Arch. Techniques

June 6, 1963

Mr. A. D. Perry
Project Manager
Department of Northern Affairs and National Resources
Fortress of Louisburg, Restoration Section
Louisburg, Nova Scotia, Canada

Dear Mr. Perry:

Since I am just now back from Italy, I came across your letter of April 11, regarding instrument survey at the Fortress of Louisburg. This interests me very much and I feel sure our ASCA group would like to have a crack at it.

At the moment, Dr. Ralph is in Italy and Carsons is in Michigan on similar surveys. Both will be occupied for most of the summer, but, all of us will be here in the fall. I wonder if there are a possibility of working this out in the fall, before it gets too cold. All of the instruments should be available before the first of September and all the staff should be here by that time.

Please let me know if this is a possibility.

Most sincerely,

Froelich Rainey
Director

FR/vv

Vlc

April 18, 1963

Mr. A. D. Perry
Projedt Manager
Department of Northern Affairs and National Resources
Fortress of Louisburg, Restoration Section
Louisburg, Nova Scotia, Canada

Dear Mr. Perry:

It is true that we are interested in the development of underground prospecting, but at the moment Dr. Rainey and Miss Ralph are abroad. Mr. Carson might be available after the first part of July, but, we do not have a magnetometer here and Mr. Carson does not feel that it would be possible to locate the graves accurately, with any equipment that he now has on hand.

I do not know when the magnetometer will be returned. Presumably not until quite late in the summer. It would not be possible for us to dend Mr. Carson in any case, since there is nothing in our budget to cover such an expense.

I am sorry to be so discouraging, but I am afraid that we cannot help you during the time that you would like to have this work done.

Sincerely yours,

Alfred Kidder II
Associate Director

AK/vv

Mr. Carson

YOUR FILE NO.

OUR FILE NO. 325

What do you think of this?

A. Rudder [?]

CANADA

# DEPARTMENT OF NORTHERN AFFAIRS AND NATIONAL RESOURCES

NATIONAL PARKS BRANCH

FORTRESS OF LOUISBOURG
RESTORATION SECTION

LOUISBURG, NOVA SCOTIA

April 11, 1963

Professor Froelich Rainey,
Director
Museum Laboratories
University Museum
University of Pennsylvania
Philadelphia, Pa.

Dear Doctor Rainey:

We understand from Mr. Edward McM. Larrabee, Senior Historical Archaeologist on this project, that you are interested in sending an operator and a resistivity meter, of the sort used experimentally at Harpers Ferry by Mr. Hamilton Carson, to the Fortress of Louisbourg for tests which might yield data useful to us and provide further knowledge about the resistivity meter and possibly the seismic surveyor. Mr. Larrabee discussed the possibility with Dr. Elizabeth Ralph about six weeks ago.

At the moment we do not have an area adequately prepared for the resistivity meter, and so will discuss this with you at a later date. In the meantime another matter of some urgency has prompted this letter.

We are going to undertake the excavation of the Chapel, one of many rooms in the Château St-Louis (1720-1760). We know of at least one burial here, that of the Duc D'Anville, and suspect that there may be others. We are anxious to know the location of the areas of disturbance likely to denote graves, to minimize the chance of injuring the burials. It is proposed to expose <u>in situ</u> any burials we unavoidably find while excavating for structural information, to record them, and then to cover and mark the graves. The entire Château will be reconstructed within a few years, and the graves are an integral part of the Chapel.

........./2

Mr. Larrabee and Mr. Iain Walker, the Junior Historical Archaeologist, who has seen work in Britain with such devices, tell me that a proton magnetometer survey would be the most likely way to discover density differences indicative of graves. They also propose a magnetometer survey of the Terreplein of the King's Bastion, an area adjoining the Château.

A physical description of the Chapel follows. It's inside measurements are about 40 ft. by 60 ft., with no known internal foundation partitions, so that the earth should be open for this entire area. The stone walls are about 2 ft. thick, and project from 1 ft. to 2 ft. above the present ground level. We expect, judging from other rooms excavated, that these walls will extend from 5 ft. to 8 ft. below the surface. Bedrock may be from 4 ft. to 10 ft. deep. The wall trenches may have been dug to bedrock, or may only extend into hard sub-soil. The natural soil is a heavy clay, with some gravel and boulders on bedrock. At this season (and, indeed, most seasons) the soil is saturated. We do not expect a surface layer of rubble.

The entire Chapel is enclosed by a shed, and heated, so that a survey could be carried out regardless of weather conditions. The area has been gridded, which would facilitate magnetometer survey. We expect soil conditions to be favourable to the machine, but know that you are interested in testing devices under different conditions. There are no electric lines nearby.

We are also anxious to publicize our work here, and would try to gain local and international press coverage to the experiment and to any participation on the part of the University Museum Laboratories.

If you have a magnetometer and operator available for a short time, and can cover the expense of sending both here, we will house and feed the operator, make full office, drafting, photographic,

........./3

and other facilities available, and cover incidental expenses. We would like to start in the Chapel by June, when the full excavation season begins. However, we could probably work elsewhere for a while if you thought you had no one available until later in the summer.

Perhaps you know where we might obtain an operator, if you do not have one. Neither of our archaeologists has operated a proton magnetometer. Mr. Larrabee has operated your resistivity meter and seismic surveyor, but stresses the fact that interpreting the results requires much more experience than merely operating the devices in the field. It would be preferable if a skilled operator conducts the tests and works up the data here. For this reason we doubt the utility of merely borrowing, say, the resistivity meter. Perhaps Dr. Ralph's Ultra-Sonic device might be tested here profitably.

In short, we have need of a survey now. The area to be tested is fully prepared, well bounded, and is not large. A survey could probably be run in one day. The results are usually best worked out with the site handy for further reference. This could also be done in relatively short time, making it a very quick project. If more time is available, I have already mentioned the tests we would like to do in the King's Bastion.

We realize that a request such as this finds plans and schedules already made far in advance. However, we need the survey, and will greatly appreciate any help or information you are able to give us.

Yours very truly,

for A. D. Perry
Project Manager

JR Thompson

REPORT OF
LOUISBOURG SURVEY
by E. M. Larrabee

Mr. F. J. Thorpe,
Research Director.

Edward McM. Larrabee,
Senior Historical Archaeologist

November 1, 1963

Preliminary report on surveys conducted by
Professor Elizabeth Ralph in August - September, 1962.

Following negotiations conducted first with Dr. Froelich Rainey, Director, and then with Professor Elizabeth Ralph, Associate Director, of the Applied Science Center for Archaeology, the University Museum, University of Pennsylvania, Philadelphia 4, Pennsylvania, it was arranged that Professor Ralph should come to Louisbourg to examine the Chapel (and other areas if possible) by means of a number of specialized instruments. Professor Ralph arrived on the afternoon of Tuesday, August 27th. She worked every day from Wednesday, the 28th through September 2nd, Monday. (Labor Day) On Tuesday, the 3rd. she ran a few lines in the morning, finished preparing her preliminary graphs and charts for presentation, and made a television appearance at suppertime. She started driving back on her return trip on the morning of Wednesday, September 4th.

Miss Ralph was assisted in her work by Mr. Larrabee, Mr. Walker, Mr. Harrison, Mr. Dunton, and Miss Linnamae. Some of the instruments required only the operator and one assistant, some, like the resistivity meter, worked fastest with three people. During her stay, Professor Ralph was housed in the guest house, and fed breakfast and supper at the cookhouse. These were the only costs of her stay and her work to the Project.

The instruments she brought were a proton magnetometer, a "Geohm" resistivity meter, a seismic surveyor and a metal detector. The proton magnetometer is themost versatile of these instruments. It measures minute difference in the earth's magnetic field. These are measured along a grid, and a contour chart is drawn of these differences, indicating disturbed areas of eath. The Geohm resistivity meter measures the resistance between two points, and to a depth which is roughly equal to the distance apart of two points. Thus, if intervals are taken at a wide spacing, you read the resistance of a lower depth than if the rods are placed with a close spacing.

The seismic surveyor works by dropping a weight, with an electric connection attached. An instant signal is given to the geophone though the electric connection, and the impulse which travels through the ground is heard later by the geophone. The instrument measures the difference betwpen the electrical and the sound signals, which allows one to plot the depth at which the major changes of density occur. It is chiefly useful for finding thick layers of material differenct from the normal strata. For instance, it is capable of finding sand or gravel strata in the clay and particularly good for finding the depth of bedrock. It is not sensitive to minor changes. The fourth instrument was a metal detector. This is of very little use since it responds only to iron, with an aural signal so that different intensities must be juedged subjeectively. It is only sensitive to iron buried at a shallow depth. The proton magnetometer was used in all areas where work was carried out, and the resistivity in two of them. The other devices were only briefly tested.

In the Chapel, the proton magnetometer was used to produce a chart of magnetic and anti-magnetic areas. The most obvious disturbances were associated with the concrete vault built in the 1930's to surround the burial of the Duc d' Anville. The concrete itself was highly magnetic, and there were strong anti-magnetic reactions on each side, as a result of the mass of cement, and of whatever iron is involved in it. The concrete vault lies behind the headstone (toward the south-east). It is aligned with the length of the Chapel. There were four areas, each about three feet wide and from seven to ten feet long, which looked very much as if they were graves. Two other areas are about two feet wide and four or five feet long. There are five or six other magnetic spots, but they are not elongated. The four long disturbances and the two shorter ones areall aligned across the Chapel, and all lie within the center third of the length of the Chapel. One of them is near the center of the floor but the others are all toward the sides. Their location suggests that the alcoves made by the buttresses on the walls may have served as burial alcoves or crypts. It should be mentioned that in several cases the long disturbances line up across the chart with several of the small disturbances. The entire phenomena may be explained, when the area is excavated, by a series of stone supports for roof columns. However, the size and range of at least some of the disturbances are highly suggestive of graves.

Resistivity readings were taken in the Chapel with the space between the two rods from which readings were taken attwo and a half feet, then again at five feet, and the results of both of these were plotted along with a final grid plotting the difference between them.

In all of these the deep disturbance made during the 1930's by the exhumation of the Duc d'Anville and the construction of the concrete box were evident. The wide spacing and the differences between the spacing gave measures too gross to be significant. At two and a half foot intervals, the readings showed a number of features in the same area as the graves, and aligned with the graves, but spaced between them. This may represent a reaction to the disturbed areas, and possibly show magnetically as the valleys between the area of high electrical resistance. The alignment of these features across the Chapel also may be explained by major structural support. Again, these features are concentrated within the central third of the length of the Chapel, and stretch from side to side, with most features being near the sides. There are some resistances near the doorway of the Chapel and some near the south corner. As these may both be entrances, this may indicate some structure associated with doorways.

The seismic survey of the Chapel was taken along two longitudinal lines. Readings indicated that depths of bedrock near the main entrance to the Chapel (north-west end, which opens to the passageway between the halves of the Chateau) ranged from 4.1 to 6.1 feet. A reading near the south corner of the Chapel, midway between the Duc D'Anville's tomb and the south-west wall, suggested a bedrock reading of four and a half feet. There was another change in speed of sound transmission at nine feet, which may represent the water table.

A series of proton magnetometer lines will run across the northern end of the terreplein. The magnetic areas toward the right face suggested a change in the original contour which the French had filled. The most noticeable features were two, or perhaps three, aligned and highly magnetic areas. These were long and narrow, and suggested either an iron pipe, in disconnected sections, or two or perhaps three cannon. It would be hard to explain such masses of iron in other ways. These lay about fifteen feet north of the capital of the line terraplein, and between thirty and forty feet south-west of the Chateau.

Readings taken over the left re-entrant Place d'Armes, with both the proton magnetometer and the resistivity meter confirmed the existence of a long disturbance, which is probably the tunnel indicated in this area by historical documents. This seems to run under the right flank of this Place d'Armes. The entry seems to be in the counterscarp approximately eighty feet to the West of the Right re-entrant angle of this Place d'Armes. ~~Here the resistivity meter was useful because of the great depth at which the feature was buried.~~ Another survey line was run along the perimeter of the Queen's Bastion which located the tunnel of the postern there. Since this tunnel was already generally known, this line was run to test the Proton Magnetometer over an expected feature. A more complete report will be made following the excavation of each of these features.

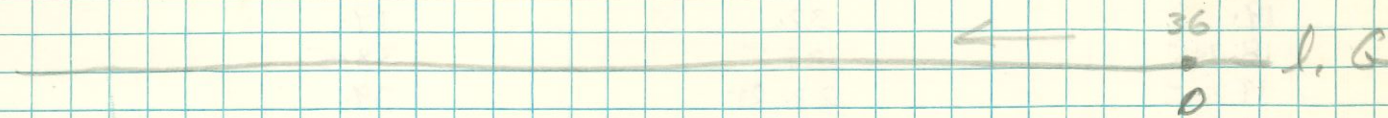
Edward McM. Larrabee

Edward McM. Larrabee,
Senior Historical Archaeologist

E.McM.L./ym

Chapel Seisomograph 8/29/63

Line G , start at line 36 , to 25




Meter

0 - 5
12
1.5
1.25
12.25
12
12.25
4.5
12.25
12.25
3.75
5.
4.75
———
12.25

1 - 8.75
7.25
1.75
6.25
15.5
15.
.75
15.25
4.5
———
15.25

2 - 3.75
7.75
7.
7.75
3.25
7.25
5.25
8.5
17.5
6.5
21.
8.75
———
17.5

3 - 9.5
3.25
2.
1.25
12.25
.75
12.5
11.75
11.75
2.
2.25
5.25
19.5
———
19.5

4 - 12
.75
1.25
12.
7.5
20.75
13.25
12.5
.75
5.25
20.75
14.
.75
———
20.75

5 - 19.75
19.5
19.75
8.
19.75
19.25
1.
} gain 7

Gain 9
4
8
3.25
14.
16.25
7.5

Gain 5
19.5
19.5
17.25
19.5
14.5
———
ave - 19.5

6 - 13.5
11.5
19.
19.
18.75
19.25
18.5
19.

[19]

7 - 22.25
18.75
19.
19.25
19.25
19.
19.

[19]

8 - 20
19
19.25
19.25
19.25
19.25
19.25

[19.25]

9 - 23.75
21.25
21.
21.
24.5
21.5
27.75
31.25
28.25
16.25
21.25
21.25

[21.25]

10 - 39.5
2.25
45.25
37.
23.5
23.25
37.25
61.25
39.5
29.25
39.75
39.75

[~~39.75~~] 23.25

11 - 40.
22.25
39.75
22.5
22.5
22.75
22.5
22.5
22.25

[22.5]

12 - 37.5
22.5
37.5
37.
37.5
37.
22.25
22.
22.
38.
30.
25.25

[~~37.5~~] > [22.25]

13 - 23
38.25
38.5
19.
38.5
39.
38.5
40.25
46.5
1
39.
38.5

[~~38.5~~] 23

14 - 59.5
40.25
40.
51.75
51.75
51.75
51.5
52.
51.75

[~~51.75~~]

15 - 52.5
52
57.
61.25
67.75
61.25
61.25
61.25
65.75
61.25
67.75
61.25
61.25

[~~61.25~~]

16- 5.25
41.
41.
41.
41.
41.

~~41.~~

17- 23.25
41.25
61.25
61.25
41.75 (bugger)
61.25
60.
23.75
33.75
52.25
64.25
28.
61.5
61.25
37.75

~~61.~~ 23.5

Retakes: on gain 5.

5- 43.25
21.25
28.75
28.25
19.25
19.75
31.
20.
20.75

Test , NE of picnic area by bridge to main road:

8/29/63

2 -
17.75
2.
18.
12.
18.5
43.25
3.25
18.25
.5
5.
8.25
1.75
18.5
8.5
9.5
———
18.25

4 -
21.25
4.
6.
12.25
6.75
7.75
22.
21.5
21.5
8.5
1.
21.5
4.5
8.25
21.5
3.25
———
21.5

6 -
19.5
36.5
36.75
36.5
19.5
9.5
16.
20.
36.
36.5
1.5
8
35.
33.
2.25
12.
———
19.5 & 36.5

8 -
8.25
4.5
5.
5.
7.
7.
6.5
8.
9.5
8.25
9.5
10.25
9.75
10.
11.
12.5

10 -
32.5
5.75
10.
6.
.75
6.5
6.5
7.25
7.5
3.75
21.
5.
10.5
20.5
36.25
13.75
7.5
6.5
1.75
4.
36.25
———
36.25 ? or 20.75

12 -
37.
40.
5 (gain from 5 to 7)
9.
6.5
13.
.25
11.
2.75
3.5
4.5
11.25
2.75
9.5
2.5
12.
19.75
13.25
———
7.

14 -
4.25
14.5
22.5
25.75
41.25
3.
7.
21.75
49.
17.75
12.25
12.25
11.25
.5
21.75
8.5
23.25
———
22 ?

16- 14.75
24.
24.5
2.
5.5
11.
32.5
36.5
24.5
.25
11.5
24.5
44.25
9.

24.5

18- 34.5
7.25
25.5
8.75
34.
40.
24.5
25.
16.25
34
5.25
8.
24.5
8.25
13.
5.
4.75

25 or 34?

20- 11.5
25.75
24.25
3.25
5.5
7.
10.5
13.
12.75
8.
.25
10.25
8.
12.5

Over right postern tunnel of Queen's Bastion: beginning from rt re-entrant ∠. 8/29/63

2 -
5.
6.
40.
8.25
1.
16.
15.
3.5
3.25
.75
3.25
(gain 7→5)
17.75 (gain 7→6)
28.
28.25
14.75

17 ?

4 -
5.5
6.
10.
7.5
8.5
33.
5.75
7.75
8.
10.25
7.5
9.5

7?

6 -
4.25
6.
4.
7.
6.5
25.5
34.25
7.
8.25
17.25
10.
7.5
17.25

17.50 ?

7 -
31.75
42.25
20.75
46.5
27.5
18.25
29.75
31.75
22.
1.5
48.25
30.
29.

~30

8 -
50.2 over tunnel
35.
68.25
28.5
35.
36.5
35.75
23.5
36.25
12.5
49.25
1.5
33.

35.5 ?

9 -
-37.25 other edge
20.5
-37.5
-37.5
-36.
-37.5
51.
-36.
-37.5
3.5
50.
4.
7.5
-37.

37.0

1.25
1.5
1.5
0
1.5
0
1.5
1.0

8.25

10 - 16.75
9.5
27.75
15.
56.
54.
55.
- 36. 0
- 36.5 +.5
55.
42.25
50.5
55.
- 36.25 +1.25
- 36.75 +.75
56.5 +1.50
- 37.5 3.50
36.6

12 - 17.25
27.5
21.25
17.5
18.5
17.25
39.
10.5
15.
10.5
32.25
21.25
40.
12.75
20.5
17.75
28.75
?

