12-14 Greville Street

Structural Calculations for Crossrail submission

Contents: Pages

Version

Section	Ver	Date	Pages Deleted	Pages Amended	Pages Added	Notes
All	1	04/03/2019				First Issue
1	2	21/03/2019		1		Incorporate comments from Crossrail

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Job Number: 23327

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Introduction

These calculations are in relation to Section 3.8, Compliance Criteria B in 'Crossrail: A technical guidance for developers' document dated December 2016. Compliance Criteria B requires 'Evidence that Surcharge Loading or transferred pile loads imposed on Crossrail assets is < 50kPa'. These calculations contain an existing load take down of the current buildings at 12-14 Greville Street based on assumptions on what we know about the buildings. This is followed by a load take down on the current proposals. For both load take downs an average pressure is calculated at invert level of the proposed raft (13.48mOD) to compare the existing and proposed surcharges at the Crossrail tunnel.

Version 2

The imposed loads have been reduced in accordance with BS6399-1:1996 table 2. The existing buildings are five storeys and the proposed building is six storeys, so both imposed loads have been reduced by 40%.

Summary Table

	Existing Loads	Proposed Loads
Dead Load	32.2kN/m^2	68.6kN/m^2
Imposed Load with reduction	9.8kN/m^2	15.0kN/m^2
Soil	-	-14.8kN/m^2
Total	42.0kN/m^2	68.8kN/m^2

The surcharge of the proposed development is higher than the existing, but the proposed surcharge is <75kN/m^2, which is generally accepted.

EXISTING LOADS - 12/13 GREVILLE STREET

PLAN AREA = 94.6 m²

- ROOF ASSUMED LOADS (Ex 1)

SLATES, BATTENS, FELT	0.55	kN/m²
TIMBER RAFTERS / INSULATION	0.2	kN/m²
CEILING / SERVICES	0.15	kN/m²
	Σ = 0.9	kN/m²
SNOW	0.6	kN/m²

DL = 85.14 kN LL = 56.76 kN.

- TYPICAL FLOOR ASSUMED LOADS. (Ex 2)

TIMBER BOARDS / PLY	0.15	kN/m²
TIMBER JOISTS	0.2	kN/m²
CEILING / SERVICES	0.15	kN/m²
	Σ = 0.5	kN/m²
IMPOSED LOAD (OFFICE)	= 2.5 + 1	
	= 3.5	kN/m²

DL = 47.3 kN LL = 331.1 kN.

- EXISTING MASONRY WALLS (Ex 3)

$\ell = 15.2\,m + 7.5\,m + 6.5\,m + 8.0\,m.$
$= 37.2\,m$

MASONRY WALLS 550 @ GROUND, 350 @ ROOF
ASSUME AN AVERAGE OF 450 mm, h = 17m

TOTAL WEIGHT = $37.2m \times 17m \times 20\ kN/m^3 \times 0.45m$
= 5691.6 kN

- BASEMENT FLOOR (Ex4)

50 SCREED	1.2	kN/m²
INSULATION	0.1	kN/m²
100 RC SLAB	2.5	kN/m²
	Σ = 3.8	kN/m²

(+ GF @ REAR, A = 52 m²) IMPOSED LOAD (OFFICE) = 2.5 · 1
= 3.5 kN/m²

DL = 557.1 kN LL = 513.1 kN.

- TOTAL DL = 85.1 + 5×47.3 + 5691.6 + 557
= 6570.2 kN.

TOTAL LL = 56.8 + 5 × 331.1 + 513.1
= 2225 kN.

EXISTING LOADS – 14 GREVILLE STREET

- ROOF (Ex5)

PLAN AREA = 246 m²

LOADING

ASHPHALT WATERPROOFING	0.45	kN/m²
TIMBER JOISTS / INSULATION	0.15	kN/m²
STEELWORK	0.5	kN/m²
CEILING SERVICES	0.15	kN/m²
	Σ = 1.25	kN/m²
SNOW / ACCESS	0.75	kN/m²

DL = 307.5 kN LL = 184.5 kN.

- TYPICAL FLOORS (E6)

50 SCREED	1.2	kN/m²
150 SLAB / PLANKS	3.7	kN/m²
STEELWORK	0.5	kN/m²
CEILING / SERVICES	0.15	kN/m²

Σ = 5.6 kN/m²

IMPOSED LOAD (OFFICE) = 2.5 + 1
= 3.5 kN/m²

- CONCRETE FLAT ROOF (Ex7)

ASHPHALT WATERPROOFING/INSULATION	0.45 kN/m²
50 SCREED	1.20 kN/m²
150 SLAB/PLANCS	3.70 kN/m²
CEILING SERVICES	0.15 kN/m²
Σ =	5.5 kN/m²
IMPOSED LOAD (NO ACCESS)	= 0.75 kN/m²

- BASEMENT FLOOR SLAB (Ex4)

50 SCREED	1.2 kN/m²
INSULATION	0.1 kN/m²
100 RC SLAB	2.5 kN/m²
Σ =	3.8 kN/m²
	= 2.5 + 1
	= 3.5 kN/m²

IMPOSED LOAD (OFFICE)

FLOOR	AREA	ROOF AREA	DL	LL
ROOF	246 m²		307 kN	184 kN
3RD	246 m²	68.4 m²	1463 kN	912 kN
2ND	340 m²	14.9 m²	1923 kN	1201 kN
1ST	355 m²	68.8 m²	2373 kN	1294 kN
G	424 m²	–	2374 kN	1484 kN
LG	107 m²	–	599 kN	375 kN
B	317 m²	107 m²	1611 kN	1110 kN

