

14 December 2011

Our ref: J11081/HD/2



Tyttenhanger House  
Coursers Road  
St Albans  
AL4 0PG

tel 01727 824666  
fax 01727 824777  
email mail@gea-ltd.co.uk  
web www.gea-ltd.co.uk

Helen Page  
Price and Myers  
30 Newman Street  
London  
W1T 1LT

Dear Helen

**Re: 15-17 MACKLIN STREET, LONDON**

Further to your instruction dated 15 September 2011, we have now completed our ground movement analysis, with regard to the proposed redevelopment of the site, which is understood to comprise the construction of an additional storey to the existing three-storey building at No 17 Macklin Street. In addition, there will be a new roof and some internal alterations to both Nos 15 and 17 Macklin Street, including new columns and lowering of the ground floor slab by approximately 600 mm if the existing foundations allow.

The analysis has been conducted on the basis of the information provided and we have modelled the ground movements that may occur as a result of the loads that have been provided for the proposed development.

Please refer to report ref J11081, issue 2, dated 22 June 2011, for information not superseded by this letter.

The comments made in this letter are limited to those that can be made on the basis of the information available. Our comments should be viewed in the context of the range of data sources consulted and no liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

The following points summarise the results of the analysis and provide advice on the most appropriate course of action. Further details of the analyses can be provided on request.

### **1.0 Exploratory Work**

Our investigation comprised four window sampler boreholes, advanced from ground level to a maximum depth of 5.0 m and a single borehole was advanced through the base of Trial Pit No 5 to a depth of 3.4 m with electrical equipment. Dynamic probing was carried out in positions adjacent to Borehole Nos 1 to 4 and through the base of Trial Pit No 11 to obtain information on the density of the soil, to a maximum depth of 3.9 m. In addition to the boreholes and dynamic probes, twelve hand-dug trial pits were initially excavated by a third party to expose the existing foundations to depths of between 0.83 m and 2.24 m. Nine of the twelve trial pits were subsequently deepened by GEA to depths of between 1.85 m and 3.10 m to provide the required information. A further trial pit has since been excavated and logged by a third party and a copy of the trial pit record has been provided by yourself and indicates that Area F is founded at a depth of 2.47 m bearing on what appears to be Langley Silt from the description.



Our investigation has been supplemented by the consulting engineers who provided a copy of the borehole record (ref; TQ385SW3596), carried out by Foundation and Exploration Services in April 1992, on behalf of Crossrail on the street outside of No 13 Macklin Street. A copy of the borehole record is appended.

## 2.0 Ground Conditions

The investigation encountered a significant thickness of made ground underlain by the Langley Silt, overlying the Lynch Hill Gravel, which was proved to the maximum depth of sampling at 5.0 m. The made ground extended to depths of between 2.1 m and 3.0 m and typically comprised brown silty sandy gravelly clay with fragments of brick, ash, plastic, glass and concrete. The underlying Langley Silt was only recorded in Borehole Nos 1 and 3, to a depth of 2.9 m, and comprised firm light orange-brown silty sandy clay with occasional fine to medium subangular to subrounded flint gravel. The Lynch Hill Gravel generally comprised light orange-brown fine to medium sand and fine to coarse angular to subrounded flint gravel.

Dynamic probe tests carried out adjacent to the boreholes indicate that the Lynch Hill Gravel is initially medium dense rapidly becoming very dense. The density of the gravel prevented further sampling of this stratum and dynamic probing could not penetrate below a depth of 3.9 m.

Groundwater was encountered during the investigation in Borehole No 2 only at a depth of 4.0 m from within the Lynch Hill Gravel.

A cable percussive borehole was drilled by Foundation and Exploration Services to the southwest of the site on Macklin Street and was advanced to a depth of 35.0 m and encountered the expected ground conditions. The made ground extended to a depth of 2.05 m, which in turn was underlain by Lynch Hill Gravel to a depth of 6.1 m, underlain by the London Clay which extended to a depth of 32.8 m, overlying the Lambeth Group, which was proved the maximum depth investigated. In-situ standard penetration tests (SPTs) were carried out in the borehole and the results are shown on the borehole log.