14 - 118.5
40.5
40.
134.
98.25
98.
40.25
61.25
19.25
70.25
9.5
56.9

57.5
41.5
98.5
76.5
40.25

Geophone over tunnel (at 8)

6 - 9.25
8.
.5
26.5
5.5
10.
11.
12.
11.25
13.75
1.5
3.25
9.75
13.75
3.
4.

4 - 21.
11.
2.5
15.5
5.
23.5
30.5
4.5
2.75
40.75
9.25
15.25
5.25
22.25
6.
3.25
11.5

2 - 43.75
19.75
6.75
14.75
11.25
3.75
6.5
16.5
16.5
9.75
7.75
22.25
14.75
10.75
5.75
5.
14.75

0 - 8.25

(gain 6→2)

Chapel Line D, N → S    8/30/63

Geophone at line 36

1 – .75
1.5
10.75
4.5
4.25
1.
1.25
.75
1.5
4.
4.5
.75
10.75
4.75

Geophone 1 m S of line 36

1 – .75
4.25
5.
5.5
5.25
5.25
5.5
5.5
5.25
1.5
.5
1.75 gain 6
13.75
4. gain 7
5.75
6.5
5.
2.75

2 – 1.75
8.
4.25
7.75
.75
8.75
8.75
1.75
17.25

2.75
7.75
8.25
2.25
5.5
6.25
3.5

3 – 6.5
.5
3.75
5.
1.5
8.75
9.75
2.
9.75
2.
9.25
7.75
1.25
1.25
9.75
5.5
6.5
18.25
10.25
3.25

4 – 9.5
7.25
1.
8.
9.
1.
7.75
1.75
8.25
7.
8.5
10.25
7.25
.5

5 – 2.25
.5
6.25
22.25
.5
1.5
1.5
3.75
1.5
4.5
9.75
2.5
22.25

6 - 9.
1.25
1.
1.
7.5
15.75
1.
10.5
8.25
4.
15.25
5.75
13.75
1.75
8.25
4.25

8 - 9.25
1.
13.75
3.25
8.
19.5
3.
1.75
8.25
5.
11.
10.
20.25
8.75
.25
4.5
9.5
1.5

7 - 1.
1.5
1.25
.5
.5
1.5
1.
1.75
1.5
8.
.25
7.25 gain 9
8.25
8.
5.25
6.25
1.
15.5
7.75
8.5
1.5
9.
7.75

9 - 9.
6.5
9.75
.5
1.
4.
1.
.5
1.25
1.5
1.5
4.
1.

Geophone 1 M N of wall

2 - 5.25
1.5
1.5
6.5
5.5
5.75
3.25
5.75
8.25
7.25
3.5
7.
4.75
1.25
1.25

3 - 1.5
4.75
8.
6.75
1.
1.5
4.
1.
1.
8.25
.75
6.5
3.75
4.
.25

4 - 3.75
6.5
1.5
9.25
1.5
8.25
1.75
1.5
8.5
4.25
5.
9.5
9.75
6.25
8.25

5- 3/4
8 1/4
9 1/4
11 1/2
9 1/4
9 3/4
6 1/4
4 3/4
9 3/4
1 1/2
8 1/4
9 1/2
3/4

---

2- gain at 1- (re-set)

13 1/2
13 1/2
14

3- 14 3/4
14 1/2
14 1/2

4- 15 3/4
15 3/4
15 1/2

5- 18
18 1/2
18
18

6- re-set at 4

20 1/4
12
12 1/4
19 1/2
20

6- re-set at 3

20
20 3/4
20 1/2
19 3/4
20 1/4

7- re-set at 4
19 3/4
11 1/4

re-set at 3 1/2

19 1/2
54 1/2
19 3/4
20 1/2
19 1/2
19 3/4

8- 18 3/4
19 1/2
19
4 1/2
18 1/2
18 3/4
18 3/4
19 1/4

9- 21 1/4
37 1/4
21 1/2
21 1/2
21 3/4
21 1/2

10- 21 3/4
22 3/4
22 1/2
16 1/2
23 1/2
22 3/4
16 1/2
21 1/2
15 1/4
17
15 3/4
16 1/2

re-set at 2

21 1/2
15 3/4

re-set at 3
17
15 1/2
15 1/4
16
22 1/2
16

11- re-set at 5

3/4
14 1/2

re-set at 4

21 1/4

re-set at 4 1/2

12
21 3/4
46
21 1/2
22 1/4
12 3/4
21 1/2

12- 18 1/4
10 1/2
10 3/4

re-set at 4

21 1/4
20 3/4
20 1/2
20 1/4
21 1/4
35 1/2
22
20 1/2

13- 21 3/4
21 3/4
21 3/4
22

14- re-set at 5

12 3/4

re-set at 4 1/2

23 1/4
22 1/2
15 1/4
22 3/4
13 3/4
23

15- 22 3/4
22 3/4
22 1/2
22 1/2
22

16- 24
24
23 1/2
23 1/4
12 3/4
23 1/4

17- re-set at

16 metres from machine

20.5
12.5
8

968

V.

968
333
635
1301

.7

572
333
239
905

2 | 7.72
3.86

Chapel Line D N → S 9/1/63

Geophone at line 36

Grid 1 1 M. 11 1/4

11 1/2

11 1/4

11 1/2

2 11 1/4

11

11

11 1/4

3 13 1/2

17 3/4

13 1/4

13 1/2

13 1/4

4 3/4

19 1/2

19 1/2

19 1/2

19 1/2

5 17

17

reset 1 1/2

17

17

16 3/4

6 35 3/4

re-set at 2

36

re-set at 2 1/2

19 1/4

35 1/4

re-set 3

19 1/4

19 3/4

19 1/2

II

19 1/2

19 1/2

19 3/4

7 40 3/4

re set 3 1/2

20 3/4

20 3/4

21

8 re-set 4

36 1/4

re-set 4 1/2

30 3/4

re-set 5

20

20

12 1/2

20 1/4

9 18 1/4
18 1/2
26
18
18 1/4

10. 50 3/4

reset 5 1/2

40

reset 6

3/4
1

reset 5 1/2

12 3/4
1

reset 5

19 3/4
19 3/4
19 3/4

11.

1
12 3/4
11 1/2

reset 4 1/2

40 1/2
40 1/2
40 1/2
40 1/2

reset 5

40 1/4

reset 5 1/2

21 3/4

28 1/4
3/4
22
12
1
21 1/2

12 3/4
49 1/4
1
3/4
1 1/4
3/4
1

reset 5

49 1/4

reset 5 1/4

49 1/4

reset 5 1/2

12 3/4
3/4
3/4

reset 5

49 1/4
7 1/4

13

46
46

reset 5 1/2

19 1/2
1
19 1/2
1

3/4

19 1/2

14 1

19 3/4

13 1/2

19 3/4

19 1/4

15 69

reset 6

3/4

1

reset 5 1/2

1

1

3/4

reset 5

100

8

57

reset 5 1/4

57

reset 5 1/2

6 3/4

27 1/4

27 1/2

49 1/2

reset 6

1

3/4

3/4

reset 5

3/4

1

67 1/2

reset 5 1/2

1

3/4

1

3/4

reset 5 1/4

1

13 1/4

1

21

1

7 1/4

1

16. 7 1/4

27

20 1/2

22 3/4

20 1/2

7 3/4

27

21

27

27

17

1

14 1/2

9 1/4

reset 5

90 3/4

reset 5 1/2

11 1/2

10 1/2
12 3/4
63
81 1/2

reset 6

1
3/4

reset 5 1/2

1

reset 9

12 3/4
12 3/4
90 1/2

reset 5 1/2

90 1/2

reset 6

3/4

reset 5 3/4

3/4

reset 5 1/2

1
1

.945

5500
650
4850 .89
6150

5500
330
5170
5830

20.9

550
1100 2
5.5

2 ) 6.5
3.25

Geohm Line # 9 "Over Tunnel" 9/1/63
path of PM line #2 Spacing: 2, 3, 1, 4, & 5 meters
start opp. bench mark, line ~ 4 m N
~ W → E

**2 m**

| ohms cc | |
|---|---|
| 144,000 | 115 |
| 164.2K | 147 |
| 182K | 145 |
| 191K | 152 |
| 182K | 145 ← on 49 of line 2 |
| 172K | 137 |
| 148K | 118 |
| 127K | 101 |
| 89K | 72 |
| 85.2K | 68 |
| 81.7K | 65 |
| 78K | 62 |
| 83K | 66 ← parapet |
| 93K | 74 |

↓ 30m

**3 m**

| ohms cc | |
|---|---|
| 151K | 80 |
| 179K | 95 |
| 192K | 102 |
| 183K | 97 |
| 158K | 84 |
| 118.5K | 63 |
| 90.5K | 48 |
| 79.1K | 42 |
| 71.9K | 38 |
| 83K | 44 |

**1 m**

| | ohms cc |
|---|---|
| 158 | 99K |
| 160 | 100K |
| 182 | 114K |
| 188 | 118K |
| 232 | 146K |
| 246 | 153K |
| 250 | 157K |
| 260 | 162K |
| 246 | 155K |
| 240 | 151K |
| 223 | 140K |
| 218 | 136K |
| 220 | 138K |
| 236 | 148K |
| 200 | 126K |
| 222 | 139K |
| 136 | 85.2K |
| 138 | 86.5K |
| 108 | 67.9K |
| 135 | 84.8K |
| 134 | 84K parapet |
| 115 | 72K |
| 124 | 84K |
| 138 | 86.5K |
| 99 | 62K |
| 141 | 88.2K |
| 112 | 70.2K |
| 142 | 89K |
| 175 | 110K |
| 173 | 108K |

**4 m**

| | ohms cc |
|---|---|
| 62 | 153K |
| 70 | 176K |
| 74 | 186K |
| 58 | 146K |
| 57 | 143K |
| 37 | 92.9K |
| 27 | 67.7K |
| 32 | 80K |

**5 m** (start)

| | ohms cc |
|---|---|
| 48 | 151K |
| 54 | 170K |
| 42 | 132K |
| 38 | 120K |
| 26 | 81.5K |
| 24 | 75.2K |

$= R \times 2\pi \times 100 \times D$

$R_{sp} = R \times 628 \times D$ (D = spacing in meters)

628 × 2 = 1256.00

6.28 × 3 = 18.84

6.28 × 4 = 25.04

6.28 × 5 = 31.40

Geohm Line #10 over "tunnel" 9/2/63

Approx. 9 m W of Line #9

start at start of PM line #8

2-m spacing

| | dim/cm | | | | |
|---|---|---|---|---|---|
| 143 | 179 K | 95 (on gravel road) | 119 K | 136 | 170 K |
| 138 | 174 K | 153 | 192 K | 123 | 154 K |
| 168 | 210 K | 127 (opp. anomaly) | 159 K | 103 (opp. BM) | 129 K |
| 175 | 220 K | 188 | 235 K | 109 | 137 K |
| 190 (opp. anomaly) | 238 K | 171 | 215 K | 117 | 146 K |
| 208 | 260 K | 187 | 235 K | 117 | 146 K |
| 191 | 240 K | 168 | 210 K | 132 | 166 K |
| 199 | 250 K | 170 | 214 K | 117 | 146 K |
| 167 | 209 K | 149 | 187 K | 112 | 140 K |
| 162 | 203 K | 166 | 208 K | 100 | 126 K |
| 162 | 203 K | 146 | 184 K | 79 | 99 K |
| 145 | 182 K | 180 | 225 K | 79 | 99 K |
| 162 | 203 K | | | | |

12 m W of line 9 ↓

↑ ~9 m E of line 9

PM Line #19 — 6 m S | PM Line 20 — 3 m S | Line 21 — 3 m S | 9/2/63

| | PM Line #19 (6 m S) | | PM Line 20 (3 m S) | | Line 21 (3 m S) |
|---|---|---|---|---|---|
| 0 | Fe | | Fe | | Fe |
| 1 | 699 | | Fe | | Fe |
| 2 | 694 | | 752 | | Fe |
| 3 | 749 | | 810 | | 910 |
| 4 | 782 | | 810 | | 803 |
| | 838 | | → Fe | | 757 |
| | 897 | | Fe | ↓ | ↓ 729 |
| | 896 | ↓ | Fe | dirt | 688 |
| 8 | 760 | dirtpile | Fe | pile → | 653 |
| | 724 | | Fe | ↑ | 673 |
| 10 | 770 | | 769 | | ↑ 718 |
| | 763 | ↑ | 785 | | 724 |
| | 756 | | Fe | | 737 |
| | 785 | | Fe | | 724 |
| | 788 | | Fe | | 702 |
| | 761 | | 690 | | 724 |
| | 754 | | 754 | | 758 |
| | 721 | | 706 | | 751 |
| | 726 | | 669 | | 754 |
| | 738 | | 695 | | 734 |
| 20 | 721 | S | 710 | | 710 |
| | 714 | edge of large pile | 700 | | 646 |
| | 708 | ↓ | 695 | | 659 |
| | 687 | | 690 | | 706 |
| | 715 | | 694 | | 728 |
| 25 | 725 | ↑ | 682 | | 740 |
| | 714 | | Fe | | 741 |
| | 706 | | 670 | | 735 |
| | 708 | | 725 | | 728 |
| | 698 | | 714 | | 721 |
| 30 | 698 | | 709 | | 714 |
| | 651 | | 700 | | 708 |
| | 616 | | 682 | | 686 |
| | 650 | | 636 | | 661 |
| | 641 | | 655 | | 636 |
| | 627 | | 628 | ↓ | ↓ 609 |
| | 609 | | 611 | on higher | 588 |
| | 598 | | 597 | ground → | 564 |
| | 580 | | 592 | | 459 |
| | 567 | | Fe in gnd. | | |
| 40 | 563 | | | | |

