



	Total destruction		General blast damage; not structural
	Damage beyond repair		Blast damage, minor in nature
	Seriously damaged; doubtful if repairable		Clearance areas
	Seriously damaged, but repairable at cost		

- V1 Flying Bomb
- V2 Long Range Rocket



1ST LINE DEFENCE

Unit 3, Maple Park
Essex Road, Hoddesdon,
Hertfordshire. EN11 0EX
Email: info@1stlinedefence.co.uk
Tel: +44 (0)1992 245 020

Client: **GEA Ltd**

Project: **19-21 High Holborn**

Ref: **OPN2542**

Source: London Metropolitan Archives

Approximate site boundary





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Client: **GEA Ltd**

Project: **19-21 High Holborn**

Ref: **OPN2542**

Source: National Monuments Record Office (Historic England)

 **Approximate site boundary**





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Approximate site boundary





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Client: **GEA Ltd**

Project: **19-21 High Holborn**

Ref: **OPN2542**

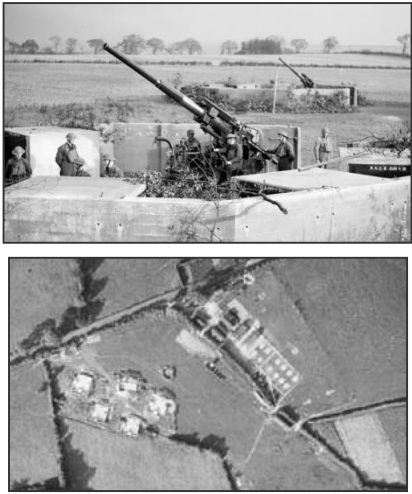
Source: National Monuments Record Office (Historic England)

 **Approximate site boundary**



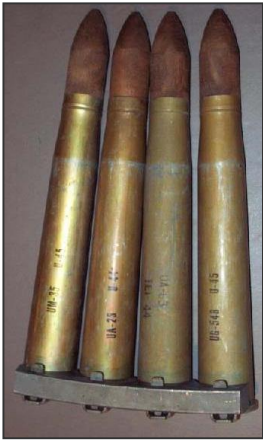
QF 3.7 Inch WWII Anti-Aircraft Projectile

Projectile Weight	28lb (12.6 kg)
Explosive Weight	2.52lbs
Fuze Type	Mechanical Time Fuze
Dimensions	3.7in x 14.7in (94mm x 360mm)
Rate of Fire	10 to 20 rounds per minute
Use	High Explosive Anti-Aircraft projectile. 4.5in projectiles were also used in this role.
Ceiling	30,000ft to 59,000ft



40mm Bofors Projectile

Projectile Weight	1.96lb (0.86kg)
Explosive Weight	300g (0.6lb)
Fuze Type	Proximity and Mechanical Time Fuze
Rate of Fire	120 rounds per minute
Projectile Dimensions	40mm x 310mm (1.6in x 12.2in)
Ceiling	23,000ft (7000m)



Unrotated Projectile (UP) – Z Battery

Projectile Weight	84lb (24.5kg)
Warhead Weight	4.28lb (1.94kg)
Warhead	Aerial Mine with a No. 700 / 720 fuze
Filling	High Explosive
Dimensions	1930mm x 82.6mm (76 x 3.25in)
Use	As a short range rocket-firing anti-aircraft weapon developed for the Royal Navy. It was used extensively by British ships during the early days of World War II. The UP was also used in ground-based single and 128-round launchers known as Z Batteries.



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Client: **GEA Ltd**

Project: **19-21 High Holborn**

Ref: **OPN2542**

Source: Various sources

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Hoddesdon
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1ST LINE DEFENCE



