Buro Happold

Appendix B Utility damage assessment results table

Dwg No.	Xdisp Ref	Material	Pipe Diameter (m)	Wall thickness (mm)	Joint Rotation (degrees)			Joint Pull-out (mm)			Tensile Strain (%)		
					Calculated	Limit	Result	Calculated	Limit	Result	Calculated	Limit	Result
1	B41.1	PE	0.090	5.65	0.306	0.25	FAIL	12.02	25	PASS	0.005	0.075	PASS
3	B34.1	PE	0.080	8.00	0.058	0.25	PASS	4.70	25	PASS	0.003	0.075	PASS
3	B34.2	PE	0.080	8.00	0.069	0.25	PASS	3.84	25	PASS	0.008	0.075	PASS
3	B35.1	Cast Iron	0.914	91.44	0.081	0.01	FAIL	5.06	0.5	FAIL	0.000	0.01	PASS
3	B35.2	Cast Iron	0.914	91.44	0.050	0.01	FAIL	5.06	0.5	FAIL	0.000	0.01	PASS
3	B36.1	PE	0.075	7.50	0.086	0.25	PASS	5.77	25	PASS	0.001	0.075	PASS
3	B36.2	PE	0.075	7.50	0.113	0.25	PASS	5.48	25	PASS	0.006	0.075	PASS
3	B79.1	Steel	0.914	91.44	0.070	0.01	FAIL	5.17	0.5	FAIL	0.000	0.05	PASS
3	B79.2	Steel	0.914	91.44	0.076	0.01	FAIL	4.92	0.5	FAIL	0.000	0.05	PASS
3	B80.1	PE	0.125	7.75	0.070	0.25	PASS	5.09	25	PASS	0.001	0.075	PASS
3	B81.1	PE	0.090	5.65	0.069	0.25	PASS	3.92	25	PASS	0.001	0.075	PASS
3	B82.1	Cast Iron	0.152	15.24	0.076	0.01	FAIL	4.02	0.5	FAIL	0.002	0.01	PASS
3	B83.1	Cast Iron	0.610	60.96	0.082	0.01	FAIL	5.18	0.5	FAIL	0.001	0.01	PASS
3	B83.2	Cast Iron	0.610	60.96	0.080	0.01	FAIL	4.24	0.5	FAIL	0.002	0.01	PASS
3	B84.1	Steel	0.914	91.44	0.047	0.01	FAIL	5.22	0.5	FAIL	0.000	0.05	PASS
4	B38.1	PE	0.180	11.00	0.070	0.25	PASS	4.84	25	PASS	0.002	0.075	PASS
4	B38.2	PE	0.180	11.00	0.078	0.25	PASS	4.81	25	PASS	0.003	0.075	PASS
5	B1.1	Cast Iron	0.508	50.80	0.025	0.01	FAIL	4.11	0.5	FAIL	0.000	0.01	PASS
5	B1.2	Cast Iron	0.508	50.80	0.035	0.01	FAIL	4.60	0.5	FAIL	0.003	0.01	PASS
5	B1.3	Cast Iron	0.508	50.80	0.057	0.01	FAIL	4.60	0.5	FAIL	0.000	0.01	PASS
5	B1.4	Cast Iron	0.508	50.80	0.072	0.01	FAIL	3.82	0.5	FAIL	0.001	0.01	PASS
5	B1.5	Cast Iron	0.508	50.80	0.071	0.01	FAIL	4.59	0.5	FAIL	0.000	0.01	PASS
5	B1.6	Cast Iron	0.508	50.80	0.006	0.01	PASS	1.54	0.5	FAIL	0.000	0.01	PASS
5	B2.1	PE	0.125	7.75	0.071	0.25	PASS	4.68	25	PASS	0.001	0.075	PASS
5	B2.2	PE	0.125	7.75	0.073	0.25	PASS	4.32	25	PASS	0.006	0.075	PASS
5	B2.3	PE	0.125	7.75	0.053	0.25	PASS	4.72	25	PASS	0.000	0.075	PASS
5	B76.1	PE	0.090	5.65	0.052	0.25	PASS	4.70	25	PASS	0.001	0.075	PASS
5	B76.2	PE	0.090	5.65	0.067	0.25	PASS	4.46	25	PASS	0.004	0.075	PASS
6	B3.1	PE	0.090	5.65	0.043	0.25	PASS	4.67	25	PASS	0.000	0.075	PASS
6	B3.2	PE	0.090	5.65	0.069	0.25	PASS	4.64	25	PASS	0.005	0.075	PASS
6	B3.3	PE	0.090	5.65	0.069	0.25	PASS	3.34	25	PASS	0.006	0.075	PASS
6	B3.4	PE	0.090	5.65	0.061	0.25	PASS	4.60	25	PASS	0.003	0.075	PASS
6	B4.1	PE	0.090	5.65	0.071	0.25	PASS	4.59	25	PASS	0.005	0.075	PASS
6	B4.2	PE	0.090	5.65	0.071	0.25	PASS	4.54	25	PASS	0.004	0.075	PASS
6	B72.1	PE	0.180	11.00	0.068	0.25	PASS	4.41	25	PASS	0.004	0.075	PASS
6	B73.1	Cast Iron	0.508	50.80	0.068	0.01	FAIL	4.46	0.5	FAIL	0.001	0.01	PASS
7	B7.1	PE	0.075	7.50	0.050	0.25	PASS	3.61	25	PASS	0.002	0.075	PASS
7	B8.1	PE	0.125	7.75	0.049	0.25	PASS	3.35	25	PASS	0.002	0.075	PASS
7	B8.2	PE	0.125	7.75	0.049	0.25	PASS	0.59	25	PASS	0.001	0.075	PASS
7	B8.3	PE	0.125	7.75	0.047	0.25	PASS	3.34	25	PASS	0.002	0.075	PASS
7	B10.1	PE	0.075	7.50	0.052	0.25	PASS	3.63	25	PASS	0.002	0.075	PASS
7	B26.1	PE	0.063	6.05	0.077	0.25	PASS	4.51	25	PASS	0.003	0.075	PASS
8	B5.1	PE	0.125	7.75	0.040	0.25	PASS	3.01	25	PASS	0.002	0.075	PASS
8	B6.1	PE	0.090	5.65	0.039	0.25	PASS	3.03	25	PASS	0.002	0.075	PASS
8	B6.2	PE	0.090	5.65	0.039	0.25	PASS	0.29	25	PASS	0.001	0.075	PASS
8	B6.3	PE	0.090	5.65	0.039	0.25	PASS	2.87	25	PASS	0.002	0.075	PASS
8	B9.1	PE	0.080	8.00	0.044	0.25	PASS	3.22	25	PASS	0.002	0.075	PASS
8	B9.2	PE	0.080	8.00	0.044	0.25	PASS	2.71	25	PASS	0.002	0.075	PASS
8	B9.3	PE	0.125	7.75	0.041	0.25	PASS	2.71	25	PASS	0.001	0.075	PASS
8	B9.4	PE	0.125	7.75	0.041	0.25	PASS	0.24	25	PASS	0.001	0.075	PASS
8	B11.1	PE	0.180	11.00	0.040	0.25	PASS	3.06	25	PASS	0.001	0.075	PASS
8	B11.2	PE	0.180	11.00	0.039	0.25	PASS	0.26	25	PASS	0.003	0.075	PASS
8	B11.3	PE	0.180	11.00	0.040	0.25	PASS	3.00	25	PASS	0.001	0.075	PASS
8	B12.1	Ductile Iron	0.100	10.00	0.039	0.01	FAIL	3.72	0.5	FAIL	0.000	0.05	PASS
8	B13.1	Cast Iron	0.076	7.62	0.042	0.01	FAIL	4.44	0.5	FAIL	0.001	0.01	PASS
8	B14.1	PE	0.076	7.62	0.037	0.25	PASS	2.64	25	PASS	0.004	0.075	PASS
8	B14.2	PE	0.076	7.62	0.037	0.25	PASS	4.22	25	PASS	0.001	0.075	PASS
8	B25.1	Ductile Iron	0.100	10.00	0.038	0.01	FAIL	3.88	0.5	FAIL	0.000	0.05	PASS
8	B25.2	Ductile Iron	0.100	10.00	0.051	0.01	FAIL	3.50	0.5	FAIL	0.000	0.05	PASS
8	B27.1	Ductile Iron	0.100	10.00	0.038	0.01	FAIL	2.69	0.5	FAIL	0.000	0.05	PASS

APPENDIX B - Northern Line Extension
Sewer Damage Assessment 01.02.13

Dwg No.	Xdisp Ref	Material	Diameter/Height (m)	Width (m)	Tensile Strain (%)			
					Calculated	Limit	Damage Category	Result
14	B36.1	Brick	1.91	N/A	0.018	0.05	(Negligible)	PASS
14	B36.2	Brick	1.91	N/A	0.033	0.05	(Negligible)	PASS
14	B37.1	Brick	1.60	N/A	0.004	0.05	(Negligible)	PASS
14	B37.2	Brick	1.60	N/A	0.036	0.05	(Negligible)	PASS
14	B38.1	Brick	0.30	N/A	0.004	0.05	(Negligible)	PASS
15	B19.1	Brick	1.14	0.76	0.024	0.05	(Negligible)	PASS
15	B19.2	Brick	1.14	0.76	0.004	0.05	(Negligible)	PASS
15	B19.3	Brick	1.14	0.76	0.027	0.05	(Negligible)	PASS
15	B19.4	Brick	1.14	0.76	0.015	0.05	(Negligible)	PASS
15	B20.1	Brick	1.14	0.76	0.023	0.05	(Negligible)	PASS
15	B20.2	Brick	1.14	0.76	0.005	0.05	(Negligible)	PASS
16	B18.1	Brick	0.30	N/A	0.002	0.05	(Negligible)	PASS
16	B18.2	Brick	0.30	N/A	0.001	0.05	(Negligible)	PASS
16	B18.3	Brick	0.30	N/A	0.004	0.05	(Negligible)	PASS
16	B23.1	Brick	0.91	0.61	0.004	0.05	(Negligible)	PASS
16	B33.1	Brick	1.14	0.76	0.004	0.05	(Negligible)	PASS
16	B34.1	Brick	0.30	N/A	0.003	0.05	(Negligible)	PASS
16	B34.2	Brick	0.30	N/A	0.000	0.05	(Negligible)	PASS
16	B39.1	Brick	0.30	N/A	0.005	0.05	(Negligible)	PASS
16	B40.1	Brick	0.30	N/A	0.004	0.05	(Negligible)	PASS
17	B6.1	Brick	1.91	N/A	0.005	0.05	(Negligible)	PASS
17	B8.1	Brick	1.52	1.02	0.002	0.05	(Negligible)	PASS
17	B8.2	Brick	1.52	1.02	0.001	0.05	(Negligible)	PASS
17	B8.3	Brick	1.52	1.02	0.001	0.05	(Negligible)	PASS
17	B8.4	Brick	1.52	1.02	0.001	0.05	(Negligible)	PASS
17	B8.5	Brick	1.52	1.02	0.001	0.05	(Negligible)	PASS
17	B8.6	Brick	1.52	1.02	0.001	0.05	(Negligible)	PASS
17	B8.7	Brick	1.52	1.02	0.001	0.05	(Negligible)	PASS
17	B8.8	Brick	1.52	1.02	0.002	0.05	(Negligible)	PASS
17	B8.9	Brick	1.52	1.02	0.000	0.05	(Negligible)	PASS
17	B8.10	Brick	1.52	1.02	0.001	0.05	(Negligible)	PASS
17	B8.11	Brick	1.52	1.02	0.001	0.05	(Negligible)	PASS
17	B8.12	Brick	1.52	1.02	0.010	0.05	(Negligible)	PASS
17	B8.13	Brick	1.52	1.02	0.009	0.05	(Negligible)	PASS
17	B8.14	Brick	1.52	1.02	0.004	0.05	(Negligible)	PASS
17	B8.15	Brick	1.52	1.02	0.006	0.05	(Negligible)	PASS
17	B8.16	Brick	1.52	1.02	0.008	0.05	(Negligible)	PASS
17	B8.17	Brick	1.52	1.02	0.007	0.05	(Negligible)	PASS
17	B11.1	Brick	0.30	N/A	0.003	0.05	(Negligible)	PASS
17	B12.1	Brick	1.15	N/A	0.004	0.05	(Negligible)	PASS
17	B13.1	Brick	0.23	N/A	0.005	0.05	(Negligible)	PASS
17	B14.1	Brick	0.30	N/A	0.005	0.05	(Negligible)	PASS
17	B15.1	Brick	3.35	2.29	0.004	0.05	(Negligible)	PASS
17	B15.2	Brick	3.35	2.29	0.004	0.05	(Negligible)	PASS
17	B16.1	Brick	3.35	2.29	0.004	0.05	(Negligible)	PASS
17	B17.1	Brick	1.37	0.91	0.004	0.05	(Negligible)	PASS
17	B30.1	Brick	1.75	N/A	0.008	0.05	(Negligible)	PASS
17	B31.1	Brick	0.23	N/A	0.007	0.05	(Negligible)	PASS

Appendix B - Northern Line Extension
Gas damage assessment - 14.03.13

8	B46.1	PE	0.180	11.00	0.040	0.25	PASS	0.35	25	PASS	0.002	0.075	PASS
8	B47.1	PE	0.076	7.62	0.037	0.25	PASS	2.70	25	PASS	0.004	0.075	PASS
8	B64.1	Ductile Iron	0.100	10.00	0.054	0.01	FAIL	4.31	0.5	FAIL	0.001	0.05	PASS
9	B15.1	PE	0.450	27.40	0.043	0.25	PASS	3.10	25	PASS	0.004	0.075	PASS
9	B17.1	PE	0.063	6.05	0.036	0.25	PASS	2.74	25	PASS	0.003	0.075	PASS
9	B17.2	PE	0.063	6.05	0.041	0.25	PASS	2.66	25	PASS	0.006	0.075	PASS
9	B48.1	PE	0.063	6.05	0.041	0.25	PASS	2.78	25	PASS	0.006	0.075	PASS
9	B49.1	PE	0.051	5.08	0.035	0.25	PASS	3.03	25	PASS	0.000	0.075	PASS
9	B54.1	PE	0.051	5.08	0.042	0.25	PASS	3.02	25	PASS	0.004	0.075	PASS
9	B58.1	Cast Iron	0.914	91.44	0.044	0.01	FAIL	3.17	0.5	FAIL	0.001	0.01	PASS
9	B59.1	Cast Iron	0.610	60.96	0.044	0.01	FAIL	3.11	0.5	FAIL	0.001	0.01	PASS
9	B60.1	Cast Iron	0.406	40.64	0.044	0.01	FAIL	3.11	0.5	FAIL	0.001	0.01	PASS
9	B61.1	Cast Iron	0.305	30.48	0.041	0.01	FAIL	3.09	0.5	FAIL	0.001	0.01	PASS
9	B61.2	Cast Iron	0.305	30.48	0.043	0.01	FAIL	3.15	0.5	FAIL	0.002	0.01	PASS
9	B62.1	Cast Iron	0.508	50.80	0.044	0.01	FAIL	3.29	0.5	FAIL	0.001	0.01	PASS
9	B74.1	PE	0.080	8.00	0.036	0.25	PASS	2.87	25	PASS	0.001	0.075	PASS
9	B74.2	PE	0.080	8.00	0.042	0.25	PASS	2.93	25	PASS	0.005	0.075	PASS
10	B16.1	PE	0.063	6.05	0.042	0.25	PASS	2.92	25	PASS	0.007	0.075	PASS
10	B55.1	PE	0.090	5.65	0.046	0.25	PASS	3.35	25	PASS	0.005	0.075	PASS
10	B56.1	Cast Iron	0.914	91.44	0.047	0.01	FAIL	3.22	0.5	FAIL	0.001	0.01	PASS
10	B57.1	Cast Iron	0.914	91.44	0.047	0.01	FAIL	3.23	0.5	FAIL	0.001	0.01	PASS
10	B65.1	PE	0.051	5.08	0.045	0.25	PASS	3.13	25	PASS	0.007	0.075	PASS
10	B75.1	PE	0.063	6.05	0.042	0.25	PASS	2.87	25	PASS	0.002	0.075	PASS
11	B21.1	PE	0.075	7.50	0.085	0.25	PASS	12.28	25	PASS	0.005	0.075	PASS
11	B21.2	PE	0.075	7.50	0.207	0.25	PASS	12.28	25	PASS	0.005	0.075	PASS
11	B22.1	PE	0.075	7.50	0.104	0.25	PASS	8.92	25	PASS	0.039	0.075	PASS
11	B22.2	PE	0.075	7.50	0.181	0.25	PASS	14.11	25	PASS	0.006	0.075	PASS
11	B23.1	PE	0.125	7.75	0.104	0.25	PASS	8.94	25	PASS	0.002	0.075	PASS
11	B43.1	Steel	0.610	60.96	0.053	0.01	FAIL	3.93	0.5	FAIL	0.001	0.05	PASS
11	B63.1	Cast Iron	0.305	30.48	0.044	0.01	FAIL	4.25	0.5	FAIL	0.001	0.01	PASS
11	B63.2	Cast Iron	0.305	30.48	0.055	0.01	FAIL	3.95	0.5	FAIL	0.002	0.01	PASS
12	B18.1	PE	0.125	7.75	0.054	0.25	PASS	3.79	25	PASS	0.027	0.075	PASS
12	B19.1	PE	0.090	5.65	0.053	0.25	PASS	3.96	25	PASS	0.005	0.075	PASS
12	B20.1	Cast Iron	0.152	15.24	0.056	0.01	FAIL	4.09	0.5	FAIL	0.001	0.01	PASS
12	B20.2	Cast Iron	0.152	15.24	0.056	0.01	FAIL	3.63	0.5	FAIL	0.002	0.01	PASS
12	B24.2	PE	0.075	7.50	0.055	0.25	PASS	4.12	25	PASS	0.005	0.075	PASS
12	B32.1	PE	0.063	6.05	0.057	0.25	PASS	4.23	25	PASS	0.004	0.075	PASS
12	B33.1	PE	0.063	6.05	0.057	0.25	PASS	4.12	25	PASS	0.007	0.075	PASS
12	B66.1	PE	0.125	7.75	0.052	0.25	PASS	3.56	25	PASS	0.003	0.075	PASS
12	B67.1	PE	0.125	7.75	0.054	0.25	PASS	3.77	25	PASS	0.002	0.075	PASS
12	B67.2	PE	0.125	7.75	0.049	0.25	PASS	3.92	25	PASS	0.004	0.075	PASS
12	B68.1	PE	0.125	7.75	0.054	0.25	PASS	3.77	25	PASS	0.005	0.075	PASS
12	B69.1	PE	0.125	7.75	0.050	0.25	PASS	3.62	25	PASS	0.003	0.075	PASS
12	B70.1	PE	0.125	7.75	0.055	0.25	PASS	4.19	25	PASS	0.003	0.075	PASS
12	B71.1	PE	0.180	11.00	0.056	0.25	PASS	4.21	25	PASS	0.004	0.075	PASS
13	B29.1	PE	0.125	7.75	0.027	0.25	PASS	6.13	25	PASS	0.033	0.075	PASS
13	B29.2	PE	0.125	7.75	0.166	0.25	PASS	13.58	25	PASS	0.004	0.075	PASS
13	B29.3	PE	0.125	7.75	0.115	0.25	PASS	9.73	25	PASS	0.001	0.075	PASS
13	B30.1	PE	0.125	7.75	0.067	0.25	PASS	4.38	25	PASS	0.008	0.075	PASS
13	B30.2	PE	0.125	7.75	0.062	0.25	PASS	4.41	25	PASS	0.004	0.075	PASS
13	B31.1	PE	0.125	7.75	0.115	0.25	PASS	9.06	25	PASS	0.005	0.075	PASS

APPENDIX B - Northern Line Extension
Sewer Damage Assessment 01.02.13

17	B31.2	Brick	0.23	N/A	0.002	0.05	(Negligible)	PASS
17	B35.1	Brick	0.30	N/A	0.007	0.05	(Negligible)	PASS
17	B35.2	Brick	0.30	N/A	0.007	0.05	(Negligible)	PASS
18	B1.1	Brick	0.31	N/A	0.021	0.05	(Negligible)	PASS
18	B1.2	Brick	0.31	N/A	0.006	0.05	(Negligible)	PASS
18	B21.1	Brick	0.31	N/A	0.064	0.05	(Very Slight)	FAIL
18	B21.2	Brick	0.31	N/A	0.047	0.05	(Negligible)	PASS
18	B22.1	Brick	0.31	N/A	0.107	0.05	(Slight)	FAIL
19	B4.1	Brick	1.37	0.91	0.017	0.05	(Negligible)	PASS
19	B4.2	Brick	1.37	0.91	0.005	0.05	(Negligible)	PASS
19	B5.1	Brick	0.30	N/A	0.023	0.05	(Negligible)	PASS
19	B5.2	Brick	0.30	N/A	0.011	0.05	(Negligible)	PASS
19	B7.1	Brick	1.37	0.91	0.025	0.05	(Negligible)	PASS
19	B9.1	Brick	0.30	N/A	0.003	0.05	(Negligible)	PASS
19	B10.1	Brick	0.30	N/A	0.006	0.05	(Negligible)	PASS
19	B24.1	Brick	0.30	N/A	0.004	0.05	(Negligible)	PASS
19	B24.2	Brick	0.30	N/A	0.003	0.05	(Negligible)	PASS
19	B26.1	Brick	0.30	N/A	0.007	0.05	(Negligible)	PASS
19	B26.2	Brick	0.30	N/A	0.009	0.05	(Negligible)	PASS
19	B27.1	Brick	0.30	N/A	0.003	0.05	(Negligible)	PASS
19	B28.1	Brick	0.30	N/A	0.007	0.05	(Negligible)	PASS
19	B28.2	Brick	0.30	N/A	0.001	0.05	(Negligible)	PASS
19	B28.3	Brick	0.30	N/A	0.009	0.05	(Negligible)	PASS
19	B29.1	Brick	0.30	N/A	0.004	0.05	(Negligible)	PASS
19	B29.2	Brick	0.30	N/A	0.010	0.05	(Negligible)	PASS
19	B41.1	Brick	0.30	N/A	0.006	0.05	(Negligible)	PASS
20	B2.1	Brick	0.31	N/A	0.020	0.05	(Negligible)	PASS
20	B3.1	Brick	0.31	N/A	0.189	0.05	**(Moderate)**	FAIL
20	B3.2	Brick	0.31	N/A	0.035	0.05	(Negligible)	PASS

APPENDIX B - Northern Line Extension
Water Damage Assessment 14.03.2013

Dwg No.	Xdisp Ref	Material	Pipe Diameter (m)	Wall thickness (mm)	Joint Rotation (degrees)			Joint Pull-out (mm)			Tensile Strain (%)		
					Calculated	Limit	Result	Calculated	Limit	Result	Calculated	Limit	Result
21	B48.1	Cast Iron	0.102	10.16	0.000	0.15	PASS	0.00	7.5	PASS	0.000	0.01	PASS
21	B49.1	Cast Iron	0.102	10.16	0.338	0.15	FAIL	12.02	7.5	FAIL	0.011	0.01	FAIL
21	B60.1	Cast Iron	0.102	10.16	0.000	0.15	PASS	0.00	7.5	PASS	0.000	0.01	PASS
21	B82.1	Cast Iron	0.102	10.16	0.165	0.15	FAIL	14.06	7.5	FAIL	0.010	0.01	PASS
21	B83.1	Cast Iron	0.762	76.20	0.000	0.15	PASS	0.00	7.5	PASS	0.000	0.01	PASS
21	B83.2	Cast Iron	0.762	76.20	0.000	0.15	PASS	0.00	7.5	PASS	0.000	0.01	PASS
22	B29.1	Cast Iron	0.381	38.10	0.110	0.15	PASS	5.53	7.5	PASS	0.006	0.01	PASS
22	B47.1	Cast Iron	0.102	10.16	0.087	0.15	PASS	5.77	7.5	PASS	0.001	0.01	PASS
22	B47.2	Cast Iron	0.102	10.16	0.113	0.15	PASS	5.48	7.5	PASS	0.012	0.01	FAIL
22	B85.1	Cast Iron	0.381	38.10	0.122	0.15	PASS	5.56	7.5	PASS	0.008	0.01	PASS
22	B86.1	Cast Iron	0.762	76.20	0.117	0.15	PASS	5.60	7.5	PASS	0.004	0.01	PASS
23	B30.1	Cast Iron	0.450	27.40	0.071	0.15	PASS	5.37	7.5	PASS	0.001	0.01	PASS
23	B30.2	Cast Iron	0.450	27.40	0.071	0.15	PASS	4.43	7.5	PASS	0.000	0.01	PASS
23	B31.1	Cast Iron	0.800	80.00	0.086	0.15	PASS	5.46	7.5	PASS	0.003	0.01	PASS
23	B31.2	Cast Iron	0.800	80.00	0.086	0.15	PASS	1.01	7.5	PASS	0.000	0.01	PASS
23	B31.3	Cast Iron	0.800	80.00	0.086	0.15	PASS	3.82	7.5	PASS	0.000	0.01	PASS
23	B31.4	Cast Iron	0.800	80.00	0.071	0.15	PASS	4.51	7.5	PASS	0.000	0.01	PASS
23	B45.1	Cast Iron	0.100	5.65	0.079	0.15	PASS	4.85	7.5	PASS	0.009	0.01	PASS
23	B45.2	Cast Iron	0.100	5.65	0.050	0.15	PASS	4.86	7.5	PASS	0.000	0.01	PASS
23	B46.1	Cast Iron	0.152	15.24	0.072	0.15	PASS	5.21	7.5	PASS	0.005	0.01	PASS
23	B61.1	Cast Iron	0.051	5.08	0.081	0.15	PASS	4.88	7.5	PASS	0.013	0.01	FAIL
23	B62.1	Cast Iron	0.152	15.24	0.075	0.15	PASS	4.13	7.5	PASS	0.002	0.01	PASS
23	B63.1	Cast Iron	0.152	15.24	0.071	0.15	PASS	5.25	7.5	PASS	0.005	0.01	PASS
23	B64.1	Cast Iron	0.152	15.24	0.073	0.15	PASS	3.94	7.5	PASS	0.002	0.01	PASS
23	B65.1	Cast Iron	0.152	15.24	0.073	0.15	PASS	5.18	7.5	PASS	0.005	0.01	PASS
23	B66.1	Cast Iron	0.150	7.75	0.067	0.15	PASS	4.72	7.5	PASS	0.003	0.01	PASS
23	B67.1	Cast Iron	0.150	7.75	0.070	0.15	PASS	3.96	7.5	PASS	0.008	0.01	PASS
23	B68.1	Cast Iron	0.800	80.00	0.071	0.15	PASS	4.86	7.5	PASS	0.006	0.01	PASS
23	B68.2	Cast Iron	0.800	80.00	0.058	0.15	PASS	5.01	7.5	PASS	0.000	0.01	PASS
23	B69.1	Cast Iron	0.450	27.40	0.071	0.15	PASS	4.59	7.5	PASS	0.015	0.01	FAIL
23	B69.2	Cast Iron	0.450	27.40	0.060	0.15	PASS	4.91	7.5	PASS	0.002	0.01	PASS
23	B70.1	Cast Iron	0.051	5.08	0.082	0.15	PASS	4.78	7.5	PASS	0.012	0.01	FAIL
23	B87.1	Cast Iron	0.381	38.10	0.070	0.15	PASS	5.10	7.5	PASS	0.001	0.01	PASS
23	B88.1	Cast Iron	0.102	10.16	0.075	0.15	PASS	5.28	7.5	PASS	0.002	0.01	PASS
23	B89.1	Cast Iron	3.810	381.00	0.082	0.15	PASS	5.27	7.5	PASS	0.001	0.01	PASS
24	B19.1	Cast Iron	0.102	10.16	0.076	0.15	PASS	3.98	7.5	PASS	0.012	0.01	FAIL
24	B20.1	Cast Iron	0.102	10.16	0.075	0.15	PASS	3.01	7.5	PASS	0.011	0.01	FAIL
24	B50.1	Cast Iron	0.100	5.65	0.000	0.15	PASS	0.09	7.5	PASS	0.000	0.01	PASS
24	B59.1	Cast Iron	0.076	7.62	0.008	0.15	PASS	1.74	7.5	PASS	0.000	0.01	PASS
24	B71.1	Cast Iron	0.076	7.62	0.028	0.15	PASS	3.96	7.5	PASS	0.000	0.01	PASS
24	B72.1	Cast Iron	0.102	10.16	0.064	0.15	PASS	3.83	7.5	PASS	0.000	0.01	PASS
24	B73.1	Cast Iron	0.102	10.16	0.076	0.15	PASS	1.15	7.5	PASS	0.000	0.01	PASS
24	B74.1	Cast Iron	0.100	5.65	0.064	0.15	PASS	4.18	7.5	PASS	0.001	0.01	PASS
24	B74.2	Cast Iron	0.100	5.65	0.067	0.15	PASS	4.18	7.5	PASS	0.010	0.01	PASS
24	B74.3	Cast Iron	0.100	5.65	0.067	0.15	PASS	4.02	7.5	PASS	0.001	0.01	PASS
24	B74.4	Cast Iron	0.100	5.65	0.057	0.15	PASS	4.69	7.5	PASS	0.001	0.01	PASS
24	B91.1	Cast Iron	0.102	10.16	0.052	0.15	PASS	3.57	7.5	PASS	0.000	0.01	PASS

