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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

REPORT ON

GRAVITY SURVEY IN THE LEIGH CREEK AREA, SOUTH AUSTRALIA.

REPORT NO. 80/1948

GEOPHYSICAL SERIES NO. 14/1948

By

Williams, L. H.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

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GRAVITY SURVEY IN THE LEIGH CREEK AREA, SOUTH AUSTRALIA, DURING 1948.

REPORT NO. 80/1948

GEOPHYSICAL SERIES NO. 14/1948

PLANS No. G 17 - 4, 5, 6, 7, 8, 9, 10 and 11.

(1) INTRODUCTION

At the request of the South Australian Government a gravity survey to investigate the possibility of further coal basins to the north of the Leigh Creek coalfield was commenced by officers of this Bureau in October, 1947. This survey was suspended in December 1947, and a report -x- was prepared dealing with the work carried out to that date. The area covered, however, was only a small part of a much larger area covered by a superficial layer of Tertiary rocks, beneath which a coal basin could exist. The work was resumed in May, 1948, and was continued until September, when the party was withdrawn.

In addition to the geophysical field work carried out on the covered area to the north of the known coal deposits, some work was done on the Center or Telford basin. A number of traverses was read on the western edge of the basin, with a view to determining places where shallow coal might be found.

(2) GEOLOGY

The area investigated during the period under review was mainly to the west and south-west of Lyndhurst. Most of it is covered by a layer of Tertiary (Eyrian) sediments, or, as in the western and north-western parts, by lines of low sandhills. The basement bocks (Precambrian slates, quartzite, etc) outcrop on the southern and south-western boundaries of the area, and to a minor extent through the superficial Tertiary layer. Leigh Creek and its tributaries cut through the area, and at the northern end they open out into a watercourse about a mile wide which is covered by tall salt bush.

(3) TECHNICAL MATTERS

The instrument used for this survey was a Heiland type GSC 2 gravimeter. This type of meter has a sensitivity of the order of one part in fifty million which is sufficient to show anomalies of the magnitude expected from basins in the bedrock, or, in the case of the Telford basin, the anomaly due to the edge of the coal seam.

A grid of stations at approximately half mile intervals was laid out over the area to be worked. A station interval of this order was considered necessary because the use of a wider spacing might result in a small basin, such as the Northern basin, which has a diameter of three-quarters of a mile, being overlooked. The main survey control was provided with accurately pegged traverses around fence lines which divided the area into blocks approximately three to five miles square. This work was carried out by surveyors attached to the South Australian Department of Mines and Electricity Trust.

-x- Preliminary Report on Geophysical Survey to the North of Leigh Creek Coalfield, South Australia. C.H. Zelman. BMRGG Report No. 1948/4.

The areas enclosed by the control traverses were subdivided by running east-west traverses, i.e., lines of equal latitude, between known points, the station distances being measured by car speedometer. Errors in latitude corrections were thus kept within reasonable limits, and errors in distance which the method necessarily introduced, were not sufficiently great to seriously modify the gravity contour patterns obtained.

One of the main difficulties in any gravity survey is that of determining the most probable elevation correction factor. There are two main methods of doing this :-

(i) direct measurement of the density of the surface materials. From this the Bouguer reduction may be calculated and then combined with the free-air reduction to give the elevation correction factor;

(ii) running a "density profile" over a topographic irregularity. In this method a series of closely spaced stations, over which an appreciable change of elevation occurs, are read with the gravimeter. The readings on these stations are then reduced using different values for the elevation correction factor. The smoothest reduced profile is then selected and the value of the elevation correction factor corresponding to it is adopted for the survey.

In this survey, method (ii) was used, and also another method described by Joseph A. Sharpe -x- -x-. His method consists essentially of statistically examining groups of three stations in lines, which are scattered over the area. Sharpe states that "the best value of the elevation correction factor is that value which minimizes the sum, over all groups, of the square of the difference between the central station reduced gravity and reduced gravity linearly interpolated between the first and third stations."

Both of the methods used gave a value of 0.068 milligals per foot for the elevation correction factor and this value has been used in reducing the results.

(4) DISCUSSION OF RESULTS

In order to demonstrate the validity of the method used, attention is drawn to the gravity contour patterns obtained over the known coal basins at Telford and the Northern field, which are shown on Plate G17/10. The anomaly over the Telford basin is a very pronounced minimum, corresponding to a considerable thickness of relatively light coal measures. That over the Northern basin is also a minimum, but owing to the relatively small thicknesses of coal measures in it, the anomaly is less marked than on the Telford basin. Nevertheless, the anomalies are of a characteristic type, and there is little doubt that similar coal basins, even if covered by a relatively thick layer of Tertiary sediments, would be found by gravity methods. However, as a result of the work carried out in 1947 and the test drill hole which followed that work, it is evident that gravity minima do occur which are not due to coal basins. There is not way of distinguishing between these two type of minima, except by drilling.

A. Area around Lyndhurst

An area of approximately fifty square miles to the west and south-west of Lyndhurst was investigated and the gravity contours are shown on Plate G17-10. Two areas of low gravity were found and there is a possibility of another developing to the north of the area covered.

-x- -x- Joseph H. Sharpe. Determination of the Elevation Corrections Factor, private publication of C.H. Frost Gravimeter Survey Inc.