Geotechnical &
Environmental
Associates

Widbury Barn
Widbury Hill
Ware
Herts SG12 7QE

Site Plan

Site 19-21 High Holborn, London, WC1V 6BS

Client The Honourable Society of Gray's Inn

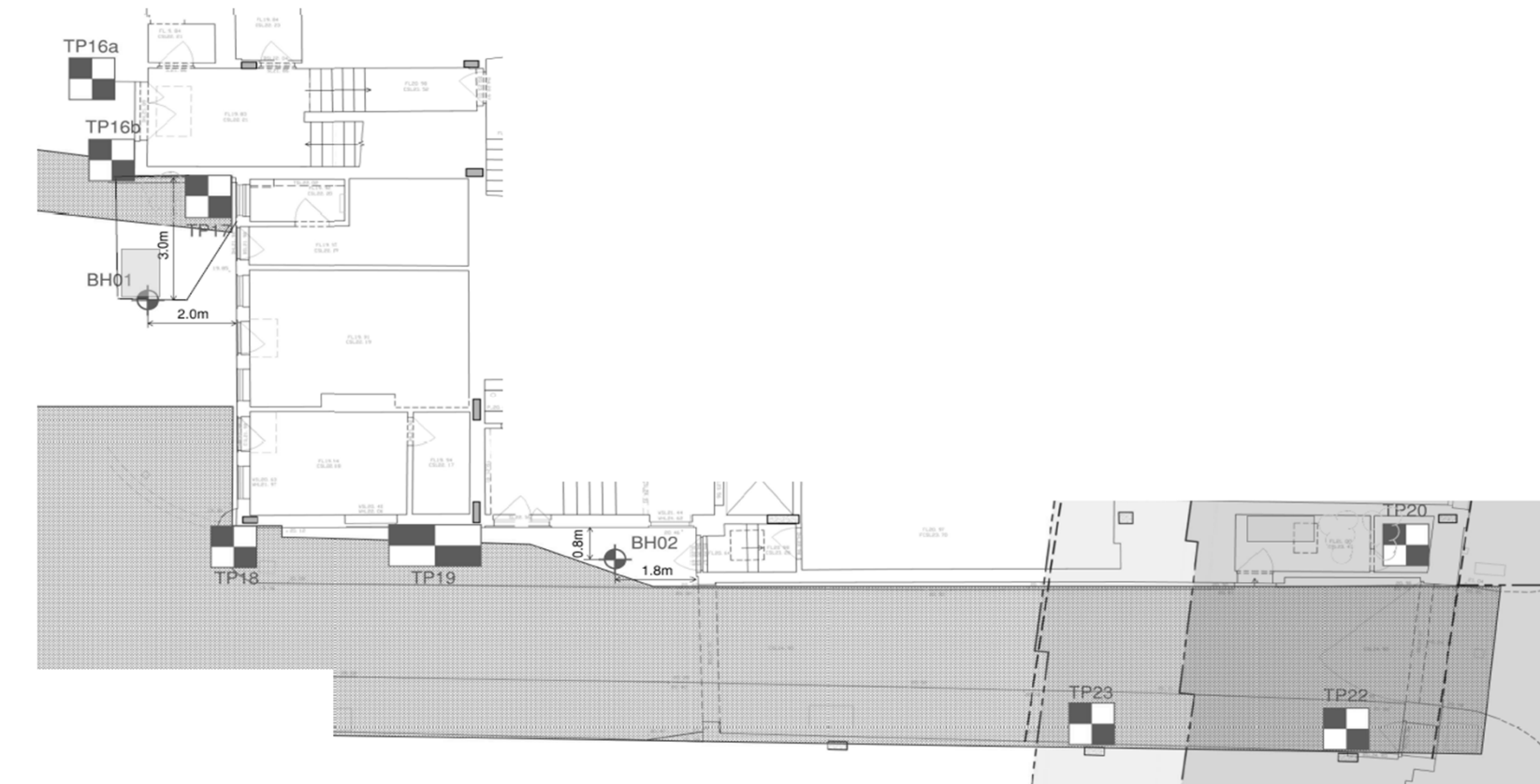
Engineer AECOM

Job Number
J15193

Sheet
1 / 1



High Holborn



Approximate Scale in metres



Express Preliminary UXO Risk Assessment

Client	GEA Ltd.
Project	Gray's Inn, Holborn
Site Address	South Square, Holborn, London, WC1R 5BH
Report Reference	EP2542-00
Date	10/03/20
Originator	OG

Assessment Objective

This preliminary risk assessment is a qualitative screening exercise to assess the likely potential of encountering unexploded ordnance (UXO) at the Gray's Inn, Holborn site. The assessment involves the consideration of the basic factors that affect the potential for UXO to be present at a site as outlined in Stage One of the UXO risk management process.

Background

This assessment uses the sources of information available in-house to 1st Line Defence Ltd to enable the placement of a development site in context with events that may have led to the presence of German air-delivered or Allied military UXO. The report will identify any immediate necessity for risk mitigation or additional research in the form of a Detailed UXO Risk Assessment. It makes use of 1st Line Defence's extensive historical archives, library and unique geo-databases, as well as internet resources, and is researched and compiled by UXO specialists and graduate researchers.

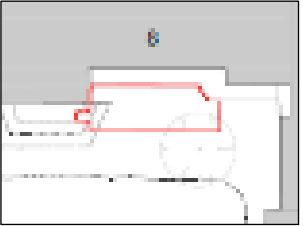
The assessment directly follows CIRIA C681 guidelines "Unexploded Ordnance, a Guide for the Construction Industry". The document will therefore assess the following factors:

- Basic Site Data
- Previous Military Use
- Indicators of potential aerial delivered UXO threat
- Consideration of any Mitigating Factors
- Extent of Proposed Intrusive Works
- Any requirement for Further Work

It should be noted that the vast majority of construction sites in the UK will have a low or negligible risk of encountering UXO and should be able to be screened out at this preliminary stage. The report is meant as a common sense 'first step' in the UXO risk management process. The content of the report and conclusions drawn are based on basic, preliminary research using the information available to 1st Line Defence at the time this report was produced. It should be noted that the only way to entirely negate risk from UXO to a project would be to support the works proposed with appropriate UXO risk mitigation measures. It is rarely possible to state that there is absolutely 'no' risk from UXO to a project.





Risk Assessment Considerations	
Site location and description/current use	The site is located within the London Borough of Camden, in the area of Holborn. It is located on the northern end of South Square, with Gray's Inn structures to the immediate north and east. Recent aerial imagery indicates the site to currently be occupied by hardstanding ground. The site is approximately centred on the OS grid reference: TQ 31064 81724. 
Are there any indicators of current/historical military activity on/close to the site?	At this stage, in-house records do not indicate that the site footprint had any former military use. No features such as WWII defensive positions, encampments or firing ranges are recorded to have been located at the site. In addition, no information of ordnance being stores, produced, or disposed of within the proposed site boundary could be found. The closest Heavy Anti-Aircraft (HAA) batteries was situated approximately 3.5km to the south-west of the site. The conditions in which unexploded anti-aircraft ordnance may have fallen unrecorded are analogous to that of aerial delivered German bombs - see the sections below for further information.
What was the pre- and post-WWII history of the site?	According to pre-WWII OS mapping dated 1937, the site was occupied by open ground on the northern side of <i>South Square</i>. Large buildings surrounded the site to the north and east, including a <i>Chapel</i> and <i>Chambers</i>. Post-WWII OS mapping dated 1952-53 indicates that the site remained occupied by open ground. Significant changes are evident in the vicinity; including the Chapel to the north now labelled <i>Chapel (Remains of)</i>. The <i>Chambers</i> is no longer labelled, and an area of <i>Ruins</i> is evident to the east.
Was the area subject to bombing during WWII?	During WWII, the site was located in the Metropolitan Borough of Holborn. This borough sustained a very high density of bombing, with 921.2 items recorded per 1,000 acres according to official Home Office statistics. This included 354 high explosive bombs, 7 parachute mines, 8 oil bombs, 4 V-1 pilotless aircraft and 1 V-2 long-range rocket, culminating in 374 incidents in total. London Bomb Census mapping records a number of bomb strikes in the immediate vicinity of the site, as well as additional bombs in the surrounding area.
Is there any evidence of bomb damage on/close to the site?	London County Council (LCC) bomb damage mapping labels structures to the immediate north, east and west of the site as <i>seriously damaged; doubtful if repairable</i>. Additional buildings in the wider area are also marked as <i>total destruction</i>.
To what degree would the site have been subject to access?	Given the site's locality within the area of Holborn Court, access is anticipated to have been frequent prior to any bombing. However, post-bombing and subsequent damage, rubble and debris is likely to have defined the area. This is likely to have significantly decreased access and observation for evidence of UXO.





