

**TRANSPORT AND WORKS ACT 1992
TOWN AND COUNTRY PLANNING ACT 1990**

PLANNING (LISTED BUILDINGS AND CONSERVATION AREAS) ACT 1990

**PROPOSED LONDON UNDERGROUND
(NORTHERN LINE EXTENSION) ORDER**

PROOF OF EVIDENCE

OF

**Jonathan R A Gammon
Engineering**

FOR

TRANSPORT FOR LONDON (TfL)

DOCUMENT TFL2/B

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APPENDIX TO PROOF OF EVIDENCE

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Appendix 1

Tables

Table 1 Summary of the typical ground conditions along the NLE route

Made Ground	+5.50 to +1.60	0.50 to 3.95	Loose to dense clayey sandy gravel with occasional cobbles to soft to firm sandy gravelly clay. Gravel and cobbles comprise flint, brick and concrete with occasional ash, clinker, metal and timber. Localised contamination evident.
Alluvium	+4.60 to -0.75	0.00 to 3.95	Soft grey clay with varying quantities of organic material, including localised bands of fibrous peat. Locally absent.
River Terrace Deposits	+4.10 to -1.95	1.25 to 10.00	Loose to dense brown sandy gravel varying to sand & gravel or locally very gravelly sand. Gravel is predominantly flint. (River Terrace Deposits may be up to 22.85m deep in local scour features)
London Clay Formation	0.00 to -9.00	19.0 to 37.00	Stiff to very stiff grey brown becoming bluey grey fissured clay with sand and silt laminations, thin bands and nodules of calcareous material, pyrite or selenite, and fragments of wood. The base of the London Clay is marked by a thin layer of sandy gravelly clay (Harwich Formation) and on occasions with particularly sandy in the basal layers
Lambeth Group	-19.00 to -41.60	5.95 to 18.90	A complex accumulation of deposits including: <ul style="list-style-type: none"> • Very stiff/hard shelly clay with occasional limestone concretions (Upper Shelly Clay) • Very dense interbedded silts, sands and very stiff/hard clays. Water bearing (Laminated Beds) • Very stiff/hard shelly clay with numerous calcareous nodules (Lower Shelly Clay) • Very stiff/hard mottled clays with thin bands of very dense silt (Lower Mottled Clay) • Rounded gravel pebbles over very dense green find to medium sand (Upnor Formation) Base of the Lambeth Group is often misinterpreted as Thanet Sand.
Thanet Sand	-23.00 to -56.80	8.50 to 12.20	Very dense greyish green silty fine sand
Upper Chalk	-63.90 to -69.00	Base not penetrated	Moderately weak to moderately strong medium density white chalk with flint bands (Grade B2)

Table 2 Building Damage Classification

Building Damage Classification ¹				
1 Risk Category	2 Max Tensile Strain %	3 Description of Degree of Damage	4 Description of Typical Damage and Likely Form of Repair for Typical Masonry buildings	5 Approx ² Crack Width (mm)
0	0.05 or less	Negligible	Hairline cracks.	
1	More than 0.05 and not exceeding 0.075	Very Slight	Fine cracks easily treated during normal redecorations. Perhaps isolated slight fracture in building. Cracks in exterior brickwork visible upon close inspection.	0.1 to 1
2	More than 0.075 and not exceeding 0.15	Slight	Cracks easily filled. Redecoration probably required. Several slight fractures inside building. Exterior cracks visible; some repointing may be required for weather-tightness. Doors and windows may stick slightly.	1 to 5
3	More than 0.15 and not exceeding 0.3	Moderate	Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Repointing and possibly replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired.	5 to 15 or a number of cracks greater than 3
4	More than 0.3	Severe	Extensive repair involving removal and replacement of sections of walls, especially over doors and windows required. Windows and door frames distorted. Floor slopes noticeably. Walls lean or bulge noticeably, some loss of bearing in beams. Utility services disrupted.	15 to 25 but also depends on number of cracks
5		Very Severe	Major repair required involving partial or complete reconstruction. Beams lose bearing, walls lean badly and require shoring. Windows broken by distortion. Danger of instability.	Usually greater than 25 but depends on number of cracks

Notes

1. The table is based on the work of Burland et al (1977) and includes typical maximum tensile strains for the various damage categories (column 2) used in phase 2 settlement analysis.

Table 3 Summary of analysis phases outlined in LUL Standard 1-050 Issue A2 (January 2009) and LUL Guidelines on ground movement due to tunneling.

Phase	Clause	Description
1 (Green field predictions of settlement)	3.6.1.4 (1-050) or 2.3 (LUL Guidelines)	<p>1. Settlement predictions for bored tunnels should be produced using empirically validated methods such as O'Reilly and New (1982), using parameters for ground loss determine from case histories.</p> <p>2. For excavations, assessment should be undertaken using models validated by empirical data based on case studies of similar excavations.</p> <p>3. For buildings that experience less than 10mm no further assessment is necessary.</p> <p>4. Buildings with settlement or heave greater than 10mm or predicted ground slope of 1:500 or steeper are subject to a Phase 2 assessment.</p>
2	3.6.1.5 (1-050) or 2.4 (LUL Guidelines)	<p>5. The movements predicted for green field conditions are imposed on buildings. (Buildings are assumed to behave flexibly and their own stiffness has no influence on ground settlement).</p> <p>6. The potential for damage is defined using the procedures described by Burland et al. (1977, cited in CIRIA 200, 2001) and placed into one of six risk categories (numbered 0 – 5).</p> <p>7. Buildings assessed to be in risk category 0, 1 or 2 are not subjected to further assessment. (Exceptions include listed buildings or building with shallow foundation in close proximity to excavations),</p> <p>8. All buildings which are placed in risk category 3 or above are subject to a Phase 3 assessment.</p>
3*	3.6.1.6 (1-050) or 2.5 (LUL Guidelines)	Each building is considered separately. The assessment will involve the development of a building specific detail model rather than the more generic model forms used in Phase 2.

*Phase 3 level of detail exceeds the requirements of the Reference Design and should be carried out during the detailed design phase.

