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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

**BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS**

505136

RECORD No. 1963/118

# MERSEY/FORTH POWER SCHEME GEOPHYSICAL SURVEYS, TASMANIA 1962

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CANBERRA, A.C.T.

*by*

*P.E. MANN*

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## ILLUSTRATIONS



## SUMMARY


The results are given of seismic refraction surveys made by the Bureau of Mineral Resources in response to an application from the Hydro-Electric Commission of Tasmania to extend surveys completed in 1960 at the 'Below Fisher' dam site and the penstock line near Lemonthyme Creek.

At the 'Below Fisher' dam site the overburden, consisting of soil, talus and scree material, till and fluvioglacial material, weathered jointed quartzite, overlies quartzite bedrock in which the seismic velocity is 10,000 to 16,000 ft/sec.

On the proposed penstock line the seismic profile indicates a complex geological structure and the bedrock may be more than 200 ft deep. A layer of basalt between 50 and 90 ft deep is postulated in the structure. Some additional drilling is recommended to test the postulated geological structure.

## 1. INTRODUCTION

In response to an application from the Hydro-Electric Commission of Tasmania (HEC), the Bureau of Mineral Resources made additional geophysical surveys to determine the nature of the overburden and the bedrock, and the depth to bedrock at two sites for the Mersey/Forth power development scheme, viz. along a penstock line near Lemonthyme Creek and at 'Below Fisher' dam site. The surveys were requested because minor design modifications to the scheme had been proposed since 1960 by the Project Designs Section of the HEC.

The results of previous geophysical surveys at these two areas are given by Polak and Duggin (1961).

Plates 2 and 4 show the layout of the geophysical traverses at Lemonthyme Creek and 'Below Fisher' dam site of the 1960 and 1962 surveys.

The seismic refraction method was used. The survey was made in May and June 1962 by a geophysical party with geophysicist P. Mann as party leader. The Commission provided a staff member, D. Hansen, for training in engineering geophysics, and four field assistants. The Commission carried out the topographical survey along the traverse lines.

## 2. GEOLOGY

The general geology of the area (Plate 1) and of the individual sites is given by Polak and Duggin (1961). The geology of each site is briefly described later.

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## 3. METHODS AND EQUIPMENT

A detailed description of the seismic method has been given by Polak and Moss (1959).

The 'method of differences' was used (Heiland, 1946, p.548) on all the seismic traverses.

An SIE 12-channel refraction seismograph was used with TIC geophones of natural frequency about 20 c/s.

## 4. 'BELOW FISHER' DAM SITE

### Location and geology

The site of the proposed 'Below Fisher' dam site on the Mersey River is about one mile downstream from the junction of the Mersey and Fisher Rivers. Approximate co-ordinates of the dam site are 420874 on the Burnie sheet of the Australia 1:250,000 map series. Traverses J and G are slightly upstream of the 1960 Traverses A, C, and D (Plate 2). Traverses K and H intersect Traverse D.

The dam site is located in a broad gorge cut out in a sequence of vertical to near-vertical Precambrian Fisher Group quartzite, schist, phyllite, and slate with approximately easterly strike. The gorge has been glaciated and this has produced a U-shaped surface profile and a blanket of till and fluvioglacial material. Quartzite crops out in the road cutting and several other places (Plate 2) but elsewhere is covered by talus and scree material and alluvium. The five drill holes on or near Traverse C, (1960 survey) were used to interpret the seismic velocities in terms of rock type.

## Seismic results

Table 1 lists the interpretation of the seismic velocities found from normal and weathering spreads and plotted on the cross-sections of Plate 3.

Table 1

| Seismic velocity (ft/sec) | Rock type |
|---|---|
| 700 to 1000 | Soil |
| 2000 to 3000 | Scree material |
| 5800 to 8000 | Partly consolidated till; weathered jointed quartzite |
| 10,000 to 16,000 | Jointed to unjointed unweathered bedrock |

The term bedrock refers to unweathered rock, (possibly jointed) with the highest recorded seismic velocity. The term overburden refers to rock in which the seismic velocity is less than 8000 ft/sec.

