DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1975/145

GOOGONG PUMPING STATION SITE, PIPELINE, AND ACCESS ROAD - QUEANBEYAN RIVER, NSW - SEISMIC REFRACTION SURVEYS 1973 and 1974

by

F.N. Michail & F.J. Taylor

Record 1975/145

GOOGONG PUMPING STATION SITE, PIPELINE, AND ACCESS ROAD - QUEANBEYAN RIVER, NSW - SEISMIC REFRACTION SURVEYS 1973 and 1974

by

F.N. Michail & F.J. Taylor

CONTENTS

PLATES

SUMMARY

At the request of the Department of Housing and Construction and the National Capital Development Commission (NCDC), the Bureau of Mineral Resources (BMR) carried out a seismic refraction survey at the Googong damsite, 8 km south of Queanbeyan, New South Wales. Investigations were required at the pumping station site and along the proposed route of the pipeline and access road. The seismic work was carried out to provide information on subsurface conditions such as nature of overburden and rippability where excavations were required.

Contained in this Record are the results of the survey, with seismic cross-sections and an interpretation of the various velocity layers recorded. Generally, the results indicate shallow but irregular weathering of average depth 5.5 m with a maximum depth of 15 m. Depth of excavation ranges from 1 m to 8.5 m. Over most of the areas investigated the recorded seismic velocities indicate that most of the excavation will require moderate to heavy blasting.

1. INTRODUCTION

BMR carried out a seismic refraction survey at the Googong Water Supply Project, located approximately 20 km southeast of Canberra, on the Queanbeyan River in New South Wales. The project, consisting of a dam, pumping station, pipeline, and access road, is required to supplement Canberra's existing water supply. Geophysical surveys for the dam site were carried out previously by Compagnie Generale de Geophysique, 1970; Kirton & Wiebenga, 1962; and Taylor & Pettifer, 1972. This survey covers the other sections of the project. The survey was carried out at the request of the Department of Housing and Construction for and on behalf of NCDC. The object of the seismic investigation was to determine rippability of the material to be excavated and to determine foundation conditions. The following four sites were investigated.

(1) Pumping station pipeline:

The proposed route of the pipeline between the diversion tunnel outlet and the pumping station was investigated at six selected locations. The field work was carried out in September 1973 (Appendix A). The seismic results were interpreted by F.J. Taylor and the geological description of the seismic cross-section was given by G.B. Simpson (Geologist, BMR).

(2) Pumping station site:

The pumping station to be located about 1 km north of the Googong damsite and will have a total capacity of 360 million litres per day. Adjacent to the station will be an electricity substation and parking facilities. The expected depth of excavation will be about 7 m. Five intersecting seismic traverses were shot on the proposed site in February 1974 (Appendix A). The results were interpreted by F.N. Michail.

(3) Treatment-plant pipeline:

Four seismic spreads were shot along the proposed pipeline between the sites for the pumping station and the water treatment plant. Field work was carried out in August 1974 (See Appendix), and the results were interpreted by F.J. Taylor.

(4) Damsite access road:

The proposed road is to provide access to the damsite from the Cooma Road. The road will be approximately 5 km long, with a 7-metre wide sealed pavement, designed for a speed of 80 km/h. The maximum cut will be about 8.5 m. Twelve spreads were completed on representative sections of the route. The survey was conducted in February and August 1974 (see Appendix). The results were interpreted by F.N. Michail and F.J. Taylor.

The term bedrock as used in this report refers to the deepest refractor detected and the term overburden refers to the weathered material above this refractor.

2. GEOLOGY

The geology of the Googong area is described by Stauffer, 1967; Strusz, 1971; Saltet, 1971; and Simpson, 1974. The geology of the area is complex. The damsite and environs lie in a belt of Palaeozoic metasediments and volcanics intruded by granite and porphyry. The bedrock in the investigated sites consist of Siluro-Devonian rocks. It generally has a complicated weathering pattern. The main rock types, are:

The Googong Granite (Siluro-Devonian), consisting of an adamellite inner mass and porphyritic margins.

The Colinton Volcanics (Upper Silurian), consisting of thick bedded dacite with minor sediment inclusions. The dacite contains many sheared and schistose zones.

The London Bridge Formation (Upper Silurian) consisting of shale, sandstone, and limestone.

The treatment plant is entirely underlain by granite, the pumping station and pumping station pipeline by both granite and dacite, and the access road to the dam by granite, dacite, and also some shale and limestone from the London Bridge Formation.

3. EQUIPMENT AND METHOD

The recording equipment used was the SIE 24-channel PSU-19 refraction seismograph with HSJ 14-Hz geophones.

Thirty refraction spreads totalling about 1.5 km were shot during the survey, using a geophone interval of 3 m on Site 1, and 2 m on Sites 2, 3, and 4. Each spread consisted of 23 geophones with the 24th as the reciprocal. Five shots were fired for each spread. The shots were at the centre of the spread, and at 1 m, and at 20 m to 33 m beyond each end of the spread. Shot-holes were drilled to a depth of 0.5 m to 0.8 m with a portable rock drill.

The interpretation was based on the intercept-time method (Heiland, 1946), and depths to different refracting layers were calculated at each shot-point and interpolated between the shot-points assuming a gradual change. This is reproduced as a broken line on the seismic cross-sections. The reciprocal method (Hawkins, 1961) was used for some of the traverse, and depths to the deepest refractor were calculated at each geophone position and reproduced as a continuous bedrock profile.

4. RESULTS

The location of the seismic traverses is shown in Plates 2 and 3 and the interpreted seismic cross-sections are presented in Plates 4 to 7.

General

The seismic results show a wide range of overburden velocities and indicate an irregular weathering pattern. Previous investigations at Googong have shown that tor weathering is quite common. The current seismic investigations show that the nature of the near-surface material varies from completely weathered rock to fresh rock; because of this irregularity, the near-surface seismic velocity data will be a good guide to the rippability of the proposed excavations. In general the occurrence of tor weathering complicates the interpretation of seismic velocities as far as rippability is concerned. However, it is generally accepted that material with seismic velocities less than 1500 m/s is readily rippable with medium-sized equipment.

The four sites investigated will be considered separately and the seismic sections will be referenced by the chainage in metres.

Pumping station pipeline.

The seismic sections are shown in Plate 4. The interpreted geological significance of the recorded seismic velocities is shown below.

Velocity (m/s)	Interpretation
300	surface soil and scree.
800 - 1500	completely to highly weathered granite or dacite
1500 - 3000	moderately to slightly weathered granite or dacite
3000 - 5000	slightly weathered to fresh granite or dacite.

A thin layer of soil or scree material has been assumed for all sections. The thickness of this layer varies from zero (granite outcrop) to 1.5 metres. Comments on individual sections are listed below.

Ch. 20 to 89 m: The section consists of a thin soil layer overlying 2 to 6 m of weathered rock which in turn overlies bedrock (4300 m/s). Almost all of the excavation is in weathered material, and moderate blasting will be required between ch. 40 and 89 m.