The first of these areas was approximately four miles west of the previously recommended drill site (Report No.1948/4) and the second about four miles S.S.W. of that site. It was possible that these two lows were due to low density Precambrian rocks, but they may have been due to coal measures lying in basins in the bedrock. It was therefore recommended that they be tested by drilling. This drilling has been carried out. Weathered Precambrian bedrock was encountered at each site at relatively shallow depths, and no coal measures were intersected.

Additional stations were occupied to complete the gravity contour pattern east from Lyndhurst, between the netting fence and Mundy Creek and from the fence bearing 138° 04' to Mundy Creek. No new gravity lows were found.

B. Telford and Northern Basins

Although a considerable amount of drilling has been done on the northern and north-eastern edges of the Telford basin and the existence of shallow coal has been proved there, only a limited number of drills have been placed on the south-western and western edges. These have failed to reveal any shallow coal, and additional drilling is contemplated in the near future. It was thought that the gravity survey might prove useful in selecting suitable drilling sites, and consequently a number of traverses were pegged in the vicinity of existing bore holes and along lines of proposed bore sites.

In order to provide a test under known conditions, a profile was run parallel to the railway line, crossing the northern edge of the coal seam which is at present being worked. The gravity profile is shown on Plate G17/8. The anomaly due to the coal seam cutting out is not very pronounced, and appears only as a minor discontinuity in the general slope of the profile. To emphasize this discontinuity dotted lines have been drawn on the profile at the northern and southern limits of the discontinuity. Immediately beneath the observed profile is a calculated profile showing the gravity change due to the known coal seam cutting out. The maximum change is 0.4 milligals, which is approximately the same as the discontinuity on the observed profile.

It will be noted that closely spaced stations are needed to show the discontinuity. Similar discontinuities on profiles made over unknown ground have been interpreted as the effect of a coal seam cutting out. However, on some of the traverses the station interval was 400 ft., and because of this, similar discontinuities may have been missed. Plate G17/11 shows the gravity contour pattern of that portion of the Telford basin which lies to the west of the railway line and which was covered by the work under review. The plate also shows positions of outcropping Precambrian rocks near the rim of the basin, as mapped by Mr. S.B. Dickinson.

The position of the gravity contour lines at the extreme western edge of the basin is uncertain, because the gravity traverses do not extend far enough in this direction. It will be noted that on the northern edge of the basin, the outer edge of the coal seam occurs between the 64 and 65 milligal contour lines, while the value on the northern rim is 66 milligals. The value on the southern rim is only 65 milligals, and the difference can be ascribed to a small regional effect.

The position of the coal edge relative to the gravity contours, will depend to some extent on the slope of the surface of the basement rocks. However, taking likely variations of slope into account, one would expect the edge of the coal seam to lie generally between the 61 and 64 milligal contour lines. It is believed that this relation, although based on a small amount of evidence, may provide a useful means of locating additional drill sites.

The gravity profile along the traverse through bore No. W6 and station TS19 (see Plate G17-7) does not show any sudden change of slope which could indicate an edge of the coal seam. However, a geological section was drawn, taking into account what is known of the geology of the area, and a gravity profile calculated from this. This calculated curve fits the observed curve very well and thus indicates a probable value for the slope of the basement rocks. Assuming that the coal seam is at the same stratigraphic height above the basement as on the northern edge it seems likely that the edge of the coal seam is about 1200 ft. north from W6. This is further from the edge of the basin than any of the existing bores near the traverse.

The traverse from GS1 to GS11 (Plate G17-5) gives a good indication that an edge of the coal exists between GS5 and GS7. But on the traverse GS12 to GS22 (Plate G17-5) this indication has almost disappeared, or takes place over a much longer distance. This attenuation of the effect could be due to faulting, which is shown to take place at the western end of the open cut.

The gravity readings on the other sites for proposed and existing bores (see Plates G17-4 and 9) give no indication of the edge of the coal seam. On some traverses this may be due to too large a station interval, being used. On others, the traverses were too near the centre of the basin. They do, however, give some indication of where these sites are situated relative to the edge of the basin. For example, the value over the outer edge of the main coal seam, where it is known from boring results, is nowhere less than 61 milligals and this condition might apply generally in the basin. At bore No. W5 the gravity value is only 58 milligals. Using a relation, based on the calculated section through bore No.2 and the edge of the basin, that 1 milligal change in anomaly is equivalent to 215 feet change in thickness of the sediments, it would appear that approximately 650 feet of sediment overlie the coal at this bore site and that none of the existing bores near W5 were drilled deep enough to intersect the coal if it is present.

The same applies to the proposed line of bores from W20 to W24.

From the relation between contour value and position of the coal edge expressed above, one would expect that the traverse from W12 to W15 crosses the edge of the coal seam. The fact that the gravity profile gives no indication of the coal could be due to the station intervals being too great, although it is by no means certain that a thick coal seam exists in this part of the basin. On other profiles it can be seen that the whole anomaly due to the coal occurs in approximately 400 ft. and since the stations along this traverse are 400 ft. apart, the anomaly could easily be missed.

The gravity profile from north to south over the Telford Basin (Plate G17-4) shows a gradual change of slope from the northern edge to the lowest point from where it rises in a similar fashion to the southern edge. The maximum change of gravity is about 10½ milligals and the value at both edges is approximately the same.

