
CONSTRUCTION	NONE			
MAINTENANCE/CLEANING	NONE			
USE	NONE			
DECOMMISSIONING/DEMOLITION	NONE			

Title				
SOUTH4A SCHEME PLAN				
Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
A1	1:1250	DK	SMC	MF
Status	Drawing Number	Date	Date	Date
P	5110309/HW/GA/0219	25/03/13	28/03/13	28/03/13
				Rev
				B

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Control String	276.605	260.000	240.000	220.000	200.000	180.000	160.000	140.000	120.000	99.756	80.000	60.000	40.000	20.000	0.000	
SILVERTOWN NB								-2.500	-2.300							
Existing Levels	2.015	2.065	2.046	2.093	2.030	2.291	2.423	3.614	5.119	5.865	5.919	5.979	5.241	3.995	2.886	
Vertical	<p>Vertical Curve Data:</p> <ul style="list-style-type: none"> Curve 1: L=49.237m, G=-0.324 Curve 2: L=121.242m, R=900.000m Curve 3: L=128.208m, R=1000.000m Curve 4: L=72.000m, R=448.994m Curve 5: L=25.915m, R=200.000m 															
Horizontal	<p>Horizontal Curve Data:</p> <ul style="list-style-type: none"> Curve 1: L=49.237m, G=-0.324 Curve 2: L=121.242m Curve 3: L=128.208m Curve 4: L=72.000m, R=448.994m Curve 5: L=25.915m, R=200.000m 															
Chainage	276.605	260.000	240.000	220.000	200.000	180.000	160.000	140.000	120.000	99.756	80.000	60.000	40.000	20.000	0.000	

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION			
IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS			
CONSTRUCTION			
MAINTENANCE/CLEANING			
USE			
DECOMMISSIONING/DEMOLITION			

P	B	FOR INFORMATION	24/04/13	PRM	B	DESIGN AMENDED	DK	24/04/13	MF	PRM
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Stat	Rev	Purpose of Issue	Date	Auth	Rev	Description	By	Date	Chk'd	Auth

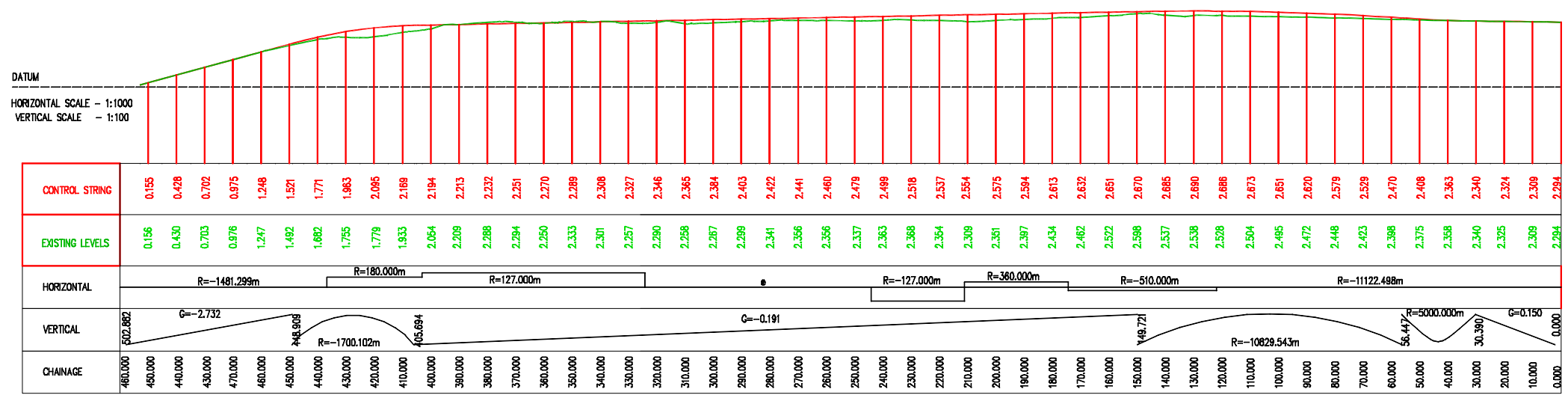
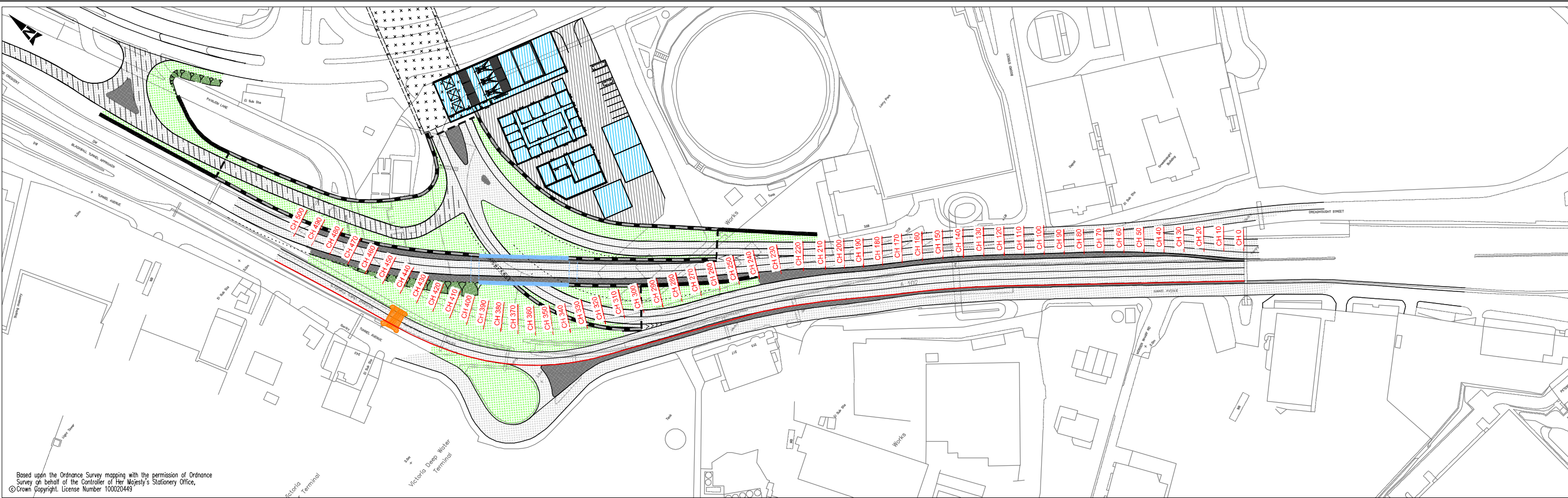
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SILVERTOWN CROSSING - HIGHWAYS

Title SOUTH 4A LONG-SECTION SHEET 1 OF 4				
Sheet Size A1	Original Scale 1:1000	Designed/Drawn DK	Checked MF	Authorised PRM
Status P	Drawing Number 5110309/HW/GA/223	Date 12/04/13	Date 12/04/13	Date 12/04/13
Rev B				

DO NOT SCALE

A1
 0 10 100



CONTROL STRING	0.155	0.428	0.702	0.975	1.248	1.521	1.771	1.963	2.095	2.189	2.194	2.213	2.232	2.251	2.270	2.289	2.306	2.327	2.346	2.365	2.384	2.403	2.422	2.441	2.460	2.479	2.499	2.518	2.537	2.554	2.575	2.594	2.613	2.632	2.651	2.670	2.685	2.690	2.686	2.673	2.651	2.620	2.579	2.529	2.470	2.408	2.363	2.340	2.324	2.309	2.294
EXISTING LEVELS	0.156	0.430	0.703	0.976	1.247	1.492	1.662	1.755	1.779	1.833	2.054	2.209	2.288	2.294	2.250	2.333	2.301	2.257	2.290	2.258	2.267	2.299	2.341	2.356	2.356	2.337	2.363	2.368	2.354	2.309	2.351	2.397	2.434	2.462	2.522	2.598	2.537	2.538	2.528	2.504	2.485	2.472	2.448	2.423	2.398	2.375	2.358	2.340	2.325	2.309	2.294
HORIZONTAL	R=1481.299m		R=180.000m				R=127.000m				R=127.000m				R=360.000m				R=510.000m				R=1122.498m																												
VERTICAL	G=-2.732		R=1700.102m				G=0.191				R=10829.543m				G=0.150																																				
CHAINAGE	460.000	460.000	440.000	430.000	420.000	410.000	400.000	390.000	380.000	370.000	360.000	350.000	340.000	330.000	320.000	310.000	300.000	290.000	280.000	270.000	260.000	250.000	240.000	230.000	220.000	210.000	200.000	190.000	180.000	170.000	160.000	150.000	140.000	130.000	120.000	110.000	100.000	90.000	80.000	70.000	60.000	50.000	40.000	30.000	20.000	10.000	0.000				

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION			
IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS			
CONSTRUCTION			
MAINTENANCE/CLEANING			
USE			
DECOMMISSIONING/DEMOLITION			

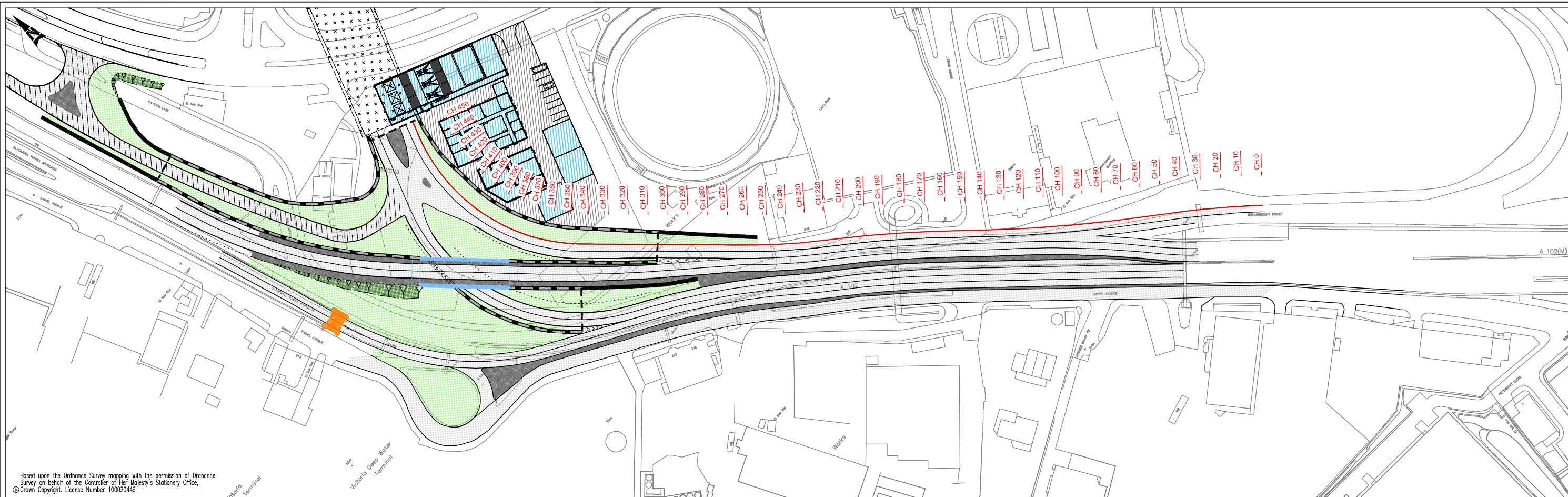
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P	A	FOR INFORMATION	SEE TITLE BLOCK	A	ORIGINAL ISSUE	SEE	SEE	TITLE BLOCK		
Stat	Rev	Purpose of Issue	Date	Auth	Rev	Description	By	Date	Chk'd	Auth