Ch. 105 to 175 and 208 to 278 m: The sections are similar. A thin layer of soil overlies slightly weathered rock (2900 to 4800 m/s). The majority of the excavation involves slightly weathered material and hence moderate to heavy blasting will be required.

Ch. 327 to 396 m: This section consists of a thin layer of soil overlying 4 m of highly weathered material (800 m/s), which in turn overlies bedrock (3000 to 5000 m/s). The majority of excavation involves the highly weathered material and hence very little blasting will be required.

Ch. 447 to 516 m: A surface soil layer overlies about 4 m of highly weathered material. The majority of the proposed excavation is in this material and hence only a small amount of blasting will be required. Moderately weathered rock (2300 to 2600 m/s) underlies this highly weathered material, and fresh rock occurs at a depth of about 10 m.

Ch. 584 to 653 m: The section shows about 4 m of highly weathered material overlying bedrock (3600 to 3900 m/s). No excavation is proposed here and the pipeline will be constructed on an embankment founded on highly weathered rock.

Pumping station.

The seismic sections from this site are shown in Plate 5. The results show a wide range of velocities, which can be divided into the following general groups.

Velocity (m/s)	Interpretation
350	soil, surface layer
1200 - 2600	highly to moderately weathered rock
4100 - 4500	slightly weathered to fresh granite or dacite.

A thin surface layer of soil overlies an intermediate layer of highly to moderately weathered rock, which in turn overlies bedrock. The thickness of the intermediate layer varies from 1.5 to 8.5 m, and the depth to bedrock varies from 2 to 9 m. The geology of the site shows a contact zone between granite and dacite (Plate 3), and this contact is evident on Traverses A and B (Plate 5) as a seismic discontinuity in the weathered layer.

Excavation depths at the site vary from 2 to 6 m, and the material to be excavated is mostly weathered rock. However, most of the seismic velocities recorded for this medium exceed 1500 m/s and hence blasting will be required for most of the excavation.

Treatment plant pipeline.

The seismic cross-sections are shown in Plate 6. The seismic work consisted of spreads located at chainage 150, 300, 500, and 725 m. The seismic velocities shown in the sections can be grouped into three general categories.

Velocity (m/s)	Interpretation
300 - 1000	soil, scree material and completely weathered rock.
1600 - 2000	moderately weathered rock
3400 - 4300	slightly weathered to fresh rock

The proposed depth of excavation for the pipeline was not known at the time of the survey, but from the sections it can be seen that any excavation beyond 2 m will require moderate to heavy blasting.

Damsite access road.

Twelve seismic spreads were located in regions of proposed road cuttings. The resultant seismic sections are shown in Plates 7 and 8 together with the proposed excavation limits. Recorded seismic velocities can be grouped as follows:

Velocity (m/s)	Interpretation
300 - 900	surface soil and scree material
900 - 1500	completely to highly weathered rock
1500 - 2600	moderately weathered rock
3200 - 4700	slightly weathered to fresh rock

At all locations surveyed a surface layer of velocity 300 to 900 m/s occurs; it represents soil and unconsolidated material. This layer can easily be excavated using light equipment. Underlying this layer is weathered rock with seismic velocities ranging from 700 to 2600 m/s. Bedrock occurs at depths from as little as 0.5 m to 15 m.

The depth of proposed cuts along the route at the sites investigated varies from 3 to 8.5 m. The following is a summary of the excavation conditions expected.

1. The seismic velocities indicate that all excavation can be carried out without blasting throughout the spreads centred at ch. 146, 2560, and 4210 m, and also southeast of ch. 1613 m, and east of ch. 2860 m.

2. Moderate blasting will be required to remove 2 to 3 m of the 1800 - 2000 m/s velocity layer throughout the spreads centred at ch. 100, 2000 and 3740 m.

3. Heavy blasting will be required for all depths of excavation except for the top layer throughout the spreads centred at ch. 1100, 3977, and 4320 m, and also northwest from ch. 1613.

4. Some blasting of varying intensity will be required on the spread at ch. 3000 m (velocity 2100 m/s) and on the western part of the spread at ch. 2860, where velocities in excess of 1500 m/s occur.

5. CONCLUSIONS

Most of the excavation at the sites investigated will require moderate to heavy blasting. Experience with previous investigations in the Googong area confirms this conclusion.

6. REFERENCES

CATERPILLER TRACTOR COMPANY, 1966 - Handbook of ripping.

CGG, 1970 - Seismic investigations at Googong dam site, Belconnen and Fyshwick, Survey done for Department of Works, 1970. Compagnie Generale de Geophysique Rep. (unpubl.).

HAWKINS, L.V., 1961 - Reciprocal method of routine seismic refraction investigations. Geophysics, 26(6), 806-19.

HEILAND, C.A., 1946 - GEOPHYSICAL EXPLORATION. Prentice-Hall Inc.

KIRTON, M., & WIEBENGA, W.A., 1962 - Googong dam sites, seismic refraction survey, N.S.W. Bur. Miner. Resour. Aust. Rec. 1962/179 (unpubl.).

SALTET, J.A., 1971 - Googong dam site, Queanbeyan River N.S.W. - Feasibility investigations 1970 and 1971. Bur. Miner. Resour. Aust. Rec. 1971/52 (unpubl.).

SIMPSON, G.B., 1974 - Googong dam site - Queanbeyan River, N.S.W. - Geological investigations 1972 and 1973. Bur. Miner. Resour. Aust. Rec. 1974/100 (unpubl.).

STAUFFER, M.R., 1967 - The problem of conical folding around the Barrack Creek Adamellite, Queanbeyan, New South Wales - J. Geol. Soc. Aust., 14(1), 49-56.

STRUSZ, D.L., 1971 - Canberra, A.C.T. and N.S.W. - 1:250 000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes. SI/55-16.

TAYLOR, F.J., & PETTIFER, G.R., 1972 - Googong dam site spillway, seismic refractions survey, 1971. Bur. Miner. Resour. Aust. Rec. 1972/2 (unpubl.).

WIEBENGA, W.A., & KIRTON, M., 1962 - Googong dam site, seismic refraction survey, N.S.W., 1961. Bur. Miner. Resour. Aust. Rec. 1962/58 (unpubl.).

APPENDIX: PERSONNEL

The following geophysical parties took part in the survey:

1 - Pumping-station pipeline:

September, 1973 - M. McDowell, D.C. Ramsay (Geophysicists), and two field hands.

2 - Pumping station:

February, 1974 - F.N. Michail (Geophysicst), M. Dickson (Trainee Technical Officer), and two field hands.