In contrast to this, the profile across the northern basin (Plate G17-6) shows a flattening for about 1600 ft. at the centre of the basin. The gravity change is only 2 milligals from the western edge to the centre and 3 milligals from the centre to the eastern edge. There is approximately 55 ft. of coal in the two seams of the northern basin and this would cause an anomaly of about 0.7 milligal. If it is assumed that the anomaly at the centre of traverse "K" is 2.5 milligals, 1.8 milligals of this must be due to sediments. Using the relation found on the Telford basin between gravity values and thickness of coal measures (215 ft. = 1 milligal) it would appear that there are -

approximately 390 ft. of sediments, which together with the coal, would give a total thickness of about 445 ft. for the coal measures in this basin. This is very much shallower than the Telford basin which apprears to be about 2400 ft. deep at its deepest point.

(5) RECOMMENDATIONS

Drilling to test the two gravity lows on the area west of Lyndhurst was recommended and has been done. Precambrian basement rocks were encountered at relatively shallow depth and no coal measures were intersected.

On the Telford Basin, the gravity profile showed a good indication of the edge of the coal seam between GS5 and GS7. GS5 is the site of bore No.S35, which intersected 4 ft. of coal at 22 ft. This could be the thin edge of a wedge of coal causing the gravity anomaly. Hence it is suggested that a bore be put down at GS6.

The calculated section at the southern end of the traverse across the Telford Basin illustrates the possibility of the coal seam cutting out at TS7. There is no noticeable discontinuity in the gravity profile at this point but this may be due to the use of a 400 ft. station spacing. It is recommended that gravity values should be re-determined near TS7 using a station interval of not more than 100 feet.

Further gravity surveys are recommended on the Telford basin as a guide to drilling. Proposed traverses are shown on Plate G17-11. From the work that has been done, it appears that the most suitable distance between stations is 100 ft. The traverse through proposed bore sites W12 to W15, on which gravity readings have been taken, should be repeated using a station interval of 100 feet and the traverse should be extended as shown.

The traverses selected for additional work should be normal to the gravity contours because in this direction the most marked effect due to the coal seam will be obtained.

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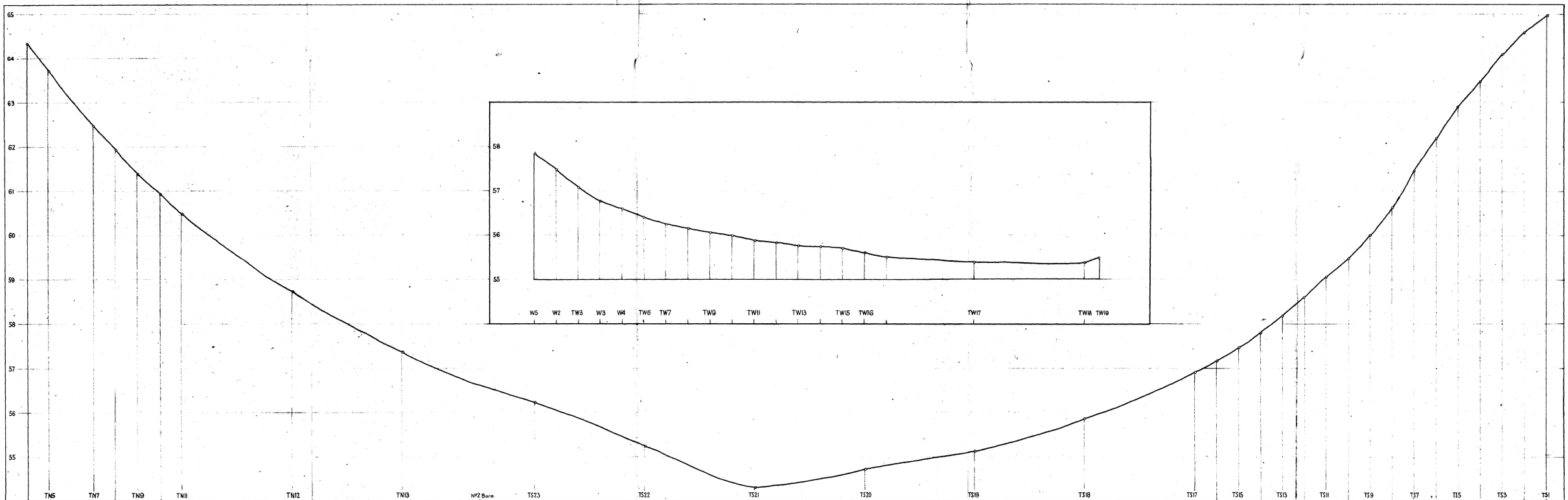
January, 1949.



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Scale

Horizontal / Vertical

0 400 800 1200 1600 2000 2400

Feet / Millirads.