24	B92.1	Cast Iron	0.305	30.48	0.057	0.15	PASS	3.31	7.5	PASS	0.000	0.01	PASS
24	B93.1	Cast Iron	0.305	30.48	0.077	0.15	PASS	0.80	7.5	PASS	0.000	0.01	PASS
24	B94.1	Cast Iron	0.102	10.16	0.092	0.15	PASS	4.69	7.5	PASS	0.007	0.01	PASS
24	B94.2	Cast Iron	0.102	10.16	0.073	0.15	PASS	4.72	7.5	PASS	0.010	0.01	PASS
25	B18.1	Cast Iron	0.178	17.78	0.071	0.15	PASS	4.59	7.5	PASS	0.009	0.01	PASS
25	B28.1	Cast Iron	0.102	10.16	0.050	0.15	PASS	3.42	7.5	PASS	0.002	0.01	PASS
25	B28.2	Cast Iron	0.102	10.16	0.050	0.15	PASS	3.56	7.5	PASS	0.006	0.01	PASS
25	B32.1	Cast Iron	0.152	15.24	0.052	0.15	PASS	4.35	7.5	PASS	0.004	0.01	PASS
25	B42.1	Cast Iron	0.102	10.16	0.080	0.15	PASS	4.51	7.5	PASS	0.006	0.01	PASS
25	B58.1	Cast Iron	0.102	10.16	0.058	0.15	PASS	4.40	7.5	PASS	0.007	0.01	PASS
25	B95.1	Cast Iron	0.102	10.16	0.072	0.15	PASS	4.64	7.5	PASS	0.009	0.01	PASS
25	B96.1	Cast Iron	0.178	17.78	0.072	0.15	PASS	4.64	7.5	PASS	0.009	0.01	PASS
25	B97.1	Cast Iron	0.102	10.16	0.068	0.15	PASS	4.43	7.5	PASS	0.007	0.01	PASS
25	B98.1	Cast Iron	0.102	10.16	0.080	0.15	PASS	5.07	7.5	PASS	0.006	0.01	PASS
26	B3.1	Cast Iron	0.102	10.16	0.033	0.15	PASS	4.20	7.5	PASS	0.003	0.01	PASS
26	B4.1	Cast Iron	0.102	10.16	0.041	0.15	PASS	3.38	7.5	PASS	0.002	0.01	PASS
26	B15.1	Cast Iron	0.102	10.16	0.043	0.15	PASS	2.72	7.5	PASS	0.002	0.01	PASS
26	B16.1	PE	0.125	7.75	0.041	0.25	PASS	4.11	25	PASS	0.003	0.08	PASS
26	B17.1	Cast Iron	0.102	10.16	0.037	0.15	PASS	4.46	7.5	PASS	0.002	0.01	PASS
26	B27.1	Cast Iron	0.381	38.10	0.039	0.15	PASS	3.04	7.5	PASS	0.002	0.01	PASS
26	B33.1	Cast Iron	0.102	10.16	0.051	0.15	PASS	4.44	7.5	PASS	0.008	0.01	PASS
26	B34.1	Cast Iron	0.305	30.48	0.041	0.15	PASS	3.08	7.5	PASS	0.007	0.01	PASS
26	B75.1	Cast Iron	0.152	15.24	0.039	0.15	PASS	3.10	7.5	PASS	0.002	0.01	PASS
26	B76.1	Cast Iron	0.102	10.16	0.044	0.15	PASS	3.80	7.5	PASS	0.004	0.01	PASS
26	B76.2	Cast Iron	0.102	10.16	0.043	0.15	PASS	2.56	7.5	PASS	0.002	0.01	PASS
26	B99.1	Cast Iron	0.076	7.62	0.040	0.15	PASS	2.98	7.5	PASS	0.004	0.01	PASS
26	B100.1	PE	0.125	7.75	0.039	0.25	PASS	3.00	25	PASS	0.006	0.08	PASS
26	B101.1	Cast Iron	0.102	10.16	0.056	0.15	PASS	4.49	7.5	PASS	0.004	0.01	PASS
26	B101.2	Cast Iron	0.102	10.16	0.056	0.15	PASS	2.15	7.5	PASS	0.010	0.01	PASS
26	B102.1	Cast Iron	0.102	10.16	0.031	0.15	PASS	4.22	7.5	PASS	0.003	0.01	PASS
27	B37.1	Cast Iron	0.102	10.16	0.036	0.15	PASS	2.81	7.5	PASS	0.011	0.01	FAIL
27	B103.1	Cast Iron	0.102	10.16	0.036	0.15	PASS	2.75	7.5	PASS	0.012	0.01	FAIL
27	B104.1	Cast Iron	0.102	10.16	0.038	0.15	PASS	2.93	7.5	PASS	0.009	0.01	PASS
28	B22.1	Cast Iron	0.610	60.96	0.040	0.15	PASS	3.23	7.5	PASS	0.009	0.01	PASS
28	B26.1	Cast Iron	0.102	10.16	0.044	0.15	PASS	3.32	7.5	PASS	0.003	0.01	PASS
28	B35.1	Cast Iron	0.102	10.16	0.037	0.15	PASS	2.93	7.5	PASS	0.014	0.01	FAIL
28	B36.1	Cast Iron	0.102	10.16	0.037	0.15	PASS	2.88	7.5	PASS	0.003	0.01	PASS
28	B55.1	Cast Iron	0.102	10.16	0.039	0.15	PASS	3.14	7.5	PASS	0.013	0.01	FAIL
28	B81.1	Cast Iron	0.102	10.16	0.039	0.15	PASS	3.07	7.5	PASS	0.011	0.01	FAIL
29	B7.1	Cast Iron	0.914	91.44	0.042	0.15	PASS	3.17	7.5	PASS	0.007	0.01	PASS
29	B8.1	Cast Iron	0.102	10.16	0.041	0.15	PASS	3.03	7.5	PASS	0.007	0.01	PASS
29	B9.1	Cast Iron	0.762	76.20	0.042	0.15	PASS	3.17	7.5	PASS	0.009	0.01	PASS
29	B10.1	Cast Iron	0.305	30.48	0.041	0.15	PASS	3.07	7.5	PASS	0.007	0.01	PASS
29	B11.1	Cast Iron	0.076	7.62	0.041	0.15	PASS	3.02	7.5	PASS	0.007	0.01	PASS
29	B51.1	Cast Iron	0.762	76.20	0.042	0.15	PASS	3.13	7.5	PASS	0.004	0.01	PASS
29	B52.1	Cast Iron	0.102	10.16	0.041	0.15	PASS	3.03	7.5	PASS	0.007	0.01	PASS
29	B53.1	Cast Iron	0.610	60.96	0.042	0.15	PASS	3.14	7.5	PASS	0.005	0.01	PASS
29	B54.1	Cast Iron	0.610	60.96	0.045	0.15	PASS	3.31	7.5	PASS	0.007	0.01	PASS
29	B77.1	Cast Iron	0.762	76.20	0.041	0.15	PASS	1.73	7.5	PASS	0.000	0.01	PASS
29	B106.1	Cast Iron	0.457	45.72	0.045	0.15	PASS	3.32	7.5	PASS	0.010	0.01	PASS

29	B107.1	Cast Iron	0.254	25.40	0.044	0.15	PASS	3.29	7.5	PASS	0.012	0.01	FAIL
30	B39.1	Cast Iron	0.102	10.16	0.090	0.15	PASS	11.42	7.5	FAIL	0.009	0.01	PASS
30	B108.1	Cast Iron	0.305	30.48	0.055	0.15	PASS	4.19	7.5	PASS	0.006	0.01	PASS
30	B109.1	Cast Iron	0.305	30.48	0.056	0.15	PASS	4.26	7.5	PASS	0.008	0.01	PASS
30	B110.1	Cast Iron	0.305	30.48	0.056	0.15	PASS	4.25	7.5	PASS	0.009	0.01	PASS
30	B111.1	Cast Iron	0.102	10.16	0.225	0.15	FAIL	7.49	7.5	PASS	0.006	0.01	PASS
31	B2.1	Cast Iron	0.076	7.62	0.059	0.15	PASS	4.40	7.5	PASS	0.014	0.01	FAIL
31	B5.1	Cast Iron	0.102	10.16	0.131	0.15	PASS	11.74	7.5	FAIL	0.010	0.01	PASS
31	B6.1	Cast Iron	0.102	10.16	0.120	0.15	PASS	9.90	7.5	FAIL	0.003	0.01	PASS
31	B6.2	Cast Iron	0.102	10.16	0.153	0.15	FAIL	14.13	7.5	FAIL	0.008	0.01	PASS
31	B12.1	Cast Iron	0.102	10.16	0.046	0.15	PASS	3.53	7.5	PASS	0.006	0.01	PASS
31	B13.1	Cast Iron	0.102	10.16	0.046	0.15	PASS	3.50	7.5	PASS	0.007	0.01	PASS
31	B21.1	Cast Iron	0.102	10.16	0.087	0.15	PASS	8.45	7.5	FAIL	0.011	0.01	FAIL
31	B23.1	Cast Iron	0.914	91.44	0.055	0.15	PASS	4.35	7.5	PASS	0.003	0.01	PASS
31	B24.2	Cast Iron	0.508	50.80	0.056	0.15	PASS	4.27	7.5	PASS	0.004	0.01	PASS
31	B25.1	Cast Iron	0.127	12.70	0.055	0.15	PASS	4.20	7.5	PASS	0.005	0.01	PASS
31	B38.1	Cast Iron	0.076	7.62	0.050	0.15	PASS	3.86	7.5	PASS	0.012	0.01	FAIL
31	B40.2	Cast Iron	0.076	7.62	0.051	0.15	PASS	4.12	7.5	PASS	0.002	0.01	PASS
31	B41.1	Cast Iron	0.102	10.16	0.044	0.15	PASS	3.62	7.5	PASS	0.005	0.01	PASS
31	B43.2	Cast Iron	0.102	10.16	0.166	0.15	FAIL	13.56	7.5	FAIL	0.008	0.01	PASS
31	B43.3	Cast Iron	0.102	10.16	0.115	0.15	PASS	9.73	7.5	FAIL	0.001	0.01	PASS
31	B56.1	Cast Iron	0.102	10.16	0.046	0.15	PASS	3.55	7.5	PASS	0.006	0.01	PASS
31	B57.1	Cast Iron	0.127	12.70	0.052	0.15	PASS	4.19	7.5	PASS	0.007	0.01	PASS
31	B78.1	Cast Iron	0.102	10.16	0.048	0.15	PASS	3.93	7.5	PASS	0.005	0.01	PASS
31	B79.1	Cast Iron	0.102	10.16	0.048	0.15	PASS	3.87	7.5	PASS	0.005	0.01	PASS
31	B80.1	Cast Iron	0.102	10.16	0.039	0.15	PASS	4.00	7.5	PASS	0.003	0.01	PASS

Appendix C Typical values of volume loss

Recorded Volume Loss	Project	Reference
Maximum recorded volume loss of 0.8%	Channel Tunnel Rail Link Contract 220	Mair (2008)
0.52 to 1.03	West Bound Jubilee Line Extension	Standing and Selman (2001)
0.72 to 1.11	East Bound Jubilee Line Extension	Standing and Selman (2001)
0.25% to 0.75% within London Clay	Channel Tunnel Rail Link contract 220, 230, 240, and 250	Bowers and Moss (2006)
Volume loss assumed in design	**Project**	**Reference**
1% to 2% in London Clay	Literature	Bracegirdle et al (1996)
1.5%	Impact of Heathrow Express Tunnel Multi Storey Car Park West Foundation (NATM Tunnel)	Buro Happold (2004)
1.3%	Jubilee Line Extension NATM Tunnel diameters less than	Mair and Taylor (2001)
1.5%	Jubilee Line Extension NATM Tunnel diameters greater than 6m	Mair and Taylor (2001)
2%	Jubilee Line Extension NATM Tunnels interacting with cross passages	Mair and Taylor (2001)

Buro Happold

Appendix D Results from sensitivity analysis

Drawing numbers:

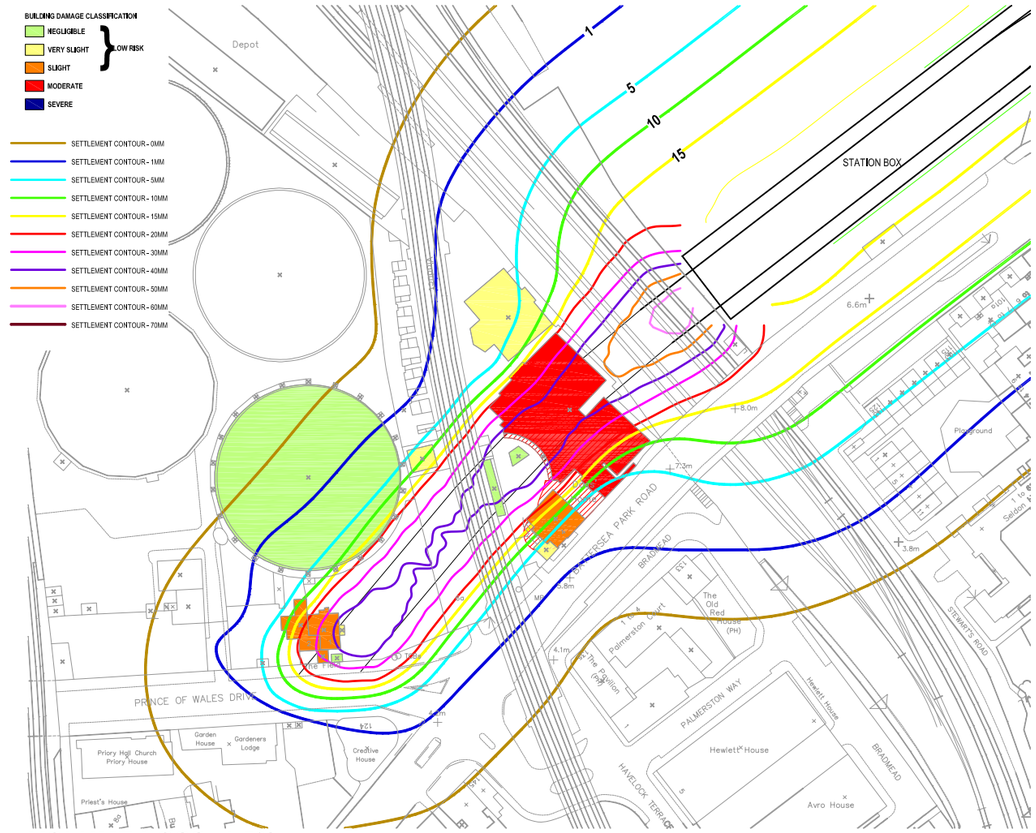
GRNLEB-BHD-TU-XX-DR-GEO-15600-03-01

GRNLEB-BHD-TU-XX-DR-GEO-15601-01-01

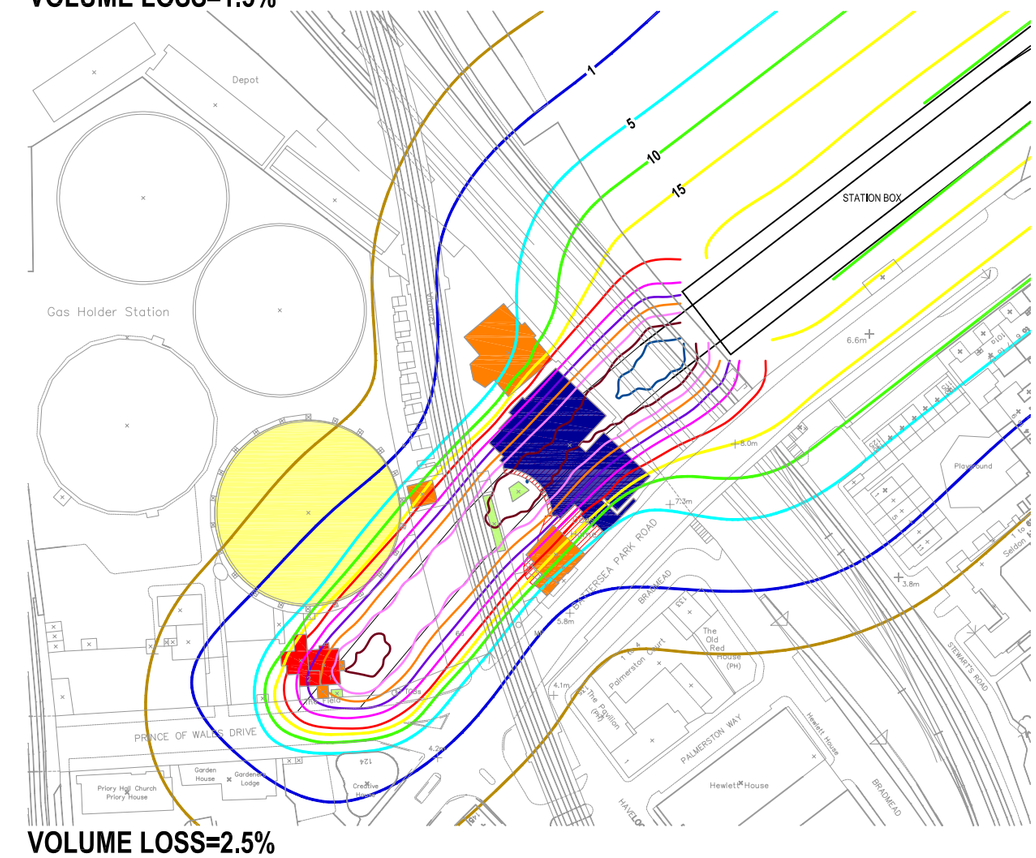
GRNLEB-BHD-TU-XX-DR-GEO-15602-02-01

GRNLEB-BHD-TU-XX-DR-GEO-15603-01-01

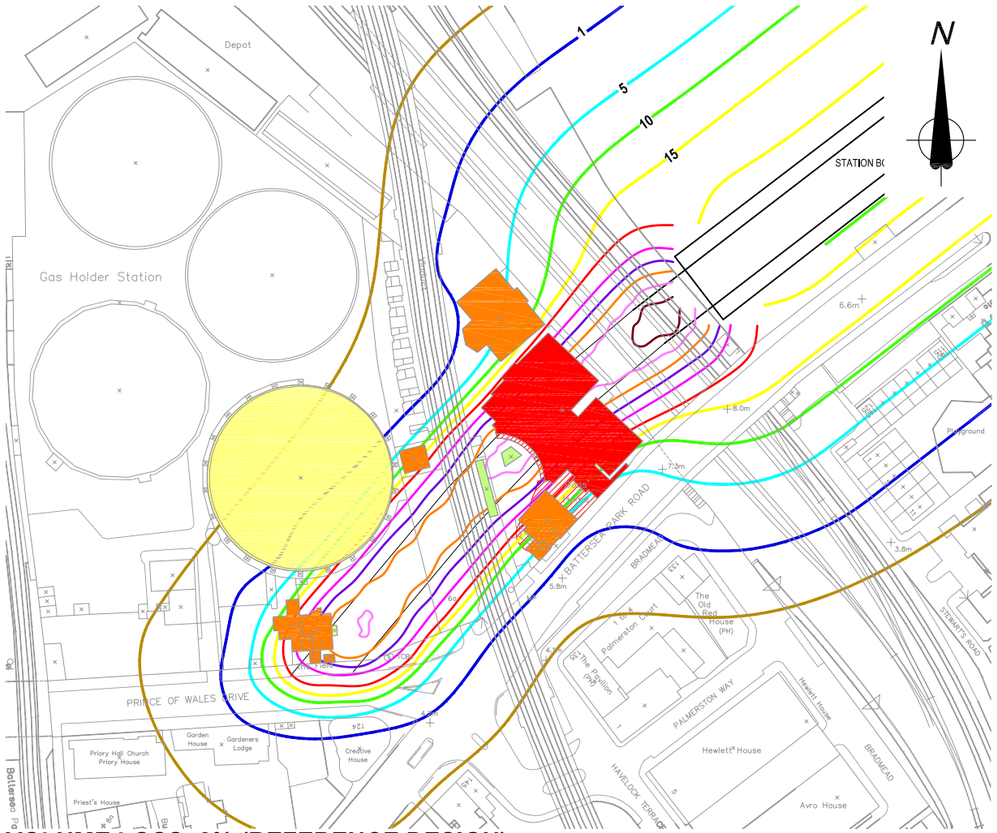
GRNLEB-BHD-TU-XX-DR-GEO-15604-02-01



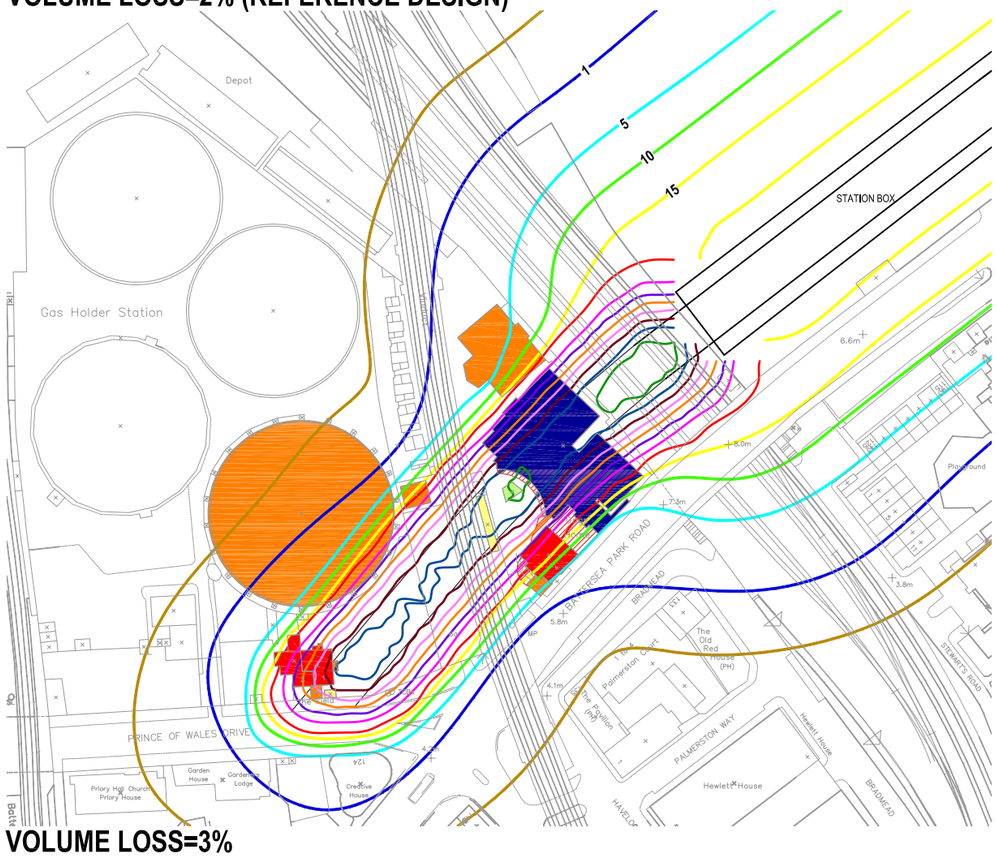
VOLUME LOSS=1.5%



VOLUME LOSS=2.5%

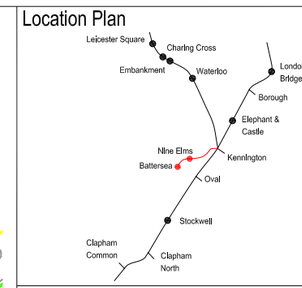


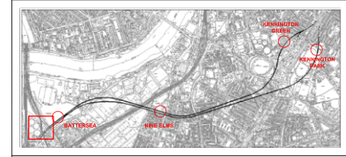
VOLUME LOSS=2% (REFERENCE DESIGN)



VOLUME LOSS=3%

Location Plan





Notes:

THIS DRAWING IS ONLY TO BE USED FOR REVIEWING THE SETTLEMENT ANALYSIS. THE PREDICTED SETTLEMENT AND BUILDING DAMAGE CLASSIFICATION SHOWN ARE FOR COMPARATIVE PURPOSES ONLY AND ARE NOT TO BE INTERPRETED WITH RESPECT TO TWAO POWERS.

1. ALL CONTOURS SHOWN ARE IN MM.
2. THE BUILDING DAMAGE CLASSIFICATION IS BASED ON 'ASSESSMENT METHODS USED IN DESIGN' FOR CROSSRAIL (BURLAND ET AL., 1977)
3. ANALYSIS HAS BEEN BASED ON THE INFORMATION AVAILABLE AT THE TIME OF DESIGN.
4. MODELLING ONLY TAKES ACCOUNT OF THE IMPACT OF THE NORTHERN LINE EXTENSION AND ASSOCIATED INFRASTRUCTURE E.G. STATION BOXES. THE EFFECTS OF BATTERSEA POWER STATION REDEVELOPMENT HAVE NOT BEEN INCORPORATED.
5. TUNNEL ALIGNMENT IS BASED ON DRAWING GRNLEB-HGL-00-XX-M2-PWY-00010-02-01.
6. CROSS PASSAGE LOCATION IS BASED ON DRAWING GRNLEB-HGL-00-XX-DR-TUN-20402-03-01.
7. SETTLEMENT DUE TO RUNNING TUNNELS ARE BASED ON A 1.5% VOLUME LOSS. SEE SETTLEMENT REPORT FOR FULL DETAILS ON OTHER TUNNEL TYPES.
8. SETTLEMENT DUE TO STATION EXCAVATIONS ARE BASED ON CURVES FROM CIRIA C580 FIGURE 2.9(B). THE GROUND MOVEMENT CURVES ARE CONSIDERED TO REPRESENT 100% GROUND MOVEMENT PROFILE. HOWEVER THE STATION EXCAVATIONS WILL HAVE AN INCREASED STIFFNESS AT THE CORNERS, THEREFORE THE SETTLEMENT CONTOURS AND BUILDING DAMAGE CLASSIFICATIONS AROUND THE EXCAVATIONS ARE CONSERVATIVE.
9. SETTLEMENT DUE TO EXCAVATIONS OF SHAFTS IS BASED ON THE LONDON UNDERGROUND MANUAL OF GOOD PRACTICE USING G-058 NEW AND BOWERS (1994).
10. THE MAP IS BASED ON ORDNANCE SURVEY, REPRODUCED FROM LANDRANGER 1:50,000 MAP BY PERMISSION OF ORDNANCE SURVEY ® ON BEHALF OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE. © CROWN COPYRIGHT 1988. ALL RIGHTS RESERVED. LICENSE NUMBER: AL 100005517, THE ORDNANCE SURVEY DATA USED WAS THAT AVAILABLE AT THE TIME OF 2012 REFERENCE DESIGN, AND THUS ANY RECENT CHANGES WILL NOT BE REFLECTED IN THE MAPS USED FOR ANALYSIS.
11. ALL BUILDINGS WITHIN CATEGORY 3 (MODERATE) OR ABOVE ARE SUBJECT TO A FURTHER PHASE OF ASSESSMENT.
12. ALL LISTED BUILDINGS WILL BE SUBJECT TO A FURTHER PHASE OF ASSESSMENT.
13. DEFECTS SURVEYS WILL BE REQUIRED ON ALL BUILDINGS PREDICTED TO EXPERIENCE 10MM OR MORE OF MOVEMENT.
14. DEFECTS SURVEYS WILL BE REQUIRED ON ALL LISTED BUILDING PREDICTED TO EXPERIENCE 1MM OR MORE OF MOVEMENT.
15. RECOMMENDED MONITORING FOR CRITICAL ASSETS IS GIVEN IN SECTION 7 OF THE SETTLEMENT REPORT. (GRNLEB-BHD-00-XX-TNT-GEO-00049)
16. ANY MONITORING PROCEDURE IS TO FOLLOW RELEVANT GUIDANCE PROVIDED BY THE BRITISH TUNNELLING SOCIETY (2004).

Rev	By	Chkd	Apprvd	Date	Description
03-01	JMB	JD	SL	19/02/13	NOTES AMENDED
02-01	JMB	JD	SL	06/02/13	CHANGE TO NOTES
01-01	JMB	JD	SL	18/01/13	FOR INFORMATION

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Transport for London

studiodareARCHITECTS

Buro Happold Consulting Engineers

Halcrow Group Ltd.
A CH2M HILL COMPANY
Elms House, 43 Brook Green
Hammersmith, London W6 7EF
TEL: 020 3479 8000
FAX: 020 3479 8001
www.halcrow.com

Halcrow

Project:

NORTHERN LINE EXTENSION
TO BATTERSEA
TWAO FOR TfL

Drawing:

SENSITIVITY ANALYSIS: EFFECT OF VOLUME LOSS

Suitability:

S4 - FORMAL ISSUE TO CLIENT

Drawn by: JMB	Date:	19/02/13
Checked by: JD	Date:	19/02/13
Approved by: SL	Date:	19/02/13
Drawing Scale: 1:1000		

Drawing No.: GRNLEB-BHD-TU-XX-DR-GEO-15600

Revision: 03-01

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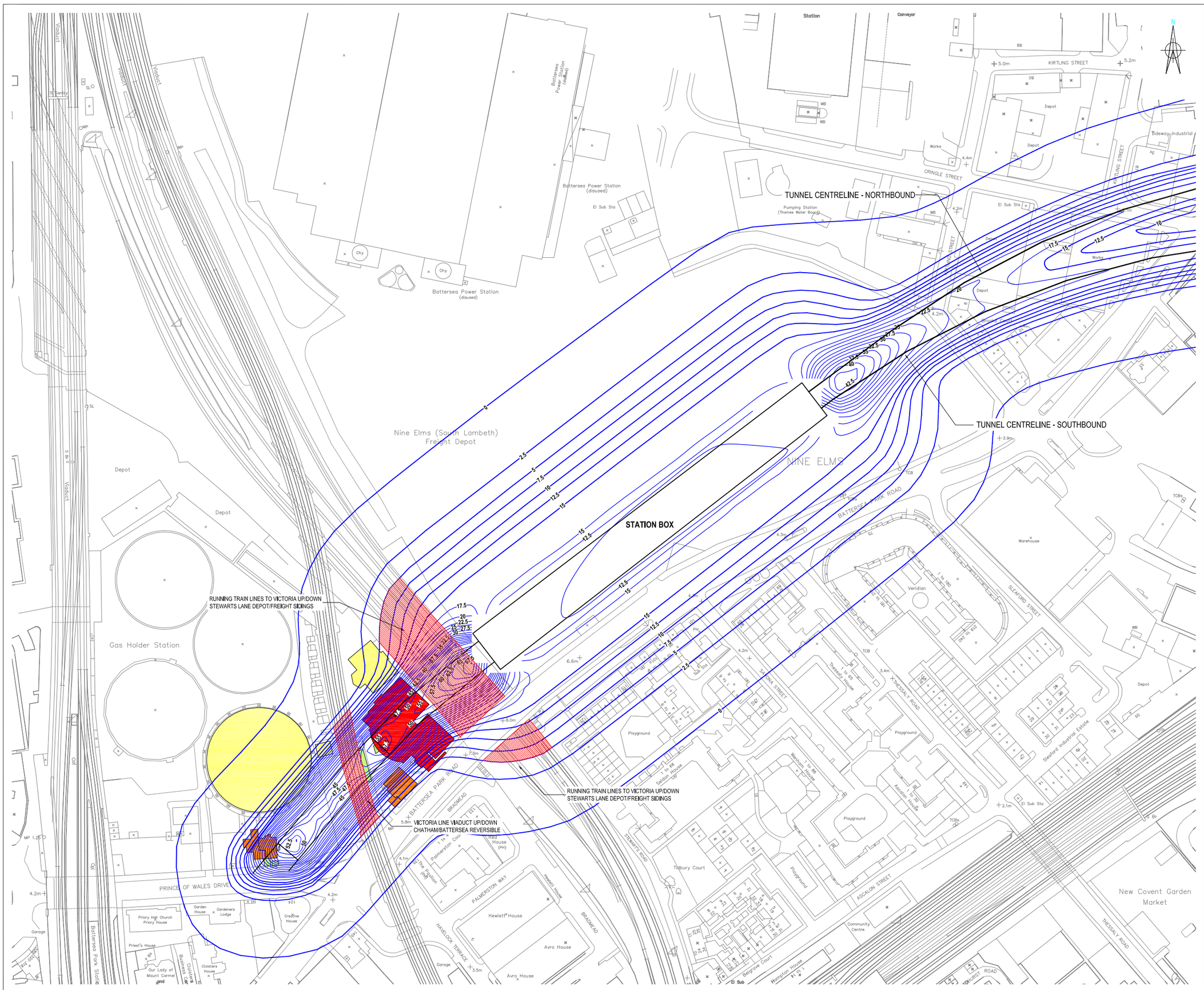

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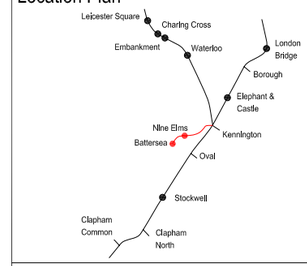
Location Plan



