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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

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GEOPHYSICAL SURVEY OF PROPOSED TUNNEL LINE, WAYATINAH "A" POWER DEVELOPMENT SCHEME, TASMANIA.

by

W.A. WIEBENGA, D.F. DYSON and L.V. HAWKINS.

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C O N T E N T S.

ILLUSTRATIONS

ABSTRACT.

Results are given of seismic refraction and resistivity surveys over the proposed Wayatinah "A" tunnel line, and shear or fault zones between the surface and a depth of 200 ft. are indicated. These zones are extrapolated to tunnel level. The reliability of the interpretation decreases below 300 ft. The depth of the tunnel is below the weathered layer.

The geophysical results allow an estimate of the tunnelling conditions to be made.

1. INTRODUCTION.

The Wayatinah "A" scheme is part of the Tasmanian Hydro-Electric Commission's Wayatinah Power Development project, and comprises:-

(i) The Nive River dam site.

(ii) The power station and penstocks.

(iii) The tunnel line.

Geophysical work has been done previously on the dam site (Wiebenga, Dyson and Hawkins 1956) and on the power station and penstocks sites (Wiebenga and Hawkins 1954). This report deals with the results of geophysical work on the tunnel line.

The proposed tunnel line extends from the Nive River dam site just below Wilson's Creek, to the top of the penstocks above the Wayatinah turn off on the Tarraleah Highway (Plate 1). The tunnel will be just over four miles in length, and will have a maximum depth of about 800 ft. below the surface.

The purpose of the geophysical survey was to determine shear or fault zones along the tunnel line, thereby enabling conclusions to be drawn as to the quality of the rock at tunnel level.

The geophysical methods applied were:-

(a) Seismic refraction.

(b) Resistivity.

The geophysical party consisted of W.A. Wiebenga and D.F. Dyson, party leaders, L.V. Hawkins, geophysicist, and from two to five field assistants provided by the Commission. The seismic survey was made in February and March, 1954. The resistivity survey was made in conjunction with other surveys, between April and November, 1954.

2. GEOLOGY.

The overburden along the proposed tunnel line consists of a layer of soil above a layer of weathered dolerite. The rock types which constitute the bedrock are:-

(a) Dolerite.

The dolerite is a medium-grained to coarse-grained crystalline rock, dark grey when fresh and dark green when weathered, due to chloritisation. Secondary calcite and iron staining along joints are common.

Three prominent directions of shearing or faulting, at approximately 0^{o}-20^{o}, 280^{o} and 320^{o}, are indicated by the physiography.

(b) Basalt.

The basalt between the Nive and Derwent rivers overlies dolerite and sandstone. It occurs as extensive sheets filling an old valley (see Plate 1).

The basalt, which is easily distinguished from the dolerite, is a fine-grained crystalline rock, light grey when weathered, and frequently vesicular. It occurs along the tunnel line only between stations 390 and 422, where it is underlain by dolerite.

Small boulders of basalt occur near stations 153 to 158, indicating the presence of a basalt formation close by.

3. METHODS.

The methods most applicable to the exploration of tunnel lines are (a) seismic refraction, and (b) resistivity.

(a) Seismic refraction.

The seismic refraction survey extended over the entire tunnel line. The "method of differences" was used. For a description of this method and its application see Heiland (1946, p.548) and Edge and Laby (1931, p.339).

A "Century" 12-channel portable refraction unit, model 506 was used.

(b) Resistivity.

The tunnel line was surveyed three times by the resistivity method, using the Wenner configuration, with electrode spacings of 40 ft. or 50 ft., 100 ft., and 200 ft. Readings were taken at 40 ft. or 50 ft., 100 ft. and 100 ft. intervals respectively. For a description of the Wenner method and its application to problems such as this, see Quilty (1953).

The depth penetration of the method is approximately equal to the electrode spacing.

The equipment used consisted of:-

(i) A "Megger" Earth Tester for the shorter spacings of 40 ft. or 50 ft. and 100 ft.

(ii) A resistivity meter, designed and built by the Bureau of Mineral Resources, for the 200 ft. spacings.

4. INTERPRETATION OF RESULTS.

The application of the results is qualitative, as the depth of the proposed tunnel is below the "fresh" rock profile except at the tunnel outlet above the penstock lines.

Shear zones are indicated by resistivity minima, the shape of the seismic "fresh" rock profile and the relatively low seismic velocity of the fractured or weathered rock (Wiebenga et al, 1956).

The following table gives the observed seismic velocities of the rock types present:-

Rock type	Velocity (ft/sec.)
Soil	1,000
Weathered dolerite	1,250-7,500
Dolerite	7,000-20,000
Basalt (weathered)	8,000

The interpretation is based on the results of both seismic and resistivity surveys.