3 - Treatment-plant pipeline:

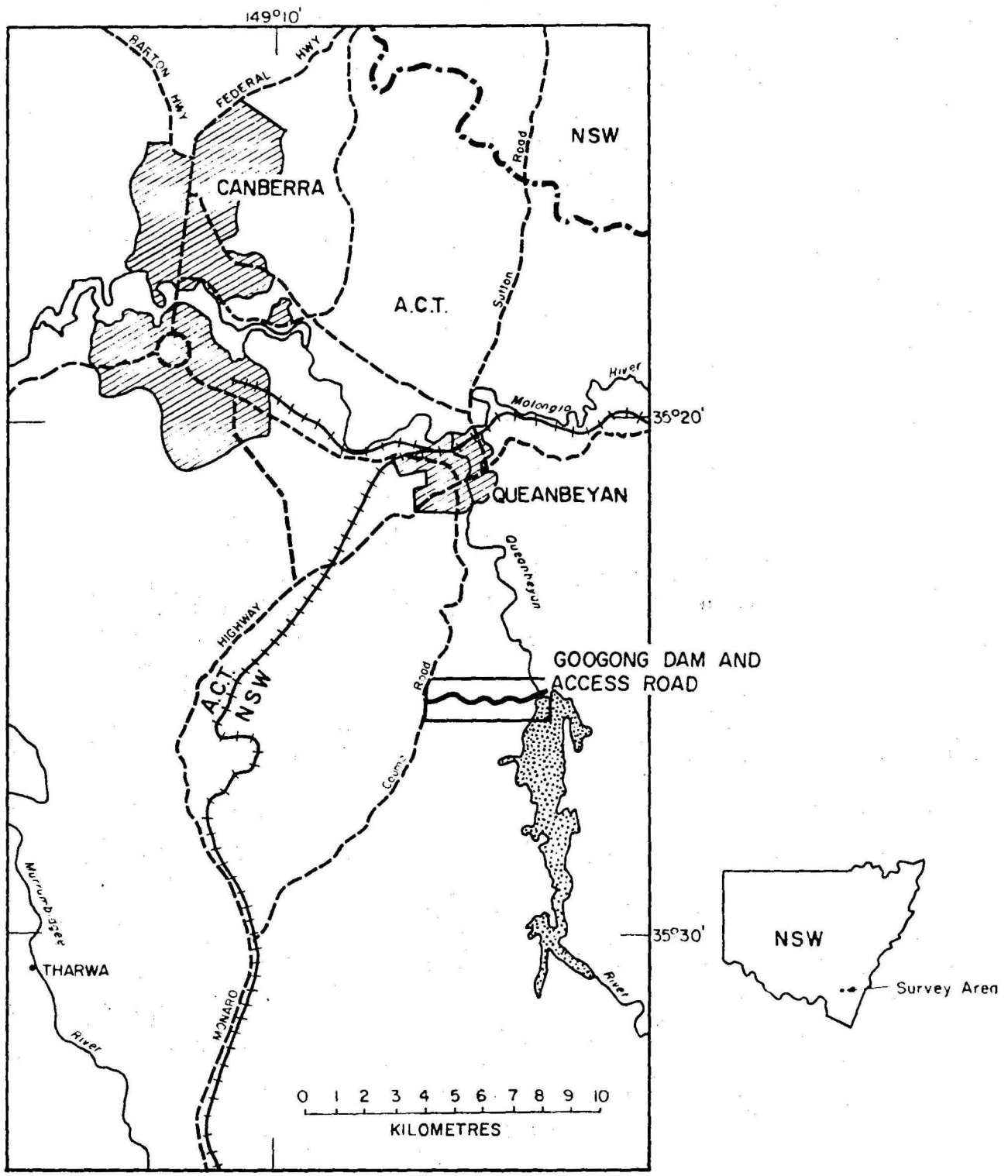
August, 1974 - F.J. Taylor (Geophysicst), A. Baumgartner (Exchange Geophysicist), two Trainee Technical Officers, and one field hand.

4 - Damsite access road:

February, 1974 - M. McDowell, F.N. Michail (Geophysicists), and two field hands.

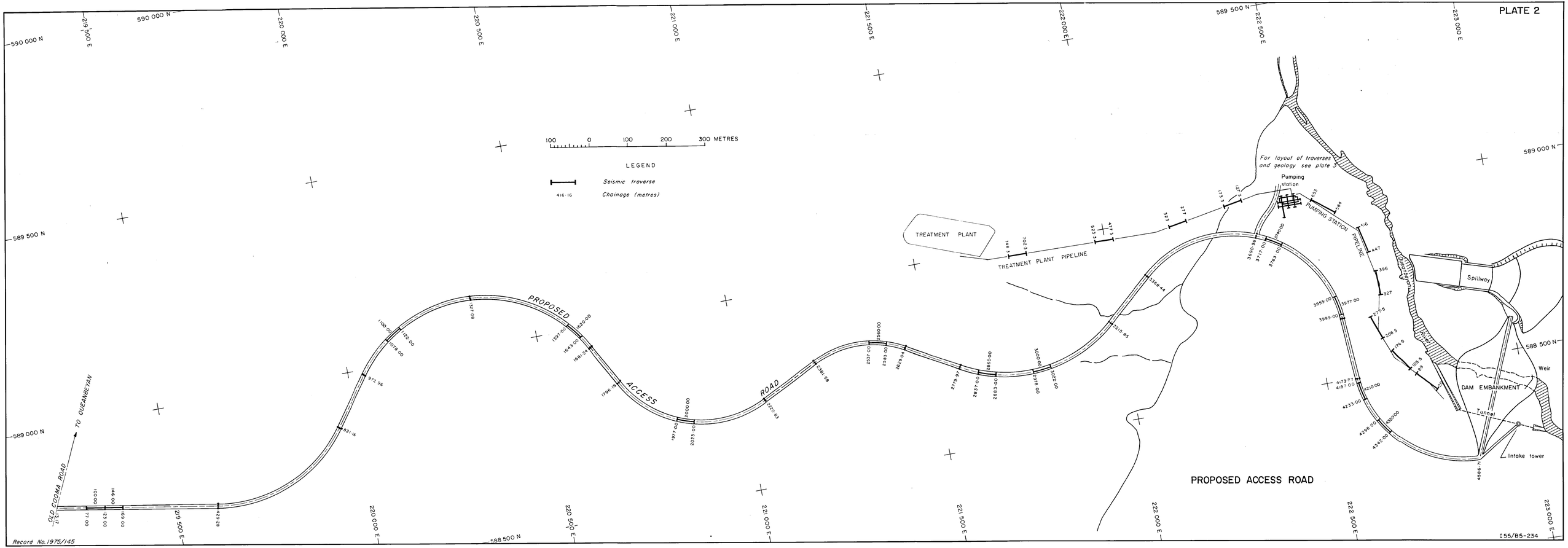
August, 1974 - F.J. Taylor (Geophysicist), A. Baumgartner (Exchange Geophysicist), two Trainee Technical Officers, and one field hand.