To what degree has the site been developed post-WWII?	Little development has occurred on site post-WWII. The site still remains occupied by an area of open land.
What is the nature and extent of the intrusive works proposed?	The proposed works are understood to comprise the replacement of some existing basement vaults, with a new plant room. This will involve the deepening of the existing floor by approximately 1-1.5m.

Summary and Conclusions

During WWII, the site was situated within the Metropolitan Borough of Holborn, which sustained an overall very high density of bombing, with an average of 921.2 items recorded per 1,000 acres according to Home Office statistics. London Bomb Census mapping for the area records a number of bomb strikes within the immediate vicinity of the site. LCC bomb damage mapping records serious levels of damage to the adjacent structures, with the northern chapel labelled as *Chapel (Remains of)* on post-WWII OS mapping.

Given this, it is not anticipated that access would have been particularly frequent within the area due to the resulting rubble and debris. As such, post-raid checks for evidence of UXO are thought to have decreased significantly.

Recommendations

Given the findings of this preliminary report, it is recommended that **further research** be undertaken in the form of a **Detailed UXO Risk Assessment**. This would involve the usage of additional archival information such as written incident records and high-resolution WWII-era aerial photography.

It should be noted, given the quality of record set available at a preliminary stage, that it is not thought likely that further desktop research would mitigate the risk on site.

Prior to or in lieu of a Detailed Assessment, it is recommended that appropriate UXO Risk Mitigation Measures are provided for intrusive works proposed.

If the client has any anecdotal or empirical evidence of UXO risk on site, please contact 1st Line Defence.



Titles

Job No.: J20048
Job Title: Proposed Chiller Plant Room, No 8 South Square
Sub-title: Ground Movement Assessment
Calculation Heading: Short-term heave due to excavation
Initials: MP
Checker:
Date Saved:
Date Checked:
Notes:
File Name: FDispl.pdd
File Path: C:\CURRENT\20-J20048 - The Honourable Society of Gray's
In\ARENDIX\GNA

History

Date	Time	By	Notes
09-Mar-2020	17:00	Matthew Penfold	New
09-Mar-2020	17:37	Matthew Penfold	
09-Mar-2020	20:53	Matthew Penfold	
09-Mar-2020	21:14	Matthew Penfold	
10-Mar-2020	09:27	Matthew Penfold	

Analysis Options

General

Global Poisson's ratio: 0.50
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: -2.50 [m OD]
Displacements at load centroids: Yes
GSA piled raft data : No

Elastic

Elastic : Yes
Analysis: Boussinesq
Stiffness for horizontal displacement calculations: Weighted average
Using legacy heave correction factor: No

Consolidation

Consolidation : No

Soil ProfilesSoil Profile 1

Layer ref.	Name	Level at top	Number of intermediate displacement levels	Youngs Modulus : Top	Youngs Modulus : Btm.	Poissons ratio	Non-linear curve
		[mOD]		[kN/m ²]	[kN/m ²]		
1	Made Ground	19.500	2	10000.	10000.	0.20000	None
2	Hardy Gravel	17.500	4	60000.	70000.	0.20000	None
3	Lackney clay	13.000	10	525000.	1350000.	0.50000	None

Soil Zones

Zone	Name	X min [m]	X max [m]	Y min [m]	Y max [m]	Profile
1	Soil Zone 1	-30.000	30.000	-40.000	30.000	Soil Profile 1

Polygonal Load Data

Load ref.	Name	Position : Level	Position : Polygon	Coords. : Rect. tolerance	Position : Polygon : Rect. tolerance	No. of Rectangles	Value : Normal (local z)
		[m]	[m]	[°]	[°]		[kN/m²]
1	Proposed Plant Room	16.50000 (8,4)	(0,0) (0,4)	(10,0) (0,4)	(10,2.5) (9,2.5)	1.0000	4 -20.000

Polygonal Loads' Rectangles

No.	Centre x	Centre y	Angle of local x from global X [Degrees]	Width [m]	Depth [m]
Load 1 : Proposed Plant Room					
(Edge 2 optimal)					
1	5.00000	1.25000	90.000	2.5000	10.000
2	4.25000	3.25000	90.000	1.5000	8.5000

Displacement Lines

	Name	X1	Y1	Z1	X2	Y2	Z2	Intervals Calculate	Detailed Results
		[m]	[m]	[m]	[m]	[m]	[m]	[No.]	
No 8 SS - A		-6.950000	2.50000 17.00000	-0.05000	2.50000 17.00000		7	Yes	No
No 8 SS - B		0.00000	2.55000 17.00000	0.00000	2.45000 17.00000		3	Yes	No
No 8 SS - C		0.05000	5.50000 17.00000	14.5000	5.50000 17.00000		10	Yes	No
No 8 SS - D		10.50000	5.45000 17.00000	10.5000	4.05000 17.00000		1	Yes	No
No 8 SS - E		10.55000	4.00000 17.00000	15.45000	4.00000 17.00000		5	Yes	No
No 8 SS - F		15.50000	12.85000 17.00000	15.50000	1.55000 17.00000		11	Yes	No
No 8 SS - G		15.45000	1.50000 17.00000	14.55000	1.50000 17.00000		1	Yes	No
No 8 SS - H		14.50000	1.45000 17.00000	14.5000	-5.95000 17.00000		7	Yes	No
No 8 SS / No 5-7 SS - I		14.55000	-6.00000 17.00000	24.45000	-6.00000 17.00000		10	Yes	No
No 8 SS - J		24.50000	-5.95000 17.00000	24.50000	13.95000 17.00000		20	Yes	No
No 8 SS / Chapel - K		24.45000	14.00000 17.00000	14.55000	14.00000 17.00000		7	Yes	No
No 8 SS / Chapel - L		16.50000	13.95000 17.00000	16.50000	13.05000 17.00000		1	Yes	No
No 8 SS / Chapel - M		16.45000	13.00000 17.00000	0.05000	13.00000 17.00000		16	Yes	No
No 8 SS / Chapel - N		0.00000	13.05000 17.00000	0.00000	20.95000 17.00000		8	Yes	No
No 8 SS - O		-0.05000	21.00000 17.00000	-6.95000	21.05000 17.00000		7	Yes	No
No 8 SS / Hall - P		-7.05000	20.95000 17.00000	-7.00000	2.55000 17.00000		18	Yes	No
Hall - A		-7.05000	9.00000 17.00000	-27.95000	9.00000 17.00000		21	Yes	No
Hall - B		-28.00000	9.05000 17.00000	-28.00000	23.45000 17.00000		17	Yes	No
Hall - C		-27.95000	24.00000 17.00000	-24.05000	24.00000 17.00000		4	Yes	No
Hall - D		-24.00000	23.95000 17.00000	-24.00000	21.05000 17.00000		17	Yes	No
Hall - E		-23.95000	21.00000 17.00000	-7.05000	21.00000 17.00000		16	Yes	No
Chapel - A		0.05000	21.00000 17.00000	24.45000	21.00000 17.00000		24	Yes	No
Chapel - B		24.50000	20.95000 17.00000	24.50000	14.05000 17.00000		6	Yes	No
No 5-7 SS - A		24.50000	-6.05000 17.00000	24.50000	-34.45000 17.00000		10	Yes	No
No 5-7 - B		24.45000	-35.00000 17.00000	14.50000	-35.00000 17.00000		10	Yes	No
No 5-7 - C		14.00000	-34.95000 17.00000	14.00000	-6.05000 17.00000		29	Yes	No

