FIRST STEPS LTD
To Success

Mr. P. Woolf,
Air Studios,
Lyndhurst Hall,
Lyndhurst Road,
Hampstead,
London NW3 5NG

11th January 2016

Dear Mr Woolf,

Addendum to Report on
Geological & Hydrogeological issues for concern
Arising from Planning Application 2015/2089/P
11 Rosslyn Hill London NW3 5UL

1A. This report is an addendum to that written by me on 2nd November 2015 and commissioned by Mr Paul Woolf of Air Studios Lyndhurst Road; it arises because of discoveries made in December 2015 within the archives of the engineering firm of Beers who were involved with converting the original chapel into Air Studios.

Summary

2A. Two ground investigations were found for the development of the Olave Centre, which was immediately adjacent to and upslope of Air Studios; one by Wimpey Laboratories (May 1982) for Phase 1 of the development (new apartments for the World Association of Girl Guides and Girl Scouts) and another for Phase 2 of the development (offices and the like) by STATS (October 1988). These complement the investigations of Ground Engineering (March 2015) for 11 Rosslyn Hill, immediately adjacent to and down slope of Air Studios. In addition a borehole drilled by Soils Engineering (February 1991) at Air Studios, as part of the studies for controlling groundwater there during conversion of the chapel, was also found. The location of all known boreholes is now shown on Fig 1A.

3A. The investigation commissioned from Ground Engineering for the development of 11 Rosslyn Hill left the following questions unanswered.

- The level of groundwater on site and its response to rainfall.
- The nature of groundwater flow across the site.
- The mechanical properties of the ground on which Air Studios is founded.
- The mechanical properties of the ground through which the basement excavations at No. 11 will penetrate.

The reason why these issues are of concern and the cause for searching archives for further information that might help address them is that no prediction of ground movement and groundwater change in response to

basement excavation and construction can be credible without a knowledge of these basic components of the ground.

4A. The discovered information contributes in part to answering some of these questions but not all; each will be considered in turn later. In summary the additional data leaves

- The level of groundwater on site and its response to rainfall unresolved.
- The nature of groundwater flow across the site better defined as being essentially within the drift and most likely in a downslope direction.
- The mechanical properties of the ground on which Air Studios is founded unresolved, and
- The mechanical properties of the ground through which the basement excavations at No. 11 will penetrate better defined, revealing an increase in strength with depth, confirmation of a marked change in strength occurring at the junction between the weathered and unweathered London Clay and the presence of bands of concretionary nodules across the site that will present obstacles to piling. The possible existence of shear surfaces of low strength within the upper levels of the London Clay remains unresolved.

The level of groundwater on site and its response to rainfall.

5A. Wimpey Laboratories drilled 5 boreholes in 7 days (cable percussion); all penetrated shallow drift (1.5m at most but usually less than 1m) overlying London Clay. Three of the 5 boreholes went to greater than 20m (BH's 1, 2 & 3) and in each of these the drift was sealed off with casing. The water levels recorded a few days after completion varied widely being 23.5m below GL in BH1, 17.5m below GL in BH 2 and rising to 7.1m below GL, and 19.5m below GL in BH 3 rising to 11.4m below GL. In other words, given the proximity of the BH's and the fact that all these levels are in the London Clay, no sensible conclusion on hydraulic potential within the London Clay can be drawn from them. That is the same situation with the water levels from the Ground Engineering for the investigation at No. 11 Rosslyn Hill. There BH1, which went to 5m below GL, was "dry", BH2 was "dry" to 18m below GL and BH3 was "dry" to 20m below GL.

6A. The Wimpey investigation also included Trial Pits one of which encountered water in the drift close to its junction with the London Clay and the other did not; both were in areas of large trees. Similar experiences were encountered in the Ground Engineering ground investigation. Eight window samplers were driven, seven to 5m below GL and one to 4m; two encountered water in the drift or at its junction with the London Clay. Four trial pits were excavated (although 5 are numbered but TP2 was cancelled) three of which encountered water.

7A. The picture from both Wimpey and Ground Engineering is the same; groundwater is travelling fastest in the drift above the London Clay. Holes into

the London Clay which seal the drift with casing record water levels many metres below the top of the London Clay. Standpipes which connect the drift to the London Clay largely fill with water derived from the drift.

8A. The STATS investigation contributes nothing to this picture.

9A. In conclusion the investigations demonstrate that mobile groundwater moving at speeds which are likely to be of significance to groundwater management is located in the drift. Its response to rainfall remains undetermined.