Seismic Line 9/3/63

Start On PM Line #13, ⊥ line 13 & 15 m W of start of line 13

Set 1

1. 1
3
19 1/4
3 3/4
3 1/2
20 3/4

2. 12 1/2
50

reset 1 1/2

10 3/4
23 3/4
8 3/4
6 3/4
13

reset 1

6
12 1/4
48 1/4
7
6 3/4
13 1/4
6 1/4

3. 24 3/4
17 1/2
12 3/4
12 3/4
43 1/4
12 3/4
13
36 3/4
13 1/2
12 3/4
12 3/4

4. 23 3/4
23 1/2
20
20
19 3/4

5. 29
30

reset 1 1/2

40 3/4
30

reset 2
47

reset 2 1/2
23 1/4
45
30 1/4

reset 3
22 3/4

reset 3 1/2
53
23 3/4
28 1/2
41 1/4

reset 4
22 1/4
31 1/2
28

reset 5

18 1/2
27 1/4

41 1/2
41

reset 5 1/2
23 1/4
24 3/4
22

6 28
28 1/4

reset 6

32
68

reset 7
28
47 1/4

reset 8
12 3/4
48 1/4
16 1/2
23 3/4
25 3/4
30 1/4
41

reset 8 1/2
42 1/2
53
53 3/4

reset 9

reset 10

24 1/2
72 3/4
30 1/2

12
49
1/2

49 1/4

7 25
51 1/2

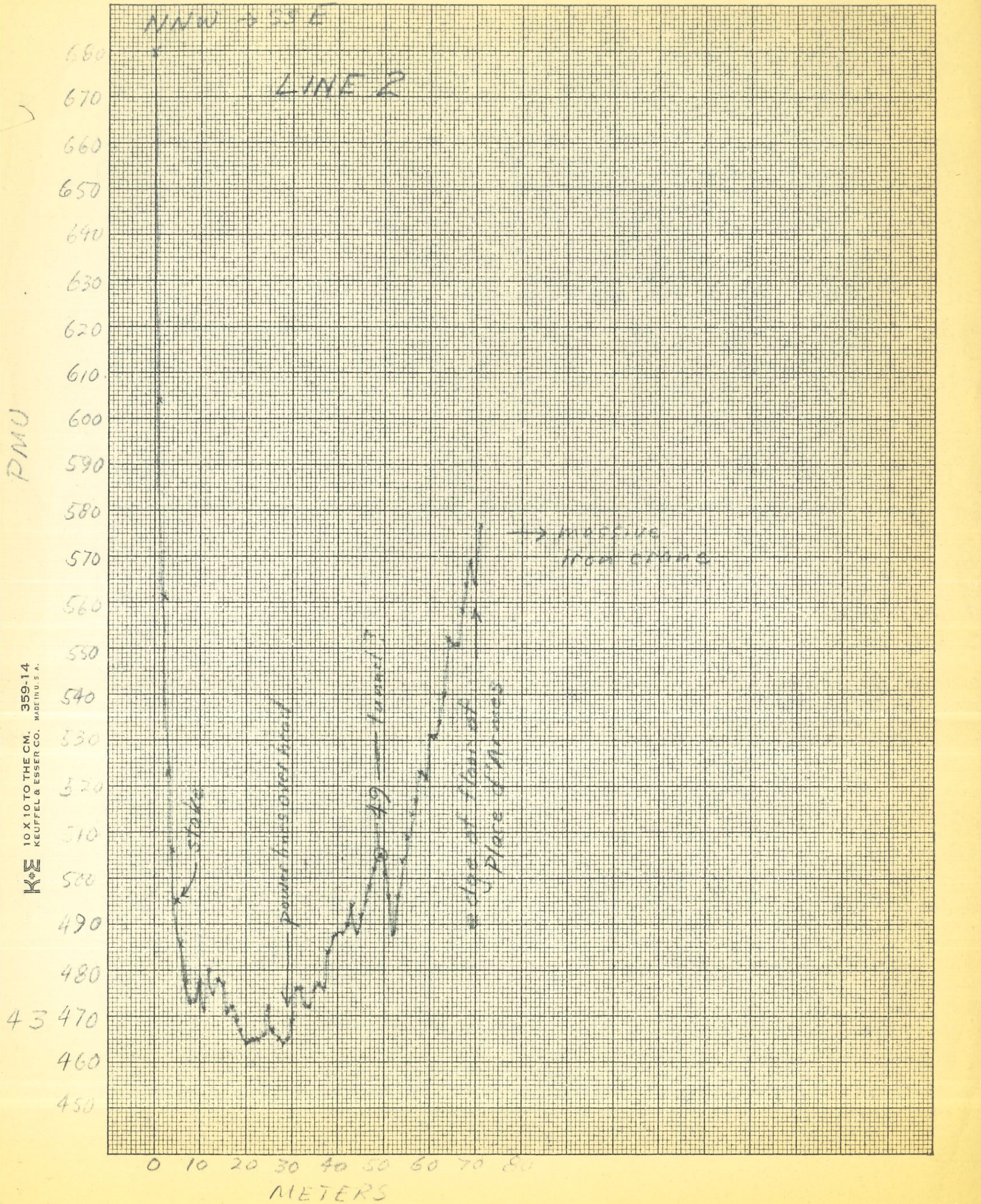
22

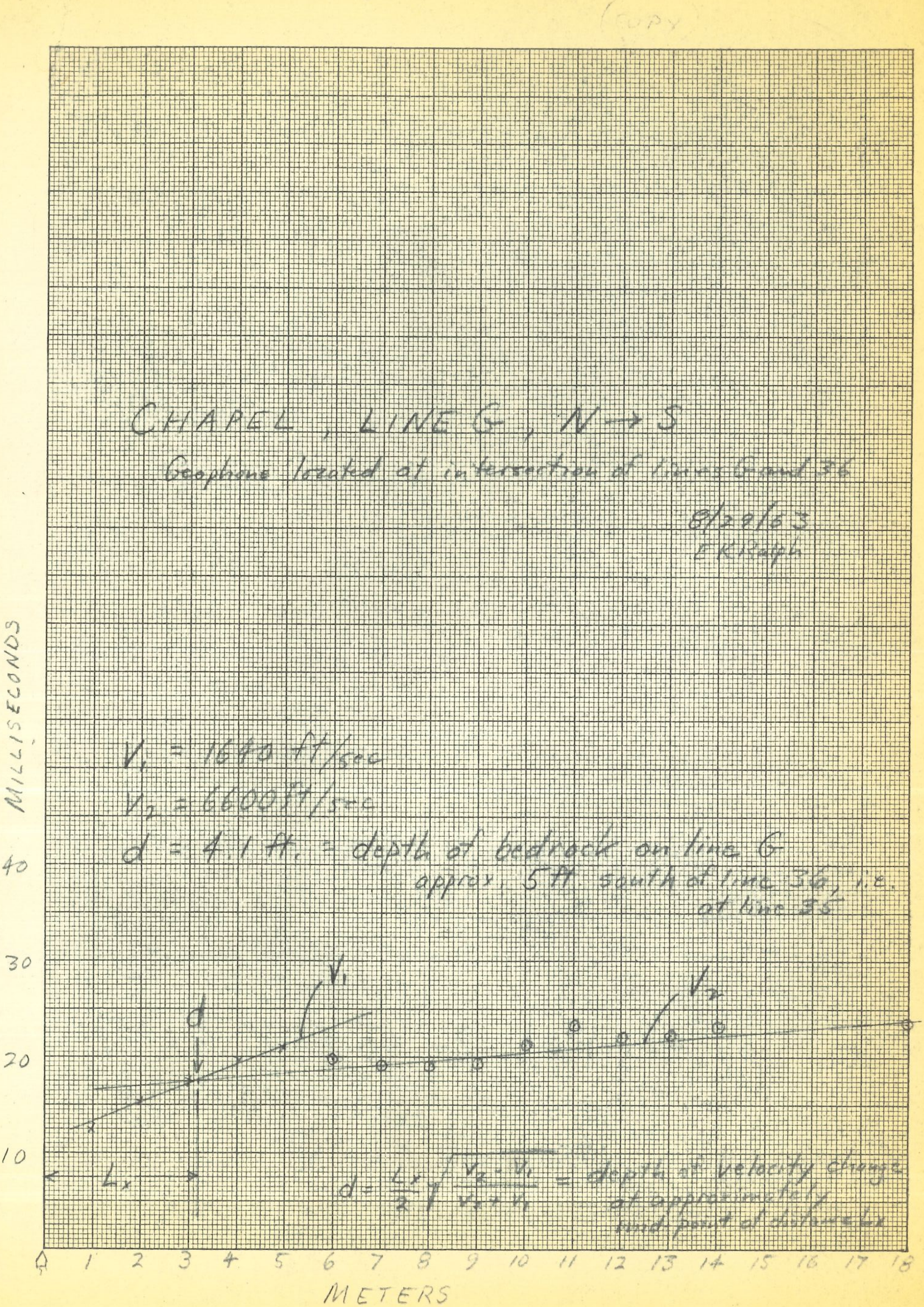
8 reset 9 1/2

15 1/2

P.M. LINES OVER "TUNNEL"

9/1/63




(COPY)
CHAPEL, LINE G, N → S
Geophone located at intersection of lines G and 36
8/29/63
E K Ralph
$V_1$ = 1640 ft/sec
$V_2$ = 6600 ft/sec
d = 4.1 ft. = depth of bedrock on line G
approx. 5 ft. south of line 36, i.e. at line 35
MILLISECONDS
40
30
20
10
$V_1$
$V_2$
d
$L_x$
$d = \frac{L_x}{2}\sqrt{\frac{V_2 - V_1}{V_2 + V_1}}$ = depth of velocity change at approximately mid point of distance $L_x$
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
METERS

Chapel Line D, S → N 8/30/63 EKRalph

(Finish at line 36)

Start (geophone location) 1 m N of S wall of chapel

Data taken after instrument gain was adjusted properly.

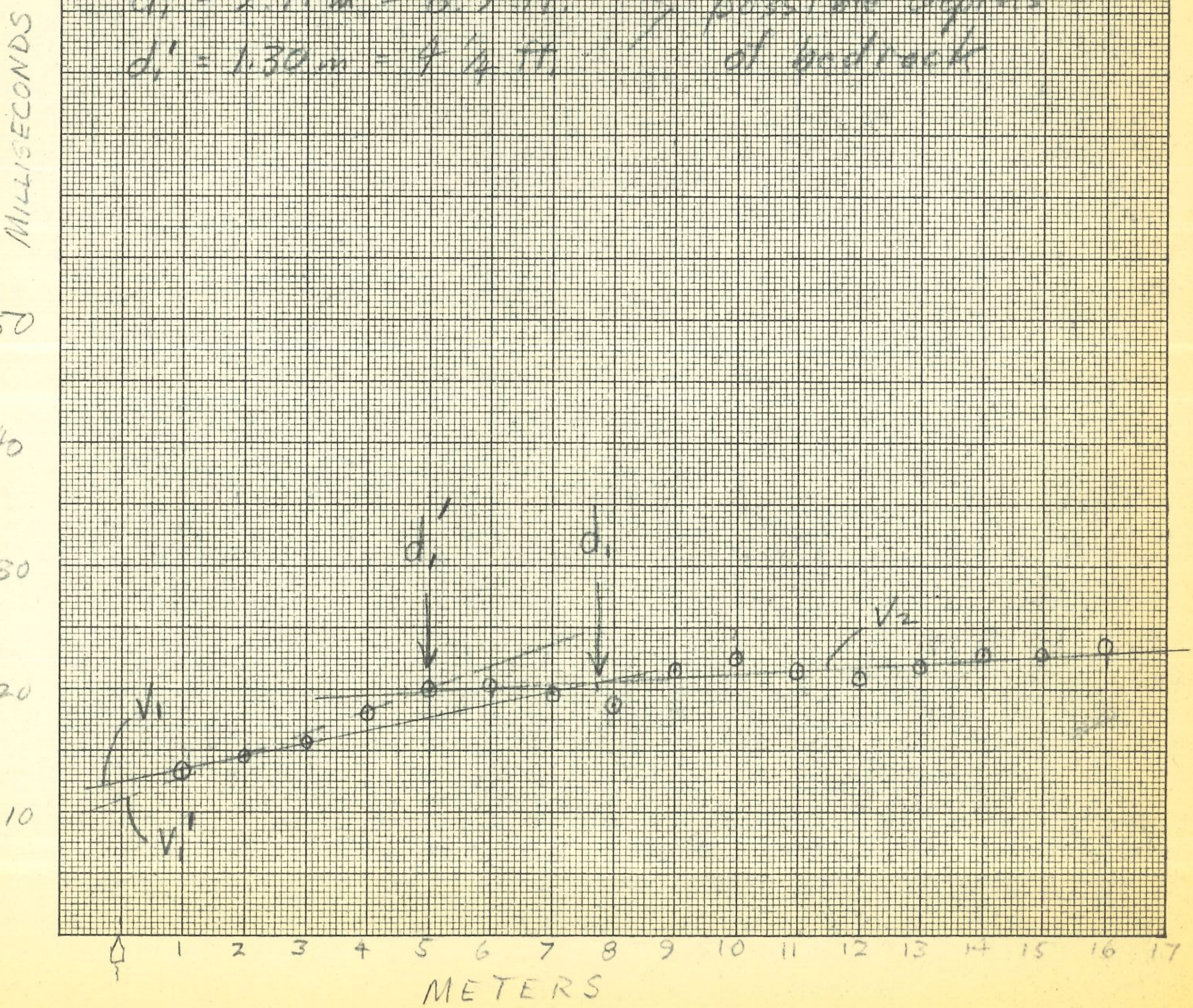
$V_1 = 968\ m/s = 3170\ ft/sec$

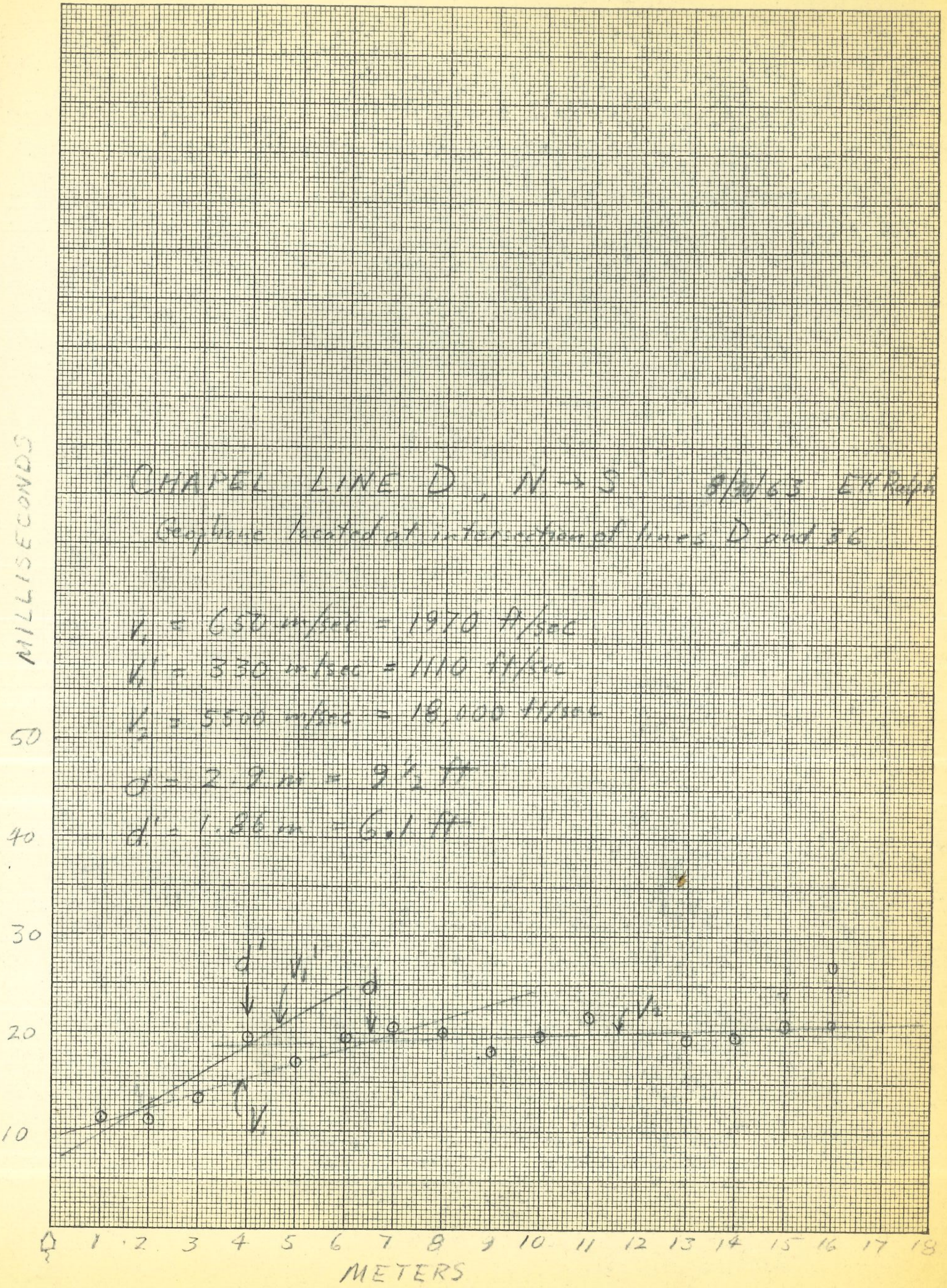
$V_1' = 572\ m/s = 1870\ ft/sec$

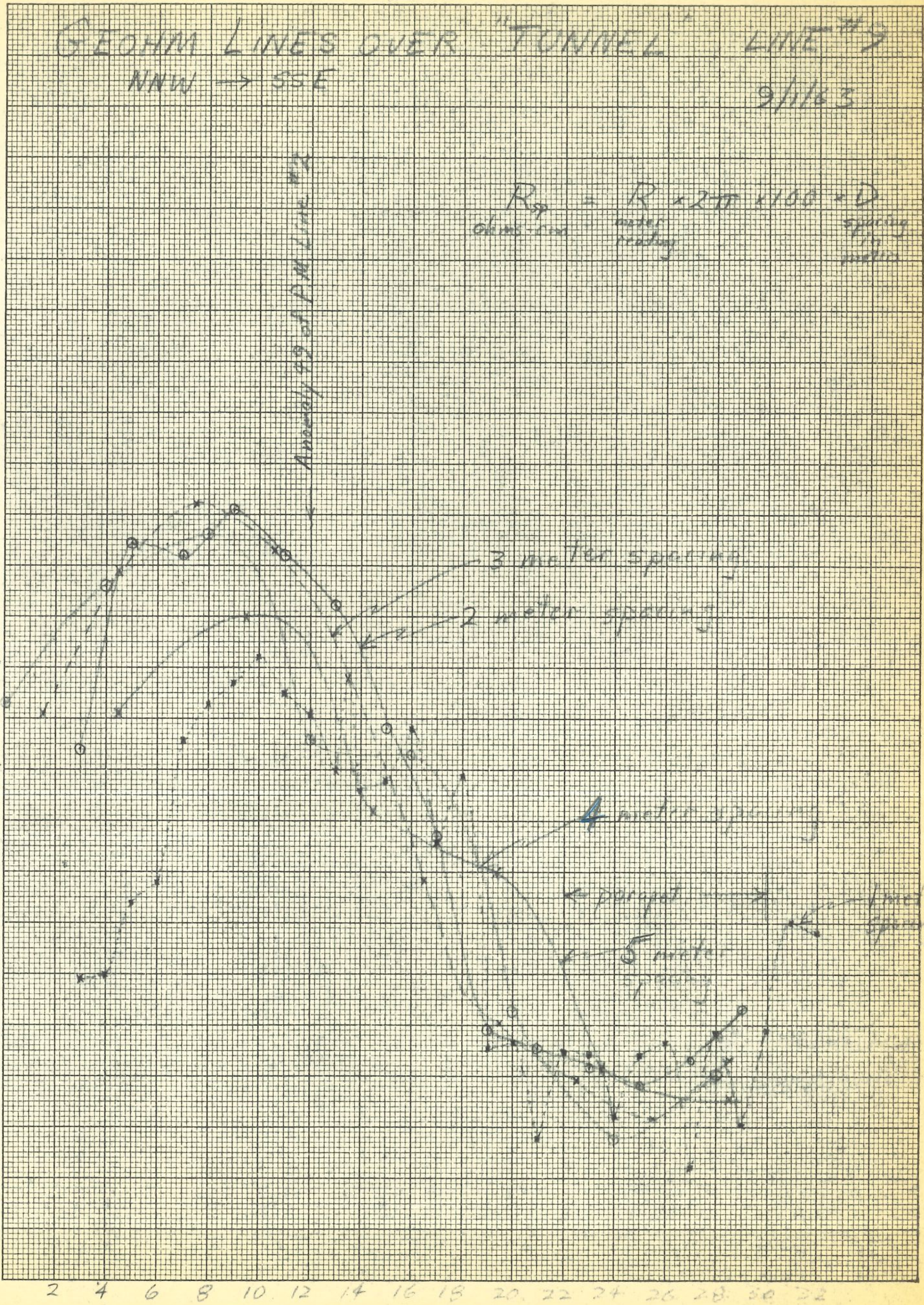
$V_2 = 3330\ m/s = 10,920\ ft/sec$

$d_1 = 2.71\ m = 8.9\ ft.$ } possible depths of bedrock

$d_1' = 1.30\ m = 4\frac{1}{4}\ ft.$

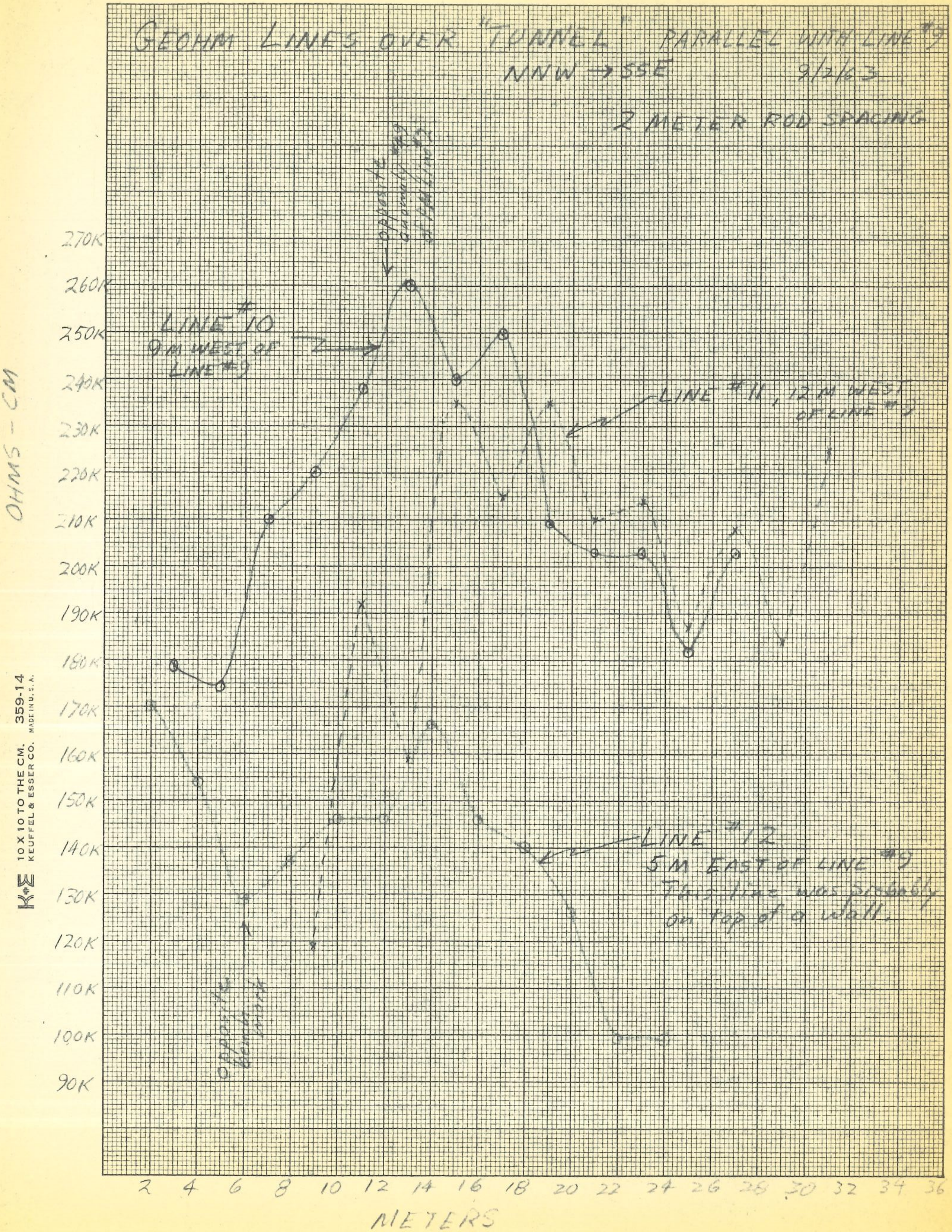



CHAPEL LINE D, N → S
Geophone located at intersection of lines D and 36
$V_1$ = 650 m/sec = 1970 ft/sec
$V_1'$ = 330 m/sec = 1110 ft/sec
$V_2$ = 5500 m/sec = 18,000 ft/sec
d = 2.9 m = 9½ ft
d' = 1.86 m = 6.1 ft
MILLISECONDS
METERS
10
20
30
40
50
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
d'
d
$V_1'$
$V_1$
$V_2$