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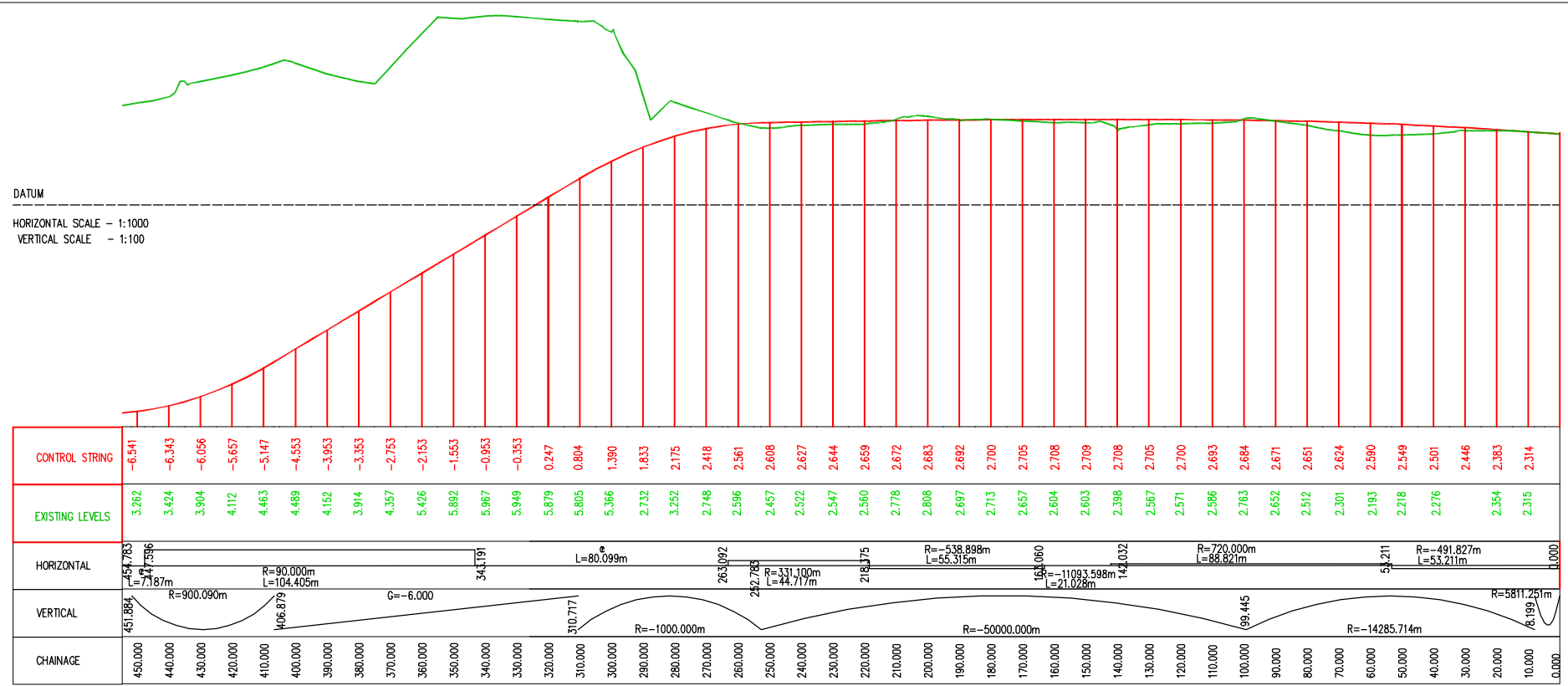
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Transport for London
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Title SOUTH 4A LONG-SECTION SHEET 2 OF 4			
Sheet Size A1	Original Scale 1:1000	Designed/Drawn DK	Checked MF
Status P	Drawing Number 5110309/HW/GA/224	Authorised PRM	Rev B

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CONSTRUCTION			
MAINTENANCE/CLEANING			
USE			
DECOMMISSIONING/DEMOLITION			

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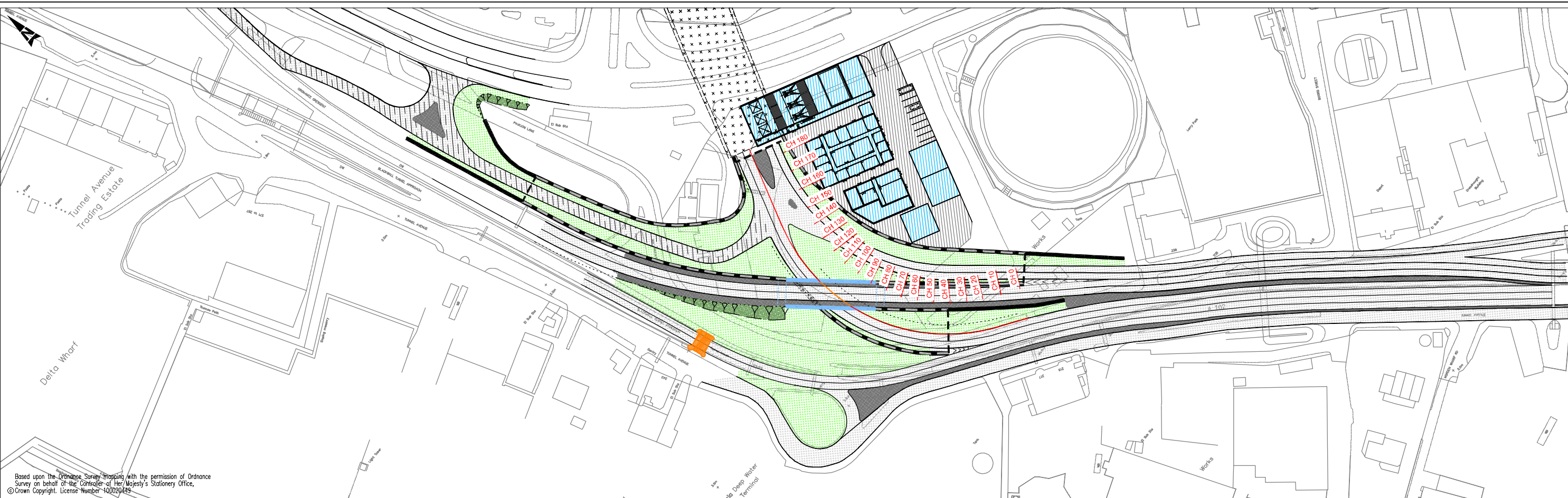
Client
Transport for London

Project
SILVERTOWN CROSSING - HIGHWAYS

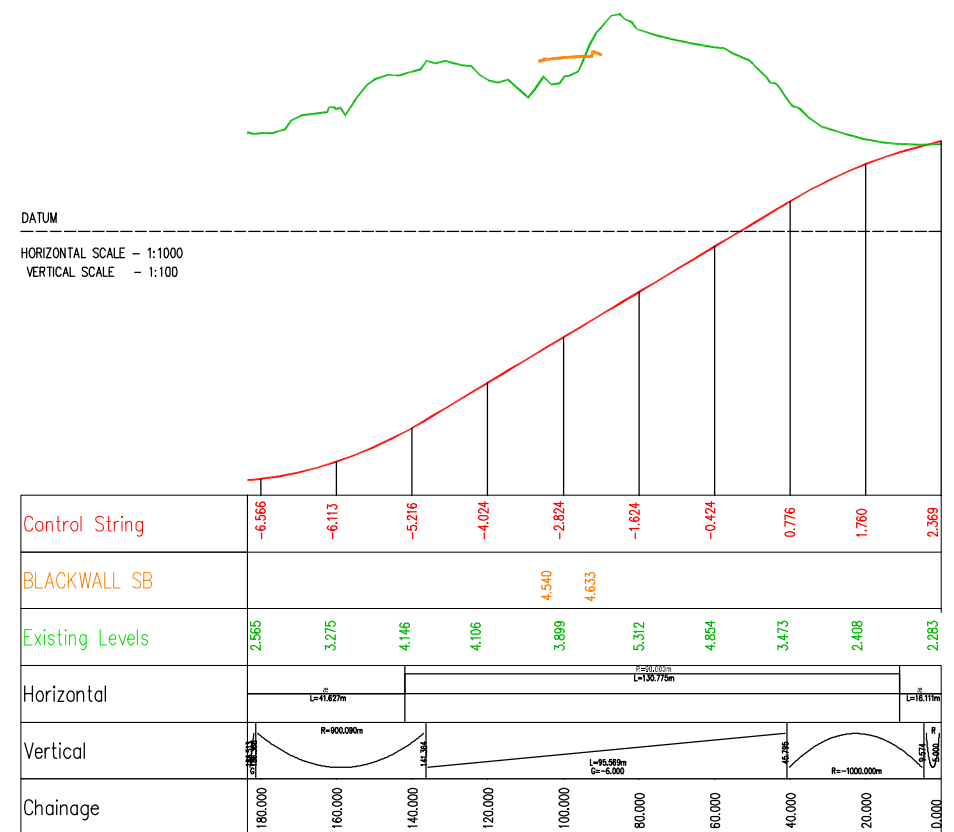
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P	A	FOR INFORMATION	SEE TITLE BLOCK	A		ORIGINAL ISSUE		SEE TITLE BLOCK		

Title SOUTH 4A LONG-SECTION SHEET 3 OF 4			
Sheet Size A1	Original Scale 1:1000	Designed/Drawn DK	Checked MF
Status P	Drawing Number 5110309/HW/GA/225	Authorized PRM	Rev B

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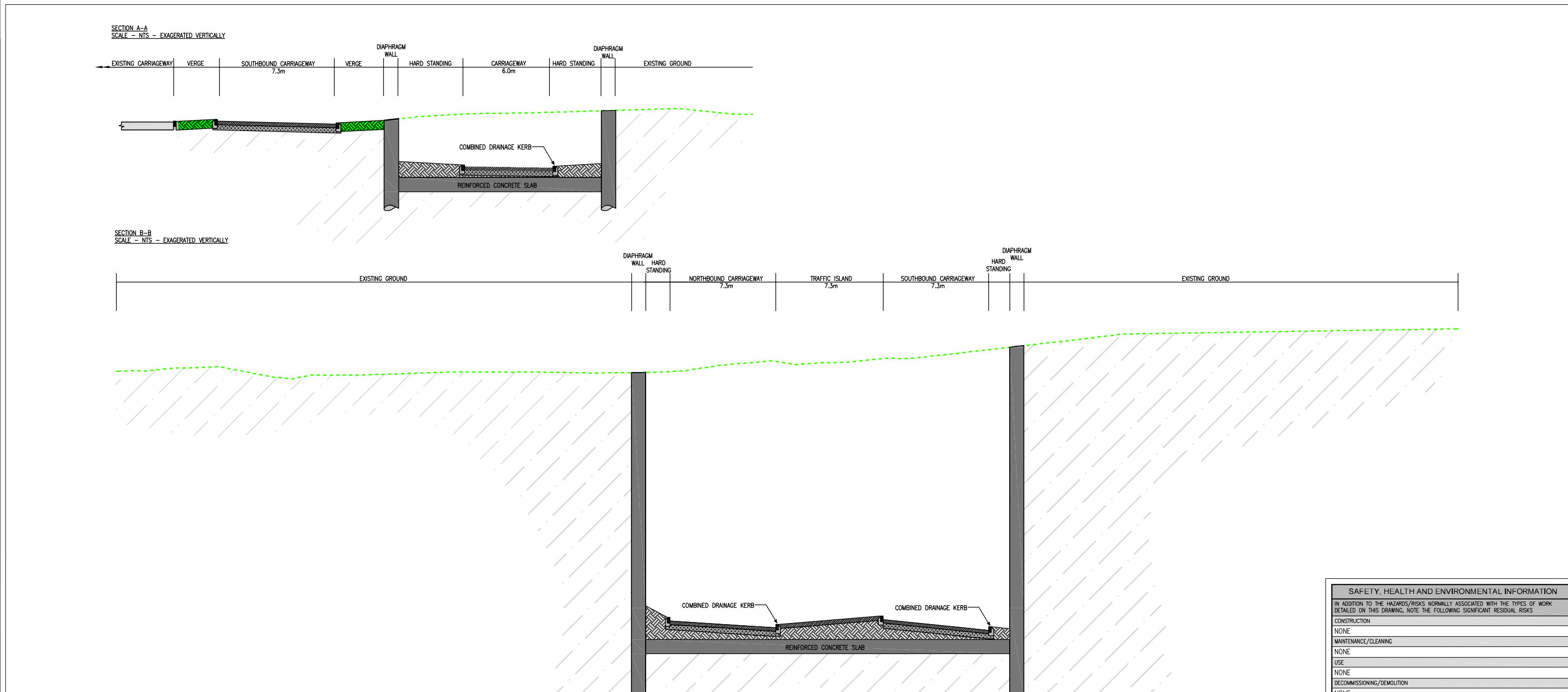
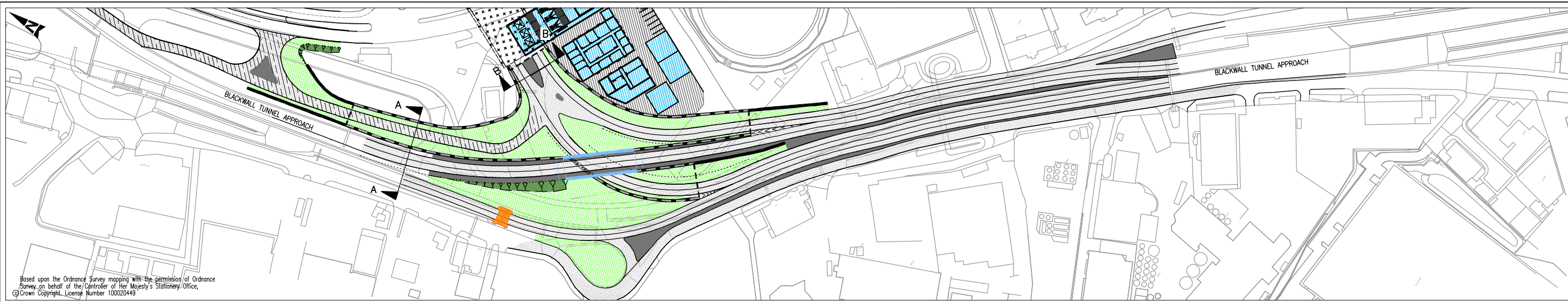
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION	
IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS	
CONSTRUCTION	
MAINTENANCE/CLEANING	
USE	
DECOMMISSIONING/DEMOLITION	