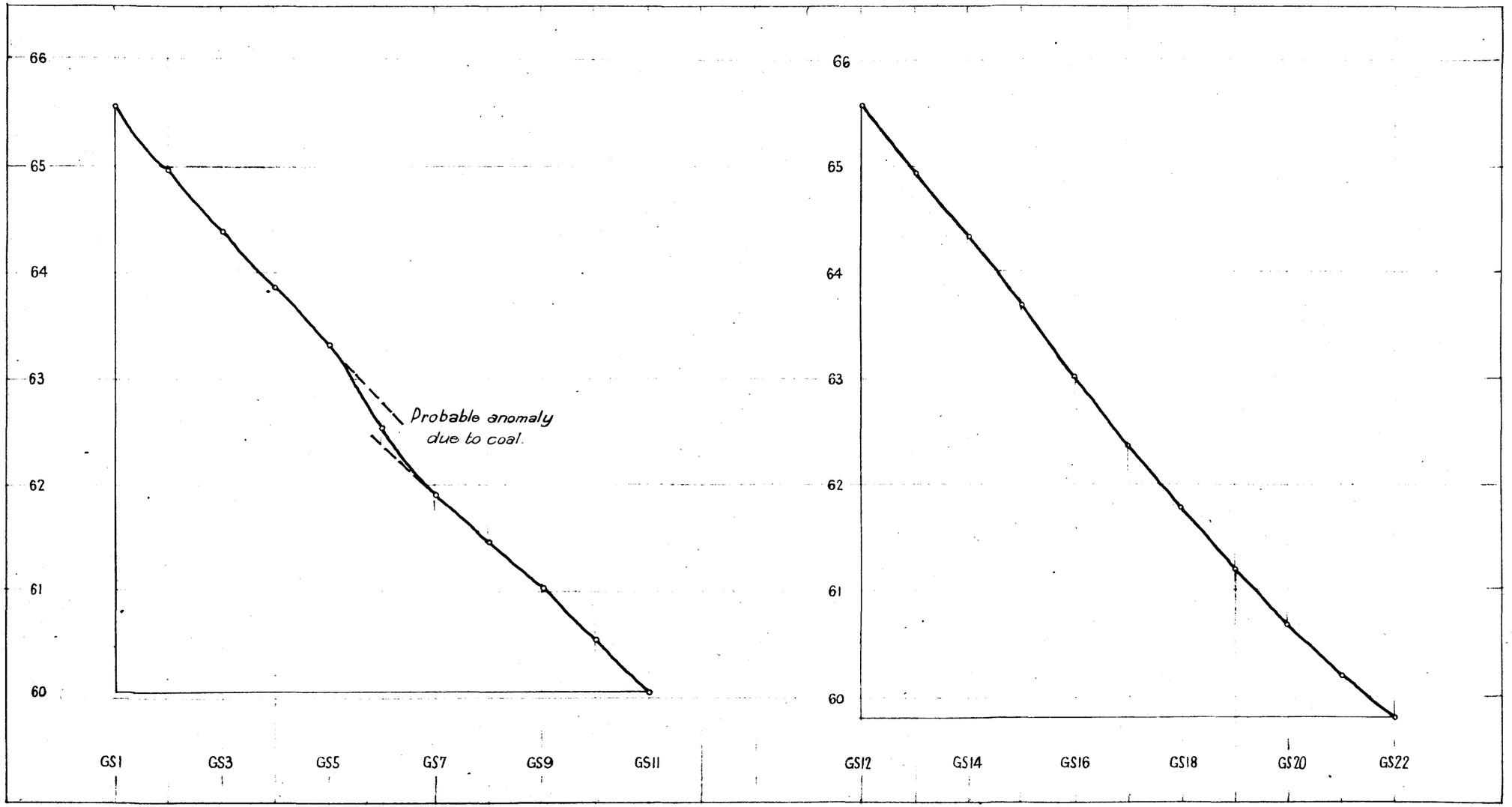
Geophysicist

LEIGH CREEK GEOPHYSICAL SURVEY

TELFORD BASIN AREA

TRAVERSES & GRAVITY PROFILES ACROSS BASIN

G17-4



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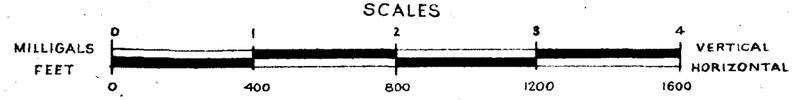
SCALES

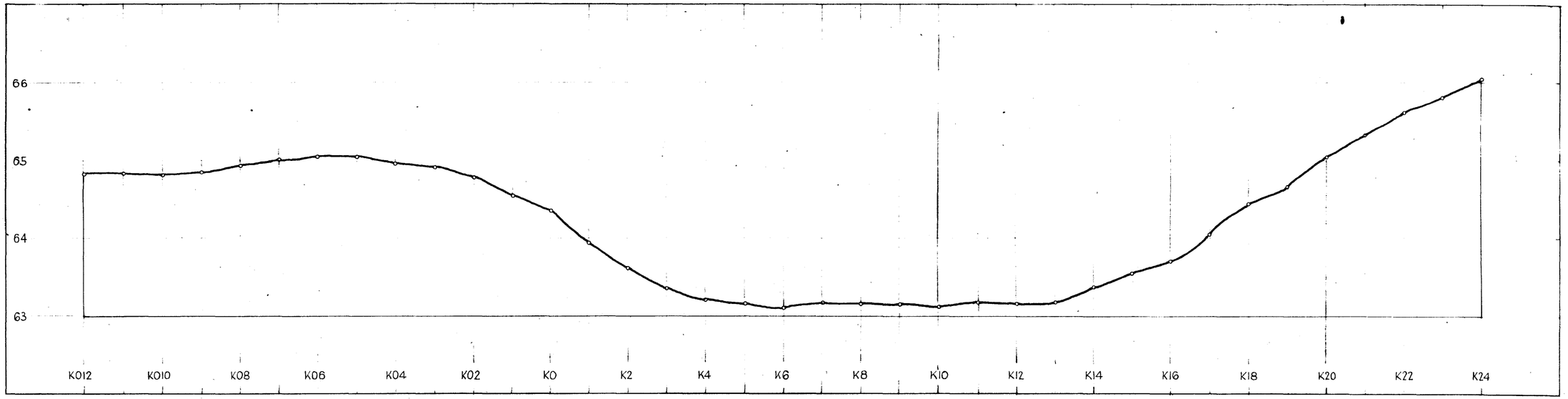


LEIGH CREEK S.A GEOPHYSICAL SURVEY

TELFORD BASIN AREA

GRAVITY PROFILES ALONG TRAVERSES OVER NORTHERN AREA OF BASIN

G 17-5



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LEIGH CREEK GEOPHYSICAL SURVEY