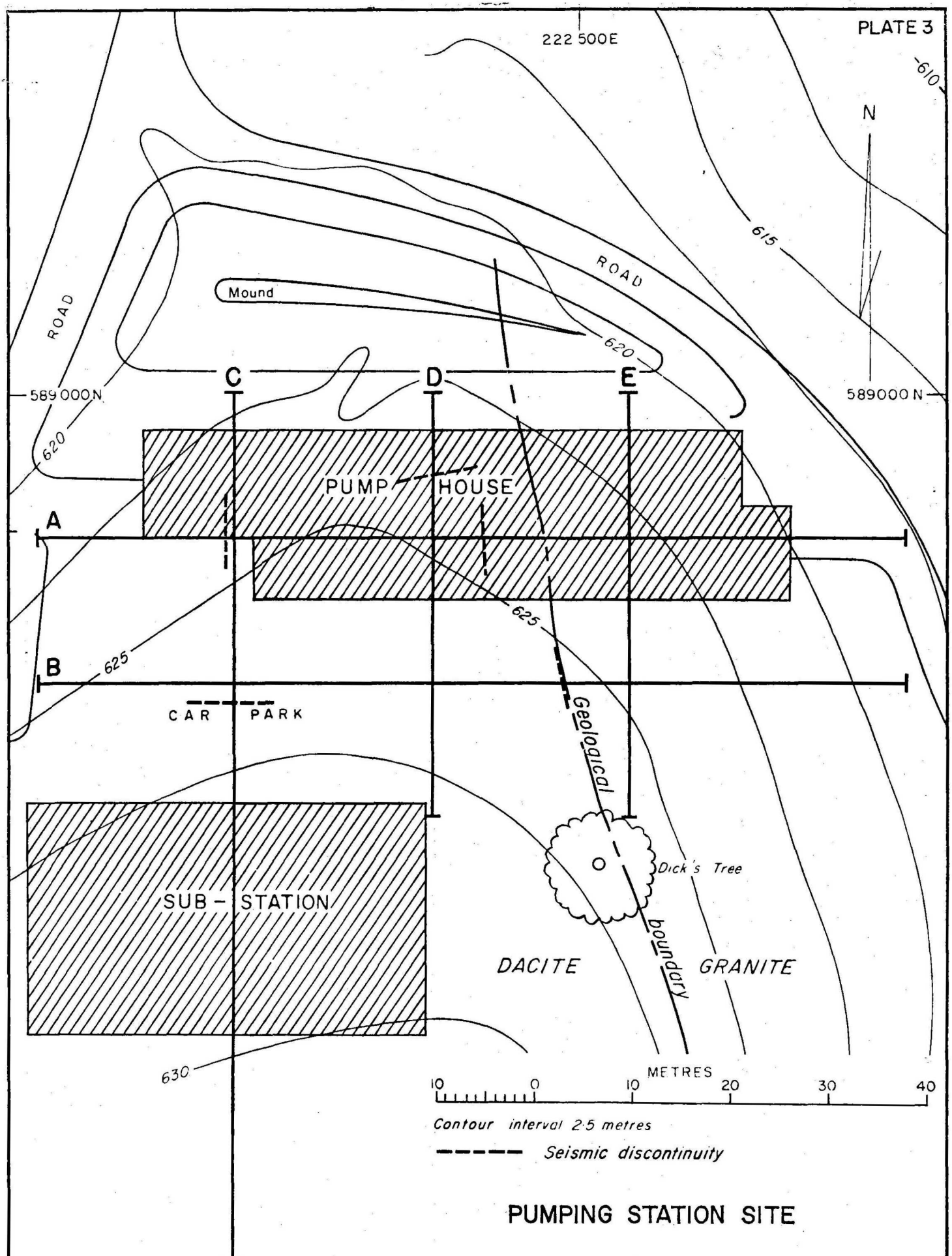
PLATE 1



GOOGONG WATER SUPPLY PROJECT
LOCALITY MAP

PLATE 2


590 000 N
589 500 N
589 000 N
588 500 N
219 500 E
220 000 E
220 500 E
221 000 E
221 500 E
222 000 E
222 500 E
223 000 E
100 0 100 200 300 METRES
LEGEND
Seismic traverse
416-16 Chainage (metres)
TO QUEANBEYAN
OLD COOMA ROAD
PROPOSED ACCESS ROAD
TREATMENT PLANT
TREATMENT PLANT PIPELINE
PUMPING STATION PIPELINE
Pumping station
For layout of traverses and geology see plate 3
Spillway
Weir
DAM EMBANKMENT
Tunnel
Intake tower
Record No. 1975/145
I55/B5-234

