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RECORD No. 1962/18

LOGAN RIVER 95.3M & 99.6M, AND BURNETT CREEK 14.9M DAM SITES SEISMIC REFRACTION SURVEYS, QUEENSLAND 1959

by

P.E. Mann and W.A. Wiebenga

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SUMMARY

This Record describes seismic refraction surveys made by the Bureau of Mineral Resources at three dam sites near Rathdowney in southern Queensland. These sites are being considered by the Irrigation and Water Supply Commission of Queensland for the development of the Logan River valley.

The survey showed that at the 95.3M site the depth to bedrock ranges from 21 to 84 ft. At the 99.6M site it disclosed a broad subsurface valley with bedrock at an average depth of 50 ft. Young's modulus of the bedrock was derived from an analysis of ground-roll waves. At the 14.9M site the measured depth to bedrock ranges from 12 to 97 ft.

At each site, positions for test drilling to check the seismic interpretation are recommended.

1. INTRODUCTION

The Irrigation and Water Supply Commission of Queensland proposes building some dams to ensure the continuity of water supplies to existing farms in the Logan River valley. Three possible sites have been selected for investigation by the Commission; two on the Logan River, and one on Burnett Creek, a tributary of the Logan River.

The two Logan River sites, designated the 95.3M and 99.6M dam sites, are situated respectively about half a mile and three miles from the township of Rathdowney (Plate 1). The Burnett Creek site, designated 14.9M, is situated about 10 miles from Rathdowney. The approximate co-ordinates of the sites are respectively 600499, 595500, and 578504, with reference to the Warwick sheet of the Australian 4-mile map series.

At the request of the Commission, the Bureau of Mineral Resources, Geology and Geophysics conducted a geophysical survey to determine the nature of, and depth to, unweathered bedrock at the three sites. The seismic refraction method was used. A party consisting of P.E. Mann, party leader and geophysicist, and J.P. Pigott, geophysical assistant, from the Geophysical Branch of the Bureau, and four field assistants supplied by the Commission, conducted the field work between 29th July and 12th August 1959. The Commission did the topographical surveying. Additional transport and some supplies for the survey party were provided by the Commission.

2. METHODS AND EQUIPMENT

A general description of the seismic refraction method and the technique of the 'method of differences' used on this survey is given by Polak and Mann (1959).

The equipment used on the survey was a 12-channel portable seismograph manufactured by the Midwestern Geophysical Laboratory and designed for shallow reflection and refraction work.

Midwestern geophones with a natural frequency of about 8 cycles per second were used to record the vertical motion of the ground. South-western Industrial Electronics horizontal-response geophones with a natural frequency of 6 c/s were used to measure the transverse wave velocity.

With the 'method of differences' the following types of geophone spreads were used :-

(a) Normal spreads: the geophones were spaced 50 ft apart in a straight line and shots were fired 50 and 200 ft beyond each end of and in line with the spread.

(b) Weathering spreads: the geophones were spaced 10 ft apart in a straight line, and shots were fired 10, 25, 40, and 75 ft beyond each end of and in line with the spread.

3. SEISMIC VELOCITIES

Seismic velocities give an approximate indication of hardness, compactness, and strength of rocks. With the aid of the following table the seismic velocities indicated on the seismic cross-sections can be interpreted in geological terms. The table is based on the known rock types outcropping in the area, and on experience in other areas.

Seismic velocities (ft/sec)	Rock types
700 to 2000	Soil, sand, silt, and clay.
2000 to 3000	Alluvial and eluvial material, not water-saturated.
3000 to 4000	Alluvial river terrace material, with clay predominant, water-saturated.
4000 to 6000	Alluvial river terrace material, with sand and gravel predominant, water-saturated.
3000 to 7000	Very weathered to weathered bedrock.
7000 to 13,000	Moderately or slight weathered to unweathered bedrock.

It is considered that rocks having a seismic velocity up to 4000 ft/sec can be easily excavated by earth-moving equipment. For rocks with velocities 4000 to 6000 ft/sec, excavation may be possible but will be more difficult. It is unlikely that rocks with a velocity greater than 6000 ft/sec can be easily excavated.

4. ELASTIC PROPERTIES

The dynamic values of the elastic constants of a rock are calculated from the formulae (Leet, 1950):

$$(V_P/V_S)^2 = (1-\sigma)/(\tfrac{1}{2}-\sigma) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$E = 1.34 \times 10^4 dV_P^2 (1+\sigma)(1-2\sigma)/(1-\sigma) \quad \ldots (2)$$

where E = Young's modulus (lb/in.^{2})

d = rock density (g/cm^3)

V_P = longitudinal velocity (ft/msec)

V_S = transverse velocity (ft/msec)

σ = Poisson's ratio

A value of Poisson's ratio can be determined from Equation (1) by measuring the transverse and longitudinal wave velocities. The values of the elastic constants can then be calculated, if the density of the medium is known or can be estimated.

Seismograms used for determining the 'time depth' and longitudinal velocity of a refractor usually record the low-frequency ground-roll waves, which are a complex movement of the ground particles resulting from the passage of near-surface waves, of which the Rayleigh and Love waves are the most important. Where vertical movement only is recorded, Rayleigh waves are predominant. The theory of Rayleigh wave dispersion shows that the ground-roll velocity (V_R) can be used to compute Poisson's ratio for the bedrock if the ratio of the overburden thickness H to the ground-roll wavelength L is small. The way in which V_R/V_P depends on H/L (in dispersion theory L/H is generally used) is difficult to calculate for all possible cases, but is qualitatively explained by Ewing, Jardetzky and Press (1957, 200-209).

If the values of V_R/V_P can be estimated for H/L = 0 (no overburden) from a graph of V_R/V_P as a function of H/L, Poisson's ratio for bedrock can be determined from a relation between Poisson's ratio and V_R/V_P (Knopoff, 1952). Young's modulus can then be calculated from Equation (2), using an estimated density of bedrock. This method is described in detail by Jesson, Wiebenga and Dooley (1961).

The value of Young's modulus for rock can also be estimated within 30 percent from an empirical relation (Mann, 1961):

$$E = 10^{-3} V_P^{2.34} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

5. LOGAN RIVER 95.3M DAM SITE

Geology

The site is in the mature valley of the Logan River immediately up-stream from the junction with Palen Creek. The valley is about 800 ft wide, and unstable banks up to 20 ft high border the river. Within the survey area, the right bank (looking down-stream) rises steeply, and the left bank gently, to a height of about 100 ft above the creek.

Geological investigation of the site has been made by the Commission (Dunlop, 1959a). The stratigraphical units are Bundamba Group rocks (Jurassic-Triassic) and alluvium (Quaternary). The Bundamba Group here consists principally of quartzose sandstone with minor amounts of conglomeratic grit, sandy shale, and shale. The beds are generally thin; sandstone members are usually less than five feet thick, with other beds forming laminations a few inches thick. The sandstone ranges from fine to coarse-grained with medium-grain predominating. There is cross-bedding in the coarser members. Joints are not common or persistent, frequently being restricted to individual beds.

On the right bank the beds strike 145° and dip east at 5° to 10°; on the left bank they strike 30° to 45° and dip west at 5° to 15°. Between the right and left banks of the river there may be a minor anticlinal flexure, probably faulted rather than sharply folded.

Outcrops are absent on the moderately sloped left bank, where the surface material consists of fine sand, silt, and soil overlying fine sand with clay.

The surface material on the steep portion of the right bank consists principally of fine eluvial sand with a trace of clay. Large sandstone floaters are numerous near the top of the slope. The floaters are being liberated from sandstone strata approximately 30 ft thick forming the ridge capping. The ridge has been formed because the sandstone strata are resistant to weathering. A thin cover of sandy silt and soil occurs on top of the ridge.

The alluvium consists of gravel, sand, and fine sand, with traces of silt and clay.

In this Record the terms 'unweathered bedrock' and 'weathered bedrock' are used. 'Unweathered bedrock' refers to the unweathered consolidated rocks of the Bundamba Group with seismic velocities of 8000 to 11,500 ft/sec; 'weathered bedrock' refers to weathered rocks of the same Group with seismic velocities of 3500 to 6000ft/sec.

Results

Plate 1 is a locality map and Plate 2 shows the traverse layout. Plate 3 shows the interpretation of the seismic results as cross-sections, giving the depth to bedrock. On the cross-sections and in the text a geophone station is referred to by the traverse letter and a number; e.g. A16 means station 16 on Traverse A.

Right Bank; Traverses A, B, and X. The right bank portion of Traverse X falls steadily from near station X2, on top of the ridge, to approximately X11, on the river terrace. Near X2 a very thin soil cover of 1-2 ft overlies a refractor with a velocity of about 5000 ft/sec. The depth of the refractor with a seismic velocity of 8000 ft/sec is about 33 ft. The 8000-ft/sec refractor is partly weathered and fractured sandstone which forms the floaters present mainly on the ridge. Farther down the slope from the ridge, near X13, layers with seismic velocities of approximately 900, 4000, and 7500 ft/sec were recorded. A layer with a low velocity (700 to 1000 ft/sec) was recorded by normal and weathering spreads between X13 and X23, and between B2 and B22. This layer is interpreted as dry unconsolidated alluvial material and sand, silt, and soil mixture comprising the right bank river terrace. The depth of this layer on Traverses B and X ranges from 21 ft near X11 to 29 ft near B13.