## 3.0 Outline of Foundation Design Proposals

Our investigation indicated that the existing foundations comprise a range of strip footings and pad foundations bearing on made ground or Langley Silt at depths of between 0.80 m and 3.00 m, understood to be supporting loads that range from approximately 105 kN/m to 421 kN/m, applying pressures of between 96 kN/m<sup>2</sup> and 384 kN/m<sup>2</sup>.

It is proposed to use the existing foundations and to add three new columns, to support new loads of between 127 kN/m to 319 kN/m, applying pressures of between 90 kN/m<sup>2</sup> and 420 kN/m<sup>2</sup>.

It is understood that the main alterations to the current foundations will take place in No 17 Macklin Street, specifically to the northern, eastern southern and western boundary walls, central columns and eastern internal wall. In No 15 Macklin Street, a central column will be constructed and there will be main alterations to the southern boundary wall.

The assumed existing and proposed new pressures are detailed in the table below.

Area	Assumed existing pressures (kN/m <sup>2</sup> )	Proposed new pressures (kN/m <sup>2</sup> )	Change in pressures (kN/m <sup>2</sup> )
A	380	272	-108
H	96	90	-6
K	324	215	-109
D	122	164	+42
J	384	450	+66
I	97	117	+20
B	344	420	+76

Area	Assumed existing pressures (kN/m <sup>2</sup> )	Proposed new pressures (kN/m <sup>2</sup> )	Change in pressures (kN/m <sup>2</sup> )
L	187	210	+23
G	206	249	+43
F	172	222	+50

The layout of the foundations with respect to the footprint of the proposed building is shown on the attached plan and the walls are numbered areas A to L in order to aid with the illustration of the results below. Areas C and D have been combined as have Areas F and G for the purpose of the analyses. The analysis has assumed that No 15 and No 17 are rectangular in shape.

The assumed soil profile used in the analysis has assumed that the made ground extends to a depth of 2.5 m, whilst the Langley Silt extends to a maximum depth of 3.0 m, underlain the Lynch Hill Gravel to a depth of 6.0 m, overlying the London Clay, which is assumed to extend to a depth of 30 m, underlain by the Lambeth Group.

Area	Trial Pit Nos	Founding Depth (m)	Bearing Stratum
A	12	1.71	Made Ground
B	10	0.82	Made Ground
C / D	1 and 2	2.5	Langley Silt
F / G	5 and 13	2.47	Langley Silt
H	12	1.8	Made Ground
I	8	3.0	Langley Silt
J	3	3.0	Made Ground?
K	11	2.5	Langley Silt
L	7	2.15	Langley Silt

On the basis of the trial pit findings it has been assumed for the analyses that Area J is founded on Langley Silt. Information from Trial Pit No 3 indicates that the existing foundation of the northern elevation of No 17 Macklin Street is apparently bearing on made ground at a depth of 3.0 m. However, space in this pit was very constricted and Borehole No 2, drilled approximately 2.0 m to the southeast of this trial pit encountered Lynch Hill Gravel at a depth of 2.9 m. The foundation, if it is bearing on made ground, is therefore likely to be very close to the top of the Lynch Hill Gravel.

During site works Trial Pit Nos 2 was terminated at depth of 0.80 m due to an internal wall that obscured access and prevented further progress. Therefore it is assumed for this analyses that the wall is founded at a depth of 2.5 m on Langley Silt based on the findings of Trial Pit No 1.

Trial Pit Nos 5 and 13 indicate that the southern boundary wall of Nos 15 and 17 Macklin Street is founded at depths of 2.47 m and 2.85 m bearing on Langley Silt. For the analysis these areas have been combined and a founding depth of 2.47 m has been assumed.

Trial Pit No 11 was terminated at a depth of 1.62 m due to an internal wall that obscured access and prevented further progress. Information obtained from Trial Pit No 13 indicates that Area K is founded at a depth of 2.5 m apparently bearing on Langley Silt.

Three trial pits were excavated along Area H and the wall is bearing on made ground at depths of 0.82 m and 1.8 m encountered in Trial Pit Nos 10 and 12 respectively and in Trial Pit No 9 the wall was found to be bearing on Langley Silt at a depth of 2.22 m. The analysis for this wall has been calculated for the worst case scenario.