The seismic cross-sections shown on Plate 3 are self-explanatory.

The overburden is thickest near J16 (88 ft) and K10 (85 ft). The bedrock profiles suggest the presence of a U-shaped glaciated valley, filled with till and alluvium.

At the intersection of Traverses H and K with Traverse D the depths to the bedrock do not agree exactly. The discrepancies in depth are probably mainly due to the different paths taken by the seismic waves with 'in line' shooting used in 1962, and 'broadside' shooting adopted by Polak and Duggin (1961). The rapid variation of the near-surface velocities affects depth estimates. With 'broadside' shooting the refractor depth is measured at a point between the geophone and the shot-point. The different depths along the refractor are calculated relative to a point on the refractor where the depth is known either from drilling or 'in line' refraction shooting. The refractor depth is probably more accurate with 'in line' shooting because the near-surface velocities are known accurately whereas in 'broadside' shooting the refractor depths are calculated on the assumption that the velocity distribution is constant along a traverse.

The seismic velocity in the bedrock on the right bank (14,000 to 16,000 ft/sec) is generally higher than on the left bank (10,000 to 14,500 ft/sec). This may be explained by variations in the degree of jointing of the bedrock.

Conclusion

The survey disclosed the typical U-shaped structure of a glaciated valley, filled with till and alluvium.

To check the results drilling is recommended on the places where the overburden is thickest, i.e. near J16 and G13.

A drill hole near G7 is recommended to check the depth and nature of bedrock near the river bed where the seismic information is incomplete.

## 5. LEMONTHYME PENSTOCK

Location and geology

The additional survey work at Lemonthyme Creek (Plate 4) consisted of extending Traverse C (1960) from Station 143 to the Forth River and surveying Traverse D and four short cross-traverses, viz. E, F, G, and H. Since the report of the 1960 survey was issued further geological information from five drill holes, viz. DDH 5811, 5812, 5813, 5814, and 5815, has been made available. For a brief geological description reference is made to Polak and Duggin (1961). Tertiary basalt unconformably overlies the Precambrian strata on the Emu Plains Plateau (Patterson, 1961). Reference will be made to basalt to interpret a complex structure revealed by the seismic work.

Seismic results

Table 2 lists an interpretation of the seismic velocities in geological terms, deduced from drilling and seismic data.

Table 2

| Seismic velocity (ft/sec) | Rock type |
|---|---|
| 1000 to 2200 | Talus material and Quaternary clay. |
| 3500 to 4000 | Highly weathered Precambrian schist. |
| 4500 to 7500 | Unconsolidated to semi-consolidated river gravels; weathered tillite; weathered schist. |
| 10,000 to 12,000 | Moderately to slightly weathered schist; unweathered tillite; possibly vesicular basalt or slightly weathered basalt. |
| 12,000 to 18,000 | Slightly weathered to unweathered schists. |

The above table is based on a comparison between the seismic results and the available geological information. It must be pointed out that the seismic velocity in rocks depends on the degree of weathering, e.g. the velocity in weathered schist may range between 3000 and 15,000 ft/sec.

The seismic cross-section along Traverse C is shown on Plate 5. A misclosure of 15 ft at Station C143 between the results of the 1960 and 1962 surveys was adjusted by distributing the error between Stations C138 and C143, i.e. over a distance of 250 ft.