On Traverse X the layer with seismic velocity 4000 to 6000 ft/sec is interpreted for the most part as weathered sandstone, but in the central part of the area, between about X10 and X25 and along Traverse B, this layer may be alluvium that is partly or wholly water-saturated. The top surface of this layer is level here, and probably represents the water-table. A transition to weathered bedrock could occur at some depth below this, without being detected by the seismic method. The depth to unweathered bedrock ranges from 33 ft near X2 to 84 ft near X18. The seismic velocity for the unweathered bedrock is 8000 to 10,000 ft/sec; a higher velocity was recorded near the river.

On Traverse A the seismic velocity of the top formation, of eluvial material and sandstone floaters, is between 1000 and 2100 ft/sec, and the depth averages about 15 ft. The weathered bedrock has a velocity of 3500 to 5500 ft/sec. The velocity of the unweathered bedrock ranges from 10,000 to 12,000 ft/sec, and the depth ranges from 83 ft near A16 to 54 ft near A22. The transition from the eluvial material of the ridge slope to the alluvium of the river terrace may be gradual or abrupt; it is not possible to delineate the boundary from the results of the seismic survey.

Left Bank: Traverses C and X. On the gradually sloping left bank, on Traverse X, the top formation, with velocity of 1900 to 2200 ft/sec, consists of soil and eluvial material overlying weathered bedrock with a velocity 4000 to 4500 ft/sec. The velocity of the unweathered bedrock is 9000 to 11,500 ft/sec, and the depth ranges from 26 ft near X32 to 69 ft at X41.

On Traverse C, the depth to unweathered bedrock (seismic velocity 10,000 to 11,500 ft/sec) averages 30ft between C12 and C22, and 65 ft between C12 and C2. Weathered bedrock of velocity 5000to 6000 ft/sec, and the top formation of soil and eluvial material with a velocity of 1300 to 2800 ft/sec, overlie the unweathered bedrock.

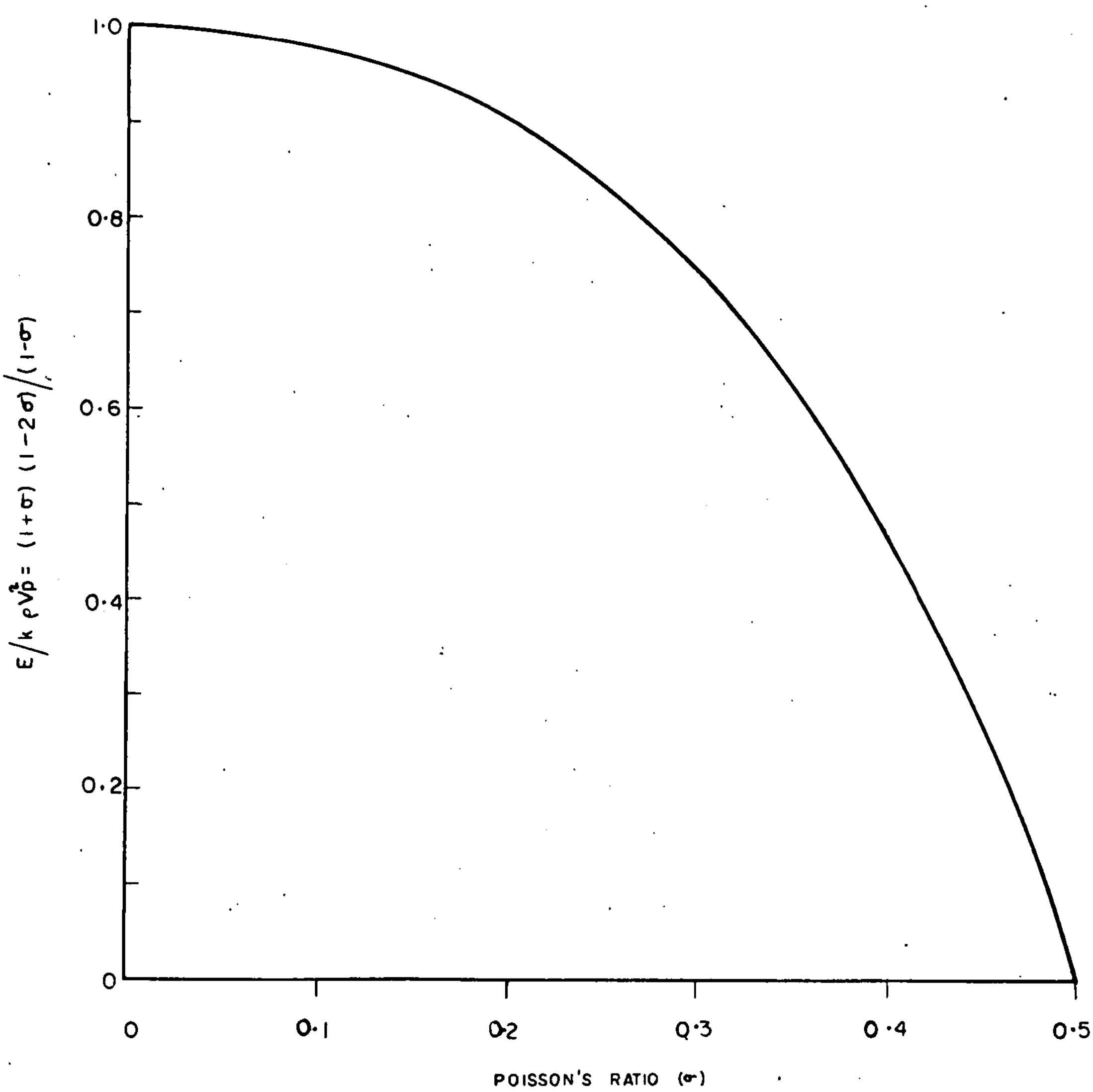
Elastic properties. Table 1 shows the ground-roll data, measured from the seismic records. The Table shows for each spread the mean bedrock velocity recorded (V_{P2}), the ratio of overburden velocity to bedrock velocity $q = V_{P1}/V_{P2}$, the mean thickness of overburden H, the ground-roll velocity and wavelength V_R and L as measured from the records, and the ratios $x = H/L$ and $r = V_R/V_{P2}$. The value of V_{P1} used in calculating q is an approximate mean value for the two layers of overburden present in most of the area. Where the increase in velocity is due to the water table, the correct value of V_{P1} should be based on the dry alluvium etc.; thus the estimate of q for B2 - B12 may be too high. However, this does not affect the main conclusions drawn below.

TABLE 1

GROUND-ROLL DATA, 95.3M SITE

Obs.No.	TRAVERSE	V_P	q	H	V_R	L	x	r
1	A2 - A12	12,000	0.42	64	6200	254	0.25	0.52
2					5700	276	0.23	0.48
3					4000	173	0.37	0.33
4					5500	248	0.26	0.46
5	A12 - A24	10,500	0.38	74	5000	240	0.31	0.48
6					4800	206	0.36	0.46
7					4500	211	0.35	0.42
8	B2 - B12	11,000	0.27	56	3600	127	0.44	0.33
9					4500	333	0.17	0.41
10					3800	205	0.27	0.35
11	X22 - X32	10,000	0.41	37	4200	193	0.19	0.42
12	X32 - X42	11,000	0.27	45	4200	122	0.37	0.38
13	C2 - C12	11,000	0.36	61	4600	138	0.44	0.42
14					4800	165	0.39	0.44
15	C12 - C22	10,500	0.20	29	5100	244	0.12	0.49
16					5600	179	0.16	0.53