Notes:

1. MODELLING ONLY TAKES ACCOUNT OF THE IMPACT OF THE NORTHERN LINE EXTENSION AND ASSOCIATED INFRASTRUCTURE E.G. STATION BOXES. THE EFFECTS OF THE BATTERSEA POWER STATION REDEVELOPMENT MASTERPLAN HAVE NOT BEEN INCORPORATED.
2. TUNNEL ALIGNMENT IS BASED ON DRAWING GRNLEB-HGL-00-XX-M2-PWY-00010-02-01.
3. ALL CONTOURS SHOWN ARE IN MM
4. SETTLEMENT DUE TO TUNNELS, IN GENERAL, IS BASED ON A 1.5% VOLUME LOSS. SEE SETTLEMENT REPORT FOR FULL DETAILS.
5. SETTLEMENT DUE TO STATION EXCAVATION IS BASED ON CURVES FROM CIRIA C580 FIGURE 2.9(b).
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15 SETTLEMENT CONTOUR (mm)

BUILDING DAMAGE CLASSIFICATION

- NEGLIGIBLE
- VERY SLIGHT
- } LOW RISK
- SLIGHT
- MODERATE
- SEVERE
- NATIONAL RAIL ASSETS WITHIN THE 5mm SETTLEMENT ZONE

Rev	By	Chkd	Apprvd	Date	Description
01-01	NG	JD	JP	18/01/13	FIRST DRAWN

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Buro Happold Consulting Engineers

Halcrow Group Ltd.
A CH2M HILL COMPANY
Elms House, 43 Brook Green
Hammersmith, London W6 7EF
TEL: 020 3479 8000
FAX: 020 3479 8001
www.halcrow.com

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Project:

NORTHERN LINE EXTENSION
TO BATTERSEA
TWAO FOR TfL

Drawing:

SENSITIVITY ANALYSIS EFFECT OF OVER RUN TUNNEL DIAMETER - 7.0M

Suitability:

S4 - FORMAL ISSUE TO CLIENT

Drawn by: NG	Date:	18/01/13
Checked by: JD	Date:	18/01/13
Approved by: JP	Date:	18/01/13
Drawing Scale: 1:1000		

Drawing No.: GRNLEB-BHD-TU-XX-DR-GEO-15601

Revision: 01-01

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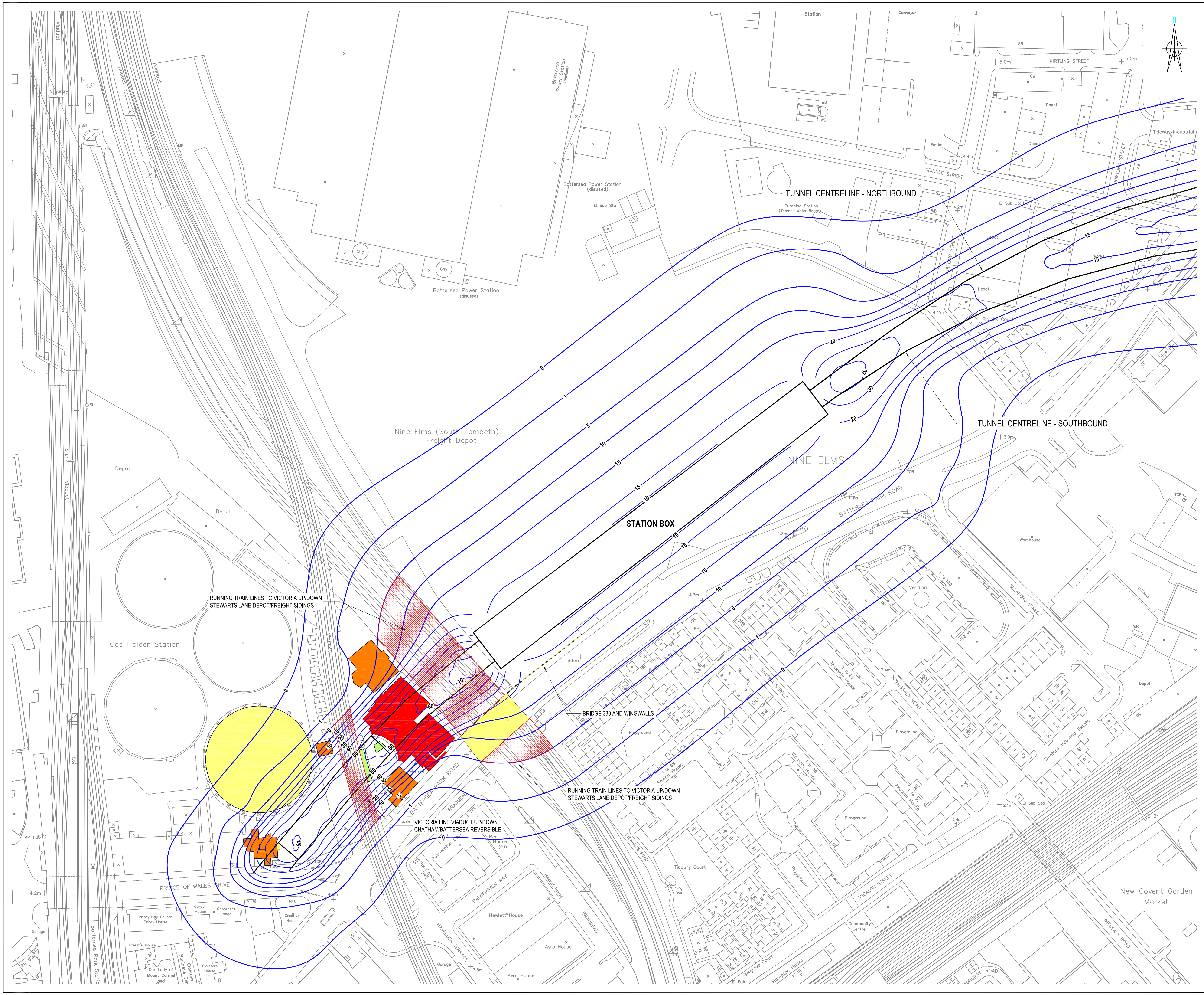

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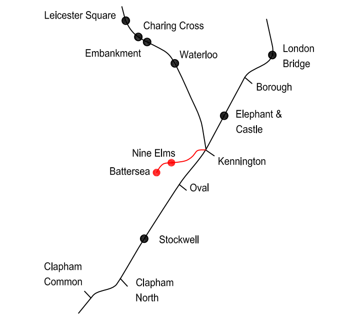
Location Plan



Notes:

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—15— SETTLEMENT CONTOUR (mm)

BUILDING DAMAGE CLASSIFICATION

- NEGLIGIBLE } LOW RISK
- VERY SLIGHT } LOW RISK
- SLIGHT
- MODERATE
- SEVERE
- NATIONAL RAIL ASSETS WITHIN THE 5mm SETTLEMENT ZONE

Rev	By	Chkd	Apprvd	Date	Description
02-01	NG	JD	SL	06/02/13	CHANGE TO NOTES
01-01	NG	JD	JP	18/01/13	FOR INFORMATION

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Buro Happold Consulting Engineers

Halcrow Group Ltd.
A CH2M HILL COMPANY
Elms House, 43 Brook Green
Hammersmith, London W6 7EF
TEL: 020 3479 8000
FAX: 020 3479 8001
www.halcrow.com

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Project:
NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL

Drawing:
SENSITIVITY ANALYSIS EFFECT OF OVER RUN TUNNEL DIAMETER - 7.5M

Suitability: S4 - FORMAL ISSUE TO CLIENT

Drawn by: NG Date: 06/02/13
Checked by: JD Date: 06/02/13
Approved by: JP Date: 06/02/13
Drawing Scale: 1:1000

Drawing No.: GRNLEB-BHD-TU-XX-DR-GEO-15602
Revision: 02-01

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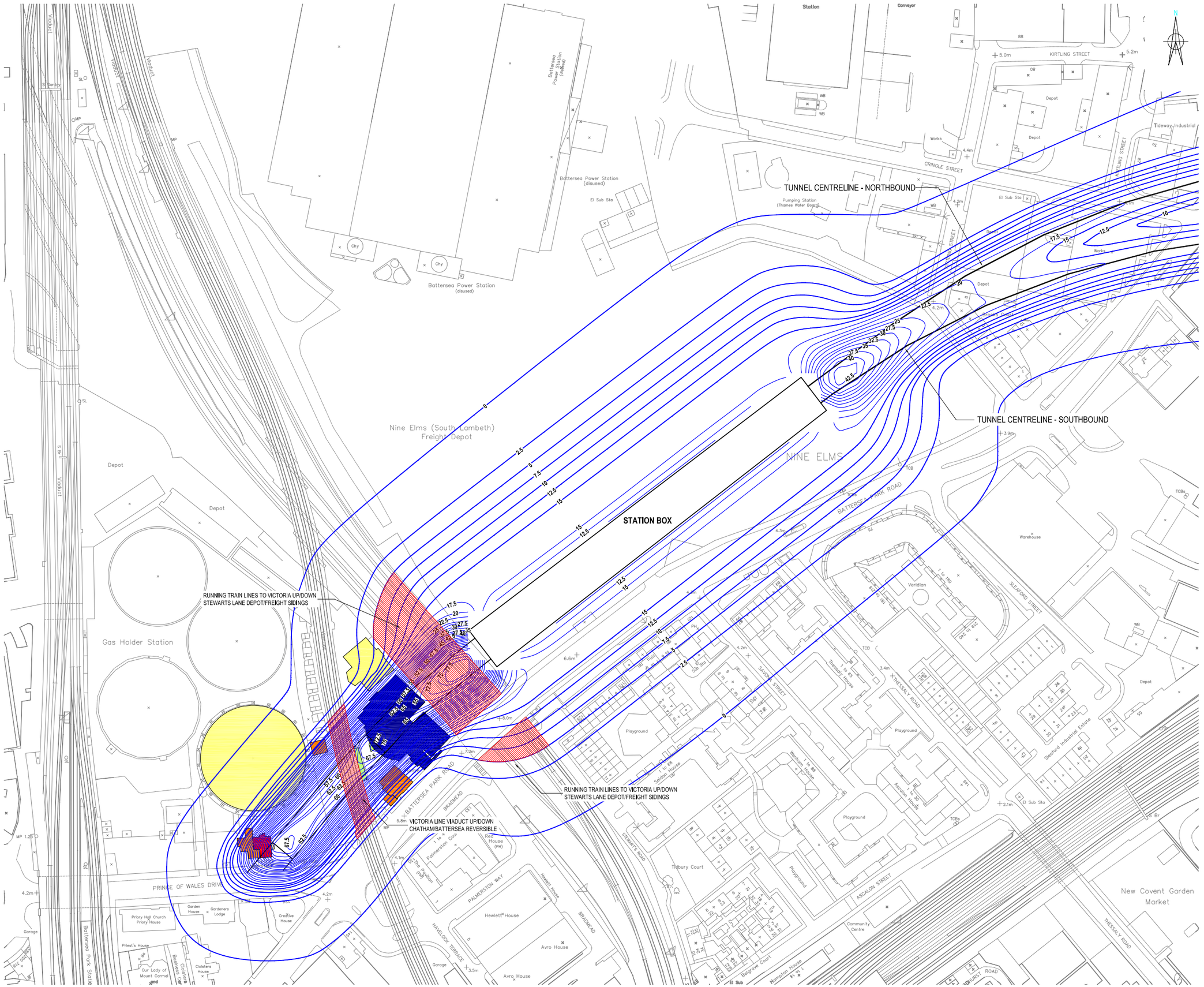
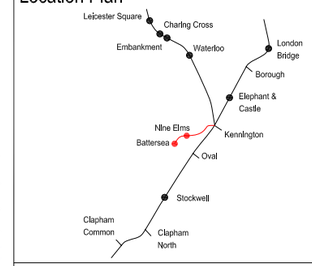
User and Plot Date : jmbarre : 12:2:2013 - 11:2 am



Location Plan



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- NEGLIGIBLE
- VERY SLIGHT
- SLIGHT

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- MODERATE
- SEVERE
- NATIONAL RAIL ASSETS WITHIN THE 5mm SETTLEMENT ZONE

Rev	By	Chkd	Apprvd	Date	Description
01-01	NG	JD	JP	18/01/13	FIRST DRAWN

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Buro Happold Consulting Engineers

Halcrow Group Ltd.
A CH2M HILL COMPANY
Elms House, 43 Brook Green
Hammersmith, London W6 7EF
TEL: 020 3479 8000
FAX: 020 3479 8001
www.halcrow.com

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Project:

NORTHERN LINE EXTENSION
TO BATTERSEA
TWAO FOR TfL

Drawing:

SENSITIVITY ANALYSIS EFFECT OF OVER RUN TUNNEL DIAMETER - 8.0M

Suitability:

S4 - FORMAL ISSUE TO CLIENT

Drawn by: NG	Date:	18/01/13
Checked by: JD	Date:	18/01/13
Approved by: JP	Date:	18/01/13
Drawing Scale: 1:1000		

Drawing No.:	Revision:
GRNLEB-BHD-TU-XX-DR-GEO-15603	01-01

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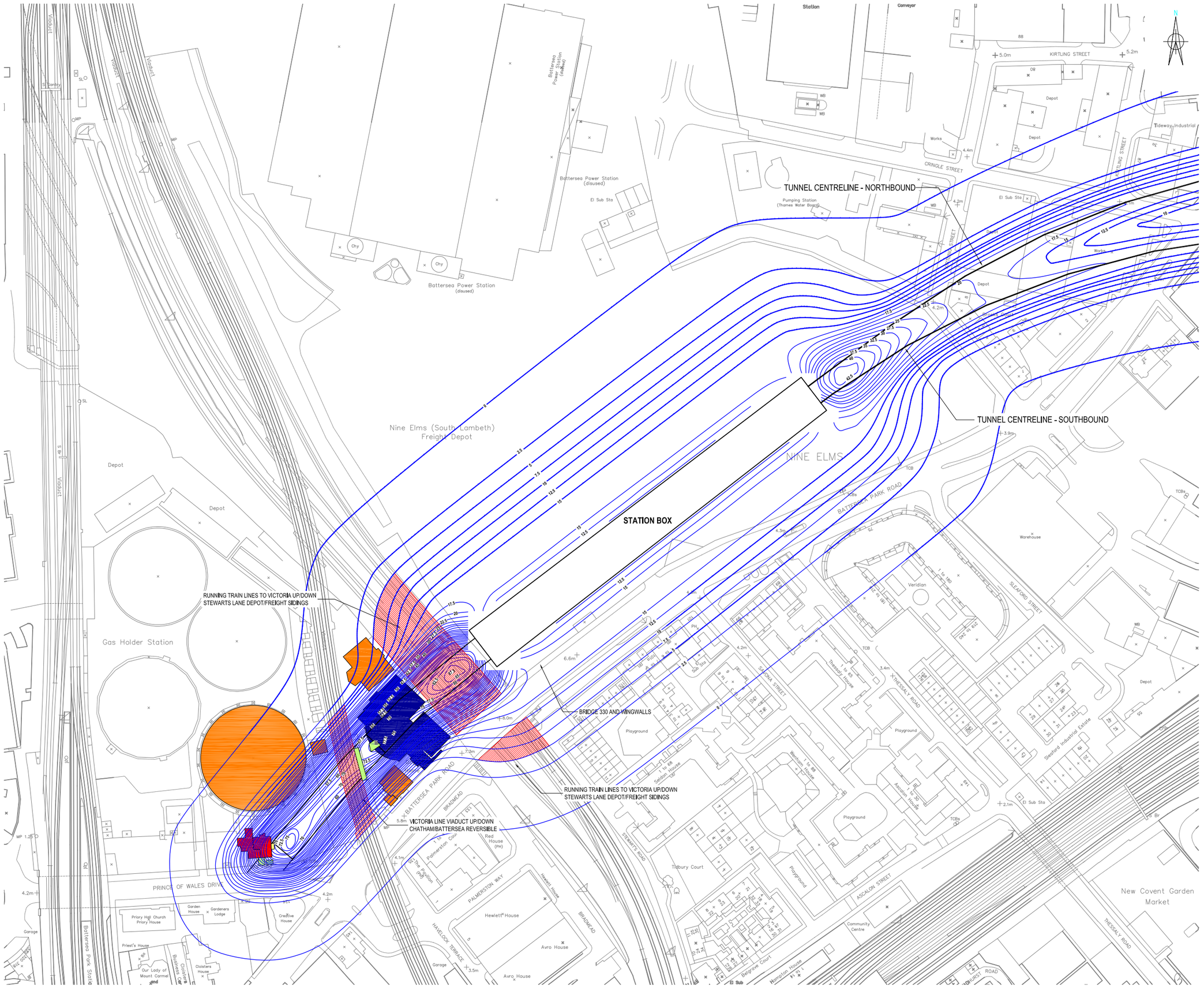
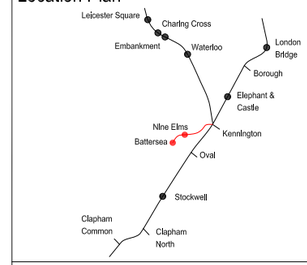
User and Plot Date : Jdewsbur - 6/2/2013 - 4:2 pm



Location Plan



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- NATIONAL RAIL ASSETS WITHIN THE 5mm SETTLEMENT ZONE

Rev	By	Chkd	Apprvd	Date	Description
02-0	NG	JD	SL	06/02/13	CHANGE TO NOTES
01-01	NG	JD	JP	18/01/13	FIRST DRAWN

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Buro Happold
Consulting Engineers

Halcrow Group Ltd.
A CH2M HILL COMPANY
Elms House, 43 Brook Green
Hammersmith, London W6 7EF
TEL: 020 3479 8000
FAX: 020 3479 8001
www.halcrow.com

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TO BATTERSEA
TWAO FOR TfL

Drawing:

SENSITIVITY ANALYSIS EFFECT OF OVER RUN TUNNEL DIAMETER - 8.5M

Suitability: S4 - FORMAL ISSUE TO CLIENT

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Checked by: JD	Date:	06/02/13
Approved by: JP	Date:	06/02/13
Drawing Scale: 1:1000		

Drawing No.:	Revision:
GRNLEB-BHD-TU-XX-DR-GEO-15604	02-01

Drawing file path & name : - : jmburre : 12:2:2013 - 11:2 am
User and Plot Date

Jonathan Dewsbury
Camden Mill
Lower Bristol Road
Bath
BA2 3DQ
UK

Telephone: +44 (0)1225 320600
Facsimile: +44 (0)870 787 4148
Email: Jonathan.Dewsbury@BuroHappold.com

I3: Concept Consultant Limited - Site Investigation

Environmental Statement

Volume II

SITE INVESTIGATION REPORT

Northern Line Extension
Kennington Station to Battersea Power Station

ISSUE 02

CONCEPT

SITE INVESTIGATION REPORT

Northern Line Extension
Kennington Station to Battersea Power Station

Prepared for: REO (Powerstation) Ltd

Concept: 10/2254-FR02

19/07/2010

Unit 8, Warple Mews,
Warple Way
London W3 0RF
Tel: 020 8811 2880
Fax: 020 8811 2881
e-mail: si@conceptconsultants.co.uk
www.conceptconsultants.co.uk

DOCUMENT ISSUE REGISTER

Job Title:	Northern Line Extension - Kennington Station to Battersea Power Station
Job Number:	10/2254
Document Type:	Factual Site Investigation Report

Document Ref:	Status/Issue No.	Date	Amendment Record (Detail)			
10/2254-FR01	Issue - 01	07/07/2010				
				Prepared By:	Checked By:	Approved By:
			Name	D Strong	O Savvidou	A Savidu
			Signature			
Document Ref:	Status/Issue No.	Date	Amendment Record (Detail)			
10/2254-FR02	Issue - 02	19/07/2010				
				Prepared By:	Checked By:	Approved By:
			Name	D Strong	O Savvidou	A Savidu
			Signature			
Document Ref:	Status/Issue No.	Date	Amendment Record (Detail)			
				Prepared By:	Checked By:	Approved By:
			Name			
			Signature			
Document Ref:	Status/Issue No.	Date	Amendment Record (Detail)			
				Prepared By:	Checked By:	Approved By:
			Name			
			Signature			

CONCEPT SITE INVESTIGATIONS
Unit 8, Warple Mews, Warple Way, London W3 0RF
Tel: 020 8811 2880 Fax: 020 8811 2881
e-mail: si@conceptconsultants.co.uk

CONTENTS

1. PROJECT PARTICULARS

Site Address:	Locations along the proposed route of the Northern Line Extension between Battersea Power Station (SW8 5BN) and Kennington Underground Station, Kennington Park Road
Client:	REO (PowerStation) Ltd
Date of Fieldwork:	19/04/2010 to 21/05/2010
Engineer:	Buro Happold Limited

2. SCOPE OF WORK:

The works carried out for this investigation included the following:

- 10 No. Cable Percussion Boreholes to a maximum depth of 40.00m below ground level;
- Installation of standpipes and vibrating wires;
- Associated geotechnical and chemical laboratory testing.

3. DESCRIPTION OF WORKS

3.1 Cable Percussion Boreholes

10 No. Cable percussion boreholes (BH01-BH10) were drilled to a maximum depth of 40.00m below the existing ground level using standard cable percussion boring rigs (Dando 150 and Dando 175) with 200mm and 150mm diameter equipment. The locations of the boreholes are shown on the Exploratory Hole Location Plan in Section 5 of this report.

Concrete and asphalt surfaces, where present at the locations of the boreholes, were broken out in advance of the drilling to allow for the hand excavation of an inspection pit to 1.20m depth. Where no hard surfacing was present, hand excavated inspection pits advanced using hand digging tools to 1.20m depth. All surfaces were reinstated to match existing upon completion of the borehole works.

Bulk samples were taken at regular intervals in the Made Ground and at each change in strata. Undisturbed 102mm nominal diameter (U102) samples were taken using a down-hole sliding hammer at regular intervals in cohesive material where possible or continuously as instructed by the Engineer.

Standard penetration tests (SPT) were carried out at regular intervals alternating with undisturbed samples. The resulting SPT 'N' values are presented in the borehole records. SPT's were taken using a split shoe sampler. Where an SPT using the split shoe sampler was not possible, due to the granular nature of the material, a solid cone was used.

Small, disturbed samples were either retrieved from the cutting shoe of the U4 sampler or from the SPT split spoon sampler. Environmental samples (Tubs, jars and vials) for chemical analysis were taken within the Made Ground at regular intervals.

Within BH02 chemical analysis were screened for Volatile Organic Content (VOC) using a Photocheck 1000+ PID at regular intervals throughout the made ground.

Groundwater observations carried out during the fieldworks and subsequent to completion of the fieldworks (as appropriate) are reported in the relevant borehole logs presented in Section 6 and groundwater monitoring Section 7 of this report.

3.2 Groundwater Monitoring

Groundwater Monitoring Results are presented in Section 7 of this report.
Full Installation details are presented on the relevant borehole logs in Section 6 of this report.

3.2.1 Standpipe/Piezometer Installations

50mm groundwater monitoring standpipes/piezometers and vibrating wires were installed in the boreholes as tabulated below.

BH	Diameter of Installation (mm)	Type of Installation	Tip (m bgl)	Top of Response Zone (m bgl)	Bottom of Response Zone (m bgl)
BH01		VW	21.00		20.00
BH02		VW	26.00		25.00
BH03		VW	26.00		25.00
BH04		VW	33.00		32.00
BH05	50	SP	35.10	33.10	35.10
BH06	50	SP	37.00	24.00	37.00
BH07	50	SP	31.00	27.00	31.00
BH08		VW	23.00		22.00
BH09	50	SP	25.00	22.00	25.00
BH10	50	SP	31.00	23.00	31.00

Note: SP indicates Standpipe/piezometer installation
VW indicates vibrating wire installation

3.2.2 Water Level Loggers

Solinist © Level loggers were installed in all standpipes on 04/06/2010. The level loggers recorded the change in water level every 5 minutes over a 3 week period.

A barometric pressure logger ("barologger") was installed above the water level in BH09. All of the presented results have been corrected for barometric pressure variations.

BH05 Level Logger results have been produced in 2 parts due to a faulty logger.

3.3 Setting Out

The locations of the boreholes were set out using GPS surveying equipment based on the coordinates provided by Buro Happold. Some of the Boreholes were subsequently relocated and a survey was carried out on completion of the fieldworks to establish "as drilled" coordinates and levels.

3.4 Logging / Laboratory Testing

Logging of the samples was carried out in accordance with BS 5930:1999 incorporating Amendment No.1 (Dec '07).

Undisturbed samples selected by the engineer were extruded and described. Individual sample descriptions and Photographs are presented in Section 8 of this report.

All soil tests were carried out in accordance with BS1377 (1990). The results are presented in Section 9 of this report.

All chemical testing has been carried out by Alcontrol in accordance with the requirements of UKAS ISO17025 and ISO17020. The results are presented in tabular formats in Section 10 of this report.

REFERENCES

British Standards Institution, Methods of test for soils for civil engineering purposes, British Standard BS 1377: 1990, BSI, London, 1990.

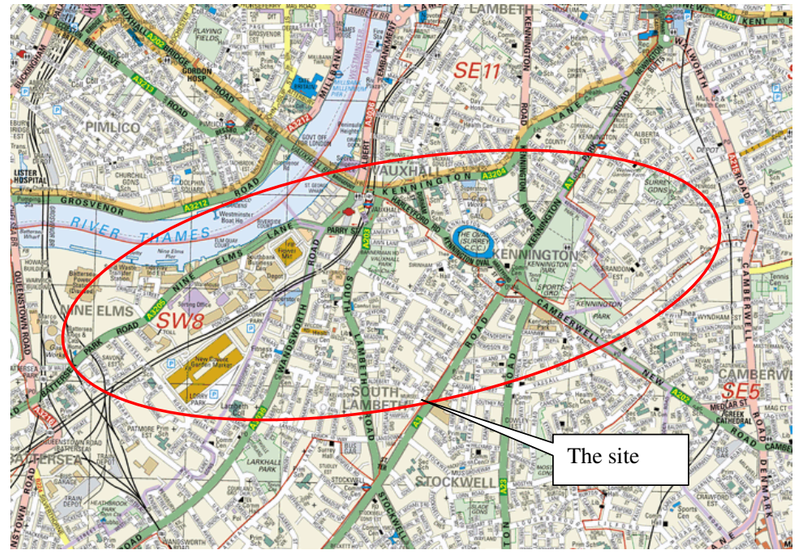
British Standards Institution, (1999) Code of practice for site investigations, British Standard BS 5930: 1999 incorporating Amendment No.1 (Dec '07), BSI, London.

Specification for Ground Investigation, Site Investigation Steering Group, Thomas Telford, London, 1999.

British Geological Survey London and the Thames Valley 4th Edition, London HMSO, 1996.

CONCEPT SITE INVESTIGATIONS

4. SITE LOCATION PLAN



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Northern Line Extension Reference Design 10/2254

5. EXPLORATORY HOLE LOCATION PLAN

COORDINATES & LEVELS

BH	EASTING (m)	NORTHING (m)	LEVEL (mOD)
BH01	529448.29	177496.69	4.08
BH02	529969.63	177326.43	1.66
BH03	530174.75	177326.64	5.49
BH04	530703.36	177270.49	4.49
BH05	530920.74	177502.02	4.39
BH06	531238.39	177554.71	4.54
BH07	531187.82	178024.31	3.25
BH08	531388.71	178144.52	3.86
BH09	531591.99	178135.77	3.95
BH10	531522.07	177927.77	3.64

NOTES

1. This drawing should not be scaled.

No			
Revision			
Drawn			
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Date			

CONCEPT SITE INVESTIGATIONS
Unit 8, Warple Mews
Warple Way Tel: 020 8811 2880
London W3 0RF Fax: 020 8811 2881
e-mail: concept@conceptconsultants.co.uk
www.conceptconsultants.co.uk

Client:	REO (Powerstation) Ltd
Project:	Northern Line Extension
Title:	Exploratory Hole Location Plan
Dwg. No:	10/2254
Status:	Issue
Scale:	NTS
Drawn: OS	Checked: AS
Passed: AS	Date: June 2010

6. CABLE PERCUSSION BOREHOLE LOGS

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH01**

Project Northern Line Extension

Job No	Date Started / Date Completed	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	19/05/10 / 21/05/10	4.08	E 529448.3 N 177496.7	40.00m

Client REO (Powerstation) Ltd

Method/ Plant Used Cable Percussion

Sheet 1 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
19/05/10		Dry	4.01		0.07	TOPSOIL.	0.20			... Roots of live appearance to 0.20m depth	
					(0.60)	Brown clayey SAND with occasional brick and concrete rubble. (MADE GROUND)	0.50	B01			
			3.41		0.67						
						Brown to reddish brown very sandy CLAY with brick and concrete fragments. (MADE GROUND)	1.00	B02			
							1.20-1.65	U03	10 blows		
					(1.73)		1.70	D04			
							2.00		N17	1, 1 / 2, 4, 4, 7	
							2.20-2.65	D05			
							2.20-2.70	B06			
			1.68		2.40						
			1.48		2.60	Soft to firm, brown mottled grey and spotted reddish brown sandy silty CLAY with clayey sand lenses. (ALLUVIUM)					
19/05/10	2.70	3.00				Medium dense to dense, yellowish brown to orangish brown very sandy well rounded fine to coarse flint GRAVEL with rare sandstone fragments. (RIVER TERRACE DEPOSITS)	3.00-3.50	B07			
							3.00		N39	4, 6 / 7, 10, 11, 11	
19/05/10	4.00	3.60					4.00-4.50	B08			
							4.00		N23	3, 4 / 4, 5, 6, 8	
19/05/01	4.50										
19/05/10	5.00	3.10					5.00-5.50	B09			
					(5.70)		5.00		N30	3, 3 / 5, 8, 8, 9	
19/05/10	6.00	2.90					6.00-6.50	B10			
							6.00		N22	2, 2 / 5, 5, 6, 6	
19/05/10	7.00	3.20				... becoming grey to greyish green and silty	7.00-7.50	B11			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
			2.60	4.50

GENERAL REMARKS

1. An inspection pit has hand excavated to 1.20m below ground level, prior to boring commencing.
2. Ø200m casing used from ground level to 9.10m depth and then reduced to Ø150m to 34.50m below ground level.
3. Water seepage encountered at 4.50m below ground level, rising to 3.11m after 20 minutes.
4. Slight water seepage encountered at 23.50m below ground level.
5. A vibrating wire piezometer installed at 20.00m depth.
6. Borehole backfilled with bentonite pellets from 40.00m to 21.00m, with sand filter between 21.00m and 19.00m and with bentonite pellets from 19.00m to ground level.

