COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

062235

BUREAU OF MINERAL RESOURCES LIBRARY 24FEB 1972 Copy 3 CANBERRA, A.C.T.

RECORDS

1957, No. 35

SEISMIC SURVEY OF THE YARRALUMLA WEIR SITE, CANBERRA, A.C.T.

by

L.V. HAWKINS and A. STOCKLIN

RECORDS 1957, NO.35

BUREAU OF MINERAL RESOURCES
LIBRARY
24FEB 1972
Copy 5
CANBERRA, A.C.T.

SEISMIC SURVEY OF THE YARRALUMLA WEIR SITE, CANBERRA, A.C.T.

by

L. V. HAWKINS and A. STOCKLIN

CONTENTS

ILLUSTRATIONS

A B S T R A C T

A seismic refraction survey was carried out at the Yarralumla weir site, on behalf of the Department of Works, Canberra, to determine the depth to, and condition of, suitable bedrock.

Using the seismic velocities recorded, estimates are made of the Young's Modulus values of the bedrock below the traverse lines surveyed, thereby giving an indication of the condition of the bedrock. Profiles are included to show the depth to bedrock along the traverse lines, and the most suitable location for the weir site is indicated.

1. INTRODUCTION.

The Department of Works, Canberra, proposes to construct a weir across the Molongo River as part of the Canberra Lakes scheme. Two alternative sites have been proposed, one at Acton and one at Yarralumla. This report describes a seismic survey conducted on the Yarralumla weir site by the Geophysical Section of the Bureau of Mineral Resources during July, 1956, in response to a request from the Department of Works. A geophysical survey was also carried out at the Acton weir site and is described by Hawkins (1957).

The Yarralumla site is located on the Molonglo River just downstream from Government House. Several test pits were dug when the site was previously under consideration for a weir. The test pits did not extend to the bedrock, and the purpose of the present survey was to determine the depth and condition of the bedrock at the site.

The Department of the Interior carried out the topographic survey and supplied traverse plans and cross-sections. Four field hands and explosives were supplied by the Department of Works, Canberra.

The geophysical party consisted of L. V. Hawkins (party leader) and A. Stocklin, geophysicists, and J. P. Pigott, field assistant.

2. GEOLOGY

The geology of the Canberra City district has been described by Opik (1955) and is shown on the geological map of Canberra (Opik, 1953).

The weir site is located on the Mt. Painter Porphyry, which is a dark massive porphyry containing xenoliths of sedimentary and igneous rocks. The Mt. Painter Porphyry, which is of Upper Silurian age, is a synorogenic intrusion and forms a sill which has been relatively little affected by tectonic stress.

In this report, the term "overburden" refers to soil, scree, alluvium and weathered porphyry, and the term "bedrock" refers to mainly unweathered porphyry, though the bedrock porphyry may be slightly weathered in shear and fracture zones.

3. METHOD AND EQUIPMENT

The seismic refraction "Method of Differences", which was used on this survey, is described in detail by Hawkins (1957). An explosive charge is used as a source of elastic waves which are refracted at elastic discontinuities. The travel times of the first arrival of the elastic waves from the shot point to a series of detectors (geophones) are recorded.

From the observed travel times, the depth to bedrock can be computed. Also, by allowing for the effect of the overburden on the travel times, the horizontal variations in the bedrock velocity can be reliably estimated (Hawkins, 1957).

The geophones were spaced at intervals of 40 feet and 10 feet.

A "Century Geophysical Corporation" 12-channel, portable refraction seismograph was used with "T.I.C." geophones of natural frequency about 20 cycles per second.

4. RESULTS.

The location of the seismic traverses is shown on Plate 1 and the bedrock profiles and seismic wave velocities are shown on Plate 2.

The minimum bedrock velocity (10,500 ft/sec) was recorded between stations 720 and 880 on traverse A and between stations 360 and 480 on traverse C; a low bedrock velocity of 11,000 ft/sec was recorded also between stations 520 and 600 on traverse A. These velocities indicate a fractured and/or partly weathered porphyry.

Bedrock velocities between 13,500 and 15,000 ft/sec occur between stations 480 and 1,000 on traverse B (13,500 to 14,000 ft/sec), between stations 160 and 360 on traverse C (14,500 ft/sec) and between stations 120 and 220 on traverse D (15,000 ft/sec). This velocity range is interpreted as representative of jointed and/or slightly weathered porphyry.

Elsewhere, bedrock velocities are between 16,500 and 20,000 ft/sec and indicate unweathered porphyry.

The average velocity through the overburden of soil, scree and weathered porphyry is between 2,900 and 3,200 ft/sec south of the river, and between 3,000 and 4,000 ft/sec north of the river.

The recorded seismic velocities can be used to estimate the Young's Modulus of the rock (Hawkins, 1957), which provides the engineer with an indication of the suitability of the rock for foundation purposes. The estimates of Young's Modulus are considered to have a maximum probable error of ± 30 per cent and are given in Table 1 below for the different values of the recorded velocity. The estimated values of Young's Modulus (E) are calculated from the empirical formula $E = V^{2.34} \times 10^{-3}$ lbs/sq. in.