GEOHM LINES OVER "TUNNEL" LINE #9
NNW → SSE
9/1/63
Rsp = R × 2π × 100 × D
ohms-cm
meter reading
spacing in meters
OHMS-CM
Anomaly #9 of P.M. Line #2
3 meter spacing
2 meter spacing
4 meter spacing
parapet
5 meter spacing
1 meter spacing
200K
190K
180K
170K
160K
150K
140K
130K
120K
110K
100K
90K
80K
70K
60K
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
METERS

LEFT FACE GLACIS



Dear Beth,
Some preliminary results from Louisbourg. Would you like any samples (Louisbourg or Fort Latour) for thermoluminescence?
Hugh

Geology Department,
Princeton University,
Princeton N.J.
November 6, 1965.

ARCHAEOMAGNETISM at Louisbourg, Nova Scotia, Canada

Dear Edward,

Below are the results of measurements on eight of the chateau oven bricks.

| BRICK | DECLINATION (degrees) | INCLINATION (degrees) | INTENSITY (e.m.u.) |
|---|---|---|---|
| 3 | 332.8 | 69.1 | $1.46 \times 10^{-2}$ |
| 4 | 346.7 | 71.4 | 9.45 " |
| 10 | 357.1 | 74.5 | 1.38 " |
| 12 | 353.3 | 76.3 | 1.55 " |
| 14 | 337.1 | 74.7 | 1.27 " |
| 16 | 337.0 | 73.5 | 3.16 " |
| 19 | 326.0 | 76.0 | 8.07 " |
| 21 | 330.7 | 71.6 | 4.72 " |

Mean Declination = 340.1

Mean Inclination = 73.4

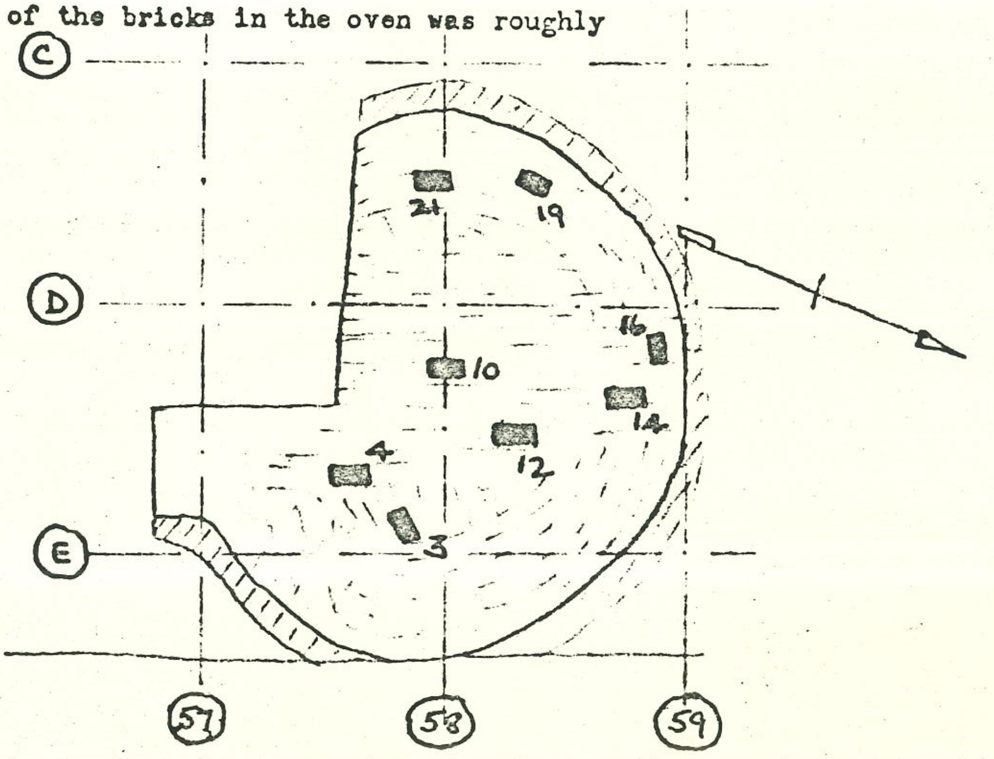
Dispersion Parameter k = 421

$\alpha_{95}$ = 2.7 degrees

Values of declination (from Dominion observatory)
1957 - 26° 15' W
1961 - 26° 06' W
ΔD is in easterly direction
My value is 19.1 W!

A few points:

1. The location of the bricks in the oven was roughly



2. The dispersion parameter k indicates the tightness of the grouping of the set of directions - the larger the value of k, the better the grouping. The value above is pretty satisfactory.

3. $\alpha_{95}$ is the semi-angle of a "cone of confidence" which can be drawn around the mean direction. There is only one chance in twenty that the true mean direction lies outside this cone of confidence.

4. I cut one inch diameter cores for the measurements. The eight results were obtained using only the top inch of such cores. Measurements made on the remainder of the core tend to differ slightly from those made on the top one inch ; for example, the results from brick 10 were

| | DECLINATION | INCLINATION |
|---|---|---|
| Top | 357.1 | 74.5 |
| Middle | 361.0 | 77.9 |
| Bottom | 354.1 | 83.3 |

There is a good chance that the bottoms of the bricks weren't heated sufficiently in the oven to wipe out all the magnetization acquired during their manufacture.

5. I've mislaid the variations since 1730 of declination and inclination in eastern Canada. Could you send me an extra copy?

6. I am doing further measurements;

   ( i) to get rid of any viscous remanent magnetization - this should improve the above accuracy;

   (ii) to find out whether or not the bricks retain any of their original (kilning) magnetization;

   (iii) a determination of the intensity of the earth's magnetic field at the time the bricks were last heated.

I've been away all summer in the Beartooth Mountains in Montana. Just great! Please send me a recent photo of the restoration work.

Best regards,

Hugh Murphy

22.0

2000
133
1867

$\sqrt{.88}$ .9 .9

19.6
3.4 ms for 7 m
$V_1 \sim$ 2000 m/s ~6600 ft/sec

6.6
3.0 ms for 4 m
$V_2 \sim$ 133 m/s ~440 ft/sec

$L_x$ = 11 m

30.5 cm/ft

21
13
8 ms for 4 m
$V_0 \sim$ 500 m/s ~1640 ft/sec

$$d_1 = \frac{11}{2}\sqrt{\frac{-[133-(-2000)]}{133+2000}}$$

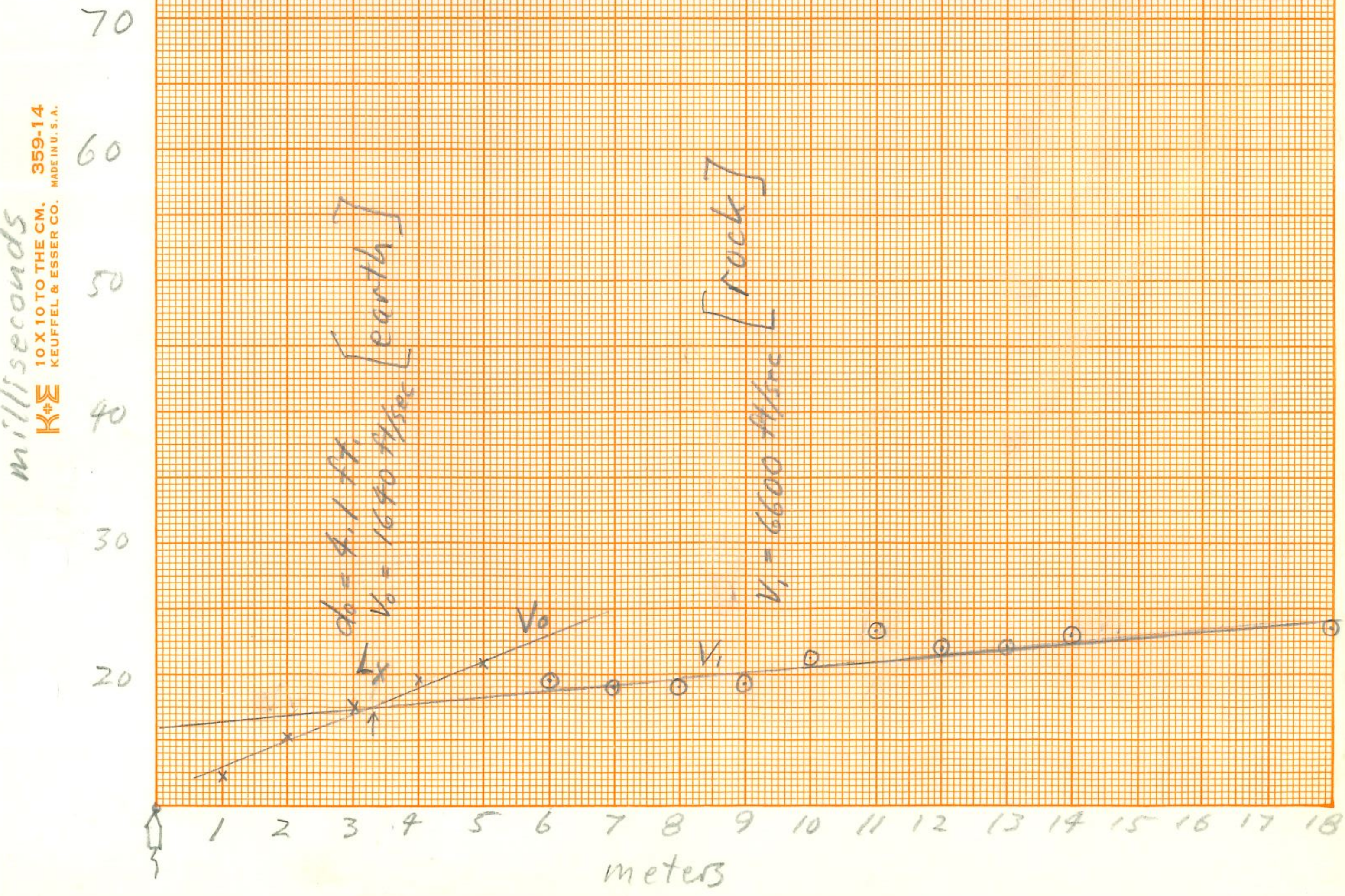
$d_1 = 6.5 \times .94 = 5.2$ m = 520 cm = 17 ft.

∴ $d_1$ at $L_x$ = 17 ft ~ sand layer?

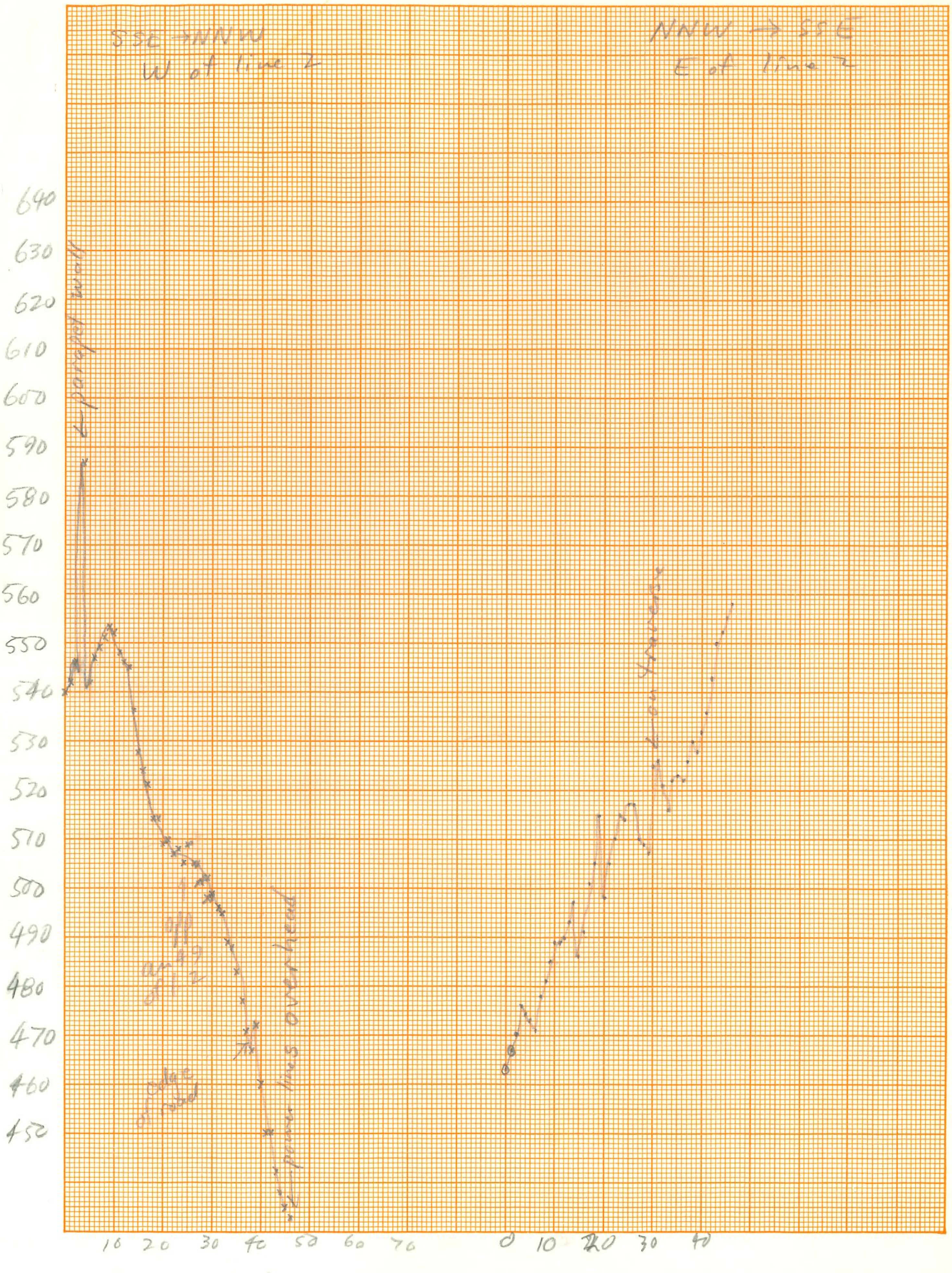
$$d_0 = \frac{3.3}{2}\sqrt{\frac{500-133}{633}} = 1.65 \times .76 = 1.25 \text{ m}$$