The nature of groundwater flow across the site.

10A. Water level data from Ground Engineering is suspect by virtue of the instrumentation used to gather it as explained in paragraphs 24 to 27 in First Steps' report of 2nd November 2015. Shepherd's Well, an established source of ground water issuing at ground level, was at the western end of Lyndhurst Road and in its day this water flowed down slope. Sections have thus been drawn normal to the topographic contours of the site to illustrate as far as possible any data that is likely to be relevant (Fig. 2A & B). Unfortunately the combined data fails to add any further information.

11A. However, the archives show there have been problems with groundwater at the chapel when it was converted to Air Studios, as recorded in the Minutes to site meetings when the subject of waterproofing the lift shaft and basement were discussed. Of particular note is a rather impassioned letter from Mr Keogh for the Contractors (Transformations) to the architect (B Parker of Heber Percy and Parker) dated 25th September 1992 in which he threatens to submit a Claim. Attached to this letter is one from Mr Roberts of White Jefferis & Associates (29th July 1992) in which details of the site condition are revealed and reproduced as 12A and 13A below.

12A. When discussing the water on site Mr Roberts describes (p2, para 2 of his letter) how the ground investigation borehole did not encounter water, as indeed was the case with the boreholes from Wimpey and Ground Exploration investigations. This was probably a common misinterpretation of water levels in such holes and must not be taken as evidence of the lack of water; the sides of boreholes in these materials expand into the hole and create suction in their pores which prevents the ground water in the clay reaching the hole. Nevertheless the borehole demonstrated that groundwater in the clay moved so slowly as not to appear in the borehole. Yet the pit of the lift, that was a few metres away from the borehole, flooded suddenly.

13A. To manage the inrush required a well and a pump but that was not all. Keeping the water out of the permanent structure also proved a problem. Mr Roberts writes (p2, para 6). "*The guides are however vague on the subject of external permanent heads of water. This is an important area of consideration in this case because the basement was expected to be founded entirely in*

London Clay with no permanent external head of water. However due to the presence of the spring (this was the invasion of groundwater into the excavation for the lift shaft) *a permanent external head of water possibly up to ground level will almost certainly exist under and all around the basement. This would remain the case unless pumping from the sump sink to intercept groundwater is continued."*

14A. In conclusion nothing is known about the level, direction and the speed of groundwater flow in the drift, or the response of this shallow groundwater to rainfall. What is abundantly clear is that shallow ground water was a problem for engineering at this site as it was for Teulon at St Stephen's across the road.

The mechanical properties of the ground on which Air Studios is founded.

15A. It was hoped that evidence of the depth and type of foundations for the original chapel would be discovered but none was. It is therefore not possible to know with certainty on what strata the chapel sits. As described in paras 14 &15 of First Steps' report 2nd November 2015, Teulon designed a very novel form of foundations for St Stephen's across the road and it is just possible that some aspect of that design was later incorporated by Waterhouse into the design of the chapel. **Nothing in the ground investigation reports or other material discovered refers to this problem.**

The mechanical properties of the ground through which the basement excavations at No. 11 will penetrate.

16A. Moisture contents and natural bulk density for the Wimpey samples indicate the London Clay is close to, if not at, full saturation and that agrees with the situation seen on the other side of Rosslyn Hill at St Stephens's where drains in the London Clay contain water and where Teulon encountered a stream running across the site. This also seems to agree with the findings from the Ground Exploration investigations.

17A. The Wimpey boreholes describe suites of concretionary nodules and these are shown on the vertical cross sections (Figs. 2Ab, 3A & 4A); only one such feature was recorded by the Ground Exploration holes (BH2) but its level agrees with one from the Wimpey holes. So it is reasonable to expect these to be present across the site. They will present an obstacle to piling.

18A. The Wimpey laboratory tests provide a useful profile of strength with depth to compare with that from laboratory tests undertaken by Ground Exploration and the profiles of both are shown on the Sections J-H and I-J (Figs. 3A & 4A). Both investigations predict strengths ranging from 250kN/m^2 to 260kN/m^2 at the level of the Northern Line tunnels reducing to 60kN/m^2 to 70kN/m^2 near base of the weathered London Clay. Further there is clearly a

hiatus in the profile of strength with depth across the boundary between the brown (weathered) and grey (unweathered) London Clay.

19A. On the basis of this strength profile it can be surmised that the stiffness of the clay will decrease towards ground level and that a sharp change in stiffness can be expected where the unweathered (grey) London Clay passes into its weathered (brown) form.

