



## appendix d

### Ground Movement Analysis

GMA Reference Plan  
XDisp Analysis – All Input Data  
XDisp Analysis – Underpinning Movements  
XDisp Analysis – Building Damage Assessment Results

PDisp Analysis – All Input Data  
PDisp Analysis – Short Term Movements  
PDisp Analysis – Total Movements

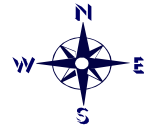
Site 95 Avenue Road, London NW8 6HY

Client 95 Avenue Road (Freehold) Limited

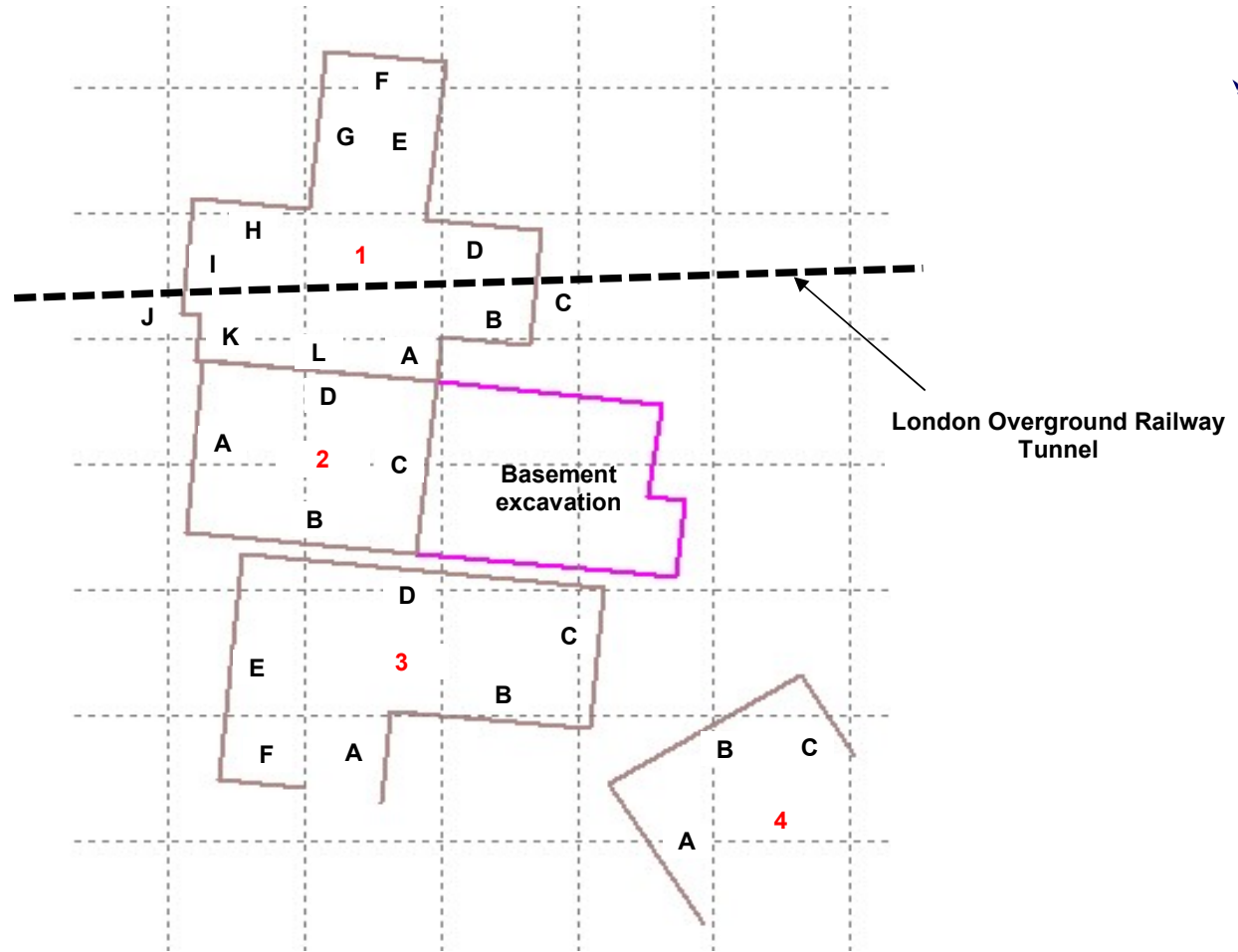
Engineer Michael Barclay Partnership

Job Number  
J22086

Sheet  
1 / 1



- 1. 95 Avenue Road
- 2. Retained Garage
- 3. Park Lodge
- 4. Avenue Lodge





95 Avenue Road, London NW8 6HY

Analysis of Movements from Basement Construction and Excavation  
Underpinning Movements

Job No.	Sheet No.	Rev.
J22086		
Drg. Ref.		
Made by ML	Date 15-Feb-2023	Checked Date

### Titles

**Job No.:** J22086  
**Job Title:** 95 Avenue Road, London NW8 6HY  
**Sub-title:** Analysis of Movements from Basement Construction and Excavation  
**Calculation Heading:** Underpinning Movements  
**Initials:** ML  
**Checker:**  
**Date Saved:** 15-Feb-2023  
**Date Checked:**  
**Notes:**  
**File Name:** Underpinning.xdd  
**File Path:** G:\PROJECTS\2022\J22086 - 95 Avenue Road, NW8\APPENDIX\GMA

### History

Date	Time	By	Notes
15-Feb-2023	21:21	Matt Legg	New
15-Feb-2023	21:42	Matt Legg	
15-Feb-2023	21:50	Matt Legg	
17-Feb-2023	10:07	Matt Legg	Open

### Displacement Lines

Ref.	Name	x1	y1	z1	x2	y2	z2	Intervals	Surface	Interpolate	
Calculate											
		[m]	[m]	[m]	[m]	[m]	[m]	[No.]	type for tunnels	imported displacements	
1	G-A	532.55171	48.27225	49.90000	531.29593	34.66562	49.90000	7	Surface	No	Yes
2	G-B	531.29593	34.66562	49.90000	548.19069	32.87618	49.90000	8	Surface	No	Yes
3	G-C	548.19069	32.87618	48.50000	549.68249	46.61262	48.50000	7	Surface	No	Yes
4	G-D	549.68249	46.61262	48.50000	532.55171	48.27225	48.50000	9	Surface	No	Yes
5	95-A	549.68249	46.61262	48.50000	550.01181	50.21601	48.50000	4	Surface	No	Yes
6	95-B	550.01181	50.21601	48.50000	556.48296	49.55236	48.50000	6	Surface	No	Yes
7	95-C	556.48296	49.55236	48.50000	557.31708	58.67916	48.50000	9	Surface	No	Yes
8	95-D	557.31708	58.67916	48.50000	548.93806	59.55414	48.50000	8	Surface	No	Yes
9	95-E	548.93806	59.55414	48.50000	550.33892	72.03819	48.50000	6	Surface	No	Yes
10	95-F	550.33892	72.03819	48.50000	541.53114	72.84307	48.50000	8	Surface	No	Yes
11	95-G	541.53114	72.84307	48.50000	540.38397	60.29097	48.50000	6	Surface	No	Yes
12	95-H	540.38397	60.29097	48.50000	531.80026	61.17588	48.50000	8	Surface	No	Yes
13	95-I	531.80026	61.17588	48.50000	530.94443	52.03107	48.50000	9	Surface	No	Yes
14	95-J	530.94443	52.03107	48.50000	532.36264	51.87711	48.50000	2	Surface	No	Yes
15	95-K	532.36264	51.87711	48.50000	532.03748	48.31925	48.50000	3	Surface	No	Yes
16	95-L	532.03748	48.31925	48.50000	549.68249	46.61262	48.50000	9	Surface	No	Yes
17	PL-A	545.64258	12.97614	48.90000	546.35450	20.38753	48.90000	7	Surface	No	Yes
18	PL-B	546.35450	20.38753	48.90000	560.87284	18.96860	48.90000	7	Surface	No	Yes
19	PL-C	560.87284	18.96860	48.90000	561.94498	30.16620	48.90000	6	Surface	No	Yes
20	PL-D	561.94498	30.16620	48.90000	535.40676	32.77432	48.90000	13	Surface	No	Yes
21	PL-E	535.40676	32.77432	48.90000	533.69422	14.88819	48.90000	9	Surface	No	Yes
22	PL-F	533.69422	14.88819	48.90000	539.93589	14.29057	48.90000	6	Surface	No	Yes
23	AL-A	569.19028	3.34787	48.90000	562.30391	14.67149	48.90000	7	Surface	No	Yes
24	AL-B	562.30391	14.67149	48.90000	576.37099	23.22627	48.90000	8	Surface	No	Yes
25	AL-C	576.37099	23.22627	48.90000	580.32463	16.72509	48.90000	7	Surface	No	Yes
26	Tunnel Crown	580.00000	54.87652	38.91000	519.32602	53.25616	38.91000	60	Surface	No	Yes