Appendix 2

Figures

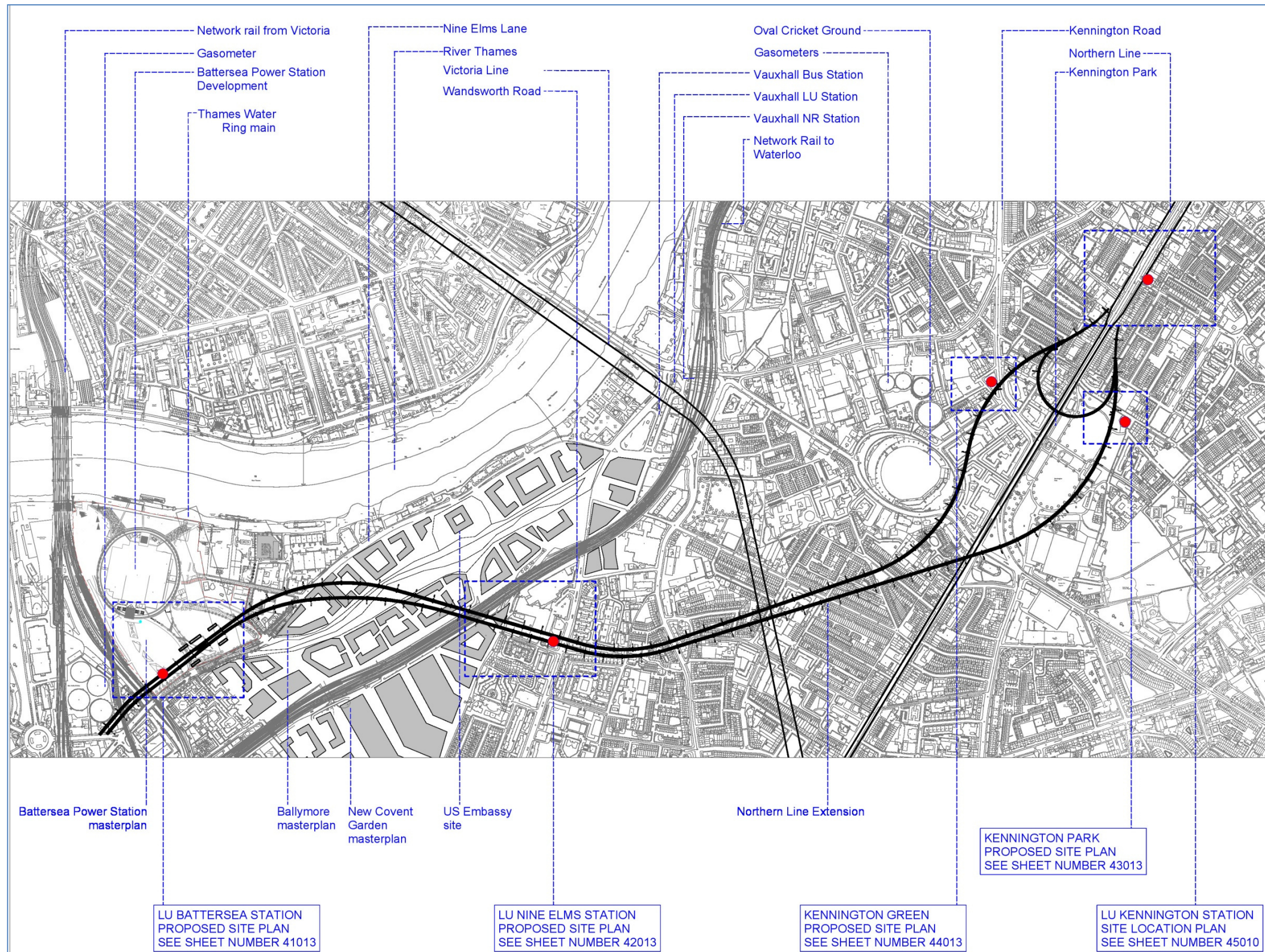


Figure 1: Scheme Layout

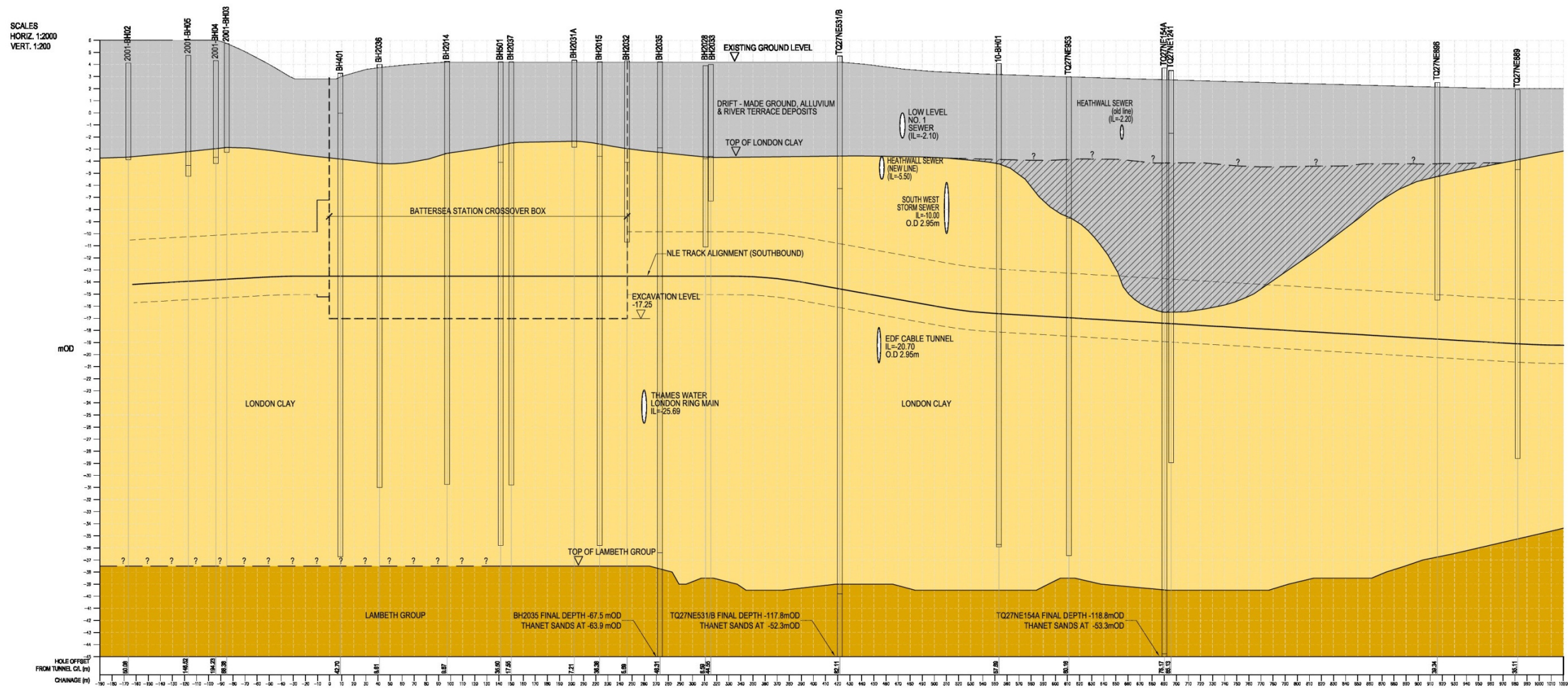


Figure 2: Geological Profile of reference design alignment (1 of 3)

SCALES
 HORIZ. 1:2000
 VERT. 1:200

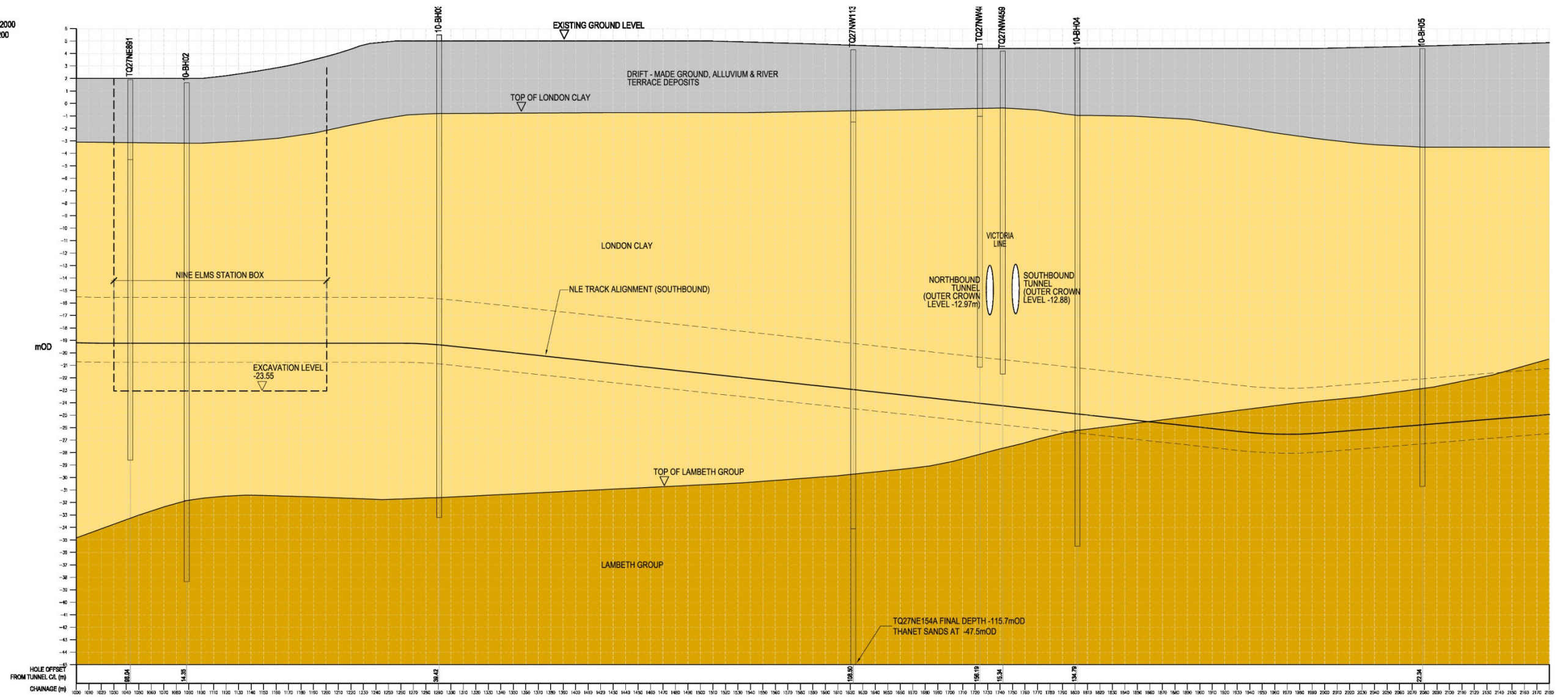


Figure 3: Geological Profile of reference design alignment (2 of 3)

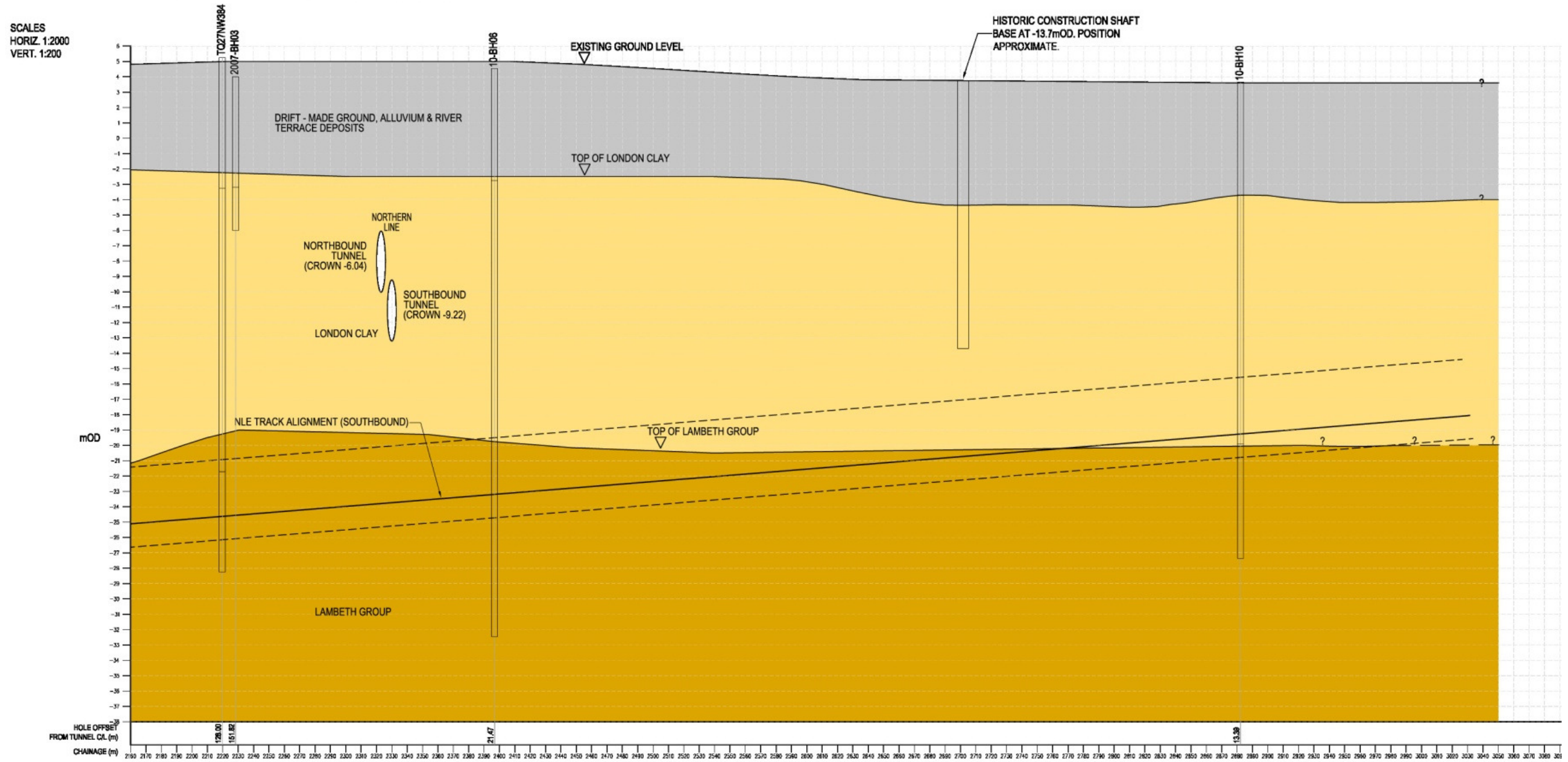


Figure 4: Geological Profile of reference design alignment (3 of 3)