Issue No. 03 | Driller SW

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH01**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	19/05/10	4.08	E 529448.3 N 177496.7	40.00m
	Date Completed 21/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	2 of 6

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
						below 6.80m	7.00		N27	2, 4 / 5, 6, 8, 8	
19/05/10	8.00	3.00					8.00	B12			
							8.00		N16	3, 5 / 5, 4, 4, 3	
			-4.22		8.30		8.30-8.70	B13			
			-4.42		8.50	Firm to stiff, grey slightly sandy slightly gravelly CLAY. Gravel is angular to well rounded fine to coarse flint. (REWORKED LONDON CLAY / RIVER TERRACE DEPOSITS)					
19/05/10	8.90	8.70				Stiff, extremely closely fissured brownish grey CLAY with occasional pockets of dark brownish grey silty sand. (LONDON CLAY)	9.00-9.45	U14	36 blows		
19/05/10	9.10	9.26				... with a band of claystone between 8.70m and 8.85m	9.50	D15			
20/05/10	9.10	9.20									
20/05/10	9.10	Dry					10.00-10.45	D16			
							10.00		N19	3, 4 / 4, 5, 5, 5	
							11.00-11.45	U17	54 blows		
							11.50	D18			
						... becoming slightly silty below 12.00m	12.00-12.45	D19			
							12.00		N23	3, 4 / 5, 5, 6, 7	
							13.00-13.45	U20	60 blows		
							13.50	D21			
							14.00-14.45	D22			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No. 03 | Driller SW

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	Date Completed 21/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	3 of 6

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
							14.00		N25	3, 4 / 5, 6, 7, 7	
							15.00-15.45	U23	68 blows		
						... becoming very closely fissured at 15.00m. Fissures are 0 - 10° and 80°- 90°, planar and smooth.	15.10		V250+kPa		
							15.20		V250+kPa		
							15.30		V250+kPa		
							15.50	D24			
							16.00-16.45	D25			
							16.00		N27	3, 5 / 6, 6, 7, 8	
							17.00-17.45	U26	80 blows		
						... with occasional tabular pyrite nodules (35x25mm) at 17.00m	17.50	D27			
							18.00	D28			
							18.00		N32	4, 5 / 7, 7, 9, 9	
							19.00-19.45	U29	84 blows		
							19.50	D30			
						... with a band of claystone between 19.60m and 19.80m	20.00-20.45	D31			
						... becoming silty below 20.00m	20.00		N34	4, 5 / 7, 8, 9, 10	
							21.00-21.45	U32	86 blows		

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
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Borehole No **BH01**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	19/05/10	4.08	E 529448.3 N 177496.7	40.00m
	Date Completed 21/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	4 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
						... becoming very closely fissured below 21.00m. Fissures are randomly orientated with smooth polished surfaces and occasionally infilled with up to 1mm of brown and grey sand.	21.10		V - Failed		
							21.20		V - Failed		
							21.30		V - Failed		
							21.50	D33			
							22.00-22.45	D34			
							22.00		N38	4, 5 / 6, 9, 10, 13	
							23.00-23.45	U35	94 blows		
						... becoming extremely closely fissured with occasional bioturbation below 23.00m					
20/05/10	9.10	▼					23.50	D36			
							24.00-24.45	D37			
					(31.20)		24.00		N38	5, 7 / 8, 9, 10, 11	
							25.00-25.45	U38	100 blows		
						... becoming slightly sandy below 25.00m					
							25.50	D39			
							26.00-26.45	D40			
							26.00		N35	4, 5 / 7, 8, 8, 12	
							27.00-27.45	U41	100 blows		
						... becoming very stiff extremely closely to very closely fissured below 27.00m. Fissures are predominantly subvertical to subhorizontal polished smooth surfaces.	27.10		V - Failed		
							27.20		V - Failed		
							27.30		V - Failed		
							27.50	D42			
						... with a pyritised wood fragment at 27.15m					
							28.00-28.45	D43			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No. 03 | Driller SW

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London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH01**

Project Northern Line Extension

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10/2254	19/05/10	4.08	E 529448.3 N 177496.7	40.00m
	Date Completed 21/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	5 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							28.00		N50/ 0.275	6, 8 / 12, 14, 15, 9	
							29.00-29.40	U44	100 blows		
							29.45	D45			
							30.00-30.45	D46			
							30.00		N50/ 0.22	6, 9 / 13, 16, 21	
							31.00-31.35	U47	100 blows		
						... becoming very stiff to stiff extremely closely fissured below 31.00m. Fissures are 0 - 20°, planar and smooth to rough.	31.10		PP250+kPa		
							31.20		PP250+kPa		
							31.40	D48			
							32.00-32.45	D49			
							32.00		N50/ 0.25	5, 9 / 12, 14, 15, 9	
							33.00-33.45	U50	100 blows		
							33.50	D51			
							34.00-34.45	D52			
							34.00		N50/ 0.265	5, 7 / 12, 13, 16, 9	
20/05/10	34.50	Dry									
21/05/10	34.50	Dry									
							35.00-35.35	U53	100 blows		

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No. 03 | Driller SW

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH01

Project Northern Line Extension

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10/2254	19/05/10	4.08	E 529448.3 N 177496.7	40.00m
	Date Completed 21/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	6 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							35.40	D54			
							36.00-36.45	D55			
							36.00		N50/ 0.22	6, 11 / 15, 16, 19	
							37.00-37.35	U56	100 blows		
							37.40	D57			
							38.00-38.45	D58			
							38.00		N51/ 0.225	5, 8 / 14, 16, 21	
							39.00-39.35	U59	100 blows		
							39.40	D60			
							39.50-39.95	D61			
							39.50		N50/ 0.175	9, 13 / 16, 22, 12	
			-35.62		39.70	Stiff, dark grey silty CLAY with black flint gravel and cobbles. (HARWICH FORMATION)					
21/05/10	34.50	Dry	-35.72		39.80	Stiff to very stiff, grey mottled greenish grey sandy CLAY with cemented shell fragments. (LAMBETH GROUP)					
			-35.92		40.00	End of Borehole					

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller	
03	SW	

CONCEPT SITE INVESTIGATIONS

8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH02

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	17/05/10	1.66	E 529969.6 N 177326.4	40.00m
	Date Completed 18/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	1 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
17/05/10		Dry	1.58		0.08	Asphalt.	0.10	ES01			
			1.41		0.25	Medium dense, brown clayey gravelly fine to coarse SAND and brick fragments. Gravel is angular flint. (MADE GROUND)	0.10			... VOC 0.00ppm	
			1.26		0.40		0.50	ES02			
							0.50	B03			
			0.98		0.68	Compacted brick and concrete cobbles. (MADE GROUND)	0.50			... VOC 0.00ppm	
					(0.52)	Very dark grey to blue, very sandy CLAY with frequent cobble sized brick and concrete fragments. (MADE GROUND)	1.00	ES04			
							1.00	B05			
			0.46		1.20		1.00			... VOC 0.00ppm	
							1.20-1.65	U06	4 blows		
						Firm to stiff, grey slightly silty CLAY with rare subrounded flint gravel. (ALLUVIUM)	1.70	D07			
					(1.10)		1.70-2.15	D08			
						Very soft, greenish brown mottled reddish brown gravelly peaty CLAY with semi-decayed wood fragments. Gravel is angular to rounded coarse flint. (ALLUVIUM)	1.70-2.20	B09			
							1.70		N1	0, 1 / 0, 0, 1, 0	
							2.00	ES10			
17/05/10	2.20	Dry	-0.64		2.30		2.00			... VOC 0.00ppm	
				1		Stiff, light grey to greenish grey slightly sandy silty CLAY. (ALLUVIUM)	2.20-2.65	U11	9 blows		
					(0.75)		2.70	D12			
							2.70-3.15	D13			
							2.70-3.05	B14			
			-1.39		3.05		2.70		N3	0, 1 / 0, 1, 1, 1	
							3.00	ES15			
						Stiff, black very clayey PEAT / peaty CLAY. (ALLUVIUM)	3.00			... VOC 0.00ppm	
					(0.55)		3.05-3.20	B16			
							3.20-3.65	U17	18 blows		
17/05/10	3.60		-1.94		3.60						
17/05/10	3.70	2.48				Medium dense to dense, grey to dark grey sandy subangular to subrounded fine to coarse flint GRAVEL. (RIVER TERRACE DEPOSITS)	3.70	D18			
							3.70-4.20	B19			
							3.70		N17	2, 3 / 3, 4, 5, 5	
					(1.25)						
							4.70-4.85	B20			
17/05/10	4.70	2.30					4.70		N13	5, 4 / 3, 3, 3, 4	
			-3.19		4.85		4.85-5.20	B21			
						Firm to stiff, fissured grey silty CLAY. (LONDON CLAY)					
17/05/10	5.50	Dry					5.50-5.95	U22	38 blows		
							6.00	D23			
							6.50	B24		No Recovery	
							6.50		N12	2, 2 / 2, 3, 3, 4	

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

1. An inspection pit has hand excavated to 1.20m below ground level, prior to boring commencing.
2. Ø200m casing used from ground level to 5.50m depth and then reduced to Ø150m at 34.10m up to 35.70m below ground level.
3. Water seepage encountered at 3.60m below ground level, rising to 2.48m after 20 minutes.
4. Water seepage encountered at 39.10m below ground level, rising to 33.80 after 20 minutes.
5. A vibrating wire piezometer installed at 25.00m depth.
6. Borehole backfilled with bentonite pellets from 40.00m to 26.00m, with sand filter between 26.00m and 24.00m and with bentonite pellets from 24.00m to ground level.

Issue No.	Driller	
03	SW	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH02

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	17/05/10	1.66	E 529969.6 N 177326.4	40.00m
	Date Completed 18/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	2 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							7.50-7.95	U25	60 blows		
						... becoming stiff, very closely fissured dark greyish brown at 7.50m. Fissures are 0-10° and 50°- 90°, planar, smooth with occasional dustings of fine to medium sand and silt.	7.80		V - Failed		
						... with orangish brown staining on fissures at 7.77m	8.00	D26			
							8.50-8.95	D27			
						... becoming slightly sandy below 8.50m	8.50		N22	3, 3 / 5, 5, 6, 6	
							9.50-9.95	U28	64 blows		
						... with occasional black staining between 9.50m and 9.95m	9.85		V180kPa		
							10.00	D29			
							10.50-10.95	D30			
							10.50		N24	3, 3 / 5, 6, 6, 7	
							11.50-11.95	U31	68 blows		
							11.60		V188kPa		
							12.00	D32			
							12.50-12.95	D33			
							12.50		N29	4, 5 / 6, 8, 7, 8	
							13.50-13.95	U34	100 blows		
							14.00	D35			

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	SW	

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH02

Project Northern Line Extension

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	Date Completed 18/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	3 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
						... with a band of claystone between 13.95m and 14.05m					
							14.50-14.95	D36			
						... becoming silty below 14.50m	14.50		N28	3, 5 / 6, 7, 7, 8	
							15.50-15.95	U37	74 blows		
						... becoming extremely closely fissured with occasional pockets of brownish grey sand and with rare bioturbation below 15.50m	16.00	D38			
							16.50-16.95	D39			
							16.50		N32	4, 5 / 7, 8, 8, 9	
							17.50-17.95	U40	82 blows		
						... becoming slightly micaceous and with rare shell fragments between 17.50m and 17.95m	17.85		V192kPa		
							18.00	D41			
						... with a band of claystone between 18.20m and 18.40m	18.50-18.95	D42			
							18.50		N33	3, 5 / 7, 8, 9, 9	
					(28.65)		19.50-19.95	U43	84 blows		
							20.00	D44			
							20.50-20.95	D45			
							20.50		N35	4, 6 / 6, 9, 9, 11	

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	SW	

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH02

Project Northern Line Extension

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10/2254	17/05/10	1.66	E 529969.6 N 177326.4	40.00m
	Date Completed 18/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	4 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							21.50-21.95	U46	100 blows		
						... with occasional bioturbation and rare pyritised wood fragments below 21.50m					
							22.00	D47			
							22.50-22.95	D48			
							22.50		N37	5, 6 / 7, 9, 10, 11	
							23.50-23.85	U49	100 blows		
						... becoming very stiff extremely closely fissured and slightly sandy below 23.50m. Fissures are subhorizontal smooth unpolished and rarely infilled with up to 1mm of grey and brown sand.	23.60		V - Failed		
							23.75		V - Failed		
							23.90	D50			
							24.50-24.95	D51			
							24.50		N40	5, 7 / 8, 10, 10, 12	
17/05/10	5.50	Dry									
18/05/10	5.50	Dry									
							25.50-25.90	U52	100 blows		
						... becoming very closely fissured below 25.50m					
							25.95	D53			
							26.50-26.95	D54			
							26.50		N45	5, 6 / 8, 11, 12, 14	
						... with sand lenses at 27.50m	27.50-27.95	U55	100 blows		
							28.00	D56			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller
03	SW

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London W3 ORF
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E-mail: si@conceptconsultants.co.uk

Borehole No BH02

Project Northern Line Extension

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10/2254	17/05/10	1.66	E 529969.6 N 177326.4	40.00m
	Date Completed 18/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	5 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							28.50-28.95	D57			
							28.50		N47/ 0.29	5, 7 / 9, 13, 12, 13	
							29.50-29.95	U58	100 blows		
							30.00	D59			
							30.50-30.95	D60			
							30.50		N50/ 0.25	6, 8 / 9, 12, 14, 15	
							31.50-31.90	U61	100 blows		
							31.95	D62			
							32.50-32.95	D63			
							32.50		N50/ 0.233	5, 9 / 12, 14, 16, 8	
			-31.84		33.50		33.50-33.95	U64	100 blows		
							33.60		V - Failed		
							33.70		V - Failed		
							33.80		V - Failed		
					(0.70)	Very stiff, greyish brown thinly to thickly laminated slighty sandy slightly silty CLAY with occasional lignite fragments and occasional bioturbation. Laminae have smooth surfaces occasionally infilled with up to 1mm of brown sand. (LAMBETH GROUP - Laminated Beds)	34.00	D65			
							34.10	D66			
			-32.54		34.20	... with a band of siltstone (?) / sandstone between 34.10m and 34.20m					
							34.50-34.95	D67			
						Stiff to very stiff, fissured grey silty CLAY with whole shells and shell fragments. (LAMBETH GROUP)	34.50		N50/ 0.22	8, 11 / 14, 16, 20	
					(1.45)						

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
34.10	34.20	00.45.00		

GENERAL REMARKS

Issue No.	Driller
03	SW

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH02**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	17/05/10	1.66	E 529969.6 N 177326.4	40.00m
	Date Completed 18/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	6 of 6

PROGRESS			STRATA				SAMPLES & TESTS					
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill	
							35.30-35.65	B68				
			-33.99		35.65		35.70-36.10	U69	100 blows			
			-34.24		35.90	Stiff to very stiff, grey to greenish grey mottled dark grey silty CLAY with occasional shells and lenses of silty fine sand. (LAMBETH GROUP)	36.15	D70				
						... becoming extremely closely fissured and brown mottled bluish grey below 35.70m	36.15-36.50	B71				
						Stiff to very stiff, very closely fissured brown mottled bluish grey CLAY. (LAMBETH GROUP)	36.50-36.95	D72				
							36.50		N50/ 0.185	9, 9 / 15, 15, 20		
					(3.20)		37.50-37.80	U73	100 blows			
							37.85	D74				
							38.50-38.95	D75				
							38.50		N50/ 0.19	10, 13 / 14, 16, 20		
18/05/10	34.70		-37.44		39.10		39.10-39.50	B76				
					(0.60)	Medium dense to dense, brown silty fine to medium SAND. (LAMBETH GROUP)	39.50-39.95	D77				
							39.50		N50/ 0.22	8, 11 / 15, 18, 17		
			-38.04		39.70							
18/05/10	35.70	21.65	-38.34		40.00	Stiff to very stiff, fissured bluish grey mottled brown CLAY. (LAMBETH GROUP)						
						End of Borehole						

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
35.30	35.65	01.15.00		

GENERAL REMARKS

Issue No.	Driller	
03	SW	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH03**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	07/05/10	5.49	E 530174.8 N 177326.6	38.70m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	1 of 6

PROGRESS			STRATA				SAMPLES & TESTS					
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill	
07/05/10		Dry	5.40		0.09	Concrete.						
					(0.31)	Medium dense, brown and greyish brown sandy clayey coarse GRAVEL with brick and concrete fragments. (MADE GROUND)	0.30	B01				
			5.09		0.40		0.50	B02				
					(0.50)	Firm, dark brown gravelly silty CLAY with occasional brick and concrete fragments. (MADE GROUND)						
			4.59		0.90		1.00	B03				
					(0.50)	Medium dense, brown and orangish brown clayey SAND with occasional fine to medium flint gravel. (RIVER TERRACE DEPOSITS)	1.20-1.65	D04				
							1.20	B05				
			4.09		1.40		1.20		N22	0, 1 / 1, 1, 9, 11		
						Medium dense to dense, yellowish brown sandy subrounded fine to coarse flint GRAVEL. (RIVER TERRACE DEPOSITS)	1.50	B06				
							2.00-2.45	D07				
							2.00	B08				
							2.00		N44	3, 6 / 7, 11, 12, 14		
							3.00-3.45	D09				
							3.00	B19				
							3.00		N26	1, 3 / 5, 6, 7, 8		
					(4.90)		4.00-4.45	D20				
							4.00	B21				
							4.00		N25	2, 4 / 4, 6, 7, 8		
							5.00-5.45	D22				
							5.00	B23				
							5.00		N32	2, 3 / 5, 6, 9, 12		
							6.00-6.45	D24				
							6.00		N14	2, 4 / 7, 3, 2, 2		
			-0.81		6.30							
						Very stiff, fissured grey to brownish grey silty CLAY. (LONDON CLAY)	6.45	B25				
							7.00-7.45	U26	29 blows			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

1. An inspection pit has hand excavated to 1.20m below ground level, prior to boring commencing.
2. Ø200m casing used from ground level to 7.50m depth and then reduced to Ø150m to 38.00m below ground level.
3. Water seepage encountered at 18.60m below ground level, rising to 18.41m after 20 minutes.
4. A vibrating wire piezometer installed at 25.00m depth.
5. Borehole backfilled with bentonite pellets from 38.7m to 26.00m, with sand filter between26.00m and 24.00m and with bentonite pellets from 24.00m to ground level.

Issue No.	Driller	
03	SW	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH03

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	07/05/10	5.49	E 530174.8 N 177326.6	38.70m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	2 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
07/05/10	7.00	Dry									
10/05/10	7.00	Dry					8.00-8.45	D28			
							8.00		N27	1, 3 / 5, 5, 7, 10	
							9.00-9.45	U29	34 blows		
							9.45	D30			
							10.00-10.45	D31			
							10.00		N20	1, 3 / 3, 5, 5, 7	
						... becoming extremely closely fissured with occasional bioturbation and pocket of dark grey sand below 11.00m	11.00-11.40	U32	32 blows		
							11.45	D33			
							12.00-12.45	D34			
							12.00		N24	2, 4 / 6, 5, 6, 7	
							13.00-13.40	U35	31 blows		
						... becoming stiff with 0 -10° and 70°- 90°, planar and smooth fissures below 13.00m	13.10		V - Failed		
							13.20		V - Failed		
						... with occasional thin laminations of brown silt and fine sand between 13.00m and 13.45m	13.30		V - Failed		
							13.45	D36			
							14.00-14.45	D37			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller
03	SW

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH03

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	07/05/10	5.49	E 530174.8 N 177326.6	38.70m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	3 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							14.00		N24	2, 3 / 4, 6, 7, 7	
							15.00-15.40	U38	43 blows		
							15.45	D39			
							16.00-16.45	D40			
						... becoming slightly sandy below 16.00m	16.00		N29	2, 5 / 6, 6, 8, 9	
							17.00-17.45	U41	40 blows		
						... with rare bioturbation and pockets of light and dark grey fine sand below 17.00m	17.45	D42			
							18.00-18.45	D43			
							18.00		N27	2, 4 / 5, 6, 8, 8	
10/05/10	7.50	1					19.00-19.45	U44	45 blows		
							19.45	D45			
							20.00-20.45	D46			
							20.00		N37	2, 4 / 5, 11, 11, 10	
							21.00-21.45	U47	47 blows		

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller
03	SW

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH03

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	07/05/10	5.49	E 530174.8 N 177326.6	38.70m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	4 of 6

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
					(30.60)	... becoming very closely fissured with rare dustings of silt and fine sand on fissure surfaces at 21.00m ... with a band of weak orangish brown MUDSTONE between 21.33m and 21.37m ... with a medium gravel size pyrite nodule at 21.45m	21.10 21.20 21.30 21.45	 D48	V - Failed V - Failed V - Failed		
							22.00-22.45 22.00	D49	 N31	3, 6 / 6, 6, 8, 11	
						... becoming extremely closely fissured and thinly bedded with rare bioturbation below 23.00m	23.00-23.45 23.45	U50 D51	59 blows		
							24.00-24.45 24.00	D52	 N36	1, 5 / 9, 10, 8, 9	
						... with no fissures and occasional bioturbation below 25.00m	25.00-25.45 25.45	U53 D54	75 blows		
							26.00-26.45 26.00	D55 N41		3, 5 / 8, 10, 11, 12	
						... becoming very stiff with occasional pockets of grey sand at 27.00m ... with a band of light brown sand between 27.03m and 27.05m	27.00-27.45 27.10 27.20 27.30	U56 	71 blows V - Failed V - Failed V - Failed		
							28.00-28.45	D57			

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	SW	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH03

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	07/05/10	5.49	E 530174.8 N 177326.6	38.70m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	5 of 6

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
						... with fossilized wood at 28.20m	28.00		N42	3, 7 / 9, 10, 11, 12	
							29.00-29.45	U58	84 blows		
							29.45	D59			
							30.00-30.45 30.00	D60	 N51	3, 7 / 12, 12, 12, 15	
10/05/10 11/05/10	7.50 7.50	Dry 30.10									
							31.00-31.45	U61	65 blows		
						... becoming extremely fissured with rare bioturbation and occasional pyrite nodules, pyritised wood fragments and pockets of light brownish grey sand below 31.00m	31.45	D62			
							32.00-32.45 32.00	D63	 N47	3, 6 / 7, 12, 13, 15	
							33.00-33.45	U64	96 blows		
							33.45	D65			
							34.00-34.45 34.00	D66	 N42/ 0.225	4, 9 / 9, 15, 18	
							35.00-35.45	U67	91 blows		

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	SW	

CONCEPT SITE INVESTIGATIONS

8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH03

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	07/05/10	5.49	E 530174.8 N 177326.6	38.70m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	6 of 6

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
						... becoming very closely fissured with occasional thin laminations of light brown silt and sand below 35.00m. Fissures are predominantly 0-20° and 70°- 90°, planar and smooth.	35.10 35.20 35.30 35.45	 D68	V - Failed V - Failed V - Failed		
							36.00-36.45 36.00	D69	N50/ 0.225	4, 9 / 13, 16, 21	
			-31.41		36.90						
			-31.61		37.10	Very stiff, dark grey silty CLAY with black flint gravel and cobbles. (HARWICH FORMATION)					
						Very stiff, thinly to thickly laminated dark grey silty CLAY with frequent laminations of light grey fine to medium sand. (HARWICH FORMATION / LAMBETH GROUP?)	37.50	D70			
11/05/10 12/05/10	38.00 38.00	Dry 37.70			(1.60)		38.00-38.45 38.10 38.20 38.30	U71	83 blows V250+kPa V250+kPa V250+kPa		
						... with a rare subangular fine to medium gravel size fragment of brown shell between 38.14m and 38.20m	38.45	D72			
12/05/01	38.00	Dry	-33.21		38.70	... with a band of claystone between 38.60m and 38.70m					
						End of Borehole					

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
36.90	38.00	02.30.00		
38.60	38.70	01.30.00		

GENERAL REMARKS

Issue No.	Driller
03	SW

CONCEPT SITE INVESTIGATIONS

8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH04

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	4.49	E 530703.4 N 177270.5	40.00m
	Date Completed 27/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	1 of 6

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
26/04/10		Dry			(0.35)	Turf over brown sandy gravelly CLAY. (MADE GROUND)					
			4.14		0.35						
					(0.60)	Brown sandy CLAY with brick fragments. (MADE GROUND)	0.50	B01			
			3.54		0.95		1.00	B02			
26/04/10		Dry				Brown sandy clayey subangular to subrounded fine to coarse flint GRAVEL. (RIVER TERRACE DEPOSITS)	1.20-1.70 1.20	B03	N32	2, 3 / 5, 7, 9, 11	
							2.00-2.50 2.00	B04	N45	6, 9 / 10, 11, 11, 13	
							3.00-3.50 3.00	B05	N24	3, 4 / 6, 5, 6, 7	
					(4.50)		4.00-4.50 4.00	B06	N37	3, 5 / 6, 8, 10, 13	
							5.00-5.45 5.00	B07	N20	2, 4 / 6, 5, 5, 4	
			-0.96		5.45		5.45	D08			
						Stiff, brown silty CLAY. (LONDON CLAY) ... becoming grey below 5.50m	5.50-5.95	U09	40 blows		
							6.00	D10			
26/04/10	6.10	Dry					6.00-6.50	D11			
							6.50 6.50	D12	N12	1, 2 / 3, 3, 3, 3	

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
			1.30	5.45

GENERAL REMARKS

1. An inspection pit has hand excavated to 1.20m below ground level, prior to boring commencing.
2. Ø200m casing used from ground level to 32.90m depth and then reduced to Ø150m to 34.20m below ground level.
3. Water seepage encountered at 31.40m below ground level, rising to 29.26m after 20 minutes.
4. Slight water seepage encountered at 37.90m below ground level.
5. A vibrating wire piezometer installed at 32.00m depth.
6. Borehole backfilled with bentonite pellets from 40.00m to 33.00m, with sand filter between 33.00m and 31.00m and with bentonite pellets from 31.00m to ground level.

Issue No.	Driller
03	SW

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH04

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	4.49	E 530703.4 N 177270.5	40.00m
	Date Completed 27/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	2 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							7.50-7.95	U13	60 blows		
						... becoming locally thinly laminated, slightly micaceous with closely spaced laminations of light brown and greenish grey fine sand at 7.50m	7.80		V188kPa		
							7.90		V208kPa		
							8.00	D14			
							8.50-8.95	D15			
							8.50		N20	2, 3 / 4, 5, 5, 6	
							9.50-9.95	U16	64 blows		
						... becoming slightly sandy, locally thinly laminated with very closely to closely spaced laminations of light brown fine sand at 9.50m	9.55		V - Failed		
							9.65		V - Failed		
							9.85		V180kPa		
							10.00	D17			
							10.50-10.95	D18			
							10.50		N21	2, 2 / 4, 5, 6, 6	
							11.50-11.95	U19	68 blows		
						... with rare closely to medium spaced laminations of light brown sand and rare pockets of dark grey fine silty sand at 11.50m	11.60		V188kPa		
							11.75		V220kPa		
						... with rare bioturbation below 11.80m	12.00	D20			
							12.50-12.95	D21			
							12.50		N26	3, 4 / 5, 6, 7, 8	
							13.50-13.95	U22	76 blows		
							14.00	D23			

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	SW	AGS

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH04

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	4.49	E 530703.4 N 177270.5	40.00m
	Date Completed 27/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	3 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							14.50-14.95	D24			
							14.50		N32	4, 5 / 7, 8, 8, 9	
							15.50-15.95	U25	84 blows		
						... becoming extremely closely fissured and grey with rare parts of silty sandy and pyrite nodules at 15.50m	16.00	D26			
							16.50	D27			
							16.50		N35	3, 5 / 7, 9, 9, 10	
							17.50-17.95	U28	92 blows		
						... becoming generally thinly laminated, slightly silty with occasional bioturbation at 17.50m	17.85		V192kPa		
						... with a band of very weak light brown claystone between 17.80m and 18.00m	18.00	D29			
					(25.25)		18.50-18.95	D30			
							18.50		N35	4, 6 / 8, 8, 9, 10	
							19.50-19.95	U31	100 blows		
							20.00	D32			
							20.50-20.95	D33			
							20.50		N37	4, 5 / 8, 9, 10, 10	
26/04/10	6.10	Dry									

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	SW	AGS

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH04

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	4.49	E 530703.4 N 177270.5	40.00m
	Date Completed 27/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	4 of 6

PROGRESS Date	Casing	Water	STRATA Level (mOD)	Legend	Depth (Thickness)	Strata Description	SAMPLES & TESTS Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
27/04/10	6.10	20.12									
27/04/10	6.10	Dry					21.50-21.90	U34	100 blows		
						... becoming thinly to thickly laminated, slightly sandy with frequent bioturbation at 21.50m	21.70		V - Failed		
							21.85		V - Failed		
						... with occasional pockets of light brown sand between 21.50m and 21.70m	21.95	D35			
							22.50-22.95	D36			
							22.50		N41	5, 6 / 8, 10, 11, 12	
							23.50-23.95	U37	100 blows		
						... becoming grey, slightly sandy with frequent pockets of light grey sand and rare pockets of dark grey dine sand with occasional bioturbation below 23.50m	24.00	D38			
							24.50-24.95	D39			
							24.50		N50	6, 7 / 9, 13, 13, 15	
							25.50-25.95	U40	100 blows		
							26.00	D41			
							26.50-26.95	D42			
							26.50		N50/ 0.295	5, 8 / 10, 12, 14, 14	
							27.50-27.90	U43	100 blows		
						... becoming very closely fissured and sandy with pockets of light brownish grey sand at 27.50m	27.95	D44			

Chiselling (m) From	To	Hours	Water Added (m) From	To

GENERAL REMARKS

Issue No. 03 | Driller SW

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH04

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	4.49	E 530703.4 N 177270.5	40.00m
	Date Completed 27/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	5 of 6

PROGRESS Date	Casing	Water	STRATA Level (mOD)	Legend	Depth (Thickness)	Strata Description	SAMPLES & TESTS Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							28.50-28.95	D45			
							28.50		N50/ 0.265	5, 7 / 10, 13, 16, 11	
							29.50-29.95	U46	100 blows		
						... becoming thinly to thickly laminated and silty with rare tabular pyrite nodules at 29.50m	30.00	D47			
							30.50-30.95	D48			
							30.50		N50/ 0.25	7, 10 / 12, 15, 16, 7	
			-26.21		30.70						
					(0.70)	Stiff, grey silty fine sandy CLAY. (LAMBETH GROUP)					
27/04/10	6.10		-26.91		31.40		31.40	D49			
27/04/10	6.10	29.20				Stiff, grey silty sandy shelly CLAY. (LAMBETH GROUP)	31.50-31.95	U50	100 blows		
							31.60		V200kPa		
						... with occasional layers of grey silty fine sand between 31.80m and 32.90m	32.00	D51			
							32.00-32.50	B52			
27/04/10	6.10	29.10					32.50-32.95	D53			
							32.50		N50/ 0.205	8, 12 / 15, 19, 16	
							33.00-33.40	B54			
							33.50-33.95	D55			
						... with coarse gravel sized fragments of strong grey slightly clayey shelly/organic(?) LIMESTONE between 33.40m and 33.80m	33.50		N75/ 0.045	25, 50 /	
							33.80-34.00	B56			
27/04/10	34.00	33.80				... becoming brown mottled blue between 33.80m and 38.70m	34.00-34.35	U57	100 blows		
						... becoming very stiff and brown mottled bluish grey at 34.00m	34.40	D58			
27/04/10	34.20	Dry					35.00-35.95	D59			

Chiselling (m) From	To	Hours	Water Added (m) From	To
33.40	33.80	01.00.00		

GENERAL REMARKS

Issue No. 03 | Driller SW

CONCEPT SITE INVESTIGATIONS

8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH04

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	4.49	E 530703.4 N 177270.5	40.00m
	Date Completed 27/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	6 of 6