NORTHERN BASIN AREA

GRAVITY PROFILE – TRAVERSE "K"

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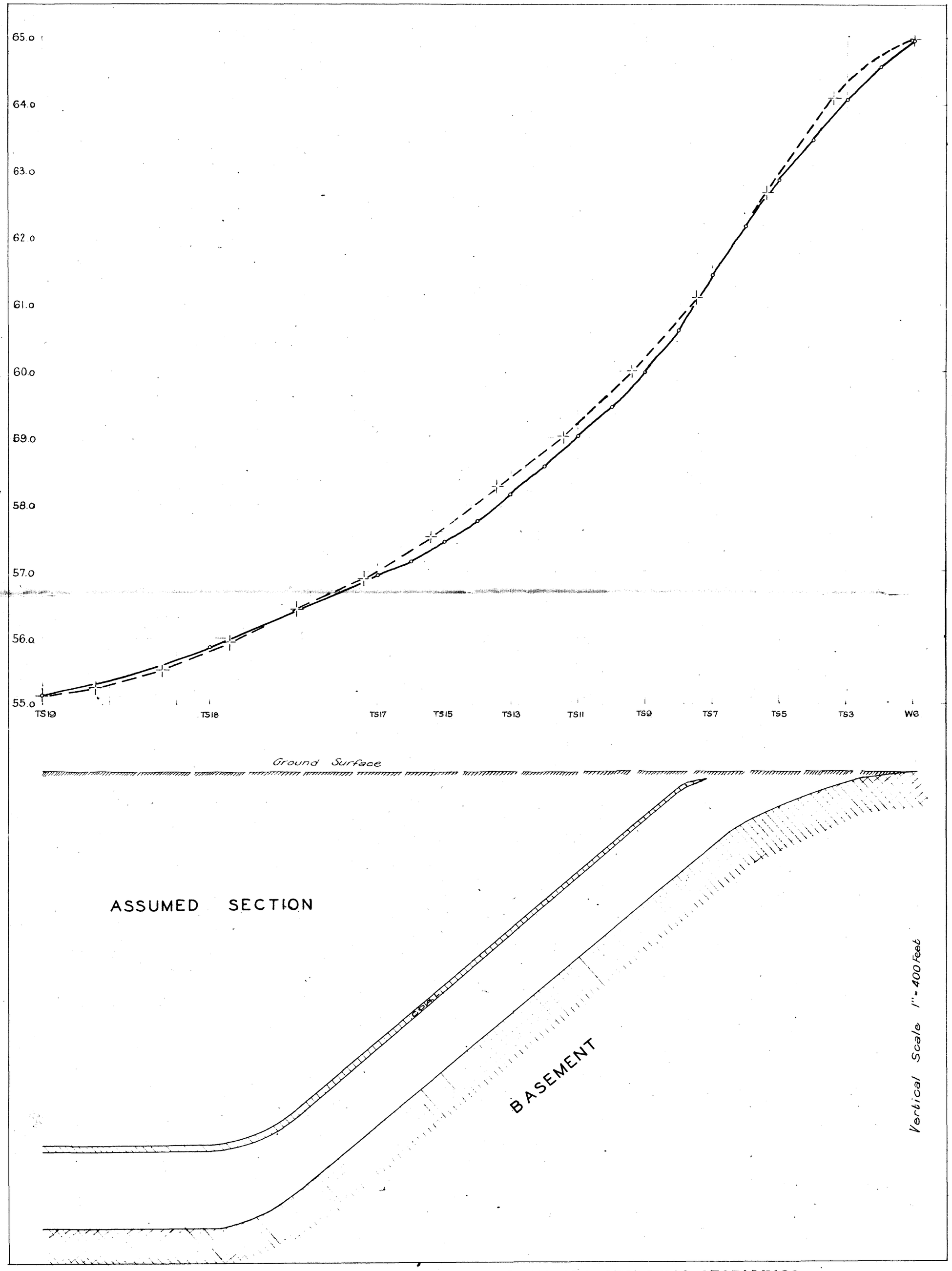
Scales

MILLIGALS 0 1 2 3 4 5
FEET 0 400 800 1200 1600 2000
VERTICAL HORIZONTAL

G17-6



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LEIGH CREEK S.A GEOPHYSICAL SURVEY