The seismic cross-sections shown on Plate 6 are self-explanatory except between Stations D162 and D192, where the cross-section shows a complicated structure. A 12,000-ft/sec refractor was recorded at only five stations between Stations D162 and D172. Between Stations D172 and D192 the time/distance curves do not show refractions from the highest-velocity layer continuously across a normal spread. The velocities and form shown by the time/distance curves have been interpreted to indicate a relatively high-velocity rock layer overlying bedrock at a great depth. This rock in which the seismic velocity is 11,000 ft/sec, is interpreted as a fairly porous, moderately weathered or vesicular basalt. It is calculated to be about 87 ft deep near D172, and between 50 and 90 ft deep near D182. Near D182 the depth to the 12,000-ft/sec refractor is about 234 ft. This figure assumed that no layer with velocity lower than 11,000 ft/sec lies between the 'basalt' and highest velocity refractor.

The depths to discontinuities shown by the seismic method and the geological discontinuities obtained from the drill hole logs are compared in Plate 4. All the seismic velocities shown on the drill hole logs were determined from weathering spreads except for DDH 5813. A velocity of 1900 ft/sec in the talus material was determined by 'up-hole' shooting.

## Conclusions

A rock in which the seismic velocity is greater than 6500 ft/sec is probably suitable for the anchor foundations of a penstock line. Rock with this seismic velocity is generally at a substantial depth along the traverses; e.g. it is probably more than 40 ft deep near the following places: C149, from C115 to C142, near C109, and from D157 to D192. The low-velocity layers are probably thickest between D180 and D189 where some further test drilling, such as deepening DDH 5813, should be done to check the interpretation of the seismic data. Further check drilling should be carried out in the places mentioned above.

## 6. REFERENCES


| | | |
|---|---|---|
| HEILAND, C.A. | 1946 | GEOPHYSICAL PROSPECTING, New York, Prentice Hall. |
| PATTERSON, S.J. | 1961 | Geological Investigation Report 644-174-2 on the Mersey Diversion Schemes. (HEC unpublished report). |

POLAK, E.J. and DUGGIN, M.J.W. 1961 Mersey-Forth power scheme geophysical surveys, Tasmania 1960. Bur.Min. Resour. Aust. Rec. 1961/29 (unpubl.).

POLAK, E.J. and MOSS, F.J. 1959 Geophysical survey at the Cluny dam site, Derwent River, Tasmania. Bur. Min. Resour. Aust. Rec. 1959/87.

REFERENCE

Cainozoic QUATERNARY
- Qt — Basalt talus material and landslip debris
- Qf — Fluvioglacial deposits, till and alluvium
- Qg — Till, talus, marsh deposits and residual gravels
- Qra — RECENT alluvium