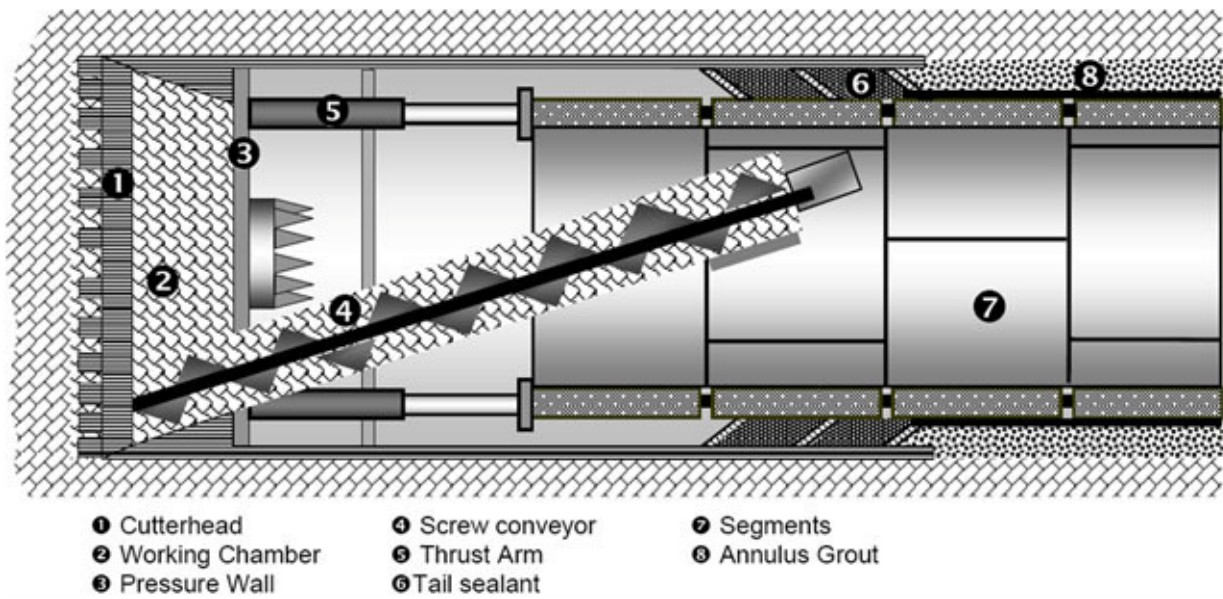


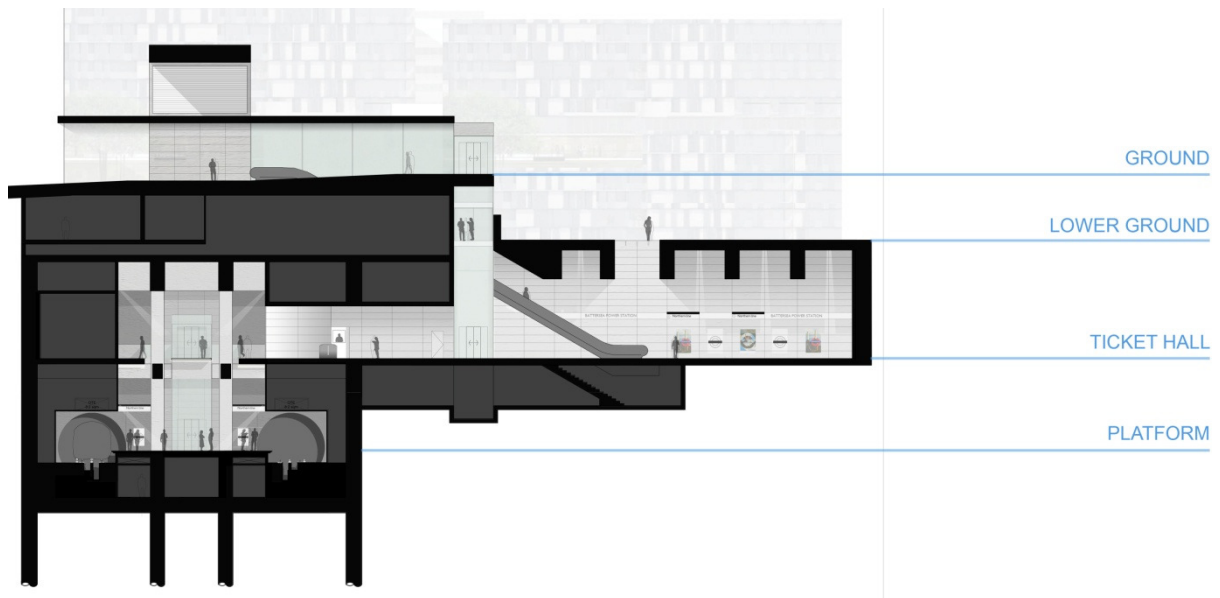
Figure 5 Earth Pressure Balance TBM Schematic



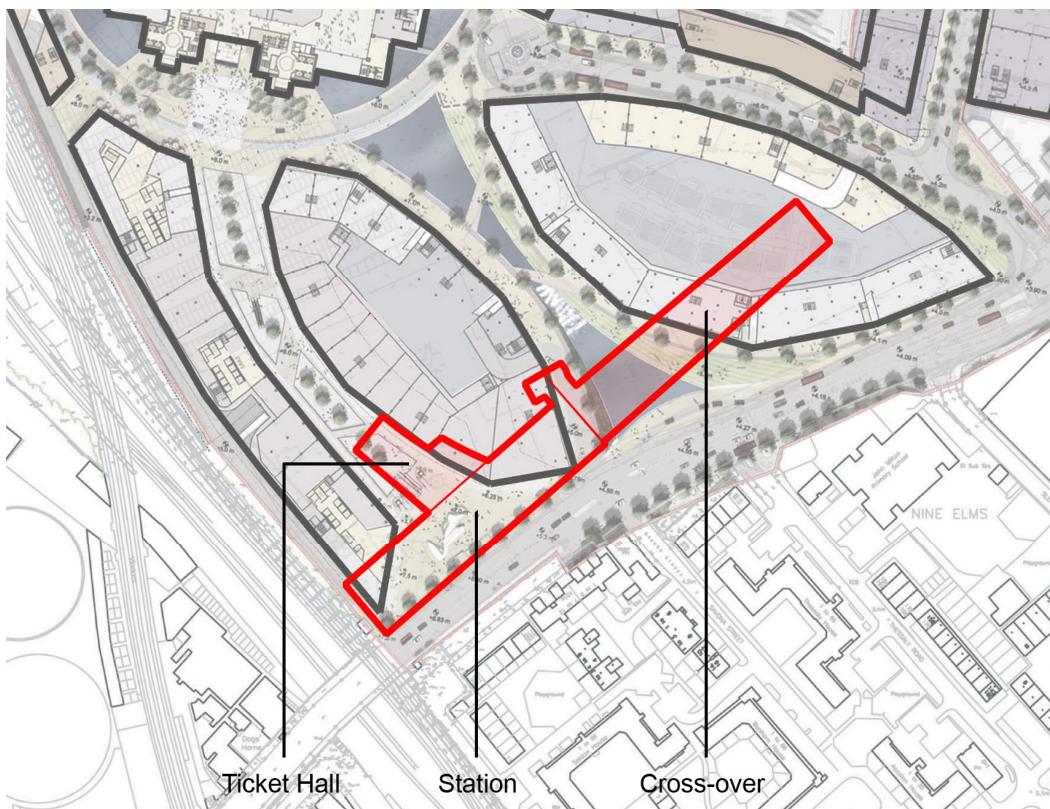
Figure 6 SCL lining



Figure 7 SGI lining

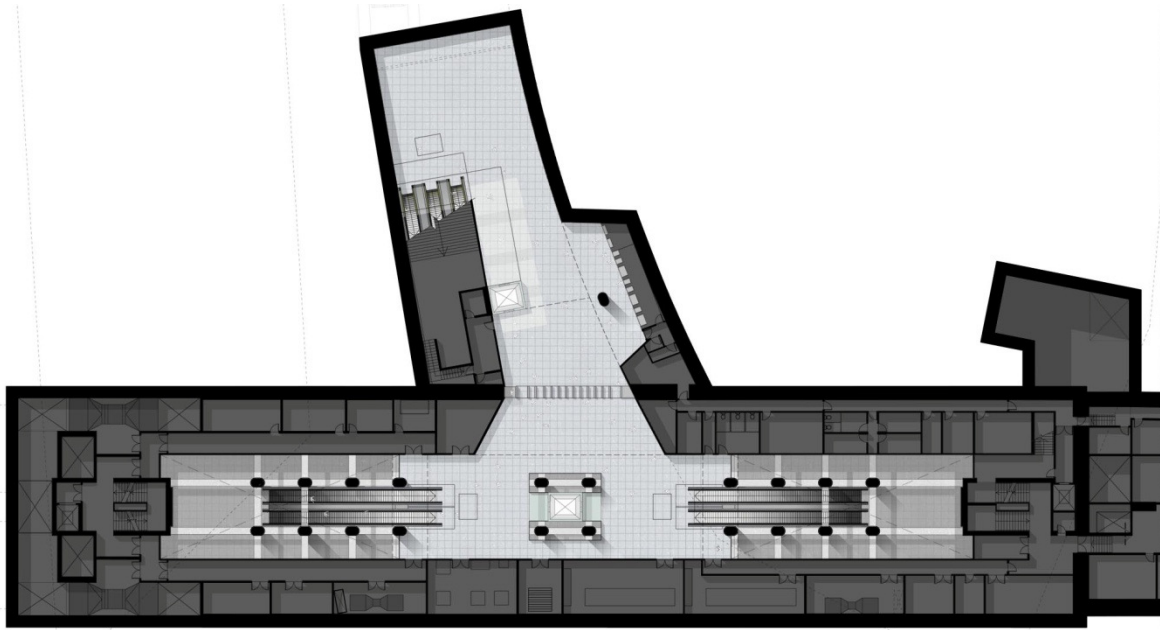


Section showing sequence of spaces from entrance to platform

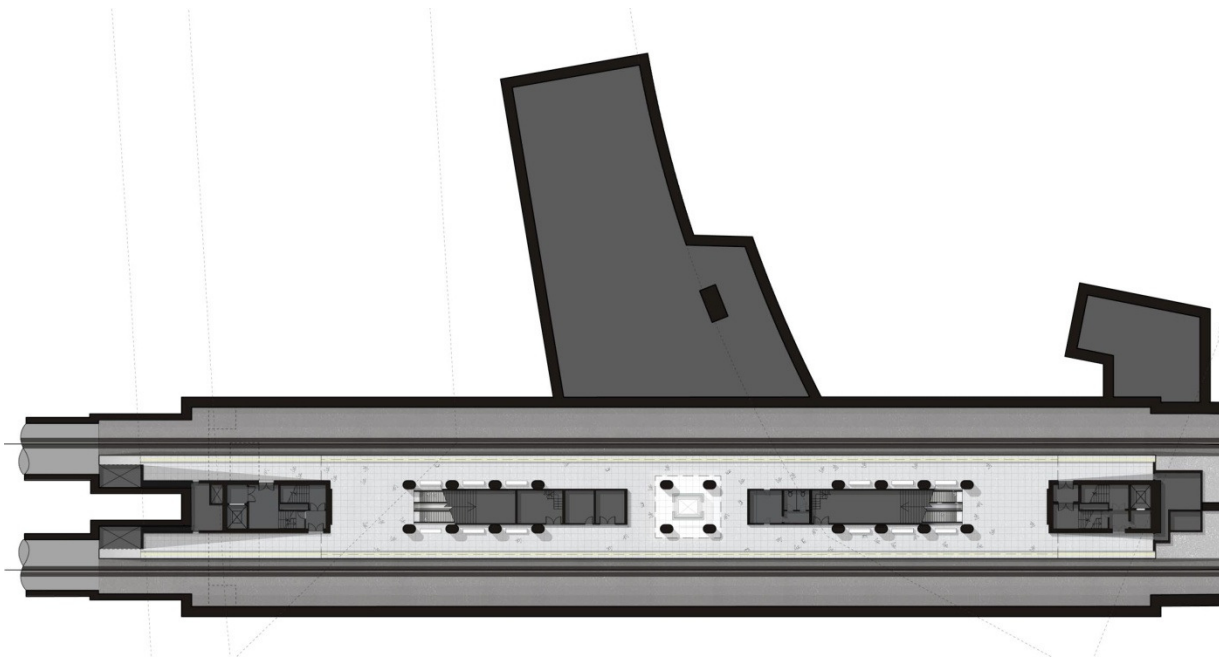


Ground level plan showing station and cross-over in outline within the completed master plan