### Displacement Grids

Ref.	Name	Extrusion:	Base line	Base	Base	Base	Base	Base	Base	Extrusion:	Extrusion:
------	------	------------	-----------	------	------	------	------	------	------	------------	------------



**95 Avenue Road, London NW8 6HY**  
**Analysis of Movements from Basement Construction and Excavation**  
**Underpinning Movements**

Job No.	Sheet No.	Rev.
<b>J22086</b>		
Drg. Ref.		
Made by ML	Date 15-Feb-2023	Checked Date

Surface Calculate	Direction	start: X	line	line	line	line	line	line:	Distance	Intervals
type			start:	start:	end:	end: Y	end:	Intervals		
for			Y	Z (level)	X		Z (level)			
tunnels			[m]	[m]	[m]	[m]	[m]	[No.]	[m]	[No.]
1 Ground Level	Global X	515.00000	0.00000	50.90000	-	80.00000	50.90000	40	70.00000	40
Surface Yes										

**Polygonal Excavations**

**Ref.** 1  
**Excavation Name:** Basement Excavation  
 Surface level [m]: 50.900  
 Contribution: Positive  
 Surface movement curves which are selected are applied between surface and [m]: 47.750

Corner	x	y	Base Level	Arc Enabled	Stiffened	Prev. Side: d	Prev. Side: p1	Prev. Side: p2*	Next Side: d	Next Side: p1	Next Side: p2*
	[m]	[m]	[m]			[m]	[%]	[%]	[m]	[%]	[%]
1	567.23	31.016	47.750	Yes	No	-	-	-	-	-	-
2	567.85	37.132	47.750	Yes	No	-	-	-	-	-	-
3	565.12	37.406	47.750	Yes	No	-	-	-	-	-	-
4	565.12	37.406	48.500	Yes	No	-	-	-	-	-	-
5	566.15	44.826	48.500	Yes	No	-	-	-	-	-	-
6	549.68	46.613	48.500	Yes	No	-	-	-	-	-	-
7	548.19	32.876	48.500	Yes	No	-	-	-	-	-	-
8	564.20	31.300	48.500	Yes	No	-	-	-	-	-	-
9	564.20	31.300	47.750	Yes	No	-	-	-	-	-	-

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
1	567.23	31.016	567.85	37.132	5 mm Underpinning Curve	5mm Underpinning Curve
2	567.85	37.132	565.12	37.406	5 mm Underpinning Curve	5mm Underpinning Curve
3	565.12	37.406	565.12	37.406	No vertical ground movement	No horizontal ground movement
4	565.12	37.406	566.15	44.826	Min 5 mm Curve	Min 5mm Curve
5	566.15	44.826	549.68	46.613	Min 5 mm Curve	Min 5mm Curve
6	549.68	46.613	548.19	32.876	Min 5 mm Curve	Min 5mm Curve
7	548.19	32.876	564.20	31.300	Min 5 mm Curve	Min 5mm Curve
8	564.20	31.300	564.20	31.300	No vertical ground movement	No horizontal ground movement
9	564.20	31.300	567.23	31.016	5 mm Underpinning Curve	5mm Underpinning Curve

**Circular Excavations**

**Vertical Ground Movement Curves**

**Curve Name:** No vertical ground movement  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]  
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]

**Curve Fitting Method:** Polynomial  
**x Order:** 1  
**y Order:** 0  
**Polynomial: z =** 0.0x + 0.0  
**Coeff. of Determination:**



95 Avenue Road, London NW8 6HY

Analysis of Movements from Basement Construction and Excavation  
Underpinning Movements

Job No. Sheet No. Rev.

J22086

Dr. Ref.

Made by Date Checked Date  
ML 15-Feb-2023

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
------	-----------	-----------	-----------	-----------	----------------------	------------------------

**Curve Name:** Min 5 mm Curve  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]  
 [0.000,0.000,0.210] [4.000,0.000,0.000]

Curve Fitting Method: Polynomial  
 x Order: 1  
 y Order: 0  
 Polynomial: z = -5.25E-2x + 2.10E-1  
 Coeff. of Determination: 1.00

**Curve Name:** 5 mm Underpinning Curve  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%)]  
 [0.000,0.000,0.160] [4.000,0.000,0.000]

Curve Fitting Method: Polynomial  
 x Order: 1  
 y Order: 0  
 Polynomial: z = -4.00E-2x + 1.60E-1  
 Coeff. of Determination: 1.00

**Horizontal Ground Movement Curves**

**Curve Name:** No horizontal ground movement  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]  
 [0.000,0.000,0.000] [1.000,0.000,0.000] [0.000,1.000,0.000] [1.000,1.000,0.000]

Curve Fitting Method: Polynomial  
 x Order: 0  
 y Order: 0  
 Polynomial: z = 0.0  
 Coeff. of Determination: 1.00

**Curve Name:** Min 5mm Curve  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]  
 [0.000,0.000,0.210] [4.000,0.000,0.000]

Curve Fitting Method: Polynomial  
 x Order: 1  
 y Order: 0  
 Polynomial: z = -5.25E-2x + 2.10E-1  
 Coeff. of Determination: 1.00

**Curve Name:** 5mm Underpinning Curve  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%)]  
 [0.000,0.000,0.160] [4.000,0.000,0.000]

Curve Fitting Method: Polynomial  
 x Order: 1  
 y Order: 0  
 Polynomial: z = -4.00E-2x + 1.60E-1  
 Coeff. of Determination: 1.00

**Damage Category Strains**

Ref.	Name	0 (Negligible)	1 (Very Slight)	2 (Slight)	3 (Moderate)
		to	to	to	to
		1 (Very Slight)	2 (Slight)	3 (Moderate)	4 (Severe)
1	Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000



95 Avenue Road, London NW8 6HY

Analysis of Movements from Basement Construction and Excavation  
Underpinning Movements

Job No.	Sheet No.	Rev.
J22086		
Drg. Ref.		
Made by ML	Date 15-Feb-2023	Checked Date

Ref.	Name	0 (Negligible) to 1 (Very Slight)	1 (Very Slight) to 2 (Slight)	2 (Slight) to 3 (Moderate)	3 (Moderate) to 4 (Severe)
------	------	---	-------------------------------------	----------------------------------	----------------------------------

**Specific Buildings - Geometry**

Ref.	Building Name	Sub-Building Name	Displacement	Distance	Distance	Vertical	Vertical	Damage Category
Poisson's Ratio	E/G		Line	Along	Along	Offsets from	Displacement	Strains
				Line: Start	Line: End	Line for Vertical Movement Calculations	Limit Sensitivity	
				[m]	[m]	[m]	[mm]	
1	Garage building	G-A	G-A	0.00000	13.66400		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
2	Garage building	G-B	G-B	0.00000	16.98900		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
3	Garage building	G-C	G-C	0.00000	13.81700		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
4	Garage building	G-D	G-D	0.00000	17.21000		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
5	95 Avenue Road	95-A	95-A	0.00000	3.61800		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
6	95 Avenue Road	95-B	95-B	0.00000	6.50500		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
7	95 Avenue Road	95-C	95-C	0.00000	9.16400		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
8	95 Avenue Road	95-D	95-D	0.00000	8.42400		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
9	95 Avenue Road	95-E	95-E	0.00000	12.56200		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
10	95 Avenue Road	95-F	95-F	0.00000	8.84400		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
11	95 Avenue Road	95-G	95-G	0.00000	12.60400		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
12	95 Avenue Road	95-H	95-H	0.00000	8.62900		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
13	95 Avenue Road	95-I	95-I	0.00000	9.18400		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
14	95 Avenue Road	95-J	95-J	0.00000	1.42600		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
15	95 Avenue Road	95-K	95-K	0.00000	3.57200		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
16	95 Avenue Road	95-L	95-L	0.00000	17.72700		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
17	Park Lodge	PL-A	PL-A	0.00000	7.44500		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
18	Park Lodge	PL-B	PL-B	0.00000	14.58700		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
19	Park Lodge	PL-C	PL-C	0.00000	11.24800		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
20	Park Lodge	PL-D	PL-D	0.00000	26.66600		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
21	Park Lodge	PL-E	PL-E	0.00000	17.96700		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
22	Park Lodge	PL-F	PL-F	0.00000	6.27000		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
23	Avenue Lodge	AL-A	AL-A	0.00000	13.25300		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
24	Avenue Lodge	AL-B	AL-B	0.00000	16.46400		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						
25	Avenue Lodge	AL-C	AL-C	0.00000	7.60800		0.0	0.10000 Burland Strain
Limits	0.20000	2.6000						