Stat	Rev	Purpose of Issue	Date	Auth	Rev	Description	By	Date	Chk'd	Auth
P	A	FOR INFORMATION	24/04/13	PRM	A	DESIGN AMENDED	DK	24/04/13	MF	PRM
P	A	FOR INFORMATION	SEE TITLE BLOCK	A		ORIGINAL ISSUE		SEE		TITLE BLOCK

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Title		SOUTH 4A LONG-SECTION SHEET 4 OF 4			
Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised	
A1	1:1000	DK	MF	PRM	
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					Rev
					B



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION			
IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS			
CONSTRUCTION	NONE		
MAINTENANCE/CLEANING	NONE		
USE	NONE		
DECOMMISSIONING/DEMOLITION	NONE		

NOTES :
 FOR DETAILS OF DIAPHRAGM WALL SEE THE MOTT MACDONALD REPORT - SILVERTOWN TUNNEL : FURTHER DEVELOPMENT OF TUNNEL ENGINEERING

Stat	Rev	Purpose of Issue	Date	Auth	Rev	Description	By	Date	Chk'd	Auth
P	B	FOR INFORMATION	24/04/13	PRM	B	AMENDED DESIGN	DK	24/04/13	MF	PRM
P	A	FOR INFORMATION	SEE TITLE BLOCK	A	ORIGINAL ISSUE	SEE TITLE BLOCK	SEE TITLE BLOCK			

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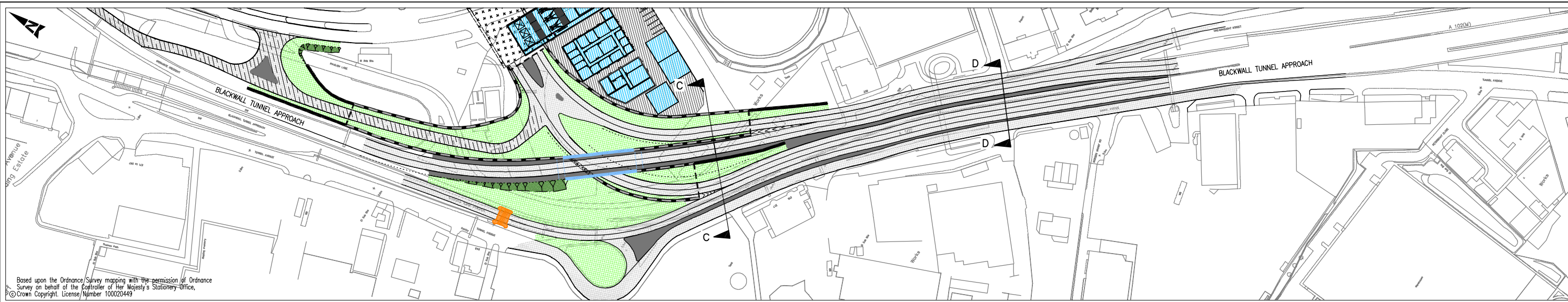
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SILVERTOWN CROSSING - HIGHWAYS

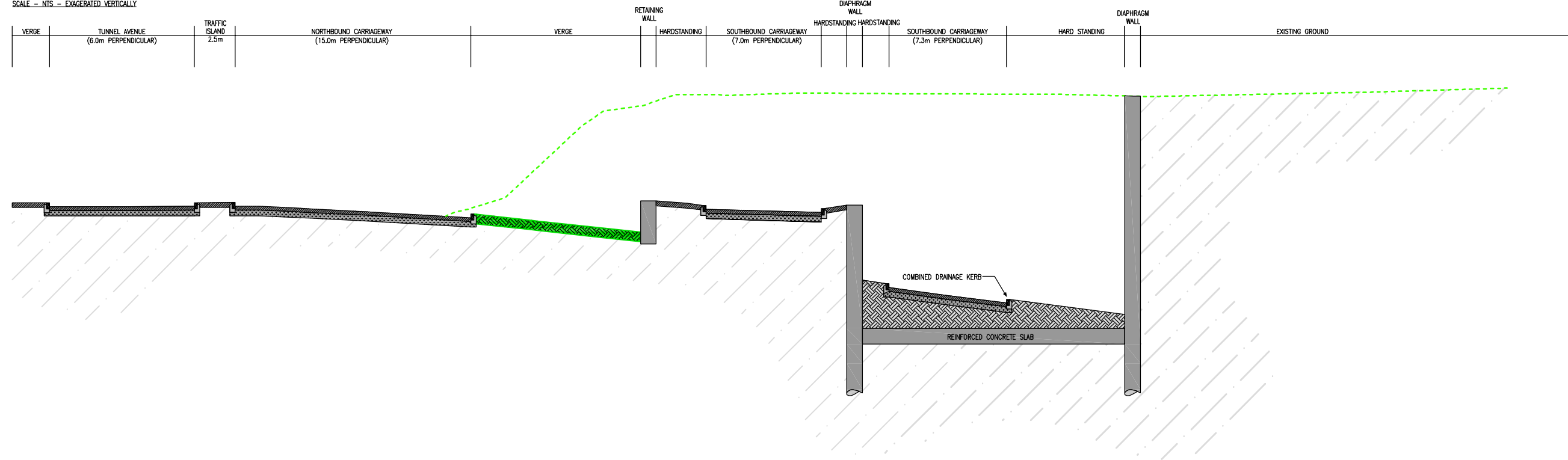
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P	5110309/HW/GA/227	12/04/13	12/03/13	12/04/13	B

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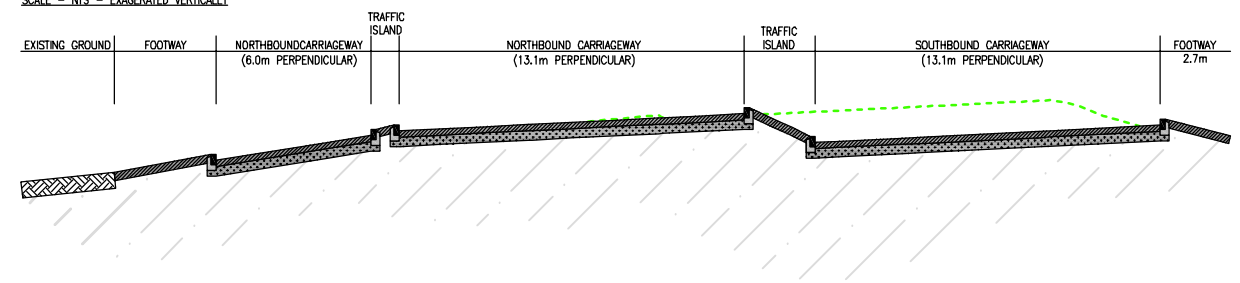


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SECTION C-C
 SCALE - NTS - EXAGGERATED VERTICALLY



SECTION D-D
 SCALE - NTS - EXAGGERATED VERTICALLY



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CONSTRUCTION	NONE		
MAINTENANCE/CLEANING	NONE		
USE	NONE		
DECOMMISSIONING/DEMOLITION	NONE		

NOTES :
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Stat	Rev	Purpose of Issue	Date	Auth	Rev	Description	By	Date	Chk'd	Auth
P	B	FOR INFORMATION	24/04/13	PRM	B	DESIGN AMENDED	DK	24/04/13	MF	PRM
P	A	FOR INFORMATION	SEE TITLE BLOCK	A	ORIGINAL ISSUE		SEE	TITLE BLOCK		

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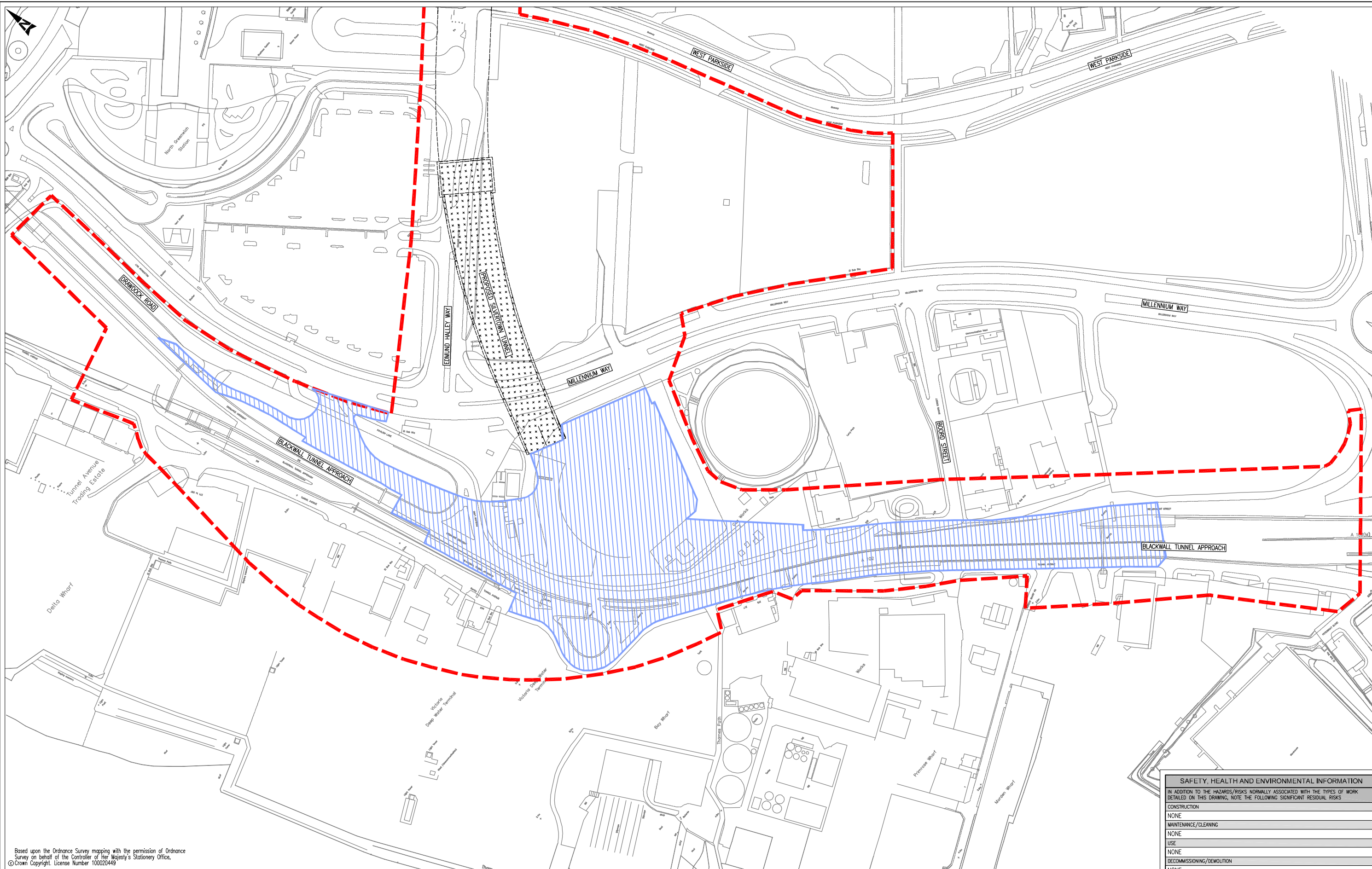
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Title		SOUTH 4A CROSS-SECTIONS SHEET 2 OF 2			
Sheet Size	Original Scale	Designed/Drawn SMC	Checked MJC	Authorised MF	
A1	1:1250	Date 15/04/12	Date 15/05/13	Date 15/05/13	
Status	Drawing Number			Rev	
P	5110309/HW/GA/228			B	