Displacement Grids

Name	Extrusion:	X1	Y1	Z1	X2	Y2	Z2	Intervals	Extrusion:	Extrusion:	Calculate Detailed
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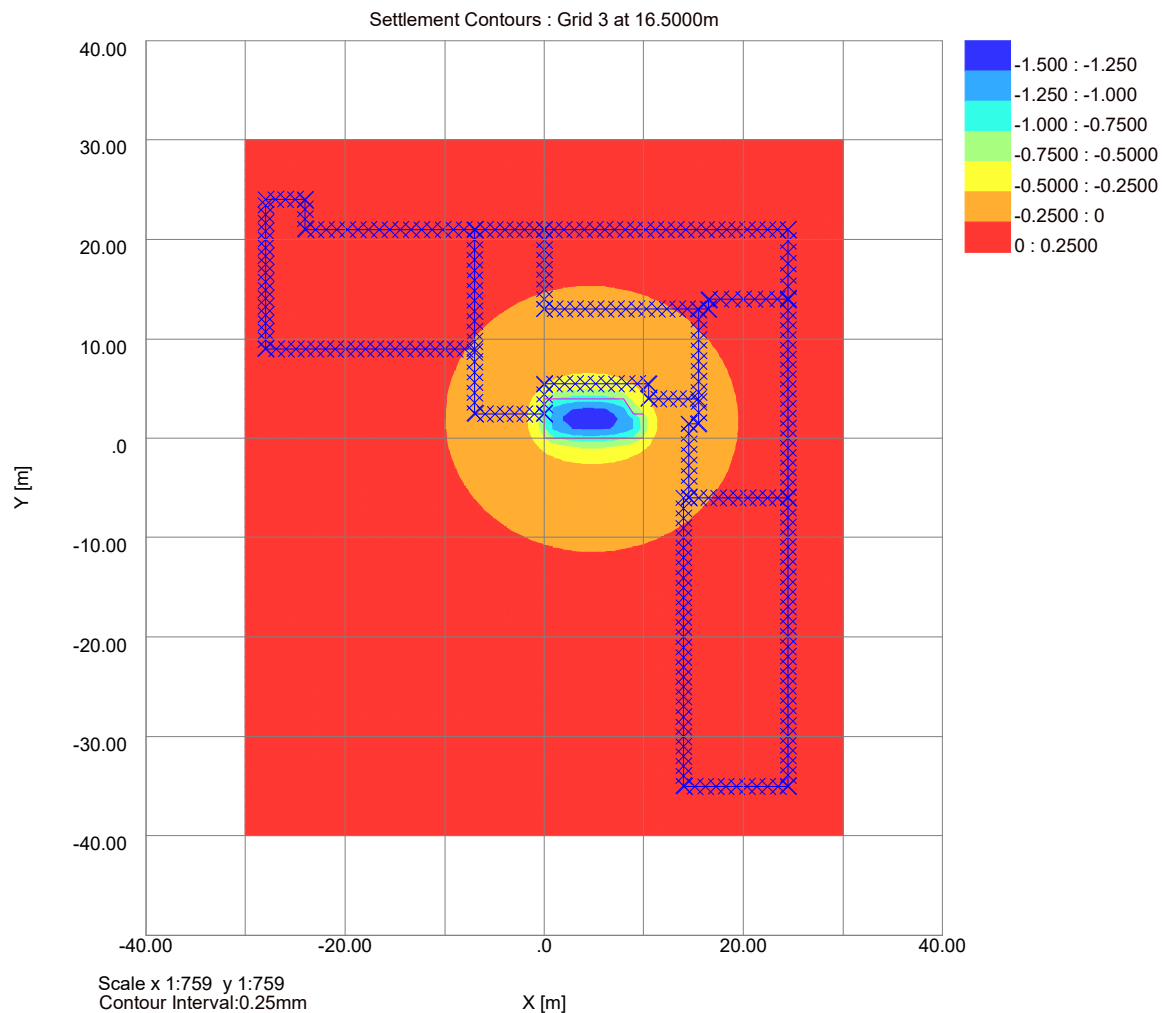


Proposed Chiller Plant Room, No 8 South Square
Ground Movement Assessment
Short-term heave due to excavation

Job No.	Sheet No.	Rev.
J20048		
Drg. Ref.		
Made by MP	Date	Checked

Direction							Along Line [No.]	Distance [m]	Intervals Along [No.]	Results
		[m]	[m]	[m]	[m]	[m]				
Displacement Grid 1	Global X	-30.00000	-40.00000	19.50000	-	30.00000	19.50000	70	60.00000	60 Yes No
Displacement Grid 2	Global X	-30.00000	-40.00000	17.50000	-	30.00000	17.50000	70	60.00000	60 Yes No
Displacement Grid 3	Global X	-30.00000	-40.00000	16.50000	-	30.00000	16.50000	70	60.00000	60 Yes No

Job No.	Sheet No.	Rev.
J20048		
Drg. Ref.		
Made by MP	Date	Checked





Proposed Chiller Plant Room, No 8 South Square
Ground Movement Assessment
Total heave