Figure 8 Battersea Station—Configuration – Sheet 1



Ticket hall & upper concourse plan



Platform level plan at Battersea Station

Figure 9 Battersea Station–Configuration – Sheet 2

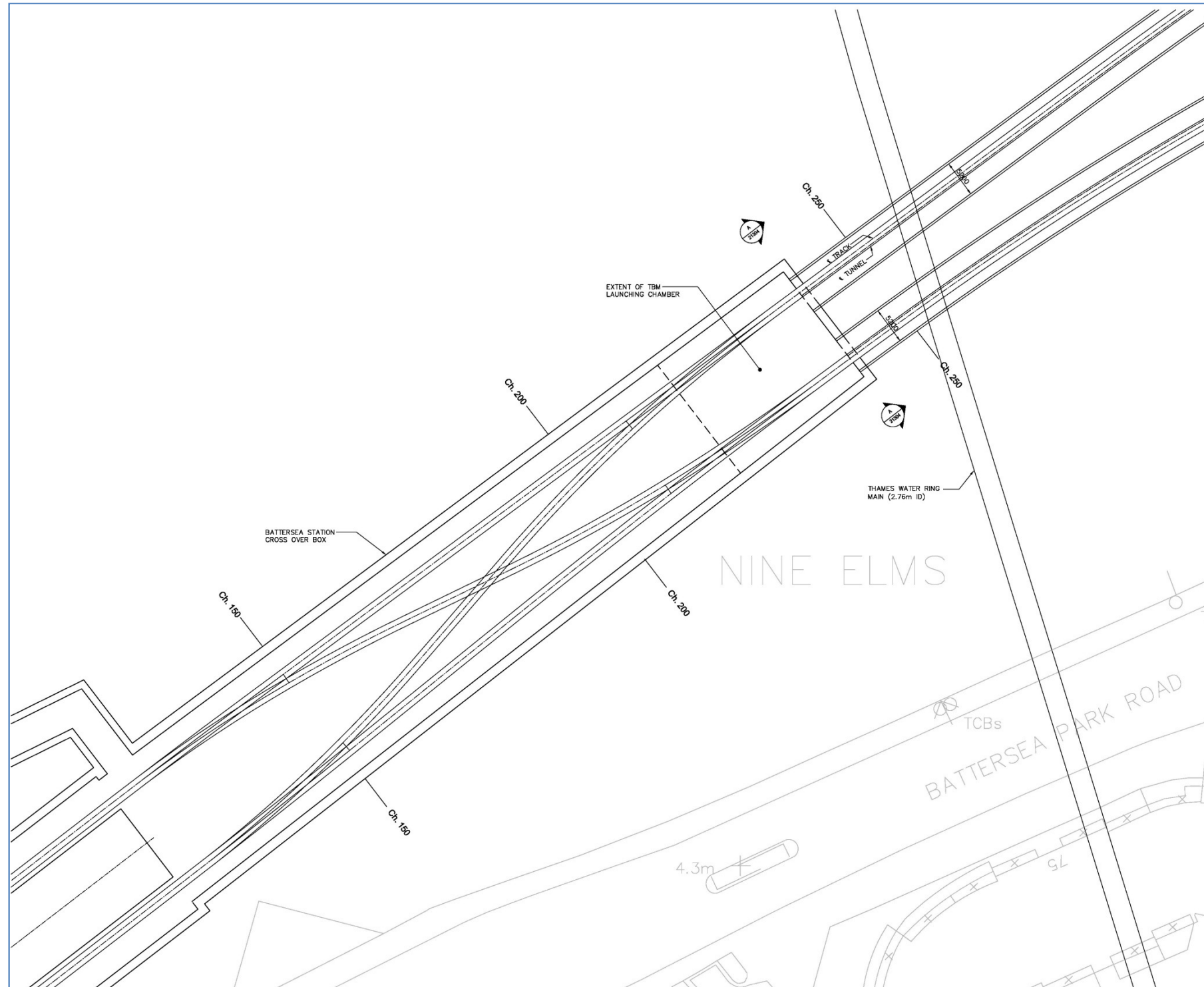


Figure 10: Battersea Station– Crossover box