$d_0$ = 4.1 ft at $L_y$

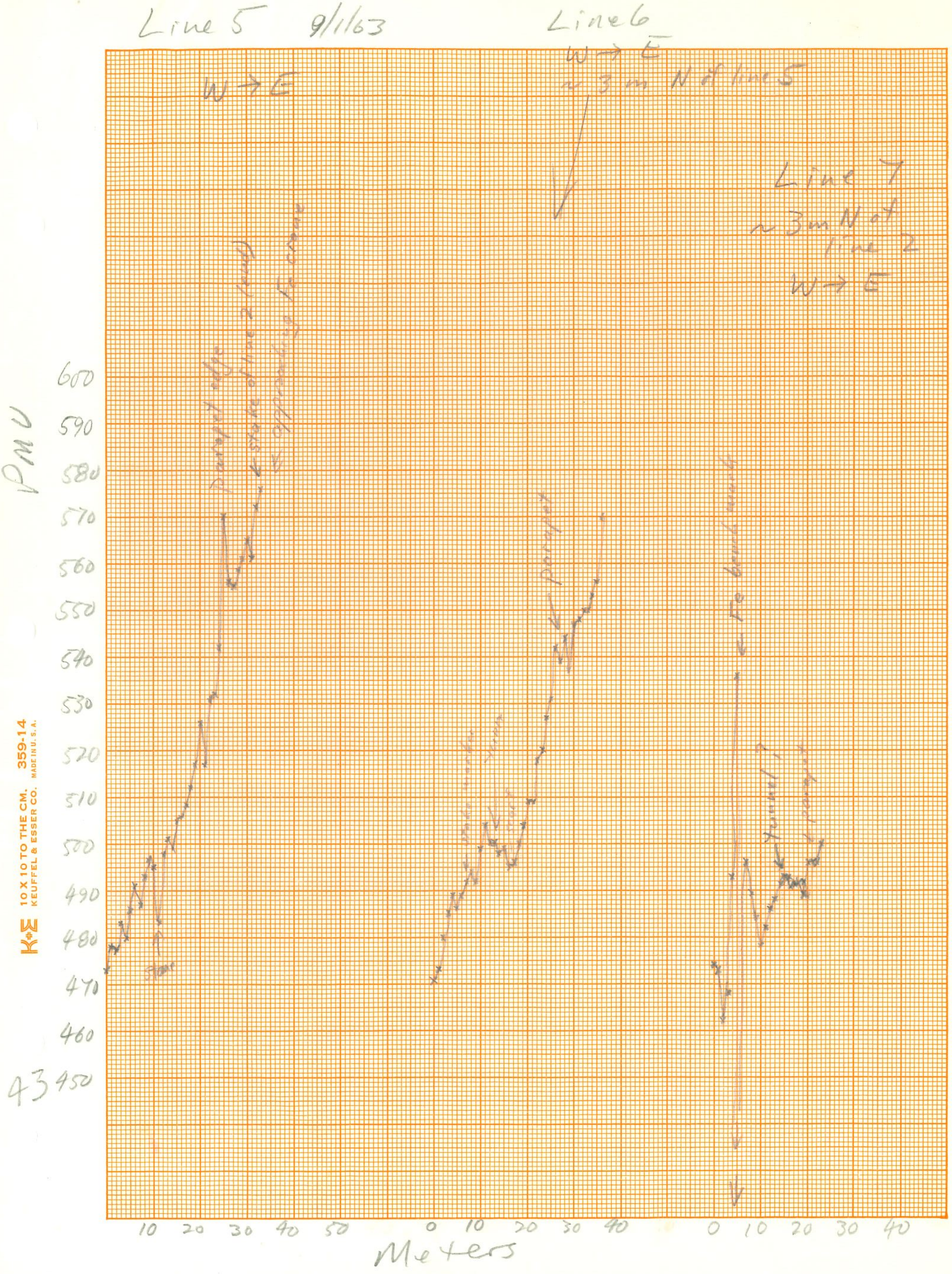
Chapel, line G N → S 8/29/63



LINE 3 LINE 4

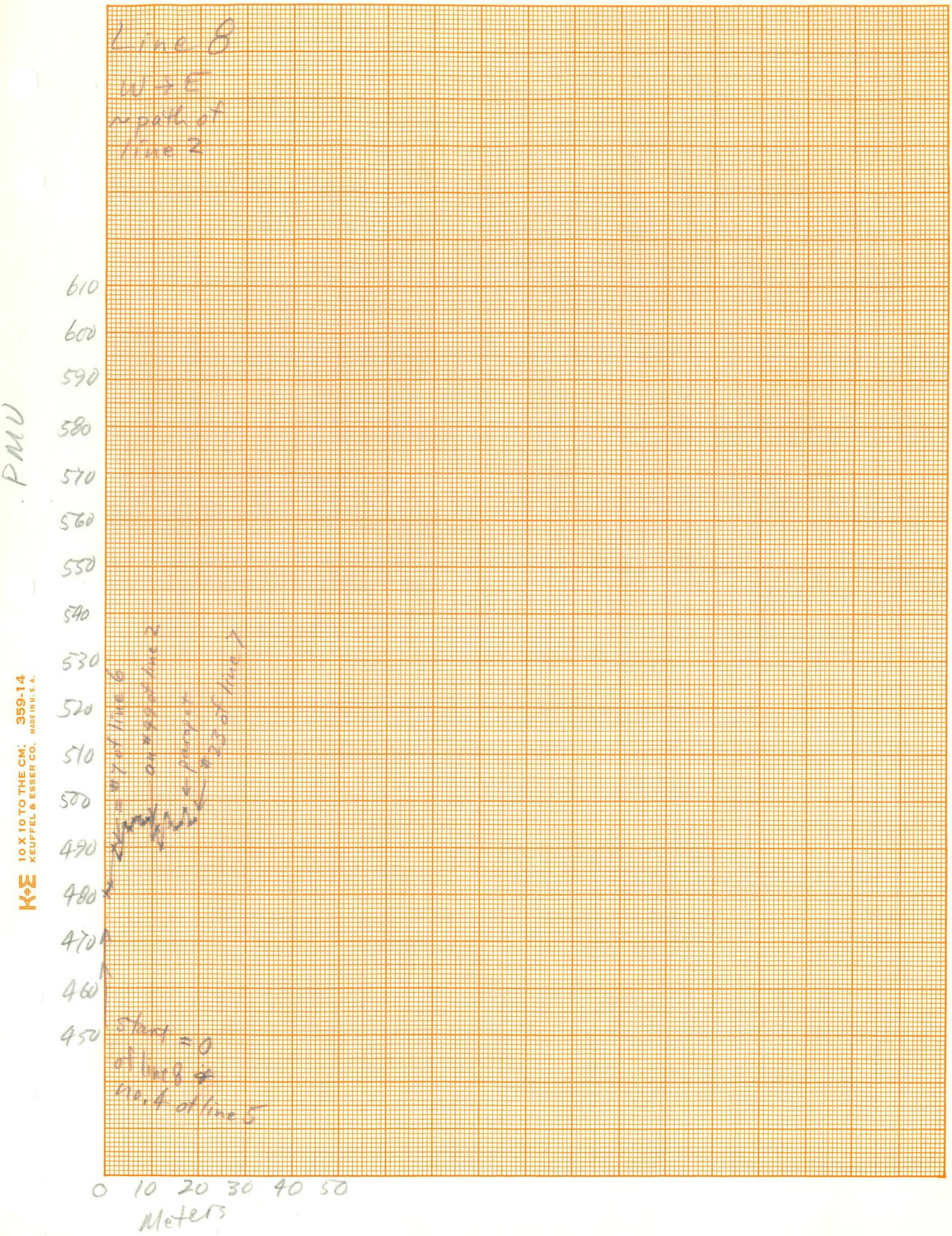



10 X 10 TO THE CM. KEUFFEL & ESSER CO. 359-14 MADE IN U.S.A.

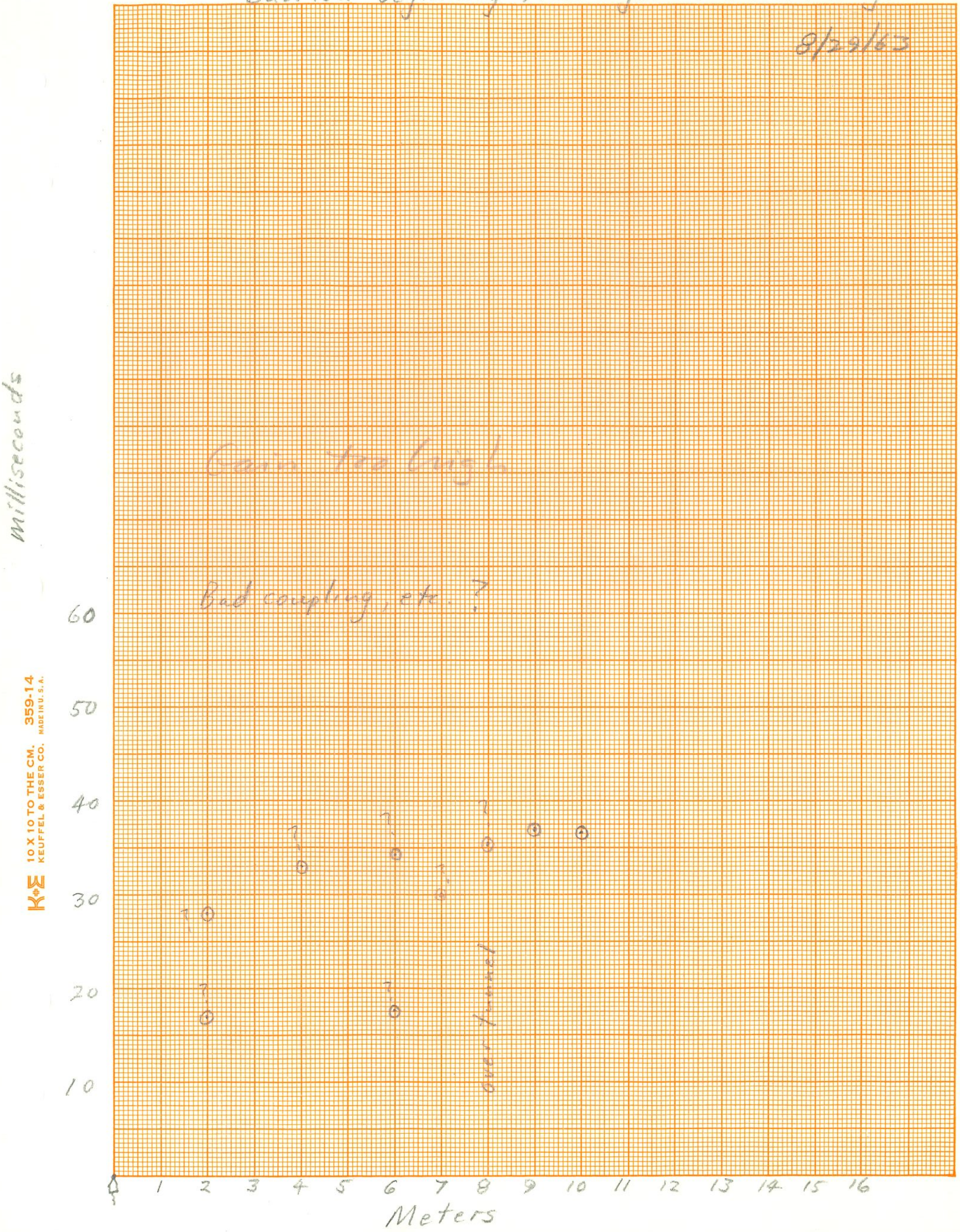


Line 5 9/1/63
W → E
Line 6
W → E
~ 3 m N of line 5
Line 7
~ 3 m N of line 2
W → E
Parapet edge
stake of line 2 (end)
approaching Fe crane
Parapet
Fe band mark
Tunnel ?
PMV
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
43
10 20 30 40 50
0 10 20 30 40
0 10 20 30 40
Meters
10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

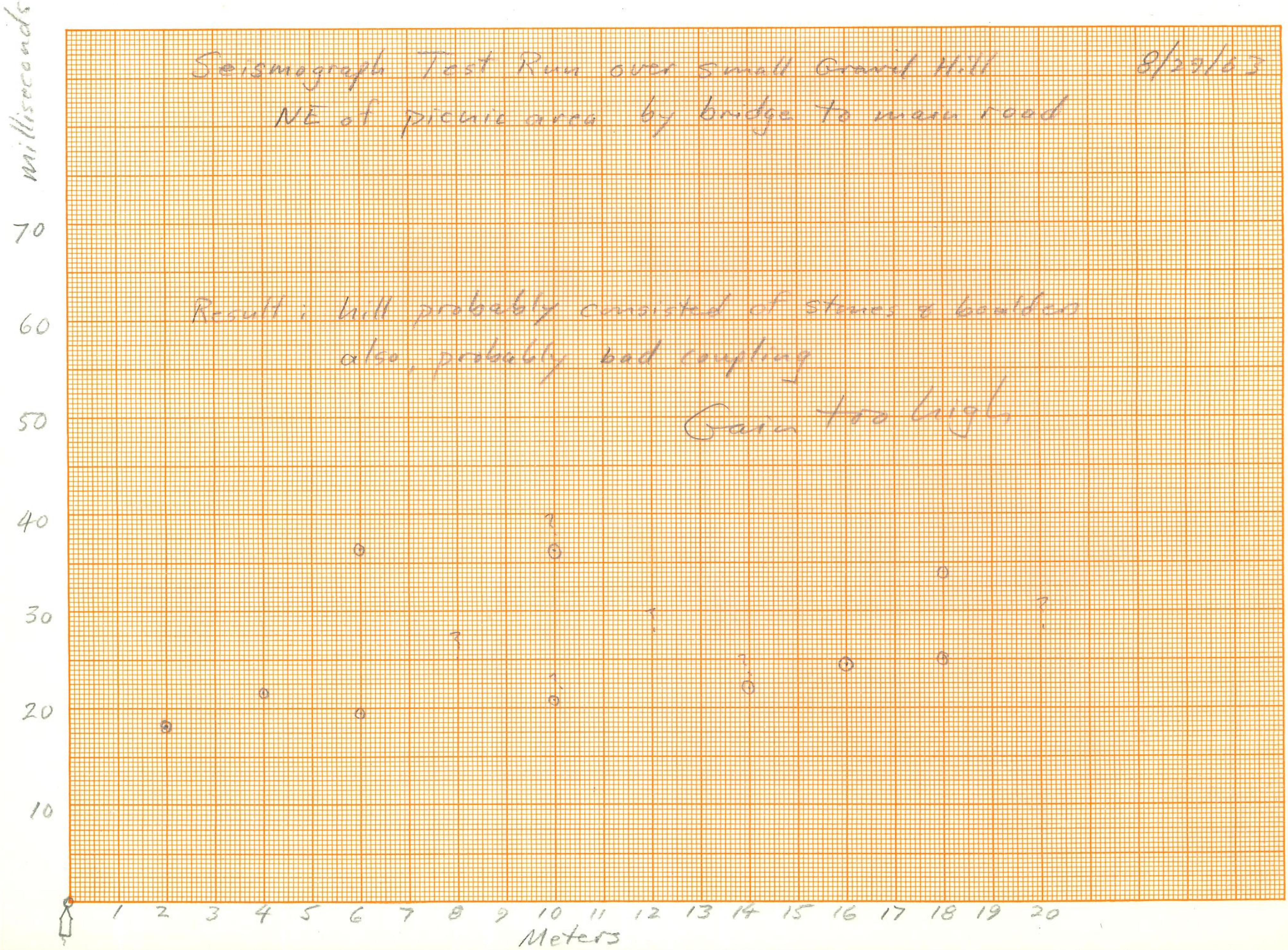
9/1/63


Line 8
W → E
~path of line 2
PMU
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
= #7 of line 6
on #9 of line 2
#23 of line 7
Start = 0
of line 8 @
no. 4 of line 5
0 10 20 30 40 50
Meters
10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

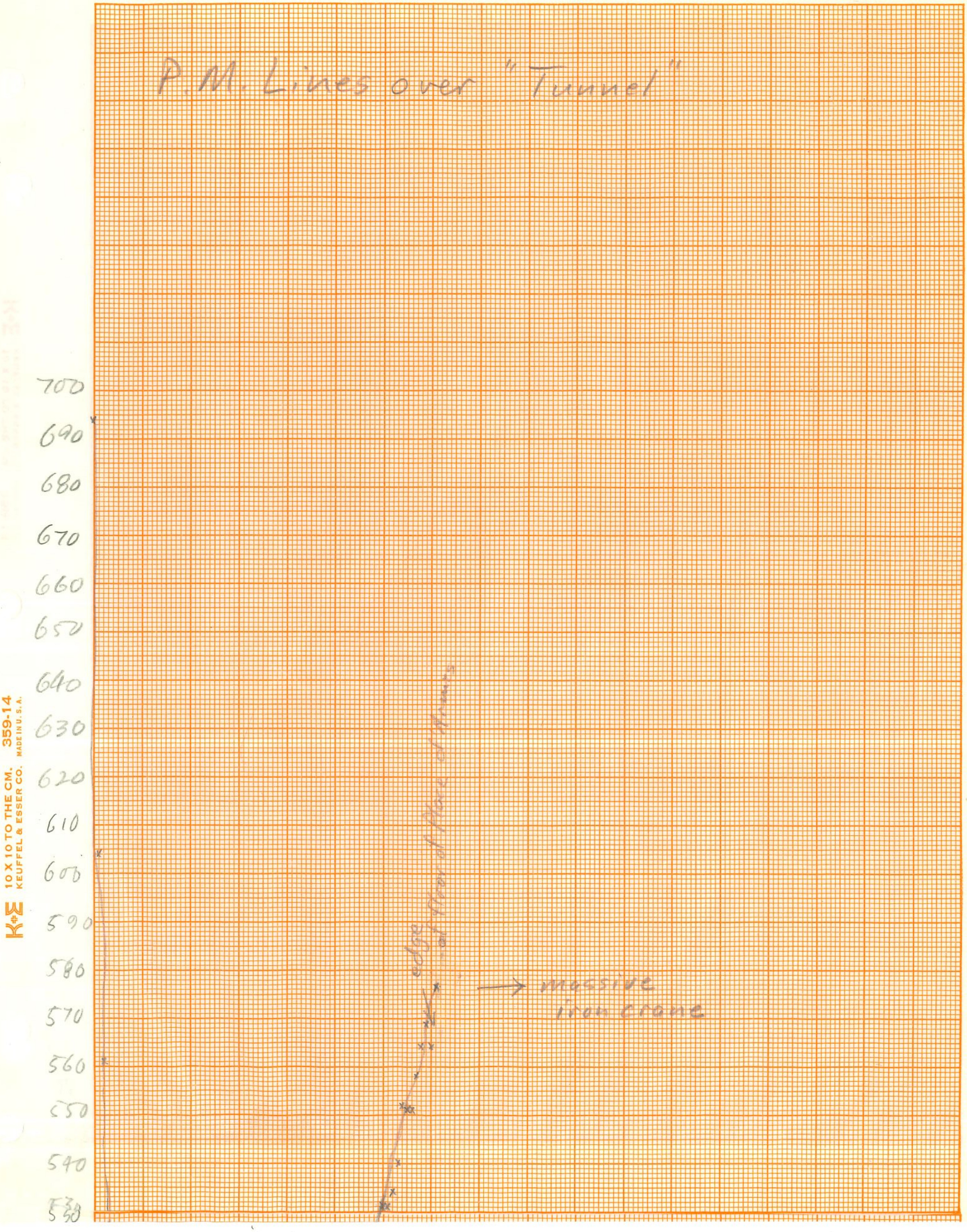
Seismograph over right postern tunnel of Queen's Bastion beginning from right re-entrant angle