TELFORD BASIN AREA

OBSERVED & CALCULATED GRAVITY PROFILES ALONG TRAVERSE AT SOUTHERN END

Observed Curve ——o——

Calculated Curve – – –+– – –

SCALES

MILLIGALS 0 1 2 3 VERTICAL

FEET 0 400 800 1200 HORIZONTAL

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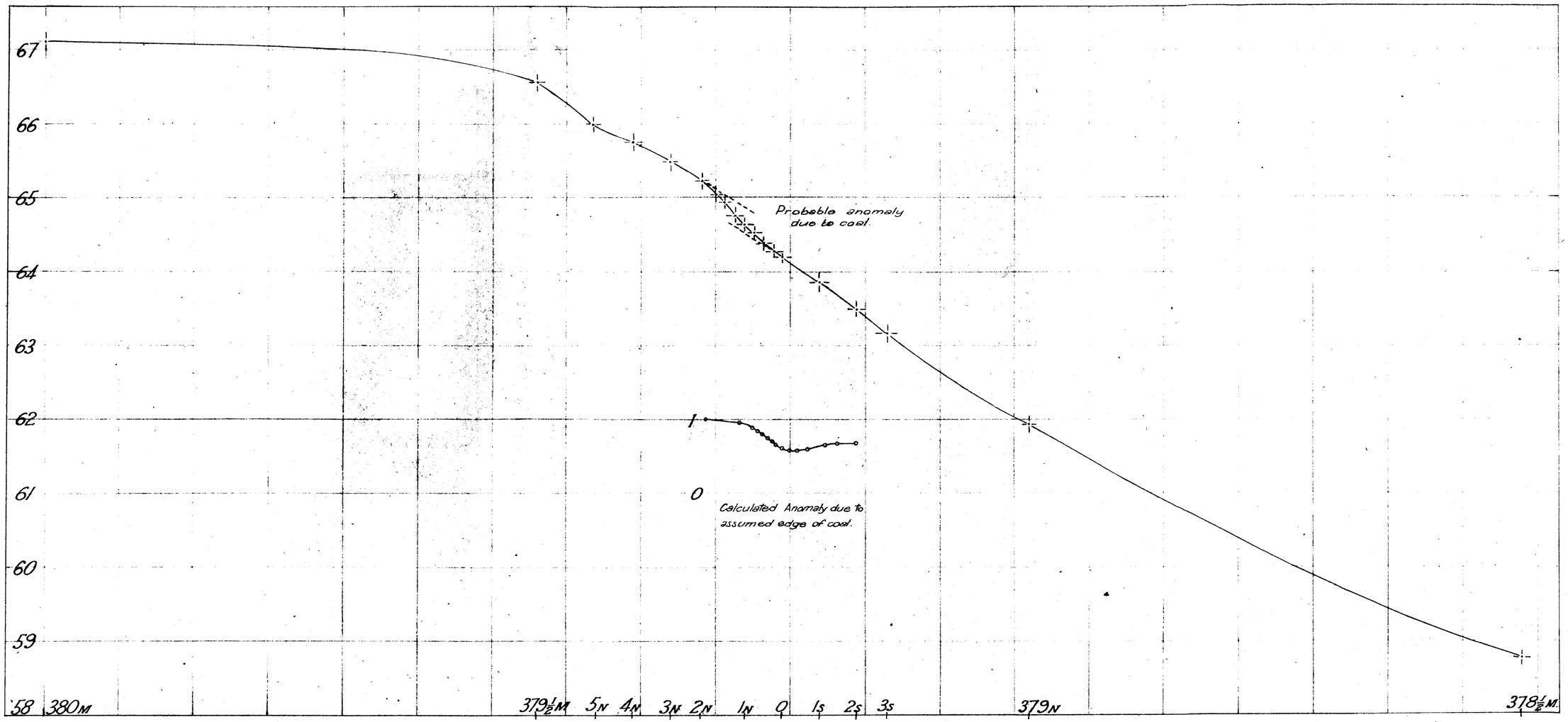
G17-7



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LEIGH CREEK S.A. GEOPHYSICAL SURVEY

TELFORD BASIN AREA

GRAVITY PROFILE ALONG RAILWAY OVER NORTHERN EDGE OF BASIN

G17-8

SCALES

MILLIGALS 0 1 2 3 4 5 VERTICAL

FEET 0 400 800 1200 1600 2000 HORIZONTAL

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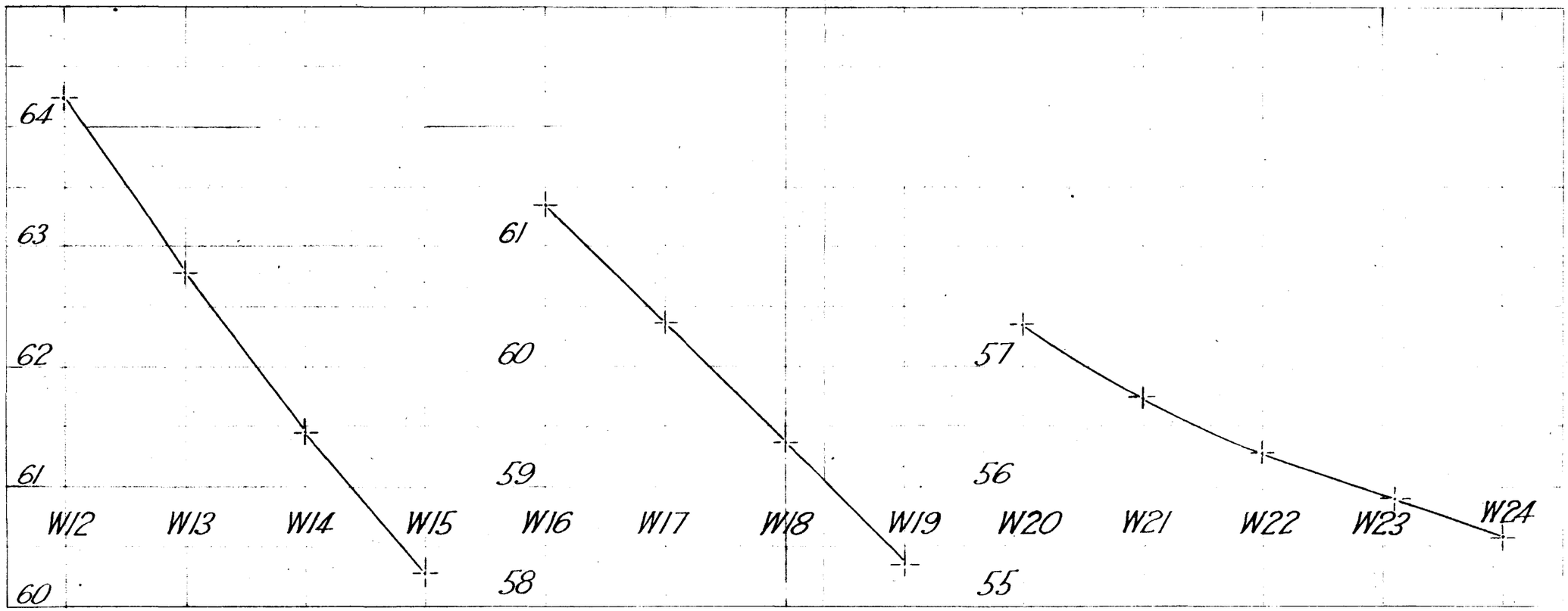