FIG. 2



RELATION BETWEEN YOUNG'S MODULUS
AND
POISSON'S RATIO

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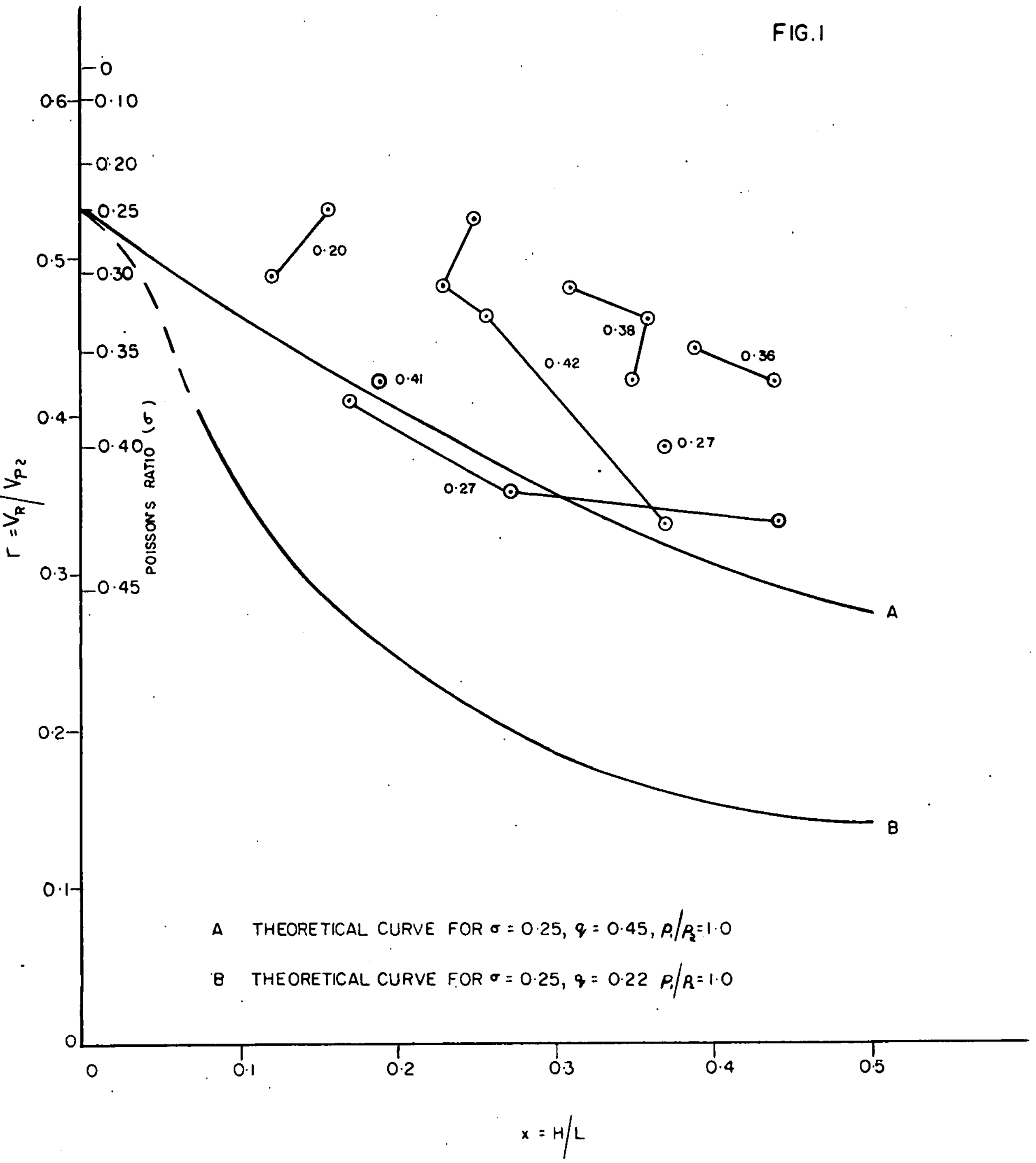
To Accompany Record No. 1962/18

FIG. 1



GROUND-ROLL DATA

LOGAN RIVER 95·3M DAM SITE

POINTS REPRESENTING DATA FROM THE SAME SPREAD ARE JOINED BY LINES.

NUMBERS NEAR EACH POINT OR GROUP OF POINTS ARE VALUES OF: $q = V_{P1} / V_{P2}$.

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In Figure 1, values of r from Table 1 are plotted against the corresponding values of x. Points representing data from the same spread are joined by lines. The value of q is shown for each point or group of points on the graph, as q is the main factor determining the shape of the dispersion curve.

The points are rather scattered, and it is difficult to draw a dispersion curve giving a reasonable fit to the data. There is very little improvement if the data are divided into groups of high and low q, or into groups corresponding to different parts of the area. Jesson et al. (1961) conclude that it may be difficult to extrapolate to $x = 0$ from data for which q is less than about 0.4, and this applies to most of the present data. However, some useful conclusions may be drawn from a comparison with theoretical curves.

Two such curves, selected from those used by Jesson et al. (op.cit.; Appendix, Fig.2) are plotted on Figure 1. There are the curves for $q = 0.45$ and 0.22, with Poisson's ratio = 0.25. All the points plotted on Figure 1 lie well above the corresponding theoretical curves. From this it is concluded that Poisson's ratio must be well below 0.25 for bedrock in this area, and almost certainly below 0.20. A low value of Poisson's ratio is believed to be typical for porous consolidated rocks such as the sandstones in this area (Wiebenga and Manganwidjoyo, 1960).

Now, the relation between Young's modulus and Poisson's ratio depends on the function $(1 + \sigma)(1 - 2\sigma)/(1 - \sigma)$ (see Chapter 4.). A graph of this function is shown in Figure 2. For values of σ between 0 and 0.20, this function varies only between 1.00 and 0.90. Thus, if we adopt a value of 0.95 for this function, the error due to lack of precise knowledge of σ cannot exceed 5 percent.

If we assume a density of 2.55 g/cm^3 for bedrock, and take the average longitudinal velocity as 10,500 ft/sec, we get a value of $E = 3.8 \times 10^6$ $lb/in.^2$. The probable accuracy of this estimate is about $\pm$ 20 percent.

Conclusions

The survey provided information on the depth to unweathered bedrock. The overburden, which consists of soil, alluvial and eluvial material, and weathered bedrock, ranges in thickness from 21 to 84 ft.

From ground-roll data, Poisson's ratio for bedrock was found to be less than 0.2, and Young's modulus about 3.8×10^6 $lb/in.^2$.

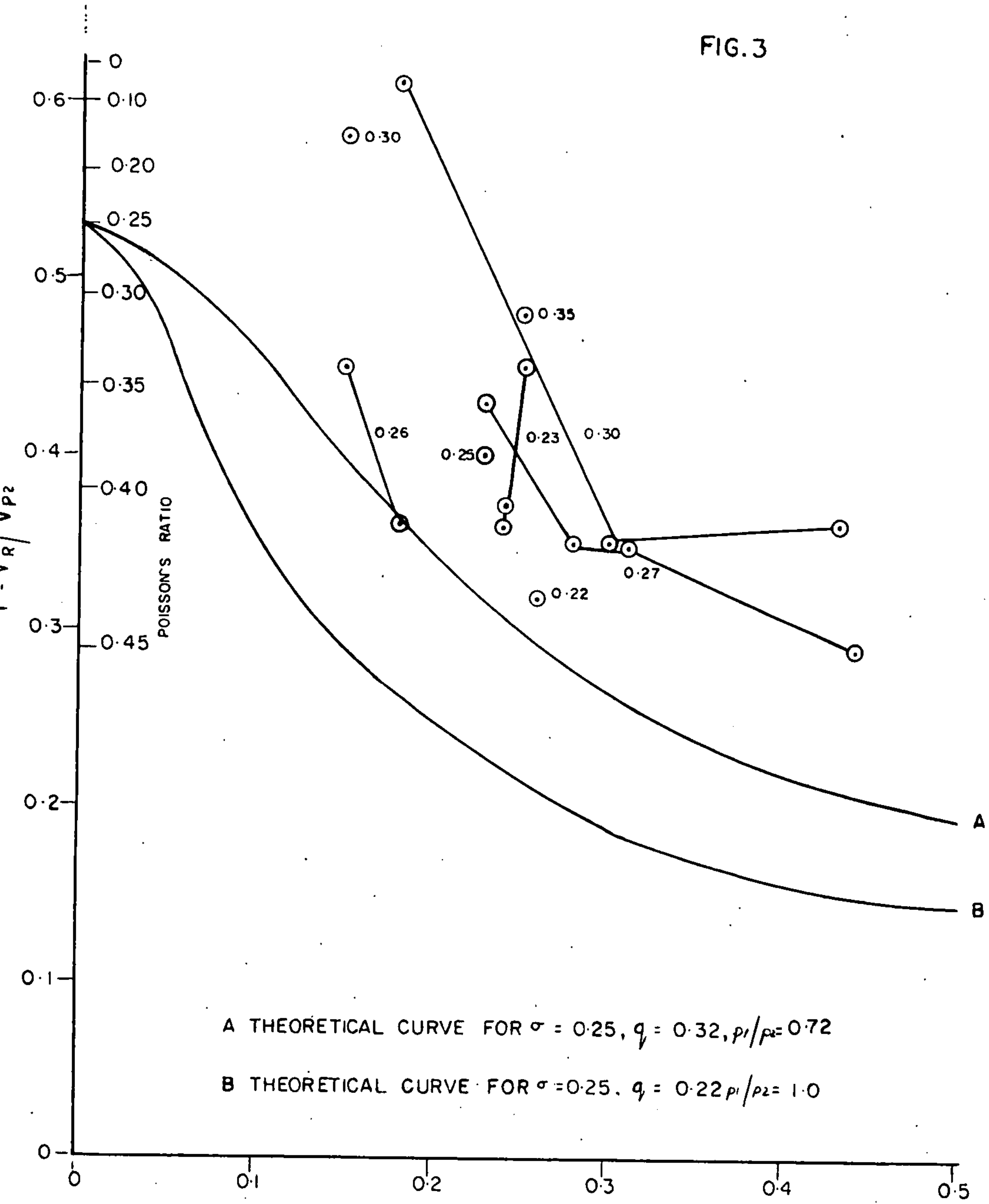
It is recommended that test drilling be done to act as a control on the seismic interpretation. The positions suggested for test drilling are:

(1) Near X16; vertical hole to test the depth and soundness of the 5750-ft/sec refractor.

(2) Near X6; vertical and angle holes to check the soundness of rock on the right abutment.

(3) Near X32; vertical hole to test the depth to bedrock and the nature of the 4000-ft/sec refractor.

FIG. 3



GROUND-ROLL DATA

LOGAN RIVER 996M DAM SITE

POINTS REPRESENTING DATA FROM THE SAME SPREAD ARE JOINED BY LINES.