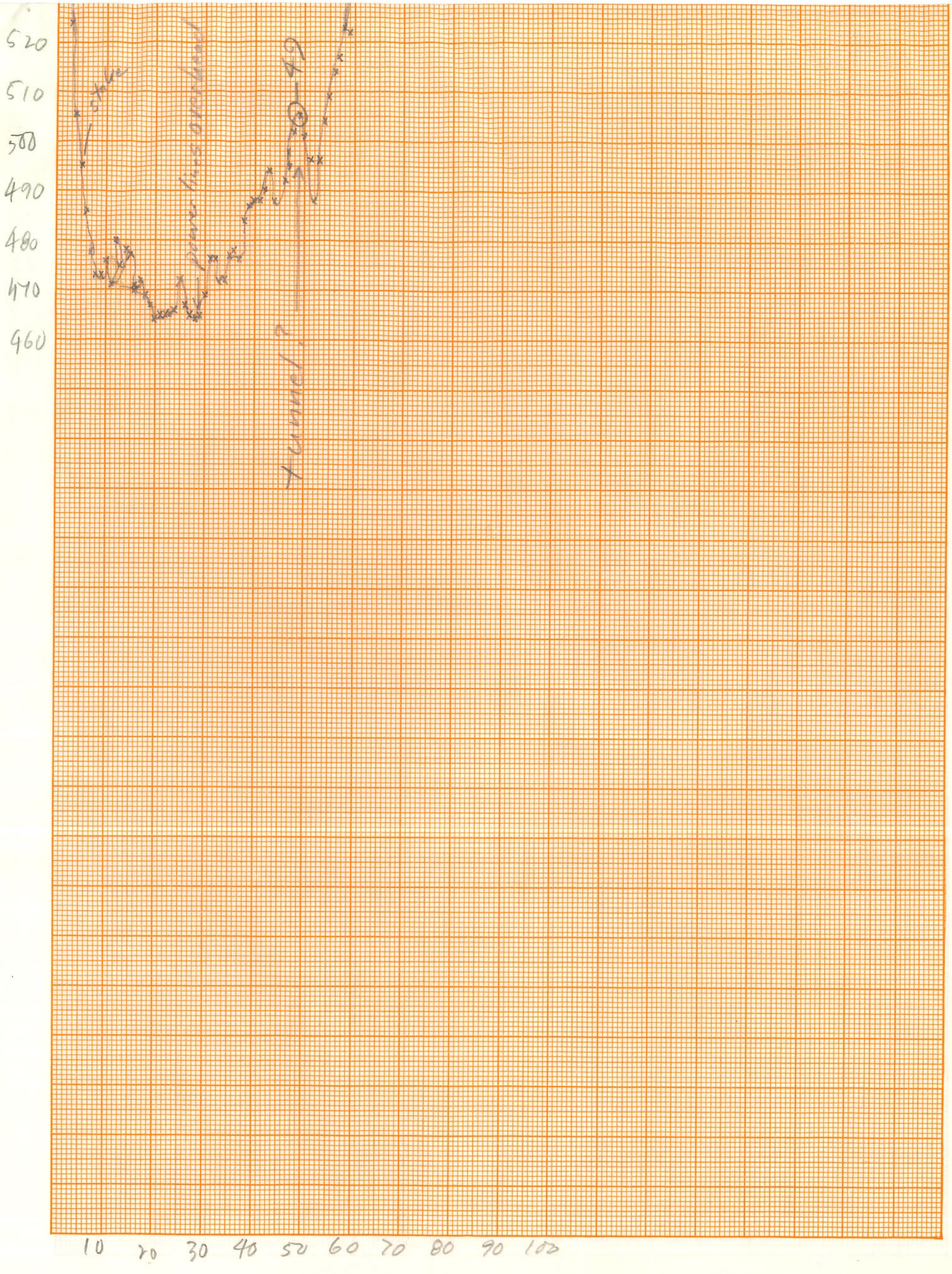


K+E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

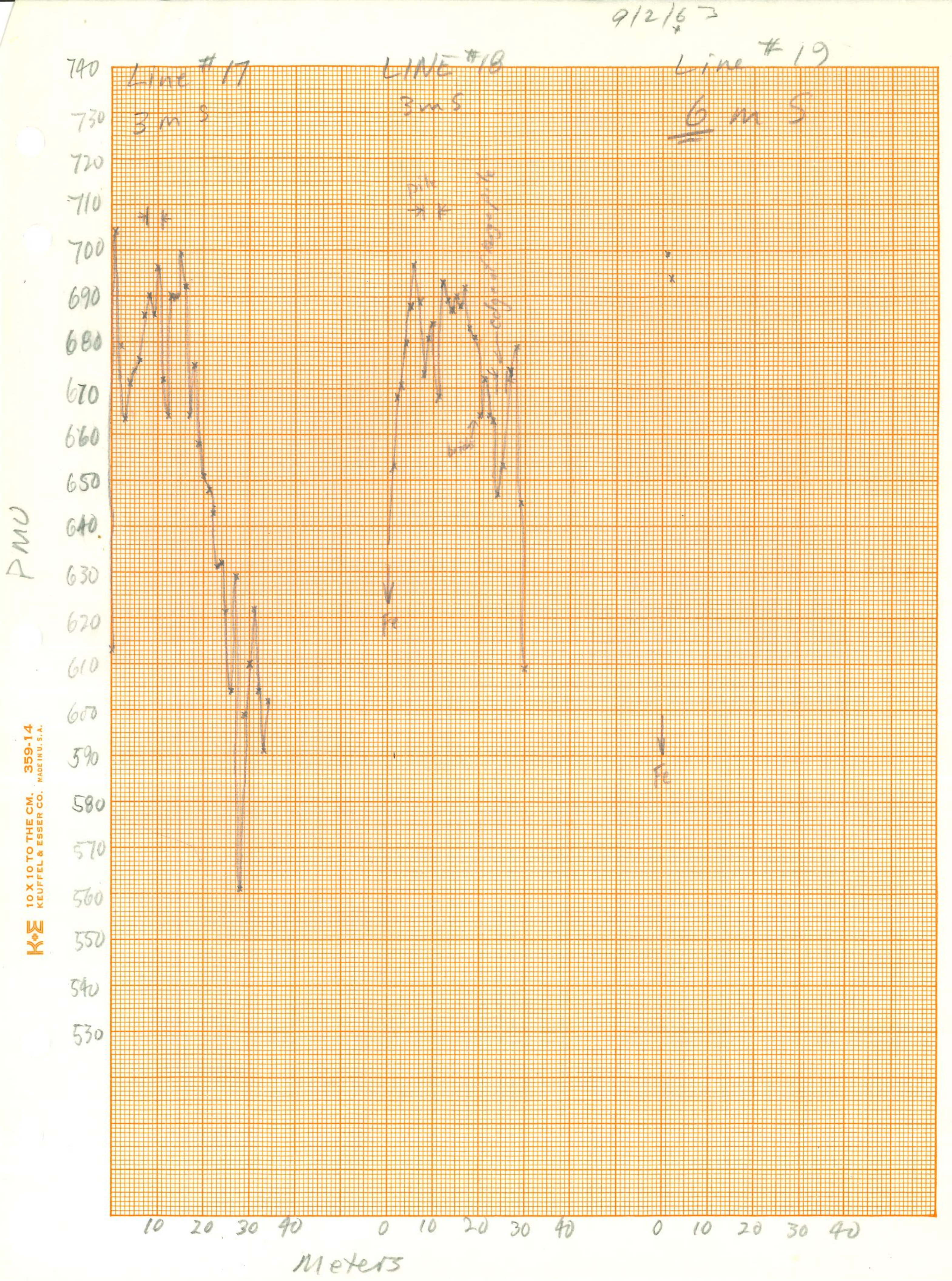


LINE #2 NNW → SSE 9/16/63

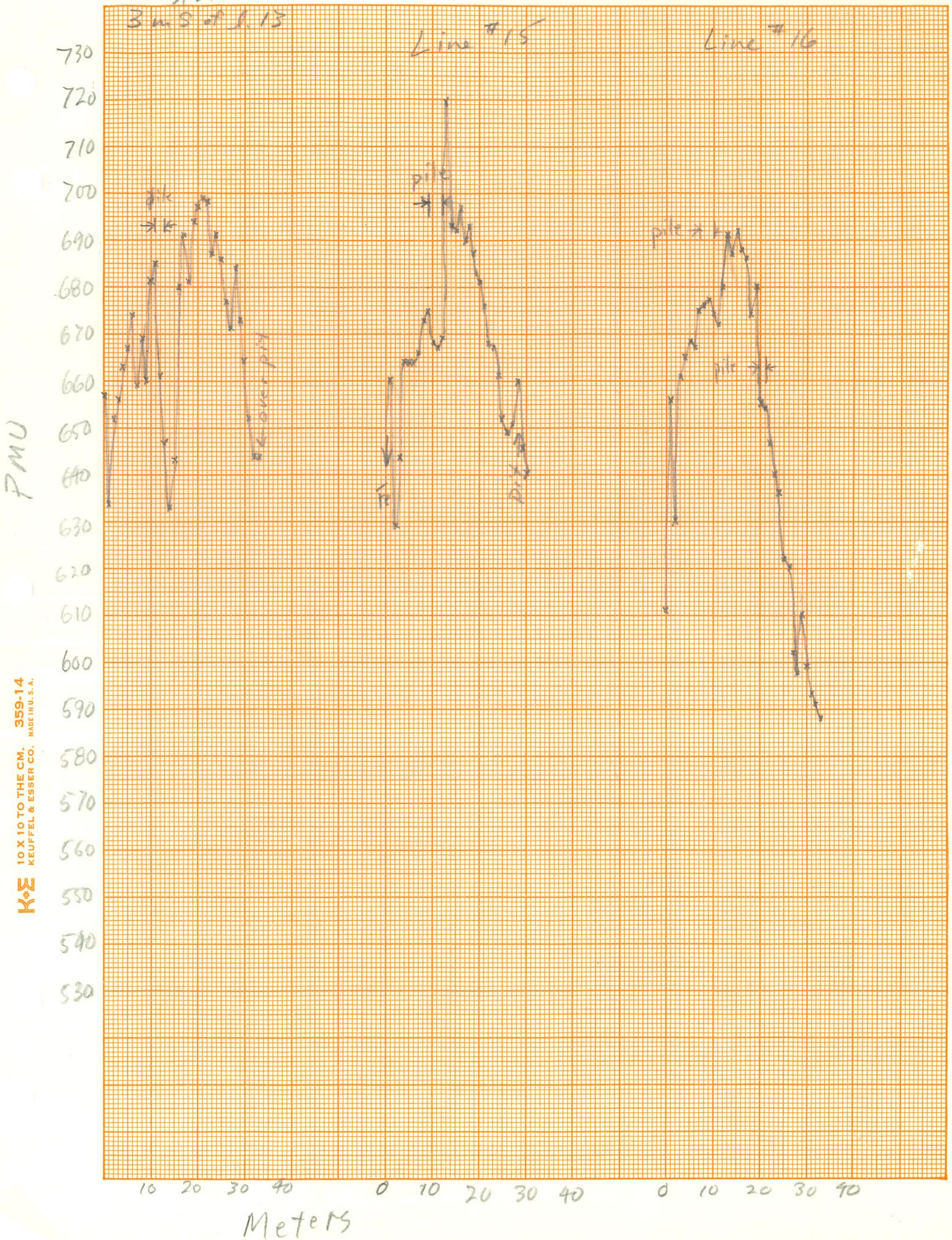




520
510
500
490
480
470
460
stake
power lines overhead
tunnel?
49
10
20
30
40
50
60
70
80
90
100

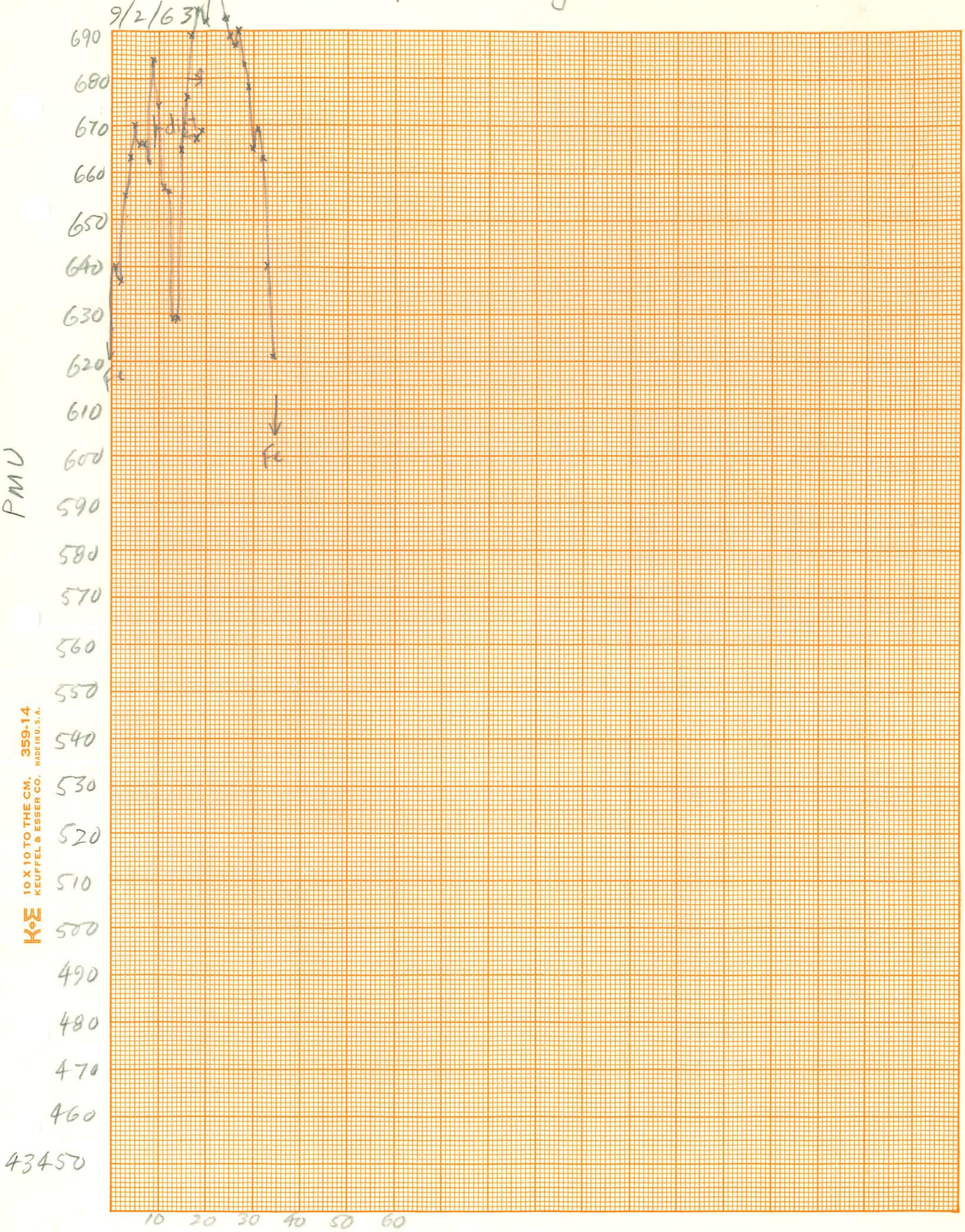

9/2/63
Line #17
3 m s
LINE #18
3 m S
Line #19
6 m S
PMU
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
Fe
Fe
10 20 30 40
0 10 20 30 40
0 10 20 30 40
Meters
10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