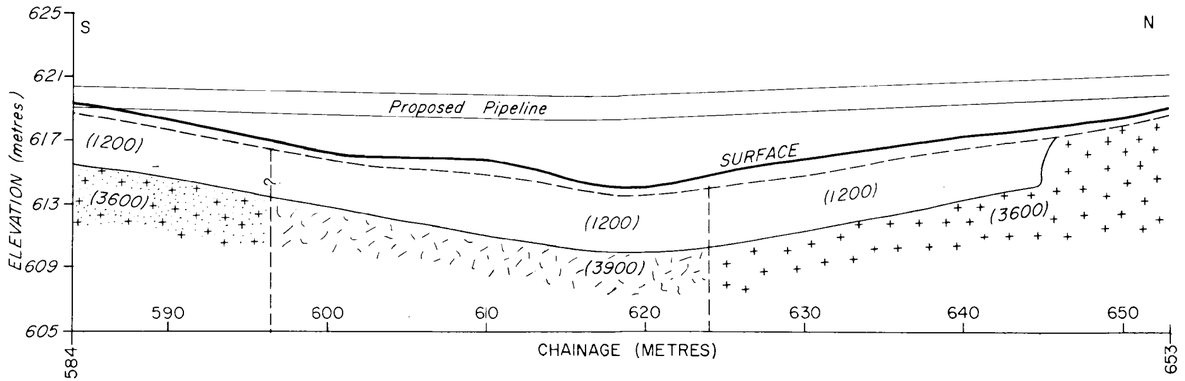


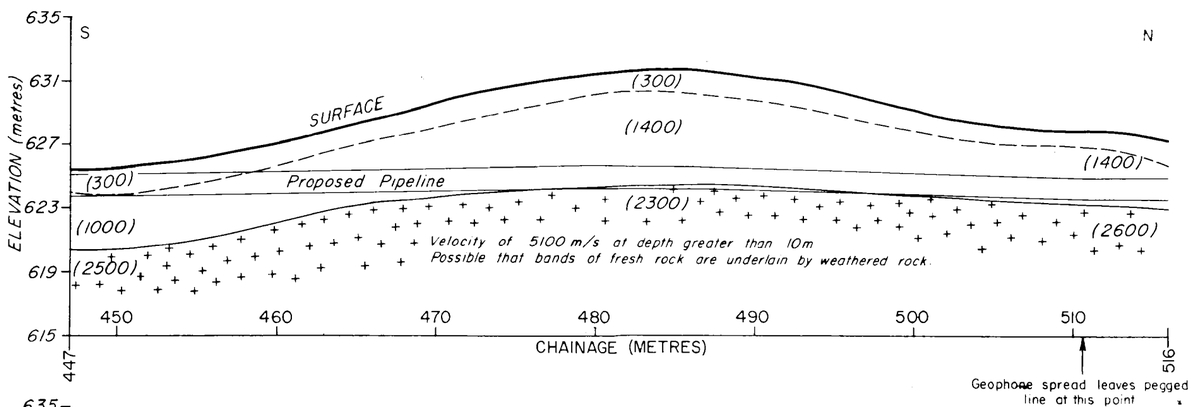
PUMPING STATION SITE

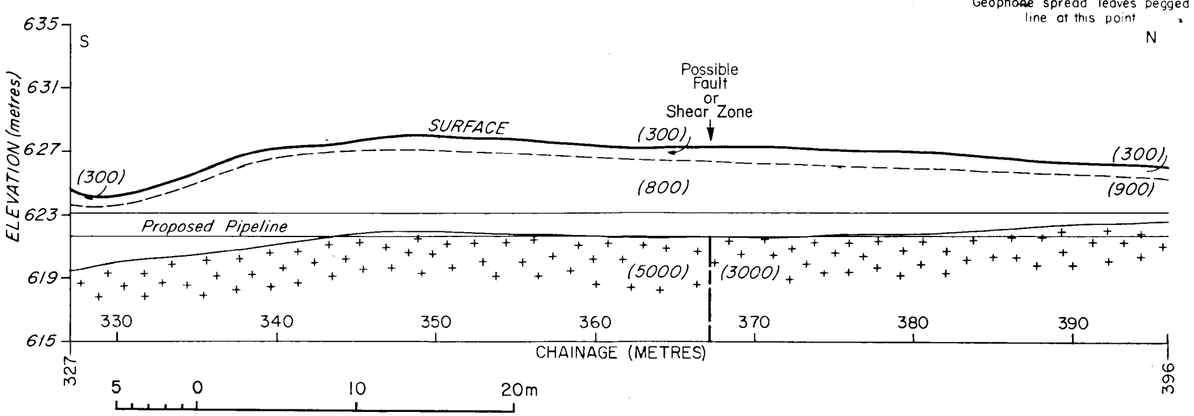
Record No. 1975/145

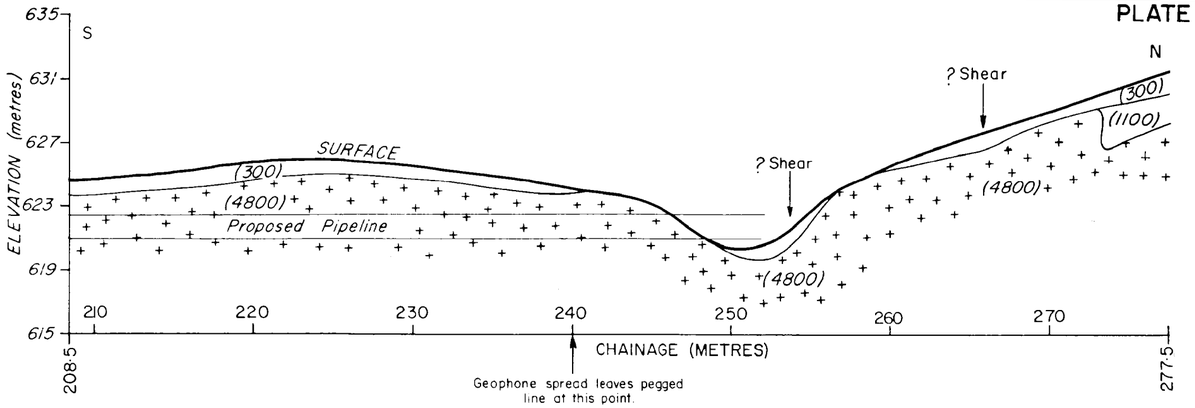
I55/B5-235A

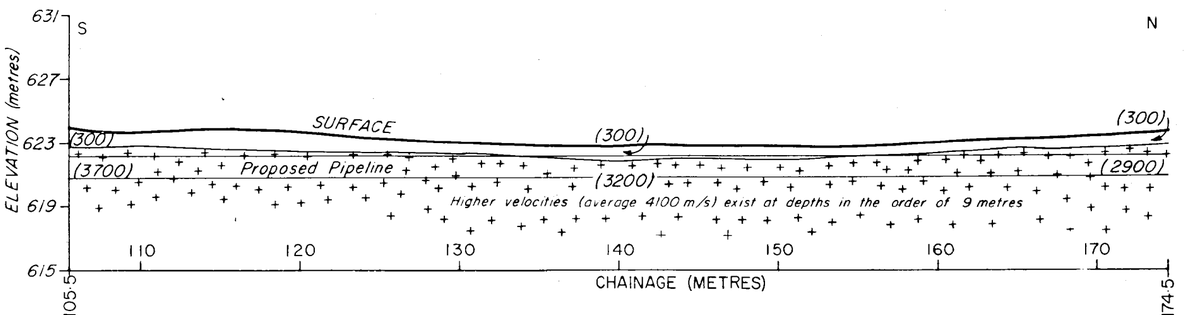
PLATE 4

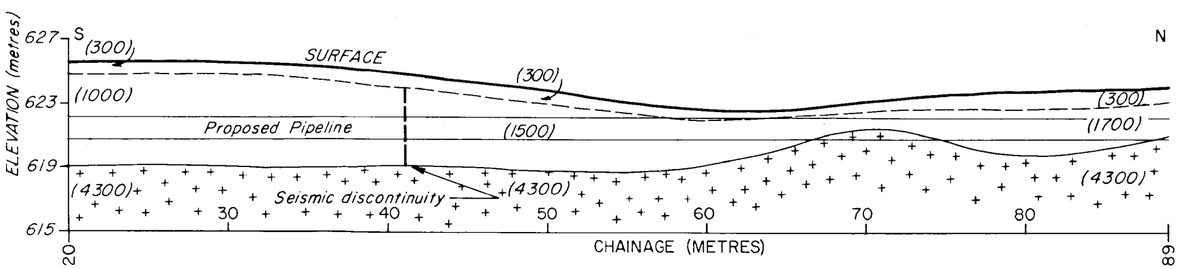












LEGEND

(4300) Seismic velocity in formation (metres/second)