Trial Pit No 10 indicated that the wall of Area B was founded on made ground at the location investigated. In view of the proposed pressure increase it will be underpinned to a depth of about 3.0 m to bear within the Lynch Hill Gravel and the analysis has been carried out on this basis.

## 4.0 Basis of Analyses

Our analyses of ground movements have been carried out on the basis of assuming that the soils behave elastically, which provides a reasonable approximation to soil behaviour at small strains. A Boussinesq analysis is used to determine stresses at depth as a result of surface loading and unloading. The soil mass is divided into a number of layers, allowing movements at various depths to be identified.

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at the site are based on information from our previous ground investigation, completed in June 2011 and the borehole record provided by the consulting engineer, carried out by Foundation and Exploration Services in April 1992, on behalf of Crossrail. The SPT 'N' Values have been plotted on a graph and included in the appendix. Relationships of  $E_u = 500 C_u$  and  $E' = 300 C_u$  for the cohesive soils and  $2000 \times \text{SPT 'N'}$  for granular soils have been used to obtain values of Young's modulus. Drained and undrained parameters have been used throughout, to provide an estimate of the total 'long term' and 'short term' movements respectively.

## 4.1 Ground Movements

### 4.1.1 Settlement

On the basis of this analysis, the following table shows the anticipated short term and total settlement of different areas of the existing foundations when subject to the additional new loads proposed.

Area	Pressure Increase (kN/m <sup>2</sup> )	Immediate Settlement (mm)	Total Settlement (mm)
B	+76	< 5	< 5
C/D	+42	< 5	5
F/G	+50	< 5	5
I	+20	< 5	< 5
J	+66	< 5	5
L	+23	< 5	5

For the values given in the above table, a roughly +/- 20% margin of error would be a reasonable assumption. The analyses have not taken into account the fact the ground has previously been loaded by the existing building and these values are, therefore, conservative.

The maximum overall settlement has been calculated to be no more than 5 mm in total, based on the approximated foundation stresses provided not being exceeded.

In our report (ref; J11081 issue 2, dated 22 June 2011 we recommended that new moderately sized spread foundations bearing in the medium dense to very dense sand and gravel of the Lynch Hill Gravel at a minimum depth of 0.75 m may be designed to apply a net allowable bearing pressure of 250 kN/m<sup>2</sup>. The investigation has indicated a significant thickness of made ground and spread foundations may have to extend to a depth of about 3.0 m to found within the Lynch Hill Gravel. The predicted settlements for the new pad foundations (1 m x 1 m) have been calculated to be no more than 5 mm in total.

A check has been made and the increase in pressures associated with the new additional load will not overstress the underlying London Clay.

#### 4.1.2 Heave

Where there is a reduction in load, some heave of the underlying soils will occur, which will comprise an "immediate" elastic component that may be expected to occur within the construction period, together with long term swelling movement that would theoretically occur over a period of many years.

Area	Pressure Reduction (kN/ m <sup>2</sup> )	Immediate Heave (mm)	Total Heave (mm)
A	-108	<5 to 10	5 to 20
H	-6	< 5	5 to 10
K	-109	< 5	5

The greatest amount of heave has been calculated to be up to about 20 mm in the centre of Area A where there is a pressure decrease of 108 kN/m<sup>2</sup>.

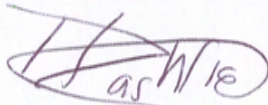
The unloading is sufficient to cause heave where Area A meets Area B. Similarly, where Area A meets Area F and Area K meets Area F / G. The overall heave has been calculated to be up to about 5 mm.

#### 5.0 Conclusions

On the basis of the analyses the ground movements associated with the loading and unloading should remain within tolerable limits for the proposed redevelopment of the site.

We trust that this information is sufficient for your present requirements.