**Specific Buildings - Bending Parameters**

Ref.	Building Name	Sub-Building Name	Height Default	Hogging:	Hogging:	Hogging:	Sagging:	Sagging:	Sagging:
------	---------------	-------------------	----------------	----------	----------	----------	----------	----------	----------



95 Avenue Road, London NW8 6HY

Analysis of Movements from Basement Construction and Excavation  
Underpinning Movements

Job No.	Sheet No.	Rev.
J22086		
Drg. Ref.		
Made by ML	Date 15-Feb-2023	Checked Date

				2nd Mom. of Area (per unit width)	Dist. of Bending Strain from N.A.	Dist. of N.A. from Edge of Beam in Tension	2nd Mom. of Area (per unit width)	Dist. of Bending Strain from N.A.	Dist. of N.A. from Edge of Beam in Tension	
		[m]		[m <sup>3</sup> ]	[m]	[m]	[m <sup>3</sup> ]	[m]	[m]	
1	Garage building	G-A	5.0000	Yes	41.667	5.0000	5.0000	10.417	2.5000	2.5000
2	Garage building	G-B	5.0000	Yes	41.667	5.0000	5.0000	10.417	2.5000	2.5000
3	Garage building	G-C	6.0000	Yes	72.000	6.0000	6.0000	18.000	3.0000	3.0000
4	Garage building	G-D	22.0000	Yes	3549.3	22.0000	22.0000	887.33	11.0000	11.0000
5	95 Avenue Road	95-A	22.0000	Yes	3549.3	22.0000	22.0000	887.33	11.0000	11.0000
6	95 Avenue Road	95-B	25.0000	Yes	5208.3	25.0000	25.0000	1302.1	12.5000	12.5000
7	95 Avenue Road	95-C	25.0000	Yes	5208.3	25.0000	25.0000	1302.1	12.5000	12.5000
8	95 Avenue Road	95-D	25.0000	Yes	5208.3	25.0000	25.0000	1302.1	12.5000	12.5000
9	95 Avenue Road	95-E	25.0000	Yes	5208.3	25.0000	25.0000	1302.1	12.5000	12.5000
10	95 Avenue Road	95-F	25.0000	Yes	5208.3	25.0000	25.0000	1302.1	12.5000	12.5000
11	95 Avenue Road	95-G	25.0000	Yes	5208.3	25.0000	25.0000	1302.1	12.5000	12.5000
12	95 Avenue Road	95-H	25.0000	Yes	5208.3	25.0000	25.0000	1302.1	12.5000	12.5000
13	95 Avenue Road	95-I	25.0000	Yes	5208.3	25.0000	25.0000	1302.1	12.5000	12.5000
14	95 Avenue Road	95-J	22.0000	Yes	3549.3	22.0000	22.0000	887.33	11.0000	11.0000
15	95 Avenue Road	95-K	22.0000	Yes	3549.3	22.0000	22.0000	887.33	11.0000	11.0000
16	95 Avenue Road	95-L	22.0000	Yes	3549.3	22.0000	22.0000	887.33	11.0000	11.0000
17	Park Lodge	PL-A	15.0000	Yes	1125.0	15.0000	15.0000	281.25	7.5000	7.5000
18	Park Lodge	PL-B	15.0000	Yes	1125.0	15.0000	15.0000	281.25	7.5000	7.5000
19	Park Lodge	PL-C	15.0000	Yes	1125.0	15.0000	15.0000	281.25	7.5000	7.5000
20	Park Lodge	PL-D	15.0000	Yes	1125.0	15.0000	15.0000	281.25	7.5000	7.5000
21	Park Lodge	PL-E	15.0000	Yes	1125.0	15.0000	15.0000	281.25	7.5000	7.5000
22	Park Lodge	PL-F	15.0000	Yes	1125.0	15.0000	15.0000	281.25	7.5000	7.5000
23	Avenue Lodge	AL-A	15.0000	Yes	1125.0	15.0000	15.0000	281.25	7.5000	7.5000
24	Avenue Lodge	AL-B	15.0000	Yes	1125.0	15.0000	15.0000	281.25	7.5000	7.5000
25	Avenue Lodge	AL-C	15.0000	Yes	1125.0	15.0000	15.0000	281.25	7.5000	7.5000

**Specific Buildings - Segment Combinations**

Stage:	Stage:	Name	Building:	Building:	Name	Sub-Building	Vertical	Segment	Start	Length	Curvature
Combined Segment	Ref.	Ref.	Name	Offset from Line for Vertical Movement Calculations	[m]	[m]	[m]				
0	Base Model	1	Garage building	G-A	0.0	No combined segments for this stage,					
specific building and offset		2	Garage building	G-B	0.0	3	0.0	0.0	None		
1		3	Garage building	G-C	0.0	5	0.0	0.0	Hogging		
0					0.0	7	0.0	0.0	None		
1		4	Garage building	G-D	0.0	9	0.0	0.0	None		
1		5	95 Avenue Road	95-A	0.0	No combined segments for this stage,					
specific building and offset		6	95 Avenue Road	95-B	0.0	12	0.0	0.0	None		
1		7	95 Avenue Road	95-C	0.0	14	0.0	0.0	None		
1		8	95 Avenue Road	95-D	0.0	No combined segments for this stage,					
specific building and offset		9	95 Avenue Road	95-E	0.0	No combined segments for this stage,					
specific building and offset		10	95 Avenue Road	95-F	0.0	No combined segments for this stage,					
specific building and offset		11	95 Avenue Road	95-G	0.0	No combined segments for this stage,					
specific building and offset		12	95 Avenue Road	95-H	0.0	No combined segments for this stage,					



95 Avenue Road, London NW8 6HY

Analysis of Movements from Basement Construction and Excavation  
Underpinning Movements

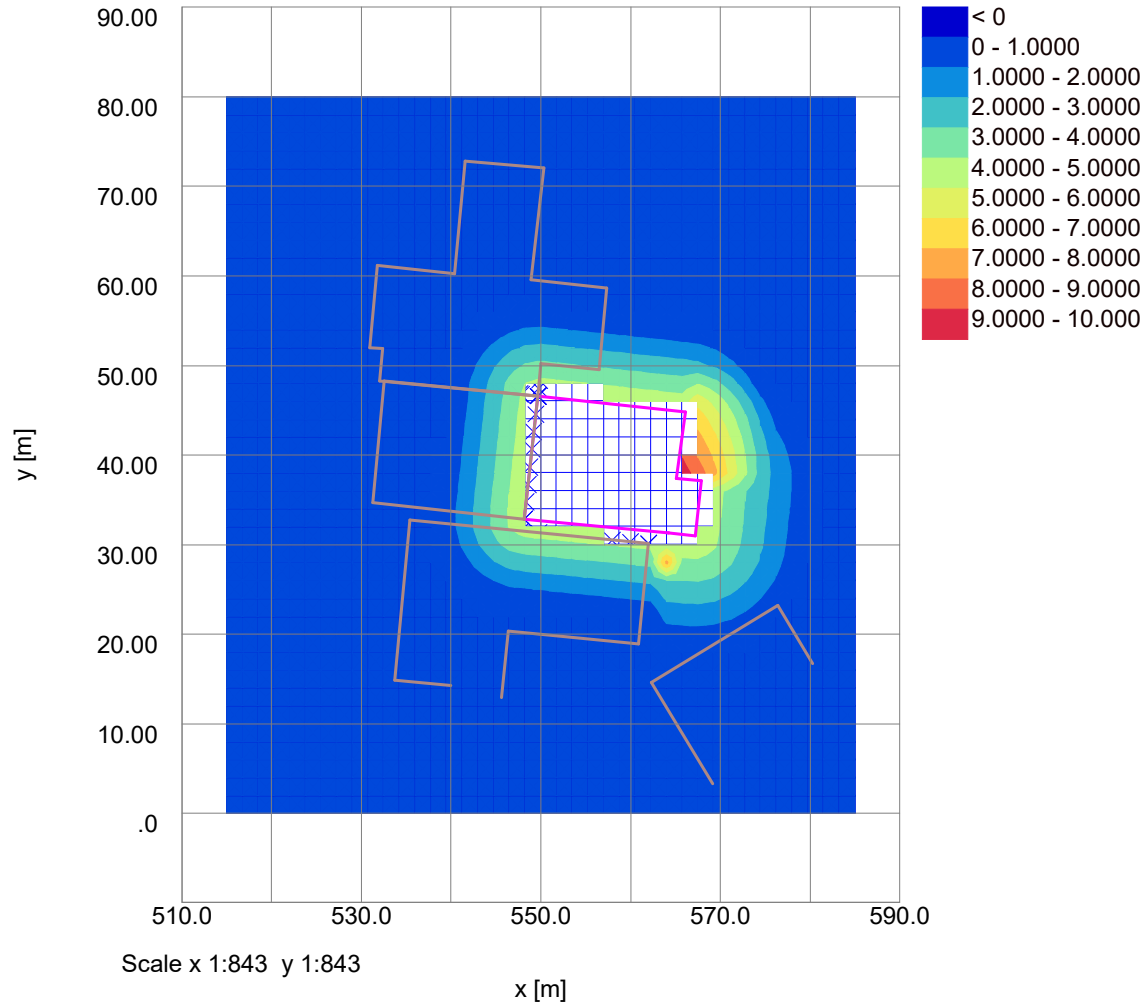
Job No.	Sheet No.	Rev.
J22086		
Drg. Ref.		
Made by ML	Date 15-Feb-2023	Checked Date