NUMBERS NEAR EACH POINT OR GROUP OF POINTS ARE VALUES OF $q = V_{P1} / V_{P2}$

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6. LOGAN RIVER 99.6M DAM SITE

Geology

The geology of the area is given by Dunlop (1959b). The stratigraphical units consist of the Marburg Sandstone (Jurassic-Triassic) and alluvium (Quaternary). The Marburg Sandstone in the vicinity of the dam site consists principally of sandstone with lesser amounts of conglomeratic grit, siltstone, sandy shale, and shale. On lithology the Sandstone may be divided into an upper and lower section. The lower section, which is characterised by interbedded quartz-rich and quartz-poor sediments, is defined as the bedrock at the dam site. The upper section, which consists of typical cross-bedded quartzose sandstone, occurs above the full supply level of the proposed dam. Outcrops are rare and generally confined to the quartz-rich beds. Topographical benches on the right bank are due to the slight differential erosion of the strata. The floor of the benches is underlain by quartz-rich strata, and the intermediate slopes by the less resistant quartz-poor beds. The surface material on the right bank consists of fine sand, silt, and soil, with some pebbles and large floaters.

The mature valley of the Logan River, approximately 800 ft wide in the vicinity of the site, has wide alluvial terraces. Unstable banks up to 15 ft high, consisting of very fine uniformly graded sand, with traces of silt and clay, border the stream. The stream bed is gravel and sand.

Results

The locality is shown on Plate 1. Plate 4 shows the layout of seismic traverses. The seismic refraction work has been interpreted to give depth to bedrock, as shown on the seismic cross-sections (Plate 5).

The survey disclosed three main layers:

(1) A low-velocity top layer, between 10 and 30 ft thick, with velocities between 700 and 1700 ft/sec. This layer is interpreted as unconsolidated rock, dry or unsaturated soil, fine sand, and silt.

(2) An intermediate layer with seismic velocities between 2800 and 4500 ft/sec. In the centre of the valley, between about A15 and A30, and along Traverse C, the upper part of this layer probably represents alluvial river-terrace material, partly or completely saturated with water. Possibly weathered bedrock occurs at greater depth in this area, with a velocity too close to that of the saturated alluvium to permit detection by the seismic method. Further uphill, outside the area of the valley proper, it probably represents weathered bedrock or eluvial material.

(3) The bottom layer with velocities of 9000 to 11,500 ft/sec, represents unweathered or only slightly weathered bedrock. A 7000-ft/sec intermediate layer near C22 presumably also represents partly weathered bedrock. In some places, e.g. near A8, A16, A29 and A37 the weathered bedrock is between 60 and 70 ft deep, but the average depth is about 50 feet.

Elastic Properties. An estimate of Poisson's ratio has been obtained from an anlysis of the ground-roll data in the same manner as in Chapter 5. Table 2 shows the data, and Figure 3 a plot of r against x.

As in the case of the 95.3M site, values of q are very low and the points on the graph are scattered, thus making extrapolation difficult. Theoretical curves are shown on Figure 3 for q = 0.32 and 0.22. The observed points are well above the theoretical curves, and again a low value of Poisson's ratio is indicated.

It is possible that the value of q should be lower than shown in Table 2 for observations Nos. 6 - 13, as part of the overburden may be water-saturated in this area (see Chapter 5 - "Elastic properties").

Some of the points have very high value of r, which would lead to theoretically impossible values of r_o if a curve similar to the theoretical ones were fitted to them. It is possible that these represent other modes of Rayleigh waves, such as the M_{21} or M_{12} modes (Ewing et al., 1957; 195). The dispersion curves for these modes approach the transverse velocity V_{s2} at a value of x greater than zero. For Poisson's ratio = 0.25, V_s/V_p = 0.58. Some of the points on the graph have values of r as high as or higher than 0.58. Thus if they do represent higher modes, the hypothesis of a low value of Poisson's ratio would be consistent with them. Measurements with 3-component geophones would be needed to confirm the nature of these waves.

Using as before a value of 0.95 for the expression

$(1 + \sigma)(1 - 2\sigma)/(1 - \sigma)$, assuming a density of 2.55 g/cm^3 for bedrock, and taking average bedrock velocity as 10,500 ft/sec, we obtain from Equation (2) a value of E = 3.8×10^6 lb/in.^{2}.

TABLE 2

GROUND-ROLL DATA, 99.6M SITE

Obs.No.	TRAVERSE	V_{P2}	q	H	V_R	L	x	r
1	A2 - A12	10,000	0.25	54	4000	232	0.23	0.40
2	B2 - B12	10,000	0.30	50	5800	327	0.15	0.58
3	B12 - B22	10,000	0.30	56	6100	311	0.18	0.61
4					3600	129	0.43	0.36
5					3500	186	0.30	0.35
6	A22 - A32	10,000	0.30	51	4800	206	0.25	0.48
7	C12 - C22	11,000	0.27	55	3200	125	0.44	0.29
8					3800	179	0.31	0.35
9					4700	235	0.23	0.43
10					3900	193	0.28	0.35
11	C2- C12	10,500	0.23	50	4700	202	0.25	0.45
12					3800	205	0.24	0.36
13					3900	211	0.24	0.37
14	D12 - D22	11,500	0.26	42	5200	274	0.15	0.45
15					4100	228	0.18	0.36
16	D2 - D12	11,500	0.22	43	3700	163	0.26	0.32

Conclusions

The geophysical survey disclosed a broad subsurface valley, probably flanked on both sides with river terraces. To confirm the presence of these river terraces and the depth to bedrock, it is recommended that test drilling be done near A7, A16, A23, and A36.

7. BURNETT CREEK 14.9M DAM SITE

Geology

The site is in a narrow valley 14.9 miles from the junction of the Burnett Creek and the Logan River. Both banks rise steadily within the survey area to a height of about 130 ft above the creek.

Geological investigation of the site has been made by the Commission (Dunlop, 1959c).

The stratigraphical units consist of Walloon Coal Measures (Jurassic-Triassic), basalt and porphyry intrusives (Tertiary), and alluvium (Quaternary).

The Walloon Coal Measures in the vicinity of the site consist of thin bedded partly calcareous shale, siltstone, and mudstone, considered by Dunlop to be present in approximately equal amounts. The beds are characterized by rapid vertical alterations, with bands rarely thicker than 3 ft. Most of the shale bands are unstable, breaking into small fragments which soften and decompose to clay after immersion and exposure. The siltstone and sandstone members are susceptible to chemical weathering. At the site the Walloon Coal Measures appear to be horizontal or dipping at a small angle (less than 5°) to the west; they contain basalt and porphyry intrusions, probably sills and dykes. The basalt shows considerable weathering and outcrops are rare. Porphyry intrusions are generally above the proposed full level of the dam. The porphyry, because of its hardness and resistance to weathering, tends to form plateaux and ridge cappings protecting the softer Walloon Coal Measures and basalt.

The porphyry crops out as numerous boulders, commonly forming scree deposits with little soil. Numerous floaters have been liberated onto adjacent slopes. The rock is close jointed and irregularly factured, and forms blocks up to two feet in diameter.

The alluvium is approximately 300 ft wide, and there are flood terrace deposits on both banks. The deposits consist of very fine uniformly graded sand, with traces of silt and clay. At the water's edge, unstable banks up to six feet high are present, and coarse gravel with fine sand occurs in the bed of the creek.

The surface material on both banks consists mainly of sand, silt, and soil with porphyry floaters.

Results

Plate 1 shows the locality, and Plate 6 shows the traverse layout. The seismic refraction work has been interpreted to give the depth to bedrock, as shown on the seismic cross-sections (Plate 7).

Right Bank: Traverses A and X. On the right bank the interpretation shows the existence of three layers; a top layer of soil with a seismic velocity of 1200 to 1500 ft/sec, an intermediate layer with velocity of 2500 to 4500 ft/sec, and the unweathered bedrock with velocity of 9000 to 10,500 ft/sec. The intermediate layer, between about X4 and X10 and along most of Traverse A, has a velocity between 4000 and 4500 ft/sec, which is interpreted as indicating terrace material consisting of water-saturated silt, sand, and gravel.

West of about A18, and south of about X4, the intermediate layer velocity changes gradually or abruptly to about 2500 ft/sec. This is interpreted as indicating very weathered bedrock or eluvial material, probably consisting of fairly dry clay, silt, and sand. At and near the creek, between X4 and X16, the intermediate layer or river terrace is missing.

The depth to unweathered bedrock ranges from 70 ft near X2 to 12 ft at X12 near the creek.

Left Bank: Traverses B, C, and X. On the left bank the interpretation shows the existence of three layers; a top layer of soil, silt, and sand, with velocity of 1100 to 1450 ft/sec, an intermediate layer of velocity 6000 ft/sec, and the unweathered bedrock with velocity of 10,000 to 12,500 ft/sec.

Between the creek and X14 on Traverse X, and along Traverse B, the intermediate layer is missing or is too thin to be detected.

North of X16 and along Traverse C the intermediate layer with velocity of about 6000 ft/sec probably represents weathered bedrock.

The depth to unweathered bedrock gradually increases from 12 ft at X12 to about 97 ft at X20. The level of unweathered bedrock between X18 and X20 is about 560 to 570 ft, approximately the same as closer to the creek between X12 and X14.