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KEY

	SAFEGUARDED CORRIDOR
	SCHEME FOOTPRINT INSIDE SAFEGUARDED CORRIDOR

Stat	Rev	Purpose of Issue	Date	Auth	Rev	Description
P	B	FOR INFORMATION	29/04/13	PRM	B	DESIGN AMENDED
P	A	FOR INFORMATION	SEE TITLE BLOCK	A	A	ORIGINAL ISSUE

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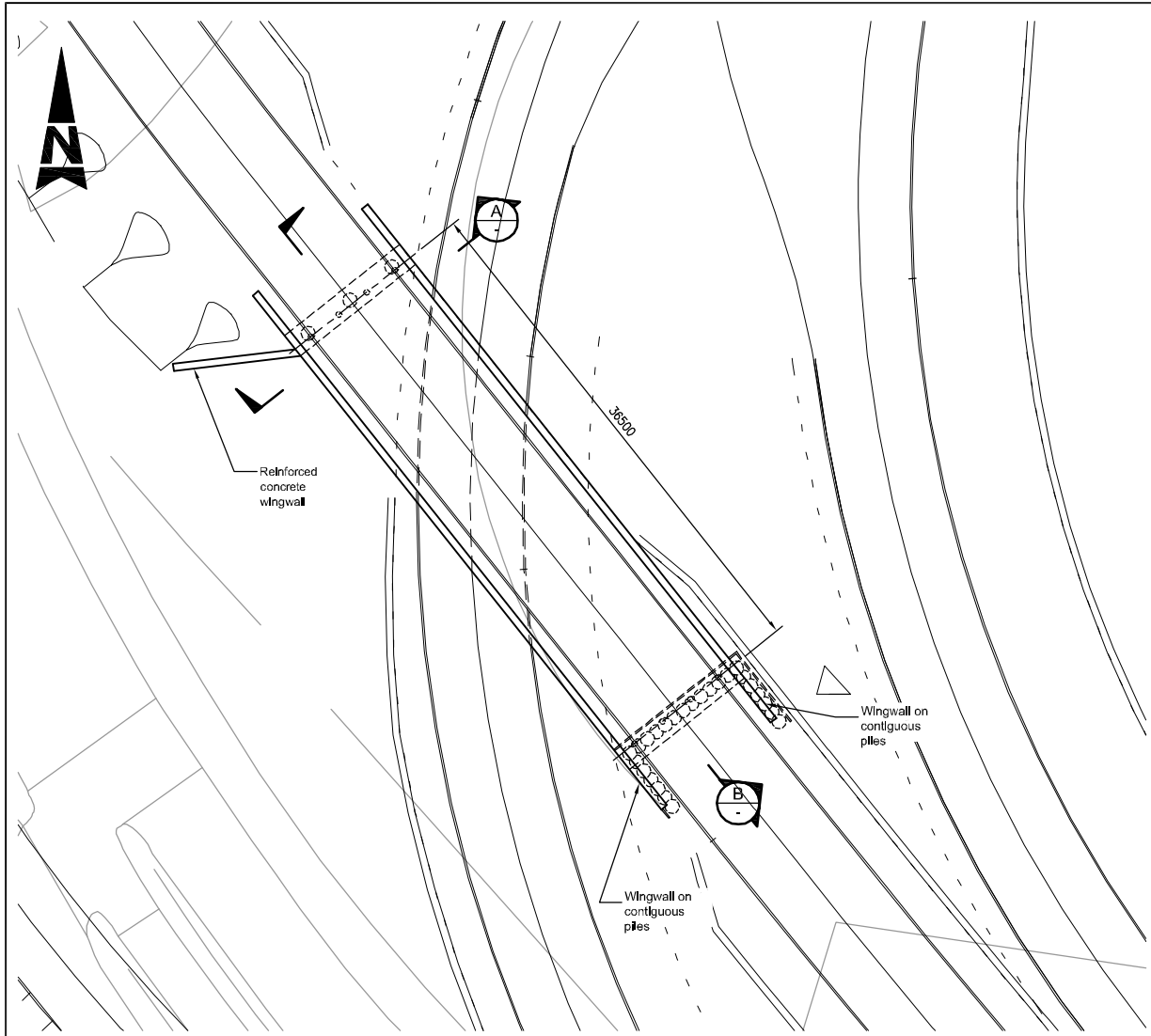
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS

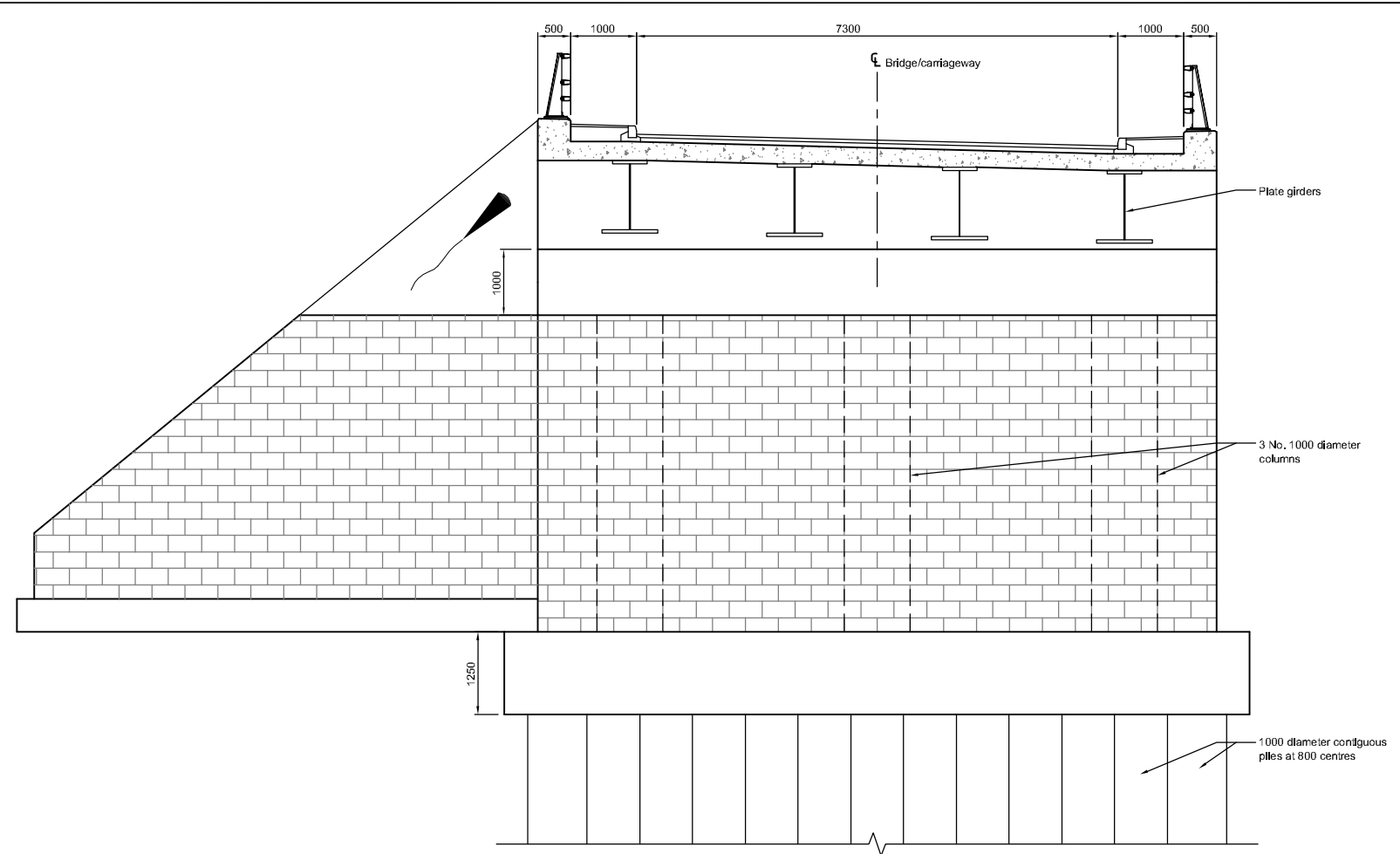
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MAINTENANCE/CLEANING	NONE
USE	NONE
DECOMMISSIONING/DEMOLITION	NONE

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Sheet Size A1	Original Scale 1:1250
Status P	Drawing Number 5110309/HW/GA/0229
Rev B	

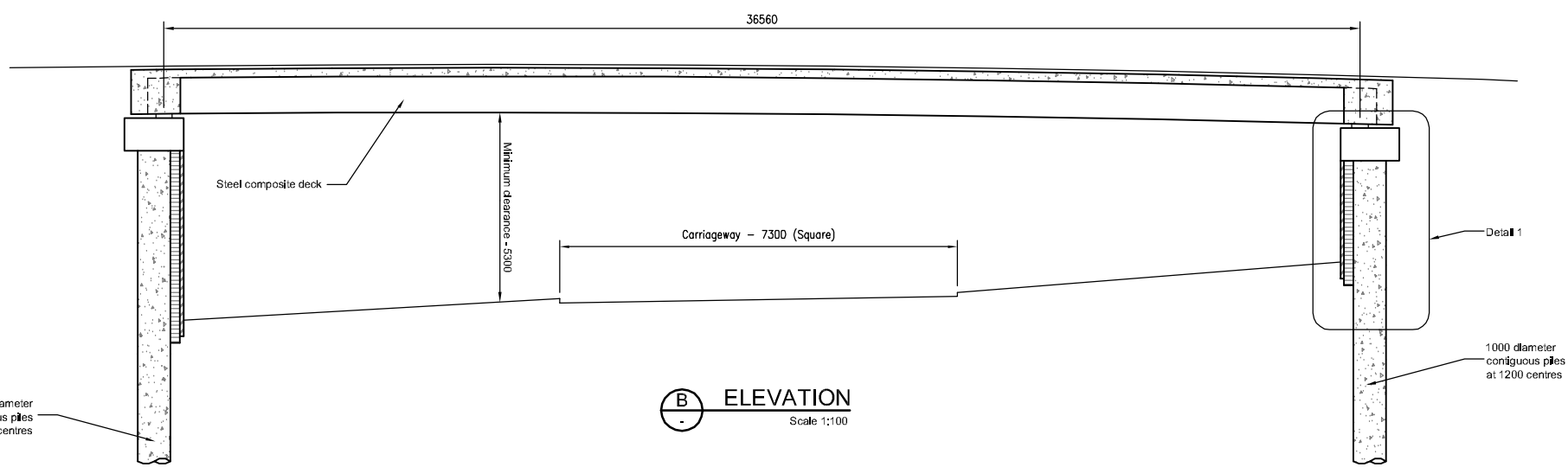
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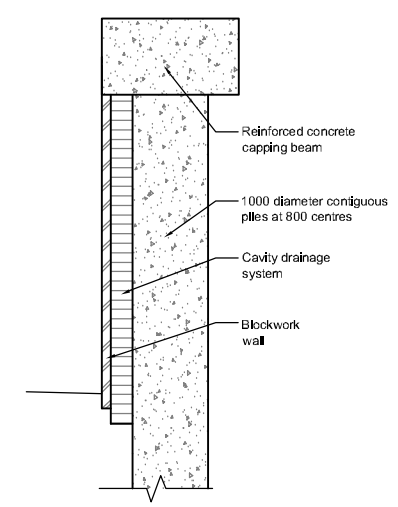
PLAN
Scale 1:250