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
							35.00		N50/ 0.25	8, 10 / 13, 15, 15, 7	
					(8.50)						
							36.00-36.45	U60	100 blows		
							36.50	D61			
							37.00-37.45	D62			
							37.00		N50/ 0.225	9, 12 / 14, 16, 20	
27/04/10	34.20										
27/04/10	34.20	37.80					38.00-38.40	U63	100 blows		
							38.45	D64			
							39.00-39.45	D65			
27/04/10	34.20	38.80					39.00		N50/ 0.19	11, 12 / 15, 20, 15	
							39.50-39.85	U66	100 blows		
			-35.41		39.90		39.90	D67			
27/04/10	34.20	39.30	-35.51		40.00	Stiff, blue mottled brown silty CLAY. (LAMBETH GROUP)					
						End of Borehole					

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller	
03	SW	

CONCEPT SITE INVESTIGATIONS

8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH05

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	06/05/10	4.39	E 530920.7 N 177502.0	35.10m
	Date Completed 10/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	1 of 6

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
06/05/10		Dry	4.19		0.20	Soft, brown to dark brown sandy CLAY with flint gravel and occasional brick fragments. (MADE GROUND)	0.25	ES01			
						Firm, brown and greyish brown gravelly sandy CLAY with brick fragments. Gravel is subrounded fine to medium flint. (MADE GROUND)	0.50	ES02			
							0.50	B04			
						... becoming brown to reddish brown with subrounded fine to medium occasionally coarse gravel below 0.85m	1.00	ES05			
06/05/10		Dry			(1.80)		1.00	B06			
							1.20-1.65	U07	32 blows		
						... becoming dark brown locally mottled yellowish brown slightly sandy slightly gravelly with occasional pockets of black carbonaceous material at 1.00m	1.70	D08			
							1.70-2.15	D09			
							1.70		N12	2, 2 / 2, 3, 3, 4	
			2.39		2.00		2.00	ES10			
06/05/10	2.20	2.00	2.19		2.20	Firm, brown sandy CLAY with occasional flint gravel. (ALLUVIUM)	2.00-2.20	B11			
							2.20-2.70	B12			
							2.20		N39/ 0.255	5, 7 / 9, 9, 10, 11	
						Medium dense to dense, brown to yellowish brown and orangish brown sandy subrounded to rounded fine to coarse GRAVEL. (RIVER TERRACE DEPOSITS)					
06/05/10	3.20	Dry					3.20-3.70	B13			
						... becoming brown slightly silty very sandy subangular to well rounded fine to coarse with rare clods of soft brown clay below 3.20m	3.20		N50/ 0.255	8, 10 / 13, 15, 15, 7	
06/05/10	4.20	4.10					4.20-4.70	B14			
							4.20		N50/ 0.25	7, 11 / 13, 16, 13, 8	
					(5.70)						
06/05/10	5.20	4.90					5.20-5.70	B15			
							5.20		N30	4, 7 / 8, 7, 7, 8	
06/05/10	6.20					... becoming brown and light brown at 6.20m	6.20-6.70	B16			
							6.20		N22	3, 4 / 5, 5, 6, 6	

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
			2.20	6.20

GENERAL REMARKS

1. An inspection pit has hand excavated to 1.20m below ground level, prior to boring commencing.
2. Ø200m casing used from ground level to 8.50m depth and then reduced to Ø150m at 27.60m up to 31.60m below ground level.
3. Water seepage encountered at 6.20m depth, rising to 5.80m after 20 minutes. Slight water seepage encountered at 27.60m, rising to 26.84m after 30 minutes. Water seepage encountered at 29.80m depth, rising to 19.92m after 20 minutes. Water seepage encountered at 33.75m depth, rising to 20.89m after 20 minutes.
4. Bailing water from borehole between 13.18m and 29.30m and at 31.80m depth.
5. Ø50 monitoring well installed at 35.10m depth, slotted between 33.10m and 35.10m below ground level.
6. Borehole backfilled with pea shingle from 35.10m to 33.10m, and with bentonite pellets f to 0.50m depth. Concrete with lockable stopcock cover installed from 0.50m to ground level

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH05

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	06/05/10	4.39	E 530920.7 N 177502.0	35.10m
	Date Completed 10/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	2 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
06/05/10	7.20	6.30					7.20-7.70	B17			
							7.20		N19	2, 4 / 5, 4, 5, 5	
06/05/10	7.70	6.51									
07/05/10	7.70	5.58	-3.51		7.90						
07/05/10	8.00	Dry				Stiff to very stiff, very closely fissured grey to brownish grey silty CLAY. (LONDON CLAY)	8.00-8.45	U18	48 blows		
							8.50	D19			
							8.50-9.00	B20			
							9.00-9.45	D21			
							9.00		N19	2, 3 / 4, 4, 5, 6	
						... becoming extremely closely fissured with occasional pockets of light brownish grey sand and rare bioturbation at 10.00m	10.00-10.45	U22	52 blows		
							10.50	D23			
							11.00-11.45	D24			
							11.00		N22	3, 4 / 5, 5, 6, 6	
						... with a claystone band between 11.70m and 11.90m	12.00-12.45	U25	54 blows		
							12.50	D26			
							13.00-13.45	D27			
							13.00		N26	3, 4 / 6, 6, 7, 7	
						... with a claystone band between 13.60m and 13.85m	14.00-14.45	U28	74 blows		

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH05

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	06/05/10	4.39	E 530920.7 N 177502.0	35.10m
	Date Completed 10/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	3 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
						... becoming extremely closely fissured with occasional bioturbation at 14.00m					
							14.50	D29			
							15.00-15.45	D30			
							15.00		N34	4, 6 / 8, 8, 9, 9	
							16.00-16.45	U31	74 blows		
							16.00		V212kPa		
						... becoming slight sandy and slightly micaceous with rare pockets of light brown and dark grey silty sand and occasional bioturbation at 16.00m	16.50	D32			
						... becoming light brown clayey SAND / sandy CLAY at 16.40m					
							17.00-17.45	D33			
							17.00		N37	4, 5 / 7, 9, 10, 11	
					(19.45)						
							18.00-18.45	U34	100 blows		
							18.50	D35			
							19.00-19.45	D36			
							20.00-20.45	U37	86 blows		
						... with rare pyrite nodules at 20.00m	20.00		V192kPa		
							20.50	D38			
							21.00-21.45	D39			

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	BN	

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH05

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	06/05/10	4.39	E 530920.7 N 177502.0	35.10m
	Date Completed 10/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	4 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							21.00		N37	4, 6 / 7, 9, 10, 11	
							22.00-22.45	U40	90 blows		
							22.50	D41			
							23.00-23.45	D42			
							23.00		N42	5, 7 / 9, 10, 11, 12	
							24.00-24.45	U43	100 blows		
							24.00		V252kPa		
						... becoming very closely fissured grey slightly sandy CLAY with occasional pockets of light brown fine sand at 24.00m	24.30		V248kPa		
						... becoming sandy with a pyritised wood fragment below 24.30m	24.50	D44			
							24.50-24.95	D45			
							24.50		N43	4, 7 / 9, 11, 11, 12	
							25.00-25.45	U46	100 blows		
							25.50	D47			
							25.50-25.95	U48	96 blows		
							26.00	D49			
							26.00-26.40	U50	100 blows		
							26.15		V - Failed		
							26.25		V - Failed		
							26.45	D51			
							26.45-26.85	U52	100 blows		
							26.90	D53			
							26.90-27.35	U54	100 blows		
						... becoming brownish grey with occasional bioturbation below 26.95m	26.90		V80kPa		
							27.05		V72kPa		
			-22.96		27.35						
07/05/10	8.50				(0.45)	Very stiff, fissured grey to dark grey silty CLAY with shells and shell fragments. (LAMBETH GROUP)	27.40	D55			
							27.40-27.60	U56	100 blows		
							27.40		PP100kPa		
							27.65	D57			
			-23.41		27.80	... with a band of cemented shells between 27.60m and 27.80m	27.90	B58			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
27.60	27.80	00.30.00		
27.90	28.10	00.45.00		

GENERAL REMARKS

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH05

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	06/05/10	4.39	E 530920.7 N 177502.0	35.10m
	Date Completed 10/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	5 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
07/05/10	28.10	Dry				Very stiff, fissured grey to dark grey silty CLAY. (LAMBETH GROUP)	28.10-28.50	U59	100 blows		
					(0.95)		28.10		PP200kPa		
						... with a band of cemented shells between 27.90m and 28.10m	28.55	D60			
						... becoming thinly to thickly interlaminated slightly sandy CLAY and light grey silty SAND at 28.10m	28.55-28.90	U61	100 blows		
			-24.36		28.75						
							28.95	D62			
						Very stiff, fissured grey to dark grey silty CLAY with shells and shell fragments. (LAMBETH GROUP)	28.95-29.15	U63	100 blows		
07/05/10	29.20	Dry									
10/05/10	29.20	13.18			(1.05)	... with a band of siltstone between 29.10m and 29.80m	29.50	D64			
10/05/10	29.80		-25.41		29.80						
						Dark brown to greyish brown silty fine to medium SAND with occasional silty clay lenses. (LAMBETH GROUP)	30.00	B65			
10/05/10	30.20	20.10					30.20-30.65	D66			
							30.20-30.70	B67			
						... becoming grey slightly clayey and slightly silty at 30.20m	30.20		N50/ 0.23	4, 8 / 12, 13, 20, 5	
					(1.60)						
10/05/10	31.20	20.00					31.20-31.65	D68			
							31.20-31.70	B69			
							31.20		N47	5, 7 / 10, 11, 13, 13	
			-27.01		31.40						
10/05/10	31.60	31.50				Stiff to very stiff, fissured grey to bluish grey mottled brown to reddish brown silty CLAY. (LAMBETH GROUP)	31.70-31.95	U70	100 blows		
							32.00	D71			
10/05/10	31.60	Dry					32.00-32.45	U73	100 blows		
						... becoming reddish brown mottled bluish grey and friable at 32.00m	32.00-32.50	B75			
							32.50	D74			
					(2.35)		32.50-32.85	U76	100 blows		
							32.90	D77			
							32.90-33.35	U78	100 blows		
							33.40	D79			
							33.40-33.70	U80	100 blows		
10/05/10	31.60		-29.36		33.75		33.75	D81			
						Dark brown to greyish brown silty fine to medium SAND. (LAMBETH GROUP)	33.75-34.25	U82	100 blows	No Recovery	
							33.75-34.25	B83			
10/05/10	31.60	20.30			(0.80)		34.25	D84			
							34.25		N50/ 0.228	7, 7 / 11, 16, 19, 4	
			-30.16		34.55						
						Very stiff, grey silty CLAY with shell fragments. (LAMBETH GROUP)	34.75-35.05	U85	100 blows		
					(0.55)						

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
29.20	29.30	00.30.00		
29.30	29.80	01.45.00		

GENERAL REMARKS

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH05**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	06/05/10	4.39	E 530920.7 N 177502.0	35.10m
	Date Completed 10/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	6 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
10/05/10	31.60	20.55	-30.71		35.10	End of Borehole	35.10	D86			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH06**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	28/04/10	4.54	E 531238.4 N 177554.7	37.00m
	Date Completed 30/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	1 of 6

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
28/04/10		Dry	4.34		0.20	Asphalt.					
			4.23		0.31	Brown sandy GRAVEL. (Type 1) (MADE GROUND)	0.50	B01			
						Brown to orangish brown gravelly sandy CLAY with brick fragments and rare pottery pieces. (MADE GROUND)	1.00	B02			
28/04/10		Dry			(2.04)		1.20-1.35 1.20 1.35-1.70	B03 B04	 N7	0, 1 / 1, 2, 2, 2	
							2.00-2.45	U05	60 blows		
			2.19		2.35						
28/04/10	3.00	2.50				Medium dense to dense, yellowish brown to orangish brown sandy subangular to subrounded fine to coarse flint GRAVEL with occasional cobbles. (RIVER TERRACE DEPOSITS)	2.50 2.70 3.00-3.50 3.00	D06 D07 B08 N31	 3, 5 / 6, 7, 9, 9		
28/04/10	4.00	3.70					4.00-4.50 4.00	B09 N50/ 0.28	 5, 8 / 10, 12, 15, 13		
28/04/10	5.00	4.50			(4.95)		5.00-5.50 5.00	B10 N31	 4, 4 / 6, 7, 8, 10		
28/04/10	6.30						6.00-6.50 6.00	B11 N23	 2, 3 / 5, 5, 6, 7		
							7.00-7.30	B12			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
			2.35	7.00

GENERAL REMARKS

1. An inspection pit has hand excavated to 1.20m below ground level, prior to boring commencing.
2. Ø200m casing used from ground level to 7.60m depth and then reduced to Ø150m at 26.05m up to 27.00m below ground level.
3. Water seepage encountered at 6.30m depth, rising to 5.65m after 20 minutes. Water seepage encountered at 24.300m depth, rising to 21.29m after 20 minutes. Slight water seepage encountered at 29.45m depth.
5. Ø50 monitoring well installed at 37.00m depth, slotted between 24.00m and 37.00m below ground level.
6. Borehole backfilled with pea shingle from 37.00m to 24.00m, and with bentonite pellets from 24.00m to 0.50m depth. Concrete with lockable stopcock cover installed from 0.50m to ground level.

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH06**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	28/04/10	4.54	E 531238.4 N 177554.7	37.00m
	Date Completed 30/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	2 of 6

PROGRESS Date	Casing	Water	STRATA Level (mOD)	Legend	Depth (Thickness)	Strata Description	SAMPLES & TESTS Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							7.00		N12	2, 4 / 3, 3, 3, 3	
			-2.76		7.30		7.30-7.50	B13			
28/04/10	7.50	5.60				Stiff to very stiff, fissured brown silty CLAY. (LONDON CLAY)					
29/04/10	7.30	7.30				... becoming grey below 7.50m					
29/04/10	7.60	Dry					8.00-8.45	U14	52 blows		
							8.50	D15			
						... with rare pockets of dark grey fine sand and rare bioturbation below 8.50m					
							9.00-9.45	B16		No Recovery	
						... with a band of claystone between 9.00m and 9.20m	9.00		N17	10, 4 / 4, 4, 5, 4	
							10.00-10.45	U17	60 blows		
						... becoming extremely closely fissured with occasional pyrite nodules and rare bioturbation below 10.00m					
							10.50	D18			
						... with a band of claystone between 10.60m and 10.90m					
							11.00-11.45	D19			
							11.00		N21	2, 4 / 4, 5, 6, 6	
							12.00-12.45	U20	62 blows		
							12.10		V - Failed		
							12.20		V - Failed		
						... becoming very closely fissured and slightly micaceous below 12.00m. Fissures are predominantly 0 -10° and 70 - 90°, planar and smooth.					
							12.50	D21			
						... with no fissures below 12.30m					
						... with a medium gravel size pyrite nodule at 12.37m					
							13.00-13.45	D22			
							13.00		N28	2, 4 / 5, 7, 8, 8	
							14.00-14.45	U23	80 blows		

Chiselling (m) From	To	Hours	Water Added (m) From	To

GENERAL REMARKS

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH06**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	28/04/10	4.54	E 531238.4 N 177554.7	37.00m
	Date Completed 30/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	3 of 6

PROGRESS Date	Casing	Water	STRATA Level (mOD)	Legend	Depth (Thickness)	Strata Description	SAMPLES & TESTS Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
						... becoming extremely closely fissured with occasional bioturbation and pockets of light brownish grey sand below 14.00m					
							14.50	D24			
						... with rare fragments of fossilised wood at 14.50m					
							15.00-15.45	D25			
							15.00		N33	3, 5 / 7, 9, 8, 9	
					(16.70)						
							16.00-16.45	U26	74 blows		
						... becoming slighty sandy and silty with no fissures below 16.00m	16.30		V120kPa		
						... with a band of frequent fine to coarse gravel size pockets of light brown fine sand between 16.00m and 16.09m	16.50	D27			
							17.00-17.45	D28			
						... becoming slightly micaceous with rare pyrite nodules below 17.00m	17.00		N33	4, 5 / 6, 8, 9, 10	
							18.00-18.45	U29	72 blows		
							18.50	D30			
							19.00-19.45	D31			
							19.00		N36	4, 5 / 7, 9, 9, 11	
							20.00-20.45	U32	80 blows		
						... becoming very closely fissured with frequent pockets of light brown fine sand below 20.00m. Fissures are 0 -10° and 70°-90°, planar and smooth.					
							20.50	D33			
							20.50-20.95	U34	90 blows		
							21.00	D35			

Chiselling (m) From	To	Hours	Water Added (m) From	To

GENERAL REMARKS

Issue No.	Driller	
03	BN	

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH06**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	28/04/10	4.54	E 531238.4 N 177554.7	37.00m
	Date Completed 30/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	4 of 6

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
							21.00-21.45	U36	100 blows		
							21.10		V - Failed		
							21.20		V - Failed		
							21.30		V - Failed		
							21.50	D37			
							21.50-21.95	U38	92 blows		
							22.00	D39			
						... becoming extremely closely fissured with occasional pyrite nodules and rare pyritised wood fragments at 22.00m	22.00-22.45	U40	100 blows		
							22.50	D41			
							22.50-22.95	U42	100 blows		
29/04/10	7.60						23.00	D43			
							23.00-23.45	U44	92 blows		
							23.50	D45			
							23.50-23.95	U46	96 blows		
						... becoming very stiff with no fissures below 23.50m	23.60		V - Failed		
							23.70		V - Failed		
			-19.46		24.00		24.00	D47			
						Stiff, very closely fissured dark greyish brown slightly sandy silty CLAY . Fissures are predominantly 0 -10° planar and smooth with frequent fine to medium gravel size pockets of light brown fine to medium sand. (HARWICH FORMATION - SWANSCOMBE MEMBER?)	24.00-24.45	U48	100 blows		
							24.10		V - Failed		
			-19.76		24.30		24.20		V - Failed		
							24.30		V - Failed		
29/04/10	7.60	21.00	-19.96		24.50		24.50	D49			
							24.50-25.95	U50	100 blows		
							24.60		V - Failed		
							24.70		V - Failed		
						... with a band of frequent medium to coarse sand size black oxidised glauconite between 24.17m and 24.26m	24.80		V - Failed		
29/04/10	7.60	20.40			(1.00)		25.00	D51			
						... with frequent subrounded to rounded fine to coarse black flint at 24.27m	25.00-25.45	U52	100 blows		
							25.10		V - Failed		
							25.20		V - Failed		
29/04/10	7.60	20.10	-20.96		25.50	Firm, dark grey locally greyish brown very sandy CLAY with frequent subangular to subrounded fine to coarse gravel size cream and light brown bivalve, gastropod shells and shell fragments. (HARWICH FORMATION - SWANSCOMBE MEMBER?)	25.30		V - Failed		
							25.50	D53			
							25.50-25.85	U54	100 blows		
29/04/10	7.60	19.70			(0.90)		25.90	D55			
							25.90-26.05	U56	100 blows		
							26.00	D57			
							26.00-26.40	D58			
29/04/10	26.40	21.30	-21.86		26.40	Soft to firm, thinly interlaminated dark grey SILT and light grey silty fine to medium SAND and occasionally grey CLAY. (LAMBETH GROUP)	26.40-26.75	U59	100 blows		
						... with frequent subangular to angular fine to medium gravel size fragments of cream and light brown bivalve at 24.70m	26.80	D60			
29/04/10	26.80	21.60					26.80-27.05	U61	100 blows		
						... becoming thinly to thickly laminated dark grey CLAY and dark grey SILT with occasional fine to medium sand below 25.00m	27.10	D62			
29/04/10	27.00	22.30					27.10-27.35	U63	100 blows		
							27.40	D64			
29/04/10	27.00	27.00				... with rare subangular fine to medium gravel size fragments of cream and light brown shells between 25.00m and 25.07m	27.40-27.70	U65	100 blows		
							27.75	D66			
29/04/10	27.00	27.50				Stiff to very stiff, grey silty CLAY with occasional shell fragments and occasional bands of compacted shells.	27.75-28.15	U67	100 blows		

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
26.05	26.40	01.00.00		

GENERAL REMARKS

Issue No.	Driller	
03	BN	

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH06**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	28/04/10	4.54	E 531238.4 N 177554.7	37.00m
	Date Completed 30/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	5 of 6

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
29/04/10	27.00	27.95				(LAMBETH GROUP)	28.20	D68			
30/04/10	27.00	27.95				... with a band of cemented shells between 26.05m and 26.40m	28.20-28.60	U69	100 blows		
						Stiff to very stiff, brown mottled red to reddish brown occasionally mottled blue to greyish blue silty CLAY. (LAMBETH GROUP)	28.65	D70			
30/04/10	27.00	Dry					28.65-29.00	U71	100 blows		
						... becoming very stiff to hard, grey mottled brown below 28.00m	29.05	D72			
							29.05-29.40	U73	100 blows		
					(5.75)		29.45	D74			
30/04/10	27.00					... becoming brown mottled grey to bluish grey below 29.30m	29.45-29.75	U75	100 blows		
							29.80	D76			
							29.80-30.25	U77	100 blows		
							30.30	D78			
						... becoming grey to bluish grey between 30.30m and 32.15m	30.30-30.75	U79	100 blows		
							30.80	D80			
							30.80-31.20	U81	100 blows		
							31.25	D82			
							31.25-31.65	U83	100 blows		
						... becoming extremely closely fissured below 31.50m	31.70	D84			
							31.70-32.00	U85	100 blows		
						... with a band of shell fragments at 31.80m	32.05	D86			
			-27.61		32.15		32.05-32.45	U87	100 blows		
						Very stiff to hard dark grey silty CLAY with partings of light grey silt, layer of white and occasionally grey silty clay with beds of shells.	32.50	D88			
30/04/10	27.00	32.40			(0.55)		32.50-32.75	U89	100 blows		
			-28.16		32.70	(LAMBETH GROUP)	32.80	D90			
30/04/10	27.00	Dry				Very stiff mottled yellowish brown silty CLAY with rare calcareous nodules. (LAMBETH GROUP)	32.80-32.95	U91	100 blows		
					(0.60)		33.00	D92			
						... with a band of limestone between 33.0m and 33.30m	33.10	D93			
			-28.76		33.30		33.30-33.65	U94	100 blows		
						Very stiff, fissured grey mottled reddish brown to yellowish brown silty CLAY. (LAMBETH GROUP)	33.70	D95			
							33.70-34.05	U96	100 blows		
							34.00	D97			
							34.10-34.50	U98	100 blows		
							34.55-34.90	U100	100 blows		
30/04/10	27.00	34.40			(2.50)		34.55	D99			
						... becoming mottled brown to reddish brown and light grey below 34.60m	34.95	D101			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

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Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	28/04/10	4.54	E 531238.4 N 177554.7	37.00m
	Date Completed 30/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	6 of 6

PROGRESS			STRATA				SAMPLES & TESTS					
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill	
			-31.26		35.80							
			-31.46		36.00	Grey clayey fine to medium SAND. (LAMBETH GROUP)	36.00-36.45	D102	N50/ 0.11	11, 13 / 26, 24		
						Very stiff to hard, fissured grey slightly silty CLAY. (LAMBETH GROUP)	36.00					
					(1.00)							
30/04/10	27.00	35.80	-32.46		37.00							
						End of Borehole						

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No. 03 | Driller BN

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH07**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	20/04/10	3.25	E 531187.8 N 178024.3	31.00m
	Date Completed 23/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	1 of 5

PROGRESS			STRATA				SAMPLES & TESTS					
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill	
20/04/10		Dry	3.15		0.10	Concrete paving over yellow coarse SAND. (MADE GROUND)	0.10			... Roots encountered to 1.80m depth		
						Greyish brown gravelly sandy CLAY, with brick and concrete fragments, occasional iron staining and rare pockets of black carbonaceous material. Gravel is subrounded fine to coarse flint. (MADE GROUND)	0.20	ES01				
							0.20	B02				
							0.50	ES03				
							0.50	B04				
							1.00	ES05				
						... with boulder sized brick and concrete fragments to 0.20m	1.00	B06				
20/04/10		Dry			(2.00)	... with clicker fragments below 0.60m	1.20	ES07				
						... becoming brown clayey gravelly SAND with occasional brick, concrete and glass fragments between 0.90m and 1.25m	1.20-1.65	D08				
							1.20	B09				
						... with large pockets of reddish orange sand below 1.25m	1.20		N4	1, 2 / 1, 1, 1, 1		
						... becoming grey mottled brown and sandy with occasional fine brick fragments below 1.80m	2.00-2.45	D19				
			1.15		2.10		2.00	B20				
						Medium dense, yellowish brown to brown slightly silty sandy subrounded to well rounded fine to coarse flint GRAVEL with rare sandstone fragments. (RIVER TERRACE DEPOSITS)	2.00		N49	2, 4 / 7, 14, 17, 11		
20/04/10	3.00	2.50					3.00-3.45	D21				
							3.00	B22				
							3.00		N25	2, 2 / 4, 5, 7, 9		
20/04/10	4.00	3.50					4.00-4.45	D23				
							4.00	B24				
							4.00		N15	2, 4 / 5, 6, 2, 2		
					(5.10)							
20/04/10	5.00	4.50				... becoming orangish brown and angular to well rounded below 5.00m	5.00-5.45	D25				
							5.00	B26				
							5.00		N24	2, 3 / 3, 5, 8, 8		
20/04/10	6.00	5.50				... with rare to occasional cobbles below 6.00m	6.00-6.45	D27				
							6.00	B28				
							6.00		N23	2, 3 / 4, 6, 6, 7		
20/04/10	6.50	5.30										
21/04/10	6.50	5.30										
21/04/10	7.00	Dry					7.00-7.45	D29				

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
			3.45	7.20

GENERAL REMARKS

1. An inspection pit has hand excavated to 1.20m below ground level, prior to boring commencing.
2. Ø200m casing used from ground level to 8.50m depth and then reduced to Ø150m to 29.50m below ground level.
3. Water seepage encountered at 19.00m below ground level, rising to 15.62m after 20 minutes.
4. Ø50 monitoring well installed at 31.00m depth, slotted between 27.00m and 31.00m below ground level.
5. Borehole backfilled with pea shingle from 31.00m to 27.00m, and with bentonite pellets from 27.00m to 0.50m depth. Concrete with lockable stopcock cover installed from 0.50m to ground level.

Issue No. 03 | Driller BN

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH07**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	20/04/10	3.25	E 531187.8 N 178024.3	31.00m
	Date Completed 23/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	2 of 5

PROGRESS			STRATA				SAMPLES & TESTS					
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill	
			-3.95		7.20		7.00	B30				
							7.00		N17	2, 2 / 3, 4, 5, 5		
						Firm to stiff, very closely fissured grey slightly sandy silty CLAY. (LONDON CLAY)	7.50	B31				
							8.00-8.45	U32	32 blows			
						... with occasional pockets of light brownish grey sand and pockets of dark grey silty sand below 8.00m	8.45	D33				
							9.00-9.45	D34				
						... with frequent to occasional claystone fragments below 9.00m	9.00		N21	2, 3 / 4, 5, 6, 6		
						... becoming slightly micaceous with bioturbation below 9.00m						
							10.00-10.45	U35	40 blows			
							10.45	D36				
							11.00-11.45	D37				
							11.00		N21	2, 3 / 4, 5, 5, 7		
						... becoming extremely closely fissured below 12.00m	12.00-12.45	U38	42 blows			
							12.45	D39				
							13.00-13.45	D40				
							13.00		N47	2, 2 / 4, 4, 7, 32		
							14.00-14.45	U41	51 blows			

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	BN	

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Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	20/04/10	3.25	E 531187.8 N 178024.3	31.00m
	Date Completed 23/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	3 of 5

PROGRESS			STRATA				SAMPLES & TESTS					
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill	
						... becoming stiff and extremely to very closely fissured below 14.00m. fissures are 0 - 20° and 70° - 90°, planar, smooth and occasionally polished. ... with a medium gravel size partly pyritised lignite nodule at 14.28m	14.10		V - Failed			
							14.20		V - Failed			
							14.30		V - Failed			
							14.45	D42				
							15.00-15.45	D43				
							15.00		N26	2, 4 / 4, 7, 7, 8		
							16.00-16.45	U44	59 blows			
							16.45	D45				
							17.00-17.45	D46				
							17.00		N38	3, 6 / 8, 9, 9, 12		
						... with occasional bioturbation and rare pockets of of dark grey silt at 17.00m						
					(21.00)							
							18.00-18.45	U47	56 blows			
							18.10		V - Failed			
						... becoming slightly silty and sandy with frequent bioturbation below 18.00m	18.20		V - Failed			
							18.30		V - Failed			
							18.45	D48				
21/04/10	8.50						19.00-19.45	D49				
21/04/10	8.50	15.62										
22/04/10	8.50	6.91										
22/04/10	20.00	Dry					20.00-20.45	U50	65 blows			
						... with occasional bioturbation and frequent pockets of dark grey sand below 20.00m						
							20.45	D51				
							20.50-20.95	U52	43 blows			
							20.95	D53				

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
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Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	20/04/10	3.25	E 531187.8 N 178024.3	31.00m
	Date Completed 23/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	4 of 5

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
						... with no fissures between 20.95m and 22.00m	21.00-21.45	U54	38 blows		
							21.45	D55			
							21.50-21.95	U56	37 blows		
						... with a band of very closely fissures between 21.50m and 21.64m	21.60		V - Failed		
							21.70		V - Failed		
							21.80		V - Failed		
							21.95	D57			
						... becoming slightly sandy below 21.95m ... with frequent bioturbation below 22.00m	22.00-22.45	U58	39 blows		
							22.45	D59			
							22.50-22.95	U60	22 blows		
							22.70		V - Failed		
							22.80		V - Failed		
							22.90		V - Failed		
							22.95	D61			
							23.00-23.45	U62	40 blows		
							23.45	D63			
							23.50-23.95	U64	45 blows		
							23.95	D65			
						... wit occasional bioturbation below 24.00m	24.00-24.45	U66	45 blows		
							24.45	D67			
							24.50-24.95	U68	39 blows		
						... becoming silty CLAY with no sand below 24.50m	24.60		V - Failed		
							24.70		V - Failed		
							24.80		V - Failed		
							24.95	D69			
							25.00-25.45	U70	47 blows		
							25.45	D71			
							25.50-25.95	U72	55 blows		
							25.95	D73			
							26.00-26.45	U74	46 blows		
							26.45	D75			
							26.50-26.95	U76	45 blows		
						... with rare pyrite nodules and occasional pockets of dark grey sand below 26.50m					
							26.95	D77			
							27.00-27.45	U78	36 blows		
							27.45	D79			
							27.50-27.95	U80	47 blows		
						... with rare pockets of dark grey sand below 27.50m					
							27.95	D81			

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	BN	

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London W3 ORF
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Borehole No BH07

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	20/04/10	3.25	E 531187.8 N 178024.3	31.00m
	Date Completed 23/04/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	5 of 5

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
			-24.95		28.20		28.00-28.45	U82	57 blows		
						Very dense, dark brownish grey and occasionally greenish grey fine to medium SAND with rare flint cobbles. (LAMBETH GROUP)	28.45	D83			
							28.50-28.95	U84	29 blows		
							28.95	D85			
							29.00-29.45	U86	75 blows		
22/04/10	29.00	Dry					29.45	D87			
23/04/10	29.00	8.54			(2.80)	... with a band of cemented siltstone between 29.50m and 31.00m					
23/04/10	29.50	Dry	-27.75		31.00		31.00	D88			
						End of Borehole	31.00		N60/ 0.075	60 /	

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	
29.45	31.00	02.00.00			

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS

8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH08**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	04/05/10	3.86	E 531388.7 N 178144.5	34.30m
	Date Completed 05/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	1 of 5

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
04/05/10		Dry	3.79		0.08	Asphalt.					
			3.66		0.20	Brown sandy GRAVEL. (Type 1) (MADE GROUND)	0.25	ES01			
			3.31		(0.35) 0.55	Firm, brown mottled yellowish brown sandy gravelly CLAY with brick fragments and rare brick cobbles. (MADE GROUND)	0.50	ES02			
			2.96		(0.35) 0.90		0.50	B03			
						Firm, brown to greyish brown sandy gravelly CLAY with shell, brick and pottery fragments. (MADE GROUND)	1.00	ES04			
					(0.75)		1.00	B05			
							1.20-1.65	U06	48 blows		
			2.21		1.65	Firm, brown to reddish brown very sandy CLAY with brick and pottery fragments. (MADE GROUND)	1.70	D07			
			1.96		1.90	Medium dense, greyish brown mottled reddish brown very clayey subrounded fine to coarse flint GRAVEL. (RIVER TERRACE DEPOSITS)	1.70-1.90	B08			
							1.70		N26	3, 5 / 7, 6, 6, 7	
							1.90-2.20	B09			
04/05/10	2.20	2.10					2.20-2.70	B10			
						Medium dense to dense, yellowish brown to orangish brown sandy subrounded to rounded fine to coarse flint GRAVEL. (RIVER TERRACE DEPOSITS)	2.20		N16	2, 2 / 3, 4, 4, 5	
04/05/10	2.70	Dry					2.70-3.20	B11			
							2.70		N16	2, 3 / 4, 3, 4, 5	
04/05/10	3.20	3.00					3.20-3.70	B12			
							3.20		N20	2, 4 / 5, 4, 5, 6	
04/05/10	3.70	Dry					3.70-4.20	B13			
							3.70		N50/ 0.29	5, 7 / 9, 11, 14, 16	
04/05/10	4.20	3.90					4.20-4.70	B14			
							4.20		N33/ 0.145	8, 11 / 13, 20	
04/05/10	4.70	4.50			(5.30)		4.70-5.20	B15			
							4.70		N45	6, 8 / 10, 10, 12, 13	
04/05/10	5.70	5.50					5.70-6.20	B16			
							5.70		N37	4, 7 / 9, 8, 9, 11	
04/05/10	6.70						6.70-7.20	B17			
							6.70		N31	3, 5 / 7, 7, 9, 8	

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
			1.90	6.30

GENERAL REMARKS

1. An inspection pit has hand excavated to 1.20m below ground level, prior to boring commencing.
2. Ø200m casing used from ground level to 7.65m depth and then reduced to Ø150m at 28.75m to 30.10m depth.
3. Water seepage encountered at 6.70m depth, rising to 5.90m after 20 minutes. Water seepage encountered at 28.05m, rising to 25.62m after 30 minutes. Water seepage encountered at 33.60m, rising to 16.44m after 20 minutes.
4. Borehole blowing between 33.60m and 31.10m depth.
5. A vibrating wire piezometer installed at 22.00m depth.
6. Borehole backfilled with bentonite pellets from 34.30m to 23.00m, with sand filter between 23.00m and 21.00m and with bentonite pellets from 21.00m to ground level.