BELOW FLOOR VOID AREA

Σ = 10650 kN 6560 kN

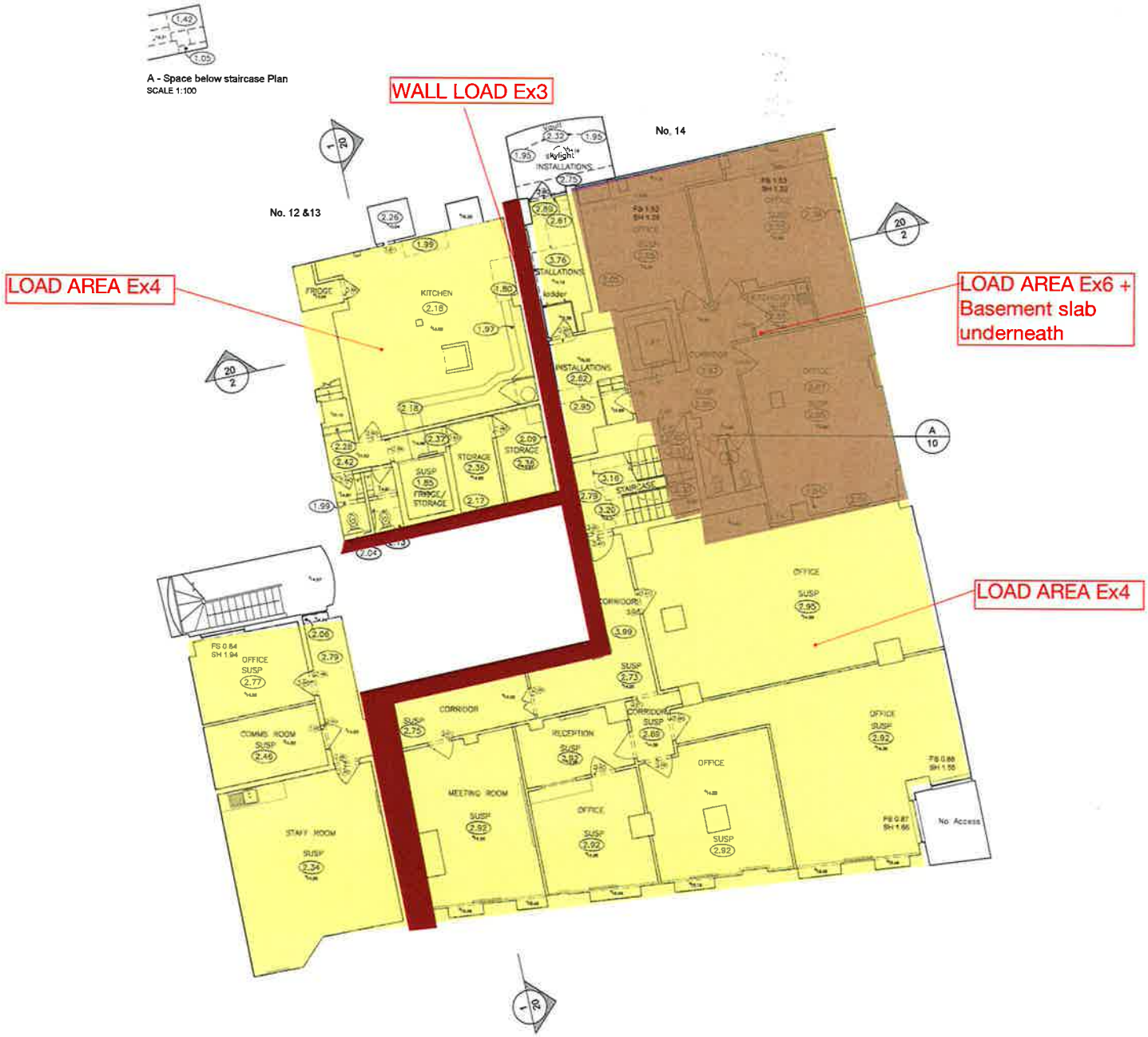
COMBINED LOADS

12/13 (DL) = 6570.2 kN 12/13 (LL) = 2225 kN
14 (DL) = 10650 kN 14 (LL) = 6560 kN

Σ (DL+LL) = 26005 kN.

TOTAL AREA = 535 m²

EXISTING PRESSURE = 48.6 kN/m²



Notes:
1) All dimensions to be checked on site.
2) Do not scale from this drawing.

Section
Drawing reference

Detail layout
Drawing reference

Rev	Issue	Date
D0	For comment	11.08.15

Frost Architects

PROJECT
12 - 14 Greville Street

DRAWING
Existing Lower Ground Floor Plan

Status DESIGN

SCALE	SIZE
1:100	A2

DRAWN BY EQH

PROJECT NO.	DRAWING NO.	REV.
15229	10	D0

1 : 100 1 2 5m

Existing Lower Ground Floor Plan
SCALE 1:100

B - Existing Restaurant Lobby Floor Plan
SCALE 1:100

LOAD AREA Ex4

WALL LOAD Ex3

No. 14

No. 12 &13

LOAD AREA Ex2

LOAD AREA Ex6

Existing Ground Floor Plan
SCALE 1:100

1 : 100 1 2 5m

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Section
Drawing reference

Detail layout
Drawing reference

Rev	Issue	Date
D0	For comment	11.08.15

Frost Architects

PROJECT
12 - 14 Greville Street

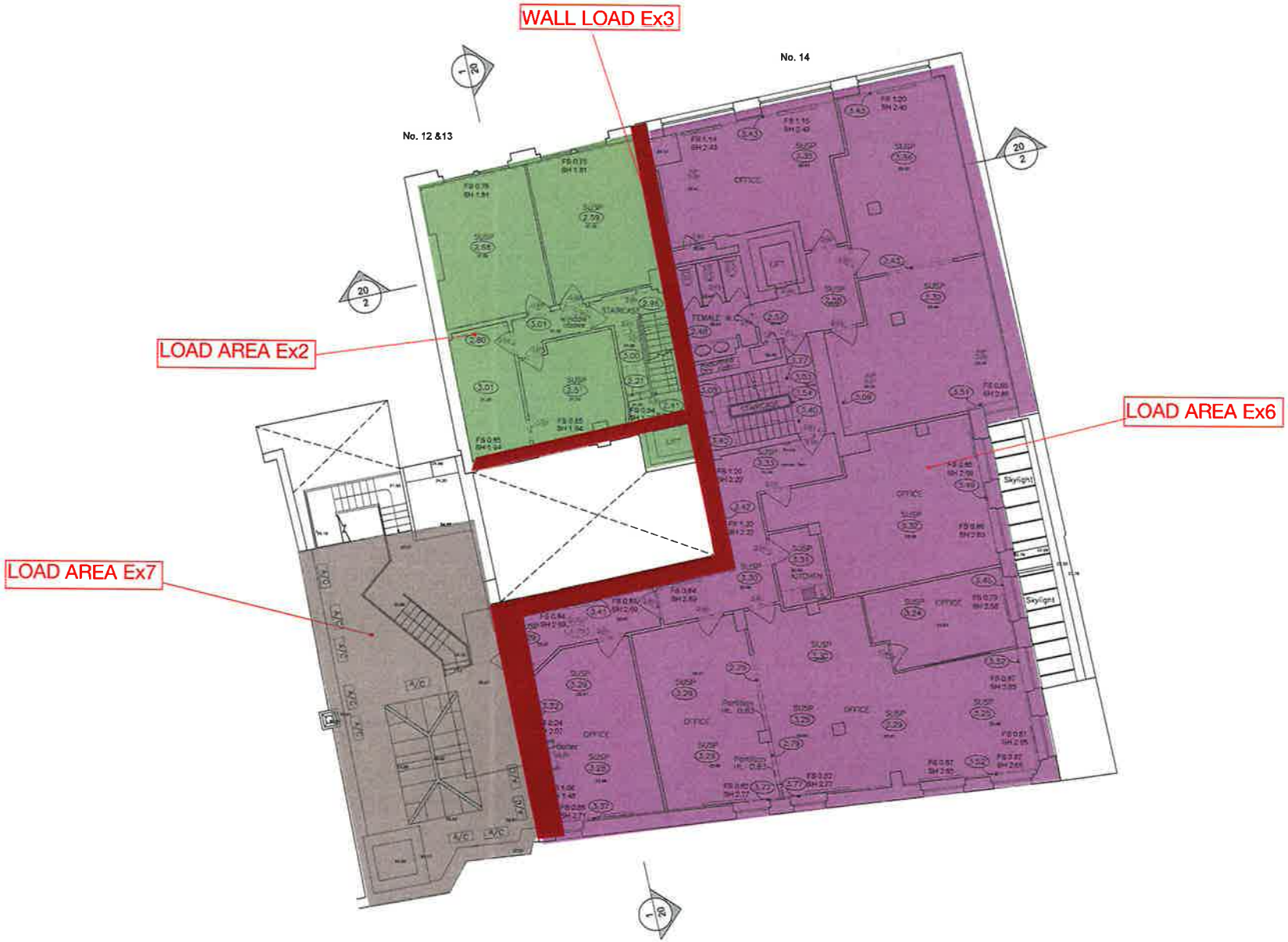
DRAWING
Existing Ground Floor Plan

Status DESIGN

SCALE 1:100 | SIZE A2 | DRAWN BY EQH

PROJECT NO.	DRAWING NO.	REV.
15229	11	D0

A3 x 5



Existing First Floor Plan
SCALE 1:100

1 : 100 1 2 5m

Notes:
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Section
Drawing reference

Rev	Issue	Date
D0	For comment	11.08.15

Frost Architects

PROJECT
12 - 14 Greville Street

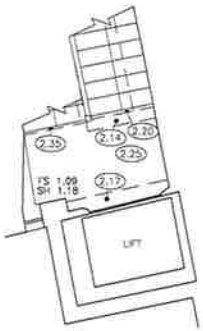
DRAWING
Existing First Floor Plan

Status DESIGN

SCALE 1:100 SIZE A2 DRAWN BY EQH

PROJECT NO. 15229 DRAWING NO. 12 REV. D0

E x 6



C - Existing Staircase Plan
SCALE 1:50

Existing Second Floor Plan
SCALE 1:100

Notes:
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Section
Drawing reference

Detail layout
Drawing reference

Rev	Issue	Date
D0	For comment	11.08.15

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PROJECT
12 - 14 Greville Street

DRAWING
Existing Second Floor Plan

Status DESIGN

SCALE	SIZE
1:100/50	A2

DRAWN BY EQH

PROJECT NO.	DRAWING NO.	REV.
15229	13	D0

Ex 7

Existing Third Floor Plan
SCALE 1:100

Notes:
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Section
Drawing reference