Interpolated boundary

Bedrock boundary

Weathered rock

Porphyritic granite margin

Granite

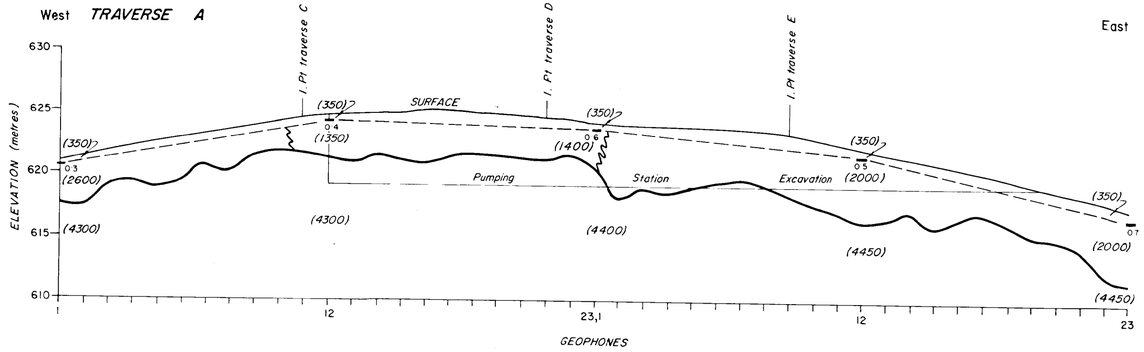
Dacite

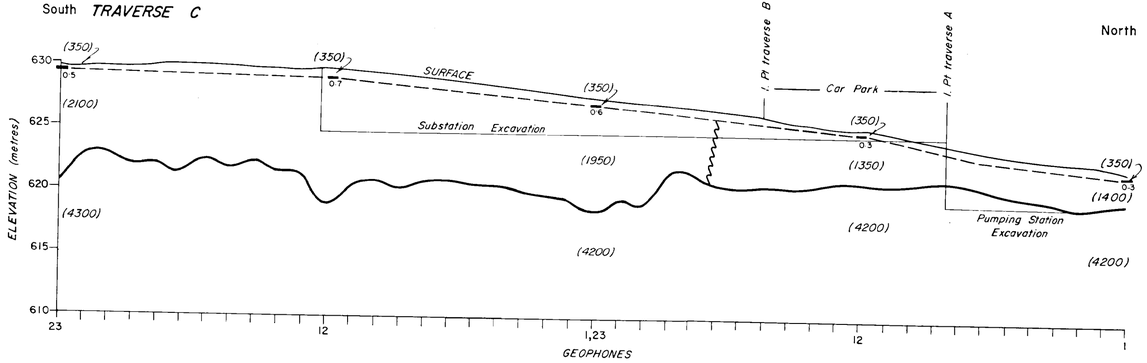
Accuracy: Velocity ± 100m/s
Depth ± 0·5 m

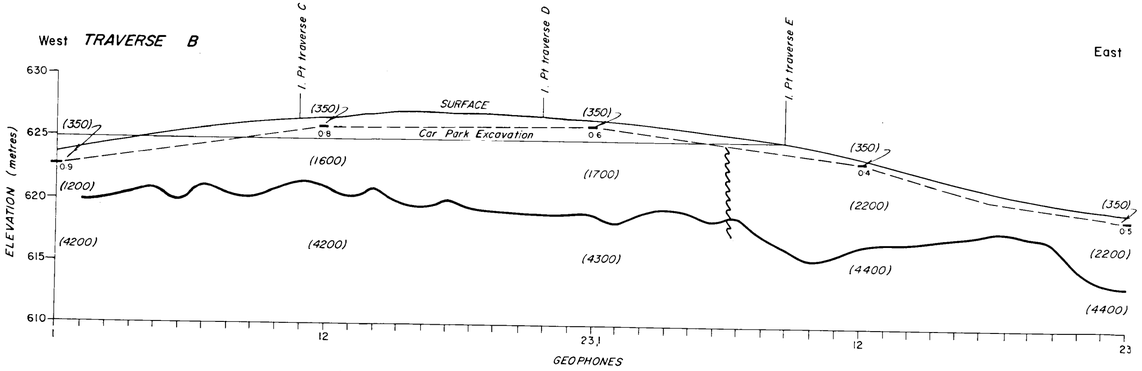
PUMPING STATION PIPELINE GEOLOGICAL AND SEISMIC CROSS-SECTIONS

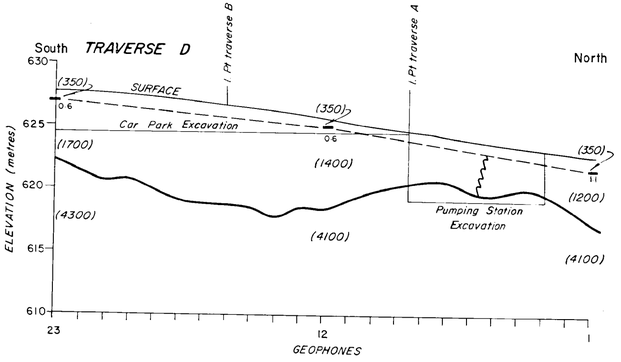
Record No 1975/145

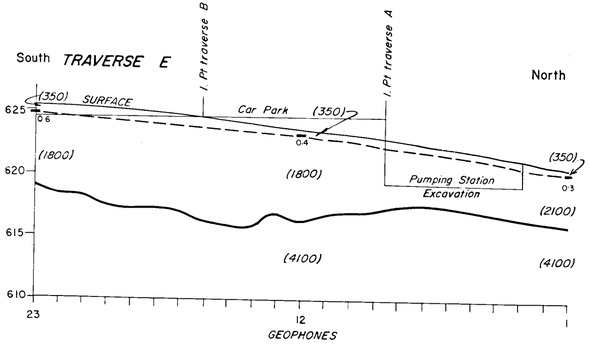
I55/B5-237











LEGEND

0·2 Depth to refractor (metres)

(2400) Seismic velocity in formation (metres/second)