Job No.	Sheet No.	Rev.
J20048		
Drg. Ref.		
Made by MP	Date	Checked

Titles

Job No.:	J20048
Job Title:	Proposed Chiller Plant Room, No 8 South Square
Sub-title:	Ground Movement Assessment
Calculation Heading:	Total heave
Initials:	MP
Checker:	
Date Saved:	
Date Checked:	
Notes:	
File Name:	FDisp2.pdd
File Path:	G:\CURRENT\20-J20048 - The Honourable Society of Gray's Inn\AFREND\X\GMA

History

Date	Time	By	Notes
09-Mar-2020	17:00	Matthew Penfold	New
09-Mar-2020	17:37	Matthew Penfold	
09-Mar-2020	21:12	Matthew Penfold	
10-Mar-2020	09:28	Matthew Penfold	Open

Analysis Options

General

Global Poisson's ratio: 0.20
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: -2.50 [m OD]
Displacements at load centroids: Yes
GSA piled raft data : No

Elastic

Elastic : Yes
Analysis: Boussinesq
Stiffness for horizontal displacement calculations: Weighted average
Using legacy heave correction factor: No

Consolidation

Consolidation : No

Soil ProfilesSoil Profile 1

Layer ref.	Name	Level at top	Number of intermediate displacement levels	Youngs Modulus : Top	Youngs Modulus : Btm.	Poissons ratio	Non-linear curve
		[mOD]		[kN/mm ²]	[kN/mm ²]		
1	Made Ground	19.500	2	10000.	10000.	0.20000	None
2	Hackney Gravel	17.500	4	60000.	70000.	0.20000	None
3	London Clay	13.000	10	39375.	101250.	0.20000	None

Soil Zones

Zone	Name	X min [m]	X max [m]	Y min [m]	Y max [m]	Profile
1	Soil Zone 1	-30.000	30.000	-40.000	30.000	Soil Profile 1

Polygonal Load Data

Load ref.	Name	Position : Level	Position : Polygon	Coords. : Polygon : Rect. tolerance	No. of Rectangles	Value : Normal (local z)
		[m]	[m]	[°]		[kN/m²]
1	Proposed Plant Room	16.50000	(0,0) (10,0) (8,4) (0,4)	(10,2.5) (9,2.5)	1.0000	4 -20.000

Polygonal Loads' Rectangles

No.	Centre : x	Centre : y	Angle of local x from global X [Degrees]	Width x [m]	Depth y [m]
Load 1 :	Proposed Plant Room				
(Edge 2 optimal)					
1	5.00000	1.25000	90.000	2.5000	10.000
2	4.25000	3.25000	90.000	1.5000	8.5000

Displacement Lines

#	Name	X1	Y1	Z1	X2	Y2	Z2	Intervals	Calculate	Detailed Results
		[m]	[m]	[m]	[m]	[m]	[m]	[No.]		
No 8 SS - A		-6.95000	2.50000	17.00000	-0.05000	2.50000	17.00000	7	Yes	No
No 8 SS - B		0.00000	2.55000	17.00000	0.00000	5.45000	17.00000	3	Yes	No
No 8 SS - C		0.05000	5.50000	17.00000	0.00000	5.50000	17.00000	10	Yes	No
No 8 SS - D		10.50000	5.45000	17.00000	10.50000	14.95000	17.00000	1	Yes	No
No 8 SS - E		10.55000	4.00000	17.00000	15.45000	4.00000	17.00000	5	Yes	No
No 8 SS - F		15.50000	12.95000	17.00000	15.50000	1.55000	17.00000	11	Yes	No
No 8 SS - G		15.45000	1.50000	17.00000	14.95000	1.50000	17.00000	1	Yes	No
No 8 SS - H		14.50000	-5.45000	17.00000	14.50000	-1.50000	17.00000	7	Yes	No
No 8 SS / No 5-7 SS - I		14.55000	-6.00000	17.00000	24.45000	-6.00000	17.00000	10	Yes	No
No 8 SS - J		24.50000	-5.95000	17.00000	24.50000	13.95000	17.00000	20	Yes	No
No 8 SS / Chapel - K		24.45000	14.00000	17.00000	16.55000	14.00000	17.00000	7	Yes	No
No 8 SS / Chapel - L		24.50000	13.95000	17.00000	16.50000	13.95000	17.00000	1	Yes	No
No 8 SS / Chapel - M		16.45000	13.00000	17.00000	0.05000	13.00000	17.00000	16	Yes	No
No 8 SS / Chapel - N		0.00000	13.05000	17.00000	0.00000	20.95000	17.00000	8	Yes	No
No 8 SS - O		-0.05000	21.00000	17.00000	-6.95000	21.00000	17.00000	7	Yes	No
No 8 SS / Hall - F		-7.00000	20.95000	17.00000	-7.00000	2.55000	17.00000	18	Yes	No
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Hall - B		-28.00000	9.05000	17.00000	-28.00000	23.45000	17.00000	17	Yes	No
Hall - C		-27.95000	24.00000	17.00000	-24.05000	24.00000	17.00000	4	Yes	No
Hall - D		-24.00000	23.95000	17.00000	-24.00000	21.05000	17.00000	3	Yes	No
Hall - E		-23.95000	-21.00000	17.00000	-7.05000	21.00000	17.00000	1	Yes	No
Chapel - A		0.05000	21.00000	17.00000	24.45000	21.00000	17.00000	24	Yes	No
Chapel - B		24.50000	20.95000	17.00000	24.50000	14.05000	17.00000	6	Yes	No
No 5-7 SS - A		24.50000	-6.95000	17.00000	24.50000	-34.95000	17.00000	29	Yes	No
No 5-7 - B		24.45000	-35.45000	17.00000	24.45000	-35.00000	17.00000	10	Yes	No
No 5-7 - C		14.00000	-34.95000	17.00000	14.00000	-6.95000	17.00000	29	Yes	No