Rev	Issue	Date
D0	For comment	11.08.15

Frost Architects

PROJECT
12 - 14 Greville Street

DRAWING
Existing Third Floor Plan

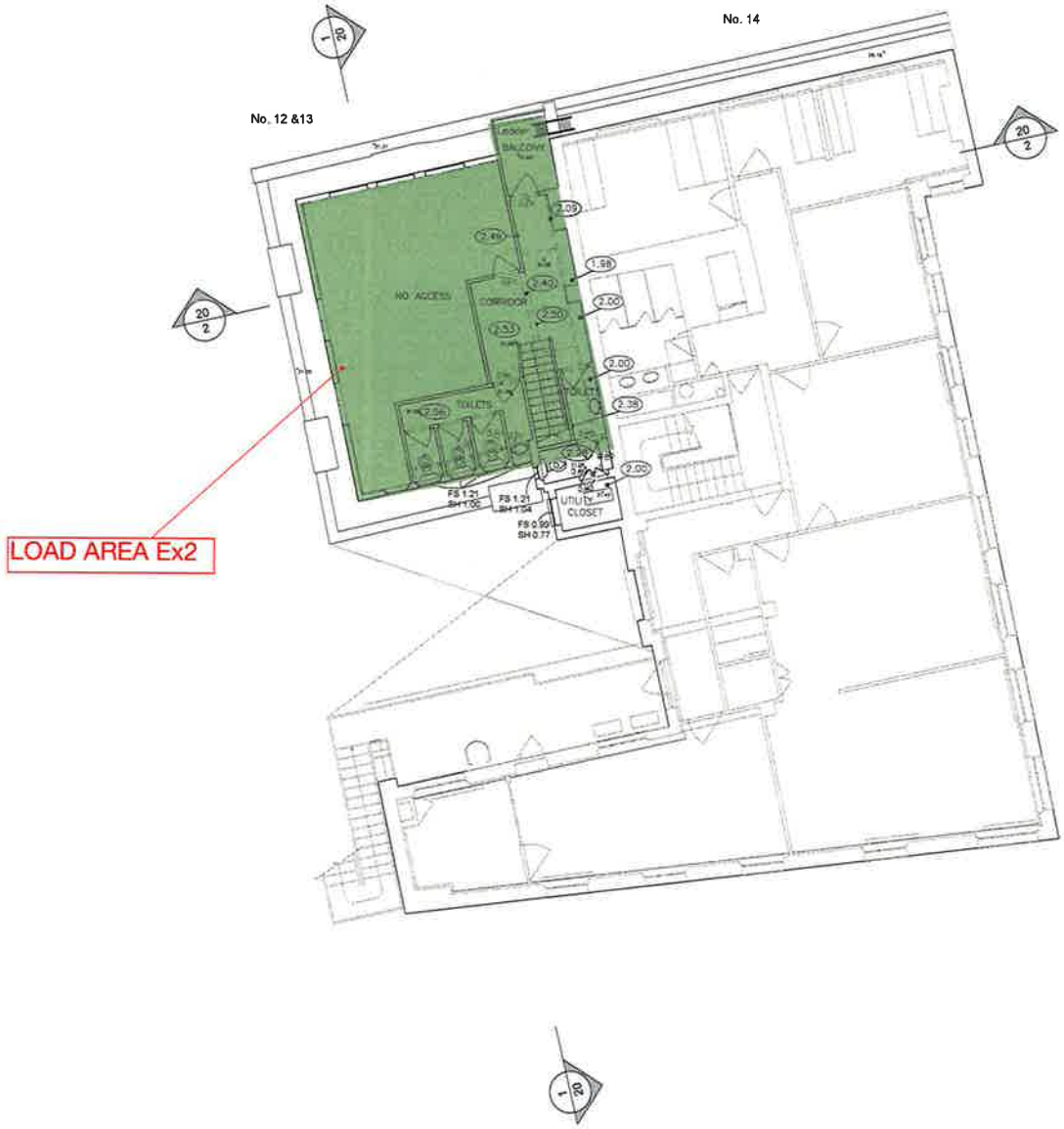
Status DESIGN

SCALE	SIZE
1:100	A2

DRAWN BY EQH

PROJECT NO.	DRAWING NO.	REV.
15229	14	D0

1 : 100 1 2 5m



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Section
Drawing reference

Rev	Issue	Date
D0	For comment	11.08.15

Frost Architects

PROJECT
12 - 14 Greville Street

DRAWING
Existing Fourth Floor Plan

Status DESIGN

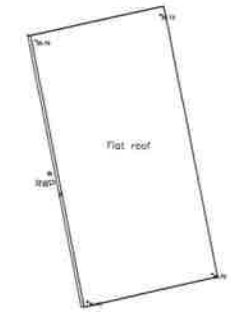
SCALE	SIZE
1:100	A2

DRAWN BY EQH

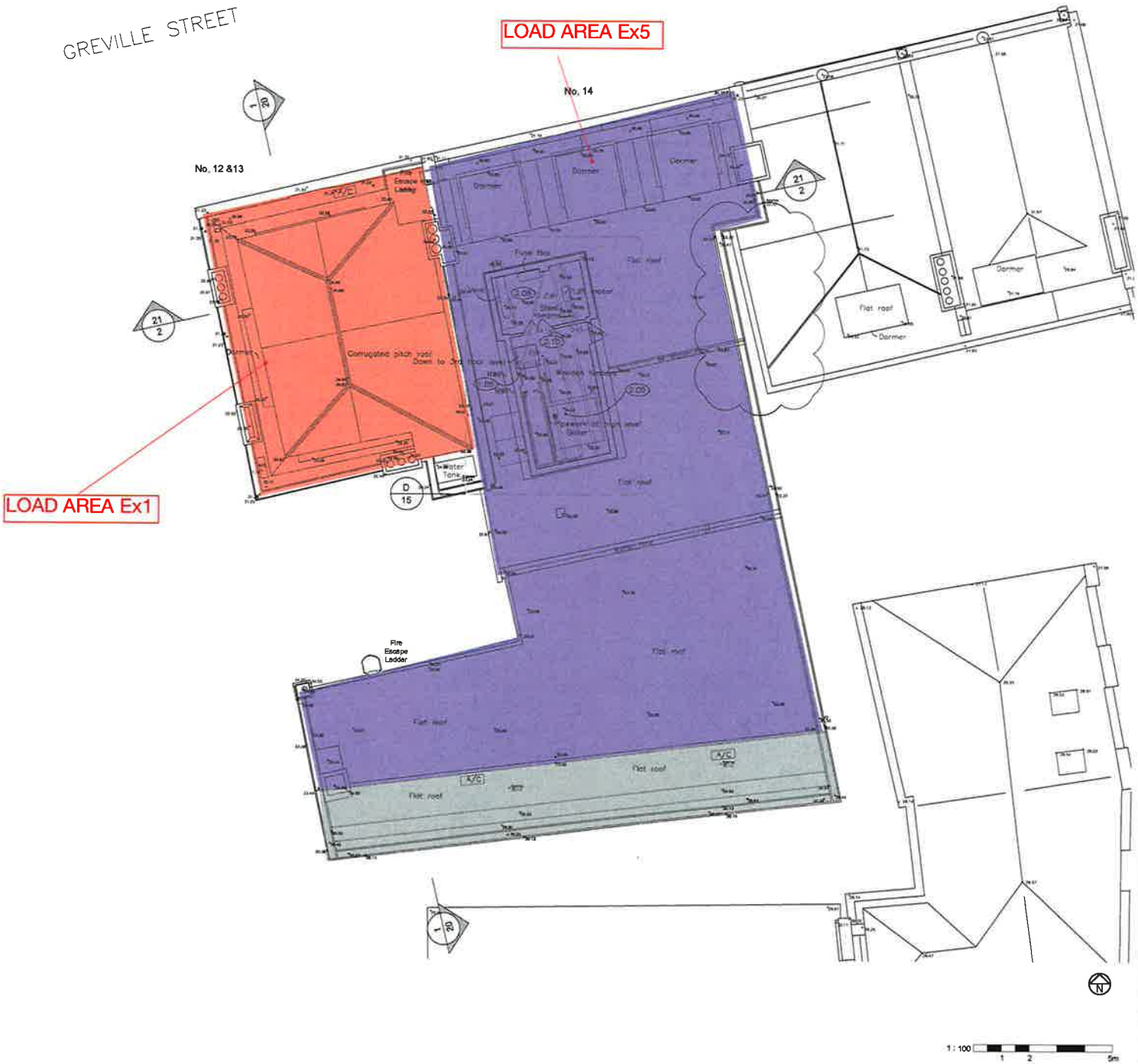
PROJECT NO.	DRAWING NO.	REV.
15229	15	D0