Shear or fault zones indicated by the geophysical results in the layer between the surface and 200 ft. are shown on Plate 2.

The most prominent shear zones occur between stations 93 and 102, 116 and 121, 143 and 159, 177 and 183, 186 and 195, 201 and 211, 223 and 245, 323 and 347, and 415 and 425. The zones of general shearing or faulting between stations 143 and 159, 223 and 245, and 323 and 347 coincide with shear zones indicated by the physiography.

The interpretation is considered reliable to a depth of 300 ft. Thereafter, the reliability of the interpretation decreases as the depth increases. Consequently, it is uncertain whether all the shear zones exist at tunnel level. Displacement from the positions marked may also occur. However, it is considered that the geophysical results indicate the approximate position and extent of shearing. Shear zones produce difficult tunnelling conditions and the results should be of value as an indication of the quality of the rock and the tunnelling conditions to be expected.

The tunnel outlet at the top of the penstocks is located on the shear zone indicated between stations 93 and 102.

The maximum depth of the basalt is approximately 90 ft. and does not extend to tunnel level.

<u>Comparison between quantitative seismic results and diamond drilling.</u>

The Commision has drilled three holes on or near the proposed tunnel line, namely DH8802 near station 224, DH8801 slightly offset and between stations 231 and 232, and DH8800 near station 150.

<u>DH8802</u>: The depth to fresh broken dolerite with some weathering along joints was 85 ft. The seismic determination of the depth to dolerite of 14,000 ft/sec velocity at station 224, was 90 ft.

<u>DH8801</u>: The depth to medium-grained, closely-jointed dolerite was 75 ft. The seismic determination of the depth to dolerite of 11,000-14,000 ft/sec velocity at station 232 was 65 ft., and at station 231 approximately 90 ft. This hole logged decomposed, brecciated and sheared dolerite below 186 ft.

DH8800: The depth to fresh broken dolerite with weathered joints was 80 ft. The seismic depth determination was 48 ft. Considerable variation of the depth to dolerite occurs within this zone.

All three drill holes are within prominent shear or fault zones.

The quantitative seismic results are considered to be accurate within ± 15% (Wiebenga and Hawkins, 1954).

Results of the resistivity survey are qualitative.

5. CONCLUSIONS.

Shear or fault zones indicated by the geophysical results in the layer between the surface and a depth of 200 ft. are extrapolated to the depth of the tunnel. These zones are shown diagrammatically below the seismic profile on Plate 2. The reliability of the interpretation decreases below a depth of 300 ft. Some of the shear zones indicated may not extend down to the tunnel level and some displacement from the positions marked may occur.

Three prominent shear or fault zones indicated by the physiography are confirmed by the geophysical results. The tunnel outlet above the penstocks is located within a shear zone.

The seismic survey showed that the basalt, which occurs over a short portion of the tunnel line, does not extend below a depth of about 90 ft. and will therefore not be met in the tunnel.

The results of the seismic survey are in good agreement with the limited drilling data available.

The geophysical results, by indicating the positions of shear zones, allow an estimate of the tunnelling conditions to be made.

6. ACKNOWLEDGEMENTS.

It is desired to acknowledge the ready co-operation of the personnel of the Resident Engineer's office at Wayatinah, and the Investigations Branch of the Hydro-Electric Commission, Hobart.