Yours sincerely  
 GEOTECHNICAL & ENVIRONMENTAL ASSOCIATES



Hannah Dashfield

*Encs*

**RECORD OF BOREHOLE No: RT30**

START DATE: 13/4/92

CASING DETAILS: 200 mm to 7.75 m  
mm to m

SHEET 1 OF 4

DRILLING METHOD: CABLE PERCUSSION

BOREHOLE DIA: 200 mm to 35.00 m  
mm to m

LOCAL GRID CO-ORDINATES:  
E...807001..... N...360791.....  
GROUND LEVEL 122.94 m LULID

EQUIPMENT: DANDO 175

Date & Time	Casing Depth (m)	Depth to Water (m)	SAMPLE			U100 Blows	U100 Rec.(m)	DESCRIPTION OF STRATA	Depth (Thickness) (m)	Level (m LULID)	Strata Symbol
			Depth (m) At/From	To	Type						
13/4	NIL	DRY						MADE GROUND: Tarmac/adn.	0.10 (0.10)	122.84	
			0.50	1.00	B	1	MADE GROUND: Light grey, gravelly, reinforced concrete.	0.25	122.69		
			1.50	2.00	B	2	MADE GROUND: Very loose to loose, fine to coarse gravel size brick fragments in much silty gravelly fine to coarse assorted sand matrix.	(1.25)			
			1.50	2.00	B	3	MADE GROUND: Soft, grey, silty, very sandy (fine to coarse) clay with much assorted fine to coarse gravel including brick fragments.	1.50	121.44		
			2.25	3.00	D	4	Soft to firm, greyish-brown, silty, sandy (fine to coarse) CLAY with some to much subangular to subrounded, flint gravel.	2.05	120.89		
			2.45	3.00	B	5	(ALLUVIUM) Below 2.50m Becoming light brown mottled reddish-brown, fine and medium, occasional coarse, gravel.	(1.20)			
			3.45	4.00	B	7	Dense, light brown, medium and occasional coarse SAND and fine and medium, occasional coarse, angular to subrounded, flint GRAVEL. (THAMES TERRACE GRAVEL)	3.25	119.69		
			4.40	5.00	B	8		(2.85)			
			5.45	6.00	B	10	Below 5.50m Becoming a gravelly sand with no coarse gravel.				
			6.20	6.50	U	12	Stiff, brown, silty CLAY. (LONDON CLAY)	6.10 (0.40)	116.84		
			7.00	7.00	D	13	Stiff, very closely to closely fissured, brownish-grey, silty CLAY. (LONDON CLAY)	6.50	116.44		
			7.75	8.00	D	14	From 8.00m to 10.00m Becoming silty to very silty.				
			7.75	9.50	U	15					
						16					

REMARKS: 1) An inspection pit for services was dug prior to boring to a depth of 1.50m (4hrs) encountering a brick foundation surrounding brick fill.  
2) Water was added to assist boring and to maintain hydrostatic head from 3.25m to 6.00m depth.  
3) Groundwater was encountered as a strike at 4.60m depth rising to 4.50m depth after 20 minutes.  
4) Standard penetration tests were carried out using BWY drive rods.  
5) On completion of the borehole, a piezometer was installed with the tip at 18.25m, and the hole backfilled with the following detail:  
Bentonite/cement grout 35.00m to 19.50m; bentonite seal 19.50m to 18.50m; sand filter response zone 18.50m to 17.50m; bentonite seal 17.50m to 16.50m; bentonite/cement grout 16.50m to 1.00m stopcock cover set in concrete 1.00m to ground level.

SCALE 1:50

Logged by	Date
NWH	15/4
Checked by	
SCL	ZS/G
Approved by	
JMC	S/P

FOUNDATION & EXPLORATION SERVICES	CRDSSRAIL PACKAGE C CHARING CROSS ROAD TO ALDERSGATE STREET	CONTRACT No. 2165
		FIGURE: A