A SECTION/ELEVATION
Scale 1:50



B ELEVATION
Scale 1:100



1 DETAIL
Scale 1:50

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CONSTRUCTION			
MAINTENANCE/CLEANING			
USE			
DECOMMISSIONING/DEMOLITION			

Stat	Rev	Purpose of Issue	Date	Auth	Rev	Description	By	Date	Chk'd	Auth
P	B	FOR INFORMATION	29/04/13	DM	B	MINIMUM CLEARANCE DIMENSIONS INCLUDED	DK	29/04/13	DM	DM
P	A	FOR INFORMATION	15/04/13	DM	A	ORIGINAL ISSUE	SEE	TITLE BLOCK		

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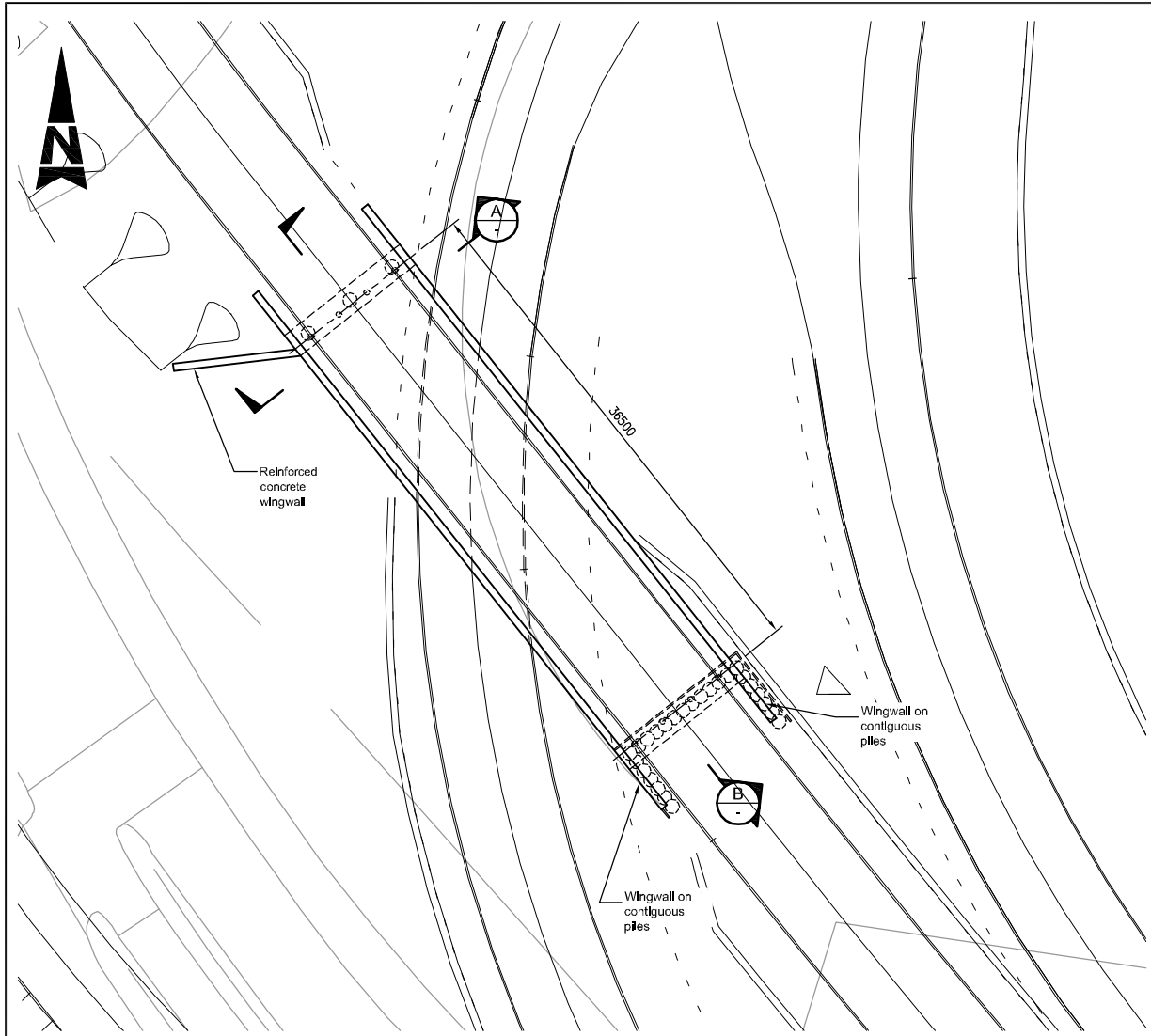
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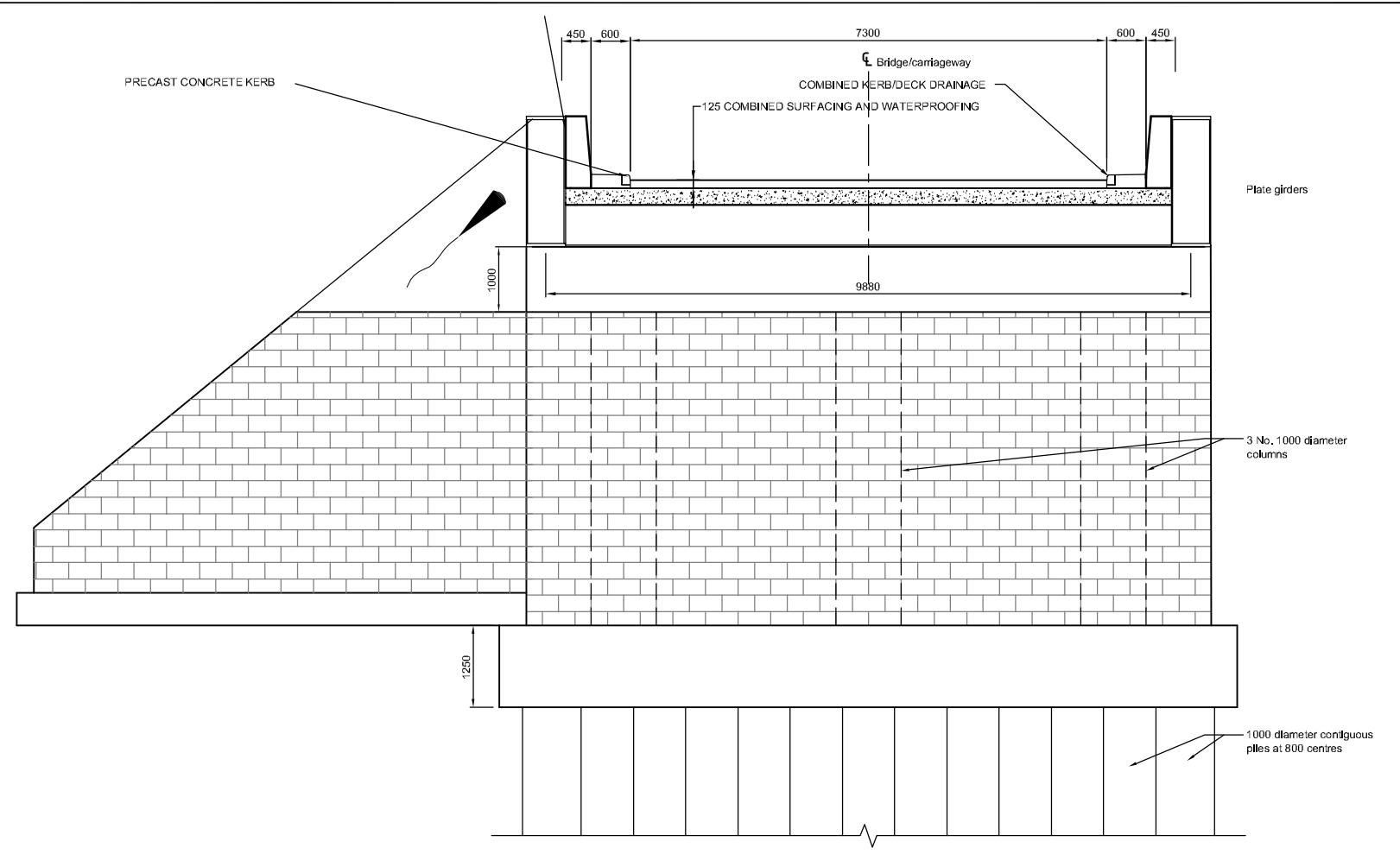
Project
SILVERTOWN CROSSING

Title		HIGHWAY BRIDGE GENERAL ARRANGEMENT OPTION 1			
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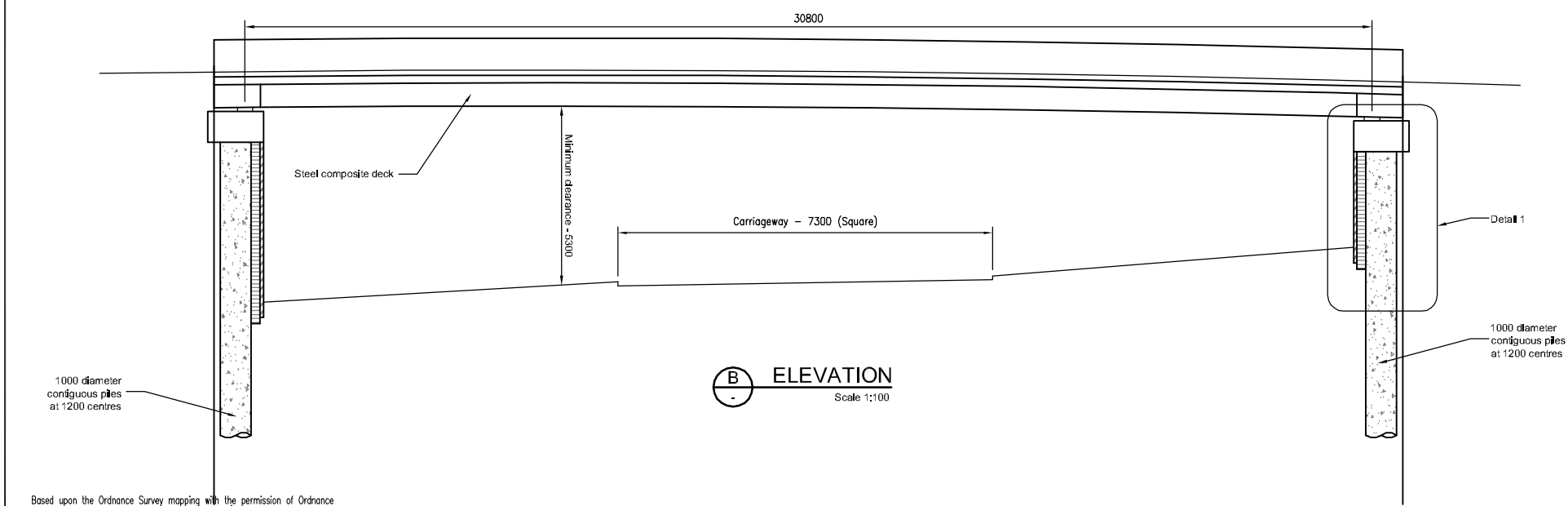
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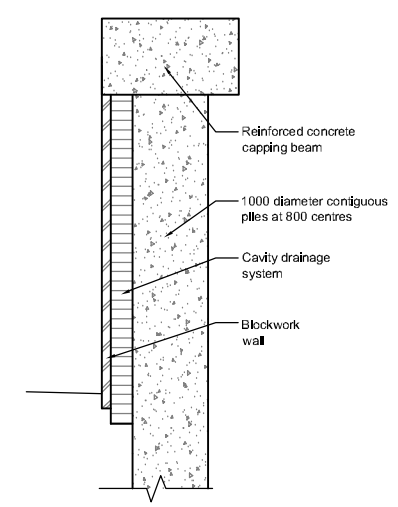
PLAN
Scale 1:250