Displacement Grids

Name	Extrusion:	X1	Y1	Z1	X2	Y2	Z2	Intervals	Extrusion:	Extrusion:	Calculate Detailed
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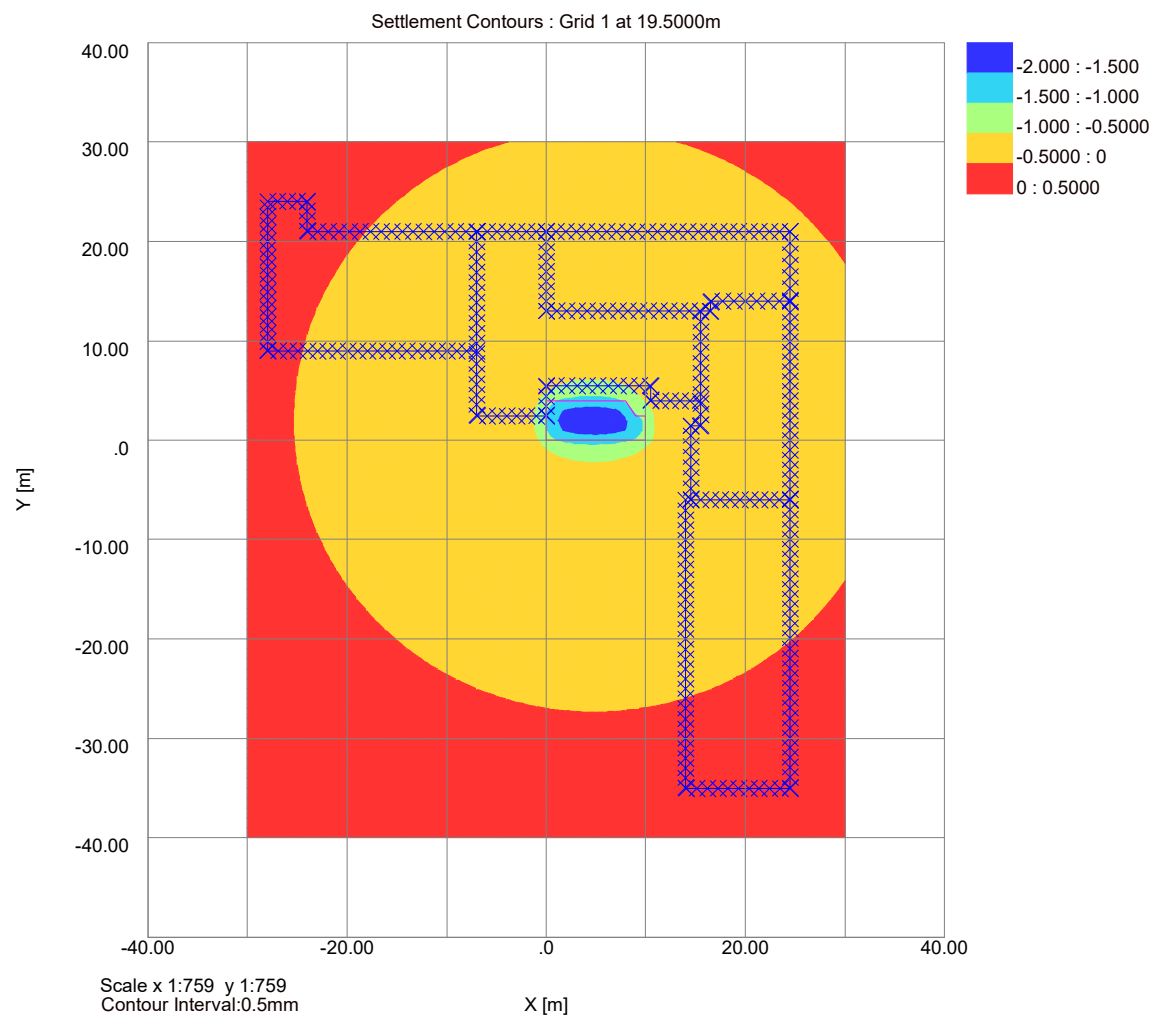


Proposed Chiller Plant Room, No 8 South Square
Ground Movement Assessment
Total heave

Job No.	Sheet No.	Rev.
J20048		
Drg. Ref.		
Made by MP	Date	Checked

Direction							Along Line [No.]	Distance [m]	Intervals Along [No.]	Results
		[m]	[m]	[m]	[m]	[m]				
Displacement Grid 1	Global X	-30.00000	-40.00000	19.50000	-	30.00000	19.50000	70	60.00000	60 Yes No
Displacement Grid 2	Global X	-30.00000	-40.00000	17.50000	-	30.00000	17.50000	70	60.00000	60 Yes No
Displacement Grid 3	Global X	-30.00000	-40.00000	16.50000	-	30.00000	16.50000	70	60.00000	60 Yes No

Job No.	Sheet No.	Rev.
J20048		
Drg. Ref.		
Made by MP	Date	Checked



Oasys

Proposed Chiller Plant Room, No 8 South Square

Ground Movement Assessment

RC Wall Installation

Job No.

Sheet No.

Rev.

J20048

Dr. Ref.

Made by

Date

Checked

MP

09-Mar-2020

Titles

Job No.:

J20048

Job Title:

Proposed Chiller Plant Room, No 8 South Square

Sub-title:

Ground Movement Assessment

Calculation Heading:

RC Wall Installation

Initials:

MP

Checker:

Date Saved:

09-Mar-2020

Date Checked:

Notes:

File Name:

XDispl.xdd

File Path:

G:\CURRENT\20-\J20048 - The Honourable Society of Gray's Inn\APPENDIX\GMA

History

Date

Time

By

Notes

09-Mar-2020

20:57

Matthew Penfold

New

09-Mar-2020

21:27

Matthew Penfold

10-Mar-2020

09:30

Matthew Penfold

Open

Displacement Lines

Ref.

Name

x1

y1

z1

x2

y2

z2

Intervals

Surface type for tunnels

Interpolate imported displacements

Calculate

[m]

[m]

[m]

[m]

[m]

[m]

[m]

[No.]