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SCALES

MILLIGALS 0 1 2 3 4 VERTICAL

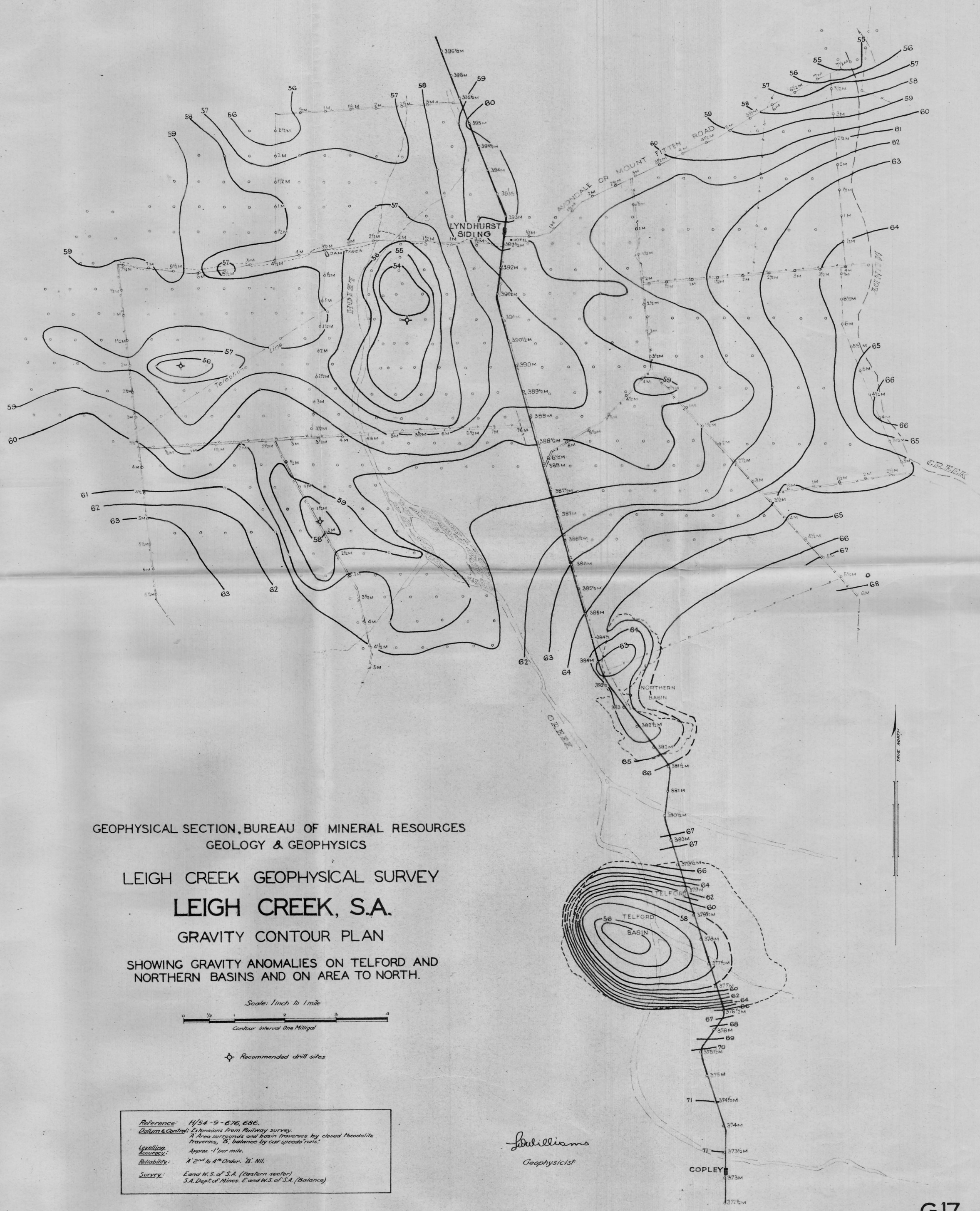
FEET 0 400 800 1200 1600 HORIZONTAL

LEIGH CREEK S.A. GEOPHYSICAL SURVEY

TELFORD BASIN AREA

GRAVITY PROFILES ALONG PROPOSED LINES OF BORES

G 17-9



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GEOLOGY & GEOPHYSICS

LEIGH CREEK GEOPHYSICAL SURVEY

LEIGH CREEK, S.A.