20A. The surface of the London Clay can be better defined with the aid of the discovered data and complements the limited data for this provided by the Ground Exploration investigations. A map of the elevations at which the London Clay was encountered i.e. the base of the drift, is shown in Fig.5A. The general picture depicted by these levels is that of an undulating surface rather like a gently corrugated sheet with the corrugations directed downslope. This would accord with the experience of water inflows associated with the lift pit and the variability of drift encountered in all the ground investigations. Excavations for brick earth are also recorded from the Belsize estate, as described in para 19 of First Steps' report of 2nd November 2015, to which the variation in drift across the site has also been attributed in part.

21A. In conclusion it can be accepted with some confidence that the strength and stiffness of the London Clay will increase with depth but have a marked change at the junction of the grey with the brown clay. It is also clear that the surface of the London Clay is most likely to be corrugated with ground water flowing downslope, mainly in the corrugations. No evidence has been found of the presence of shear surfaces in the upper layers of the London Clay but the general shape of the London Clay surface and the geological history of the are indicate their presence should be checked. Calcareous nodules are present and form distinct horizons within the London Clay; they are an obstacle to piling.

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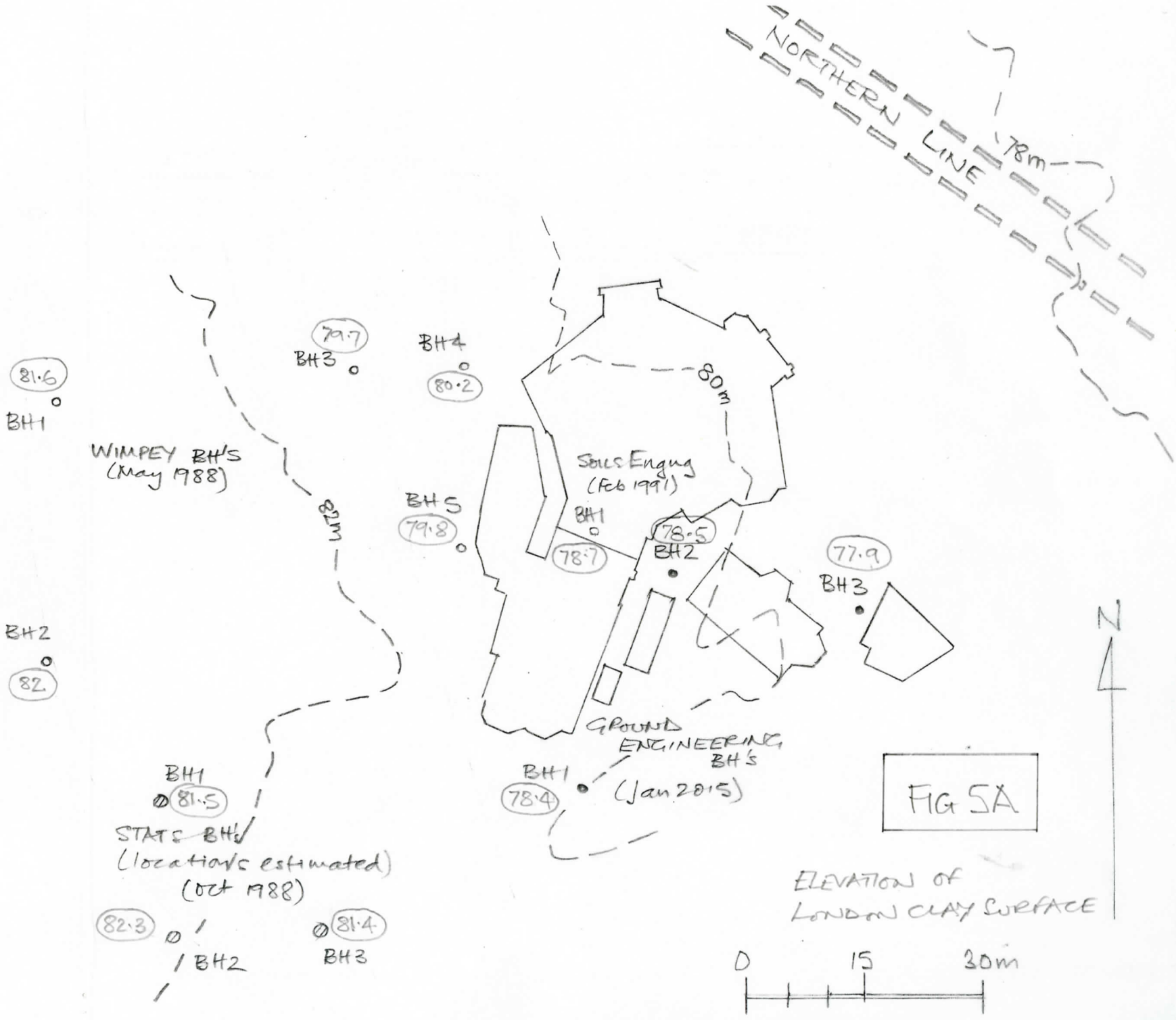
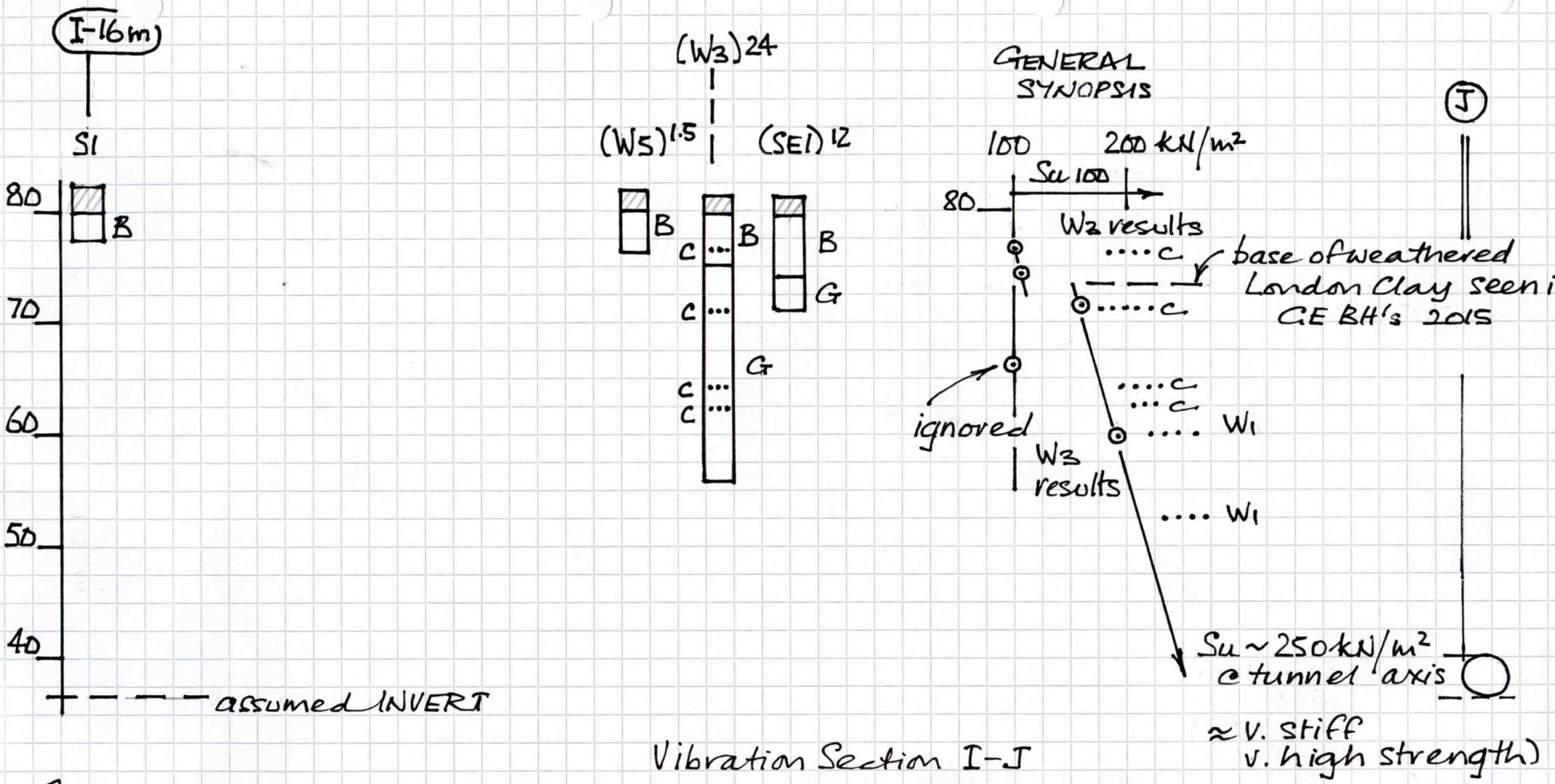
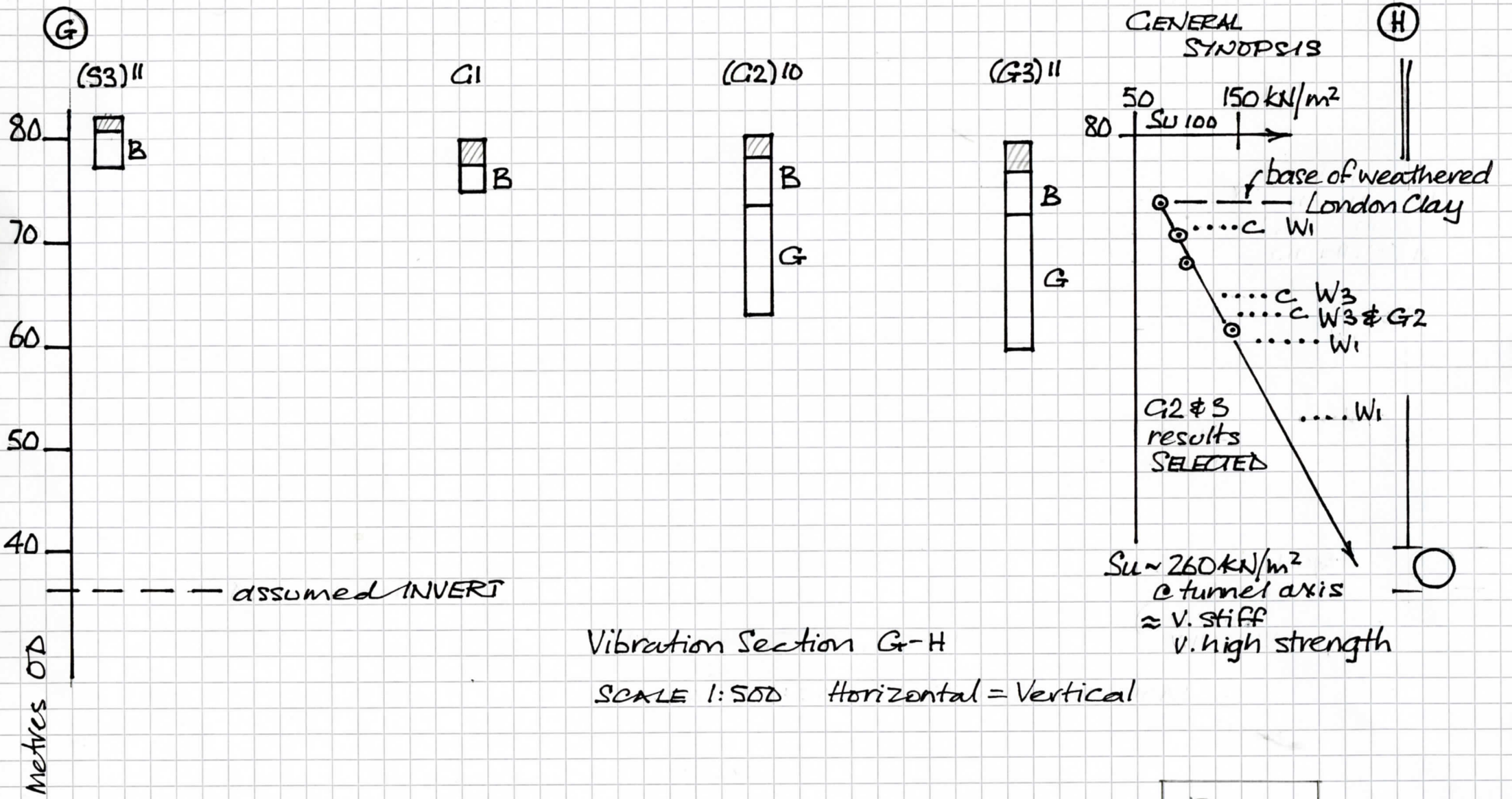