1

No 8 SS - A

-6.95000

2.50000

17.00000

-0.05000

2.50000

17.00000

7

Surface

No

Yes

2

No 8 SS - B

0.00000

2.55000

17.00000

0.00000

5.45000

17.00000

3

Surface

No

Yes

3

No 8 SS - C

0.05000

5.50000

17.00000

10.45000

5.50000

17.00000

10

Surface

No

Yes

4

No 8 SS - D

10.50000

5.45000

17.00000

10.50000

4.05000

17.00000

1

Surface

No

Yes

5

No 8 SS - E

10.55000

4.00000

17.00000

15.45000

4.00000

17.00000

5

Surface

No

Yes

6

No 8 SS - F

15.50000

12.95000

17.00000

15.50000

1.55000

17.00000

11

Surface

No

Yes

7

No 8 SS - G

15.45000

1.50000

17.00000

14.55000

1.50000

17.00000

1

Surface

No

Yes

8

No 8 SS - H

14.50000

1.45000

17.00000

14.50000

-5.95000

17.00000

7

Surface

No

Yes

9

No 8 SS / No 5-7 SS - I

14.55000

-6.00000

17.00000

24.45000

-6.00000

17.00000

10

Surface

No

Yes

10

No 8 SS - J

24.50000

-5.95000

17.00000

24.50000

13.95000

17.00000

20

Surface

No

Yes

11

No 8 SS / Chapel - K

24.45000

14.00000

17.00000

16.55000

14.00000

17.00000

7

Surface

No

Yes

12

No 8 SS / Chapel - L

16.50000

13.95000

17.00000

16.50000

13.05000

17.00000

1

Surface

No

Yes

13

No 8 SS / Chapel - M

16.45000

13.00000

17.00000

0.05000

13.00000

17.00000

16

Surface

No

Yes

14

No 8 SS / Chapel - N

0.00000

13.05000

17.00000

0.00000

20.95000

17.00000

8

Surface

No

Yes

15

No 8 SS - O

-0.05000

21.00000

17.00000

-6.95000

21.00000

17.00000

7

Surface

No

Yes

16

No 8 SS / Hall- P

-7.00000

20.95000

17.00000

-7.00000

2.55000

17.00000

18

Surface

No

Yes

17

Hall - A

-7.05000

9.00000

17.00000

-27.95000

9.00000

17.00000

21

Surface

No

Yes

18

Hall - B

-28.00000

9.05000

17.00000

-28.00000

23.45000

17.00000

17

Surface

No

Yes

19

Hall - C

-27.95000

24.00000

17.00000

-24.05000

24.00000

17.00000

4

Surface

No

Yes

20

Hall - D

-24.00000

23.95000

17.00000

-24.00000

21.05000

17.00000

3

Surface

No

Yes

21

Hall - E

-23.95000

21.00000

17.00000

-7.05000

21.00000

17.00000

16

Surface

No

Yes

22

Chapel - A

0.05000

21.00000

17.00000

24.45000

21.00000

17.00000

24

Surface

No

Yes

23

Chapel - B

24.50000

20.95000

17.00000

24.50000

14.05000

17.00000

6

Surface

No

Yes

24

No 5-7 SS - A

24.50000

-6.05000

17.00000

24.50000

-34.95000

17.00000

29

Surface

No

Yes

25

No 5-7 - B

24.45000

-35.00000

17.00000

14.05000

-35.00000

17.00000

10

Surface

No

Yes

26

No 5-7 - C

14.00000

-34.95000

17.00000

14.00000

-6.05000

17.00000

29

Surface

No

Yes

Displacement Grids

Ref.

Name

Extrusion: Direction

Base line start: X

Base line start: Y

Base line start: Z (level)

Base line end: X

Base line end: Y

Base line end: Z (level)

Base line: Intervals

Extrusion: Distance

Extrusion: Intervals

Surface type for tunnels

Calculate

[m]

[m]

[m]

[m]

[m]

[m]

[m]

[No.]

[m]

[No.]

1

Displacement Grid 1

Global X

-30.00000

-40.00000

19.50000

-

30.00000

19.50000

70

60.00000

60

Surface

Yes

2

Displacement Grid 2

Global X

-30.00000

-40.00000

17.50000

-

30.00000

17.50000

70

60.00000

60

Surface

Yes

3

Displacement Grid 3

Global X

-30.00000

-40.00000

16.50000

-

30.00000

16.50000

70

60.00000

60

Surface

Yes

Polygonal Excavations

Ref.

1

Excavation Name:

RC Wall Installation

Surface level [m]:

19.500

Contribution:

Positive

Surface movement curves which are selected are applied between surface and [m]:

17.000

Corner

x

y

Base Level

Arc Enabled

Stiffened

Prev. d

Prev. p1

Prev. p2*

Next. d

Next. p1

Next. p2*

[m]

[m]

[m]

[m]

[%]

[%]

[m]

[%]

[%]

1

0.0

0.0

16.500

Yes

No

-

-

-

-

-

-

2

10.000

0.0

16.500

Yes

No

-

-

-

-

-

-

3

10.000

2.5000

16.500

Yes

No

-

-

-

-

-

-

4

9.0000

2.5000

16.500

Yes

No

-

-

-

-

-

-

5

8.0000

4.0000

16.500

Yes

No

-

-

-

-

-

-

6

0.0

4.0000

16.500

Yes

No

-

-

-

-

-

-

Side

x1

y1

x2

y2

G.M. Curve: Vertical

G.M. Curve: Horizontal

[m]

[m]

[m]

[m]

1

0.0

0.0

10.000

0.0

Inst. of planar diaphragm wall in stiff clay (CIRIA C760 Fig. 6.9(b))

Inst. of planar diaphragm wall in stiff clay (CIRIA C760 Fig. 6.9(a))

2

10.000

0.0

10.000

2.5000

No vertical ground movement

No horizontal ground movement

3

10.000

2.5000

9.0000

2.5000

No vertical ground movement

No horizontal ground movement

4

9.0000

2.5000

8.0000

4.0000

No vertical ground movement

No horizontal ground movement

5

8.0000

4.0000

0.0

4.0000

No vertical ground movement

No horizontal ground movement

6

0.0

4.0000

0.0

0.0

No vertical ground movement

No horizontal ground movement

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

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Printed 10-Mar-2020

Time 09:30



Proposed Chiller Plant Room, No 8 South Square
Ground Movement Assessment
RC Wall Installation