GRAVITY CONTOUR PLAN

SHOWING GRAVITY ANOMALIES ON TELFORD AND NORTHERN BASINS AND ON AREA TO NORTH.

Scale: 1 inch to 1 mile

0 ½ 1 2 3 4

Contour interval One Milligal

Recommended drill sites

Reference:	H/54-9-676, 686.
Datum & Control:	Extensions from Railway survey. 'A' Area surrounds and basin traverses by closed theodolite traverses, 'B', balance by car speedo "runs."
Levelling Accuracy:	Approx. ·1' per mile.
Reliability:	'A' 2nd to 4th Order. 'B' Nil.
Survey:	E and W.S. of S.A. (Eastern sector) S.A. Dept. of Mines. E and W.S. of S.A. (Balance)

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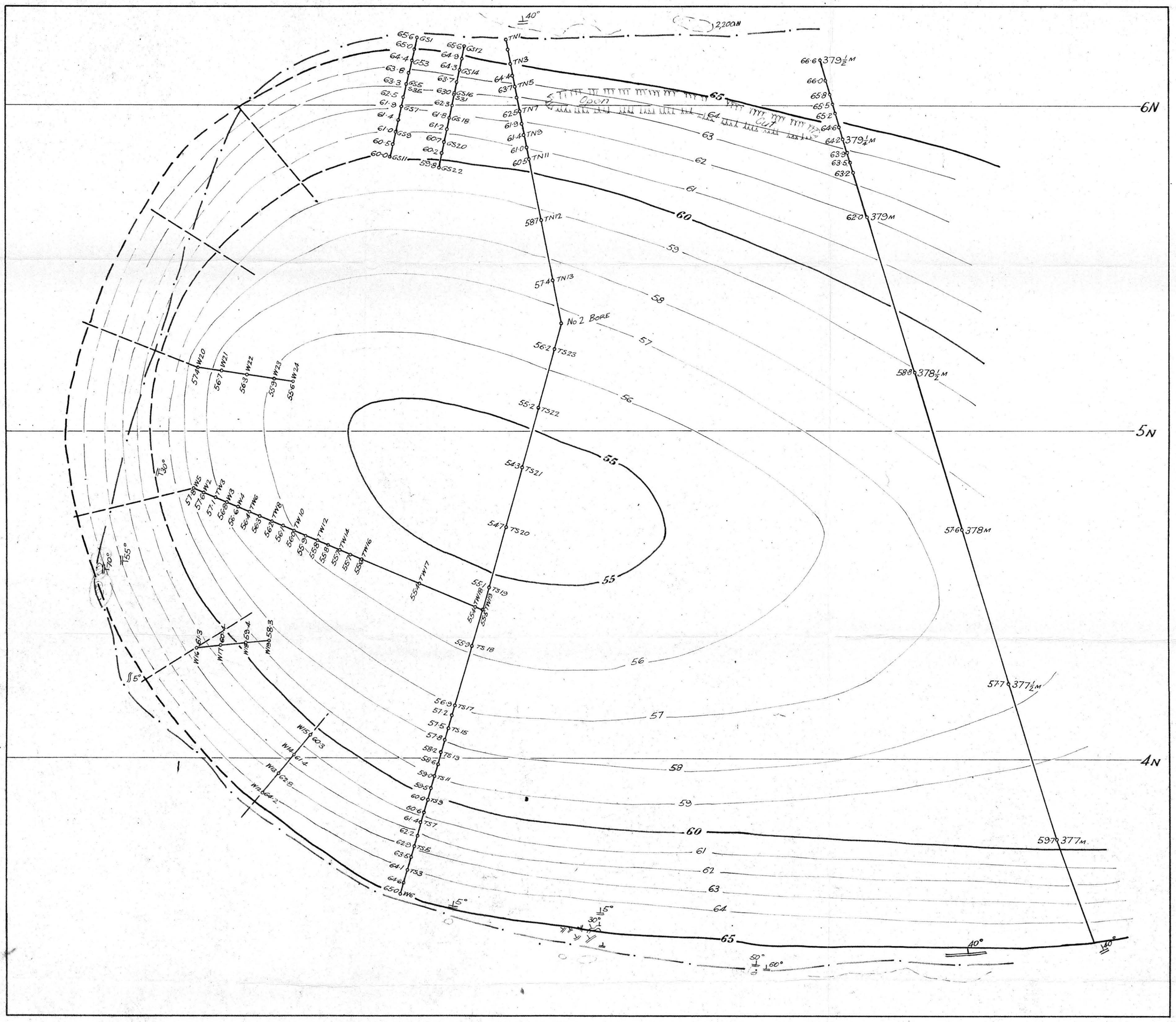
G17-10



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LEGEND

- Contours
- Form Lines (probable)
- Recommended traverses & extensions
- Edge of basin
- Outcropping Precambrian rocks

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Geophysicist

SCALE
0 1000 2000 3000 4000 5000 FEET

Contour interval = 1 Milligal.

LEIGH CREEK, S.A., GEOPHYSICAL SURVEY,

TELFORD BASIN AREA

GRAVITY CONTOURS & STATION LOCATIONS.

G17-11.