1 : 100 1 2 5m

Existing Fourth Floor Plan
SCALE 1:100



D - Roof over Plant Room
SCALE 1:100



Existing Roof Plan
SCALE 1:100

Notes:
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Section
Drawing reference

Detail layout
Drawing reference

Rev	Issue	Date
D0	For comment	11.08.15

Frost Architects

PROJECT
12 - 14 Greville Street

DRAWING
Existing Roof Plan

Status DESIGN

SCALE	SIZE
1:100	A2

DRAWN BY EQH

PROJECT NO.	DRAWING NO.	REV.
15229	16	D0

Ex10

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Job No 23327 Page P1 Ver
Date August 18 Eng TM Chd
Job Greville Street

Finishes

	Zone	Screed	sulation/I	Finishes	Ceiling/Services	Total	
Timber Roof	A	0	0.2	0.45	0.15	0.8	kN/m²
Raised floor	B	0	0	0.4	0.15	0.55	kN/m²
Flat roof	C	1.2	0.45	0.95	0.15	2.75	kN/m²
Basement	D	1.2	0.1	0.2	0	1.5	kN/m²

Loading

No	Finishes			DEAD	LIVE
1	A	Timber roof		0.8	0.8
2	B	Office - conc	275 thick	7.4	3.5
3	B	Office - lightweight		0.6	3.5
4	B	Office - 300 conc	300 thick	8.1	3.5
5	B	Office - ground	275 thick	7.4	4.0
6	C	Office - lightweight		2.8	4.0
7	C	Conc roof	275 thick	9.6	0.8
8	C	Conc roof - plant	275 thick	9.6	5.0
9	D	Raft	750 thick	20.3	4.0
10	D	200 slab	200 thick	6.5	4.0

ROOF

(8) CONC ROOF AREA = 59.6 m²

(1) TIMBER ROOF AREA = 245.0 m² PLANT AREA = 32.5 m²

DL = (59.6m² x 9.6 kN/m²) + (277.5 m² x 0.8 kN/m²)
= 794.2 kN.

LL = (59.6m² x 5.0 kN/m²) + (245.0m² x 0.75 kN/m²)
+ (32.5 m² x 3 kN/m²).
= 579.3 kN

FOURTH

(4) CONC FLOOR AREA = 367.6 m²

(3) TIMBER FLOOR AREA = 83.9 m²

DL = (367.6 m² x 8.1 kN/m²) + (83.9m² x 0.55 kN/m²) x ½.
= 3011.1 kN.

LL (367.6 m² + $\frac{83.9m^2}{2}$) x 3.5 kN/m²
= 1433.4 kN

THIRD

(2) CONC FLOOR AREA = 367.6 m²

(7) CONC ROOF AREA = 48.9 m²

(3) TIMBER FLOOR AREA = 83.9 m²

(1) TIMBER ROOF AREA = 17.4 m²

DL = (367.6 m² x 7.4 kN/m²) + (48.9m² x 9.6 kN/m²)
+ (83.9m² x 0.55kN/m² x ½) + (17.4m² x 0.8 kN/m² x ½)
= 3219.7 kN.

LL = (367.6 m² + $\frac{83.9m^2}{2}$) x 3.5 kN/m² + (48.9m² + $\frac{17.4m^2}{2}$)
x 0.75 kN/m²

= 1476.6 kN.

SECOND / FIRST

(2) CONC FLOOR AREA = 436.6 m²

(3) TIMBER FLOOR AREA = 101.5 m² FIRST ROOF = 4.23m²

DL = (436.6m² × 7.4kN/m²) + (101.5m² × ½ × 0.55kN/m²)
= 3258.7 kN. (+ 3.38 kN)

LL = (436.6m² + 101.5m²/2) × 3.5 kN/m²
= 1705.7 kN (+ 3.17 kN).

GROUND

(5) CONC FLOOR AREA = 436.6 m²

(6) TIMBER FLOOR AREA = 105.7 m²

DL = 3261.0 kN.

LL = (436.6m² + 101.5m²/2) × 4.0 kN/m²
= 1957.8 kN.

BASEMENT

(9) 750 FLOOR AREA = 436.6 m²

(10) 200 SLAB AREA = 105.7 m²

DL = (436.6m² × 20.3 kN/m²) + (105.7m²/2 × 6.5kN/m²)
= 9207 kN.

LL = (436.6m² + 105.7m²/2) × 4.0 kN/m²
= 1958 kN.

VERTICAL ELEMENTS

9 No. C1 = $9 \times 0.45 \times 0.45 \times 25\ kN/m^3 \times 2.95m$
= 134.4 kN.

23 No. C2 = $23 \times 0.25 \times 0.25 \times 25\ kN/m^3 \times 3.35m$.
= 120.4 kN.

26 No. C3 = $26 \times 0.3 \times 0.3 \times 25\ kN/m^3 \times 3.35m$
= 195.9 kN

5 No. C4 = $5 \times 0.2^2 \times \pi \times 25\ kN/m^3 \times 3.65m$
= 57.3 kN.

14 No. C5 = $14 \times 0.15^2 \times \pi \times 25\ kN/m^3 \times 3.35m$
= 82.9 kN.

TOTAL WALL AREA = 618 m^2
THICKNESS = 0.2 m.

Wt = $618 \times 0.2 \times 25\ kN/m^3$
= 3090 kN.

TOTAL LOAD

DL =

	794.2	kN
	3011.1	kN
	3219.7	kN
(+3.4)	2× 3258.7	kN
	3261.0	kN
	9207.0	kN
	134.4	kN
	120.4	kN
	195.9	kN
	57.3	kN
	82.9	kN
	3090	kN

Σ = 29695 kN

LL =

	579.1	kN
	1433.4	kN
	1476.6	kN
(+3.2)	2× 1705.7	kN
	1958.0	kN
	1958.0	kN

Σ = 10820 kN.