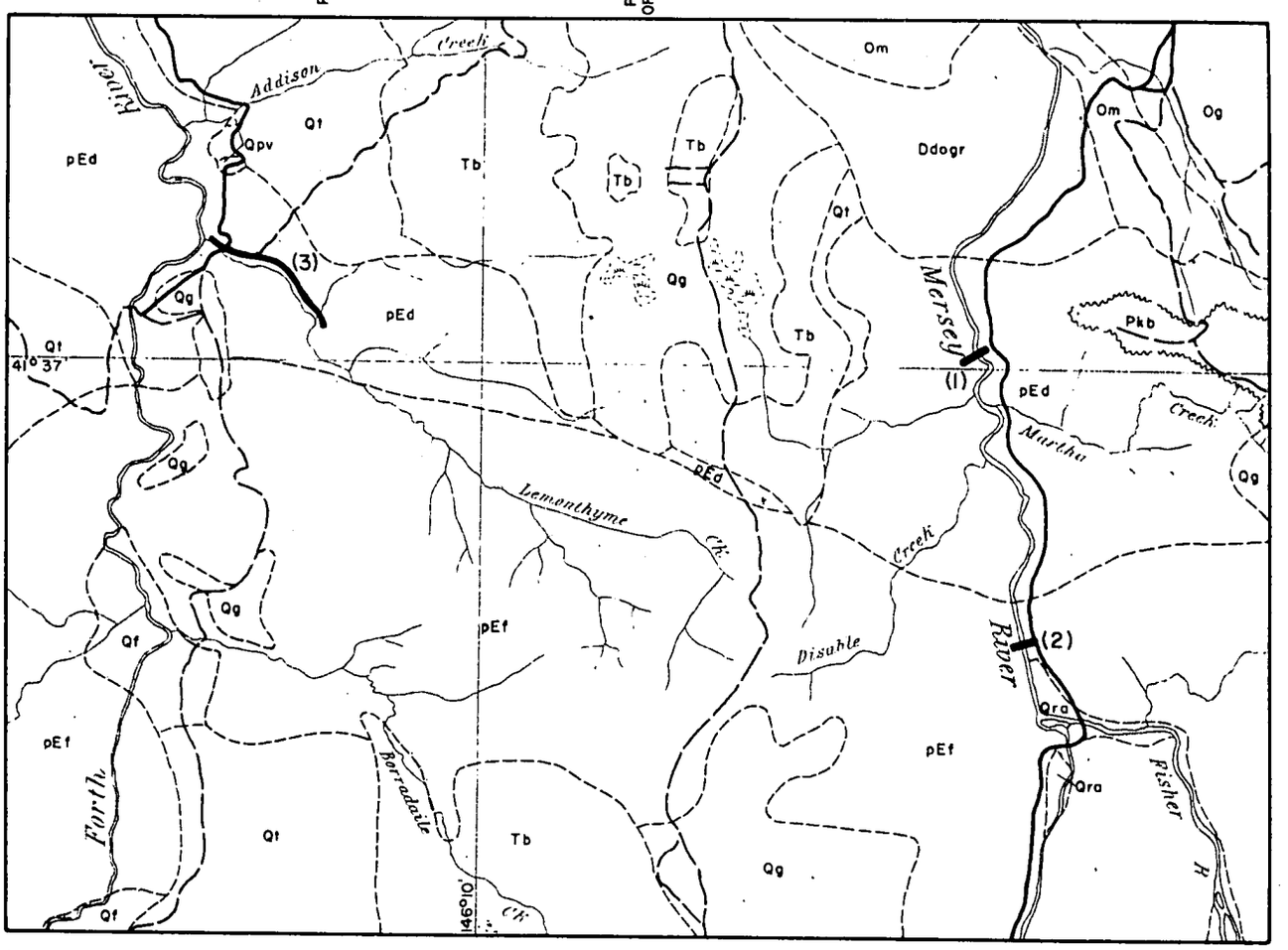
Tb — TERTIARY basalt

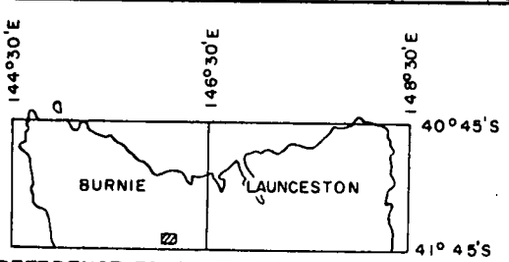
Palaeozoic PERMIAN
- Pkb — Kansas Creek beds

Palaeozoic DEVONIAN
- Ddogr — Dove granite

Palaeozoic ORDOVICIAN
- Og — Gordon limestone
- Om — Moina Sandstone

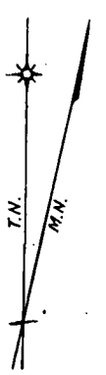
Precambrian
- pEd — Dove group
- pEf — Fisher group




REFERENCE TO AUSTRALIA STANDARD MAP SERIES : BURNIE

(1) Martha Creek dam site (Polak and Duggin 1961)
(2) 'Below Fisher' dam site
(3) Lemonthyme penstock line