NORTHERN LINE
78m
80m
82m
WIMPEY BH's
(May 1988)
81·6
BH1
BH2
82·
79·7
BH3
BH4
80·2
BH5
79·8
Soils Engng
(Feb 1991)
BH1
78·7
78·5
BH2
77·9
BH3
GROUND
ENGINEERING
BH's
(Jan 2015)
BH1
78·4
BH1
81·5
STATS BH's
(locations estimated)
(Oct 1988)
82·3
BH2
81·4
BH3
N
FIG 5A
ELEVATION OF
LONDON CLAY SURFACE
0
15
30m



Vibration Section I-J

SCALE 1:500 Horizontal = Vertical

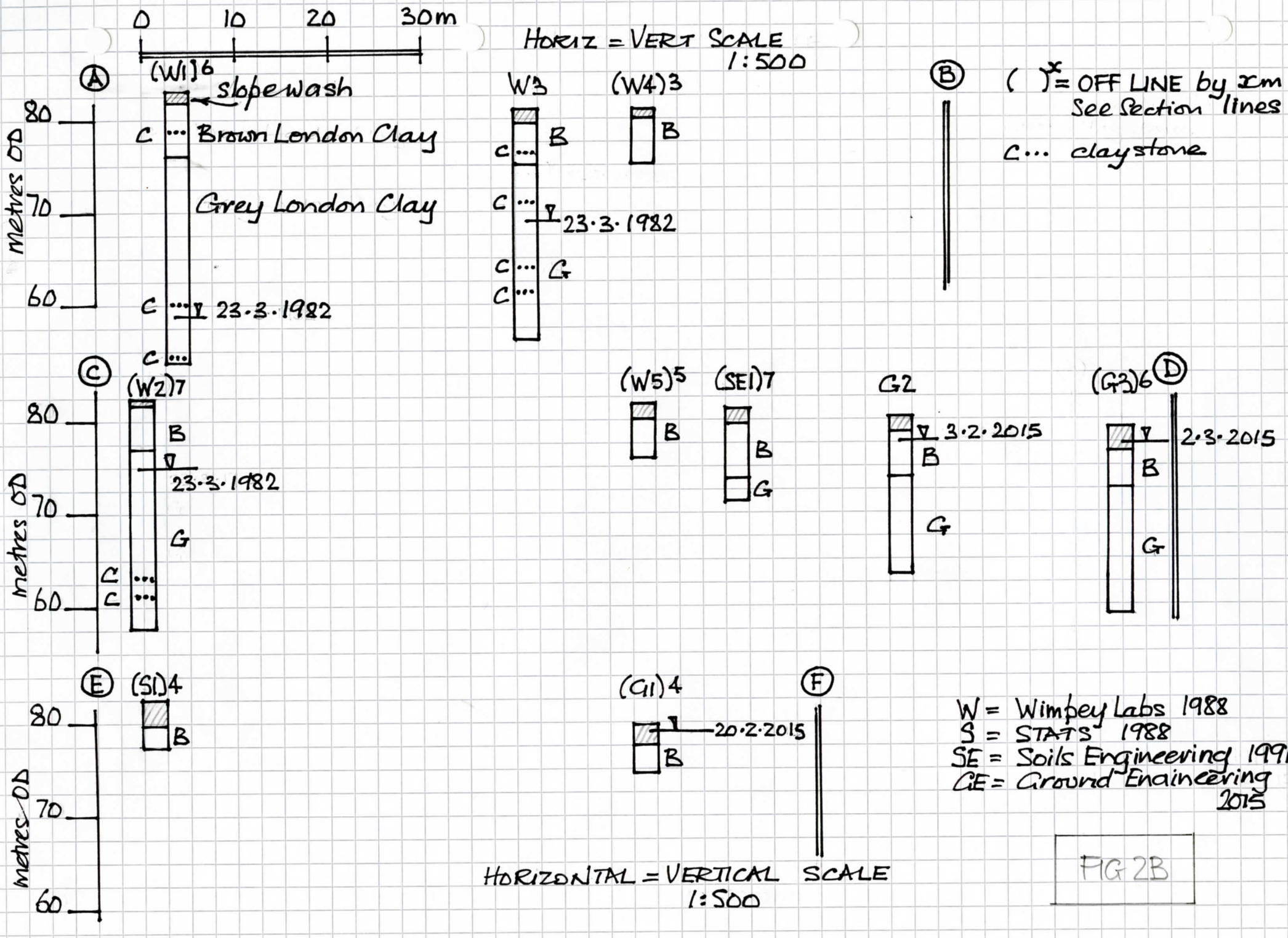
FIG 4A



Vibration Section G-H

SCALE 1:500 Horizontal = Vertical

FIG 3A


0
10
20
30m
HORIZ = VERT SCALE
1:500
A
(W1)6
slopewash
Brown London Clay
Grey London Clay
23·3·1982
80
70
60
metres OD
W3
(W4)3
B
C
G
23·3·1982
B
(W5)5
(SE1)7
G2
3·2·2015
(G3)6
D
2·3·2015
C
(W2)7
E
(S1)4
(G1)4
20·2·2015
F
( )x = OFF LINE by x m
See Section lines
C... claystone
W = Wimpey Labs 1988
S = STATS 1988
SE = Soils Engineering 1991
GE = Ground Engineering 2015
HORIZONTAL = VERTICAL SCALE
1:500
FIG 2B