# RECORD OF BOREHOLE No: RT30

START DATE: 13/4/92

CASING DETAILS: 200 mm to 7.75 m  
mm to m

SHEET 2 OF 4

DRILLING METHOD: CABLE PERCUSSION

BOREHOLE DIA: 200 mm to 35.00 m  
mm to m

LOCAL GRID CO-ORDINATES:  
E...80700.1... N 36079.1...  
GROUND LEVEL 122.94...m.LULID

EQUIPMENT: DANDD 175

Date & Time	Casing Depth (m)	Depth to Water (m)	SAMPLE				U100 Rec.(m)	U100 SPT Blows /N	DESCRIPTION OF STRATA	Depth (Thickness) (m)	Level (m.LULID)	Strata Symbol	
			Depth (m)		Type	No.							Test Length (mm)
			At/From	To									
					D	16		(Continued from Sheet 1)					
	7.75	DRY	10.50		D	17	17	(LONDON CLAY)					
	7.75	DRY	11.00		U	18	42						
	7.75	DRY	11.50		D	19	48						
	7.75	DRY	12.00		U	20	40	From 12.00m to 17.50m With occasional partings of silt.					
	7.75	DRY	12.50		D	21	45						
	7.75	DRY	12.50		U	22	40						
	7.75	DRY	13.00		D	23	45						
	7.75	DRY	13.00		U	24	40						
	7.75	DRY	13.50		D	25	45						
	7.75	DRY	13.50		U	26	45						
	7.75	DRY	14.00		D	27	41	At 14.00m Locally very stiff.					
	7.75	DRY	14.00		U	28	42						
	7.75	DRY	14.50		D	29	42						
	7.75	DRY	14.50		U	30	44						
	7.75	DRY	15.00		D	31	39						
	7.75	DRY	15.00		U	32	55	From 16.57m TO 16.61m With a cobble of light brown CLAYSTONE.					
	7.75	DRY	15.50		D	33	38						
	7.75	DRY	15.50		U	34	42						
	7.75	DRY	16.00		D	35	42						
	7.75	DRY	16.00		U	36	40						
	7.75	DRY	16.50		D	37	43						
	7.75	DRY	16.50		U	38	42						
	7.75	DRY	17.00		D	39	38						
	7.75	DRY	17.00		U	40	42						
	7.75	DRY	17.50		D	41	43						
	7.75	DRY	17.50		U	42	40	At 18.00m Locally thinly laminated.					
	7.75	DRY	18.00		D	43	43						
	7.75	DRY	18.00		U	44	40						
	7.75	DRY	18.50		D	45	43	From 18.50m to 18.59m With a cobble of light brown CLAYSTONE.					
	7.75	DRY	18.50		U	46	38						
	7.75	DRY	19.00		D	47	45						
	7.75	DRY	19.00		U	48	40						
	7.75	DRY	19.50		D	49	45	From 19.50m to 20.50m Becoming very closely fissured.	(26.30)				
	7.75	DRY	19.50		U	50	42						
	7.75	DRY	20.00		D	51		(Continued on Sheet 3)					
	7.75	DRY	20.00		U	52							

REMARKS:

Logged by	NWH	Date	15/4
Checked by	SCL		25/6
Approved by	JMC		5/9

SCALE 1:50

**FOUNDATION & EXPLORATION SERVICES**

CROSSRAIL PACKAGE C  
CHARING CROSS ROAD  
TO ALDERSGATE STREET

CONTRACT No. 2165

FIGURE: A







START DATE: 13/4/92	<b>RECORD OF BOREHOLE No: RT30</b>	SHEET 4 OF 4
DRILLING METHOD: CABLE PERCUSSION	CASING DETAILS: 200 mm to 7.75 m mm to m	LOCAL GRID CO-ORDINATES: E...887001... N...360791...
EQUIPMENT: DANDO 175	BOREHOLE DIA: 200 mm to 35.00 m mm to m	GROUND LEVEL 122.94 m LULUD

Date & Time	Casing Depth (m)	Depth to Water (m)	SAMPLE			U100 Test Length (mm)	U100 Rec. (m)	DESCRIPTION OF STRATA	Depth (Thickness) (m)	Level (m LULUD)	Strata Symbol
			Depth (m) To	Type	No.						
	7.75	DRY	30.00	D	72		S 56	(Continued from Sheet 3) (LONDON CLAY)			
	7.75	DRY	31.50	U	73		48				
			32.00	D	74						
	7.75	DRY	33.00	D	75	180	S 50	Very stiff, closely fissured, greyish-brown slightly mottled light bluish-grey, silty CLAY.  (WOOLWICH AND READING BEDS - UPPER MOTTLED CLAY)	32.80	90.14	
	7.75	DRY	34.50	U	76		70		(2.20)		
14/4	7.75	DRY	35.00	D	77			END OF BOREHOLE	35.00	87.94	

REMARKS:	Logged by	Date
	N/H	15/4
	Checked by	
	SCL	25/6
	Approved by	
	<i>JMC</i>	3/7