PM Line #14
9/2/63

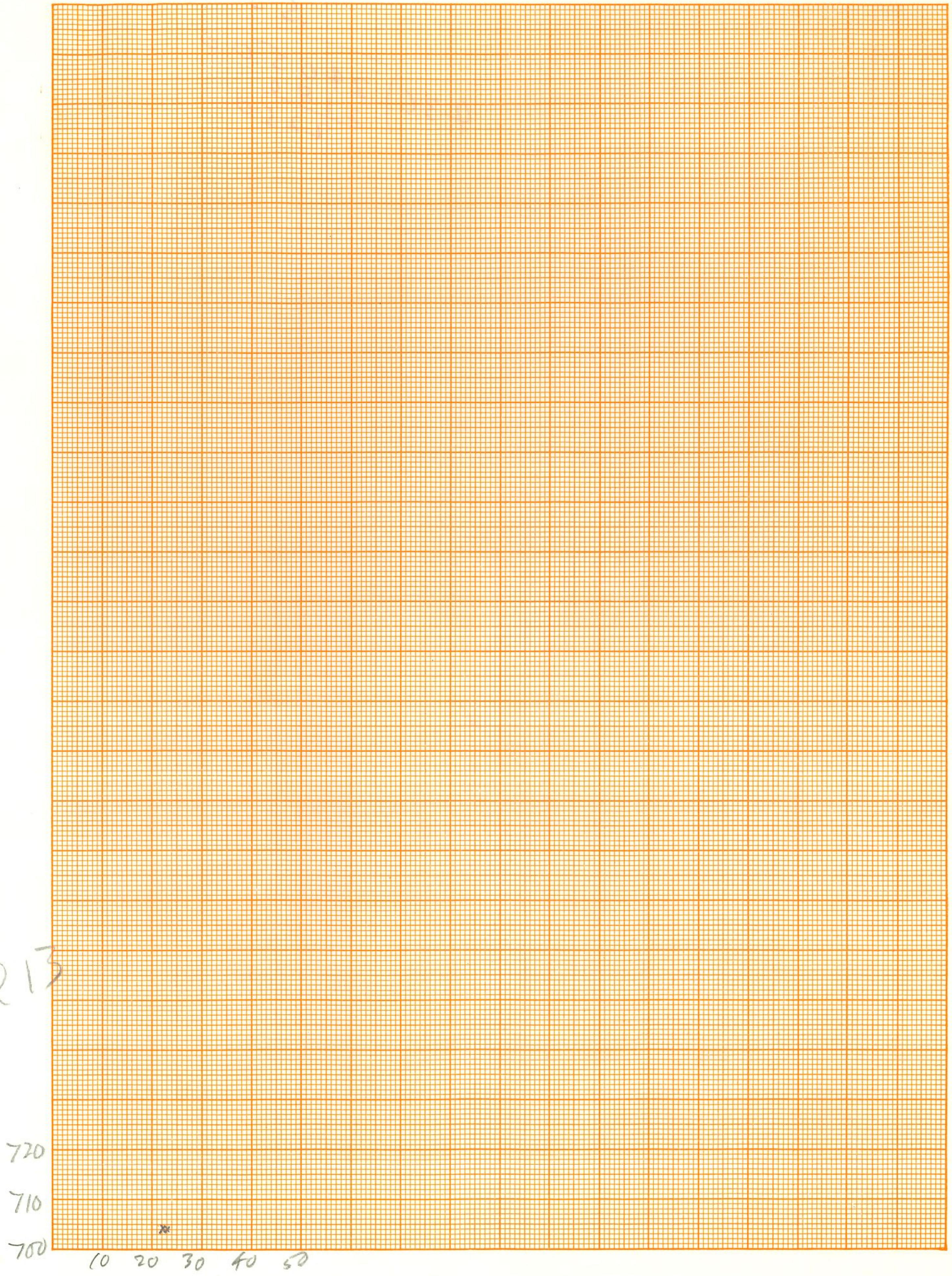


P.M. Line #13 Terraplein of King's Bastion

9/2/63



e 13

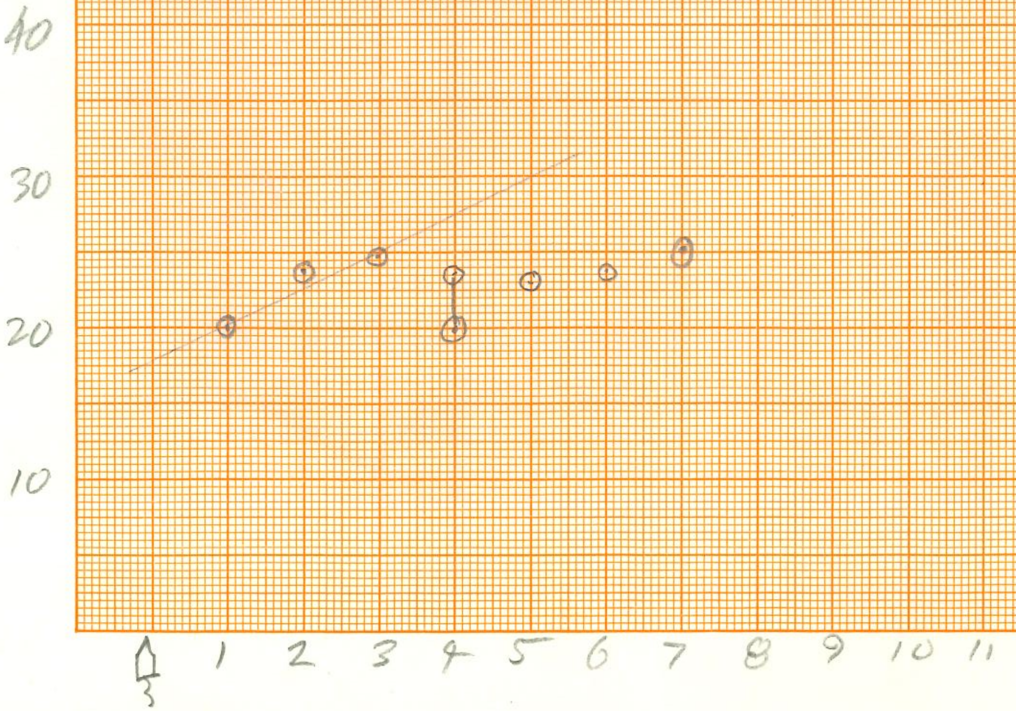


.55

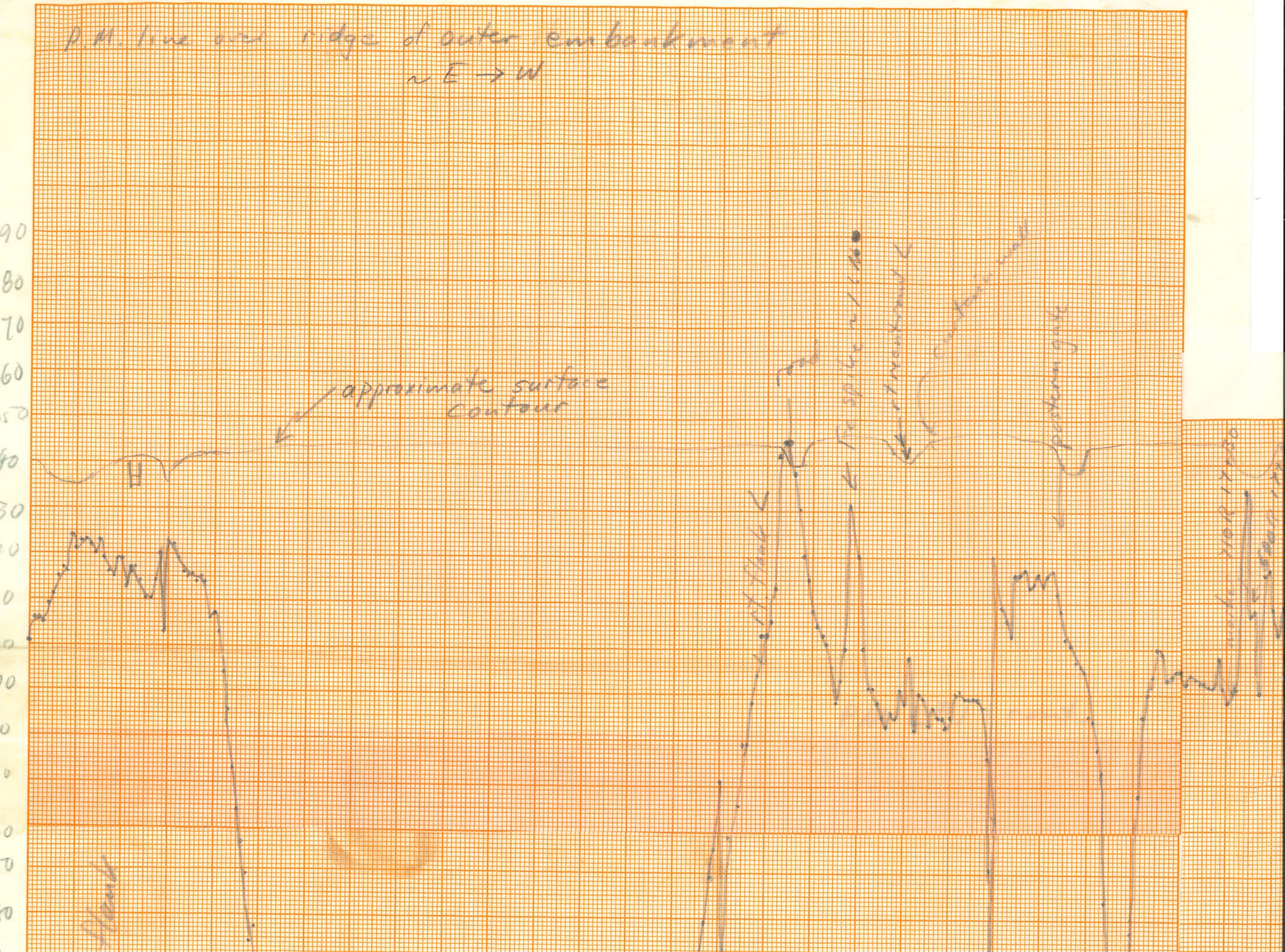
436) 240500

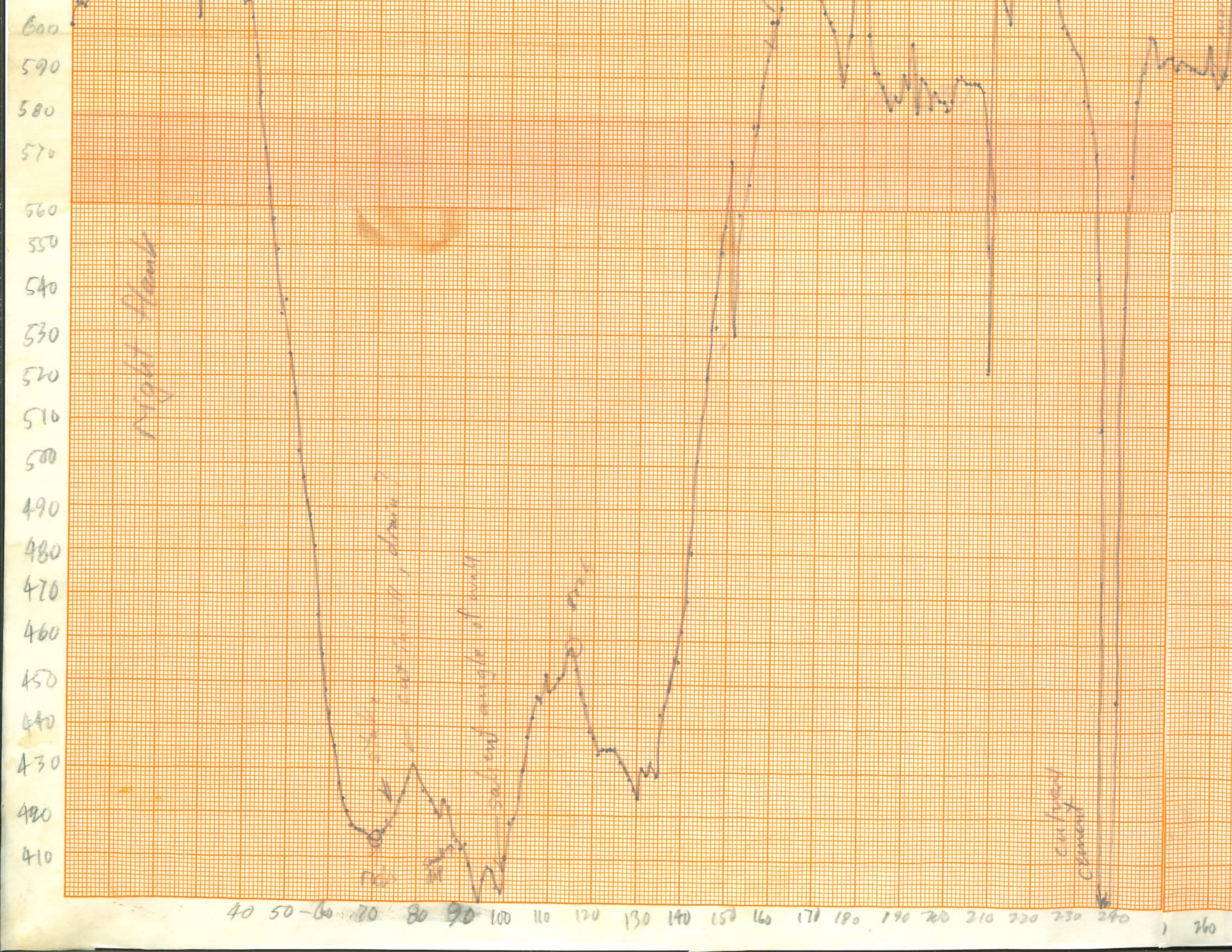
2180

2250

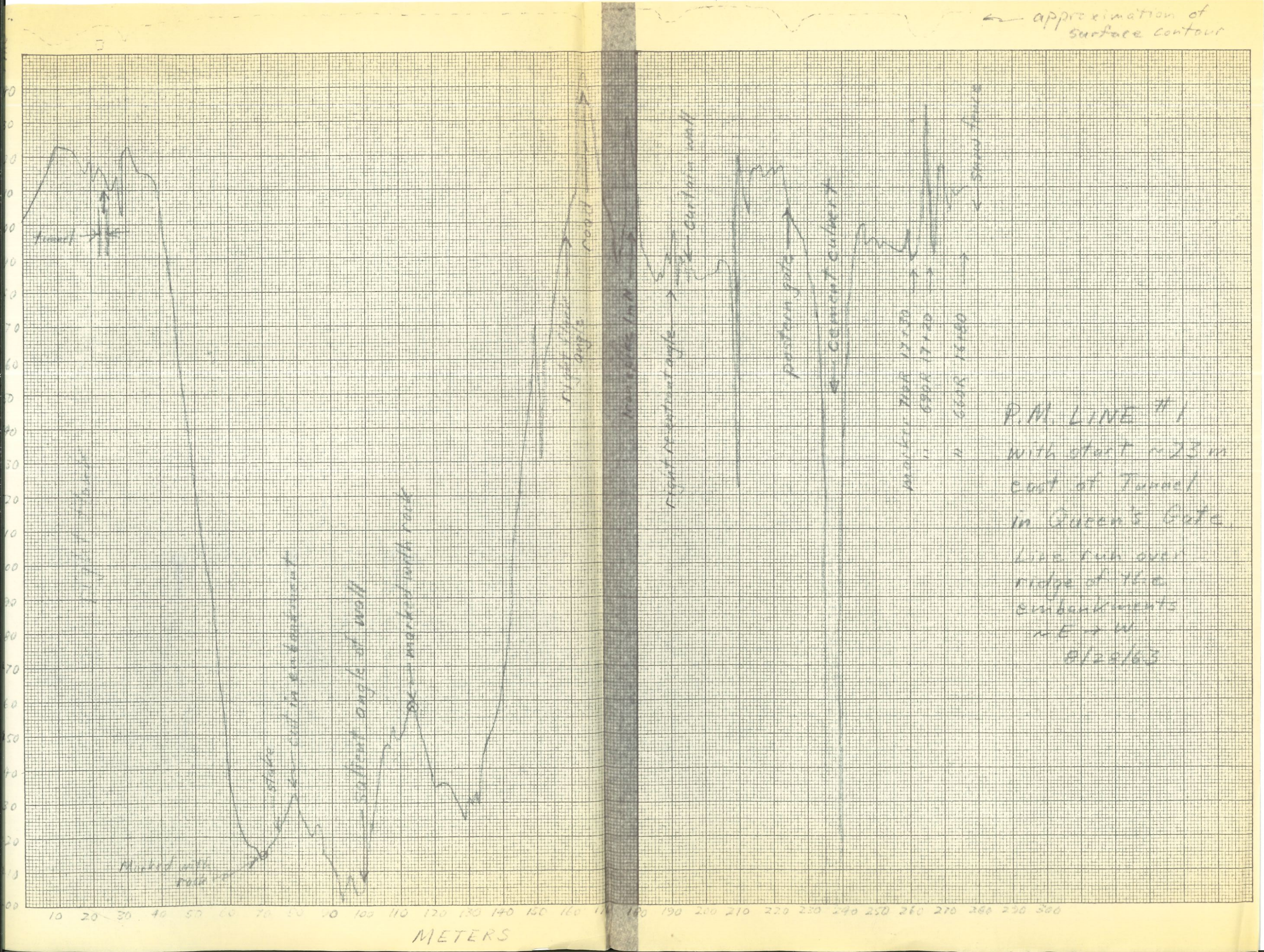

40
30
20
10
1
2
3
4
5
6
7
8
9
10
11

Tunnel of Queen's Gate P.M. Line #1 8/28/63

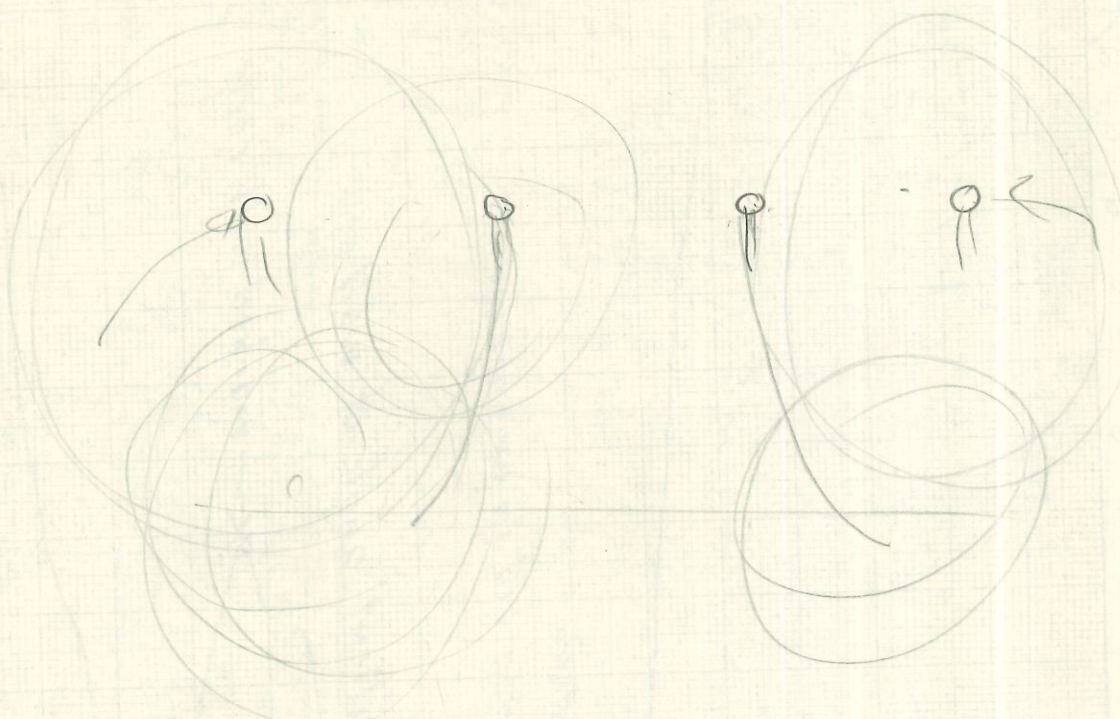



Right Hand
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
260

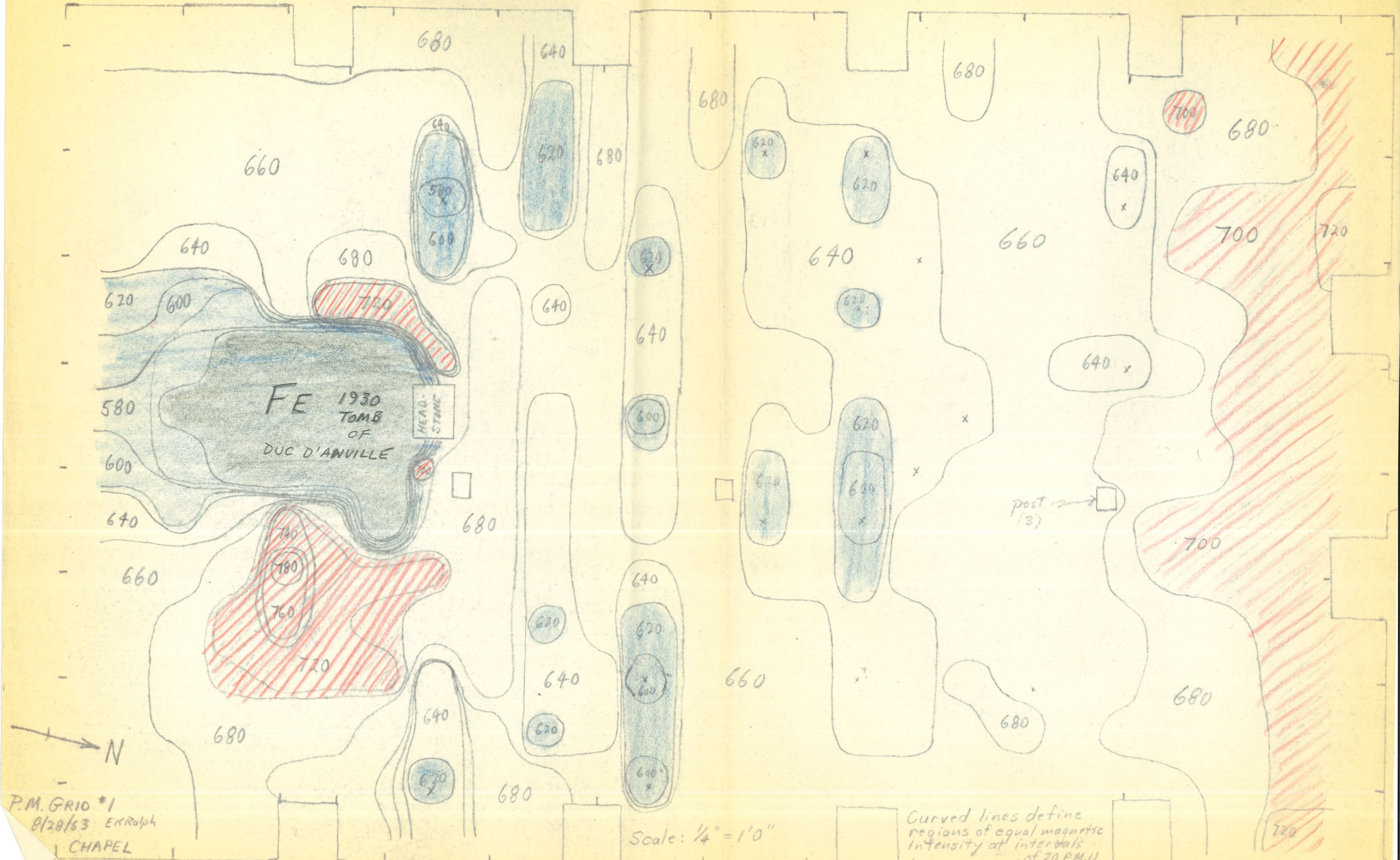
P M L #1 cont.