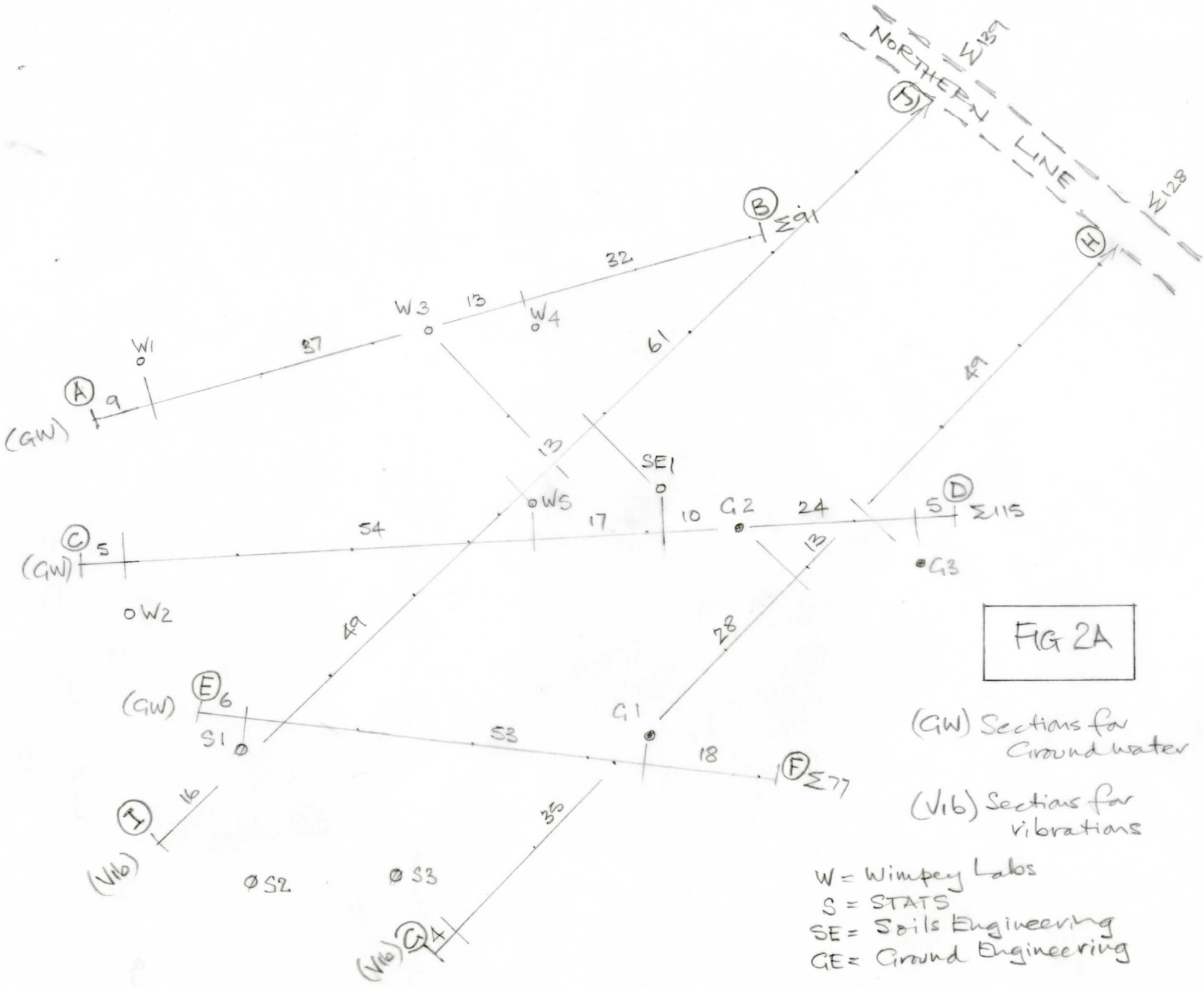


FIG 2A

(GW) Sections for Ground water

(V16) Sections for vibrations

W = Wimpey Labs
S = STATS
SE = Soils Engineering
GE = Ground Engineering

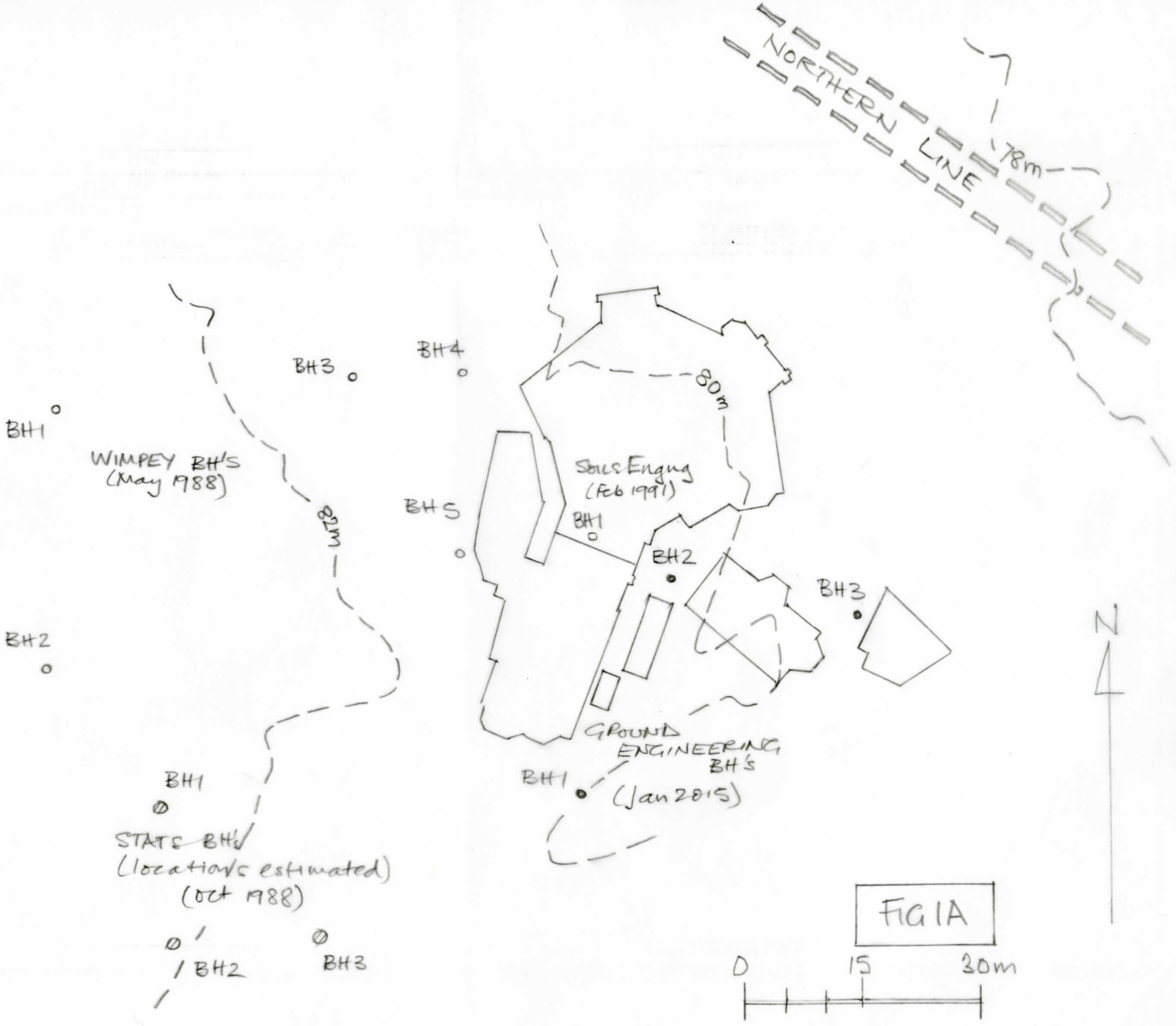

NORTHERN LINE
78m
80m
BH4
BH3
BH1
WIMPEY BH's
(May 1988)
BH5
Soils Engng
(Feb 1991)
BH1
BH2
BH3
BH2
GROUND
ENGINEERING
BH's
BH1
(Jan 2015)
BH1
STATS BH's
(locations estimated)
(Oct 1988)
BH2
BH3
N
0
15
30m

FIG 1A