Stage:	Stage:	Name	Building:	Building:	Name	Sub-Building	Vertical	Segment	Start	Length	Curvature
Combined	Segment	Ref.	Ref.	Name	Name	Offset from	Line for				
specific building and offset		13	95 Avenue Road	95-I		0.0		No combined segments for this stage,			
specific building and offset		14	95 Avenue Road	95-J		0.0		No combined segments for this stage,			
specific building and offset		15	95 Avenue Road	95-K		0.0		No combined segments for this stage,			
specific building and offset		16	95 Avenue Road	95-L		0.0		24	0.0	0.0	None
1		17	Park Lodge	PL-A		0.0		No combined segments for this stage,			
specific building and offset		18	Park Lodge	PL-B		0.0		No combined segments for this stage,			
specific building and offset		19	Park Lodge	PL-C		0.0		28	0.0	0.0	Hogging
0		20	Park Lodge	PL-D		0.0		30	0.0	0.0	Hogging
0						0.0		32	0.0	0.0	None
1		21	Park Lodge	PL-E		0.0		No combined segments for this stage,			
specific building and offset		22	Park Lodge	PL-F		0.0		No combined segments for this stage,			
specific building and offset		23	Avenue Lodge	AL-A		0.0		No combined segments for this stage,			
specific building and offset		24	Avenue Lodge	AL-B		0.0		37	0.0	0.0	None
0		25	Avenue Lodge	AL-C		0.0		No combined segments for this stage,			
specific building and offset											



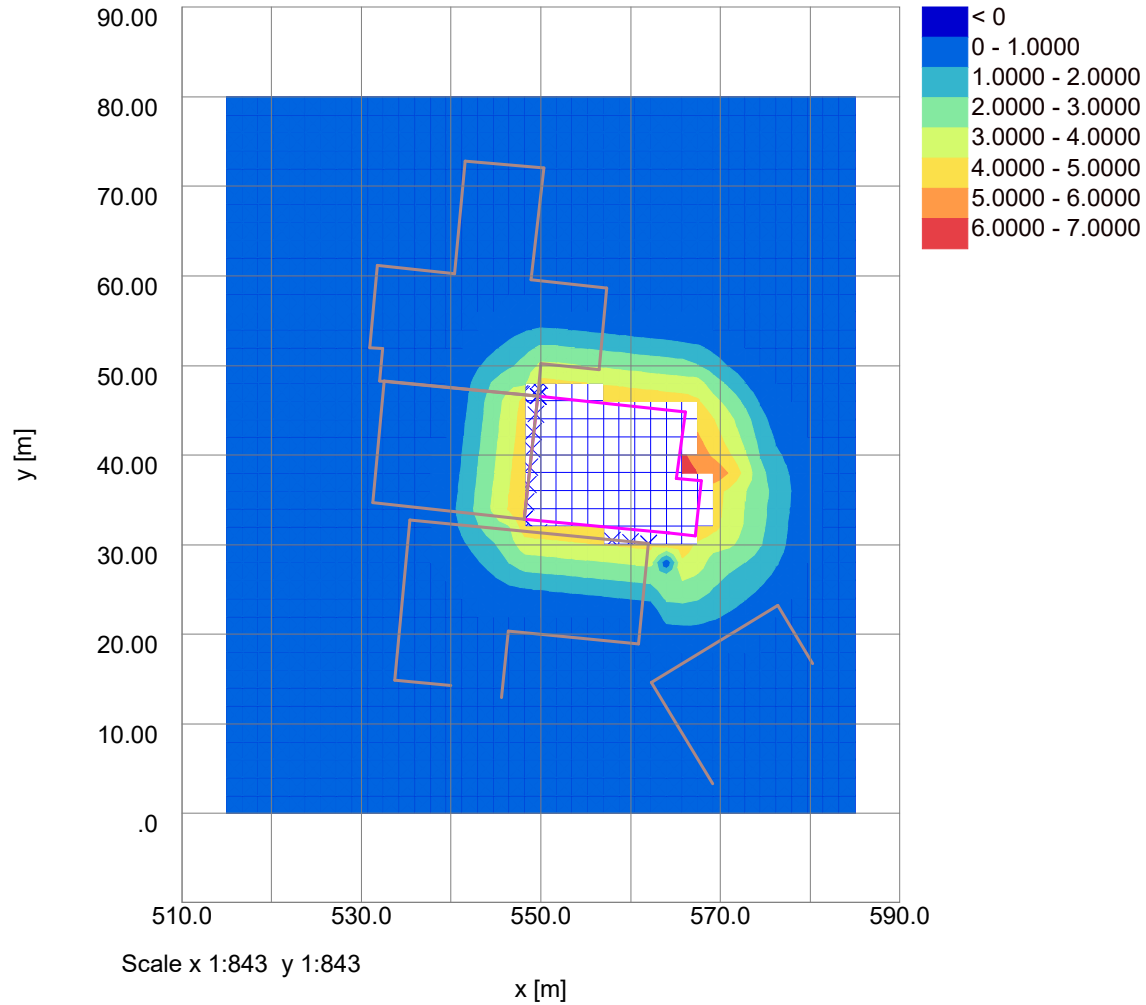
Job No.	Sheet No.	Rev.
J22086		
Drg. Ref.		
Made by ML	Date 15-Feb-2023	Checked Date

Vertical Settlement Contours: Grid 1 (level 50.900m) (Interval 1mm)



Job No.	Sheet No.	Rev.
J22086		
Drg. Ref.		
Made by ML	Date 15-Feb-2023	Checked Date

Horizontal Displacement Contours: Grid 1 (level 50.900m) Interval 1mm







**GEOTECHNICAL AND ENVIRONMENTAL ASSOCIATES LTD**

95 Avenue Road, London NW8 6HY

Analysis of Movements from Basement Construction and Excavation  
Underpinning Movements

Job No.	Sheet No.	Rev.
J22086		
Drg. Ref.		
Made by ML	Date 15-Feb-2023	Checked Date