<b>FOUNDATION &amp; EXPLORATION SERVICES</b>	CROSSRAIL PACKAGE C CHARING CROSS ROAD TO ALDERSGATE STREET	CONTRACT No. 2165  FIGURE: A
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Geotechnical &  
Environmental  
Associates

Tythenhanger House  
Coursers Road  
St Albans  
Herts AL4 0PG

### SPT & Cohesion / Depth Graph

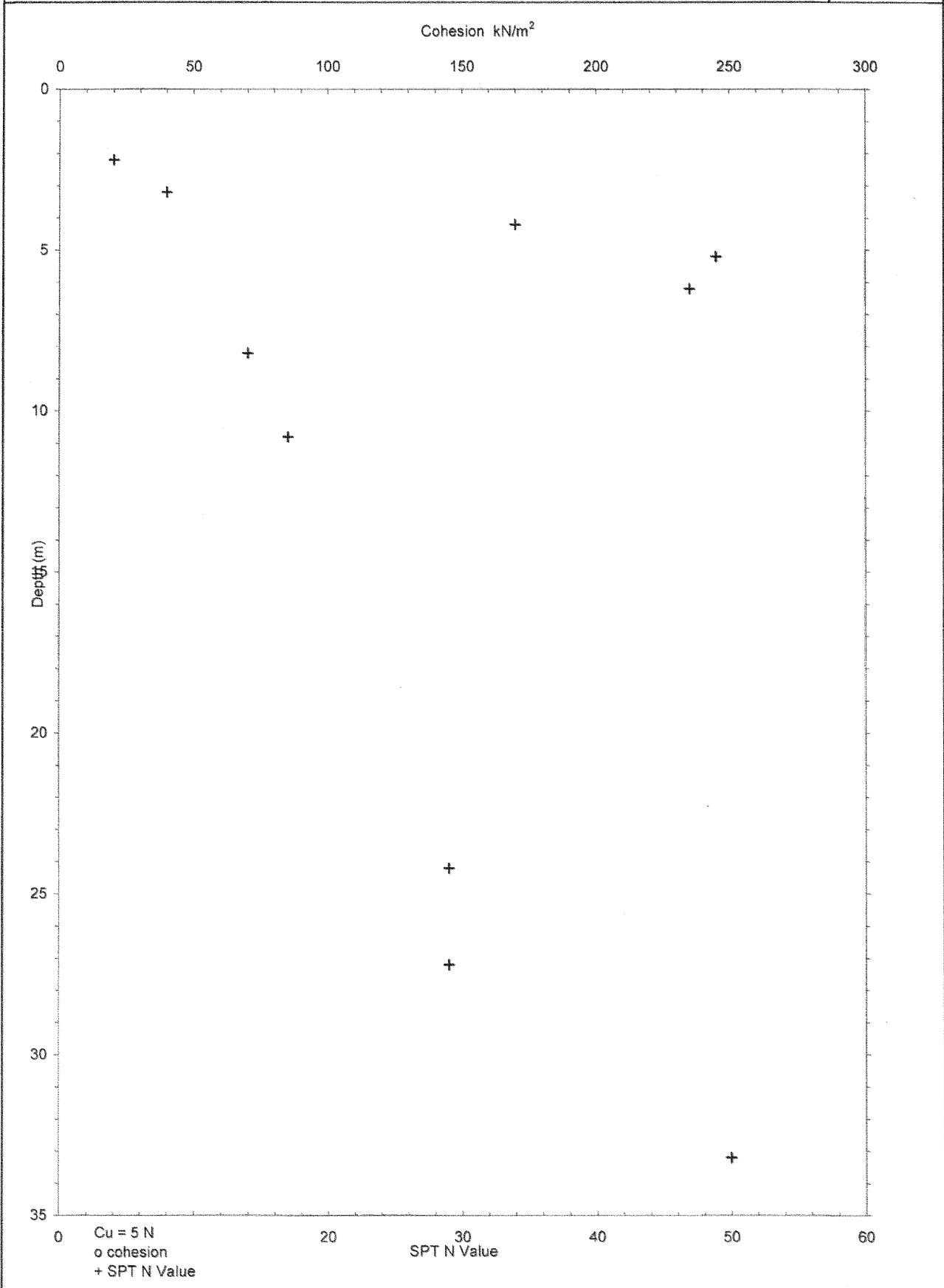
Site 15-17 Macklin Street, London, WC2B 5NG