Issue No.	Driller	
03	SW	

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH08**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	04/05/10	3.86	E 531388.7 N 178144.5	34.30m
	Date Completed 05/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	2 of 5

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
			-3.34		7.20		7.30	D18			
04/05/10	7.50	7.40				Stiff to very stiff, fissured brown mottled greyish brown silty CLAY. (LONDON CLAY) ... becoming greyish brown to grey below 7.40m	7.50-7.95	U19	38 blows		
							8.00	D20			
							8.00-8.50	B21			
04/05/10	7.65	Dry					8.50-8.95	D22			
							8.50		N17	2, 3 / 3, 4, 5, 5	
							9.50-9.95	U23	48 blows		
							10.00	D24			
							10.50-10.95	D25			
							10.50		N24	3, 4 / 5, 6, 6, 7	
							11.50-11.95	U26	58 blows		
						... becoming extremely fissured grey with occasional bioturbation and rare pockets of cemented silt and rare pyrite nodules below 11.50m	12.00	D27			
						... with a band of claystone between 12.20m and 12.40m	12.50-12.95	D28			
							12.50		N26	3, 4 / 5, 6, 7, 8	
							13.50-13.95	U29	64 blows		
						... becoming very closely fissurred with no pyrite nodules below 13.50m. Fissures are randomly orientated with slight polishing.	13.65		V - Failed		
							13.80		V130+kPa		
							14.00	D30			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller	
03	SW	

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Borehole No **BH08**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	04/05/10	3.86	E 531388.7 N 178144.5	34.30m
	Date Completed 05/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	3 of 5

PROGRESS Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	SAMPLES & TESTS Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							14.50-14.95	D31			
							14.50		N64/ 0.055	5, 11 / 14, 50	
						... with a band of claystone between 14.65m and 14.95m	15.00-15.45	U32	84 blows		
							15.50	D33			
							15.50-15.95	U34	76 blows		
							16.00	D35			
							16.00-16.45	U36	80 blows		
							16.50	D37			
							16.50-16.95	U38	92 blows		
							17.00	D39			
						... becoming extremely closely fissured with occasional pockets of light dark grey sand at 17.00m	17.00-17.45	U40	100 blows		
							17.50	D41			
					(20.63)		17.50-17.95	U42	94 blows		
							18.00	D43			
							18.00-18.45	U44	92 blows		
						... fissures becoming subvertical and subhorizontal with unpolished surfaces below 18.00m	18.15		V - Failed		
							18.30		V - Failed		
							18.50	D45			
						... with rare bioturbation below 18.50m	18.50-18.95	U46	96 blows		
							19.00	D47			
							19.00-19.45	U48	100 blows		
							19.50	D49			
							19.50-19.95	U50	100 blows		
04/05/10	7.65	Dry					20.00	D51			
05/05/10	7.65	Dry					20.00-20.45	U52	94 blows		
							20.50	D53			
							20.50-20.95	U54	94 blows		
						... becoming slightly sandy below 20.70m					
							21.00	D55			

Chiselling (m) From	To	Hours	Water Added (m) From	To

GENERAL REMARKS

Issue No. 03 | Driller SW

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8 Warple Way
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Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH08**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	04/05/10	3.86	E 531388.7 N 178144.5	34.30m
	Date Completed 05/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	4 of 5

PROGRESS Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	SAMPLES & TESTS Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							21.00-21.45	U56	100 blows		
							21.15		V - Failed		
							21.30		V - Failed		
							21.50	D57			
						... with pockets of brownish grey and dark grey sand and rare bioturbation at 21.40m	21.50-21.95	U58	100 blows		
							22.00	D59			
							22.00-22.45	U60	90 blows		
							22.50	D61			
							22.50-22.95	U62	92 blows		
							23.00	D63			
							23.00-23.45	U64	100 blows		
							23.50	D65			
							23.50-23.95	U66	94 blows		
						... becoming extremely closely to very closely fissured below 23.50m. Fissures are randomly orientated and smooth.	23.65		V - Failed		
							23.80		V - Failed		
						... with a smooth polished shear surface at 23.55m	24.00	D67			
							24.00-24.45	U68	96 blows		
							24.50	D69			
							24.50-24.95	U70	100 blows		
							25.00	D71			
							25.00-25.45	U72	100 blows		
							25.50	D73			
							25.50-25.80	U74	100 blows		
							25.85	D75			
							25.85-26.30	U76	100 blows		
							26.25	D77			
							26.25-26.65	U78	100 blows		
							26.70	D79			
							26.70-27.15	U80	100 blows		
							27.20	D81			
							27.20-27.60	U82	100 blows		
						... with frequent bioturbation, rare partings of grey fine sand and rare pyritised lignite below 27.20m	27.30		V - Failed		
							27.50		V - Failed		
							27.65	D83			
						... becoming very closely fissured, slightly silty sand sandy below 27.65m	27.65-28.10	U84	100 blows		
			-23.97		27.83		27.80		V - Failed		
			-24.14		28.00	... with a band of well rounded medium flint	27.95		V - Failed		

Chiselling (m) From	To	Hours	Water Added (m) From	To

GENERAL REMARKS

Issue No. 03 | Driller SW

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH08**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	04/05/10	3.86	E 531388.7 N 178144.5	34.30m
	Date Completed 05/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	5 of 5

PROGRESS Date	Casing	Water	STRATA Level (mOD)	Depth (Thickness)	Strata Description	SAMPLES & TESTS Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
05/05/10	7.65				gravel at 27.80m	28.15	D85			
05/05/10	7.65	28.00			Greyish brown thickly laminated clayey SAND with rare shell fragments. Laminae infilled with up to 1mm grey sand. (HARWICH FORMATION?)	28.15-28.40	U86	100 blows		
05/05/10	7.65	28.25				28.45	D87			
						28.45-28.70	U88	100 blows		
					... with a band of well rounded medium flint gravel at 28.00m	28.75	D89			
05/05/10	28.85	28.20				28.85-29.20	U90	100 blows		
				(1.80)	Stiff, dark grey slighty sandy silty CLAY with frequent shell fragments (oysters) (LAMBETH GROUP)					
					... with a band of cemented shells between 28.75m and 28.85m	29.25	D91			
					... with a band of siltstone between 29.25m and 29.80m	29.50	D92			
			-25.94	29.80		29.80	D93			
05/05/10	29.90	29.80			Stiff, fissured grey mottled reddish brown and blue sandy CLAY. (LAMBETH GROUP)	29.90-30.30	U94	100 blows		
						30.35	D95			
						30.50-31.00	B96			
05/05/10	30.10	Dry				31.00-31.45	D97			
						31.00		N50/ 0.25	8, 9 / 12, 14, 14, 10	
				(3.80)						
						32.00-32.45	U98	100 blows		
						32.50	D99			
						33.00-33.45	D100			
						33.00		N50/ 0.215	10, 13 / 15, 18, 17	
			3 -29.74	33.60						
					Dense to very dense, brown silty SAND. (THANET SAND)	33.60-34.00	B101			
				(0.70)		34.00-34.30	D102			
						34.00		N50/ 0.245	4, 8 / 11, 14, 17, 8	
05/05/10	30.10	Dry	-30.44	34.30	End of Borehole					

Chiselling (m) From	To	Hours	Water Added (m) From	To
28.75	28.85	00.15.00		
29.25	29.80	01.30.00		

GENERAL REMARKS

Issue No. 03 | Driller SW

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH09**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	3.95	E 531592.0 N 178135.8	31.50m
	Date Completed 05/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	1 of 5

PROGRESS Date	Casing	Water	STRATA Level (mOD)	Depth (Thickness)	Strata Description	SAMPLES & TESTS Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
26/04/10		Dry	3.75	0.20	Asphalt over reinforced concrete. (MADE GROUND)	0.30	ES01			
			3.65	0.30	Brown clayey SAND with brick and stale tile fragments. (MADE GROUND)	0.30	B02			
						0.50	ES03			
						0.50	B04			
				(1.00)	Brown, sandy CLAY with occasional brick fragments and rare cobbles. (MADE GROUND)					
			2.65	1.30		1.20	ES05			
						1.20	B06			
26/04/10	1.50	Dry			Dark yellowish brown sandy subangular to subrounded fine to coarse flint GRAVEL. (RIVER TERRACE DEPOSITS)	1.50	ES05			
						1.50	B06			
						1.50-1.95	B07			
						1.50-2.00	B08			
						1.50		N16	2, 2 / 3, 4, 4, 5	
						2.50-2.95	B09			
						2.50-3.00	B10			
						2.50		N19	2, 3 / 4, 4, 5, 6	
26/04/10	3.00	2.40								
27/04/02	3.00	Dry								
27/04/10	3.50	3.20				3.50-3.95	B11			
						3.50-4.00	B12			
					... becoming orangish brown and angular to rounded fine to medium with rare sandstone fragments below 3.50m	3.50		N22	3, 3 / 4, 5, 6, 7	
				(5.30)						
27/04/10	4.50	4.30				4.50-4.95	B13			
						4.50-5.00	B14			
						4.50		N29	3, 3 / 6, 7, 7, 9	
27/04/01	5.30	1								
27/04/10	5.50	5.20				5.50-5.95	B15			
						5.50	B16			
					... becoming angular to well rounded fine to coarse below 5.50m	5.50	B17			
						5.50		N31	3, 4 / 5, 8, 8, 10	
						6.50-6.95	B18			
						6.50	B19			
			-2.65	6.60		6.60	B20			
					Firm to stiff, fissured brown to greyish brown silty CLAY. (LONDON CLAY)	7.00-7.45	U21	50 blows		

Chiselling (m) From	To	Hours	Water Added (m) From	To
			1.50	5.30

GENERAL REMARKS

1. An inspection pit has hand excavated to 1.50m below ground level, prior to boring commencing.
2. Ø200m casing used from ground level to 7.50m depth and then reduced to Ø150m at 24.50m up to 31.00m below ground level.
3. Water seepage encountered at 5.30m and was sealed off at 6.70m depth. Water seepage encountered at 24.50m below ground level, rising to 20.07m after 20 minutes.
4. Bailing water between 26.50m and 27.95m. Borehole blowing between 31.50m and 25.60m.
5. Ø50 monitoring well installed at 25.00m depth, slotted between 22.00m and 25.00m below ground level.
6. Borehole backfilled with soil arisings between 31.50m and 26.50m, with bentonite pellets from 26.50m to 25.00m, pea shingle from 25.00m to 22.00m, and with bentonite pellets from 22.00m to 0.50m depth. Concrete with lockable stopcock cover installed from 0.50m to ground level.

Issue No. 03 | Driller BN

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No BH09

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	3.95	E 531592.0 N 178135.8	31.50m
	Date Completed 05/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	2 of 5

PROGRESS Date	Casing	Water	STRATA Level (mOD)	Legend	Depth (Thickness)	Strata Description	SAMPLES & TESTS Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
						... with a band of claystone at 7.30m ... becoming grey below 7.40m	7.45	D22			
27/04/10	7.50	Dry					8.00-8.45 8.00	D23	N21	3, 4 / 5, 5, 5, 6	
						... becoming extremely closely to very closely fissured and slightly silty below 9.00m. Fissures are subvertical to subhorizontal moderately polished surfaces.	9.00-9.45 9.05 9.28	U24	40 blows V - Failed V - Failed		
						... becoming extremely closely fissured with rare bioturbation and rare tabular claystone fragments below 10.00m	10.00-10.45	U25	35 blows		
							10.45	D26			
							11.00-11.45 11.00	D27	N24	4, 4 / 5, 6, 6, 7	
						.. fissure surfaces becoming polished and occasionally undulating below 12.00m	12.00-12.45 12.10 12.20	U28	38 blows V - Failed V - Failed		
							12.45	D29			
							13.00-13.45 13.00	D30	N28	4, 5 / 6, 6, 7, 9	
							14.00-14.45	U31	36 blows		

Chiselling (m) From	To	Hours	Water Added (m) From	To

GENERAL REMARKS

Issue No. 03 | Driller BN

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Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	3.95	E 531592.0 N 178135.8	31.50m
	Date Completed 05/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	3 of 5

PROGRESS Date	Casing	Water	STRATA Level (mOD)	Legend	Depth (Thickness)	Strata Description	SAMPLES & TESTS Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
							14.45	D32			
							15.00-15.45	U33	38 blows		
27/04/10 28/04/10	7.50 7.50	Dry Dry			(17.95)		15.45 15.50-15.95	D34 U35	41 blows		
							15.95 16.00-16.45	D36 U37	34 blows		
						... becoming very closely fissured with occasional bioturbation and rare pockets of dark grey sand and rare pyrite nodules below 16.50m	16.45 16.50-16.95	D38 U39	35 blows		
							16.95 17.00-17.45	D40 U41	31 blows		
						... becoming stiff and sandy with frequent bioturbation and no fissures below 17.50m	17.45 17.50-17.95 17.60 17.70 17.80	D42 U43	33 blows V - Failed V - Failed V - Failed		
							17.95 18.00-18.45	D44 U45	32 blows		
							18.45 18.50-18.95	D46 U47	32 blows		
							18.95 19.00-19.45	D48 U49	29 blows		
							19.45 19.50-19.95 19.60 19.80	D50 U51	34 blows V - Failed V - Failed		
						... with occasional pockets and partings of grey sand and a subhorizontal (30°) band of fine grey sand with occasional tabular pyrite nodules between 19.70m and 19.72m	19.95 20.00-20.45	D52 U53	30 blows		
							20.45 20.50-20.95	D54 U55	29 blows		
							20.95	D56			

Chiselling (m) From	To	Hours	Water Added (m) From	To

GENERAL REMARKS

Issue No. 03 | Driller BN

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Borehole No **BH09**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	3.95	E 531592.0 N 178135.8	31.50m
	Date Completed 05/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	4 of 5

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
							21.00-21.45	U57	26 blows		
							21.45	D58			
							21.50-21.95	U59	32 blows		
						... becoming extremely closely fissured and sandy with frequent pockets of grey sand and occasional pyrite nodules and rare pyritised wood fragments and a fossilised shark tooth below 21.50m	21.95	D60			
							22.00-22.45	U61	39 blows		
							22.45	D62			
							22.50-22.95	U63	42 blows		
							22.95	D64			
							23.00-23.45	U65	40 blows		
						... becoming very closely fissured below 23.00m	23.45	D66			
							23.50-23.95	U67	47 blows		
						... becoming closely fissured below 23.50	23.60		V - Failed		
						... with a 45° polished slightly undulating shear surface at 23.65	23.80		V - Failed		
							23.95	D68			
							24.00-24.45	U69	49 blows		
							24.10		V - Failed		
						... becoming very stiff with no fissures below 24.20m	24.30		V - Failed		
							24.45	D70			
28/04/10	24.50		-20.60		24.55	... becoming sandy below 24.25m	24.50-24.95	U71	30 blows		
						Stiff, greyish brown thinly laminated slightly sandy CLAY. Laminae infilled with up to 1mm of grey fine sand. (HARWICH FORMATION?)	24.65		V - Failed		
							24.80		V - Failed		
							24.95	D72			
							25.00-25.45	U73	41 blows		
						... becoming silty with frequent partings of light brown sand and with tabular pyrite nodule at 24.55m					
							25.45	D74			
						... becoming very stiff and slightly silty below 24.80m	25.50-25.75	U75	75 blows		
28/04/10	25.50	Dry			(2.25)		25.75	D76			
29/04/10	25.50	18.00				... with a band of cemented shells between 25.70m and 26.30m					
						... with a band of siltstone between 26.30m and 26.80m	26.50	D77			
			-22.85		26.80						
						Very stiff to hard, fissured reddish brown mottled bluish grey slightly silty CLAY. (LAMBETH GROUP)	27.00-27.45	U78	41 blows		
							27.45	D79			
							27.50-27.95	U80	53 blows		
29/04/10	27.50	Dry					27.95	D81			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
25.75	26.80	02.20.00		

GENERAL REMARKS

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH09**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	26/04/10	3.95	E 531592.0 N 178135.8	31.50m
	Date Completed 05/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	5 of 5

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
05/05/10	27.50	19.30					28.00-28.45	U82	85 blows		
							28.45	D83			
							28.50-28.95	U84	78 blows		
						... becoming blue to bluish grey mottled reddish brown and olive/greenish brown below 28.60m	28.95	D85			
					(4.40)		29.00-29.30	U86	100 blows		
							29.45	D87			
05/05/10	29.00	Dry					29.50-29.85	U88	100 blows		
							29.95	D89			
							30.00-30.36	U90	98 blows		
							30.45	D91			
							31.00-31.45	D92			
							31.00		N52	4, 5 / 11, 12, 12, 17	
			-27.25		31.20						
						Dark reddish brown to greyish brown silty fine to medium SAND. (LAMBETH GROUP)					
05/05/10	31.00	Dry	-27.55		31.50						
						End of Borehole					

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller	
03	BN	

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH10**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	11/05/10	3.64	E 531522.1 N 177927.8	31.00m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	1 of 5

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
11/05/10		Dry	3.34		0.30	Turf over dark brown to grey silty sandy CLAY. (TOPSOIL)	0.10 0.25	ES01		... Roots of live appearance to 0.20m depth	
					(1.30)	Medium dense, brown to dark brown silty gravelly SAND with bick fragments and rare brick cobbles. (MADE GROUND)	0.50 0.50 1.00 1.00 1.20-1.70 1.20	ES02 B03 ES04 B05 B06	N6	1, 0 / 1, 2, 1, 2	
			2.04		1.60		1.70-21.50	U07	36 blows		
			1.54		(0.50) 2.10	Soft to firm, brown to dark brown silty sandy CLAY with occasional flint gravel. (MADE GROUND?)	2.00	ES08			
			1.29		2.35	Medium dense, brown occasionally mottled orangish brown sandy clayey GRAVEL. (RIVER TERRACE DEPOSITS)	2.20 2.20-2.70 2.20	D09 B10	N35	2, 4 / 5, 9, 10, 11	
11/05/10	3.20	3.00			(1.25)	Medium dense to dense, orangish brown to brown sandy subangular to subrounded fine to coarse flint GRAVEL. (RIVER TERRACE DEPOSITS)	3.20-3.70 3.20	B11	N17	4, 4 / 3, 4, 5, 5	
			0.04		3.60	... with lenses of brown sandy clay between 3.30m and 3.60m					
			-0.46		(0.50) 4.10	Medium dense to dense, orangish brown to brown fine to coarse SAND with occasional subangular to subrounded fine to coarse flint gravel. (RIVER TERRACE DEPOSITS)	4.20-4.70 4.20	B12	N30	3, 5 / 7, 7, 7, 9	
11/05/10	4.20	Dry				Medium dense to dense, orangish brown to brown sandy subangular to subrounded fine to coarse flint GRAVEL. (RIVER TERRACE DEPOSITS)					
11/05/10	5.20	4.70			(3.25)		5.20-5.70 5.20	B13	N42	5, 7 / 9, 10, 11, 12	
11/05/10	6.20	6.00					6.20-6.70 6.20	B14	N32	3, 5 / 6, 8, 8, 10	
11/05/10	6.80										

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
			2.35	7.35

GENERAL REMARKS

1. An inspection pit has hand excavated to 1.20m below ground level, prior to boring commencing.
2. Ø200m casing used from ground level to 7.60m depth and then reduced to Ø150m at 23.55m up to 31.00m below ground level.
3. Water seepage encountered at 6.80m depth, rising to 6.19m after 20 minutes. Water seepage encountered at 23.10m depth, rising to 18.27m after 20 minutes.
4. Ø50 monitoring well installed at 31.00m depth, slotted between 23.00m and 31.00m below ground level.
5. Borehole backfilled with pea shingle from 31.00m to 23.00m, and with bentonite pellets from 23.00m to 0.50m depth. Concrete with lockable stopcock cover installed from 0.50m to ground level.

Issue No.	Driller	
03	BN	

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8 Warple Way
London W3 ORF
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E-mail: si@conceptconsultants.co.uk

Borehole No **BH10**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	11/05/10	3.64	E 531522.1 N 177927.8	31.00m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	2 of 5

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
11/05/10	7.20	6.20	-3.71		7.35		7.20-7.35 7.20	B15	N11	4, 3 / 2, 3, 3, 3	
						Firm to stiff, fissured brown silty CLAY. (LONDON CLAY) ... becoming stiff, grey to greyish brown below 7.40m	7.35-7.70	B16			
11/05/10	7.60	Dry					8.00-8.45 8.00	D17 N16		2, 2 / 3, 4, 4, 5	
							9.00-9.45	U18	38 blows		
							9.50	D19			
							10.00-10.45 10.00	D20 N22		2, 3 / 5, 5, 6, 6	
							11.00-11.30	U21	100 blows		
						... becoming extremely closely fissured and grey with rare pyrite nodules below 11.00m ... with occasional orangish brown siltstone fragments at 11.25m ... with a band of claystone between 11.30m and 11.50m	11.35	D22			
							12.00-12.45 12.00	D23 N24		3, 4 / 5, 6, 6, 7	
							13.00-13.45	U24	60 blows		
						... becoming extremely closely to very closely fissured, slightly silty with rare pockets of brown fine sand and rare bioturbation below 13.00m. Fissures are randomly orientated with unpolished smooth surfaces.	13.15 13.30 13.50	D25	V - Failed V - Failed		
							14.00-14.45	D26			

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller	
03	BN	

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8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH10**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	11/05/10	3.64	E 531522.1 N 177927.8	31.00m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	3 of 5

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
							14.00		N32	4, 6 / 6, 7, 9, 10	
							15.00-15.45	U27	68 blows		
					(15.45)	... becoming very closely fissured with occasional pockets of light grey sand below 15.00m					
							15.50	D28			
							15.50-15.95	U29	74 blows		
							16.00	D30			
							16.00-16.45	U31	80 blows		
11/05/10	7.60	Dry					16.50	D32			
12/05/10	7.60	Dry					16.50-16.95	U33	78 blows		
							17.00	D34			
							17.00-17.45	U35	86 blows		
						... with grey silty fine sand lenses at 17.40m	17.50	D36			
						... becoming very stiff extremely closely to very closely fissured and slightly silty slightly sand with occasional bioturbation below 17.50m	17.50-17.95	U37	90 blows		
							17.65		V - Failed		
							17.80		V - Failed		
							18.00	D38			
						... with frequent bioturbation between 17.55m and 17.65m	18.00-18.45	U39	90 blows		
						... with a lignite fragment at 17.60m					
							18.50	D40			
							18.50-18.95	U41	98 blows		
							19.00	D42			
							19.00-19.35	U43	100 blows		
							19.40	D44			
							19.40-19.85	U45	82 blows		
							19.90	D46			
							19.90-20.35	U47	92 blows		
						... with a 45° polished slightly undulating shear surface at 19.95m	20.05		V - Failed		
						... with a fissure infilled with grey fine sand at 20.10m	20.15		V - Failed		
							20.40	D48			
						... with a pyrite nodule at 20.20m	20.40-20.85	U49	100 blows		
							20.90	D50			
							20.90-21.35	U51	100 blows		

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To

GENERAL REMARKS

Issue No.	Driller
03	BN

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No **BH10**

Project Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	11/05/10	3.64	E 531522.1 N 177927.8	31.00m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	Cable Percussion	4 of 5

PROGRESS			STRATA				SAMPLES & TESTS			Field Records	Instrument/ Backfill
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result		
							21.40	D52			
							21.40-21.80	U53	100 blows		
							21.85	D54			
							21.85-22.25	U55	100 blows		
							22.30	D56			
							22.30-22.75	U57	100 blows		
						... with a 45° polished striated shear surface at 22.35m	22.45		V - Failed		
							22.60		V - Failed		
			-19.16		22.80	... with a pyrite nodule at 22.65	22.80	D58			
						... with frequent bioturbation at 22.72m	22.80-23.05	U59	100 blows		
							22.90		V - Failed		
12/05/10	7.60					Stiff, very thinly bedded dark greyish brown sandy CLAY with frequent medium to coarse gravel size pockets of brown clayey fine to medium sand. (HARWICH FORMATION)	22.95		V - Failed		
					(0.90)		23.10	D60			
							23.10-23.60	B61			
12/05/10	23.60	17.80				... with a medium gravel size lignite fragment at 22.80m	23.60-23.90	U62	100 blows		
			-20.06		23.70		23.60		V - Failed		
						... with a subrounded medium black flint at 22.86m	23.90		V - Failed		
12/05/10	24.00	18.30				... with frequent coarse sand size oxidised glauconite between 22.89m and 22.95m	23.95	D63			
						... with a band of dark brown clayey subrounded coarse black flint GRAVEL between 23.00m and 23.05m	23.95-24.35	U64	100 blows		
							24.10		V - Failed		
							24.20		V - Failed		
							24.40	D65			
						... becoming stiff, dark grey silty very sandy with occasional pockets of grey sand below 23.60m	24.40-24.60	U66	100 blows		
							24.65	D67			
					(2.15)		24.65-24.75	U68	100 blows		
							24.70		V - Failed		
						Firm, dark grey thinly laminated silty very sandy CLAY. Laminae infilled with up to 1mm of grey fine sand. (LAMBETH GROUP)	24.80	D69			
							25.00-25.70	B70			
						... with frequent cream shell fragments (oysters) between 23.78m and 23.84m					
						... laminae infilled with brown sand and occasional tabular pyrite nodules below 23.88m					
12/05/10	25.80	17.10	-22.21		25.85		25.80-26.15	U71	100 blows		
						... becoming firm to stiff, thinly to thickly laminated, slightly sandy and slightly silty below 23.95m	25.90		V18 (2)kPa		
							26.00		V18 (2)kPa		
							26.10		V6 (0)kPa		
12/05/10	26.20	16.50				... with a tabular pyrite nodule at 24.10m	26.20	D72			
					(0.85)	... becoming very stiff, thickly laminated brownish grey silty CLAY below 24.65m	26.20-26.55	U73	100 blows		
							26.30		PP250+kPa		
12/05/10	26.60	16.50				... with a medium gravel size shell fragment at 24.76m	26.40		PP140+kPa		
			-23.06		26.70		26.60	D74			
						... becoming slightly clayey between 25.70m and 26.70m	26.60-27.05	U75	100 blows		
						... with a band of light yellowish grey occasionally clayey fine to medium SAND between 25.80m and 25.86m					
							27.10	D76			
							27.10-27.50	B77			
						Soft to firm, light brownish grey sandy SILT. (LAMBETH GROUP)					
12/05/10	27.50	16.00					27.50-27.95	D78			
						... becoming brownish green between 25.90m and 26.70m	27.50-28.00	B79			
							27.50		N44	4, 6 / 8, 10, 12, 14	
						... becoming stiff, light brownish grey mottled grey and orangish brown below 26.40m					
						... becoming stiff grey SILT below 26.44m					

Chiselling (m)			Water Added (m)	
From	To	Hours	From	To
24.80	25.30	01.30.00		
25.40	25.70	01.30.00		

GENERAL REMARKS

Issue No.	Driller
03	BN

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

Borehole No
BH10

Project
Northern Line Extension

Job No	Date Started	Ground Level (mOD)	Co-Ordinates	Final Depth
10/2254	11/05/10	3.64	E 531522.1 N 177927.8	31.00m
	Date Completed 12/05/10			

Client	Method/ Plant Used	Sheet
REO (Powerstation) Ltd	**Cable Percussion**	5 of 5