Elastic Properties. By using the empirical relation expressed by Equation (3), the value of Young's modulus for bedrock with a velocity of 9000 to 12,500 ft/sec ranges from 1.9×10^6 to 4.0×10^6 lb/in.^{2} with an accuracy of about 30 percent.

Conclusions

If the survey results have not ruled out the possibility of a dam being built at this site, it is recommended that holes be drilled to check the depths to bedrock and the nature of the rocks at the following places:

(1) X3, to check the 2500-ft/sec layer.

(2) X7, to check the existence of a river terrace

(3) X12 and X20, to check the nature of the 6000-ft/sec layer.

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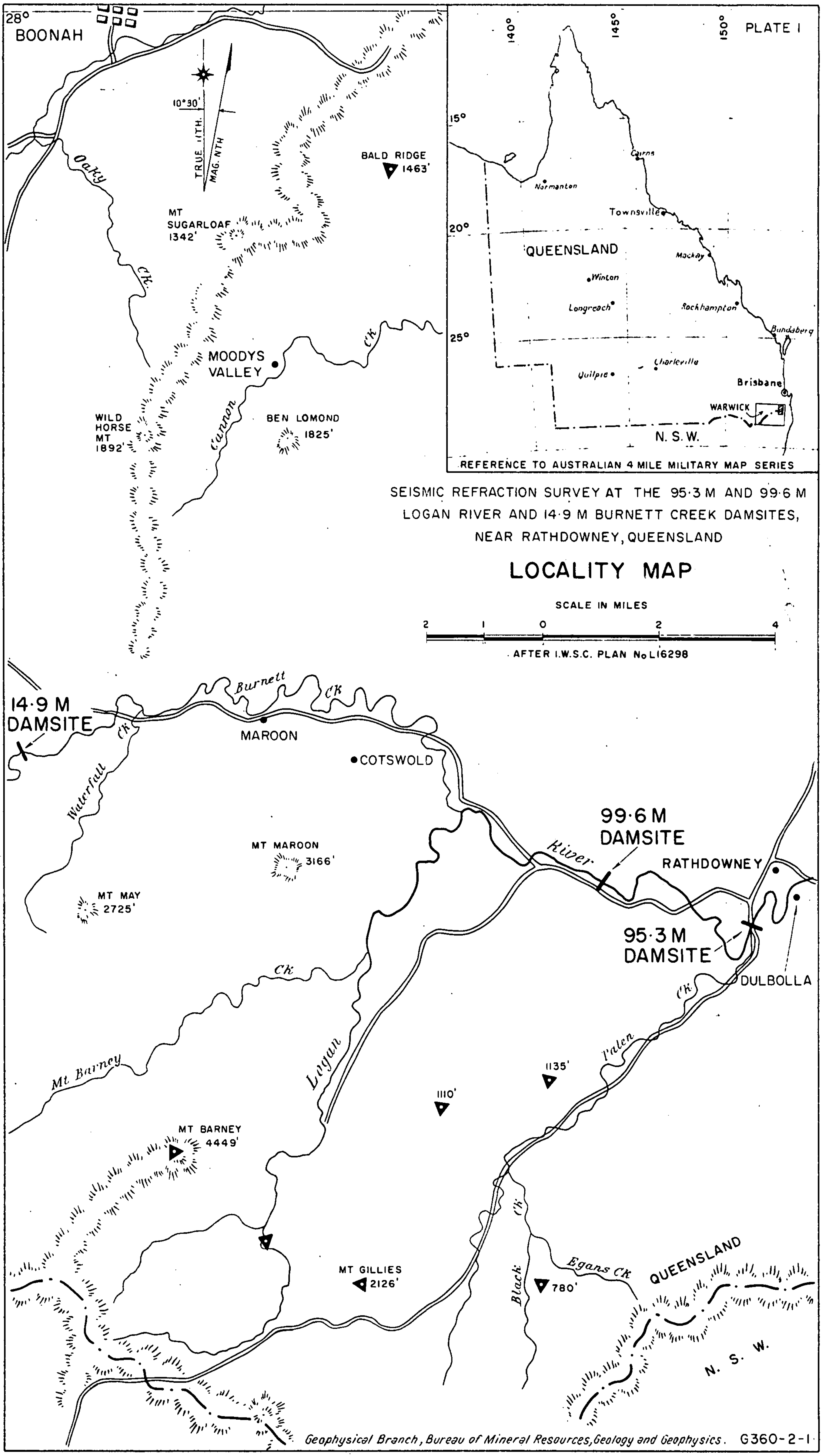