A SECTION/ELEVATION
Scale 1:50



B ELEVATION
Scale 1:100



1 DETAIL
Scale 1:50

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CONSTRUCTION			
MAINTENANCE/CLEANING			
USE			
DECOMMISSIONING/DEMOLITION			

Stat	Rev	Purpose of Issue	Date	Auth	Rev	Description	By	Date	Chk'd	Auth
P	B	FOR INFORMATION	29/04/13	DM	B	MINIMUM CLEARANCE DIMENSIONS INCLUDED	DK	29/04/13	DM	DM
P	A	FOR INFORMATION	15/04/13	DM	A	ORIGINAL ISSUE	SEE	TITLE BLOCK		

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Transport for London

Project
SILVERTOWN CROSSING

Title HIGHWAY BRIDGE GENERAL ARRANGEMENT OPTION 2	
Sheet Size A1	Original Scale
Status P	Drawing Number 5110309/ST/GA/0236
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Appendix C: Geotechnical Conceptual Design Report

Geotechnical Conceptual Design Report

To:	Mike Frobel		
From:	Angela Bellis	Email:	Angela.bellis@atkinsglobal.com
Phone:	01223 81 4197	Date:	15 th April 2013
Ref:	5111977.600	cc:	
Subject:	<u>TfL Silvertown Crossing</u> : Geotechnical Conceptual Design		

The TfL Silvertown Crossing scheme will involve the construction of a tunnel to cross the River Thames and which will require new highway road alignments at the northern and southern tunnel portals to allow integration of the proposed works to the existing highway network.

Following consideration of various highway alignments TfL has instructed Atkins to undertake conceptual design for options South 4, North 5A and North 5B and also consider the design for an additional option for the south site. The additional south site option is to follow the same principles as per South 4 however the alignment shall not be constrained by the highway boundary on the western side of the A102 so as to result in a straighter highway alignment. Therefore, the main geotechnical aspects of this additional option will remain the same as per option South 4. Option South 4 has two versions one with and one without a bus link from Millennium Way to Silvertown Tunnel.

It should be noted that as part of southern site options the Footbridge in the vicinity of Boord Street will be re-located, however the foundation design will not form part of this conceptual design submission.

The geotechnical design aspects required as part of each option are as follows:

- South 4 without bus link (see Drawing No. 5110309/HW/GA/0107)
 - Earthworks – Major conventional cutting slopes are proposed between the tunnel south portal and proposed bridge. A relatively low rise approach embankment is also proposed west of the bridge.
 - Bridge foundations – Piled foundations are proposed at the bridge abutments.
 - Retaining walls – Due to land take restrictions retaining walls are proposed to support the eastern bridge approach embankment.
- South 4 with bus link (see Drawing No. 5110309/HW/GA/0103)
 - Earthworks – A major conventional cutting slope is proposed between the tunnel south portal and proposed bridge. The cutting west of the portal extends towards the western end of the proposed junction to allow the construction of the bus link.

In addition a relatively low rise conventional embankment slope is proposed south of the western bridge approach embankment.

- Bridge foundations – Piled foundations are proposed at the bridge abutments.
- Retaining walls – Due to land take restrictions retaining walls are proposed to support the eastern bridge approach embankment and the north side of the western approach embankment.
- North 5A (see Drawing No. 5110309/HW/GA/0207)
 - Earthworks – A major cutting slope is required directly west of the tunnel north portal. Relatively minor cuttings and embankments are required along the proposed road to connect Dock road to the new roundabout that runs parallel to the Docklands light railway line. Further earthworks in the form of a cutting and embankment are proposed along the road proposed to allow connection between the new roundabout and Lower Lea Crossing road.
 - Retaining Walls – A major retaining wall is proposed along the eastern boundary of the proposed works that will extend between the tunnel north portal and new roundabout. A relatively short retaining wall is also proposed to the west of the new roundabout.
- North 5B (see Drawing No. 5110309/HW/GA/0208)
 - Earthworks – Major cutting slopes are required at the tunnel north portal. Relatively minor cuttings and embankments are required along the proposed road to connect Dock road to the new roundabout that runs parallel to the Docklands light railway line. Further earthworks in the form of a cutting and embankment are proposed along the road proposed to allow connection between the new roundabout and Lower Lea Crossing road.
 - Retaining Walls – A retaining wall is proposed along the western side of the new roundabout.

The following sections summarise conceptual design information relating to the geotechnical aspects required as part of each of the highway alignment options, South 4 without bus link, South 4 with bus link, North 5A and North 5B.

1. South 4 Earthworks - with and without bus link

1.1. Earthworks

Figure 1 below shows the earthworks considered in the conceptual design for option South 4 without bus link. The maximum cutting depth of EWK/S1 and EWK/S2 is 10m and 7.5m respectively, whilst the maximum embankment height of EWK/S3 is 2.5m.

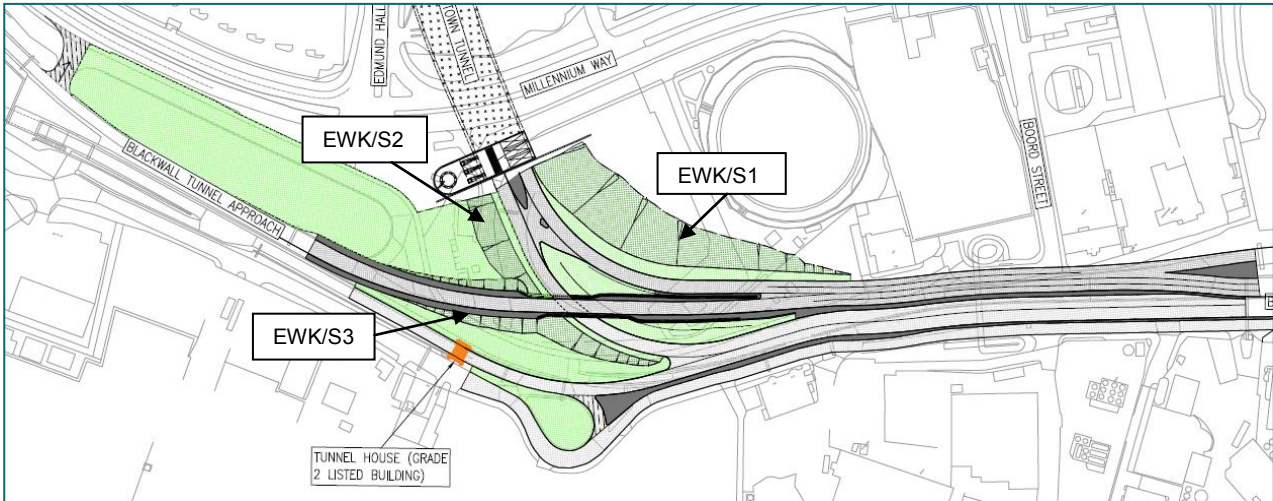


Figure 1 – Earthworks at South 4 without bus link

Figure 2 below shows the additional earthworks considered in the conceptual design for option South 4 with bus link. The maximum cutting depth of EWK/S4 is 7.5m and the maximum embankment height of EWK/S5 is 1.5m.



Figure 2 – Earthworks at South 4 with bus link

1.2. Ground Conditions

During the conceptual design stage the exploratory holes available directly within the extents of the proposed earthworks, were the BGS historical exploratory holes. These exploratory holes were reviewed to allow the determination of the ground model along each earthwork.

The available BGS historical exploratory holes recorded the presence of Made Ground, Alluvium, River Terrace Deposits and London Clay within the extents of the proposed earthworks.

In general the Made Ground was found to comprise granular and cohesive materials. The Made Ground of granular consistency was described as light brown / dark grey clayey Sand with some

angular to sub-angular gravel sized fragments of brick, concrete and flint or as Fill of concrete, ash and sand. The cohesive portion of the Made Ground was described as soft to firm light brown sandy Clay with some angular to sub-rounded gravel sized fragments of brick, concrete and flint. The maximum recorded depth of this material was 5m below existing ground level.

The Alluvium was typically described as soft to firm dark grey Clay with occasional small pockets of peat and soft dark brown clayey Peat. The Alluvium deposits were recorded to underlay the Made Ground and extend typically between 4.2m and 6.5m below existing ground level with a thickness variation between 1m and 5m.

The River Terrace Deposits were found to underlay the Alluvium and were typically described as medium dense to dense light brown sub-angular to rounded sandy Gravel. This material was recorded to extend typically between 10.7m and 11.7m below existing ground level with a thickness variation between 5.1m and 7.4m.

London Clay was found to underlay the layer of River Terrace Deposits and was typically described as grey to blue very stiff fissured silty Clay. The thickness of this material was proven to vary between 3.3m and 13m, with the base varying between 14m and 25m below existing ground level.

All soils encountered beneath the London Clay layer were not examined further as they were beyond the influence depth of the proposed earthworks.

The exploratory holes recorded the groundwater level to vary between 1.5mbegl (0.5m AoD) and 4.5mbegl (-1.4m AoD). It should be noted that hydraulic continuity occurs between River Thames and the site through the River Terrace Deposits and therefore the groundwater level is expected to be influenced by the river level fluctuations.

1.3. Design Assumptions

The following assumptions were considered to allow the earthworks conceptual design:

- Design undertaken based on Eurocode 7
- All proposed earthwork slopes are to be constructed with a slope gradient of 1V:3H;
- Embankment fill to comprise general Class 1/2 fill material;
- For embankments a uniformly distributed loading of 20kPa was applied across the carriageway to simulate traffic loading and a uniformly distributed loading of 10kPa was applied across the proposed verge to simulate future maintenance loading. In the case of cuttings a uniformly distributed loading of 10kPa was applied across the crest to simulate future maintenance loading;
- It was assumed that a 1.5m deep toe drain will be provided along the proposed cut slopes.

1.4. Analysis Outcomes

As mentioned in section 1.2 the ground models were based on the available BGS historical exploratory holes and therefore the testing available for the in-situ materials was limited to Standard Penetration Test (SPT) results. General Atterberg Limit and Particle Size Distribution test result ranges were provided within the Mott Macdonald Geotechnical Desk Study Report for the New Thames River Crossings, which summarised the information from exploratory holes undertaken approximately 500m north of the site under consideration.

The stability and settlement analysis undertaken indicated the following:

- **EWK/S1** – The available historical exploratory holes within the extents of this slope indicated that the slope will most likely be formed within granular deposits and the analysis showed that a satisfactory design factor against slope instability will be achieved for a 1V:3H, 10m deep cutting slope. Due to the presence of highly permeable River Terrace Deposits at the lower slope part and high ground water level it is likely that slope drains will be required to ensure stability.

One of the exploratory holes located approximately 15m south of the southern slope end (earthwork shallower end) indicated the presence of very soft to soft Made Ground and Alluvium. An additional analysis undertaken for the southern slope end (up to 5m deep) indicated that it will not be possible to form 1V:3H slopes within the upper very soft deposits.