TOTAL Σ = 40515 kN AREA = 432.7 m^2

PROPOSED PRESSURE = 40515 / 432.7
= 93.6 kN/m^2

EXISTING FFL = 14.28 - 0.1 (FINISHES) - 0.1 (SCRE
U/S OF EXISTING = 14.08

PROPOSED SSL = 14.28 - 0.75 (RAFT) - 0.05 (BLINDING)
U/S OF PROPOSED = 13.48

↳ WEIGHT OF SOIL = 14.08 - 13.48 x 18 kN/m³
= 10.8 kN/m²

∴ WEIGHT OF SOIL IN REAR OF 12/13 GREVILLE STREET

17.55 - 14.28 = 3.27 m A = 7.7 x 4.7 = 36m²

Wt = (3.27 x 36 x 18 kN/m³) / 535m.
= 3.96 kN/m²

Wt(SOIL) = 14.8 kN/m²

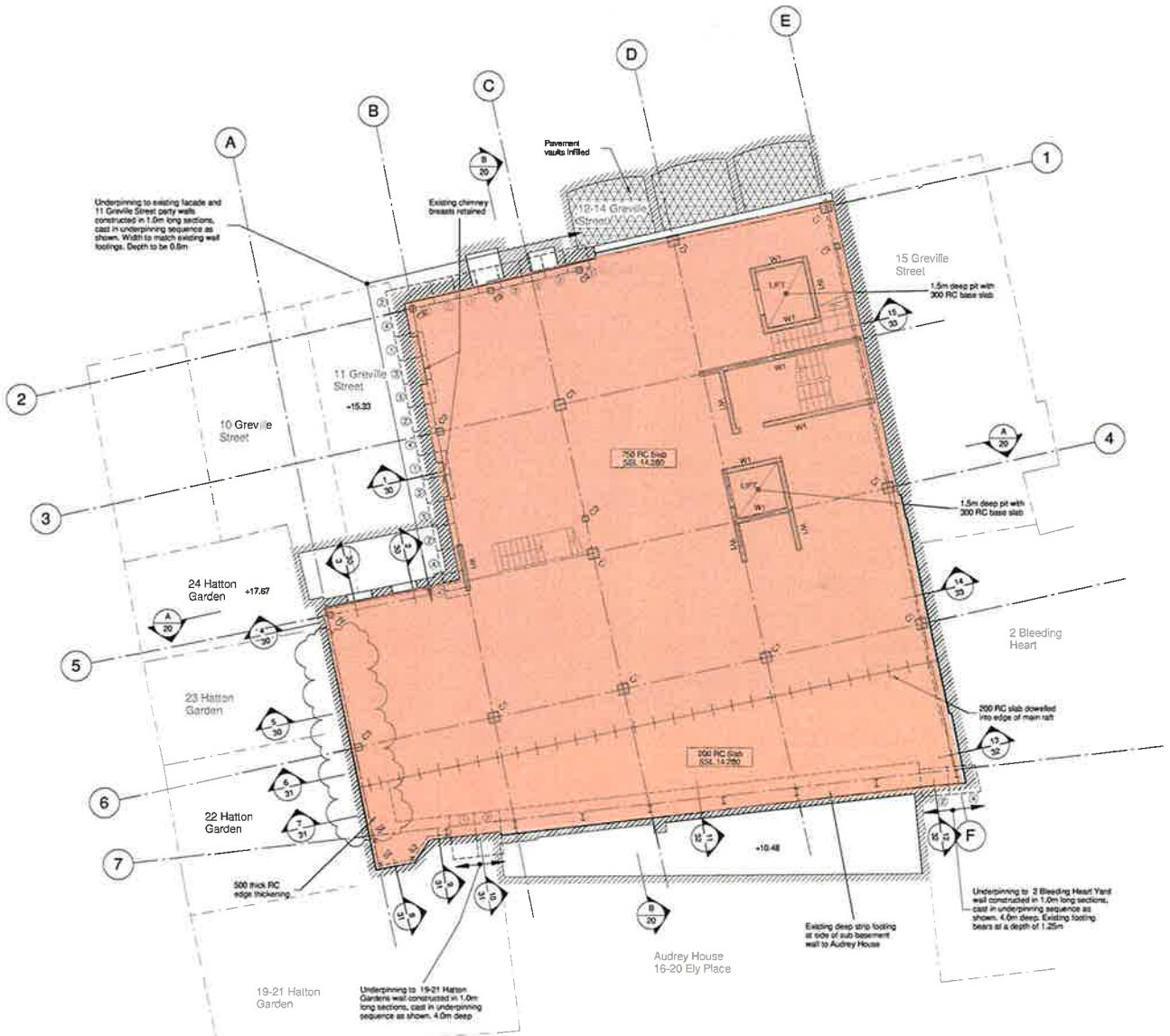
∴ NET INCREASE IN PRESSURE
= 93.6 kN/m² - 14.8 kN/m² - 48.6 kN/m²
= 30.2 kN/m² < 50 kN/m²
∴ OK

COLUMNS	
C1	450x450 RC
C2	250x250 RC
C3	300x300 RC
C4	400ø RC
C5	300ø RC
S1	305x165x40 UB
S2	152x152x23 UC
S3	139.7ø x 8.3 CHS

BEAMS	
B1	203x203x46 UC
B2	152x89x16 UB
B3	254x254x107 UC
B4	254x254x73 UC
B5	254x254x132 UC
B6	300x200x8 RHS
B7	203x133x30 UB
B8	200x200x16 SHS

WALLS	
W1	200 RC Wall

TIMBER	
T1	225x50 C24 joists at 400crs
T2	150x50 C24 joists at 400crs



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3 Health & Safety :
All specific drawing notes are to be read in conjunction with the project "Information Pack" and "Site Rules".

4 For general notes refer to Drawing No. 23327/01.

Ver	Date	Drawn	Eng	Amendment
1	13/08/18	SA	TM	Issued for Information, RIBA Stage 3
1	13/07/18	SA	TM	Issued for party wall awards

12-14 GREVILLE STREET LONDON EC1N 8SB

BASEMENT PLAN

Status
STAGE 3 REPORT
NOT FOR CONSTRUCTION

Drawn Sophie Arup	Eng Tom Matsuzaka
Scales 1 : 100	
Drawing No 23327 / 09	Ver 2

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020 7631 5128
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COLUMNS	
C1	450x450 RC
C2	250x250 RC
C3	300x300 RC
C4	400ø RC
C5	300ø RC
S1	305x165x40 UB
S2	152x152x23 UC
S3	139.7ø x 6.3 CHS

BEAMS	
B1	203x203x46 UC
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WALLS	
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T1	225x50 C24 joists at 400cm
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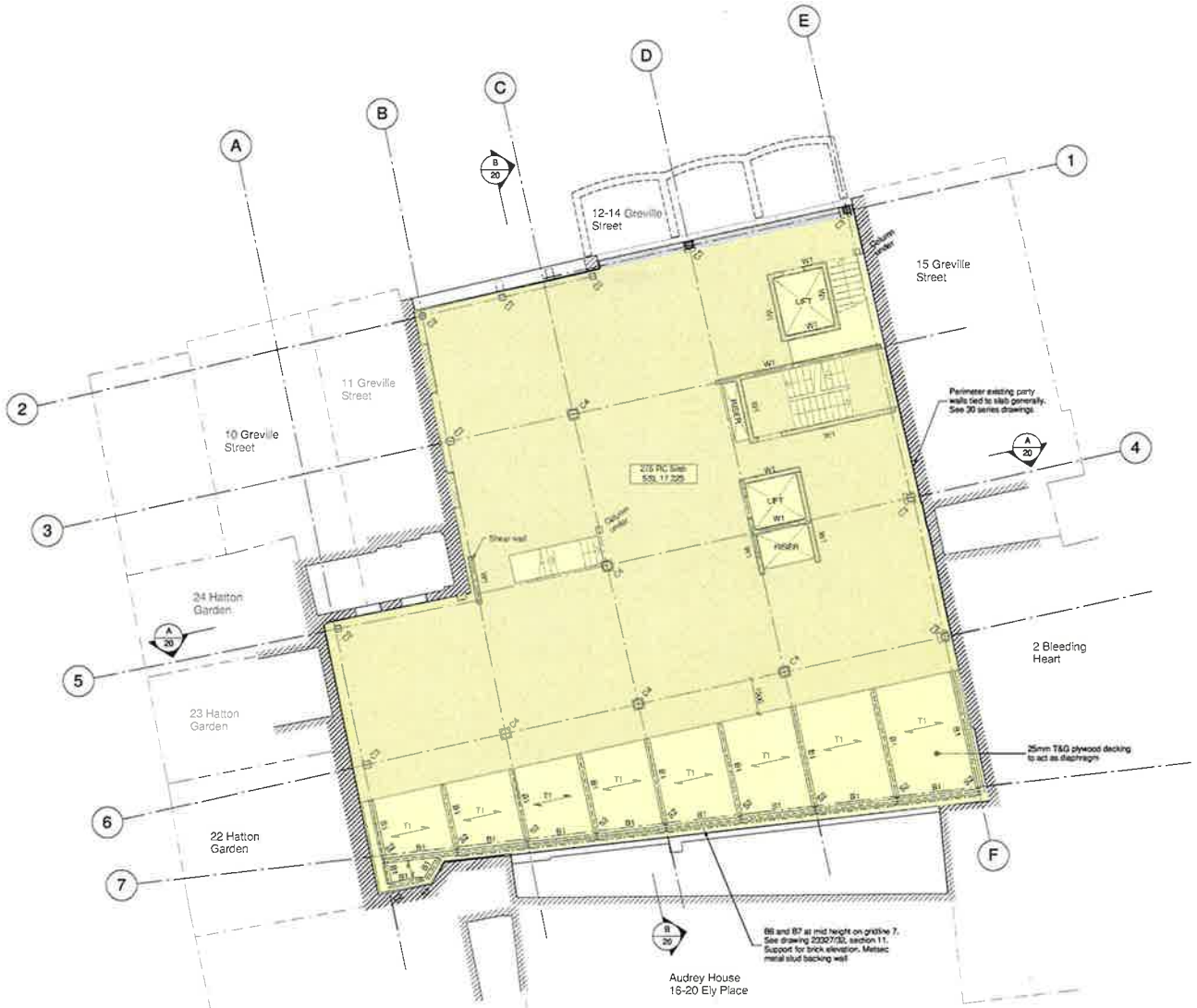