Job No.	Sheet No.	Rev.
J20048		
Drg. Ref.		
Made by MP	Date 09-Mar-2020	Checked

Side	x1 [m]	y1 [m]	x2 [m]	y2 [m]	G.M. Curve: Vertical	G.M. Curve: Horizontal
y Order:				0		
Polynomial: z =				0.0x + 0.0		
Coeff. of Determination:						
Curve Name:	Inst. of planar diaphragm wall in stiff clay (CIRIA C760 Fig. 6.9(b))					
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) (%)]					
	[0.000,0.000,0.050][0.050,0.000,0.047][0.100,0.000,0.043][0.150,0.000,0.040] [0.200,0.000,0.037][0.250,0.000,0.034][0.300,0.000,0.031][0.350,0.000,0.028] [0.400,0.000,0.025][0.450,0.000,0.022][0.500,0.000,0.020][0.550,0.000,0.018] [0.600,0.000,0.015][0.650,0.000,0.013][0.700,0.000,0.012][0.750,0.000,0.010] [0.800,0.000,0.008][0.850,0.000,0.007][0.900,0.000,0.006][0.950,0.000,0.005] [1.000,0.000,0.004][1.050,0.000,0.003][1.100,0.000,0.003][1.150,0.000,0.002] [1.200,0.000,0.002][1.250,0.000,0.001][1.300,0.000,0.001][1.350,0.000,0.001] [1.400,0.000,0.001][1.450,0.000,0.000][1.500,0.000,0.000]					
Curve Fitting Method:	Polynomial					
x Order:	4					
y Order:	0					
Polynomial: z =	-1.2355E-2x ⁴ + 3.4814E-2x ³ - 2.8885E-3x ² - 6.5618E-2x + 4.9987E-2					
Coeff. of Determination:	1.0000					

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:	
Curve Name:	Inst. of planar diaphragm wall in stiff clay (CIRIA C760 Fig. 6.9(a))
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) (%)]
	[0.000,0.000,0.050][1.500,0.000,0.000]
Curve Fitting Method:	Polynomial
x Order:	1
y Order:	0
Polynomial: z =	-3.33E-2x + 5.00E-2
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

Specific Buildings - Geometry

Ref.	Building Name	Sub-Building Name	Displacement Line	Distance Along Line: Start	Distance Along Line: End	Vertical Offsets from Line for Vertical Movement Calculations [m]	Vertical Displacement Limit Sensitivity [mm]	Damage Category Strains	Poisson's Ratio	E/G
1	No 8 South Square	A	No 8 SS - A	0.00000	6.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
2	No 8 South Square	B	No 8 SS - B	0.00000	2.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
3	No 8 South Square	C	No 8 SS - C	0.00000	10.39900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
4	No 8 South Square	D	No 8 SS - D	0.00000	1.40000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
5	No 8 South Square	E	No 8 SS - E	0.00000	4.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
6	No 8 South Square	F	No 8 SS - F	0.00000	11.39900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
7	No 8 South Square	G	No 8 SS - G	0.00000	0.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
8	No 8 South Square	H	No 8 SS - H	0.00000	7.40000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
9	No 8 South Square / No 5-7 South Square	I	No 8 SS / No 5-7 SS - I	0.00000	0.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
10	No 8 South Square	J	No 8 SS - J	0.00000	19.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
11	No 8 South Square / Chapel	K	No 8 SS / Chapel - K	0.00000	7.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
12	No 8 South Square / Chapel	L	No 8 SS / Chapel - L	0.00000	0.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
13	No 8 South Square / Chapel	M	No 8 SS / Chapel - M	0.00000	16.40000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
14	No 8 South Square / Chapel	N	No 8 SS / Chapel - N	0.00000	7.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
15	No 8 South Square	O	No 8 SS - O	0.00000	2.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
16	No 8 South Square / Hall	P	No 8 SS / Hall- P	0.00000	18.40000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
17	Hall	A	Hall - A	0.00000	20.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
18	Hall	B	Hall - B	0.00000	14.39900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
19	Hall	C	Hall - C	0.00000	3.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
20	Hall	D	Hall - D	0.00000	2.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
21	Hall	E	Hall - E	0.00000	16.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
22	Chapel	A	Chapel - A	0.00000	24.40000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
23	Chapel	B	Chapel - B	0.00000	6.89900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
24	No 5-7 South Square	A	No 5-7 SS - A	0.00000	28.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
25	No 5-7 South Square	B	No 5-7 - B	0.00000	10.39900	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
26	No 5-7 South Square	C	No 5-7 - C	0.00000	28.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

Specific Buildings - Bending Parameters

Ref.	Building Name	Sub-Building Name	Height	Default	Hogging: 2nd Mom. of Area (per unit width)	Hogging: Dist. of Bending Strain from N.A.	Hogging: N.A. from Edge of Beam in Tension [m]	Sagging: 2nd Mom. of Area (per unit width)	Sagging: Dist. of Bending Strain from N.A.	Sagging: N.A. from Edge of Beam in Tension [m]
			[m]		[m ³]	[m]	[m]	[m ³]	[m]	[m]
1	No 8 South Square	A	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
2	No 8 South Square	B	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
3	No 8 South Square	C	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
4	No 8 South Square	D	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
5	No 8 South Square	E	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
6	No 8 South Square	F	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
7	No 8 South Square	G	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
8	No 8 South Square	H	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
9	No 8 South Square / No 5-7 South Square	I	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
10	No 8 South Square	J	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
11	No 8 South Square / Chapel	K	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
12	No 8 South Square / Chapel	L	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
13	No 8 South Square / Chapel	M	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
14	No 8 South Square / Chapel	N	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
15	No 8 South Square	O	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
16	No 8 South Square / Hall	P	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
17	Hall	A	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
18	Hall	B	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
19	Hall	C	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000



Proposed Chiller Plant Room, No 8 South Square
Ground Movement Assessment
RC Wall Installation

Job No. Sheet No. Rev.

J20048

Drg. Ref.

Made by
MP

Date
09-Mar-2020

Checked

Ref.	Building Name	Sub-Building Name	Height	Default	Hogging:	Hogging:	Hogging:	Sagging:	Sagging:	Sagging:
					2nd Mom. of Area	Dist. of Bending	Dist. of N.A. from	2nd Mom. of Area	Dist. of Bending	Dist. of N.A. from
20 Hall		D	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
21 Hall		E	10.000	Yes	333.33	10.000	10.000	83.333	5.0000	5.0000
22 Chapel		A	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
23 Chapel		B	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
24 No 5-7 South Square		A	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
25 No 5-7 South Square		B	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000
26 No 5-7 South Square		C	13.000	Yes	732.33	13.000	13.000	183.08	6.5000	6.5000