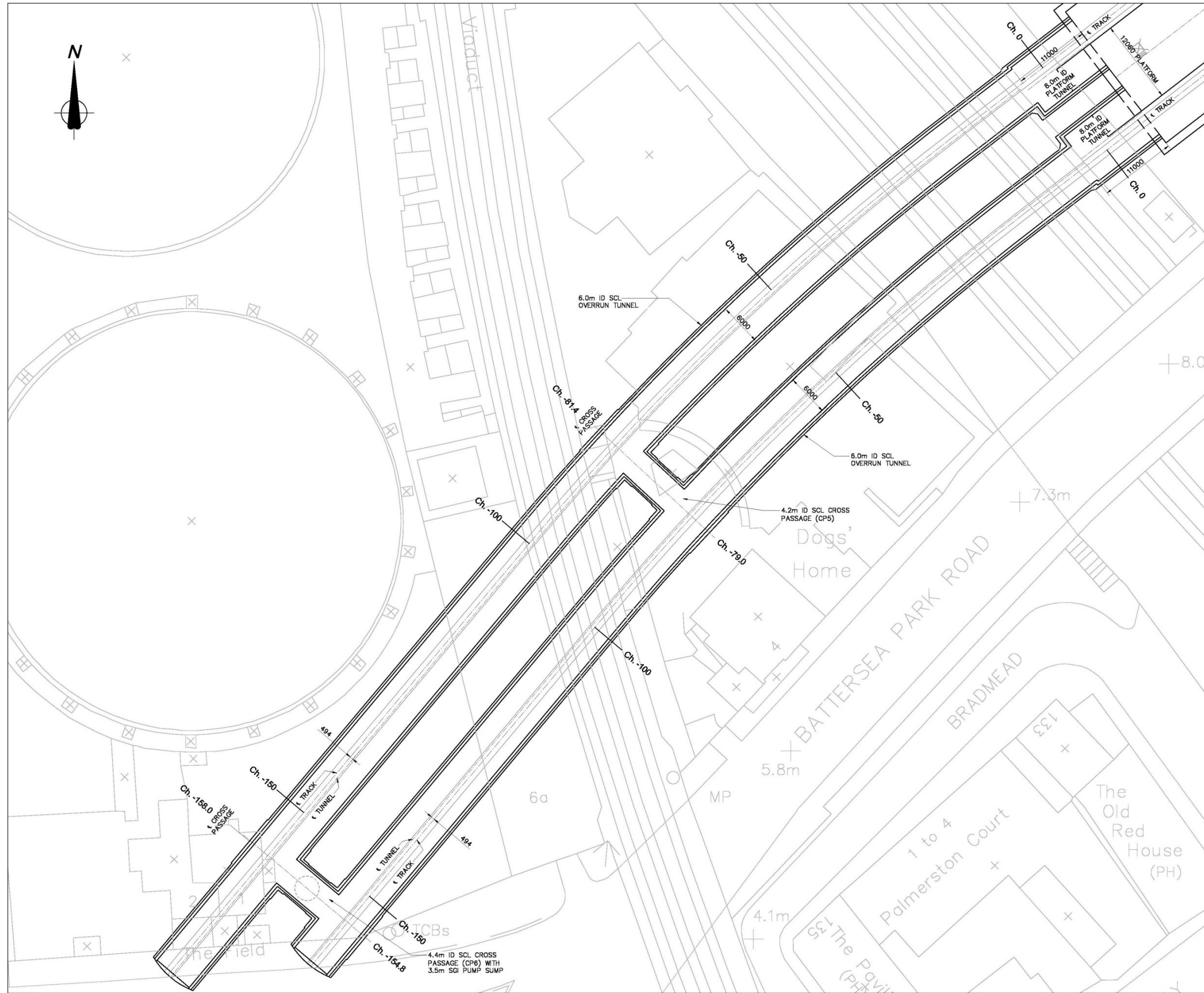


Figure 11: Battersea Station Overrun Tunnels

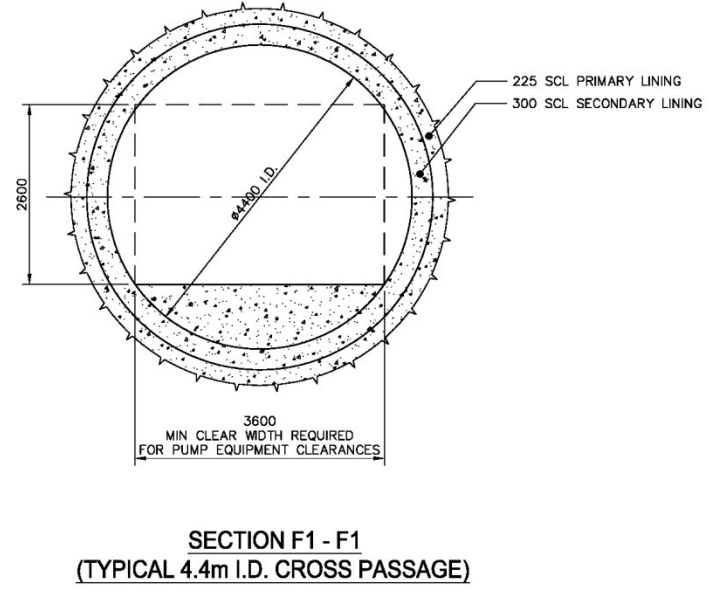
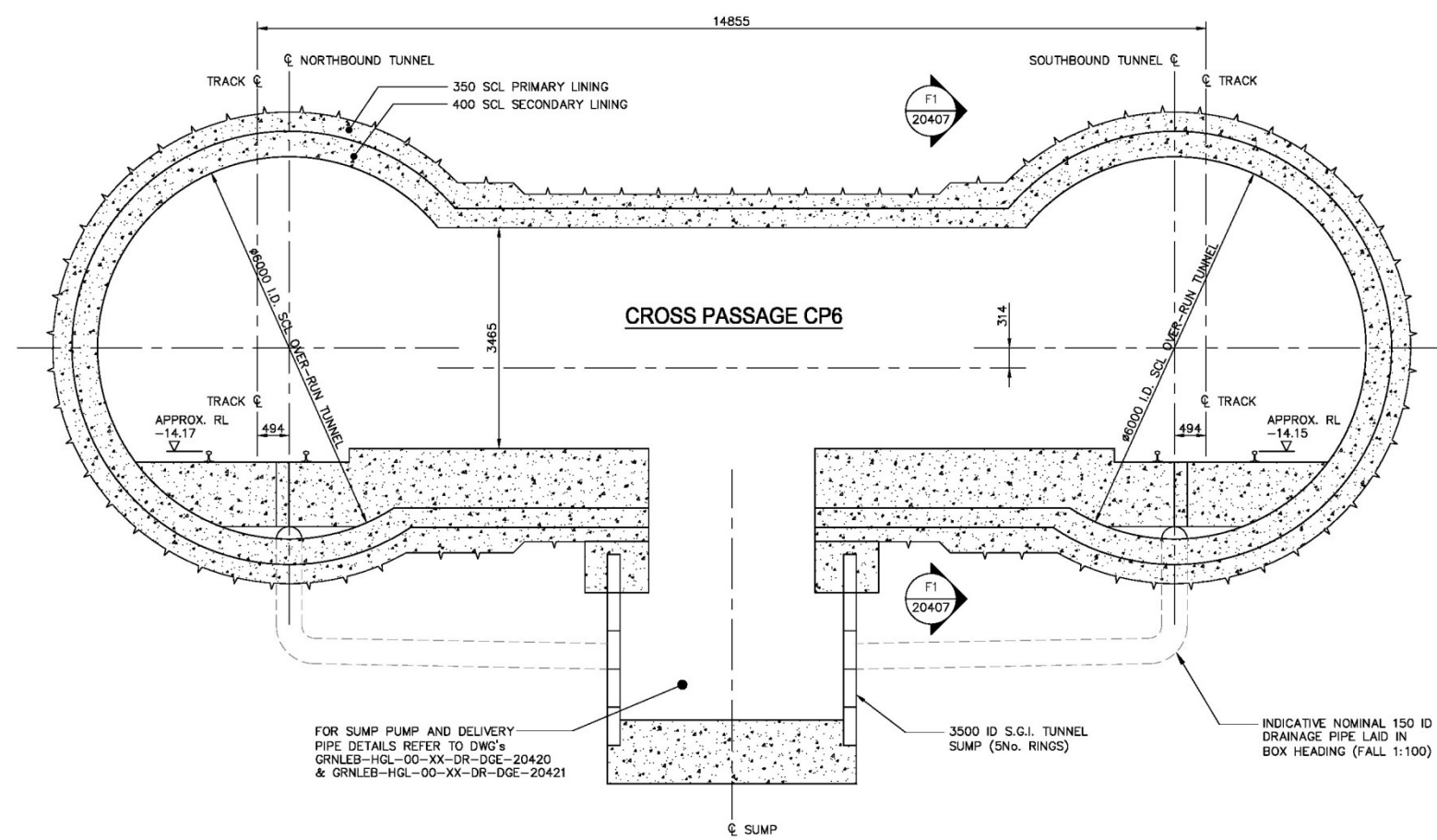
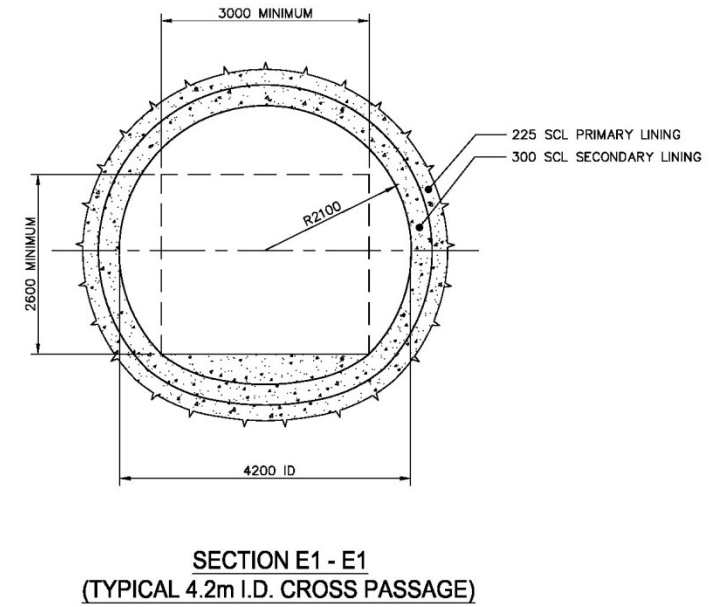
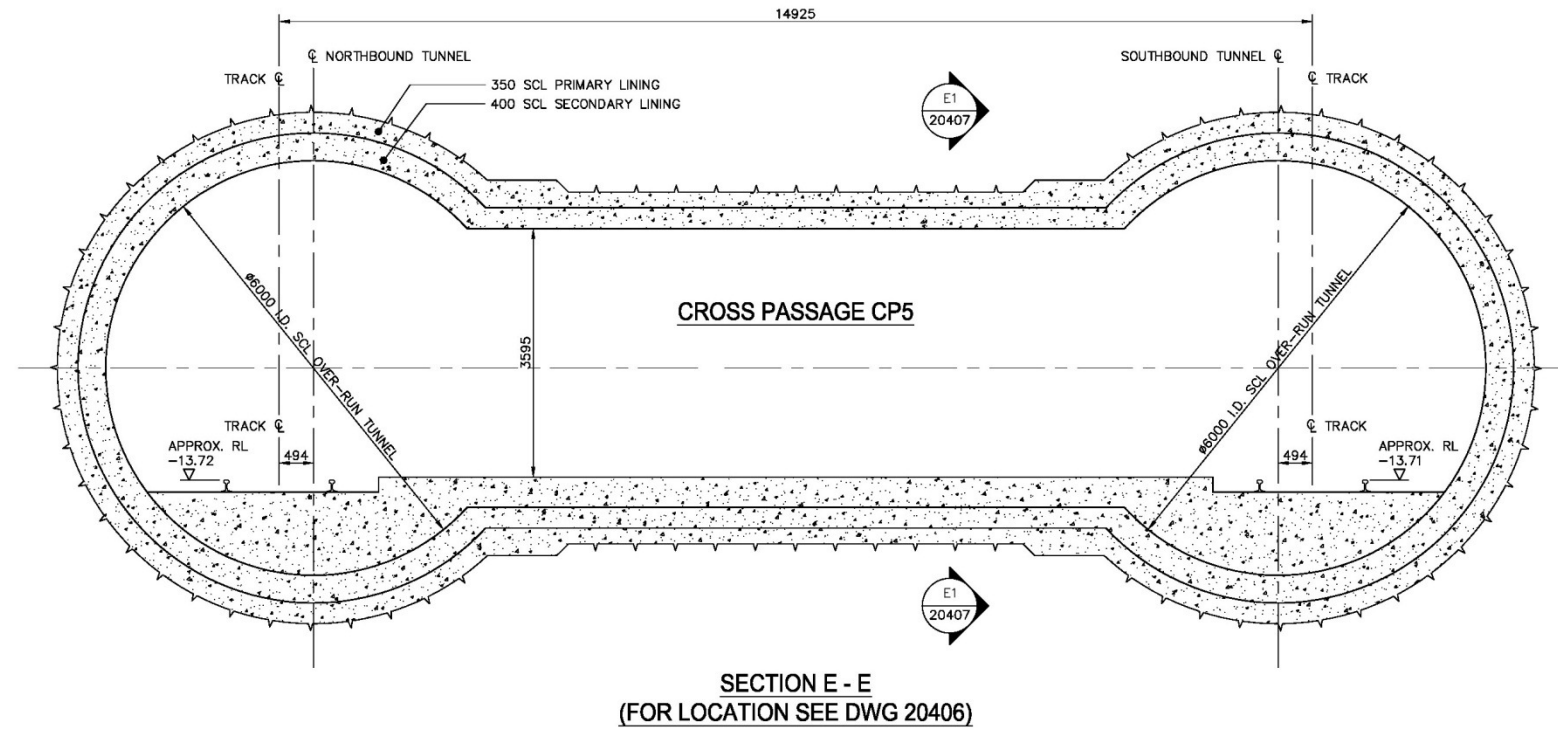