TABLE 1.

Rock type	Seismic wave velocity (ft/sec)	Young's Modulus lbs/sq. in.	Young's Modulus dynes/cm^2
Overburden	2,900 - 3,200	0.13×10^6 - 0.17×10^6	0.09×10^{11} - 0.117×10^{11}
	3,000 - 4,000	0.14×10^6 - 0.28×10^6	0.096×10^{11} - 0.193×10^{11}
Bedrock	10,500 - 11,000	$2.7. \times 10^6$ - 3.0×10^6	1.86×10^{11} - 2.06×10^{11}
	13,500 - 15,000	4.8×10^6 - 6.0×10^6	3.31×10^{11} - 4.13×10^{11}
	16,500 - 20,000	7.5×10^6 - 12.0×10^6	5.17×10^{11} - 8.27×10^{11}

North of the river, the depth to bedrock ranges from 15 feet at station 240 to 56 feet at station 800, both on traverse F. Along traverse E, the depth to bedrock ranges from 16 to 24 feet and along traverse D from 17 to 29 feet.

South of the river, the depth to bedrock along traverse A ranges from 6 feet at station 960 to 46 feet at station 600, the average depth being 34 feet; along traverse B, the depth to bedrock ranges from 4 feet at station 1,000 to 47 feet at station 200, the average depth being 29 feet; along traverse C, the depth to bedrock ranges from 7 feet at station 520 to 39 feet at station 200, the average depth being 29 feet.

The depths calculated from the seismic results are considered to have a maximum error of $\pm$ 15 per cent.

5. CONCLUSIONS

The investigation indicates that as regards depth to bedrock, traverses B (average bedrock depth 29 ft) and E (average bedrock depth 21 ft) are more favourable than traverses A and D. Also, the estimates for Young's modulus (4.8×10^6 lbs./sq.in. or greater) indicate that the bedrock along traverses B and E is more suitable for foundation purposes than that along traverses A and D.

..../4

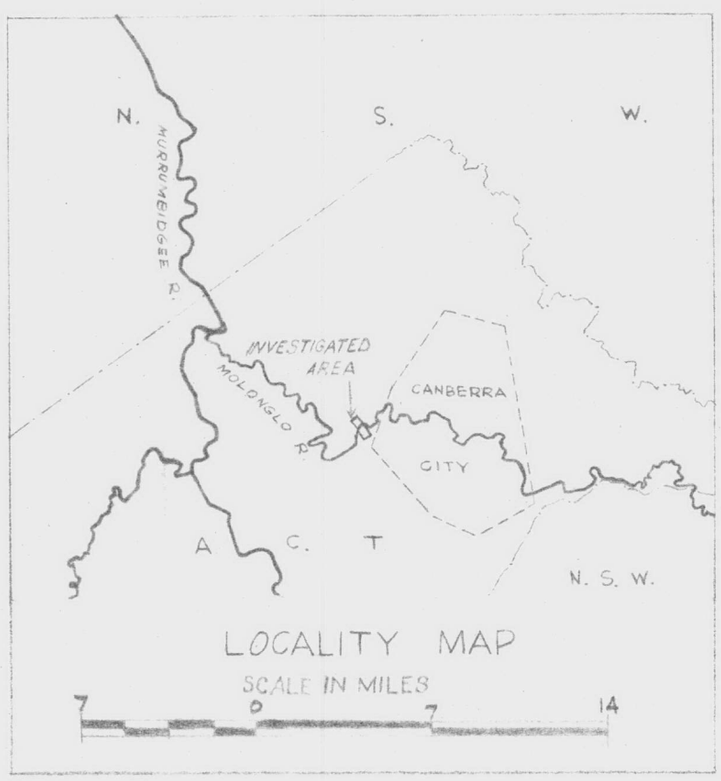
6. REFERENCES.

Hawkins, L.V., 1957 - Geophysical survey of the Acton weir site, Canberra, A.C.T. Bur. Min. Resour. Aust., Records 1957, No.31

Opik, A.A., 1955 - The Geology of the Canberra City District. The Aust. Cap. Terr. as a region.

Opik, A. A.,1953 - Geological Map of Canberra. Bur. Min. Resour. Aust. A.C.T. G2-12.

PLATE: I



LEGEND

80 120 160 GEOPHYSICAL TRAVERSE AND STATIONS

(2000) SEISMIC VELOCITY WITHIN BEDROCK (FT/SEC)

////// FRACTURED AND/OR PARTLY WEATHERED BEDROCK

SCALE IN FEET

100 0 100 200

SEISMIC SURVEY OF THE YARRALUMLA WEIR SITE, CANBERRA, A.C.T.