To Accompany Record No 1962/18

LEGEND

SEISMIC TRAVERSE WITH STATIONS

357° 00' MAGNETIC BEARING

FENCE

SEISMIC REFRACTION SURVEY AT THE 95·3 M. LOGAN RIVER DAMSITE, NEAR RATHDOWNEY, QUEENSLAND

LAYOUT OF TRAVERSES

SCALE IN FEET

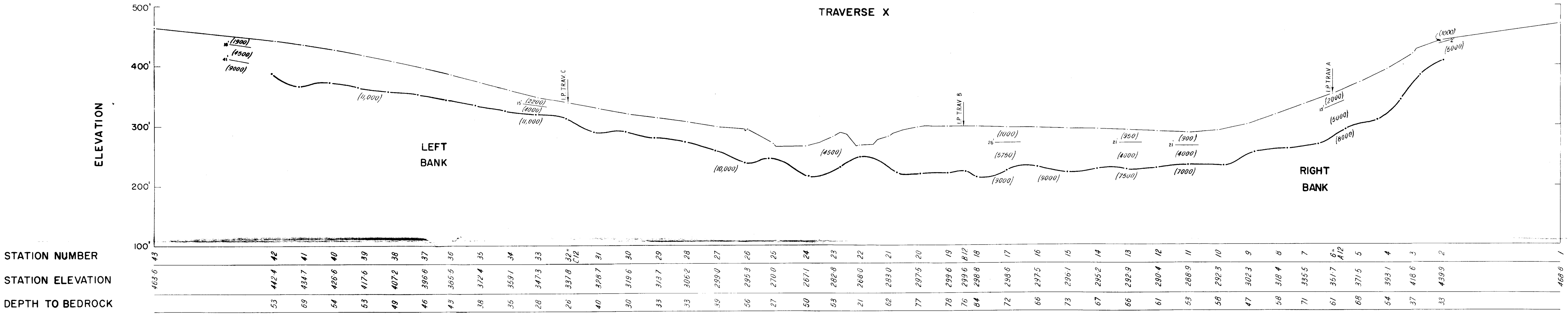
200 100 0 200 400 600

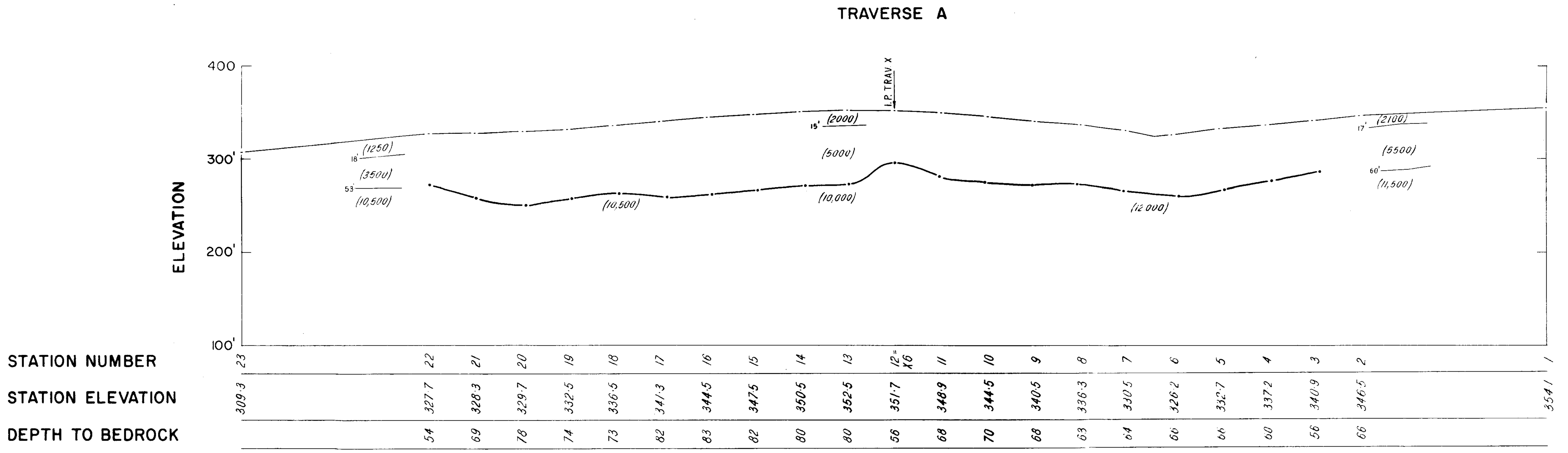
AZIMUTH DATUM: MAGNETIC

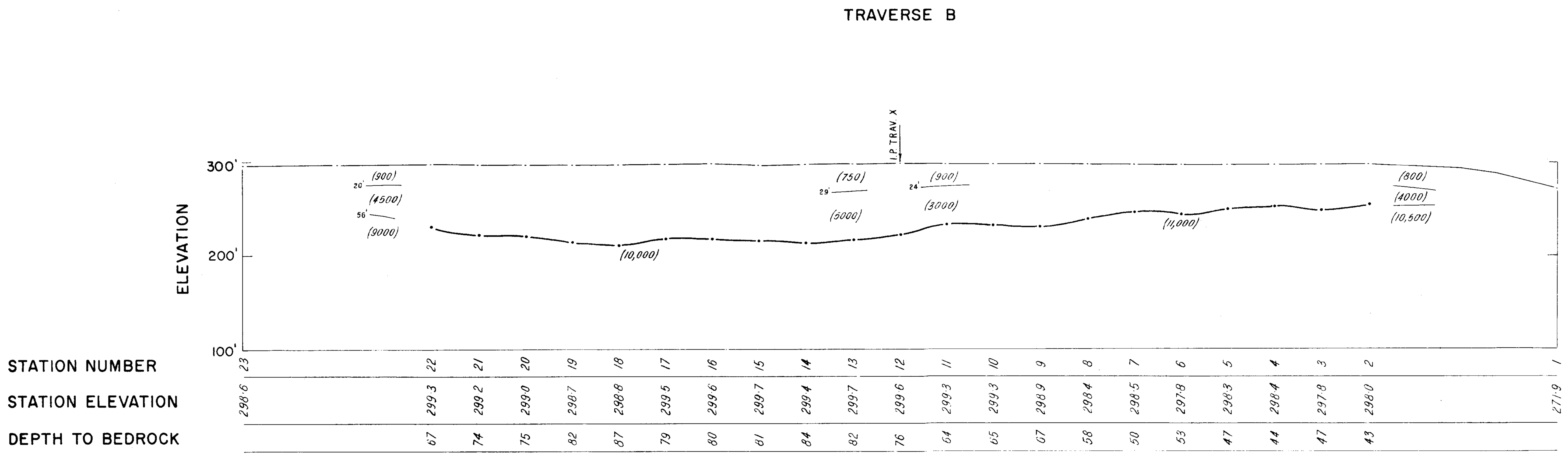
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G360-2-6

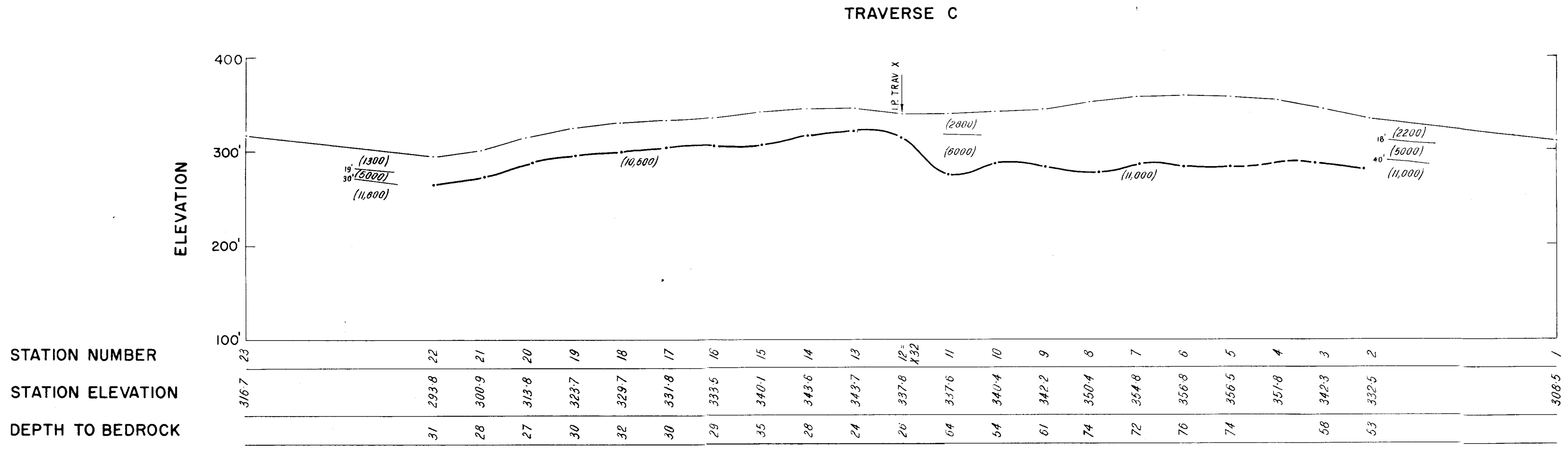
To Accompany Record No. 1962/18

PLATE 3









LEGEND.