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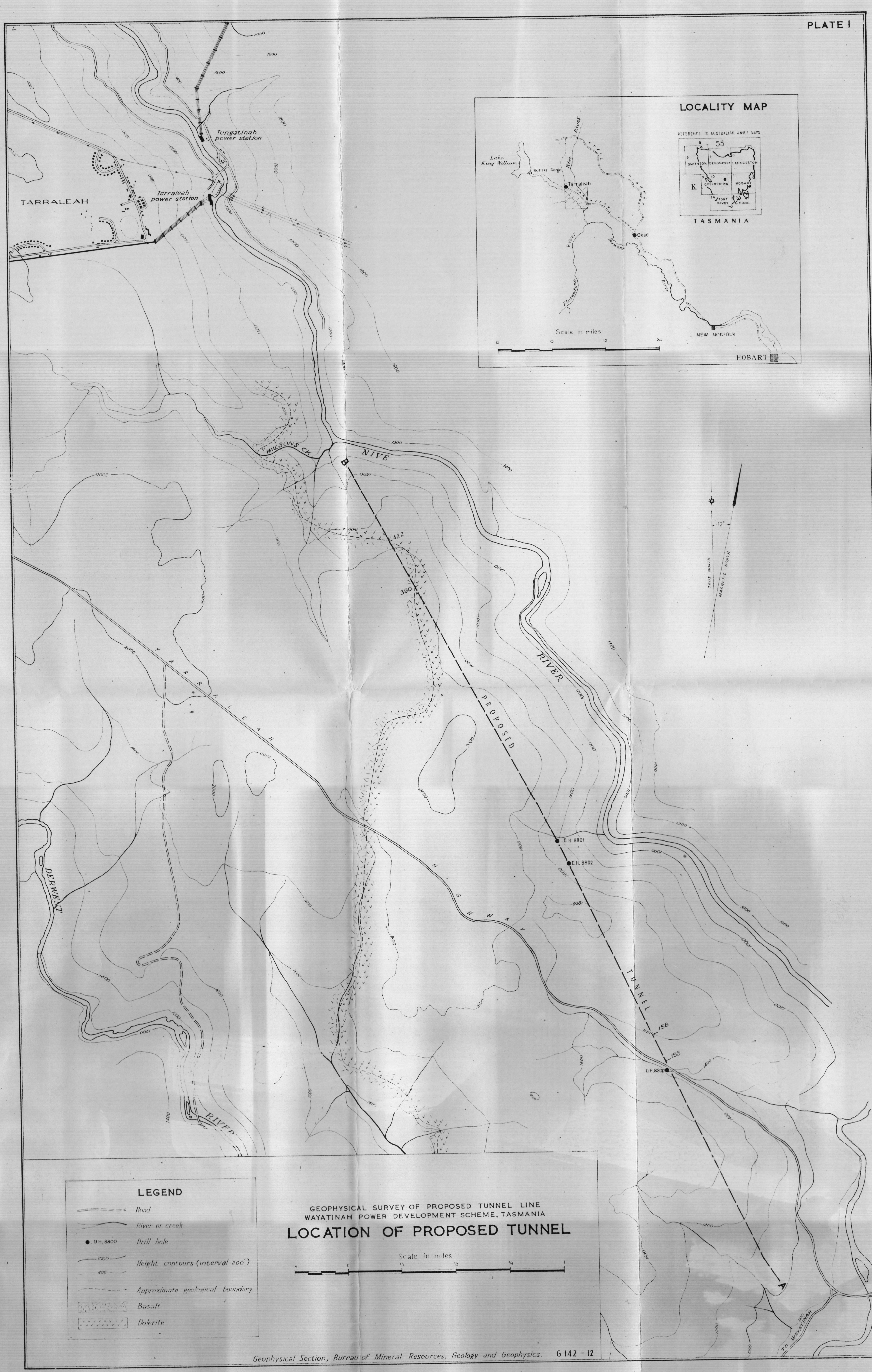
PLATE I
LOCALITY MAP
REFERENCE TO AUSTRALIAN 4-MILE MAPS
55
SMITHTON
DEVONPORT
LAUNCESTON
K
QUEENSTOWN
HOBART
PORT DAVEY
HUON
TASMANIA
Lake King William
Butlers Gorge
Nive River
Tarraleah
Ouse
Derwent River
Florentine River
NEW NORFOLK
HOBART
Scale in miles
Tungatinah power station
Tarraleah power station
TARRALEAH
WILSONS CK.
NIVE RIVER
B
422
390
PROPOSED TUNNEL
TARRALEAH HIGHWAY
D.H. 8801
D.H. 8802
D.H. 8800
158
153
A
DERWENT RIVER
To WAYATINAH
TRUE NORTH
MAGNETIC NORTH
12°
LEGEND
Road
River or creek
D.H. 8800 Drill hole
Height contours (interval 200')
Approximate geological boundary
Basalt
Dolerite
GEOPHYSICAL SURVEY OF PROPOSED TUNNEL LINE
WAYATINAH POWER DEVELOPMENT SCHEME, TASMANIA
LOCATION OF PROPOSED TUNNEL
Scale in miles
Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics.
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PLATE 2

Weathered dolerite
Fresh dolerite
Basalt
Shear zones extrapolated to tunnel level

Geophysical station
(14000) Seismic velocity (ft/sec.)
Resistivity profile (200 ft. spacing)
" " (100 " ")
" " (50 " ")

William A Wiebenga
GEOPHYSICIST

GEOPHYSICAL SURVEY OF PROPOSED TUNNEL LINE,
WAYATINAH POWER DEVELOPMENT SCHEME, TASMANIA

SEISMIC AND RESISTIVITY PROFILES AND GRAPHIC INTERPRETATION

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics

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