Figure 12 Cross Passage –CP1 and CP2

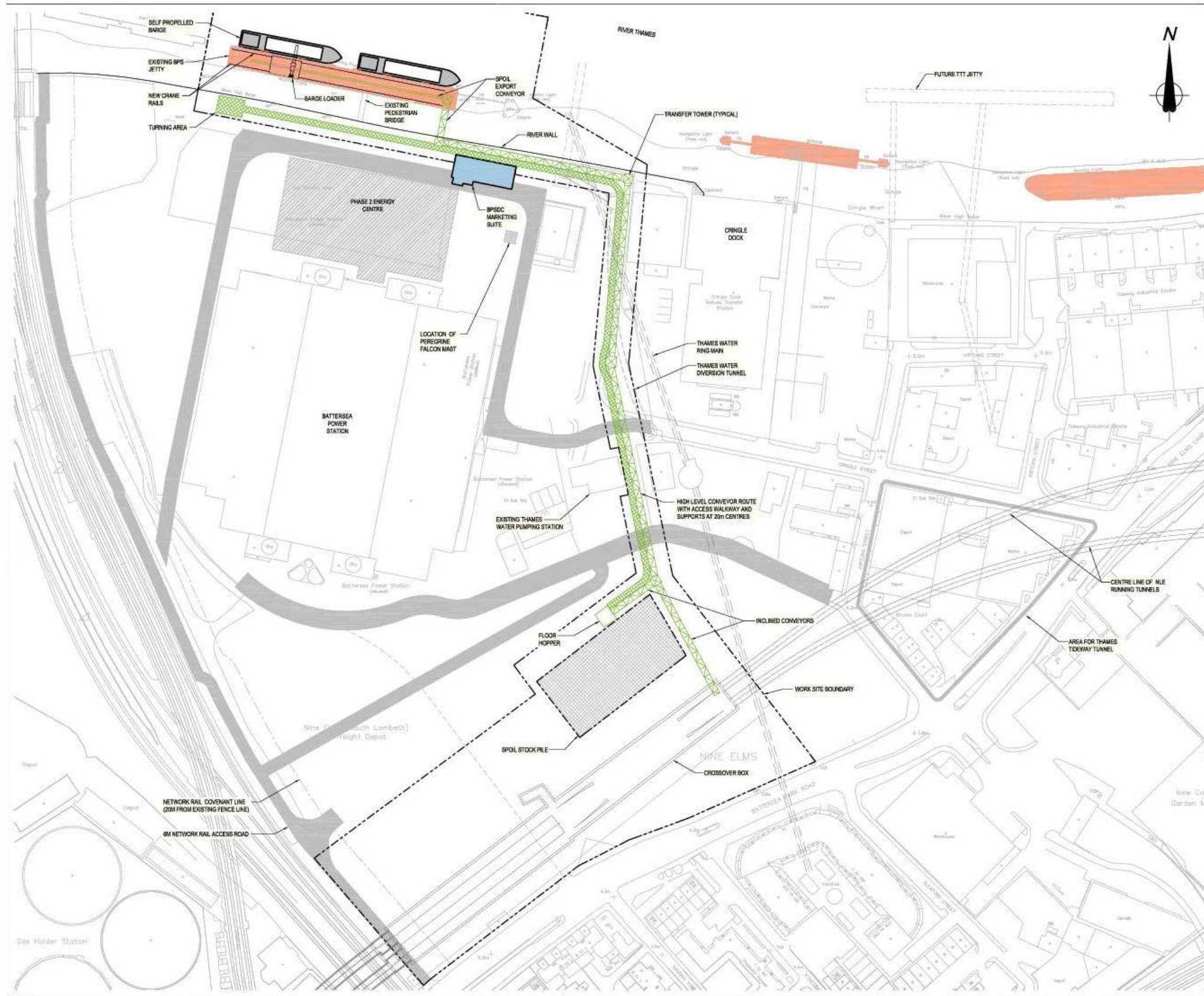


Figure 14: Battersea Station Overrun Tunnels

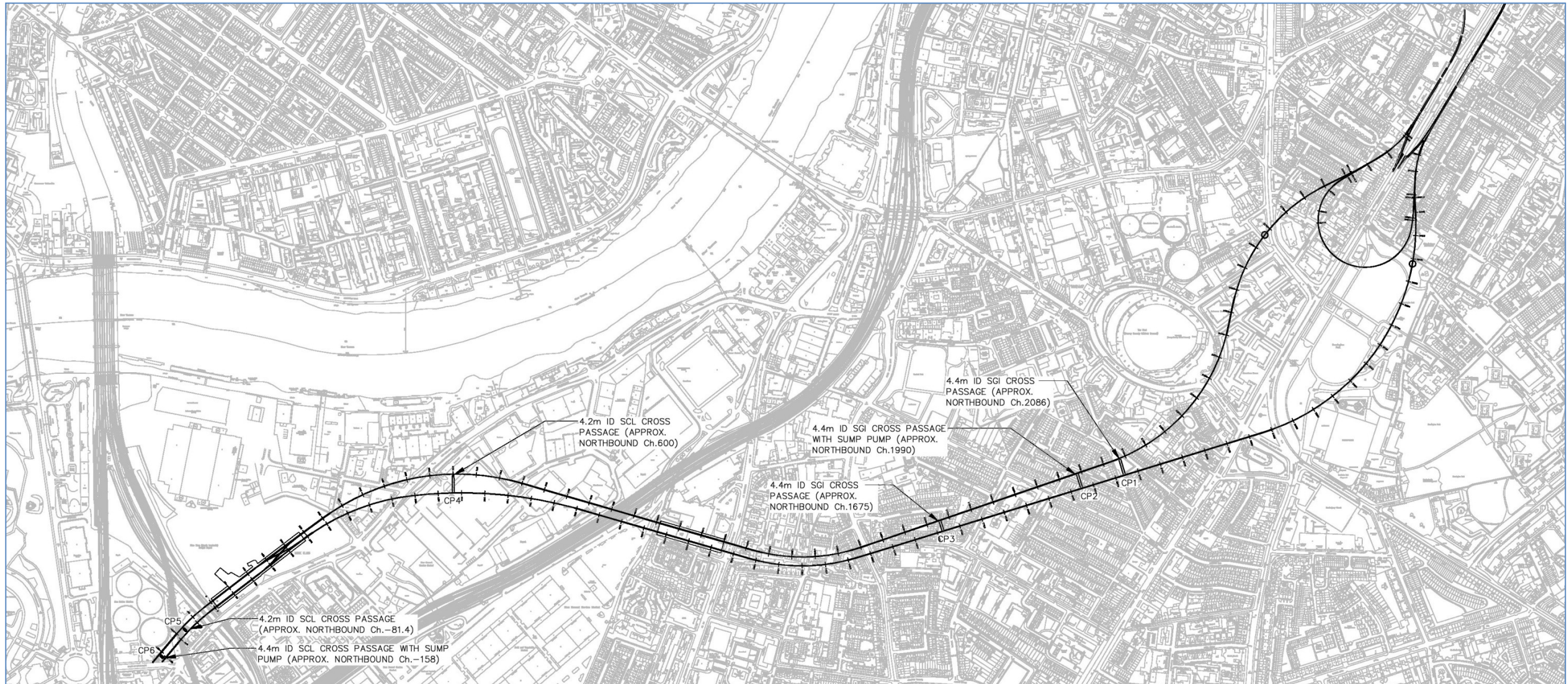
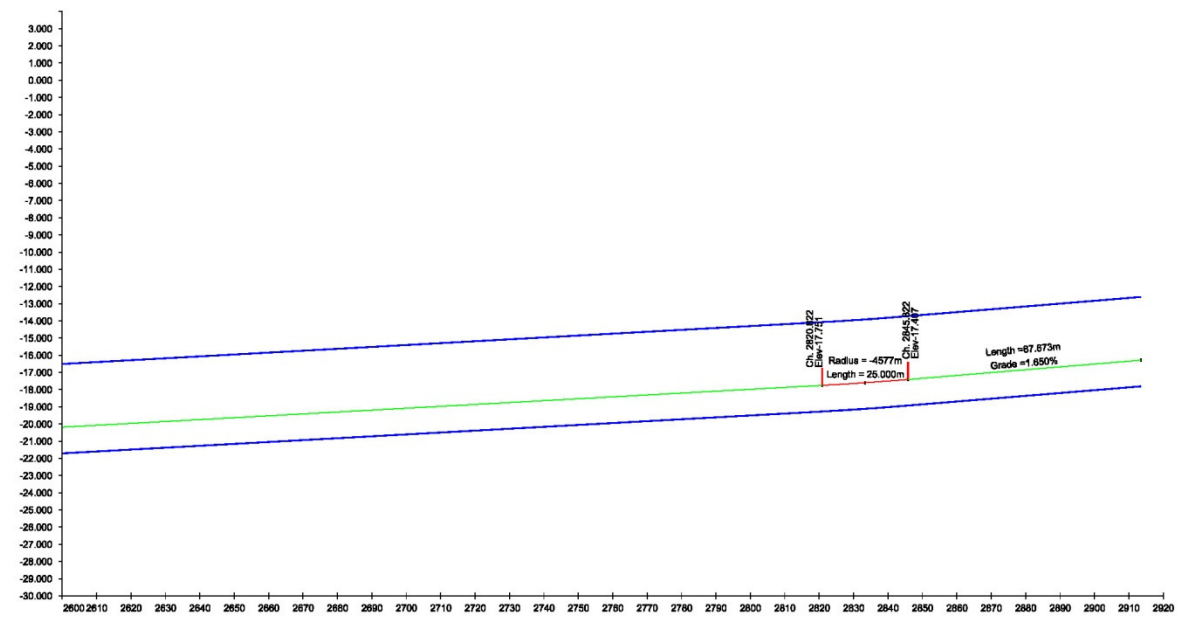
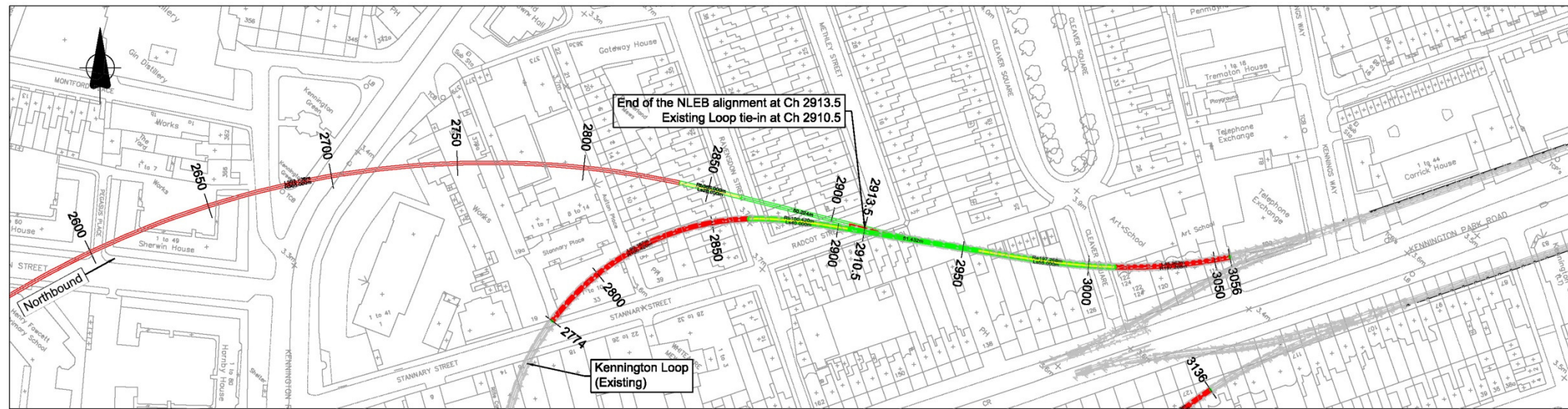
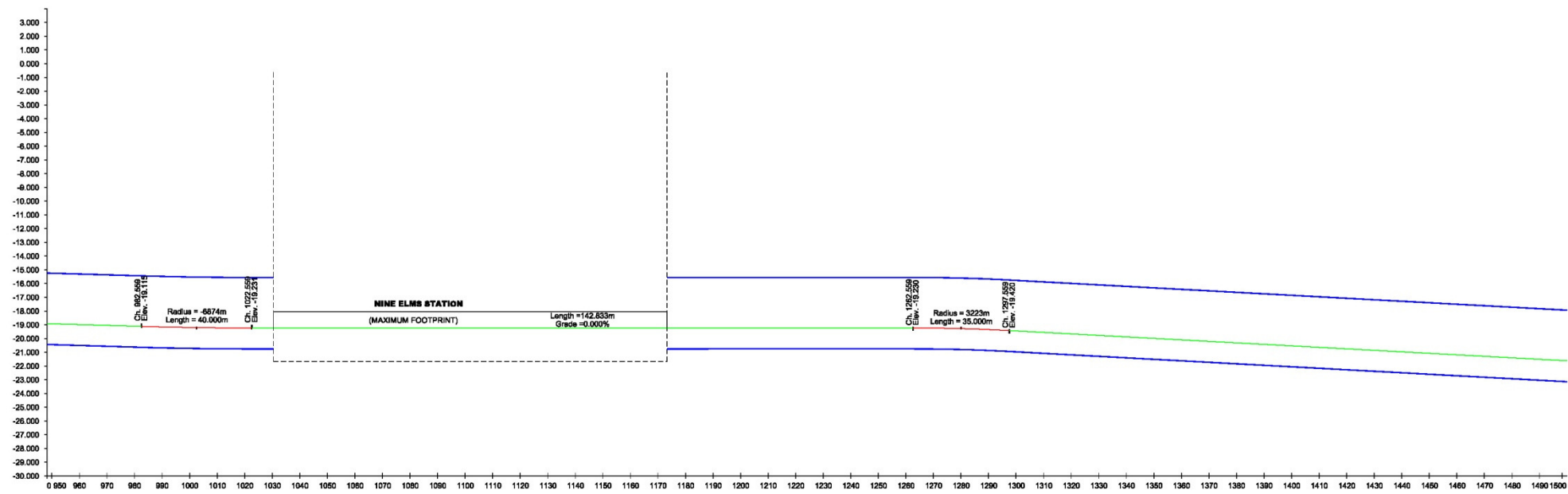
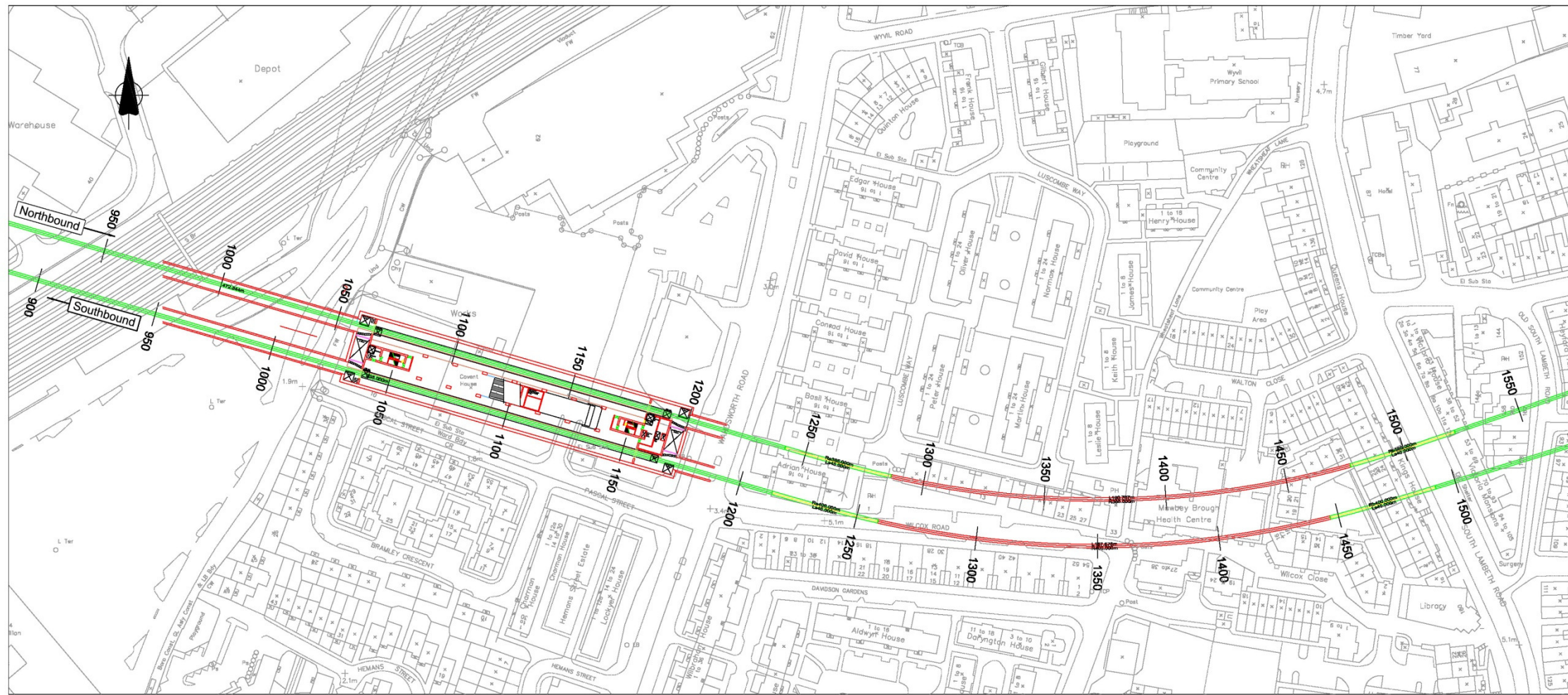