(5000) FORMATION WITH SEISMIC VELOCITY 5000 FT/SEC

40' —— DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY

SEISMIC REFRACTION SURVEY AT THE 95·3 M. LOGAN R. DAMSITE, NEAR RATHDOWNEY, QUEENSLAND

TRAVERSES A, B, C AND X

SECTIONS

HORIZONTAL AND VERTICAL SCALES IN FEET

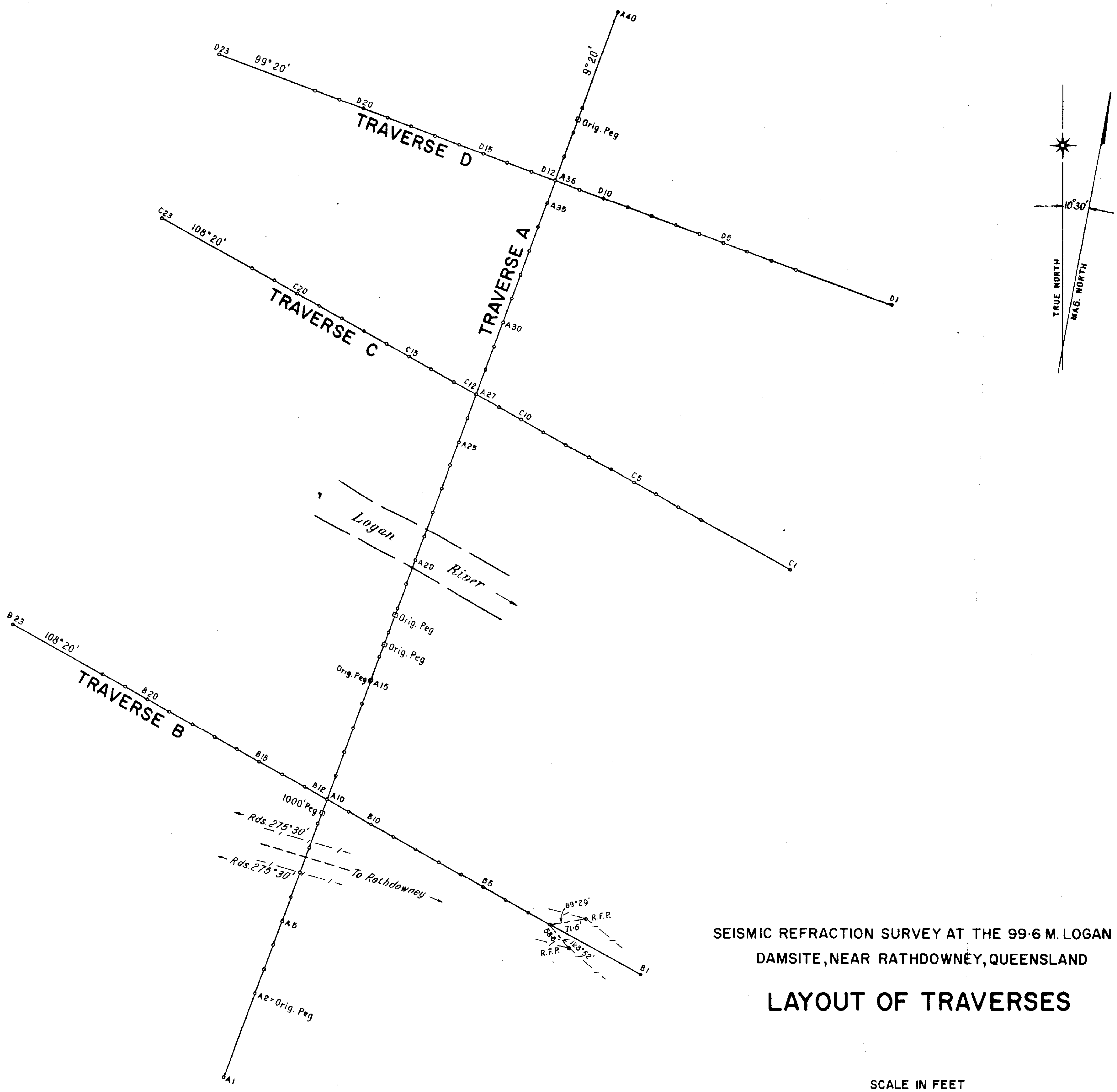
100 0 100 200 300 400

ELEVATION IN FEET ABOVE STATE DATUM

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G360-2-7

To Accompany Record No. 1962/18

PLATE 4



SEISMIC REFRACTION SURVEY AT THE 99·6 M. LOGAN RIVER DAMSITE, NEAR RATHDOWNEY, QUEENSLAND

LAYOUT OF TRAVERSES

SCALE IN FEET

200 100 0 200 400 600

AZIMUTH DATUM: MAGNETIC

LEGEND

C15 — SEISMIC TRAVERSE WITH STATIONS

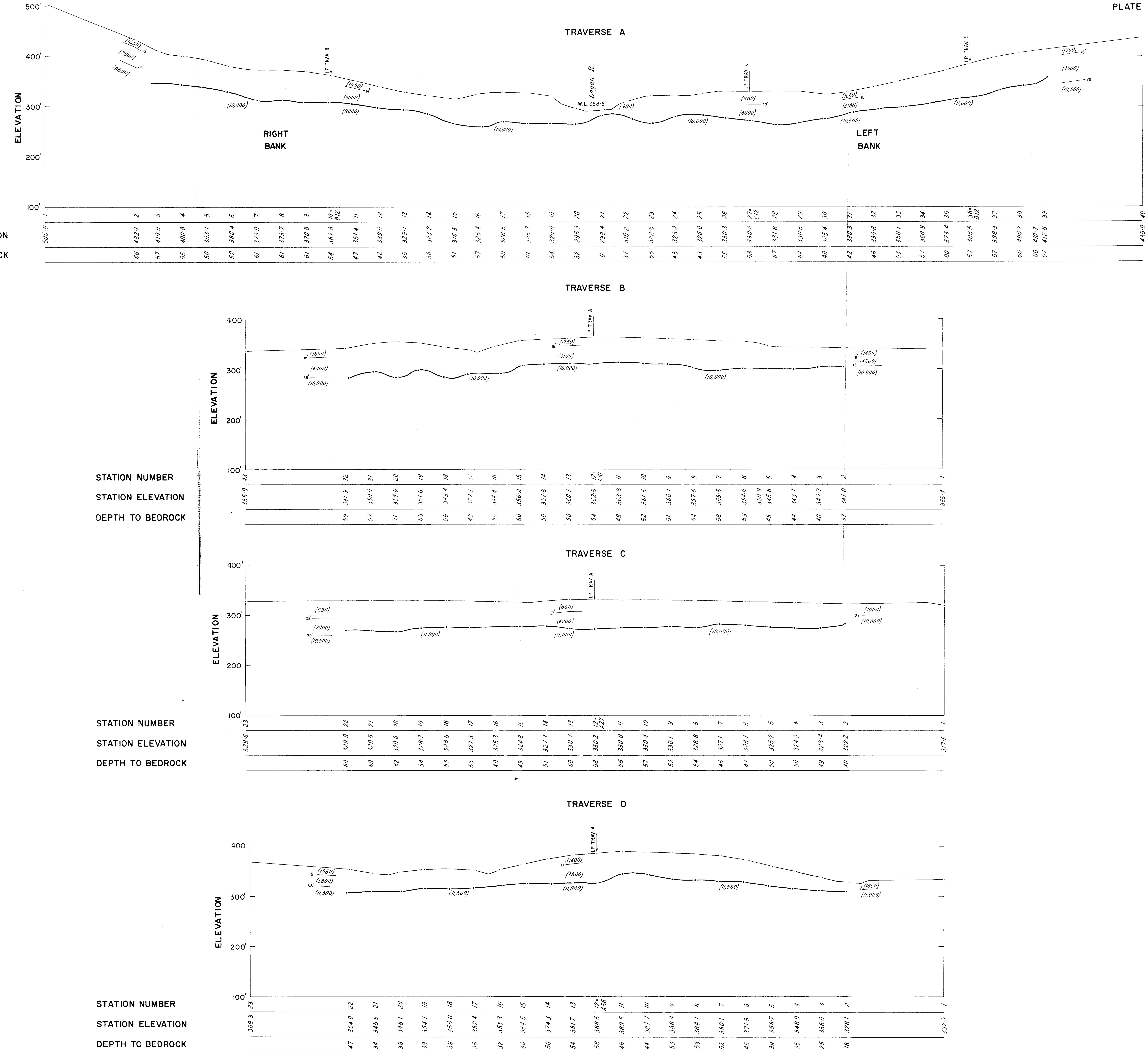
108° 20' — MAGNETIC BEARING

—/—/— FENCE

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G360-2-4

To Accompany Record No 1962/18

PLATE 5



LEGEND

(10,000) FORMATION WITH SEISMIC VELOCITY 10,000 FT/SEC

38' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY

I.P. TRAV. A INTERSECTION POINT

SEISMIC REFRACTION SURVEY AT THE 99·6M LOGAN RIVER DAMSITE, NEAR RATHDOWNEY, QUEENSLAND

TRAVERSES A,B,C AND D

SECTIONS

HORIZONTAL AND VERTICAL SCALES IN FEET

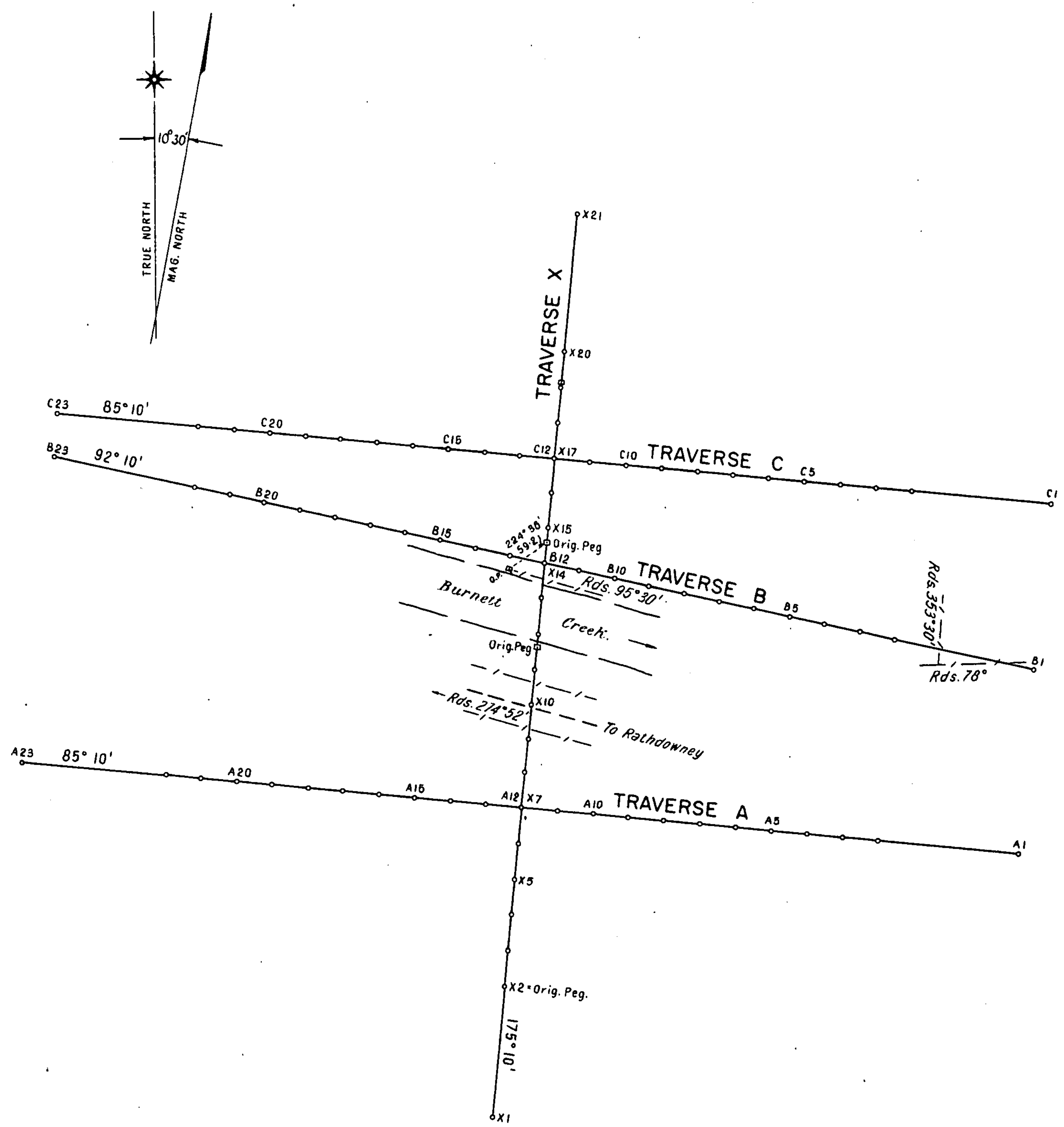
100 0 100 200 300 400

ELEVATION IN FEET ABOVE STATE DATUM

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G360-2-9

To Accompany Record No 1962/18

PLATE 6



LEGEND

C10 — SEISMIC TRAVERSE WITH STATIONS

85° 10' — MAGNETIC BEARING

—/—/— FENCE

SEISMIC REFRACTION SURVEY AT THE 14·9M. BURNETT CREEK DAMSITE, NEAR RATHDOWNEY, QUEENSLAND.