LOCALITY MAP AND TRAVERSE PLAN

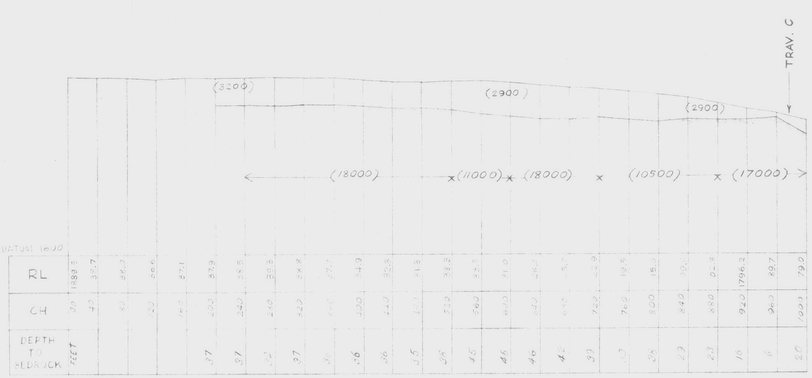
L. V. Hawkins.

GEOPHYSICIST

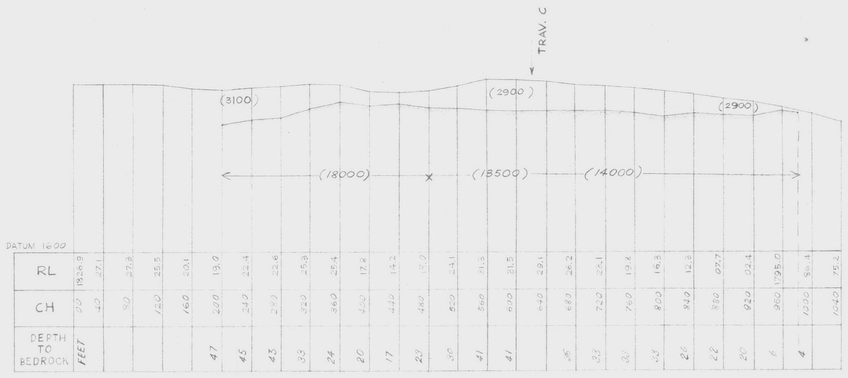
G 263-7

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

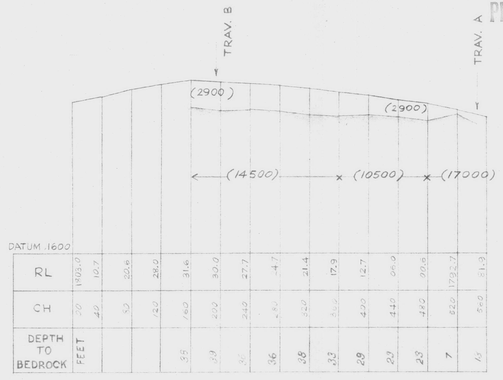
PLATE 2



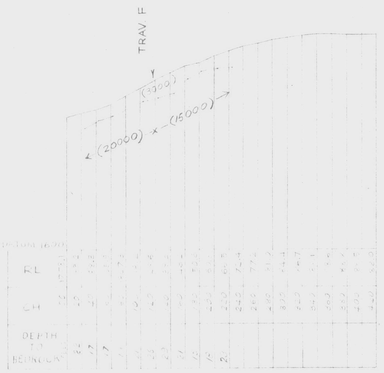
TRAVERSE "A"



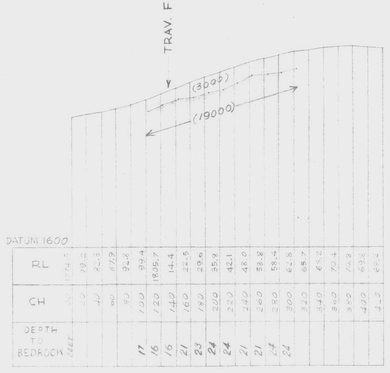
TRAVERSE "B"



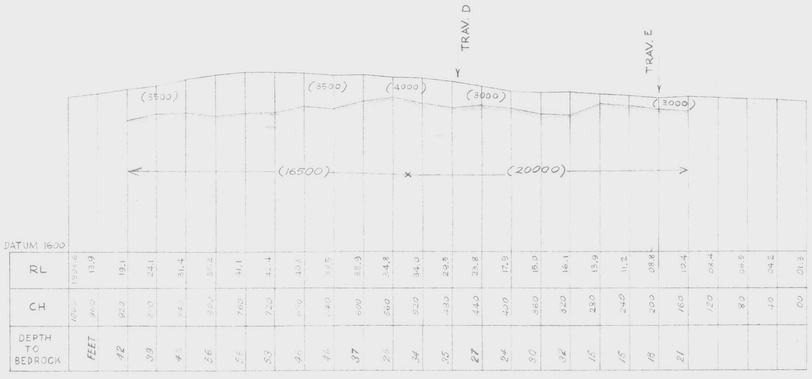
TRAVERSE "C"



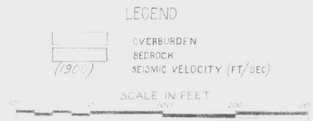
TRAVERSE "D"



TRAVERSE "E"



TRAVERSE "F"



L. V. Hawkins.
GEOPHYSICIST

SEISMIC SURVEY OF THE
YARRALUMLA WEIR SITE, CANBERRA A.C.T.

VERTICAL SECTIONS SHOWING UNWEATHERED ROCK PROFILES

6263.8

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, CANBERRA, A.C.T.