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Ver	Date	Drawn	Eng	Amendment
2	13.8.18	SA	TM	Issued for Information. RIBA Stage 3
1	13.7.18	SA	TM	Issued for party wall awards

12-14 GREVILLE STREET
LONDON EC1N 8SB

GROUND FLOOR PLAN

Status
STAGE 3 REPORT
NOT FOR CONSTRUCTION

Drawn Sophie Arup Eng Tom Matsuzaka

Scales 1 : 100

Drawing No 23327 / 10 Ver 2

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10

COLUMNS	
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C5	300ø RC
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WALLS	
W1	200 RC Wall

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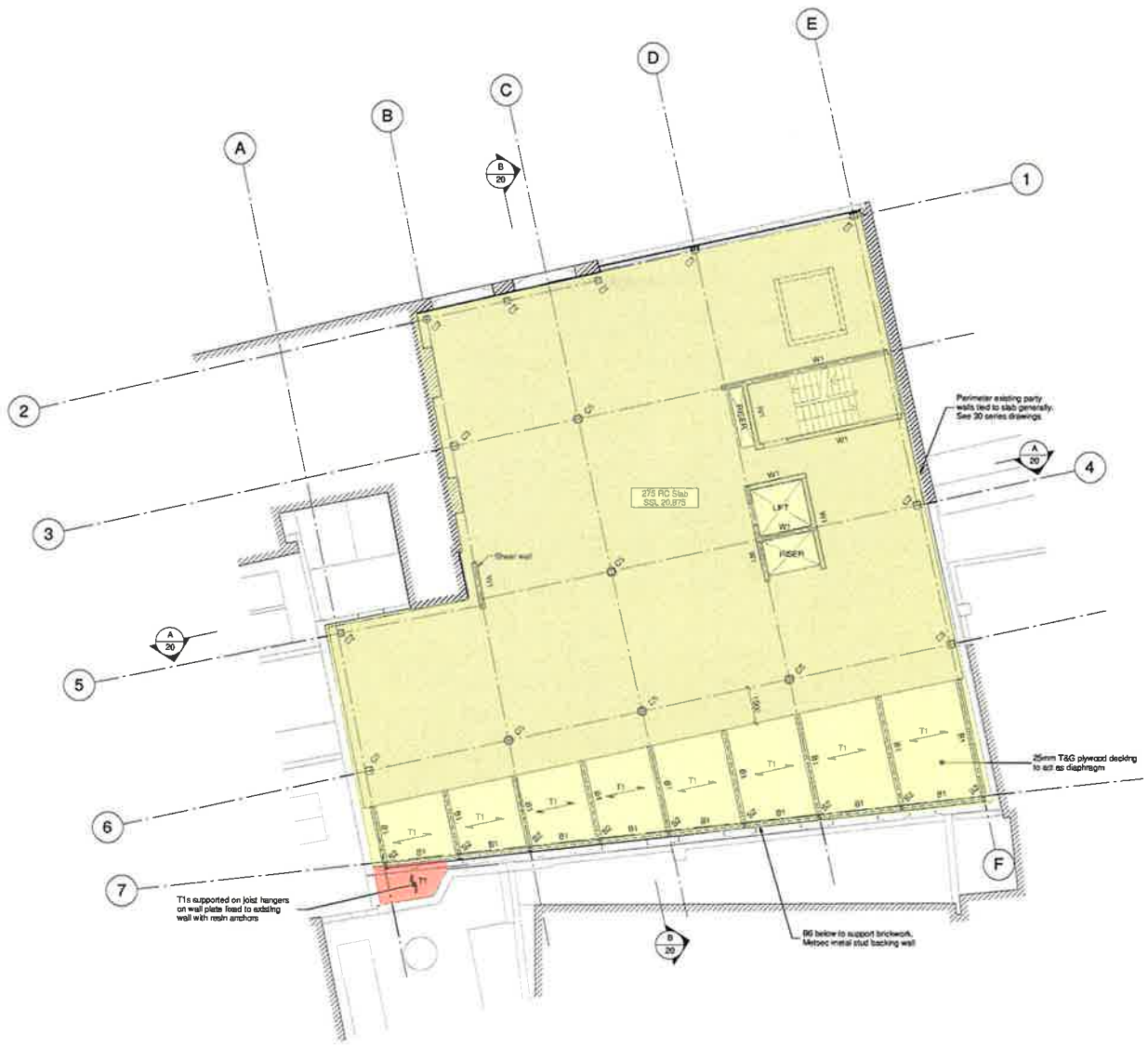
T1	225x60 C24 joists at 400crs
T2	150x60 C24 joists at 400crs



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Ver	Date	Drawn	Eng	Amendment
1	03.08.18	SA	TM	Issued for Information. RIBA Stage 3

12-14 GREVILLE STREET
LONDON EC1N 8SB

FIRST FLOOR PLAN

Status
STAGE 3 REPORT
NOT FOR CONSTRUCTION

Drawn Sophie Arup	Eng Tom Matsuzaka
Scales 1 : 100	
Drawing No 23327 / 11	Ver 1

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COLUMNS	
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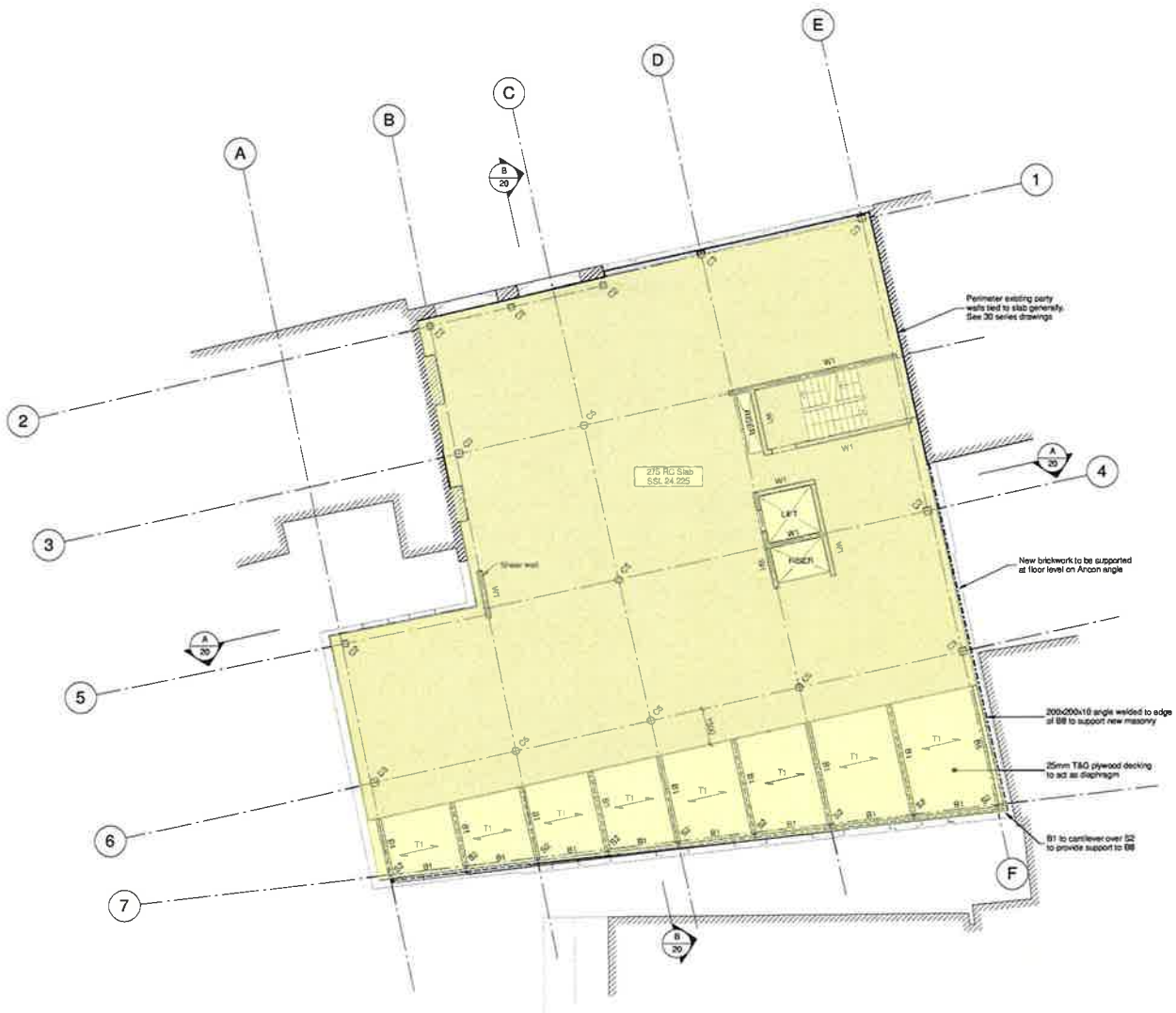
B5	254x254x132 UC
B6	200x200x8 RHS
B7	203x133x30 UB
B8	200x200x16 SHS