LAYOUT OF TRAVERSES

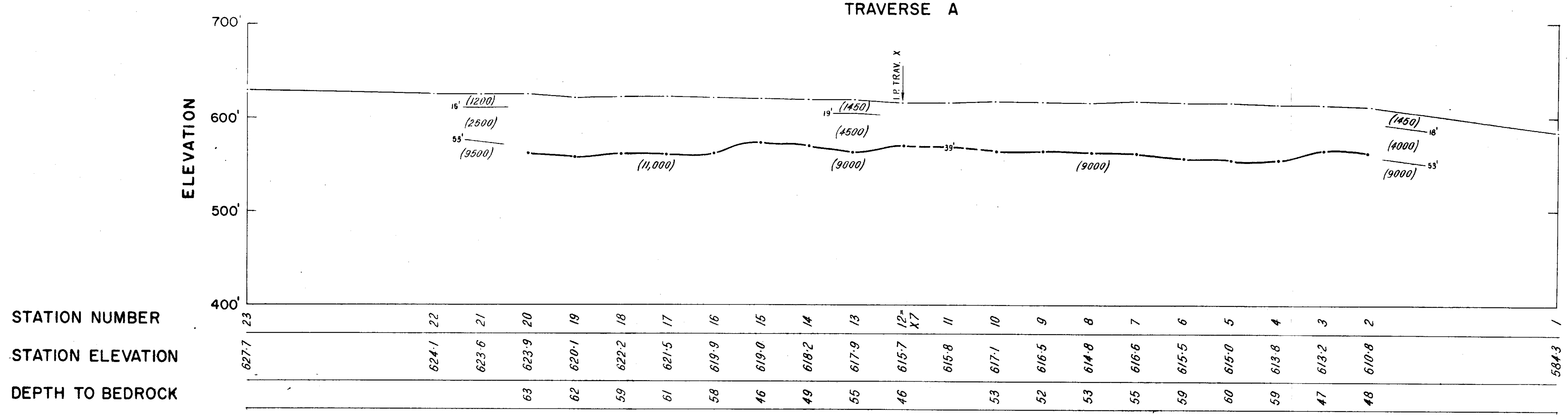
SCALE IN FEET

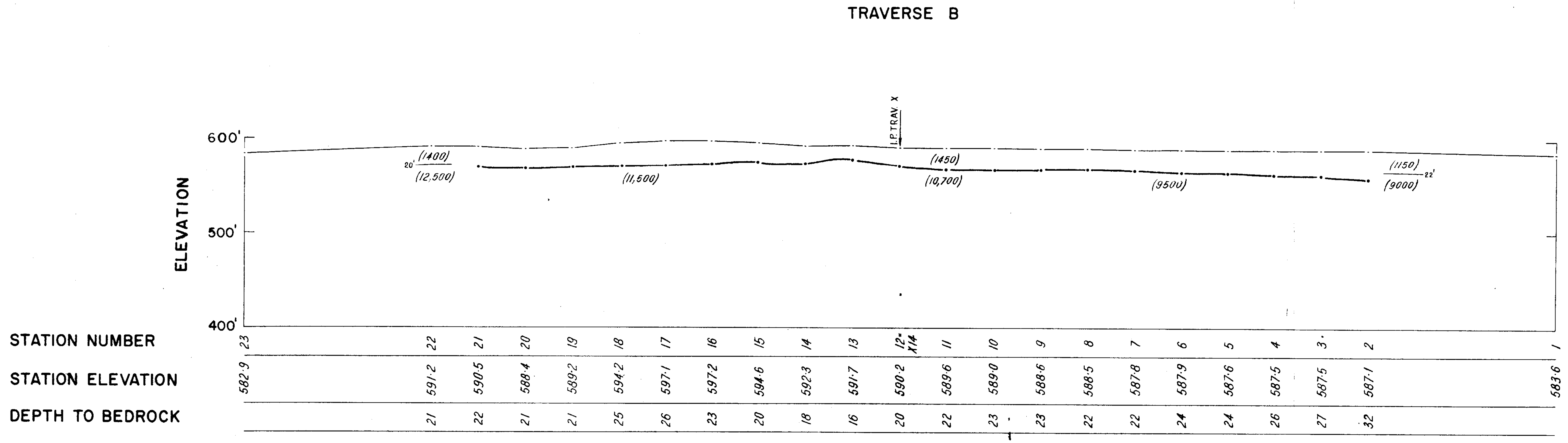
200 100 0 200 400 600

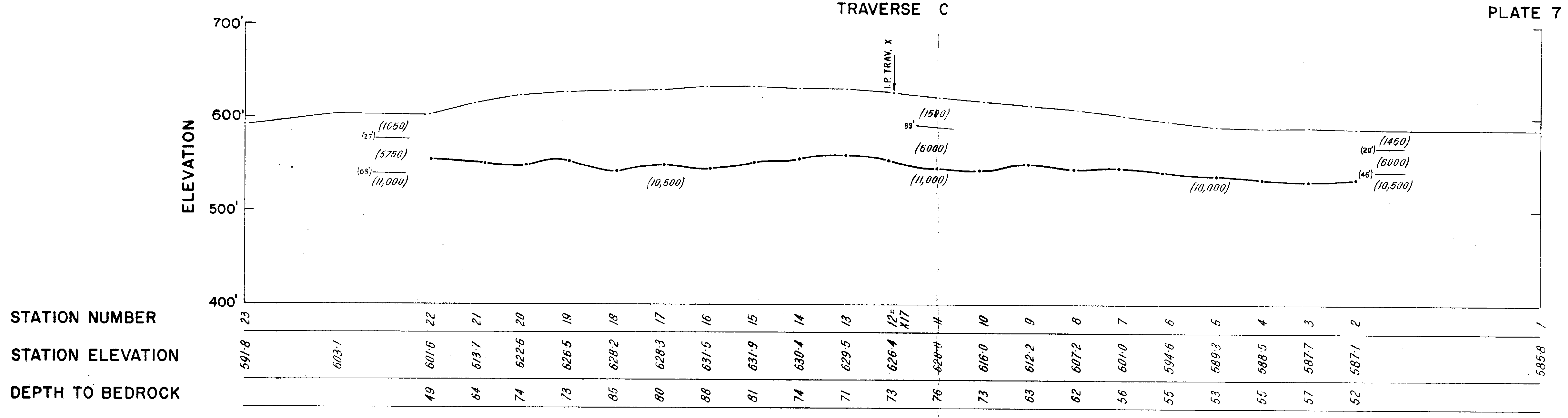
AZIMUTH DATUM: MAGNETIC

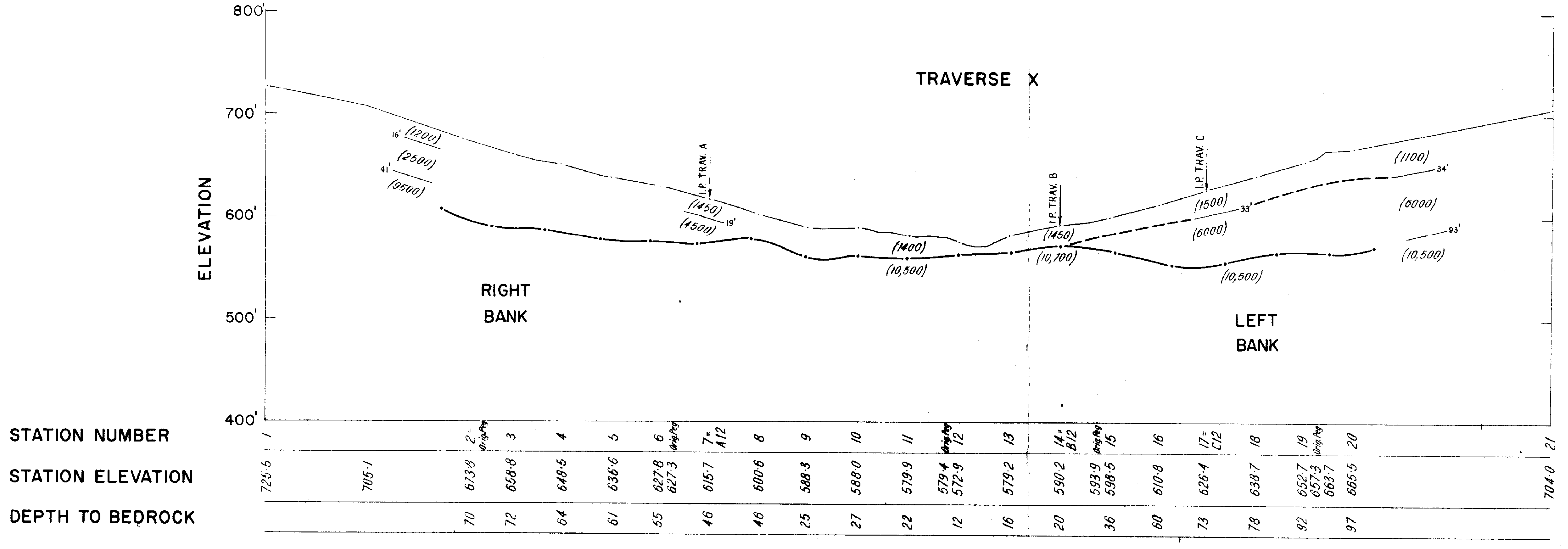
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G360-2-5

To Accompany Record No.1962/18









LEGEND

(6000) FORMATION WITH SEISMIC VELOCITY 6000 FT/SEC

22' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY

I.P. TRAV. X INTERSECTION POINT

HORIZONTAL AND VERTICAL SCALES IN FEET

100 0 100 200 300

ELEVATION IN FEET ABOVE STATE DATUM

SEISMIC REFRACTION SURVEY AT THE 14·9M. BURNETT CK DAMSITE, NEAR RATHDOWNEY, QUEENSLAND

TRAVERSES A, B, C AND X

SECTIONS