Seismic discontinuity

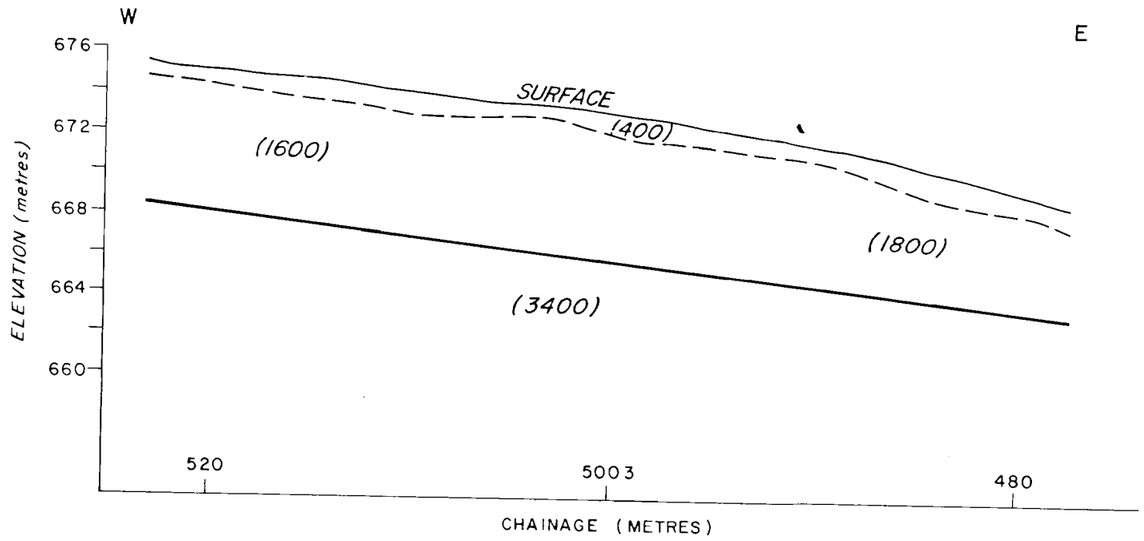
Metres

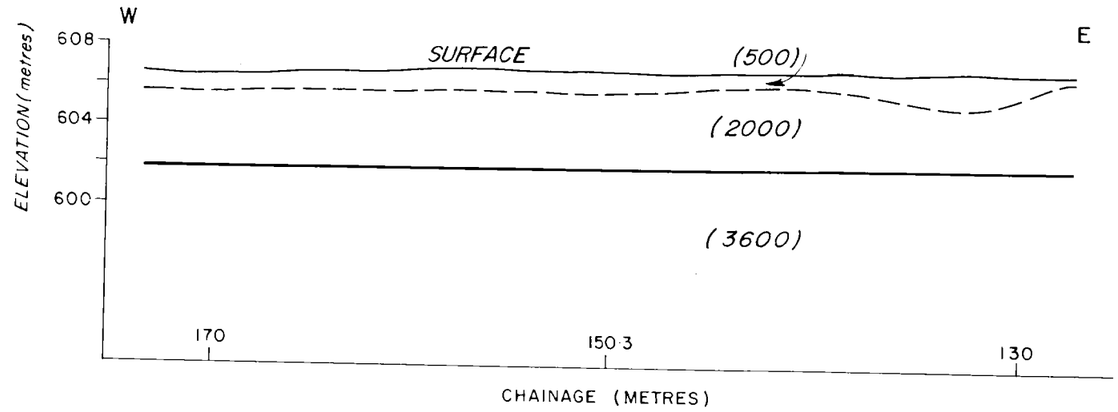
4 2 0 2 4 8 12 16 20

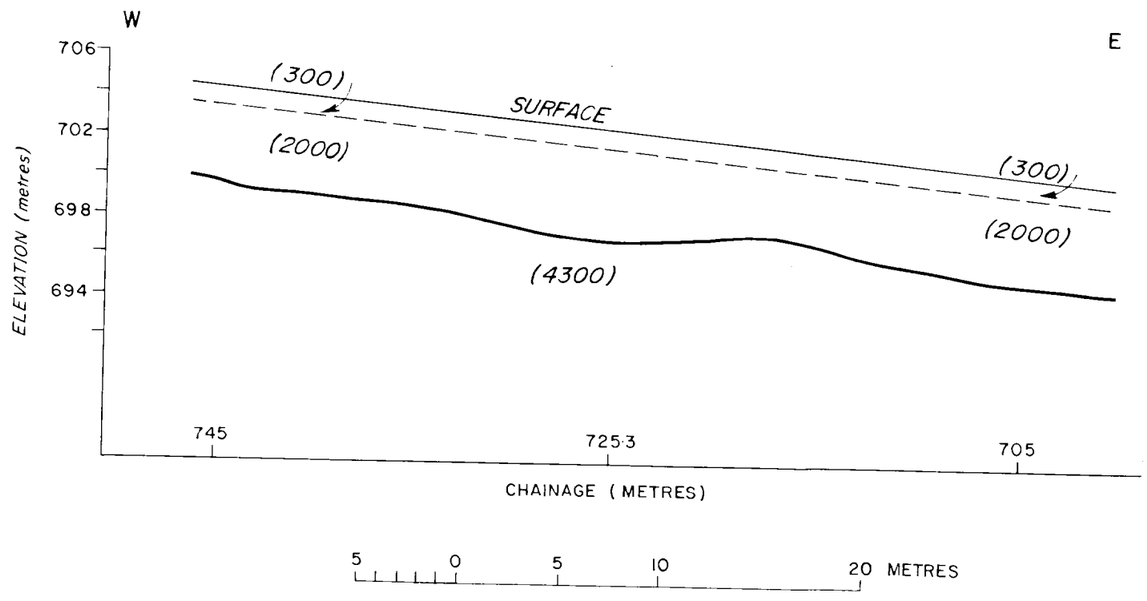
Horizontal scale

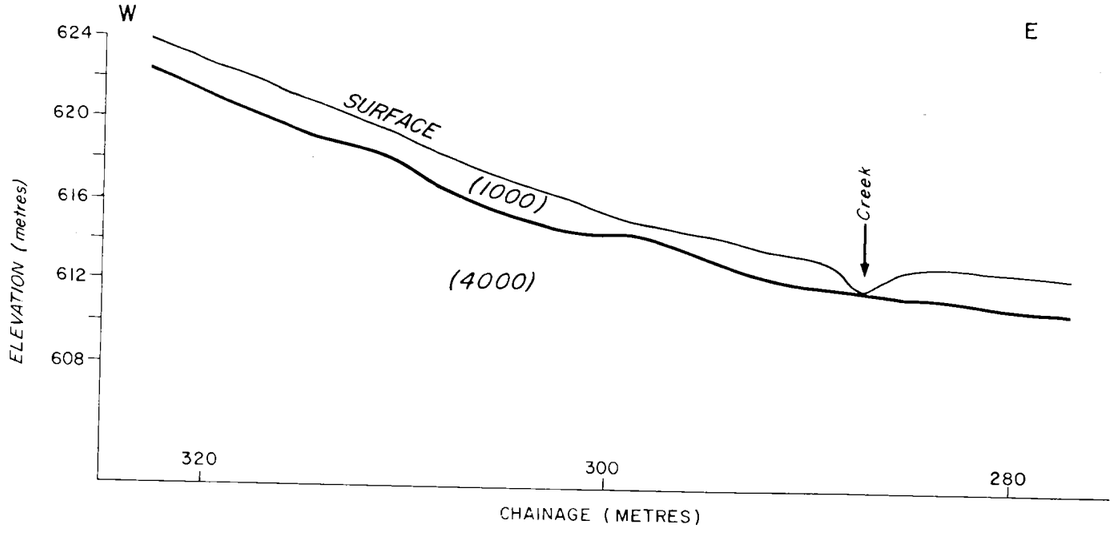
PUMPING STATION SEISMIC CROSS-SECTIONS TRAVERSE A,B,C,D,E

Record No 1975/145







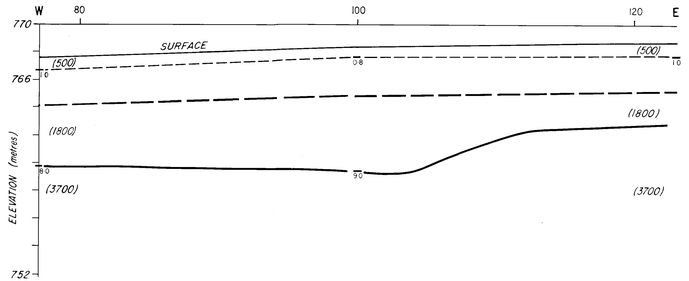


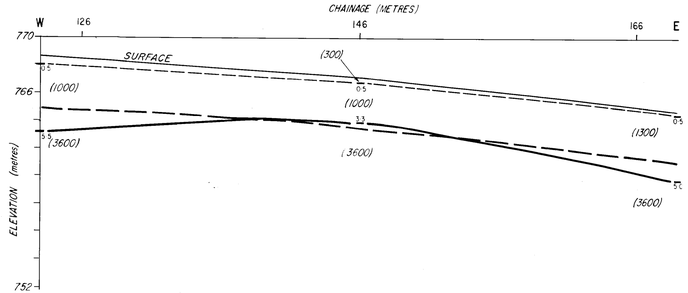
TREATMENT PLANT PIPELINE

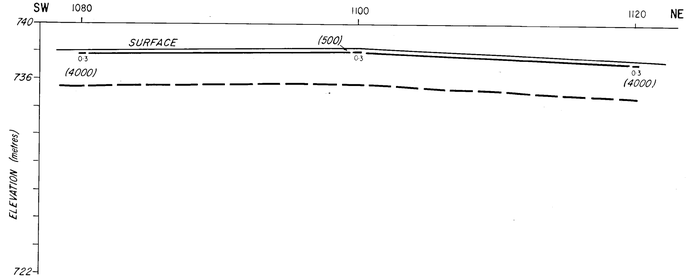
SEISMIC CROSS-SECTIONS

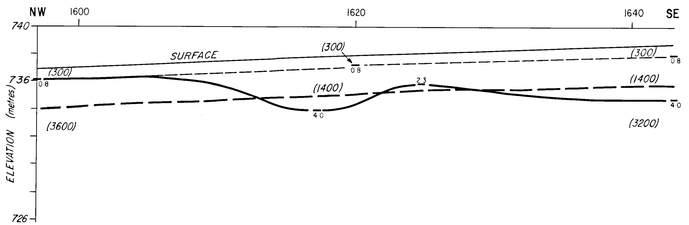
Record No.1975/145

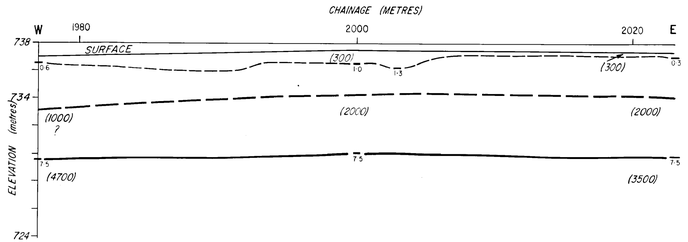
PLATE 7

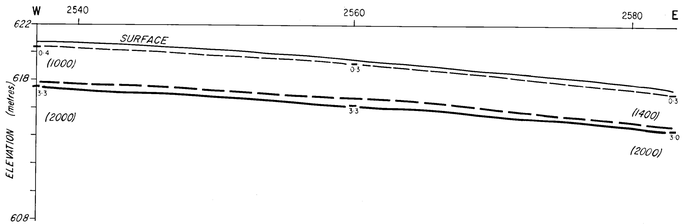


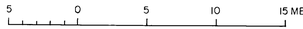