Figure 12 – Cross Passage Locations



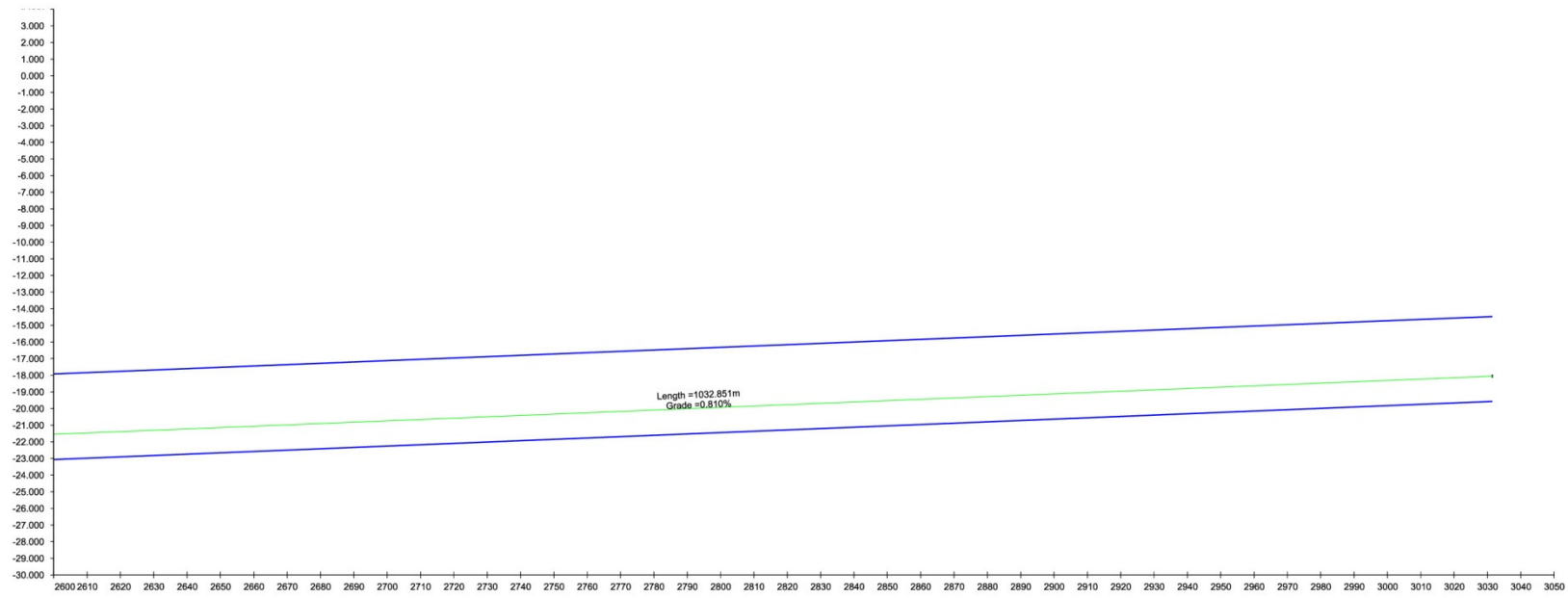
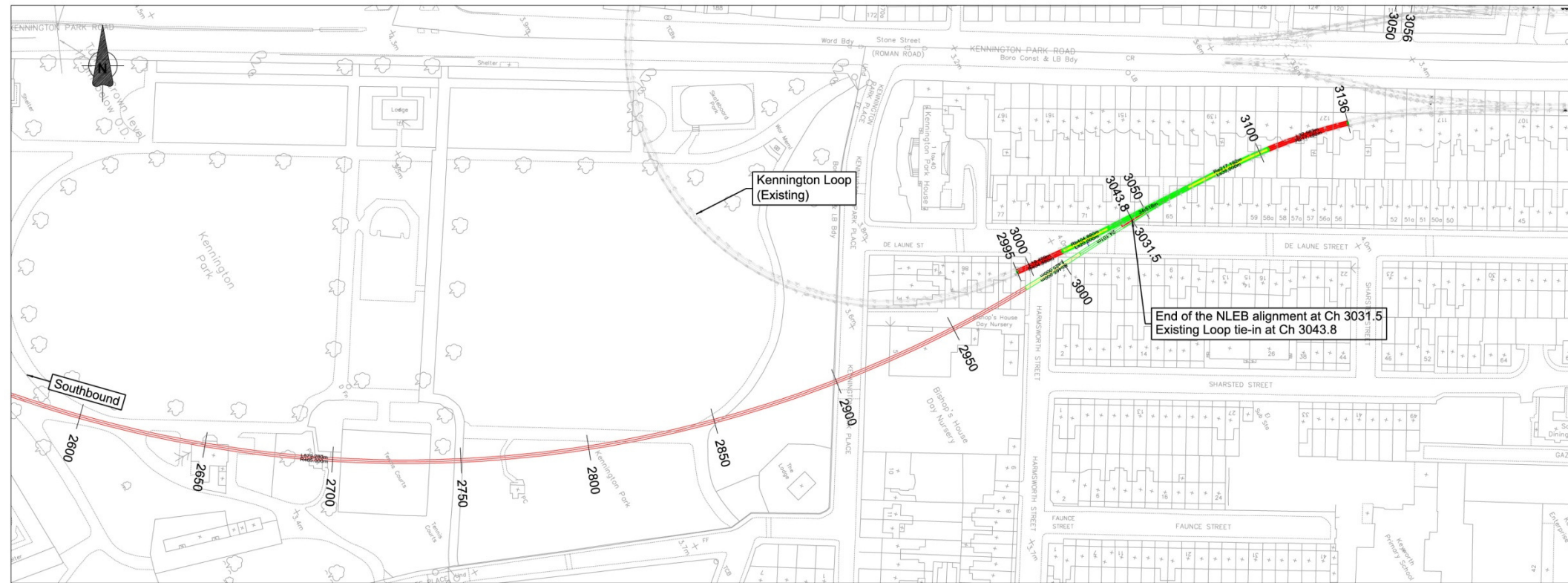
Chainage:	2600	2610	2620	2630	2640	2650	2660	2670	2680	2690	2700	2710	2720	2730	2740	2750	2760	2770	2780	2790	2800	2810	2820	2830	2840	2850	2860	2870	2880	2890	2900	2910	2920	
Proposed Low Rail Level:	-18.188	-18.207	-18.226	-18.245	-18.264	-18.283	-18.302	-18.321	-18.340	-18.359	-18.378	-18.397	-18.416	-18.435	-18.454	-18.473	-18.492	-18.511	-18.530	-18.549	-18.568	-18.587	-18.606	-18.625	-18.644	-18.663	-18.682	-18.701	-18.720	-18.739	-18.758	-18.777	-18.796	-18.815
Proposed Vertical Alignment:	L=739.00 Grade=1.10%																N=205.50 R=1475.50 Grade=1.65%										L=49.50 STRAIGHT							
Proposed Horizontal Alignment:	R=333.00 L=333.75																R=258.00 L=258.00										L=49.50 STRAIGHT							
Proposed Cant Alignment:	C=44.00 S=7.50																R=258.00 L=258.00																	
Maximum Speed:	40.0km/h																																	