Stage	Stage Name	Specific Name	Specific Building	Sub-building Name	Vertical Offset	Segment	Start	Length	Curvature	Deflection	Average	Max	Max
Ref.	of Vertical	Building	Building	Name	from Line for						Ratio	Horizontal	Tensile
	12	95 Avenue Road	95 Avenue Road	95-H	0.0	All vertical displacements are less than the limit sensitivity.							
	13	95 Avenue Road	95 Avenue Road	95-I	0.0	All vertical displacements are less than the limit sensitivity.							
	14	95 Avenue Road	95 Avenue Road	95-J	0.0	All vertical displacements are less than the limit sensitivity.							
	15	95 Avenue Road	95 Avenue Road	95-K	0.0	All vertical displacements are less than the limit sensitivity.							
	16	95 Avenue Road	95 Avenue Road	95-L	0.0	1	9.8485	2.0662	None	0.0	0.052493	0.052493	
-524.65E-6	-524.69E-6	13342.1		(Very Slight)									
						2	11.915	5.8122	Sagging	0.028444	0.0091466	0.032136	
754.93E-6	754.98E-6	1231.3		0 (Negligible)									
	17	Park Lodge	Park Lodge	PL-A	0.0	All vertical displacements are less than the limit sensitivity.							
	18	Park Lodge	Park Lodge	PL-B	0.0	All vertical displacements are less than the limit sensitivity.							
	19	Park Lodge	Park Lodge	PL-C	0.0	1	3.7496	3.7496	None	0.0	0.052500	0.052500	
-524.72E-6	-524.72E-6	8940.2		1 (Very Slight)									
						2	7.4992	0.0	None	0.0	0.0	35.763E-9	
-524.72E-6	-524.72E-6	-		0 (Negligible)									
						3	7.4992	3.7488	None	0.0	0.052500	0.052500	
-524.72E-6	-524.72E-6	3.8433E+18		1 (Very Slight)									
	20	Park Lodge	Park Lodge	PL-D	0.0	1	0.0	1.0256	None	0.0	1.6011E-9	35.763E-9	
-16.011E-12	91.684E-9	2.7770E+18		0 (Negligible)									
						2	1.0256	4.0340	None	0.0	1.6011E-9	35.763E-9	
-16.011E-12	91.684E-9	2.7768E+18		0 (Negligible)									
						3	5.0596	14.260	Sagging	0.0097558	-0.012341	0.0059060	
789.11E-6	509.33E-6	9978.3		0 (Negligible)									
						4	19.320	3.2437	None	164.63E-6	0.041469	0.041523	
-439.93E-6	516.49E-6	10265.0		(Negligible)									
	21	Park Lodge	Park Lodge	PL-E	0.0	All vertical displacements are less than the limit sensitivity.							
	22	Park Lodge	Park Lodge	PL-F	0.0	All vertical displacements are less than the limit sensitivity.							
	23	Avenue Lodge	Avenue Lodge	AL-A	0.0	All vertical displacements are less than the limit sensitivity.							
	24	Avenue Lodge	Avenue Lodge	AL-B	0.0	1	8.2321	0.76911	None	0.0	0.0014317	0.0014317	
-24.404E-6	-114.98E-6	86840.0		(Negligible)									
						2	9.0012	7.4628	None	0.0032506	-0.0016339	0.0025564	
34.397E-6	-114.98E-6	29454.0		(Negligible)									
	25	Avenue Lodge	Avenue Lodge	AL-C	0.0	1	0.0	0.0	None	0.0	0.0	35.763E-9	
-146.94E-6	215.91E-6	4027.9		0 (Negligible)									

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.



95 Avenue Road, London NW8 6HY

Analysis of Movements from Basement Construction and Excavation

Underpinning Movements

Job No.	Sheet No.	Rev.
J22086		
Drg. Ref.		
Made by ML	Date 15-Feb-2023	Checked Date

**Specific Building Damage Results - All Combined Segments**

Stage Category Ref.	Stage: Name	Specific Building: Ref.	Specific Building: Name	Sub-building Name	Vertical Offset from Line for Vertical Movement Calculations [m]	Combined Segment	Start [m]	Length [m]	Curvature	Deflection Ratio [%]	Average Horizontal Strain [%]	Max Tensile Strain [%]	Damage
0	Base Model	1	Garage building	G-A	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		2	Garage building	G-B	0.0	1	8.4946	8.4944	Sagging	0.022151	-0.0070338	0.026238	0
(Negligible)		3	Garage building	G-C	0.0	1	0.0	6.9086	Hogging	0.036490	-0.036474	0.025535	0
(Negligible)						2	6.9086	6.9084	Sagging	0.036479	0.0	0.048225	0
(Negligible)		4	Garage building	G-D	0.0	1	0.0	7.6493	Sagging	0.024607	0.019551	0.034415	0
(Negligible)		5	95 Avenue Road	95-A	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		6	95 Avenue Road	95-B	0.0	1	0.0	6.5050	None	3.4843E-6	-523.04E-6	104.61E-6	0
(Negligible)		7	95 Avenue Road	95-C	0.0	1	0.0	5.0916	None	0.0	0.052485	0.052485	1 (Very Slight)
(Negligible)		8	95 Avenue Road	95-D	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		9	95 Avenue Road	95-E	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		10	95 Avenue Road	95-F	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		11	95 Avenue Road	95-G	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		12	95 Avenue Road	95-H	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		13	95 Avenue Road	95-I	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		14	95 Avenue Road	95-J	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		15	95 Avenue Road	95-K	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		16	95 Avenue Road	95-L	0.0	1	9.8485	7.8785	Sagging	0.023887	0.020515	0.034404	0
(Negligible)		17	Park Lodge	PL-A	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		18	Park Lodge	PL-B	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		19	Park Lodge	PL-C	0.0	1	3.7496	7.4984	None	0.0	0.052500	0.052500	1 (Very Slight)
(Negligible)		20	Park Lodge	PL-D	0.0	1	0.0	5.0596	None	0.0	1.6011E-9	35.763E-9	0
(Negligible)						2	5.0596	17.504	Sagging	0.011497	-0.0023696	0.012928	0
(Negligible)		21	Park Lodge	PL-E	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		22	Park Lodge	PL-F	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		23	Avenue Lodge	AL-A	0.0	No combined segments for this stage, specific building and offset.							
(Negligible)		24	Avenue Lodge	AL-B	0.0	1	8.2321	8.2319	None	0.0034758	-0.0013475	0.0027873	0
(Negligible)		25	Avenue Lodge	AL-C	0.0	No combined segments for this stage, specific building and offset.							



**GEOTECHNICAL AND ENVIRONMENTAL ASSOCIATES LTD**

95 Avenue Road, London NW8 6HY

Analysis of Movements from Basement Construction and Excavation

Underpinning Movements

Job No.	Sheet No.	Rev.
---------	-----------	------

J22086

Drg. Ref.

Made by ML	Date 15-Feb-2023	Checked	Date
---------------	---------------------	---------	------

Stage:	Stage:	Name	Specific	Specific	Sub-building	Vertical	Combined	Start	Length	Curvature	Deflection	Average	Max	Damage
Category	Ref.	Building:	Building:	Name	Name	Offset from	Segment				Ratio	Horizontal	Tensile	
		Ref.	Ref.			Line for						Strain	Strain	
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.														
Calculations														
						[m]		[m]			[%]		[%]	[%]



# GEOTECHNICAL AND ENVIRONMENTAL ASSOCIATES LTD

95 Avenue Road, London NW8 6HY  
 Analysis of Vertical Movements from Basement Excavation  
 Drained Analysis

Job No.	Sheet No.	Rev.
DJ22086		
Drg. Ref.		
Made by	Date	Checked
ML		

### Titles

Job No.: J22086  
 Job Title: 95 Avenue Road, London NW8 6HY  
 Sub-title: Analysis of Vertical Movements from Basement Excavation  
 Calculation Heading: Drained Analysis  
 Initials: ML  
 Checker:  
 Date Saved:  
 Date Checked:  
 Notes:  
 File Name: Drained.pdd  
 File Path: G:\PROJECTS\2022\J22086 - 95 Avenue Road, NW8\APPENDIX\GMA

### History

Date	Time	By	Notes
15-Feb-2023	20:39	Matt Legg	New
15-Feb-2023	21:36	Matt Legg	
17-Feb-2023	10:23	Matt Legg	Open

### Analysis Options

#### General

Global Poisson's ratio: 0.20  
 Maximum allowable ratio between values of E: 1.5  
 Horizontal rigid boundary level: 0.90 [m OD]  
 Displacements at load centroids: Yes  
 GSA piled raft data: No

#### Elastic

Elastic: Yes

#### Consolidation

Consolidation: No

### Soil Profiles Undrained

Layer ref.	Name	Level at top [mOD]	Number of intermediate displacement levels	Youngs Modulus [kN/m²] : Top	Youngs Modulus [kN/m²] : Btm.	Poissons ratio	Non-linear curve
1	MG	50.900	1	10000.	10000.	0.50000	None
2	L.CLAY	49.900	1	30000.	33500.	0.50000	None
3	L.CLAY	48.900	2	33500.	40500.	0.50000	None
4	L.CLAY	46.900	3	40500.	51000.	0.50000	None
5	L.CLAY	43.900	5	51000.	68500.	0.50000	None
6	L.CLAY	38.900	8	68500.	96500.	0.50000	None
7	L.CLAY	30.900	10	96500.	131500.	0.50000	None
8	L.CLAY	20.900	20	131500.	201500.	0.50000	None

### Soil Profiles Drained

Layer ref.	Name	Level at top [mOD]	Number of intermediate displacement levels	Youngs Modulus [kN/m²] : Top	Youngs Modulus [kN/m²] : Btm.	Poissons ratio	Non-linear curve
1	MG	50.900	1	6000.0	6000.0	0.20000	None
2	L.CLAY	49.900	1	18000.	20100.	0.20000	None
3	L.CLAY	48.900	2	20100.	24300.	0.20000	None
4	L.CLAY	46.900	3	24300.	30600.	0.20000	None
5	L.CLAY	43.900	5	30600.	41100.	0.20000	None
6	L.CLAY	38.900	8	41100.	57900.	0.20000	None
7	L.CLAY	30.900	10	57900.	78900.	0.20000	None
8	L.CLAY	20.900	20	78900.	120900.	0.20000	None