WALLS	
W1	200 RC Wall

TIMBER	
T1	225x50 C24 joists at 400crs
T2	150x50 C24 joists at 400crs



Notes :-

1. This drawing is to be read in conjunction with all relevant Architect's, Engineer's and specialists' drawings and specifications.
2. Do not scale from this drawing in either paper or digital form. Use written dimensions only. To check that this drawing has been printed to the intended scale this bar should be 50mm long @A1 or 25mm long @ A3
3. Health & Safety : All specific drawing notes are to be read in conjunction with the project "Information Pack" and "Site Rules".
4. For general notes refer to Drawing No. 23327/01.

Ver	Date	Drawn	Eng	Amendment
1	13.06.16	SA	TM	Issued for Information, RIBA Stage 3

12-14 GREVILLE STREET
LONDON EC1N 8SB

SECOND FLOOR PLAN

Status
STAGE 3 REPORT
NOT FOR CONSTRUCTION

Drawn Sophie Arup	Eng Tom Matsuzaka
Scales 1 : 100	
Drawing No 23327 / 12	Ver 1

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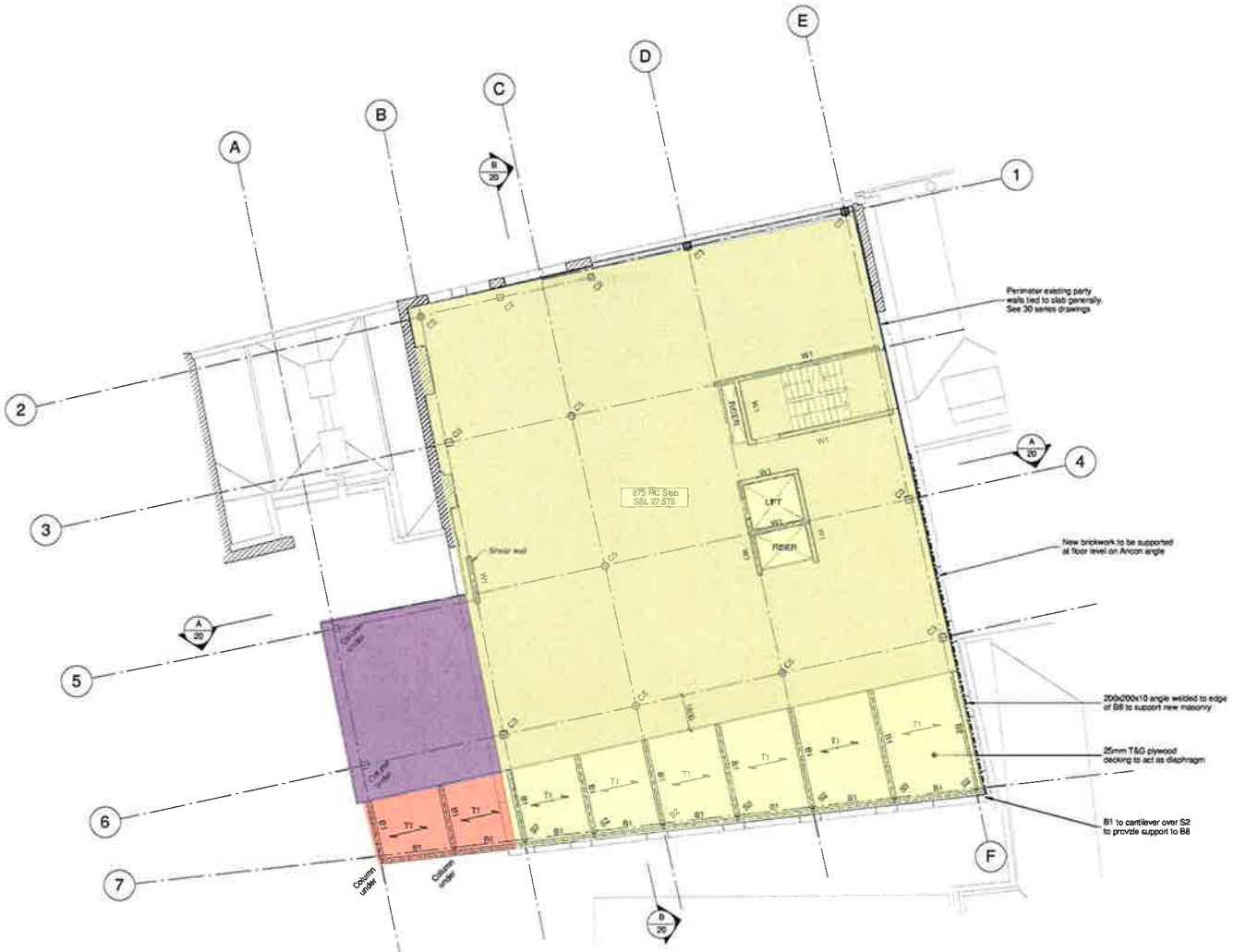
COLUMNS	
C1	450x450 RC
C2	350x350 RC
C3	300x300 RC
C4	400ø RC
C5	300ø RC
S1	305x165x40 UB
S2	152x152x23 UC
S3	139.7ø x 6.3 CHS

BEAMS	
B1	203x203x46 UC
B2	152x89x16 UB
B3	254x254x167 UC
B4	254x254x73 UC
B5	254x254x132 UC
B6	300x200x8 RHS
B7	203x133x30 UB
B8	200x200x16 SHS

WALLS	
W1	200 RC Wall

TIMBER	
T1	225x50 C24 joists at 400crs
T2	150x50 C24 joists at 400crs



Notes :-

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3 Health & Safety :
All specific drawing notes are to be read in conjunction with the project "Information Pack" and "Site Rules".