PROGRESS			STRATA				SAMPLES & TESTS				
Date	Casing	Water	Level (mOD)	Legend	Depth (Thickness)	Strata Description	Depth (m)	Type No	Test Result	Field Records	Instrument/ Backfill
12/05/10	28.50	15.60			(3.00)	Medium dense to dense, greyish brown SAND locally glauconitic. (THANET SAND) ... with a pocket of grey silt at 26.80m	28.50-28.95 28.50-29.00 28.50	D80 B81	N50/ 0.28	3, 7 / 7, 12, 17, 14	
12/05/10	29.50	15.30	-26.06		29.70		29.50 29.50-30.00	D82 B83			
						Dense to very dense, grey silty SAND. (THANET SAND)	29.80		N33	3, 5 / 7, 7, 9, 10	
					(1.30)		30.50-31.00 30.50	B84	N28	No Recovery 2, 4 / 6, 6, 8, 8	
12/05/10	31.00	15.50	-27.36		31.00						
						End of Borehole					

Chiselling (m)			Water Added (m)		GENERAL REMARKS
From	To	Hours	From	To	

Issue No.	Driller	
03	BN	

7. GROUNDWATER MONITORING RESULTS

Borehole	Depth of Installation	Date of Installation	Type	Top	Bottom	Date & Time	Depth (mbgl)	Depth (mOD)	Remarks
BH05	35.10	10/05/2010	SP	33.10	35.10	10/05/2010 11:00:00	20.51	-16.12	
	35.10	10/05/2010	SP	33.10	35.10	11/05/2010 08:00:00	20.00	-15.61	
	35.10	10/05/2010	SP	33.10	35.10	12/05/2010 12:10:00	19.70	-15.31	
	35.10	10/05/2010	SP	33.10	35.10	13/05/2010 14:00:00	19.17	-14.78	
	35.10	10/05/2010	SP	33.10	35.10	17/05/2010 10:00:00	19.10	-14.71	
	35.10	10/05/2010	SP	33.10	35.10	18/05/2010 10:10:00	19.08	-14.69	
	35.10	10/05/2010	SP	33.10	35.10	19/05/2010 12:40:00	19.11	-14.72	
	35.10	10/05/2010	SP	33.10	35.10	20/05/2010 10:00:00	19.09	-14.7	
	35.10	10/05/2010	SP	33.10	35.10	21/05/2010 16:05:00	19.10	-14.71	
	35.10	10/05/2010	SP	33.10	35.10	27/05/2010 16:30:00	19.05	-14.66	
	35.10	10/05/2010	SP	33.10	35.10	04/06/2010 11:35:00	18.97	-14.58	
	35.10	10/05/2010	SP	33.10	35.10	15/06/2010 17:10:00	19.07	-14.68	
	35.10	10/05/2010	SP	33.10	35.10	15/06/2010 17:50:00	19.78	-15.39	... Diver removed
	35.10	10/05/2010	SP	33.10	35.10	28/06/2010 13:45:00	19.07	-14.68	
BH06	37.00	30/04/2010	SP	24.00	37.00	30/04/2010 16:50:00	29.28	-24.74	
	37.00	30/04/2010	SP	24.00	37.00	04/05/2010 14:45:00	12.96	-8.42	
	37.00	30/04/2010	SP	24.00	37.00	05/05/2010 12:18:00	12.95	-8.41	
	37.00	30/04/2010	SP	24.00	37.00	06/05/2010 16:40:00	12.96	-8.42	
	37.00	30/04/2010	SP	24.00	37.00	07/05/2010 10:20:00	12.96	-8.42	
	37.00	30/04/2010	SP	24.00	37.00	10/05/2010 15:10:00	12.93	-8.39	
	37.00	30/04/2010	SP	24.00	37.00	11/05/2010 08:50:00	12.94	-8.4	
	37.00	30/04/2010	SP	24.00	37.00	12/05/2010 12:50:00	12.93	-8.39	
	37.00	30/04/2010	SP	24.00	37.00	13/05/2010 14:00:00	12.92	-8.38	
	37.00	30/04/2010	SP	24.00	37.00	17/05/2010 10:50:00	12.93	-8.39	
	37.00	30/04/2010	SP	24.00	37.00	18/05/2010 09:55:00	12.95	-8.41	
	37.00	30/04/2010	SP	24.00	37.00	19/05/2010 12:25:00	12.94	-8.4	
	37.00	30/04/2010	SP	24.00	37.00	20/05/2010 09:45:00	12.93	-8.39	
	37.00	30/04/2010	SP	24.00	37.00	21/05/2010 15:50:00	12.94	-8.4	
	37.00	30/04/2010	SP	24.00	37.00	27/05/2010 17:45:00	12.97	-8.43	
	37.00	30/04/2010	SP	24.00	37.00	04/06/2010 13:45:00	12.96	-8.42	
	37.00	30/04/2010	SP	24.00	37.00	15/06/2010 14:10:00	12.97	-8.43	
	37.00	30/04/2010	SP	24.00	37.00	15/06/2010 14:45:00	13.46	-8.92	... Diver removed
	37.00	30/04/2010	SP	24.00	37.00	28/06/2010 14:35:00	13.01	-8.47	
BH07	31.00	23/04/2010	SP	27.00	31.00	23/04/2010 17:00:00	10.70	-7.45	
	31.00	23/04/2010	SP	27.00	31.00	26/04/2010 11:00:00	10.42	-7.17	
	31.00	23/04/2010	SP	27.00	31.00	27/04/2010 17:00:00	10.30	-7.05	
	31.00	23/04/2010	SP	27.00	31.00	28/04/2010 08:00:00	10.19	-6.94	
	31.00	23/04/2010	SP	27.00	31.00	29/04/2010 14:00:00	10.01	-6.76	

GENERAL REMARKS

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

GROUNDWATER MONITORING

Project: Northern Line Extension

Client: REO (Powerstation) Ltd

Job No: 10/2254

Borehole	Depth of Installation	Date of Installation	Type	Top	Bottom	Date & Time	Depth (mbgl)	Depth (mOD)	Remarks
BH07	31.00	23/04/2010	SP	27.00	31.00	30/04/2010 16:35:00	9.91	-6.66	
	31.00	23/04/2010	SP	27.00	31.00	04/05/2010 15:11:00	9.47	-6.22	
	31.00	23/04/2010	SP	27.00	31.00	05/05/2010 12:01:00	9.40	-6.15	
	31.00	23/04/2010	SP	27.00	31.00	06/05/2010 16:10:00	9.35	-6.1	
	31.00	23/04/2010	SP	27.00	31.00	07/05/2010 10:00:00	9.28	-6.03	
	31.00	23/04/2010	SP	27.00	31.00	10/05/2010 14:20:00	9.20	-5.95	
	31.00	23/04/2010	SP	27.00	31.00	11/05/2010 08:10:00	9.18	-5.93	
	31.00	23/04/2010	SP	27.00	31.00	12/05/2010 12:25:00	9.17	-5.92	
	31.00	23/04/2010	SP	27.00	31.00	13/05/2010 15:05:00	9.16	-5.91	
	31.00	23/04/2010	SP	27.00	31.00	17/05/2010 10:10:00	9.14	-5.89	
	31.00	23/04/2010	SP	27.00	31.00	18/05/2010 09:25:00	9.12	-5.87	
	31.00	23/04/2010	SP	27.00	31.00	19/05/2010 11:40:00	9.15	-5.9	
	31.00	23/04/2010	SP	27.00	31.00	20/05/2010 09:10:00	9.15	-5.9	
	31.00	23/04/2010	SP	27.00	31.00	21/05/2010 15:10:00	9.14	-5.89	
	31.00	23/04/2010	SP	27.00	31.00	27/05/2010 16:45:00	9.13	-5.88	
	31.00	23/04/2010	SP	27.00	31.00	04/06/2010 14:02:00	9.08	-5.83	
	31.00	23/04/2010	SP	27.00	31.00	15/06/2010 15:10:00	9.90	-6.65	
	31.00	23/04/2010	SP	27.00	31.00	15/06/2010 15:30:00	10.56	-7.31	... Diver removed
	31.00	23/04/2010	SP	27.00	31.00	28/06/2010 15:10:00	9.92	-6.67	
BH09	25.00	05/05/2010	SP	22.00	25.00	05/05/2010 17:00:00	10.52	-6.57	
	25.00	05/05/2010	SP	22.00	25.00	06/05/2010 16:25:00	10.48	-6.53	
	25.00	05/05/2010	SP	22.00	25.00	13/05/2010 15:35:00	10.39	-6.44	
	25.00	05/05/2010	SP	22.00	25.00	04/06/2010 15:35:00	10.34	-6.39	
	25.00	05/05/2010	SP	22.00	25.00	15/06/2010 16:00:00	10.35	-6.4	
	25.00	05/05/2010	SP	22.00	25.00	15/06/2010 16:20:00	11.55	-7.6	... Diver removed
	25.00	05/05/2010	SP	22.00	25.00	28/06/2010 16:10:00	10.37	-6.42	
BH10	31.00	13/05/2010	SP	23.00	31.00	13/05/2010 11:35:00	10.78	-7.14	
	31.00	13/05/2010	SP	23.00	31.00	17/05/2010 10:35:00	10.55	-6.91	
	31.00	13/05/2010	SP	23.00	31.00	18/05/2010 09:45:00	10.52	-6.88	
	31.00	13/05/2010	SP	23.00	31.00	19/05/2010 12:10:00	10.50	-6.86	
	31.00	13/05/2010	SP	23.00	31.00	20/05/2010 09:25:00	10.47	-6.83	
	31.00	13/05/2010	SP	23.00	31.00	21/05/2010 10:42:00	10.42	-6.78	
	31.00	13/05/2010	SP	23.00	31.00	27/05/2010 17:25:00	10.38	-6.74	
	31.00	13/05/2010	SP	23.00	31.00	04/06/2010 16:00:00	10.07	-6.43	
	31.00	13/05/2010	SP	23.00	31.00	15/06/2010 16:30:00	10.07	-6.43	
	31.00	13/05/2010	SP	23.00	31.00	15/06/2010 17:00:00	11.33	-7.69	... Diver removed
	31.00	13/05/2010	SP	23.00	31.00	28/06/2010 16:45:00	10.08	-6.44	

GENERAL REMARKS

CONCEPT SITE INVESTIGATIONS
8 Warple Way
London W3 ORF
Telephone: 020 8811 2880_Fax: 020 8811 2881
E-mail: si@conceptconsultants.co.uk

GROUNDWATER MONITORING

Project: Northern Line Extension

Client: REO (Powerstation) Ltd

Job No: 10/2254

CONCEPT SITE INVESTIGATIONS

Vibrating Wire Piezometer: BH01

Installed depth(mbgl): 20.0 — Ground Level (mOD): 4.08
Instrument Number 314312 — Range kPa: 518
k factor kPa -0.146072618 per digit — Date Installed: 21/05/2010

Date	Time	Microseconds	Digits (B units)	Pressure kPa	Reduced Level (mOD)	Head (m)	Remarks
21/05/2010	10:50	3256	9432.6	0.00	0.00	0.00	Base reading
21/05/2010	12:00	3454	8382.1	153.44	-0.27	15.65	After Installation
27/05/2010	18:00	3430	8499.9	136.25	-2.02	13.90	
04/06/2010	10:20	3436	8470.2	140.58	-1.58	14.34	
15/06/2010	12:55	3437	8465.3	141.30	-1.51	14.41	
28/06/2010	13:00	3441	8445.6	144.17	-1.21	14.71	

Note: For ease of entry, using mini readout CLP04, the reading of 0.03389 has beeen entered as 3389

Northern Line Extension

10/2254

GEOSENSE

VIBRATING WIRE TRANSDUCER CALIBRATION

Model	G51-Series
Serial	314312
Works ID	57 12 18

Cal date	9-Jun-08
DPI No	52001702
Baro	1015.0
Temp °C	19

Applied pressure		Readings [digit]			Calculated Pressure		Error % fso	
psi	kPa	1 up	2 up	avg.[digit]	lin.[kPa]	polyn.[kPa]	linear	polynomial
0.000	0.000	9449	9449	9449	1.05	-0.07	0.20%	-0.01%
15.083	104.000	8745	8745	8745	103.89	104.11	-0.02%	0.02%
30.022	207.000	8045	8045	8045	206.14	207.04	-0.17%	0.01%
45.105	311.000	7334	7334	7334	310.00	310.91	-0.19%	-0.02%
60.044	414.000	6624	6624	6624	413.71	413.96	-0.06%	-0.01%
75.127	518.000	5902	5902	5902	519.17	518.05	0.23%	0.01%

Calibration of master DPI valid from 04 May 2006. UKAS Certificate of Calibration 00930 issued by Chamois Metrology (UKAS Accredited Calibration Laboratory 0822)

CALIBRATION FACTORS

Linear factor (k)

kPa per digit	psi per digit
-0.146072618	-0.021185

Polynomial factors

kPa		psi
A	-6.73989E-07	-9.77503E-08
B	-0.135725916	-0.019685
C	1342.578811	194.7177391

Note: Digits are $Hz^2 \times 10^{-3}$ units.
(please consult the relevent User Manuals for conversion of other reading units)
Polynomial calculation $[kPa] = A * (digit)^2 + B * (digit) + C$

THIS CERTIFICATE IS VALID ONLY WHEN CARRYING THE OFFICIAL ORIGINAL STAMP OF MGS-GEOSENSE BELOW

CERTIFIED INSPECTOR 1 MGS GEOSENSE CALIBRATED

Geotechnical Centre, Rougham Industrial Estate, Rougham, Bury St Edmunds, Suffolk, IP30 9ND, England
t +44 (0)1359 271167 f +44 (0)1359 271168 e info@mgs.co.uk www.mgsgeosense.co.uk
Geosense is a division of Marton Geotechnical Services Ltd Registered in England 2481929

CONCEPT SITE INVESTIGATIONS

Vibrating Wire Piezometer: BH02

Installed depth(m): 25.0 — Ground Level (mOD): 1.66
Instrument Number 314307 — Range kPa: 518
k factor kPa -0.147379888 per digit — Date Installed: 19/05/2010

Date	Time	Microseconds	Digits (B units)	Pressure kPa	Reduced Level (mOD)	Head (m)	Remarks
19/05/2010	09:00	3270	9352.0	0.00	0.00	0.00	Base reading
19/05/2010	10:00	3476	8276.4	158.52	-7.17	16.17	After Installation
20/05/2010	08:10	3486	8229.0	165.51	-6.46	16.88	
21/05/2010	14:00	3491	8205.4	168.98	-6.10	17.24	
27/05/2010	16:00	3496	8182.0	172.44	-5.75	17.59	
04/06/2010	11:20	3499	8167.9	174.51	-5.54	17.80	
15/06/2010	13:10	3500	8163.3	175.20	-5.47	17.87	
28/06/2010	13:00	3500	8163.3	175.20	-5.47	17.87	

Note: For ease of entry, using mini readout CLP04, the reading of 0.03389 has beeen entered as 3389

Northern Line Extension

10/2254

GEOSENSE

VIBRATING WIRE TRANSDUCER CALIBRATION

Model	G51-Series
Serial	314307
Works ID	57 12 13

Cal date	9-Jun-08
DPI No	52001702
Baro	1015.0
Temp °C	19

Applied pressure		Readings [digit]			Calculated Pressure		Error % fso	
psi	kPa	1 up	2 up	avg.[digit]	lin.[kPa]	polyn.[kPa]	linear	polynomial
0.000	0.000	9338	9338	9338	0.91	-0.13	0.18%	-0.03%
15.083	104.000	8638	8638	8638	104.07	104.28	0.01%	0.05%
30.022	207.000	7946	7946	7946	206.06	206.89	-0.18%	-0.02%
45.105	311.000	7240	7240	7240	310.11	310.95	-0.17%	-0.01%
60.044	414.000	6537	6537	6537	413.72	413.95	-0.05%	-0.01%
75.127	518.000	5822	5822	5822	519.10	518.06	0.21%	0.01%

Calibration of master DPI valid from 04 May 2006. UKAS Certificate of Calibration 00930 issued by Chamois Metrology (UKAS Accredited Calibration Laboratory 0822)

CALIBRATION FACTORS

Linear factor (k)

kPa per digit	psi per digit
-0.147379888	-0.021375

Polynomial factors

kPa		psi
A	-6.33414E-07	-9.18657E-08
B	-0.1377773	-0.019982
C	1341.664634	194.5851536

Note: Digits are $Hz^2 \times 10^{-3}$ units.
(please consult the relevent User Manuals for conversion of other reading units)
Polynomial calculation $[kPa] = A * (digit)^2 + B * (digit) + C$

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Geotechnical Centre, Rougham Industrial Estate, Rougham, Bury St Edmunds, Suffolk, IP30 9ND, England
t +44 (0)1359 271167 f +44 (0)1359 271168 e info@mgs.co.uk www.mgsgeosense.co.uk
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Vibrating Wire Piezometer: BH03

Installed depth(m): **25.0** Ground Level (mOD) 5.49
Instrument Number 314309 Range kPa 518
k factor kPa -0.140190363 per digit Date Installed: 12/05/2010

Date	Time	Microseconds	Digits (B units)	Pressure kPa	Reduced Level (mOD)	Head (m)	Remarks
12/05/2010	10:50	3313	9110.8	0.00	0.00	0.00	Base reading
13/05/2010	13:30	3417	8564.7	76.57	-11.70	7.81	After Installation
14/05/2010	08:20	3437	8465.3	90.50	-10.28	9.23	
17/05/2010	08:35	3495	8186.6	129.56	-6.29	13.22	
18/05/2010	09:00	3498	8172.6	131.53	-6.09	13.42	
19/05/2010	11:00	3501	8158.6	133.49	-5.89	13.62	
20/05/2010	08:30	3504	8144.6	135.45	-5.69	13.82	
21/05/2010	14:20	3506	8135.3	136.75	-5.56	13.95	
27/05/2010	15:20	3510	8116.8	139.35	-5.30	14.21	
04/06/2010	11:30	3514	8098.3	141.94	-5.03	14.48	
15/06/2010	18:20	3516	8089.1	143.23	-4.90	14.61	
28/06/2010	13:15	3515	8093.7	142.58	-4.97	14.54	

Note: For ease of entry, using mini readout CLP04, the reading of 0.03389 has beeen entered as 3389

GEOSENSE

VIBRATING WIRE TRANSDUCER CALIBRATION

Model	G51-Series
Serial	314309
Works ID	57 12 15

Cal date	9-Jun-08
DPI No	52001702
Baro	1015.0
Temp °C	19

Applied pressure		Readings [digit]			Calculated Pressure		Error % fso	
psi	kPa	1 up	2 up	avg.[digit]	lin.[kPa]	polyn.[kPa]	linear	polynomial
0.000	0.000	9113	9113	9113	1.14	0.03	0.22%	0.01%
15.083	104.000	8381	8381	8381	103.76	103.97	-0.05%	0.00%
30.022	207.000	7651	7651	7651	206.10	206.98	-0.17%	0.00%
45.105	311.000	6910	6910	6910	309.98	310.88	-0.20%	-0.02%
60.044	414.000	6168	6168	6168	414.00	414.24	0.00%	0.05%
75.127	518.000	5419	5419	5419	519.00	517.90	0.19%	-0.02%

Calibration of master DPI valid from 04 May 2006. UKAS Certificate of Calibration 00930 issued by Chamots Metrology (UKAS Accredited Calibration Laboratory 0822)

CALIBRATION FACTORS

Linear factor (k)

kPa per digit	psi per digit
-0.140190363	-0.020332

Polynomial factors

	kPa	psi
A	-6.095685E-07	-8.84097E-08
B	-0.13131799	-0.019047
C	1247.484439	180.925952

Note: Digits are Hz^2 x 10^3 units.
(please consult the relevent User Manuals for conversion of other reading units)

Polynomial calculation *[kPa] = A * (digit)^2 + B * (digit) + C*

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CERTIFIED CALIBRATED INSPECTOR 1 MGS GEOSENSE

Geotechnical Centre, Rougham Industrial Estate, Rougham, Bury St Edmunds, Suffolk, IP30 9ND, England
t +44 (0)1359 271167 f +44 (0)1359 271168 e info@mgs.co.uk www.mgsgeosense.co.uk

CONCEPT SITE INVESTIGATIONS

Vibrating Wire Piezometer: BH04

Installed depth(m): **32.0** Ground Level (mOD) 4.49
Instrument Number 314311 Range kPa 518
k factor kPa -0.152032384 per digit Date Installed: 28/04/2010

Date	Time	Microseconds	Digits (B units)	Pressure kPa	Reduced Level (mOD)	Head (m)	Remarks
28/04/2010	15:40	3352	8900.0	0.00	0.00	0.00	Base reading
30/04/2010	14:00	3570	7846.3	160.21	-11.17	16.34	After Installation
04/05/2010	11:45	3574	7828.7	162.88	-10.90	16.61	
05/05/2010	09:30	3573	7833.1	162.21	-10.96	16.55	
06/05/2010	07:50	3572	7837.5	161.54	-11.03	16.48	
07/05/2010	09:45	3571	7841.9	160.87	-11.10	16.41	
10/05/2010	13:35	3571	7841.9	160.87	-11.10	16.41	
11/05/2010	07:45	3571	7841.9	160.87	-11.10	16.41	
12/05/2010	12:05	3571	7841.9	160.87	-11.10	16.41	
13/05/2010	15:50	3571	7841.9	160.87	-11.10	16.41	
17/05/2010	08:55	3574	7828.7	162.88	-10.90	16.61	
18/05/2010	09:15	3574	7828.7	162.88	-10.90	16.61	
19/05/2010	11:20	3574	7828.7	162.88	-10.90	16.61	
20/05/2010	08:45	3574	7828.7	162.88	-10.90	16.61	
21/05/2010	14:40	3574	7828.7	162.88	-10.90	16.61	
27/05/2010	15:10	3571	7841.9	160.87	-11.10	16.41	
04/06/2010	11:40	3572	7837.5	161.54	-11.03	16.48	
15/06/2010	18:10	3573	7833.1	162.21	-10.96	16.55	
28/06/2010	13:20	3572	7837.5	161.54	-11.03	16.48	

Note: For ease of entry, using mini readout CLP04, the reading of 0.03389 has beeen entered as 3389

Northern Line Extension 10/2254

GEOSENSE

VIBRATING WIRE TRANSDUCER CALIBRATION

Model	G51-Series
Serial	314311
Works ID	57 12 17

Cal date	9-Jun-08
DPI No	52001702
Baro	1015.0
Temp °C	19

Applied pressure		Readings [digit]			Calculated Pressure		Error % fso	
psi	kPa	1 up	2 up	avg.[digit]	lin.[kPa]	polyn.[kPa]	linear	polynomial
0.000	0.000	8918	8918	8918	0.11	-0.09	0.02%	-0.02%
15.083	104.000	8234	8234	8234	104.10	104.14	0.02%	0.03%
30.022	207.000	7558	7558	7558	206.88	207.04	-0.02%	0.01%
45.105	311.000	6875	6875	6875	310.72	310.88	-0.05%	-0.02%
60.044	414.000	6196	6196	6196	413.95	413.99	-0.01%	0.00%
75.127	518.000	5510	5510	5510	518.24	518.04	0.05%	0.01%

Calibration of master DPI valid from 04 May 2006. UKAS Certificate of Calibration 00930 issued by Chamois Metrology (UKAS Accredited Calibration Laboratory 0822)

CALIBRATION FACTORS

Linear factor (k)

kPa per digit	psi per digit
-0.152032384	-0.022050

Polynomial factors

kPa		psi
A	-1.28468E-07	-1.8632E-08
B	-0.150178874	-0.021781
C	1349.427262	195.710988

Note: Digits are $Hz^2 \times 10^{-3}$ units.
(please consult the relevent User Manuals for conversion of other reading units)
Polynomial calculation *[kPa] = A * (digit)² + B * (digit) + C*

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Geotechnical Centre, Rougham Industrial Estate, Rougham, Bury St Edmunds, Suffolk, IP30 9ND, England
t +44 (0)1359 271167 f +44 (0)1359 271168 e info@mgs.co.uk www.mgsgeosense.co.uk

CONCEPT SITE INVESTIGATIONS

Vibrating Wire Piezometer: BH08

Installed depth(m): 22.0
Instrument Number 314313
k factor kPa -0.137727925 per digit

Ground Level (mOD) 3.86
Range kPa 518
Date Installed:

Date	Time	Microseconds	Digits (B units)	Pressure kPa	Reduced Level (mOD)	Head (m)	Remarks
06/05/2010	10:50	3298	9193.9	0.00	0.00	0.00	Base reading
10/05/2010	14:45	3469	8309.8	121.76	-5.72	12.42	After Installation
11/05/2010	08:20	3470	8305.0	122.42	-5.65	12.49	
12/05/2010	12:30	3470	8305.0	122.42	-5.65	12.49	
13/05/2010	15:20	3470	8305.0	122.42	-5.65	12.49	
14/05/2010	09:00	3471	8300.2	123.08	-5.59	12.55	
17/05/2010	10:15	3472	8295.5	123.74	-5.52	12.62	
18/05/2010	09:25	3472	8295.5	123.74	-5.52	12.62	
19/05/2010	11:35	3472	8295.5	123.74	-5.52	12.62	
20/05/2010	08:55	3472	8295.5	123.74	-5.52	12.62	
21/05/2010	14:55	3472	8295.5	123.74	-5.52	12.62	
27/05/2010	16:55	3469	8309.8	121.76	-5.72	12.42	
04/06/2010	15:10	3470	8305.0	122.42	-5.65	12.49	
15/06/2010	15:45	3470	8305.0	122.42	-5.65	12.49	
28/06/2010	15:50	3468	8314.6	121.10	-5.79	12.35	

Note: For ease of entry, using mini readout CLP04, the reading of 0.03389 has been entered as 3389

Northern Line Extension

10/2254

GEOSENSE

VIBRATING WIRE TRANSDUCER CALIBRATION

Model	G51-Series
Serial	314313
Works ID	57 12 19

Cal date	9-Jun-08
DPI No	52001702
Baro	1015.0
Temp °C	19

Applied pressure		Readings [digit]			Calculated Pressure		Error % fso	
psi	kPa	1 up	2 up	avg.[digit]	lin.[kPa]	polyn.[kPa]	linear	polynomial
0.000	0.000	9194	9194	9194	1.26	0.00	0.24%	0.00%
15.083	104.000	8450	8450	8450	103.73	103.97	-0.05%	0.00%
30.022	207.000	7707	7707	7707	206.06	207.07	-0.18%	0.01%
45.105	311.000	6953	6953	6953	309.91	310.93	-0.21%	-0.01%
60.044	414.000	6199	6199	6199	413.75	414.03	-0.05%	0.01%
75.127	518.000	5433	5433	5433	519.25	518.00	0.24%	0.00%

Calibration of master DPI valid from 04 May 2006. UKAS Certificate of Calibration 00930 issued by Chamois Metrology (UKAS Accredited Calibration Laboratory 0822)

CALIBRATION FACTORS

Linear factor (k)

kPa per digit	psi per digit
-0.137727925	-0.019975

Polynomial factors

kPa		psi
A	-6.6932E-07	-9.70732E-08
B	-0.127937306	-0.018555
C	1232.835485	178.8013756

Note: Digits are $Hz^2 \times 10^{-3}$ units.
(please consult the relevent User Manuals for conversion of other reading units)
Polynomial calculation *[kPa] = A * (digit)² + B * (digit) + C*

THIS CERTIFICATE IS VALID ONLY WHEN CARRYING THE OFFICIAL ORIGINAL STAMP OF MGS-GEOSENSE BELOW

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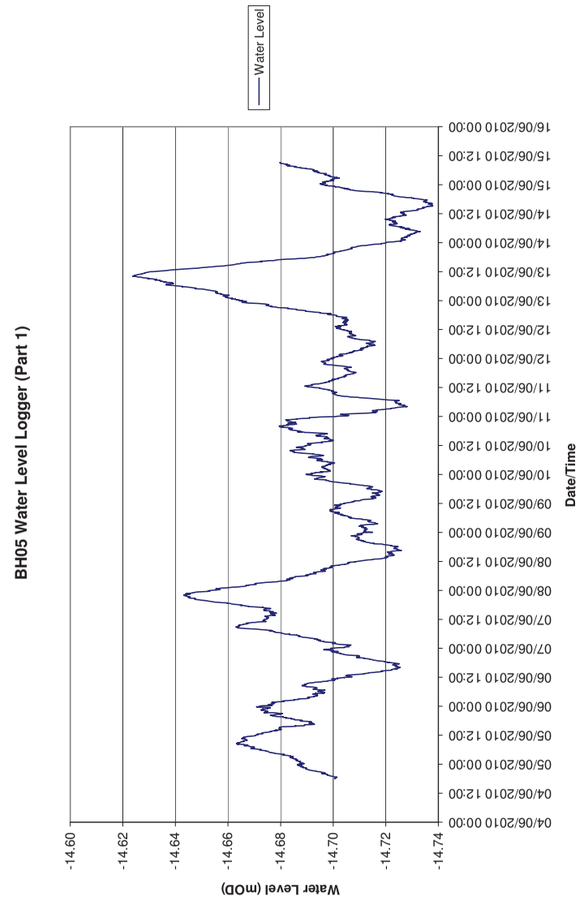
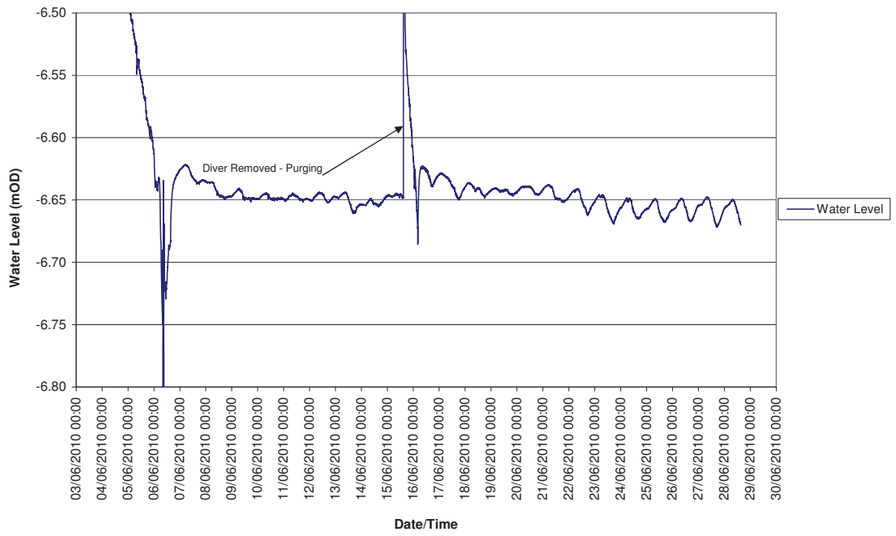
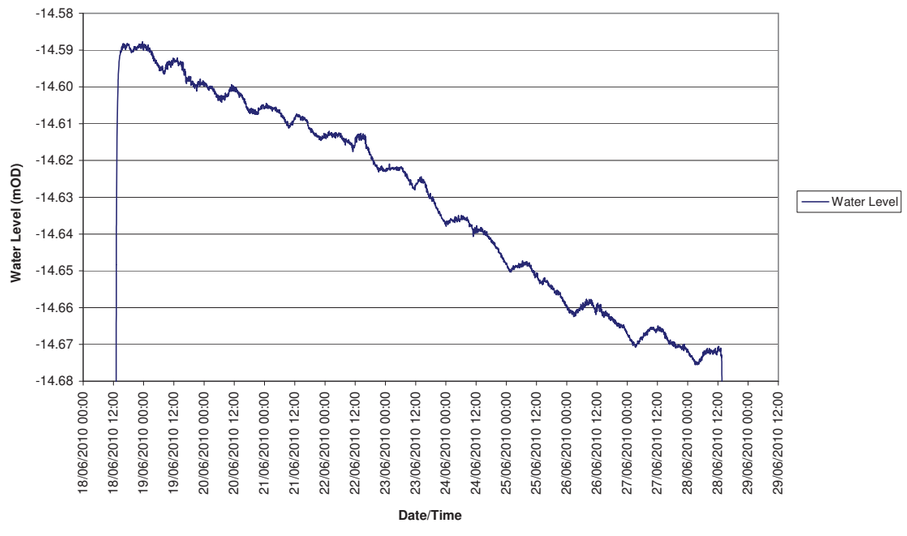
Geotechnical Centre, Rougham Industrial Estate, Rougham, Bury St Edmunds, Suffolk, IP30 9ND, England
t +44 (0)1359 271167 f +44 (0)1359 271168 e info@mgs.co.uk www.mgsgeosense.co.uk