### Soil Zones

Zone	Name	X min [m]	X max [m]	Y min [m]	Y max [m]	Profile
1	Zone 1	515.00	585.00	0.0	80.000	Drained

### Polygonal Load Data

Load ref.	Name	Position : Level [m]	Position : Polygon [m]	Coords. : Polygon [m]	Position : Polygon : Rect. tolerance [%]	No. of Rectangles	Value : Normal [kN/m²]
1	Main Excavation	48.50000	(566,44.8)	(550,46.6)	10.000	4	-47.000
2	Front Lightwell	47.75000	(567,31)	(568,37.1)	10.000	1	-57.000

### Polygonal Loads' Rectangles

No.	Centre x [m]	Centre y [m]	Angle of local x from global X [Degrees]	Width x [m]	Depth y [m]
<b>Load 1 : Main Excavation</b> (Edge 2 optimal)					
1	557.05936	38.94348	-96.198	13.656	16.324
2	554.86850	32.28634	-96.198	0.053836	13.405
3	552.19737	32.52228	-96.198	0.053836	8.0430
4	549.52625	32.75821	-96.198	0.053836	2.6810
<b>Load 2 : Front Lightwell</b> (Edge 1 optimal)					
1	566.10138	34.21822	84.133	6.1417	2.8910

### Displacement Lines

Name	X1 [m]	Y1 [m]	Z1 [m]	X2 [m]	Y2 [m]	Z2 [m]	Intervals [No.]	Calculate	Detailed Results
G-A	532.55171	48.27225	49.90000	531.29593	34.66562	49.90000	7	Yes	Yes
G-B	531.29593	34.66562	49.90000	548.19069	32.87618	49.90000	8	Yes	Yes
G-C	548.19069	32.87618	48.50000	549.68249	46.61262	48.50000	7	Yes	Yes
G-D	549.68249	46.61262	48.50000	532.55171	48.27225	48.50000	9	Yes	Yes
95-A	549.68249	46.61262	48.50000	550.01181	50.21601	48.50000	4	Yes	Yes
95-B	550.01181	50.21601	48.50000	556.48296	49.55236	48.50000	6	Yes	Yes
95-C	556.48296	49.55236	48.50000	557.31708	58.67916	48.50000	9	Yes	Yes
95-D	557.31708	58.67916	48.50000	548.33806	59.55414	48.50000	8	Yes	Yes
95-E	548.33806	59.55414	48.50000	550.33892	72.03819	48.50000	6	Yes	Yes



**GEOTECHNICAL AND ENVIRONMENTAL ASSOCIATES LTD** J22086

95 Avenue Road, London NW8 6HY

Analysis of Vertical Movements from Basement Excavation

Drained Analysis

Job No.	Sheet No.	Rev.
Drg. Ref.		
Made by ML	Date	Checked

Name	X1	Y1	Z1	X2	Y2	Z2	Intervals	Calculate	Detailed
	[m]	[m]	[m]	[m]	[m]	[m]	[No.]		Results
95-F	550.33892	72.03819	48.50000	541.53114	72.84307	48.50000	8	Yes	Yes
95-G	541.53114	72.84307	48.50000	540.38397	60.29097	48.50000	6	Yes	Yes
95-H	540.38397	60.29097	48.50000	531.80026	61.17588	48.50000	8	Yes	Yes
95-I	531.80026	61.17588	48.50000	530.94443	52.03107	48.50000	9	Yes	Yes
95-J	530.94443	52.03107	48.50000	532.36264	51.87711	48.50000	2	Yes	Yes
95-K	532.36264	51.87711	48.50000	532.03748	48.31925	48.50000	3	Yes	Yes
95-L	532.03748	48.31925	48.50000	549.68249	46.61262	48.50000	9	Yes	Yes
PL-A	545.64258	12.97614	48.90000	546.35450	20.38753	48.90000	7	Yes	Yes
PL-B	546.35450	20.38753	48.90000	560.87284	18.96860	48.90000	7	Yes	Yes
PL-C	560.87284	18.96860	48.90000	561.94498	30.16620	48.90000	6	Yes	Yes
PL-D	561.94498	30.16620	48.90000	535.40676	32.77432	48.90000	13	Yes	Yes
PL-E	535.40676	32.77432	48.90000	533.69422	14.88819	48.90000	9	Yes	Yes
PL-F	533.69422	14.88819	48.90000	539.93589	14.29057	48.90000	6	Yes	Yes
AL-A	569.19028	3.34787	48.90000	562.30391	14.67149	48.90000	7	Yes	Yes
AL-B	562.30391	14.67149	48.90000	576.37099	23.22627	48.90000	8	Yes	Yes
AL-C	576.37099	23.22627	48.90000	580.32463	16.72509	48.90000	7	Yes	Yes
Tunnel Crown	580.00000	54.87652	38.91000	519.32602	53.25616	38.91000	60	Yes	Yes

**Displacement Grids**

Name	Extrusion: Direction	X1	Y1	Z1	X2	Y2	Z2	Intervals Along Line [No.]	Extrusion: Distance [m]	Extrusion: Intervals Along [No.]	Calculate	Detailed
		[m]	[m]	[m]	[m]	[m]	[m]					Results
Ground Level	Global X	515.00000	0.00000	50.90000	-	80.00000	50.90000	40	70.00000	40	Yes	Yes