INTERPOLATED BOUNDARY

EXCAVATION LIMIT

BEDROCK BOUNDARY

(2350) SEISMIC VELOCITY IN FORMATION (metres/second)

2·4 DEPTH TO REFRACTOR (metres)

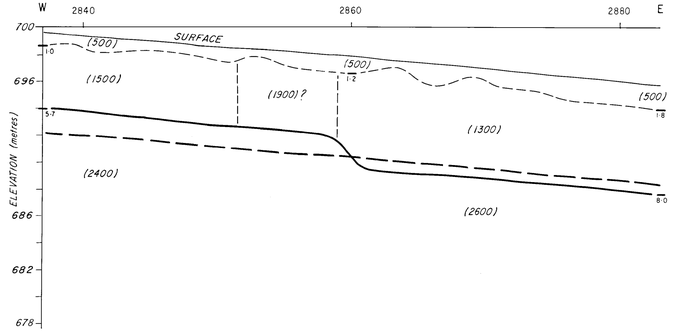
GOOGONG DAM ACCESS ROAD

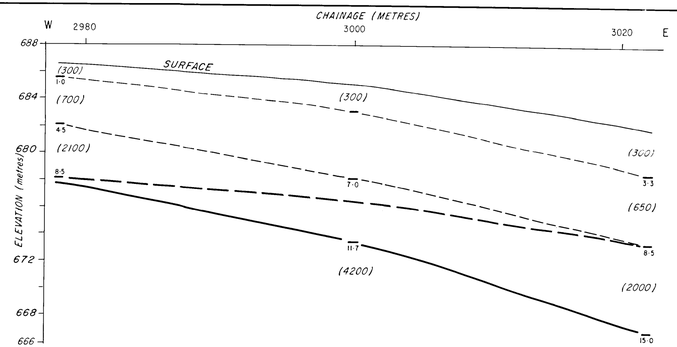
SEISMIC CROSS-SECTION

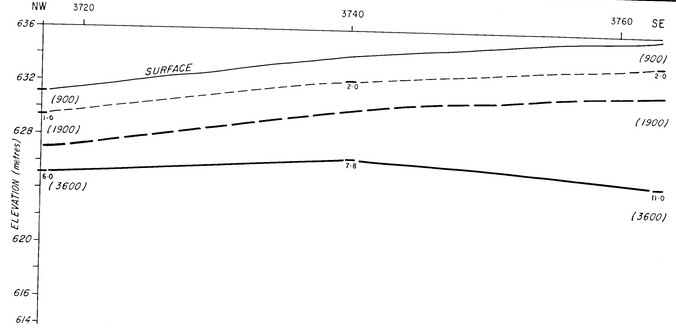
Record No. 1975/145

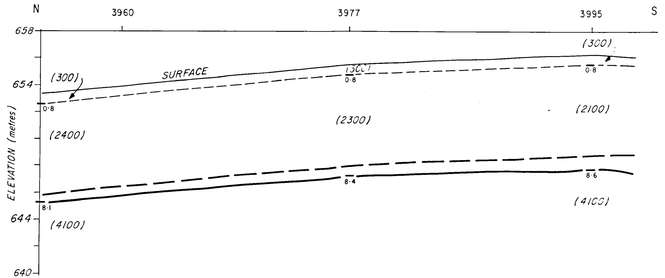
I 55/85-254

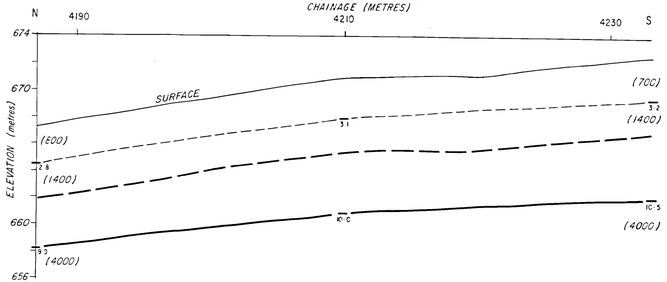
PLATE 8

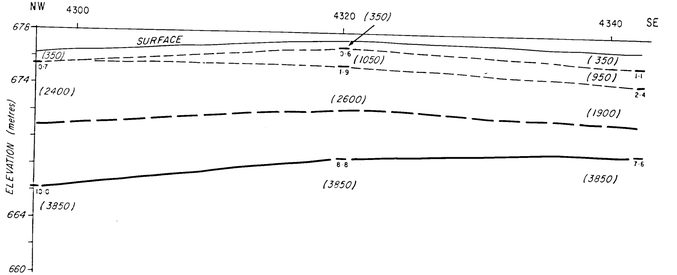












INTERPOLATED BOUNDARY

EXCAVATION LIMIT

BEDROCK BOUNDARY

(350) SEISMIC VELOCITY IN FORMATION (metres/second)

2·4 DEPTH TO REFRACTOR (metres)

GOOGONG DAM ACCESS ROAD
SEISMIC CROSS-SECTIONS

Record No.1975/145