- **EWK/S2** – The analysis indicated that it will not be possible to form a 1V:3H slope profile within the upper part of the slope where Alluvium and Peat deposits are expected. The Peat layer was recorded to be up to 1.7m thick. It will be necessary to form a slacker slope profile within the Alluvium and Peat deposits or over-excavate and place high frictional material against these low frictional deposits. Due to the presence of highly permeable River Terrace Deposits at the lower slope part and high ground water level it is likely that slope drains will be required to ensure stability.
- **EWK/S3** – The analysis indicated that there are no stability issues for the proposed embankment with a slope gradient of 1V:3H when using Class1 or Class 2 fill with a minimum $\Phi' = 26$ degrees. The total settlement for this earthwork is anticipated to be less than 100mm. The available exploratory hole did not indicate the presence of any soft deposits within the earthwork footprint and therefore no improvement works are likely to be required.
- **EWK/S4** – The analysis indicated that it may not be possible to form a 1V:3H slope profile within the upper part of the slope where very soft to soft organic Alluvium is expected. It will be necessary to form slacker slope profile within the softened Alluvium deposits or over-excavate and place high frictional material against these low frictional deposits. Due to the presence of highly permeable River Terrace Deposits at the lower slope part and high ground water level it is likely that slope drains will be required to ensure stability.
- **EWK/S5** – The analysis indicated that there are no stability issues for the proposed embankment slope with a slope gradient of 1V:3H and using Class1 or Class 2 with a minimum $\Phi' = 26$ degrees. The total settlement for this earthwork is anticipated to be less than 100mm. The available exploratory hole did not indicate the presence of any soft deposits at shallow depth beneath the earthwork footprint and therefore no improvement works are likely to be required.

1.5. Design / Construction Issues

As part of options South 4 with and without bus link, deep cuttings are proposed to allow continuation between the tunnel south portal and highway network. Following the review of the available exploratory holes it was concluded that high ground water level exists at the site that is hydraulically connected to River Thames through the River Terrace Deposits.

The stability analysis undertaken highlighted that slope drains will be required to ensure stability against continual seepage.

The presence of continual seepage also raises issues relating to permanent pumping requirements, dealing with potentially contaminated ground water that also leads to health and safety issues of the maintenance personnel.

Due to the above mentioned issues it was decided to propose the construction of water tight retaining walls instead of conventional cutting slopes. The proposal of this alternative option has the following advantages:

- Retention of greater area of land for use for development or tunnel infrastructure purposes;
- Reduction of material volume to be excavated and disposed of site. It should be noted that there is a strong possibility of significantly contaminated soils to be present on site which will result in expensive disposal costs. The reduction of material volume to be disposed of will also result in less environmental impact in terms of lorry movements;
- Some remediation has been carried out in the area but details have not yet been obtained. These may have included cut off walls within the ground which could be compromised by the cutting slope construction;
- Minimise volume of potentially contaminated groundwater that must be dealt with (potentially pumped) at the tunnel portal. The presence of high ground water level and high permeability soils will result in continual seepage within the slope faces that can lead to instability. To prevent instability, slope drains will be required and groundwater will drain into the road drainage and mix with surface water drainage resulting in further increased water volume to be dealt with. The use of retaining walls will have the advantage of acting as a cut off for groundwater when the wall penetrates London Clay (which underlies the Made Ground and River Terrace Deposits). This will act to minimise the seepage into the road-box construction;
- Temporary works involving dewatering are likely to be reduced.

The construction of a retaining wall option will have the following disadvantages:

- High initial construction costs. In order to reap the benefits of the retaining wall it is likely that it will need to be designed to withstand water pressures and to exclude water which also adds to the cost of the wall option;
- Require structural inspections;

- Construction programme could be longer (however the plant for retaining wall construction would be on site for construction of other parts of the project).

Overall the advantages of using retaining walls appear to significantly outweigh those of earthworks cutting slopes. In addition it gives more surety on cost and design with the information available at this stage in the project.

Therefore, the additional southern site option (option South 4A) that aimed for a straighter road alignment on the western side of the A102, will also involve the provision of retaining walls.

2. South 4A Earthworks

As discussed in section 1.5, it is preferable to construct water tight retaining walls instead of conventional earthwork cutting slopes to eliminate the issues associated to high ground water levels and highly permeable deposits.

Figure 3 below shows the proposed earthworks involved as part of option South 4A. EWK/S1A is as per EWK/S3 of option South 4 and earthwork EWK/S2A is as per earthwork EWK/S5 of option South 4. The stability and settlement analysis undertaken for these earthworks indicated that there are no slope stability issues for the proposed embankment slopes to be formed with a slope gradient of 1V:3H and using Class1 or Class 2 (with a minimum $\Phi' = 26$ degrees). The total settlement for these earthworks is anticipated to be less than 100mm.



Figure 3 – Earthworks at South 4A

3. South 4A Structures

Option South 4A involves the construction of retaining walls instead of conventional earthwork cut slopes and therefore three additional retaining walls are proposed in comparison to Option 4 with and without bus link.

The available relevant exploratory holes recorded the presence of Made Ground that was described as sandy Clay and clayey Sand. The thickness of this material was found to vary

between 2.5m and 5m. The Made Ground was found to overly up to 2m thick layer of Alluvium that was described as soft organic Clay / soft Peat. The Alluvium overlies 6m of River Terrace Deposits that are described as medium dense to dense slightly sandy to very sandy Gravel. The exploratory holes recorded London Clay to underlie the River Terrace Deposits. The London Clay layer was described as very stiff fissured silty and sandy Clay and was found to extend up to 10m below the River Terrace Deposits. The maximum recorded groundwater level was 0m AoD, which coincides approximately with the base of the Made Ground material.

3.1. Bridge Foundations

The bridge foundations are proposed to comprise water tight structures as with the retaining walls to avoid any water seepages and therefore to be incorporated within the overall curtain cut off wall. The curtain cut off wall is discussed in more detail under section 6 of this report.

The conceptual design was undertaken based on preliminary loadings derived for an integral bridge deck construction and ground conditions summarised above. The analysis undertaken indicated the following:

- South abutment: secant piles 1m diameter installed by Continuous Flight Auger (CFA) in a row of 10m width up to capping beam elevation integral with bridge. The total length of the piles provisionally 18m (12m embedment length and 6m retained height).
- North abutment: secant piles 1m diameter installed by CFA in a row 10m width (12m embedded length with an additional 2.5m to the pile cap above design groundwater elevation. Total length of proposed piles provisionally 14.5m. Sleeved piles are proposed supporting the integral bridge deck to be constructed above the secant pile cap inside a Reinforced Earth wall.

It is proposed that rectangular steel reinforcement cages are adopted to eliminate risk of the auger blade damaging the installed cages during construction of adjacent piles.

3.2. Retaining Walls

The retaining walls proposed at the southern tunnel portal are to be designed by the tunnel Designer (Mott Macdonald). To ensure that the risk of significant groundwater seepage is eliminated at the tunnel portal area it is proposed that the toe of these retaining walls extend into the London Clay that underlies the River Terrace Deposits and that a wall/barrier is provided underneath the portal to ensure continuation of the overall curtain cut off wall.

The analysis undertaken for the retaining walls indicated the following:

- South approach to the south bridge - CFA secant pile or diaphragm walls with the final method to be decided on practicality, price and risks associated with each option. These walls are proposed as continuous with the bridge foundations as part of a curtain groundwater cut-off to the portal. The retained height is considered to be around a maximum of 6.8m. Width/diameter of piles/walls 1m and maximum depth of 16m next to the bridge abutments. The length reduces to 1m penetration into London Clay or around 12m length as the retained height reduces but also ensuring that the requirement to form part of the cut-off continues. Where the carriageway rises above

design maximum groundwater elevation (around 0m AOD to 1.0m AOD) the retained height governs the pile/wall length which may be up to 5m.

- North approach to south bridge - A Reinforced Earth (RE) wall is proposed underneath the bridge and along the east side above the bus lane. Due to the presence of soft Alluvium at depth beneath the footprint of the reinforced earth wall, improvements works in the form of stone columns may be required to eliminate differential settlements. On the west side an embankment slope is proposed. Facing style (blocks/panels) and type of reinforcement (geo-grid/ steel reinforcement to be determined based on Client/Supplier requirements. The reinforcement length is expected to be 4m to 6m with an approximate vertical spacing of 400mm.

4. North 5A & 5B Earthworks

4.1. Earthworks

Figure 3 below shows the earthworks considered in the conceptual design for option North 5A. The maximum cutting depths and embankment heights are as follows:

- Maximum embankment heights: EWK/N1 = 1.5m, EWK/N4 = 0.8m and EWK/N6 = 0.7m;
- Maximum cutting depths: EWK/N2 = 3.0m, EWK/N3 = 1.5m, EWK/N5 = 1.0m and EWK/N7= 9.2m.

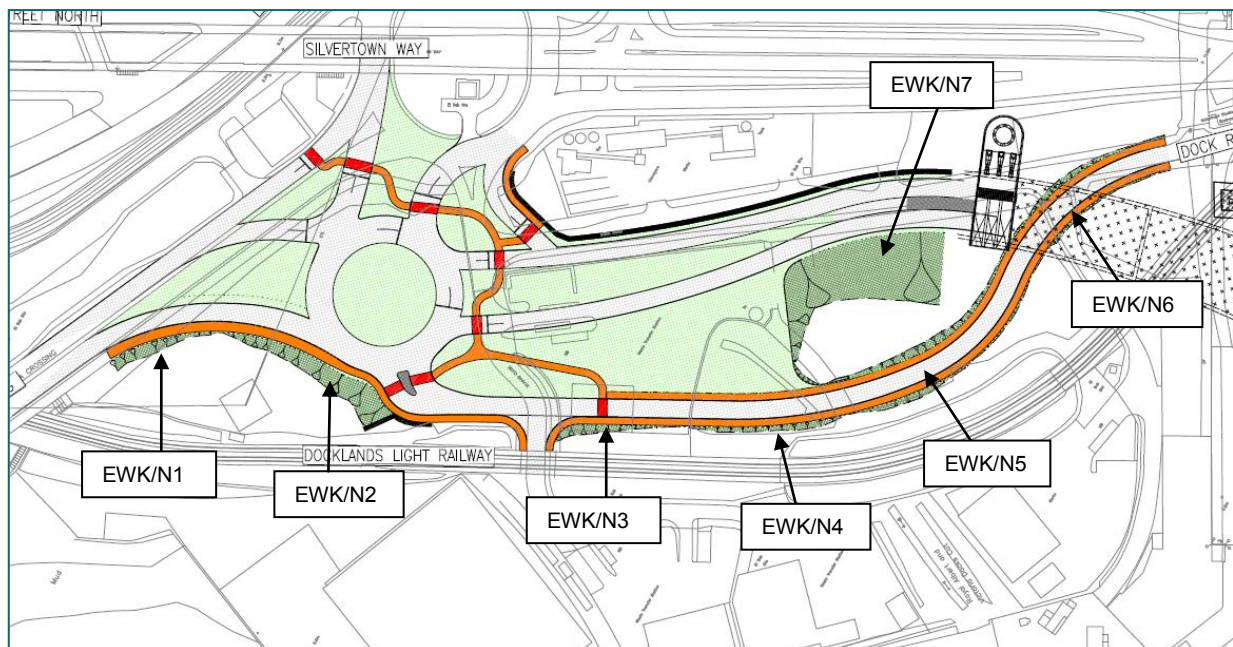


Figure 4 – Earthworks at North 5A

Figure 4 below shows the additional earthwork considered in the conceptual design for option North 5B. The maximum cutting depth of EWK/N8 is 5.5m.



Figure 5 – Earthworks at North 5B

4.2. Ground Conditions

During the conceptual design stage the exploratory holes available directly within the extents of the proposed earthworks, were the BGS historical exploratory holes. These exploratory holes were reviewed to allow the determination of the ground model along each earthwork.

The relevant BGS historical exploratory holes recorded the presence of Made Ground, Alluvium, River Terrace Deposits and London Clay within the extents of the proposed earthworks.

The Made Ground was mainly found to comprise cohesive material that was described as soft to firm brown and grey silty sandy Clay with some angular to sub-rounded gravel sized fragments of brick, chalk, concrete and flint. The maximum recorded depth of this material was 5.1m below existing ground level. Some of the exploratory holes recorded this material as Fill of ash, brick and gravel.

The Alluvium was typically described as soft to firm grey brown silty Clay with occasional organic debris. The Alluvium deposits were recorded to underlay the Made Ground and extend typically between 3.8m and 6.5m below existing ground level with a thickness variation between 1.4m and 3.5m.