4 For general notes refer to Drawing No. 23327/01.

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THIRD FLOOR PLAN

Status
STAGE 3 REPORT
NOT FOR CONSTRUCTION

Drawn Sophie Arup	Eng Tom Matsuzaka
Scales 1 : 100	
Drawing No 23327 / 13	Ver 1

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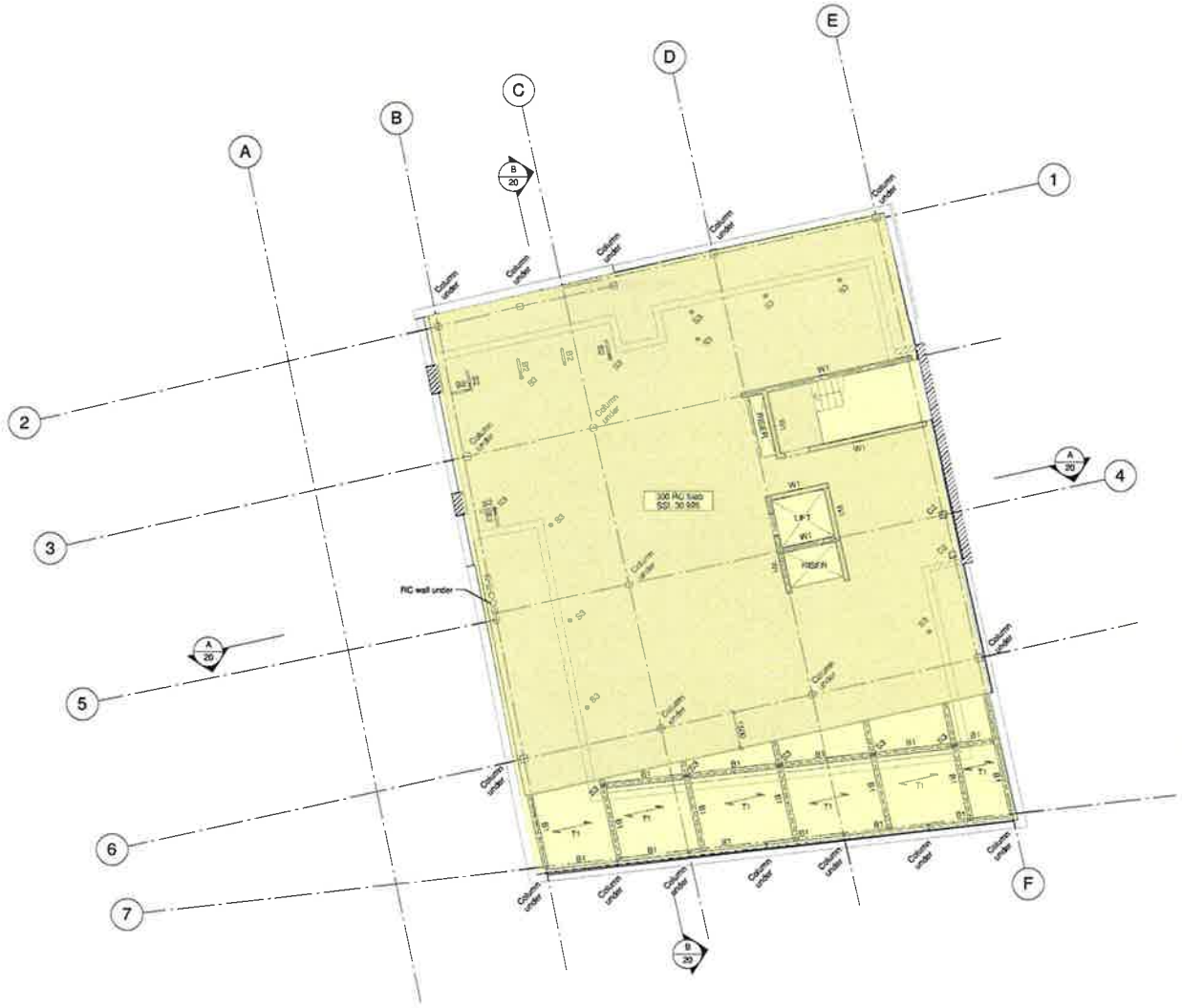
P10

COLUMNS	
C1	450x450 RC
C2	250x250 RC
C3	300x300 RC
C4	400ø RC
C5	300ø RC
S1	305x165x40 UB
S2	152x152x23 UC
S3	139.7ø x 6.3 CHS

BEAMS	
B1	203x203x46 UC
B2	152x89x16 UB
B3	254x254x107 UC
B4	254x254x73 UC
B5	254x254x132 UC
B6	300x200x8 RHS
B7	203x133x30 UB
B8	200x200x16 SHS

WALLS	
W1	200 RC Wall

TIMBER	
T1	225x50 C24 joists at 400crs
T2	150x50 C24 joists at 400crs



Notes :-

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3 Health & Safety :
All specific drawing notes are to be read in conjunction with the project "Information Pack" and "Site Rules".

4 For general notes refer to Drawing No. 23327/01.

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FOURTH FLOOR PLAN

Status
STAGE 3 REPORT
NOT FOR CONSTRUCTION

Drawn Sophie Arup	Eng Tom Matsuzaka
Scales 1 : 100	
Drawing No 23327 / 14	Ver 1

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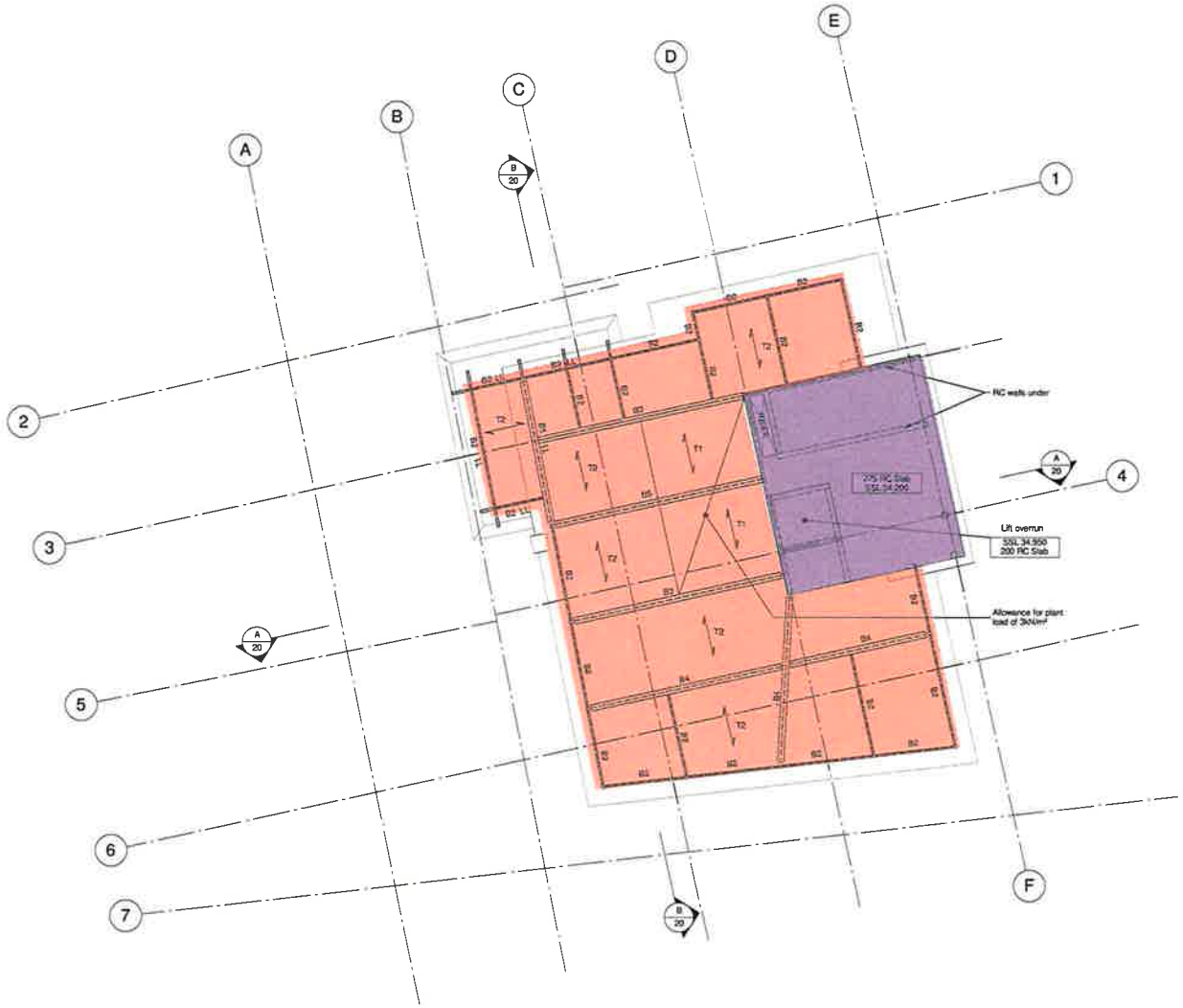
COLUMNS	
C1	450x450 RC
C2	250x250 RC
C3	300x300 RC
C4	400ø RC
C5	300ø RC
S1	305x165x40 UB
S2	152x152x23 UC
S3	139.7ø x 6.3 CHS

BEAMS	
B1	203x203x46 UC
B2	152x89x16 UB
B3	254x254x167 UC
B4	254x254x73 UC
B5	254x254x132 UC
B6	300x200x8 RHS
B7	203x133x30 UB
B8	200x200x16 SHS

WALLS	
W1	200 RC Wall

TIMBER	
T1	225x50 C24 joists at 400crs
T2	150x50 C24 joists at 400crs



Notes :-

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4 For general notes refer to Drawing No. 23327/01.

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ROOF PLAN

Status
STAGE 3 REPORT
NOT FOR CONSTRUCTION

Drawn Sophie Arup	Eng Tom Matsuzaka
Scales 1 : 100	
Drawing No 23327 / 15	Ver 1

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