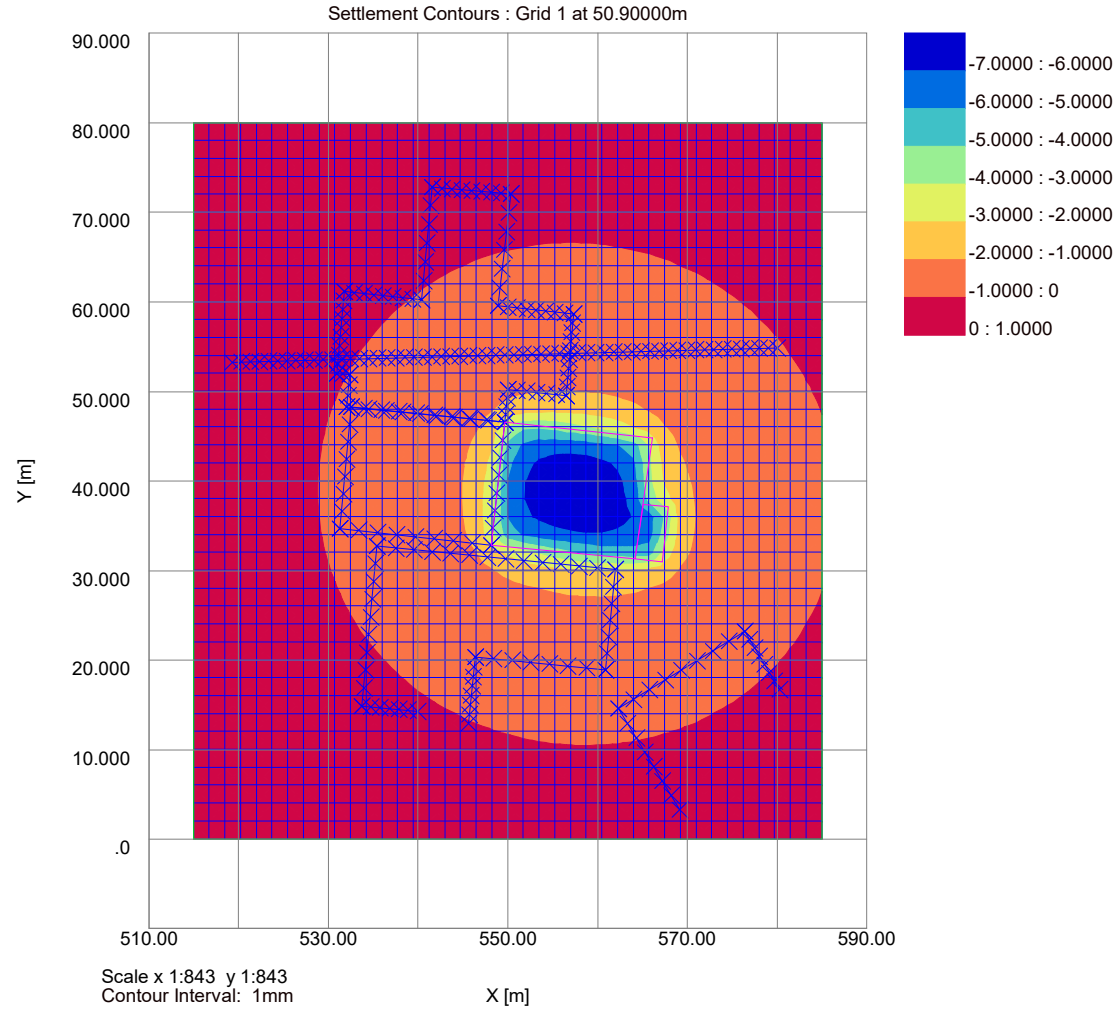


95 Avenue Road, London NW8 6HY

Analysis of Vertical Movements from Basement Excavation

Undrained Short-term Movements

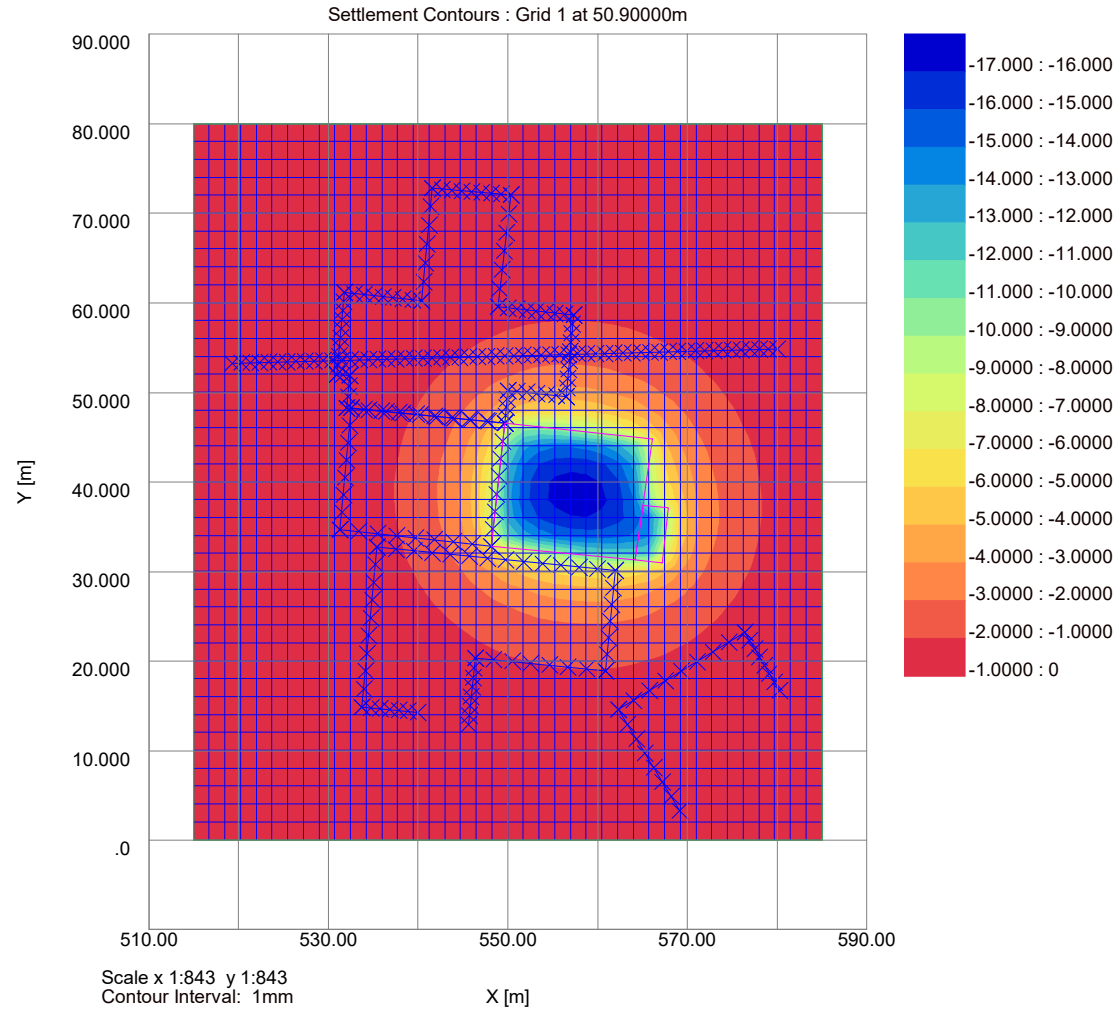
Job No.	Sheet No.	Rev.
J22086		
Drg. Ref.		
Made by ML	Date	Checked