approximation of surface contour
tunnel
Marked with rock
stake
cut in embankment
salient angle of wall
marked with rock
road
right re-entrant angle
curtain wall
postern gate
cement culvert
snow fence
P.M. LINE #1
with start ~23 m
east of Tunnel
in Queen's Gate.
Line run over
ridge of the
embankments
~E → W
8/29/63
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
METERS

of
tour

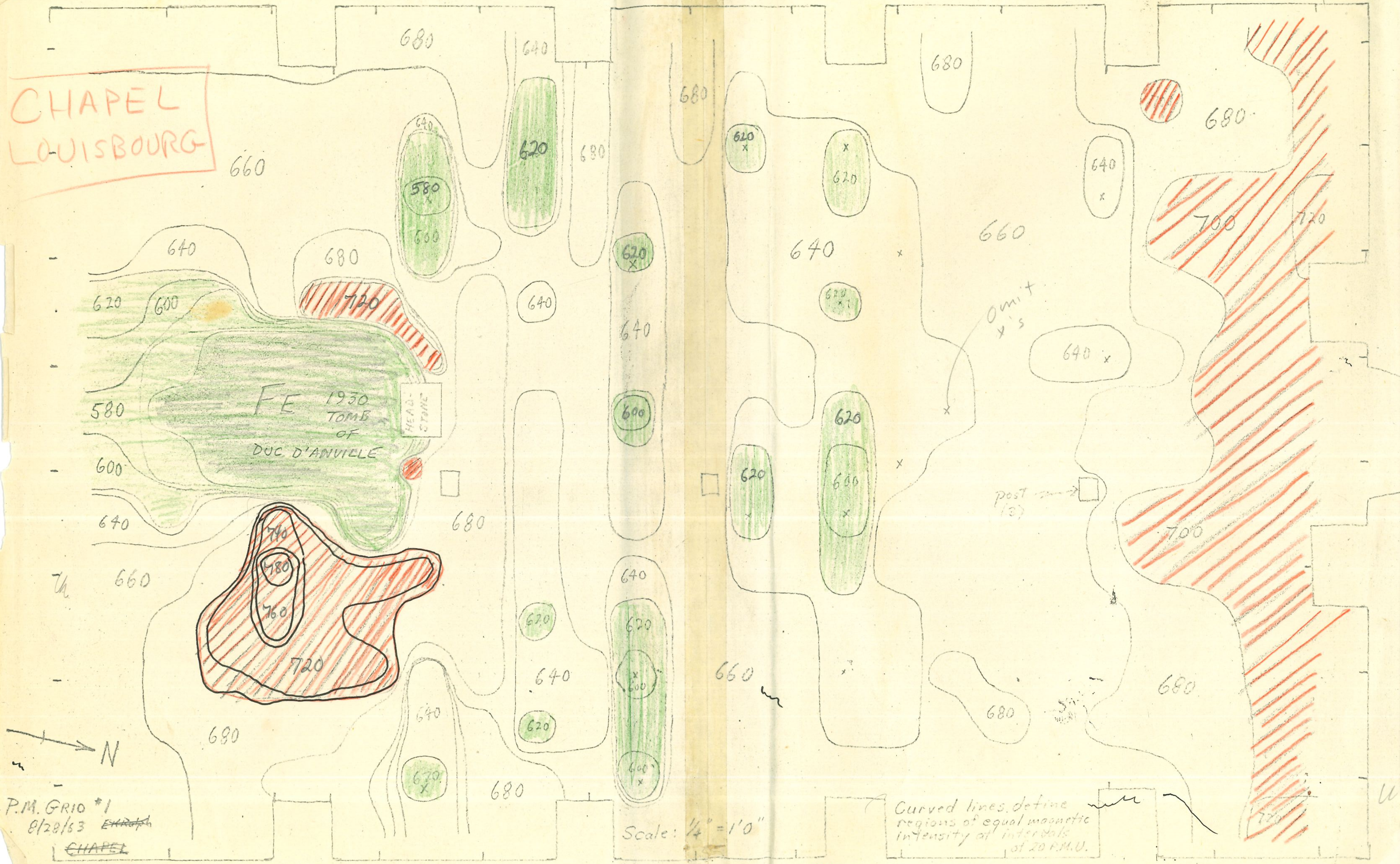


500 cc topsoil = 10 P.M.U. = very magnetic

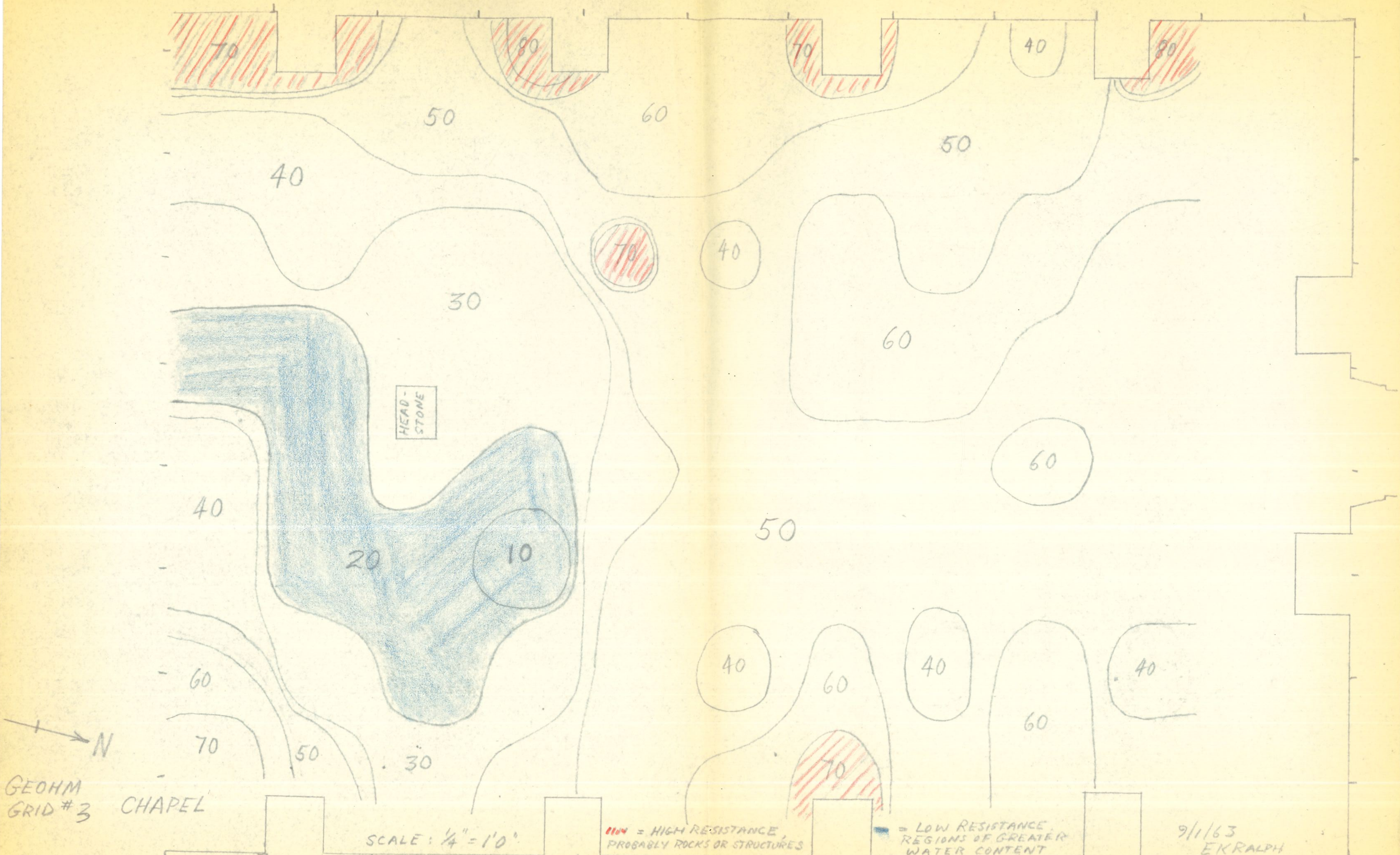



Base reading = 43660 P.M.U. = 0.551 oersteds — = magnetic regions /// = anti-magnetic regions x = location of temporary stakes

500 cc topsoil = 10 P.M.U. = very magnetic — Omit




Base reading = 43660 P.M.U. = 0.551 oersteds — [green] = magnetic regions — [red] = anti-magnetic regions




ROD SPACING = 5 FEET VALUES PLOTTED IN OHMS CURVED LINES DEFINE REGIONS OF EQUAL RESISTANCE AT INTERVALS OF 10 OHMS

GEOHM
GRID #4
CHAPEL

DIFFERENCE GRID BETWEEN #2 (2½ FT SPACING) AND #3 (5 FT SPACING)

FIGURES HERE EQUAL AVERAGE OF TWO OF GRID #2 SUBTRACTED FROM TWICE THE CORRESPONDING VALUE OF GRID #3.

VALUES PLOTTED IN OHMS

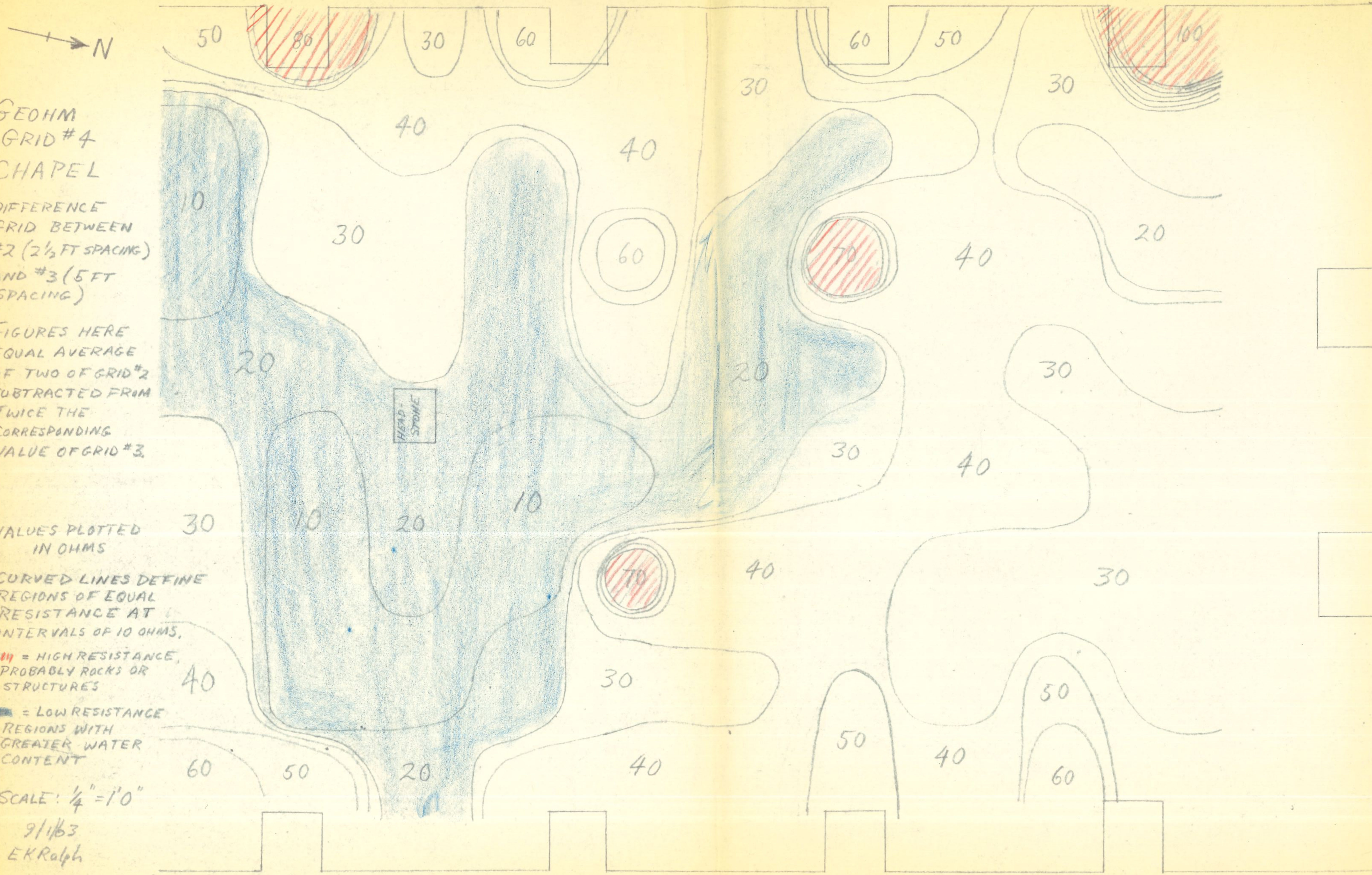
CURVED LINES DEFINE REGIONS OF EQUAL RESISTANCE AT INTERVALS OF 10 OHMS.

[red hatching] = HIGH RESISTANCE, PROBABLY ROCKS OR STRUCTURES

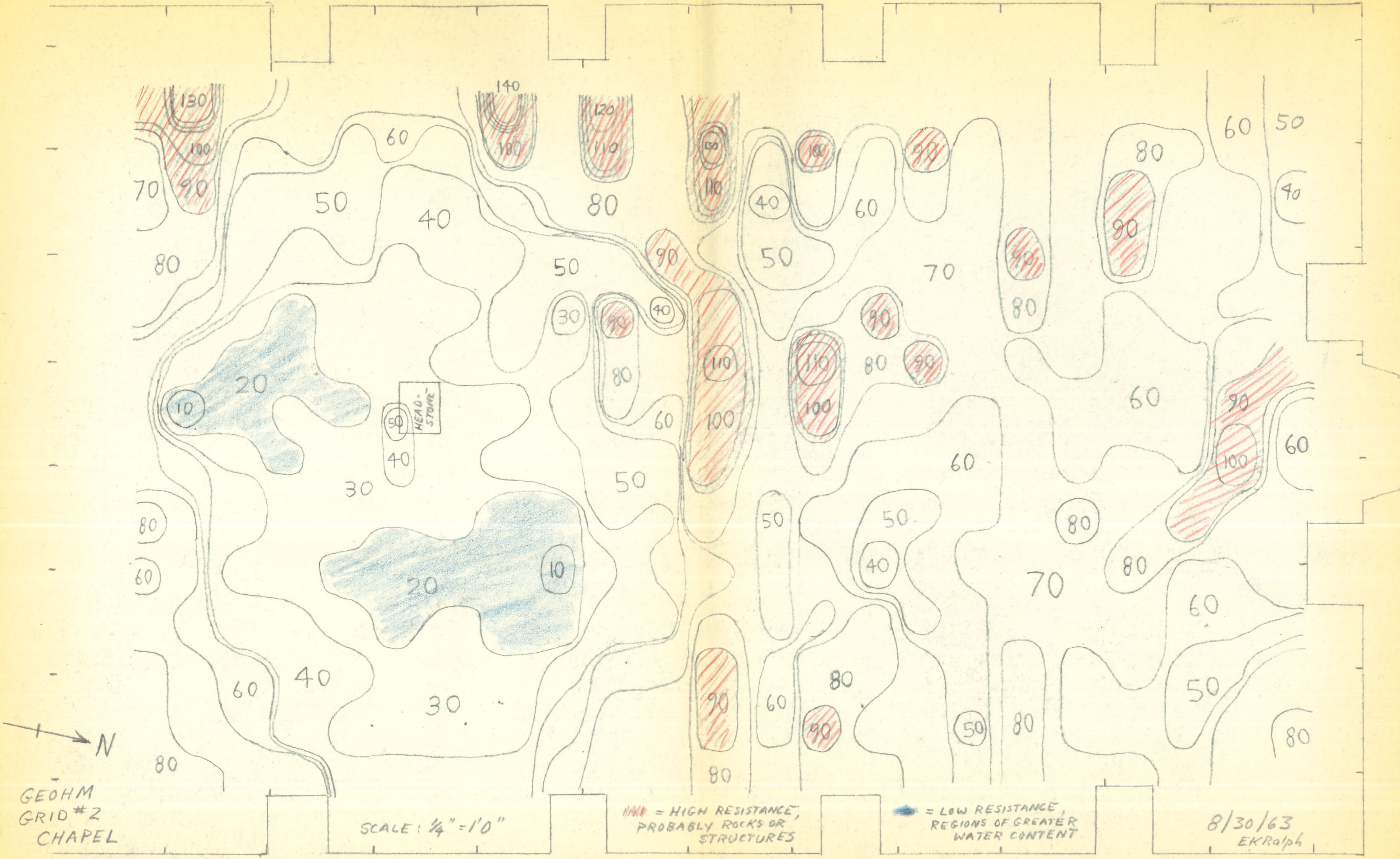
[blue shading] = LOW RESISTANCE REGIONS WITH GREATER WATER CONTENT

SCALE: ¼" = 1'0"

9/1/63
EKRalph




GRID #5
KING'S BASTION
TERREPLEIN
(NORTH SEGMENT)
Sept. 1, 1963
Base Unit = 43,600 pmu's
Scale: 1cm = 1m.
N
METERS
40
35
30
25
20
15
10
5
0
LINE #16
LINE #17
LINE #18
LINE #19
LINE #20
LINE #21
Dirt Pile
Dirt pile
0-20
20-40
40-60
60-80
80-100
Fe
500
600
400




ROD SPACING = 2 1/2 FEET VALUES PLOTTED IN OHMS CURVED LINES DEFINE REGIONS OF EQUAL RESISTANCE AT INTERVALS OF 10 OHMS