Figure 21 – Northbound Horizontal and Vertical Track Alignment Sheet 6



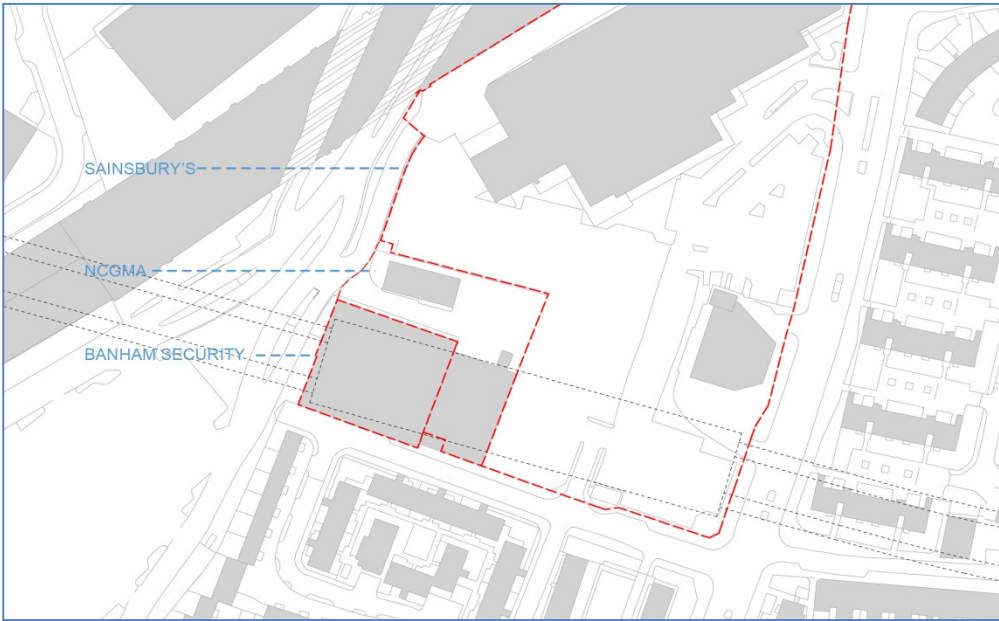
Chainage:	960	980	1000	1020	1040	1060	1080	1100	1120	1140	1160	1180	1200	1220	1240	1260	1280	1300	1320	1340	1360	1380	1400	1420	1440	1460	1480	1500
Proposed Low Rail level:	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80
Proposed Vertical Alignment:	L=55.40 Gradient=0.00%		N=5873.30										L=142.83 Gradient=0.00%		N=3223.00		L=68.00 Gradient=1.20%											
Proposed Horizontal Alignment:	L=278.00 STRAIGHT															T=142.83		T=142.83										
Proposed Cant Alignment:	0.00															0.00		0.00										
Maximum Speed:																75.00		75.00										

Figure 24 – Northbound Horizontal and Vertical Track Alignment Sheet 9

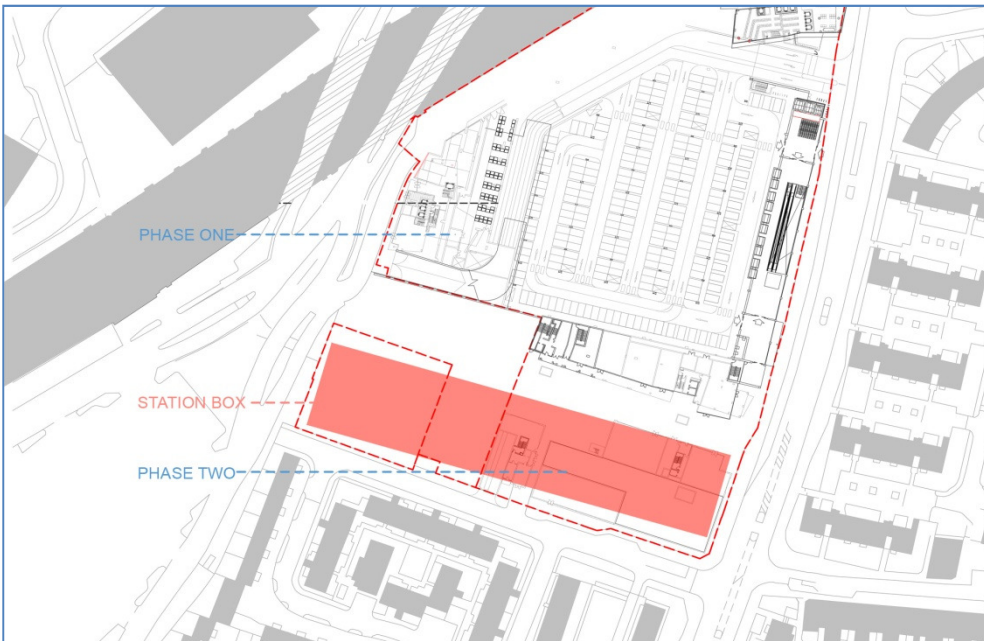


Chainage:	2600	2610	2620	2630	2640	2650	2660	2670	2680	2690	2700	2710	2720	2730	2740	2750	2760	2770	2780	2790	2800	2810	2820	2830	2840	2850	2860	2870	2880	2890	2900	2910	2920	2930	2940	2950	2960	2970	2980	2990	3000	3010	3020	3030	3040	3050	
Proposed Low Rail Level:	17.14	17.15	17.16	17.17	17.18	17.19	17.20	17.21	17.22	17.23	17.24	17.25	17.26	17.27	17.28	17.29	17.30	17.31	17.32	17.33	17.34	17.35	17.36	17.37	17.38	17.39	17.40	17.41	17.42	17.43	17.44	17.45	17.46	17.47	17.48	17.49	17.50	17.51	17.52	17.53	17.54	17.55	17.56	17.57	17.58	17.59	17.60
Proposed Vertical Alignment:	L=1032.85																																														
Proposed Horizontal Alignment:	S=455.00 L=279.28																																														
Proposed Cart Alignment:	S=455.00 L=279.28																																														
Maximum Speed:	65.0km/h																																														

Figure 27 – Northbound Horizontal and Vertical Track Alignment Sheet 12

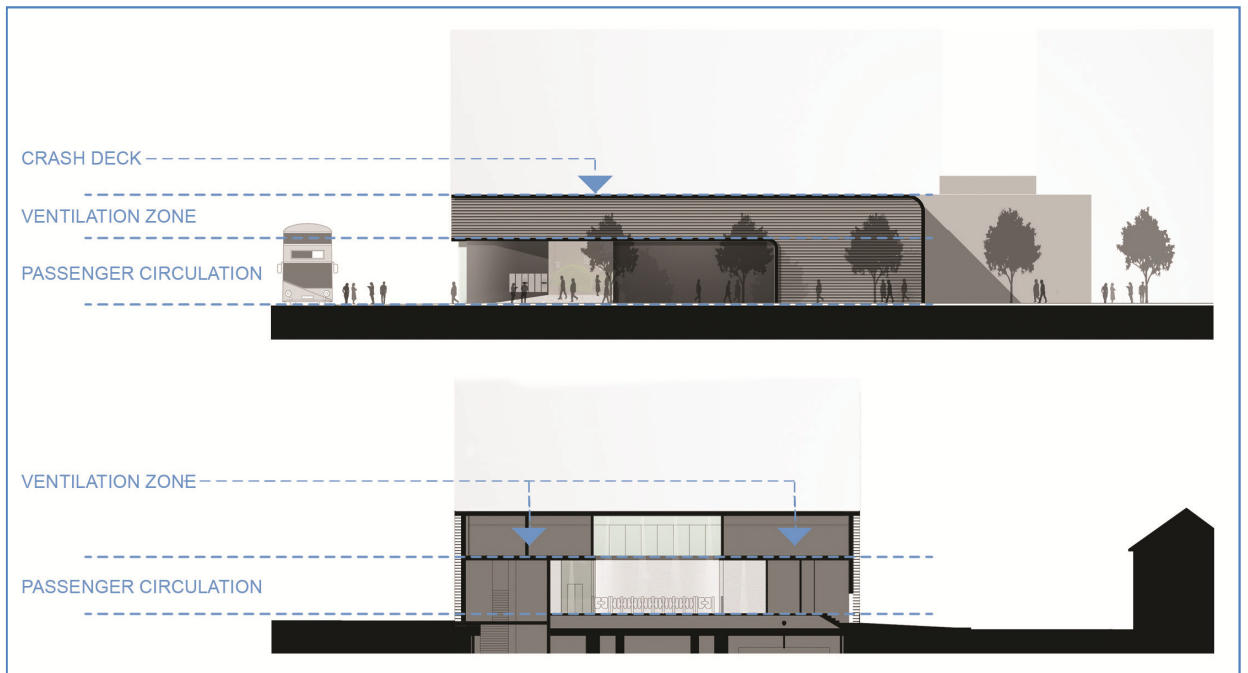


Existing site layout at Nine Elms

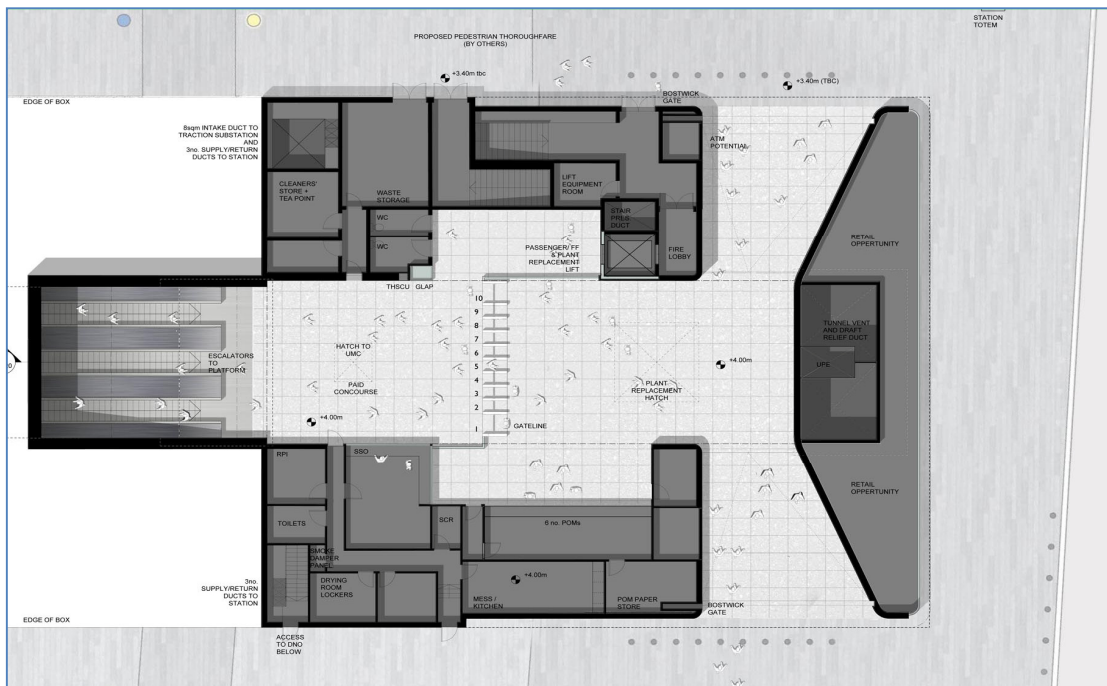


Approved Sainsbury's scheme showing phases 1 & 2

Figure 28 Nine Elms Plans Configuration – Sheet 1



Aspects of the station entrance building



Ticket hall ground level plan

Figure 29 Nine Elms Plans Configuration – Sheet 2