The River Terrace Deposits were found to underlay the Alluvium and were typically described as loose to dense brown and grey sub-angular to rounded sandy Gravel. This material was recorded to extend typically between 7m and 9.8m below existing ground level with a thickness variation between 2.3m and 4.3m.

London Clay was found to underlay the layer of River Terrace Deposits and was typically described as grey brown stiff to very stiff fissured silty Clay. The thickness of this material was proven to vary between 13.5m and 18.5m with the base varying between 21.5m and 27.7m below existing ground level.

All soils encountered beneath the London Clay were not examined further as they were beyond the influence depth of the proposed earthworks.

The exploratory holes recorded the groundwater level to vary between 1.8m and 4.8m below existing ground level (-1.3m AoD to -0.35m AoD). It should be noted that hydraulic continuity occurs between River Thames and the site through the River Terrace Deposits and therefore the groundwater level is expected to be influenced by the river level fluctuations.

4.3. Design Assumptions

The following assumptions were considered to allow the earthworks conceptual design:

- Design undertaken based on Eurocode 7
- All proposed earthwork slopes are to be constructed with a slope gradient of 1V:3H;
- Embankment fill to comprise general Class 1/2 fill material;
- For embankments a uniformly distributed loading of 20kPa was applied across the carriageway to simulate traffic loading and a uniformly distributed loading of 10kPa was applied across the proposed verge to simulate future maintenance loading. In case of the cuttings a uniformly distributed loading of 10kPa was applied across the crest to simulate future maintenance loading;
- It was assumed that a 1.5m deep toe drain will be provided along the proposed cut slopes.

4.4. Analysis Outcomes

As mentioned in section 4.2 the ground models were based on the available BGS historical exploratory holes and therefore the testing available for the in-situ materials was limited to SPT results. General Atterberg Limit and Particle Size Distribution test result ranges were provided within the Mott Macdonald Geotechnical Desk Study Report for the New Thames River Crossings, which summarised the information from exploratory holes undertaken approximately 50m south of the southern boundary of the site under consideration (300m south-east from the site centre).

The stability and settlement analysis undertaken indicated the following:

- **EWK/N1, EWK/N4 and EWK/N6** – the analysis indicated that there are no stability issues for the proposed embankments with a slope gradient of 1V:3H and using Class 1 or Class 2 with a minimum $\Phi' = 26$ degrees. The total settlements for these earthworks are anticipated to be less than 100mm. The available exploratory holes did not indicate the presence of soft deposits at shallow depth beneath the earthwork footprint and therefore no improvement works will be required.
- **EWK/N2** – the analysis indicated that in general the slope will be possible to be constructed with the proposed slope gradient of 1V:3H, however treatment will be locally required where very soft Alluvium is encountered within the slope face. The treatment may be in the form of over-excavating and placing high frictional material against these low frictional deposits.
- **EWK/N3 and EWK/N5** – the analysis indicated that there are no stability issues for the proposed cut slopes.

- **EWK/7 and EWK/8** – The analysis indicated that it will be possible to form the cutting slopes with a gradient of 1V:3H provided that relatively low PI (<40%) cohesive materials are encountered. Due to the presence of highly permeable River Terrace Deposits at the lower part of the slope and high ground water level it is likely that slope drains will be required to ensure stability.

4.5. Design / Construction Issues

As part of options North 5A and 5B, deep cuttings are proposed to allow continuation between the tunnel northern portal and highway network. Following the review of the available exploratory holes it was concluded that high ground water level exists at the site that is hydraulically connected to the River Thames through the River Terrace Deposits and the same design /construction issues apply as for South 4 with and without bus link options, which are discussed in detail under section 1.5.

Therefore, it is preferred to construct water tight retaining walls at the area of the tunnel portal instead of conventional earthworks so as to minimise contamination risks, excavation volumes, pumping requirements and instability risks due to continual seepage. These revised proposed works will form option North 5C.

5. North 5C Earthworks

As discussed in section 5.5, it is preferable to construct water tight retaining walls instead of conventional earthwork cutting slopes to eliminate the issues associated with high ground water levels and highly permeable deposits.

Figure 6 below shows the proposed earthworks involved as part of option North 5C. The majority of earthworks along the proposed Dock Road remain similar as per the earthworks proposed for North 5A and 5B with the exception of earthworks EWK/N3C (2m deep cutting) and EWK/N4C (3.5m high embankment).



Figure 6 – Earthworks at North 5C

The analysis outcomes summarised for EWK/N1, EWK/N2, EWK/N5 and EWK/N6 under section 5.4 are still applicable. Further analysis undertaken for EWK/N3C and EWK/N4C indicated that there are no stability issues for the currently proposed 1V:3H slopes.

5.1. Retaining Walls

The retaining walls proposed at the northern tunnel portal are to be designed by the Tunnel Designer (Mott Macdonald). To ensure that there will be no significant issues with water seepage at the tunnel portal area it is proposed that the toe of these retaining walls extend into the London Clay that underlies the River Terrace Deposits and that a wall/barrier is provided underneath the portal to ensure continuation of the overall curtain cut off wall.

A retaining wall (RW/N1C in Figure 6) is proposed west of the Docklands Light Railway bridge with a maximum retained height of 3m. The relevant historical exploratory hole indicated Made Ground (ash, brick and gravel) down to 1.1mbgl, overlying Alluvium (soft silty Clay) up to 3.1m in thickness. The Alluvium was found to overly 4.1m of River Terrace Deposits (medium dense to dense slightly sandy Gravel), which overlies stiff fissured Clay material (London Clay). The groundwater level is indicated to exist 1.8mbgl (-0.1m AoD).

The retaining wall is expected to be founded within the soft Alluvium material and the following retaining wall options were considered:

- Reinforced concrete wall or modular retaining wall system constructed on short piled (up to 2.5m long) foundation to transfer loads to the River Terrace Deposits. However it may be possible to achieve sufficient stability and minimise differential settlement issues by over excavating soft deposits and replace with high friction material.
- Over excavation and construction of geo-grid reinforced earth slope with a maximum slope angle of 70 degrees. As with the retaining wall option over-excavation of soft material and replacement with high frictional material may be required to ensure stability.

Provided that sufficient land take is available the most cost effective option will involve the construction of the steepened geo-grid reinforced earth slope that will utilise up to 4m long geo-grid reinforcement at 0.5m vertical spacing.

6. Curtain Cut Off Wall

There are a number of significant risks identified at the site including, but not limited to the following:

1. high groundwater level hydraulically connected to the River Thames which would cause continuous groundwater seepage into the works and tunnel area;
2. presence of higher permeability materials leading to slope instability;
3. presence of potentially contaminated groundwater and associated processing and health and safety risks and cost of processing groundwater;

4. heave of London Clay caused by unloading around 8m of overburden at the portal entrance but also lesser unloading outwards along the proposed roads;
5. water ingress through movement/expansion joints;
6. up-thrust from groundwater displaced by concrete slabs connected to retaining walls.

To mitigate the significant risks noted above the options considered are as follows:

- water tight secant, diaphragm or part slurry barriers creating an overall curtain cut off wall. The curtain wall would be extended upwards to be the foundations for secant pile retaining walls and/or diaphragm walls. Underneath road carriageways the slurry walls may be considered to eliminate hard areas under the pavement.
- sealed concrete slab road pavement connected to secant pile/diaphragm walls resisting clay heave, as required, around the portal extending outwards as far as heave is found to be significant.

These risk mitigations are concluded to be preferable to the conventional earthworks resulting in the development of options South 4A and North 5C. The general position of the curtain wall/barrier option connected to the retaining walls/bridge pile foundations is indicated in Figure 7 below. The extent of this wall shall ensure that the top is above the maximum expected groundwater elevation and the toe of the wall will extend 1m minimum into the London Clay. The position of the reinforced concrete slab road pavement would be within the curtain wall shown on Figure 7. The construction of the concrete slabs is required to ensure that the heave is controlled as well as eliminate water seepages.

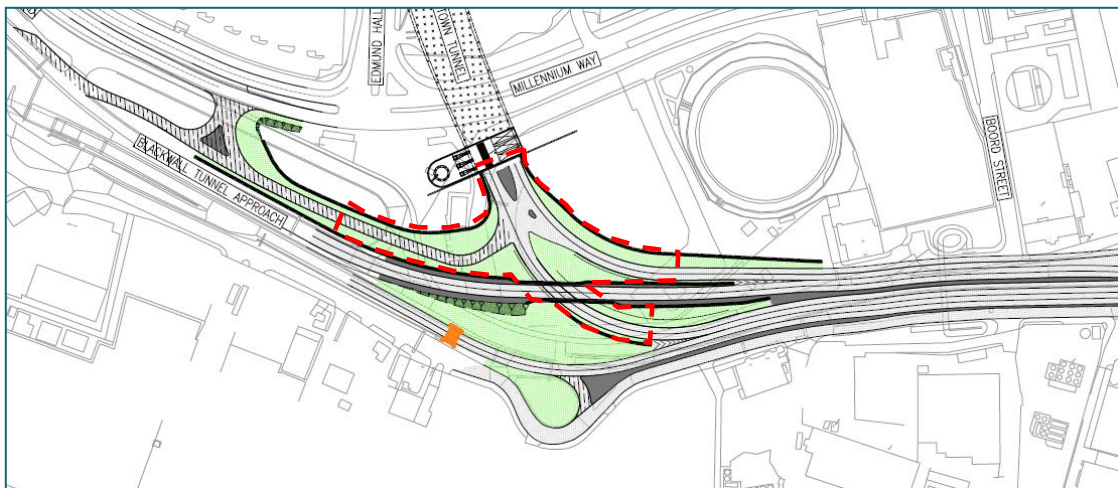


Figure 7 – Approximate outline of curtain cut off wall

7. Additional Ground Investigation

During the conceptual design stage (for both the South and North sites) the information relating to soils and groundwater was mainly based on the available BGS historical exploratory holes. However, the information available was limited and mainly comprised soil descriptions and in-situ SPT results. Therefore, an additional Ground Investigation is proposed to obtain information to allow the derivation of design parameters to be used during the preliminary/detailed design stages.

The additional Ground Investigation is expected to comprise hand dug/machine excavated trial pits, window samples and cable percussive boreholes with or without rotary follow on. Hand dug trial pits will be required at the location of the window sample and cable percussive boreholes to ensure that no services are present and machine excavated trial pits will be required where minor earthworks or at grade construction is proposed.

Window sample boreholes will be required at the areas where the determination of the Alluvium base depth is required. Cable percussive boreholes will be undertaken within the areas where it is necessary to determine the depth to the top of the London Clay such as where the curtain cut off wall is required. Cable percussive boreholes with rotary follow on will be required where the holes need to penetrate through the London Clay material such as at the location of the proposed bridges and retaining wall sections close to the south and north portal, where long piles are proposed.

At this stage it is anticipated that the following nos. of exploratory holes will be required:

- 28 No. Hand dug trial pits to 1.2mbgl
- 8 No. Machine excavated trial pits to 3.5mbgl
- 15 No. Window sample boreholes to 6.5mbgl
- 4 No Cable Percussive boreholes to 12mbgl
- 9 No Cable percussive boreholes with rotary follow on to 25mbgl

Bulk, small disturbed and thin walled U100 samples will be obtained during the proposed Ground Investigation. In-situ testing will mainly comprise Standard Penetration Tests (SPTs) and Hand Shear Vane (HSV) tests.

The following laboratory testing is expected to be undertaken as part of the additional Ground Investigation:

- Moisture Contents
- Atterberg Limits
- Particle Size Distribution (Wet Sieve Method)
- Particle Size Distribution (Pipette Method)
- Quick Undrained Triaxial (single stage)
- Consolidation
- pH and Soluble Sulphate (BRE)
- Organic content
- Soil Contamination Testing Suite
- Soil Leachate Contamination Testing Suite
- Soil Leachate Contamination Testing Suite

8. Further Reporting

Further to undertaking the additional Ground Investigation the following will be required to allow the development of the proposed works to detailed design stage:

- Preliminary Sources Study Report;
- Brief Ecology Search;
- Archaeology Desk Study;
- UXO Desk Study.

ATKINS

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