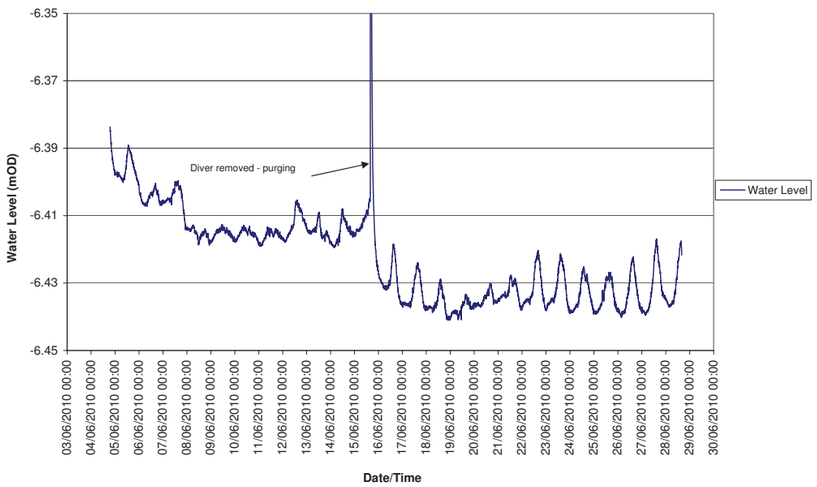
BH07 Water Level Logger



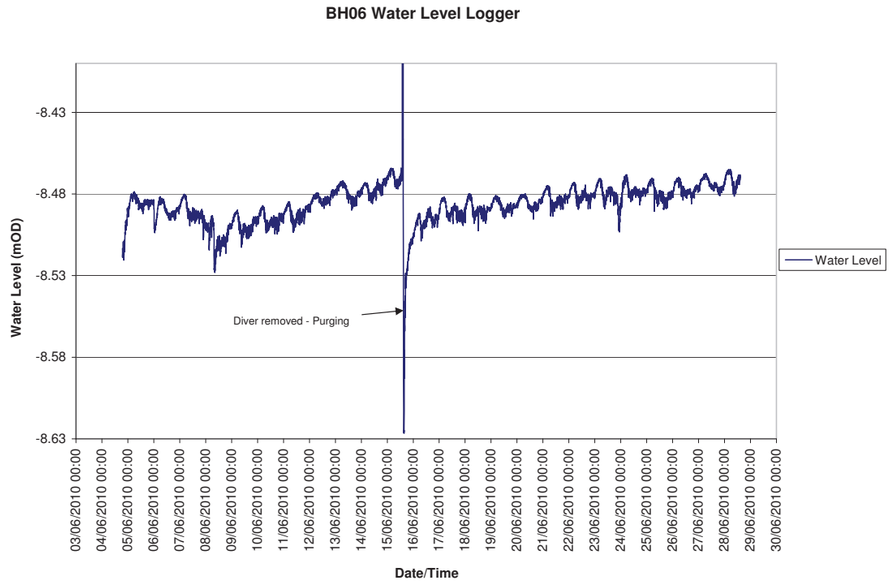
BH05 Water Level Logger (Part 2)

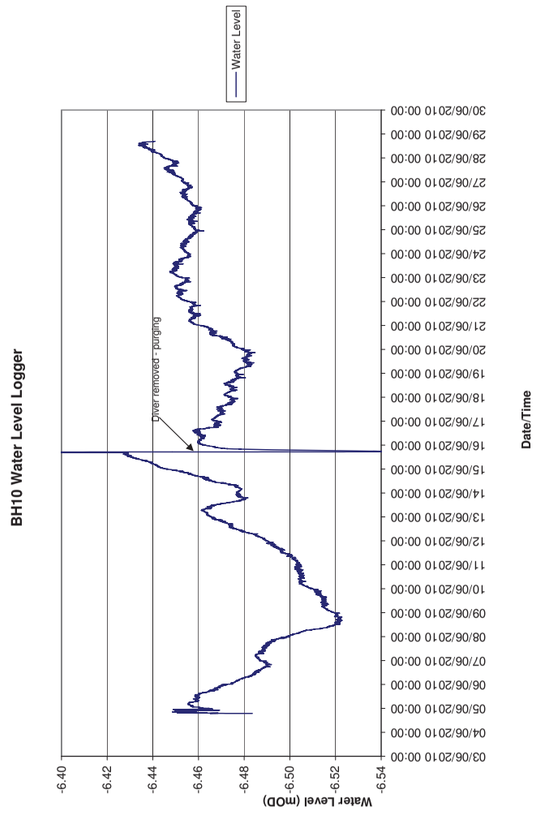


BH09 Water Level Logger



BH06 Water Level Logger





8. SPLIT AND DESCRIBE UNDISTURBED SAMPLE LOGS

Unit 8, Warple Mews
London W3 0RF

CONCEPT SITE INVESTIGATIONS

Tel: 020 8811 2880
Fax: 020 8811 2881
email: si@conceptconsultants.co.uk

Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH01
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

15.00m - 15.45m

Stiff, very closely fissured dark brownish grey silty CLAY.Fissures are 0-10° and 80°-90°, planar, smooth.

... V250+kPa (15.10m)
... V250+kPa (15.20m)
... V250+kPa (15.30m)

... with occasional fine to medium gravel size pockets of brown fine to medium sand below 15.05m

... with a thin lamination of brown silty fine to medium sand at 15.10m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH01
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

21.00m - 21.42m

Very stiff, greyish brown very closely fissured slightly silty CLAY. Fissures are randomly orientated with smooth polished surfaces and occasional infilled with up to 1mm of brown and grey sand.

... V failed (21.10m)
... V failed (21.20m)
... V failed (21.30m)

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH01
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

27.00m - 27.45m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty CLAY with occasional bioturbation. Fissures are predominately subvertical and subhorizontal with polished smooth surfaces.

... V failed (27.10m)
... V failed (27.20m)
... V failed (27.30m)

... with pyritised wood fragments (5x60mm) at 27.15m

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Fax: 020 8811 2881
email: si@conceptconsultants.co.uk

Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH01
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

31.00m - 31.35m

Stiff to very stiff, extremely closely fissured dark brownish grey silty slightly sandy CLAY. Sand is fine to medium. Fissures are 0-20°, planar and smooth to rough.

... PP250+kPa (31.10m)
... PP250+kPa (31.20m)

... becoming very sandy between 31.00m and 31.13m

... with frequent tubes (<2mm Ø) unfilled with grey silt between 31.24m and 31.35m

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CONCEPT SITE INVESTIGATIONS

Tel: 020 8811 2880
Fax: 020 8811 2881
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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH02
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

7.50m - 7.95m

Stiff, very closely fissured dark greyish brown silty CLAY.Fissures are 0-10° and 50°-90°, planar, smooth with occasional dustings of fine to medium sand and silt on 0-10° fissures.

... V failed (7.80m)

... with coarse gravel size pockets of orangish brown staining on fissures at 7.77m

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CONCEPT SITE INVESTIGATIONS

Tel: 020 8811 2880
Fax: 020 8811 2881
email: si@conceptconsultants.co.uk

Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH02
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

23.50m - 23.85m

Very stiff, greyish brown extremely closely fissured slightly sandy slightly silty CLAY with occasional bioturbation. Fissures are smooth, unpolished and rarely infilled with up to 1mm greyish brown sand.

... V failed (23.60m)
... V failed (23.75m)

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH02
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

33.50m - 33.95m

Very stiff, greyish brown thinly to thickly laminated slightly sandy slightly silty CLAY with occasional lignite fragments and occasional bioturbation. Laminae are smooth and occasionally infilled with up to 1mm light brown sand.

... V failed (33.60m)
... V failed (33.70m)
... V failed (33.80m)

... becoming thinly laminated with frequent sand infill and sandy below 33.70m

... with a pocket of thinly laminated light brown silt/fine sand (50x70mm) at 33.88m

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Tel: 020 8811 2880
Fax: 020 8811 2881
email: si@conceptconsultants.co.uk

Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH03
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

13.0m - 13.40m

Stiff, very closely fissured dark brownish grey silty CLAY.Fissures are 0-10° and 70°-90°, planar, smooth with occasional thin laminations and dustings of brown silt and fine to medium sand.

... V failed (13.10m)
... V failed (13.20m)
... V failed (13.30m)

... with a thin lamination of orangish brown fine to medium sand at 13.05m and at 13.28m

... becoming orangish brown silty fine to medium SAND between 13.38m and 13.40m

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CONCEPT SITE INVESTIGATIONS

Tel: 020 8811 2880
Fax: 020 8811 2881
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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH03
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

21.0m - 21.45m

Stiff, very closely fissured dark greyish brown silty CLAY. Fissures are predominately 0-10° and 80°-90°, planar, smooth with rare thin dustings of silt and fine sand on fissures.

... V failed (21.10m)
... V failed (21.20m)
... V failed (21.30m)

... with a medium gravel size pocket of light brown fine to medium sand at 21.15m

... with a band of weak orangish brown MUDSTONE between 21.33m and 21.37m

... with a medium gravel size pocket of grey pyrite at 21.38m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH03
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

27.0m - 27.45m

Very stiff, greyish brown slightly sandy slightly silty CLAY with occasional pockets of grey sand (20x20mm) and occasional bioturbation.

... V failed (27.10m)
... V failed (27.20m)
... V failed (27.30m)

... with a band of light brown sand between 27.03m and 27.05m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH03
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

35.0m - 35.45m

Stiff, very closely fissured dark brownish grey silty CLAY. Fissures are predominately 0-20° and 70°-90°, planar, smooth with occasional thin laminations of light brown silt and fine to medium sand.

... V failed (35.10m)
... V failed (35.20m)
... V failed (35.30m)

... with a thin lamination of light brown fine to medium sand at 35.09m

... with a thin lamination of light brown silt at 35.13m and 35.17m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH03
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

38.0m - 38.45m

Very stiff, thinly to thickly laminated dark grey silty CLAY with frequent laminations of light grey fine to medium sand.

... PP250+kPa(38.10m)
... PP250+kPa(38.20m)
... PP250+kPa(38.30m)

... with laminations are highly deformed possible drilling disturbance between 38.00m and 38.13m

... with rare subangular fine to medium gravel size fragments of brown shell between 38.14m and 38.20m

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CONCEPT SITE INVESTIGATIONS

Tel: 020 8811 2880
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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH04
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

7.50m - 7.95m

Grey locally thinly laminated slightly micaceous CLAY with closely spaced laminations of light brown and greenish grey fine sand.

... V188kPa (7.80m)
... V208kPa (7.90m)

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Fax: 020 8811 2881
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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH04
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

9.50m - 9.95m

Grey slightly sandy locally thinly laminated CLAY with very closely to closely spaced laminations of light brown fine sand (up to 12mm thick)

... V failed (9.55m)
... V failed (9.65m)
... V180kPa (9.85m)

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CONCEPT SITE INVESTIGATIONS

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH04
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

11.50m - 11.95m

Grey slightly sandy locally thinly laminated CLAY with closely to medium spaced laminations of light brown fine sand and rare pockets of dark grey fine silty sand.

... V188kPa (11.60m)
... V220kPa (11.75m)

... with rare bioturbation below 11.80m

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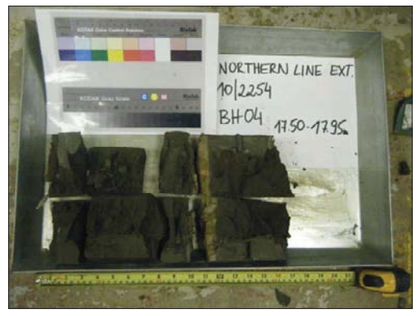
Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH04
Carried out for	REO (Powerstation) Ltd	Date		Photograph	



17.50m - 17.95m

Grey generally laminated slightly silty CLAY with occasional bioturbation.

... V192kPa (17.85m)

... with a band (20mm thick) of very weak light brown claystone at 17.80m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH04
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

21.50m - 21.90m

Grey slightly sandy thinly to thickly laminated CLAY with occasional bioturbation

... V Failed (21.70m)
... V Failed (21.85m)

... with frequent bioturbation between 21.50m and 21.55m

... with occasional pockets of light brown sand (50x40mm) between 21.50m and 21.70m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH04
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

29.50m - 29.95m

Grey thinly to thickly laminated slightly sandy silty CLAY with occasional pockets of light brown fine sand between laminae with occasional bioturbation, rare pyrite nodules (15x20mm & 55x70mm)

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH04
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

31.50m

Dark grey locally thinly laminated shelly CLAY.

... V200kPa (31.60m)

... becoming slightly clayey SAND below 31.85m

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London W3 0RF

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH05
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

16.00m - 16.45m

Grey slightly sandy slightly micaceous CLAY with rare pockets of light brown sand (5x10mm) and dark grey silty sand (10x15mm) and rare bioturbation.

... V212kPa (16.00m)

... with occasional pockets of dark grey and grey fine sand (20x20mm) below 16.15m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH05
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

20.00m - 20.45m

Grey slightly sandy CLAY with rare pockets of light brown sand (10x10mm) and rare pyrite nodules (20x25mm) and rare to occasional bioturbation.

... V192kPa (20.00m)

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH05
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

24.00m - 24.45m

Very closely fissured slightly sandy grey CLAY with occasional pockets of light brown fine sand (10x20mm).

... V252kPa (24.00m)
... V248kPa (24.30m)

... becoming sandy with rare pyritised wood fragments (10x10mm) below 24.30m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH05
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

26.00m - 26.40m

Very closely fissured slightly sandy grey CLAY generally thinly laminated with occasional pockets of light brown fine sand (10x10mm)

... V failed (26.15m)
... V failed (26.25m)

... becoming sandy below 26.30

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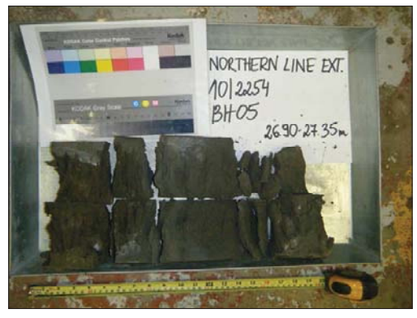
Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH05
Carried out for	REO (Powerstation) Ltd	Date		Photograph	



26.90m - 27.35m

Brownish grey sandy CLAY with occasional pockets of light brown fine sand (10x15mm) with occasional bioturbation.

... V80kPa (26.90m)
... V72kPa (27.05m)

... becoming grey below 27.05m

... with a band of very weak calcareous sandy mudstone(?) and rare shell fragments at 27.30m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH05
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

27.40m - 27.60m

Grey to dark grey shelly CLAY. ... PP100kPa (27.40m)

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH05
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

28.10m - 28.50m

Thinly to thickly laminated dark grey slightly sandy CLAY and light grey silty SAND. ... PP200kPa (28.10m)

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Tel: 020 8811 2880
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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH06
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

12.0m - 12.30m

Very stiff to stiff, very closely fissured dark greyish brown slightly micaceous silty CLAY. Fissures are predominantly 0-10° and 70°-90°, planar, smooth. ... V failed (12.10m)
... V failed (12.20m)

12.30m - 12.42m

Stiff, dark greyish slightly micaceous silty sandy CLAY with frequent coarse sand size tubes infilled with silt.

... with a medium gravel size nodule of light grey pyritised silt at 12.37m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH06
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

16.0m - 16.45m

Stiff, dark greyish brown slightly sandy silty CLAY with occasional coarse sand to fine gravel size tubes infilled with white silt. ... V120kPa (16.30m)

... with abundant fine to coarse gravel size pockets of light brown fine to medium sand between 16.00ma and 16.09m

... with a medium gravel size pocket of dark grey silt at 16.26m

... with a medium gravel size pocket of grey pyrite at 16.41m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH06
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

20.0m - 20.45m

Stiff, very closely fissured dark greyish brown silty CLAY with frequent medium gravel size pocket of light brown fine to medium sand . Fissures are 0-10° and 70°-90°, planar, smooth.

... V failed (20.10m)
... V failed (20.20m)
... V failed (20.30m)

... with a medium gravel size pocket of light grey fine to medium sand at 20.03m

... with abundant coarse sand to fine gravel size tubes infilled with white silt between 20.08m and 20.11m

... with a coarse gravel size pocket of brown clayey fine sand between 20.12m and 20.15m

... with a medium gravel size pocket of grey pyritised silt at 20.26m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH06
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

23.50m - 23.95m

Very stiff, dark brownish grey silty CLAY with frequent fine to medium gravel size pockets of light brown fine to medium sand and abundant coarse sand to fine gravel size tubes infilled with white silt..

... V failed (23.60m)
... V failed (23.70m)

... with a coarse gravel size pocket with abundant forams at 23.57m

... becoming very closely fissured between 23.58m and 23.61m. Fissures are 0-30°, planar, smooth.

... becoming very thinly bedded with dustings of light brown fine to medium sand between 23.66m and 23.80m

... with a thin lamination of light brown silt and fine to medium sand with abundant fine gravel size tubes infilled with white silt at 23.70m

... with a medium gravel size pocket of light brown fine sand at 23.84m

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

24.00m - 24.27m

Stiff, very closely fissured dark greyish brown slightly sandy silty CLAY with frequent medium gravel size pocket of light brown fine to medium sand . Fissures are predominately 0-10°, planar, rough.

... V failed (24.10m)
... V failed (24.20m)
... V failed (24.30m)

... with abundant medium to coarse sand size black oxidised glauconite and fine to coarse gravel size tube infilled with white silt between 24.17m and 24.26m

... with frequent subrounded to rounded fine to coarse gravel of black flint at 24.27m

24.27m - 24.45m

Stiff, dark grey locally greyish brown very sandy CLAY with abundant subangular to subrouded fine to coarse gravel size cream to light brown bivalve and gastropod shells and shell fragments.

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH06
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

24.50m - 24.92m

Soft to firm, thinly interlaminated dark grey SILT / light grey silty fine to medium SAND and occasional grey CLAY.

... V failed (24.60m)
... V failed (24.70m)
... V failed (24.80m)

... with laminations of slightly clayey sandy SILT between 24.50m and 24.60m

... with a lamination of light brown fine to medium sand between 24.60m and 24.62m

... with thin laminations of dark grey clay between 24.63m and 24.68m

... with a thin lamination with frequent subangular to angular fine to medium gravel size fragments of cream and light brown bivalve shell at 24.70m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH06
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

25.00m - 25.41m

Firm, thinly to thickly interlaminated dark grey CLAY and dark grey SILT and occasional light greyish brown fine to medium SAND.

... V failed (25.10m)
... V failed (25.20m)
... V failed (25.30m)

... with rare subangular fine to medium gravel size fragments of cream and light brown shells between 25.00m and 25.07m

... with frequent thin laminations of light grey silt between 25.15m and 25.25m

... with predominantly thinly laminated dark grey CLAY with occasional dustings of light brown silt on laminae between 25.34m and 25.41m

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London W3 0RF

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Tel: 020 8811 2880
Fax: 020 8811 2881
email: si@conceptconsultants.co.uk

Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH07
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

14.00m - 14.40m

Stiff, very closely fissured dark greyish brown slightly micaceous silty CLAY. Fissures are 70°- 90°, planar, smooth and occasionally polished.

... V failed (14.10m)
... V failed (14.20m)
... V failed (14.30m)

... with a medium gravel size fragment of partially pyritised lignite at 14.28m

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Fax: 020 8811 2881
email: si@conceptconsultants.co.uk

Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH07
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

18.00m - 18.42m

Stiff locally very stiff, very closely fissured dark brownish grey slightly sandy CLAY with frequent coarse sand to fine gravel size tubes infilled with white silt. Fissures are 0 -20° and 80°- 90°, planar, smooth.

... V failed (18.10m)
... V failed (18.20m)
... V failed (18.30m)

... with frequent fine to medium gravel size pockets of light brown fine to medium sand between 18.36m and 18.42m

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Tel: 020 8811 2880
Fax: 020 8811 2881
email: si@conceptconsultants.co.uk

Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH07
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

21.50m - 21.94m

Stiff, dark brownish grey silty sandy CLAY with frequent coarse sand to fine gravel size tubes infilled with white silt / fine sand.

... V failed (21.60m)
... V failed (21.70m)
... V failed (21.80m)

... becoming very closely fissured between 21.50m and 21.64m. Fissures are 0 -10° and 80°- 90°, planar, smooth.

... with a coarse gravel size patch of very dark grey staining on 80° fissures surface at 21.56m

... with abundant coarse sand to fine gravel size tubes infilled with white silt between 21.69m and 21.83m

... with a coarse gravel size pocket of dark brown fine to medium sand at 21.81m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH07
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

22.50m - 22.95m

Stiff, very closely fissured dark brownish grey silty sandy CLAY with frequent coarse sand to fine gravel size tubes infilled with white silt. Fissures are 0 -20° and 70°- 90°, planar, smooth.

... V failed (22.70m)
... V failed (22.80m)
... V failed (22.90m)

... with frequent 0 -10° fissures, planar, smooth between 22.50ma and 22.55m

... with abundant coarse sand size tubes infilled with white and light brown fine sand between 22.60m and 22.66m

... with a fine gravel size fragments of black lignite at 22.81m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH07
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

24.50m - 24.87m

Stiff, very closely fissured dark brownish grey silty CLAY. Fissures are 0 - 10° and 80°- 90°, planar, smooth and occasionally polished.

... V failed (24.60m)
... V failed (24.70m)
... V failed (24.80m)

... with occasional medium gravel size pockets of light brown fine to medium sand at 24.52m

... with thin impersistent laminae of light brown fine to medium sand at 24.58m

... with a medium gravel size nodule of grey pyrite at 24.73m

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Tel: 020 8811 2880
Fax: 020 8811 2881
email: si@conceptconsultants.co.uk

Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH08
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

13.50m - 13.92m

Very stiff, greyish brown extremely closely fissured slightly silty sandy CLAY with occasional bioturbation. Fissures are randomly aligned with slight polishing.

... V failed (13.65m)
... V130+kPa (13.80m)

... fissures becoming polished below 13.75m

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

18.00m - 18.38m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty sandy CLAY with occasional bioturbation. Fissures are subvertical and subhorizontal unpolished, smooth.

... V failed (18.15m)
... V failed (18.30m)

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

21.00m - 21.40m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty slightly sandy CLAY with occasional bioturbation and occasional inclusions of fine grey sand (40x40mm). Fissures are subvertical and subhorizontal slightly polished.

... V failed (21.15m)
... V failed (21.30m)

... with frequent bioturbation at 21.35m

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

23.50m - 23.80m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty CLAY with occasional pockets of light brown fine sand (up to 40x40mm) and rare purite nodules (6x10mm). Fissures are predominantly randomly orientated with smooth surfaces.

... V failed (23.65m)
... V failed (23.80m)

... with a smooth polished 30° shear surface at 23.55m

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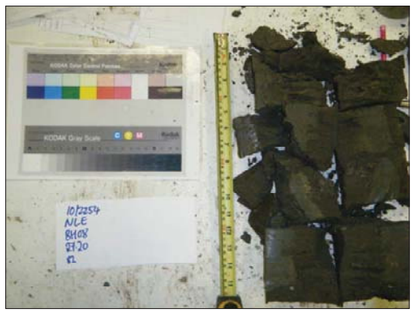
Carried out for	REO (Powerstation) Ltd	Date		Photograph	



27.20m - 27.58m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty slightly sandy CLAY with frequent bioturbation, rare patrings of grey fine sand (30x20mm) and rare pyritised lignite(10x50mm). Fissures are predominantly subhorizontal and rough.

... V failed (27.30m)
... V failed (27.50m)

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

27.65m - 27.83m

Very stiff to stifff, greyish brown very closely fissured slightly silty CLAY. Fissures are subhorizontal and subvertical, smooth.

... V failed (27.80m)
... V failed (27.95m)

... with a band of well rounded medium flint gravels at 27.80m

27.83m - 28.00m

Greyish brown thinly laminated clayey SAND with rare shell fragments. Laminae infilled with up to 1mm grey sand.

... with a band of well rounded medium flint gravels at 28.00m

28.00m - 28.10m

Stiff, dark grey slightly sandy silty CLAY with frequent shell fragments (oysters).

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH09
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

9.00m - 9.28m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty CLAY with rare black specks (5x5mm). Fissures are subvertical and subhorizontal, moderately polished surfaces.

... V failed (9.05m)
... V failed (9.28m)

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH09
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

12.00m - 12.44m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty CLAY. Fissures are subvertical and subhorizontal, polished surfaces occasionally undulated.

... V failed (12.10m)
... V failed (12.20m)

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH09
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

17.50m - 17.90m

Stiff, dark brownish grey silty sandy CLAY with abundant coarse sand to fine gravel size tubes infilled with white silt and/or fine sand.

... with frequent fine to medium gravel size pockets of light brown fine sand between 17.59m and 17.80m

... V failed (17.60m)
... V failed (17.70m)
... V failed (17.80m)

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH09
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

19.50m - 19.92m

Very stiff, greyish brown slightly silty slightly sandy CLAY with occasional bioturbation and occasional pockets of grey sand (10x20mm) and occasional partings of grey sand (up to 40x50mm)

... with a subhorizontal (30°) band of fine grey SAND with occasional tabular pyrite nodules (50x50mm) between 19.70m and 19.72m

... V failed (19.60m)
... V failed (19.80m)

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH09
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

23.50m - 23.92m

Very stiff, greyish brown very closely fissured slightly sandy slightly silty CLAY with pockets of brown silt (up to 40x40mm). Fissures are subvertical and subhorizontal, polished, smooth.

... V failed (23.60m)
... V failed (23.80m)

... with a 45° polished slightly undulating shear surface at 23.65m

... with occasional bioturbation below 23.80m

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

24.00m - 24.35m

Very stiff, greyish brown slightly sandy slightly silty CLAY with occasional bioturbation and occasional pockets of brown sand (30x30mm).

... V failed (24.10m)
... V failed (24.30m)

... becoming grey below 24.15m

... becoming sandy below 24.25m

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

24.50m - 24.65m

Stiff, greyish brown sandy silty CLAY with frequent partings of light brown sand (up to 8mm)

... V failed (24.65m)
... V failed (24.80m)

... with a tabular pyrite nodule (25x40mm) at 24.55m

24.65m - 24.92m

Stiff, greyish brown thinly laminated slightly sandy silty CLAY. Laminaes infilled with up to 2mm of grey fine sand.

... becoming very stiff and slightly silty below 24.80m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH10
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

13.00m - 13.45m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty CLAY with rare pockets of brown fine sand (10x20mm) and rare bioturbation. Fissures are randomly orientated with unpolished smooth surfaces.

... V failed (13.15m)
... V failed (13.30m)

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH10
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

17.50m - 17.92m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty slightly sandy CLAY with occasional bioturbation. Fissures are randomly orientated with unpolished smooth surfaces.

... V failed (17.65m)
... V failed (17.80m)

... becoming grey with frequent bioturbation between 17.55m and 17.65m

... with a lignite fragment (20x50mm) at 17.60m

... with occasional pockets of brown sand (20x20mm) below 17.70m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH10
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

19.90m - 20.30m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty CLAY. Fissures are randomly orientated with unpolished smooth surfaces.

... V failed (20.05m)
... V failed (20.15m)

... with a 45° polished slightly undulating shear surface at 19.95m and 20.05m

... with a pyrite nodule (20x40mm) at 20.20m

... with occasional bioturbation at 20.15m

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

22.30m - 22.75m

Very stiff, greyish brown extremely closely to very closely fissured slightly silty slightly sandy CLAY with occasional bioturbation and occasional pockets of light brown sand. Fissures are randomly orientated with smooth surfaces.

... V failed (22.45m)
... V failed (22.60m)

... with a 45° polished striated shear surface at 23.35m

... with a pyrite nodule (10x10mm) at 22.65m

... with frequent bioturbation at 22.72m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH10
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

22.80m - 23.05m

Stiff, very thinly bedded dark greyish brown sandy CLAY with frequent medium to coarse gravel size pockets of brown clayey fine to medium sand.

... V failed (22.90m)
... V failed (22.95m)

... with medium gravel size fragment of black lignite at 22.80m

... with a subrounded medium gravel of black flint at 22.86m

... with abundant coarse sand size oxidised glauconite between 23.00m and 23.05m

... with frequent coarse sand size tubes infilled with white silt between 22.80m and 22.84m

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

23.60m - 23.90m

Firm, dark grey silty very sandy CLAY with occasional pockets of grey fine sand (30x40mm)

... V failed (23.60m)
... V failed (23.90m)

... becoming thinly laminated with laminae infilled with up to 1mm of grey fine sand below 23.70m

... with frequent shell fragments (oysters) between 23.78m and 23.84m

... laminae infilled with brown sand and occasional tabular pyrite nodules (30x30mm) along laminae below 23.88m

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

23.95m - 24.35m

Firm to stiff, dark grey thinly to thickly laminated slightly sandy slightly silty CLAY with laminae occasionally infilled with up to 1mm of grey sand.

... V failed (24.10m)
... V failed (24.20m)

... with a tabular pyrite nodule (10x40mm) at 24.10m

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Carried out for	REO (Powerstation) Ltd	Date		Photograph	

24.65m - 24.75m

Very stiff, thickly laminated brownish grey silty CLAY.

... V failed (24.70m)

... with a subangular medium gravel size fragment of cream shell at 24.67m

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH10
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

25.80m - 25.85m

Light yellowish grey fine to medium occasionally coarse SAND.

... V18kPa (2) (25.90m)
... V18kPa (2) (26.00m)
... V16kPa (0) (26.10m)

25.85m - 26.15m

Soft to firm, light brownish grey sandy SILT. Sand is fine to medium.

... with a coarse gravel size pocket of slightly gravelly fine to coarse SAND at 25.88m. Gravel is subangular to angular fine of multicoloured flint.

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Site Name	Northern Line Extension	Job No.	10/2254	HOLE TYPE	BH10
Carried out for	REO (Powerstation) Ltd	Date		Photograph	

26.20m - 26.50m

Stiff, light brownish grey mottled grey and orangish brown sandy SILT. Sand is fine to medium. ... PP250+kPa (26.30m) ... PP140+kPa (26.40m)

... with a coarse gravel size pocket of grey clay at 26.23m

... becoming grey SILT between 26.44m and 26.50m

9. LABORATORY TEST RESULTS