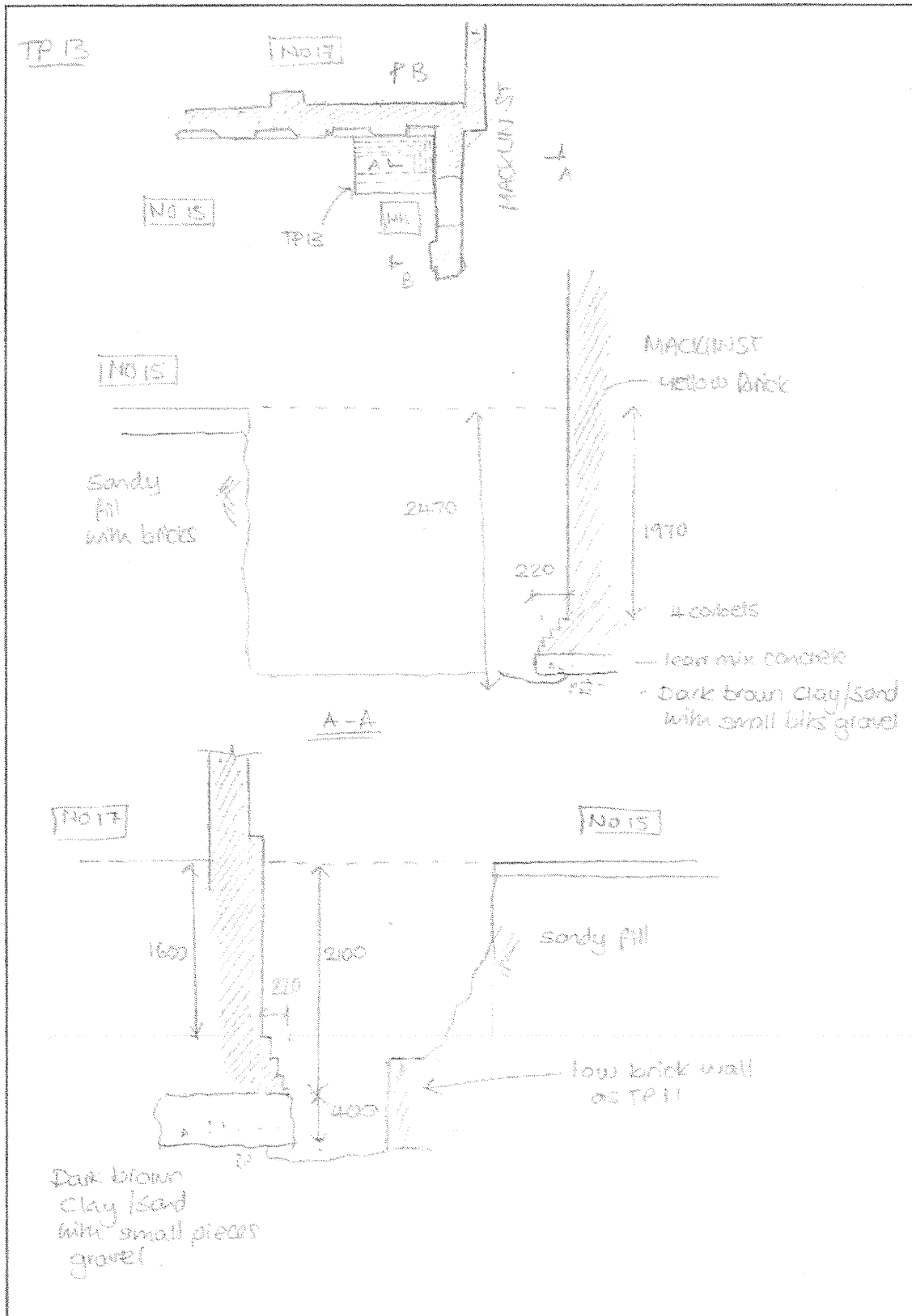
Client Durley Investment Corporation

Engineer Price and Myers

Job Number  
J11081

Sheet  
1 / 1





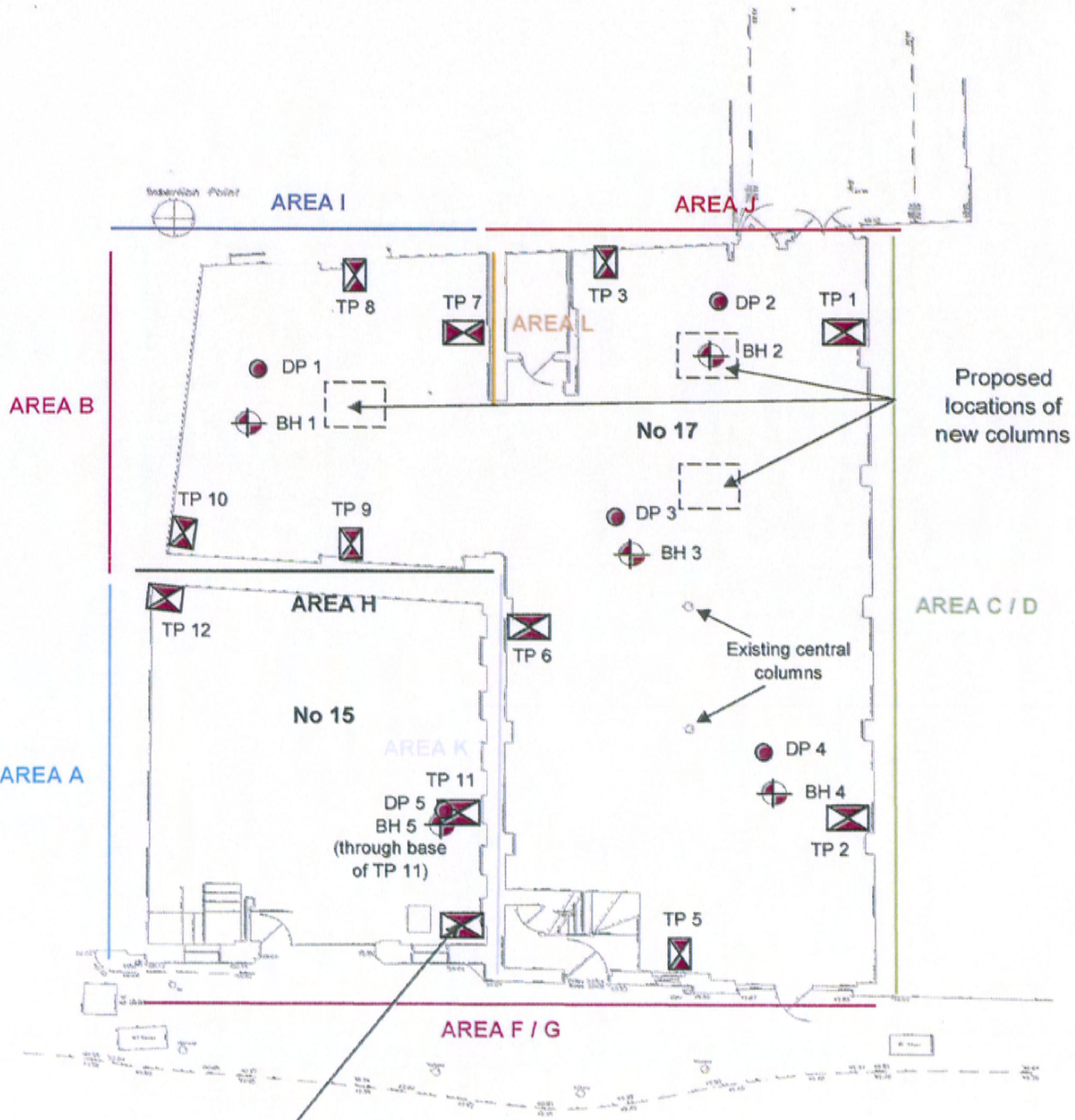
Site 15-17 Macklin Street, London, WC2B 5NG

Job Number  
J11081

Client Durley Investment Corporation

Sheet  
1 / 1

Engineer Price and Myers



Location of TP No 13:  
excavated and logged  
by third party

Note to Scale