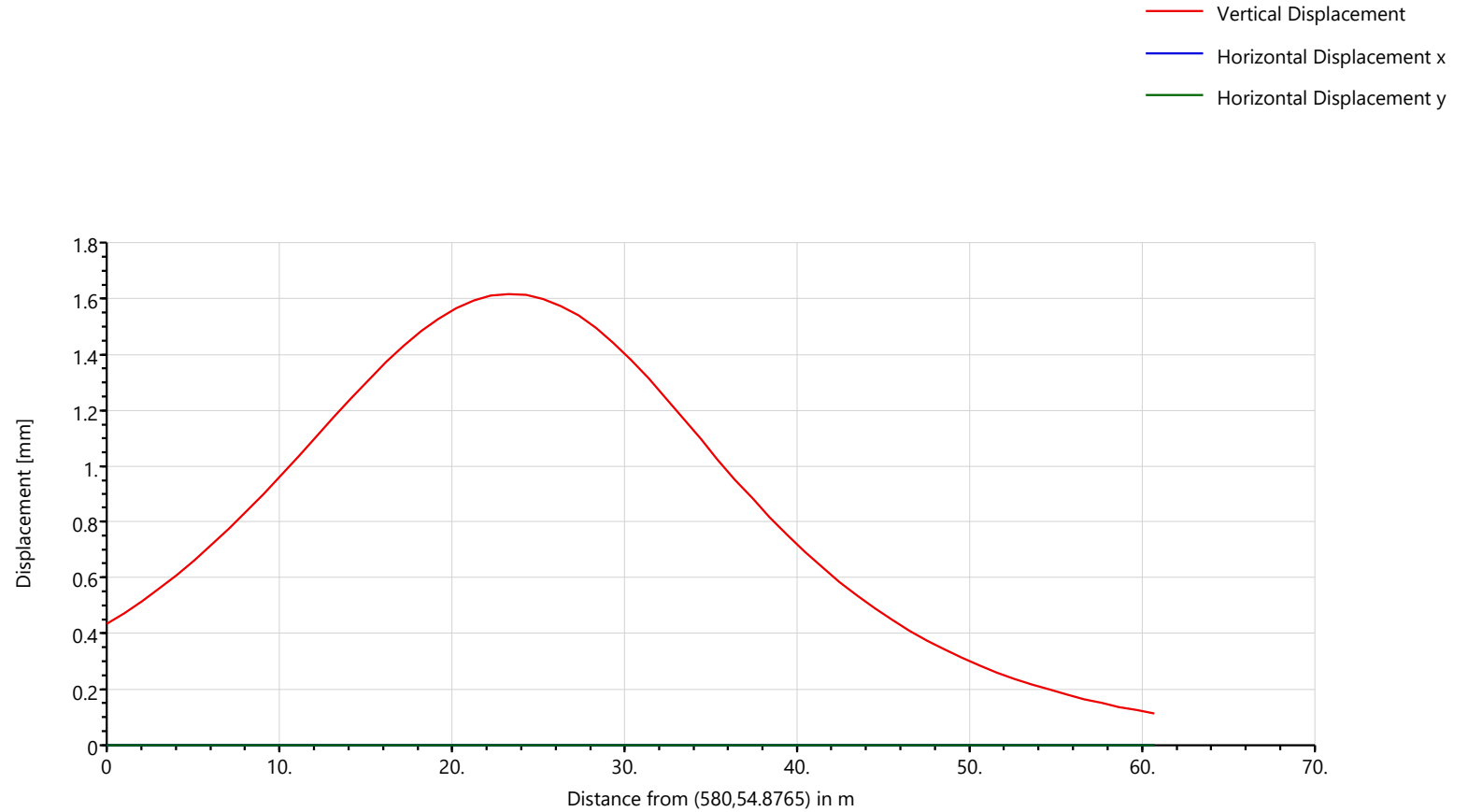
95 Avenue Road, London NW8 6HY

Analysis of Vertical Movements from Basement Excavation  
Drained Analysis

Job No.	Sheet No.	Rev.
J22086		
Drg. Ref.		
Made by ML	Date	Checked



### Displacement for Tunnel Crown



95 Avenue Road, London NW8 6HY

Analysis of Vertical Movements from Basement Excavation

Drained Analysis

Job No.	Sheet No.	Rev.
---------	-----------	------

J22086

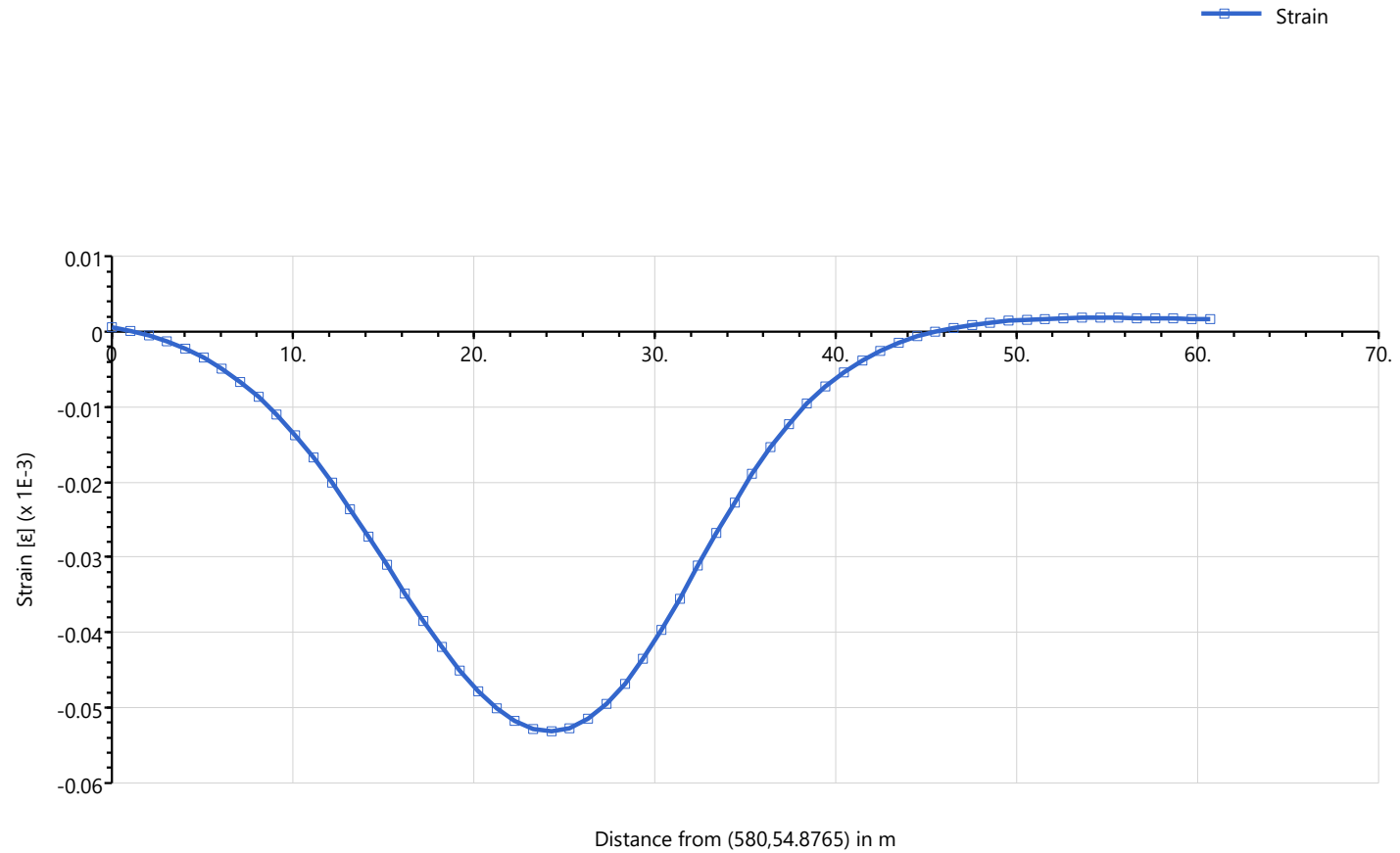
Drg. Ref.

Made by  
ML

Date

Checked

### Strain for Tunnel Crown



95 Avenue Road, London NW8 6HY

Analysis of Vertical Movements from Basement Excavation

Drained Analysis

Job No.	Sheet No.	Rev.
---------	-----------	------

J22086

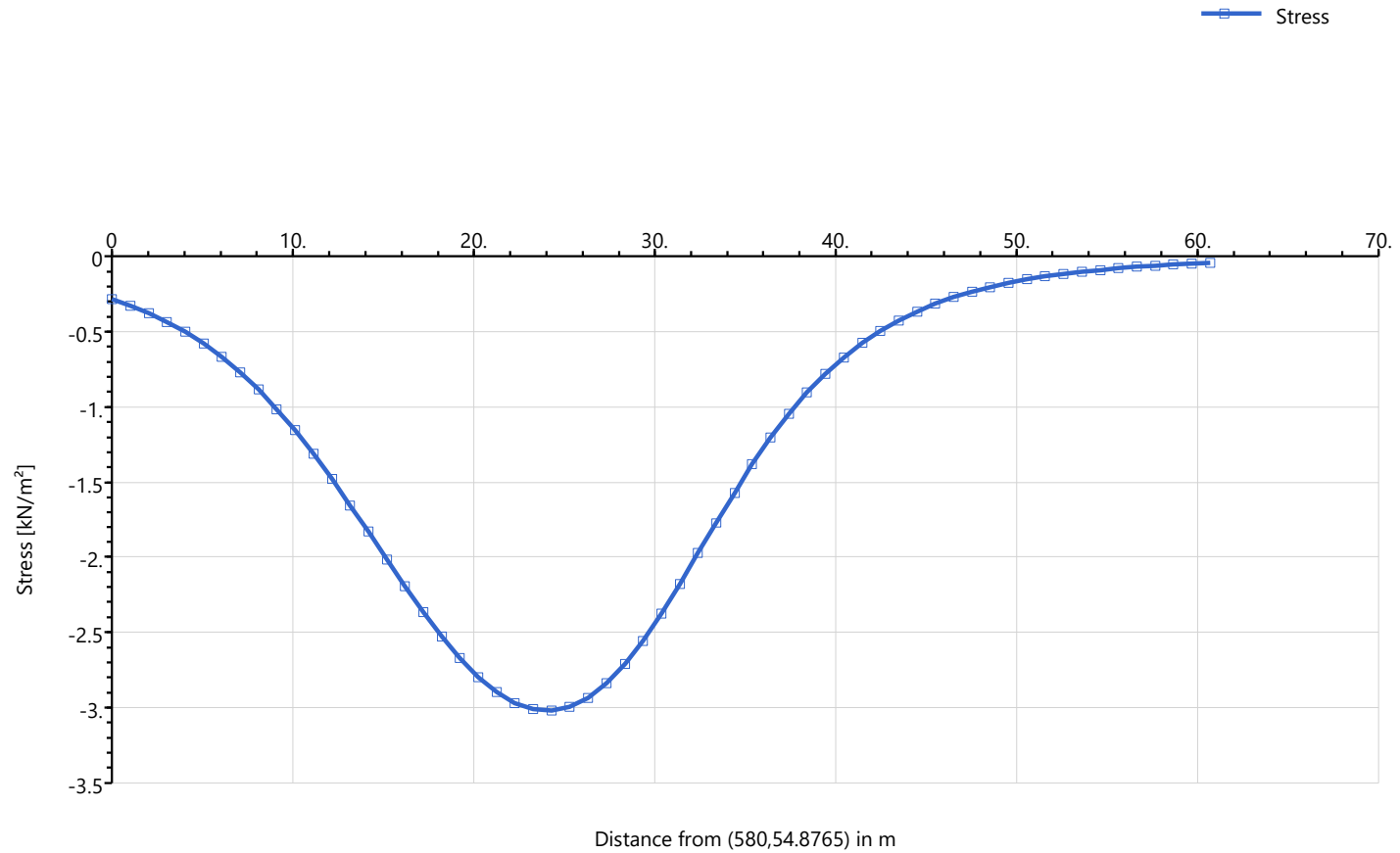
Drg. Ref.

Made by  
ML

Date

Checked

### Stress for Tunnel Crown





Geotechnical &  
Environmental  
Associates

### Herts:

Widbury Barn  
Widbury Hill  
Ware  
Hertfordshire  
SG12 7QE  
tel 01727 824666  
mail@gea-ltd.co.uk

### Notts:

Church Farm  
Gotham Road  
Kingston on Soar  
Notts  
NG11 0DE  
tel 01509 674888  
midlands@gea-ltd.co.uk

### Manchester:

Peter House  
Oxford Street  
Manchester  
M1 5AN  
tel 0161 209 3032  
mail @ gea-ltd.co.uk

[www.gea-ltd.co.uk](http://www.gea-ltd.co.uk)