UPPER MERSEY-FORTH POWER SCHEME
GEOPHYSICAL SURVEY, TASMANIA 1962

# GEOLOGICAL AND LOCALITY MAP

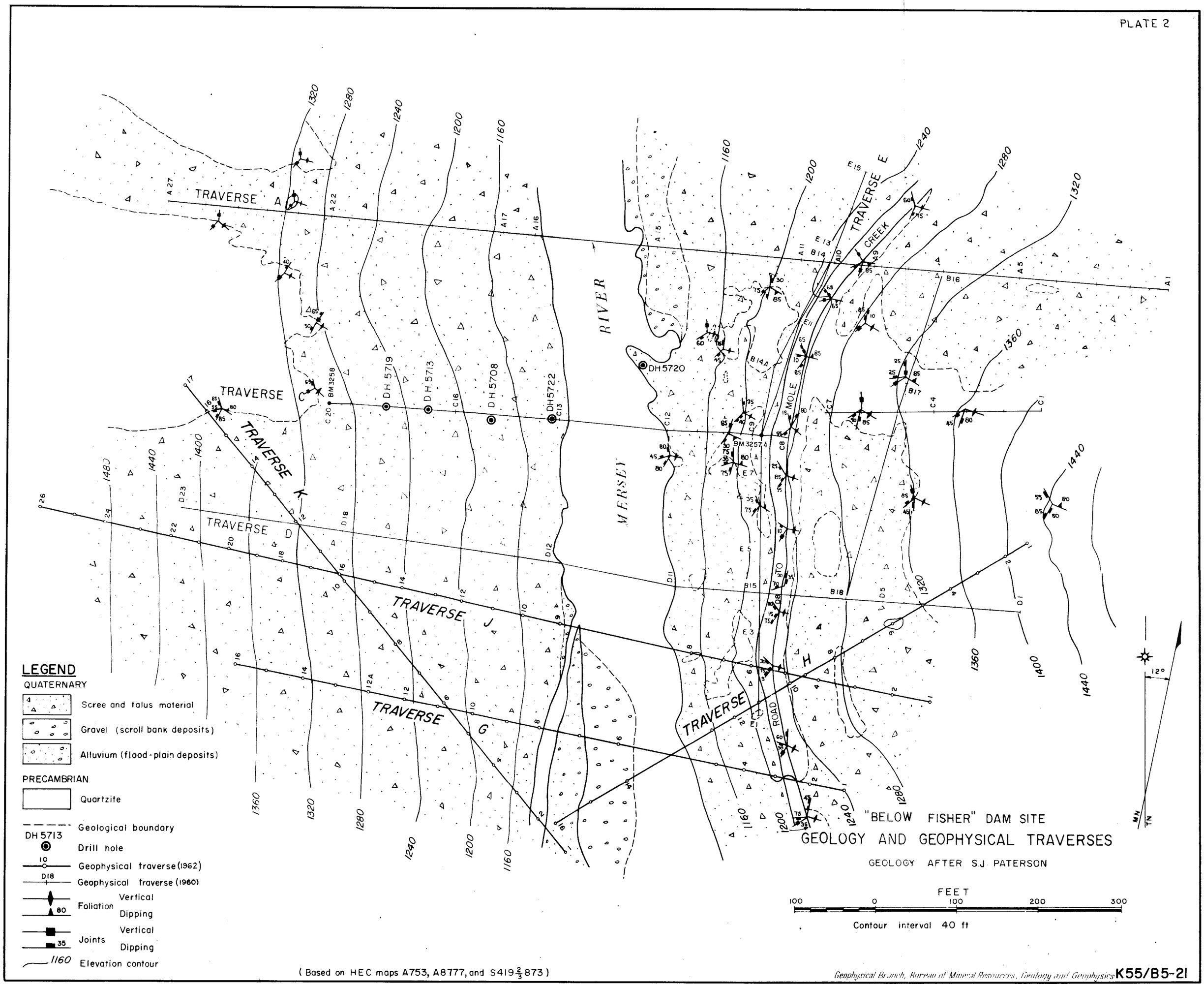
(AFTER DEPARTMENT OF MINES, TASMANIA MIDDLESEX 1-MILE GEOLOGICAL MAP)

SCALE IN MILES

1 0 1 2 3

*Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics* K55/B5-29

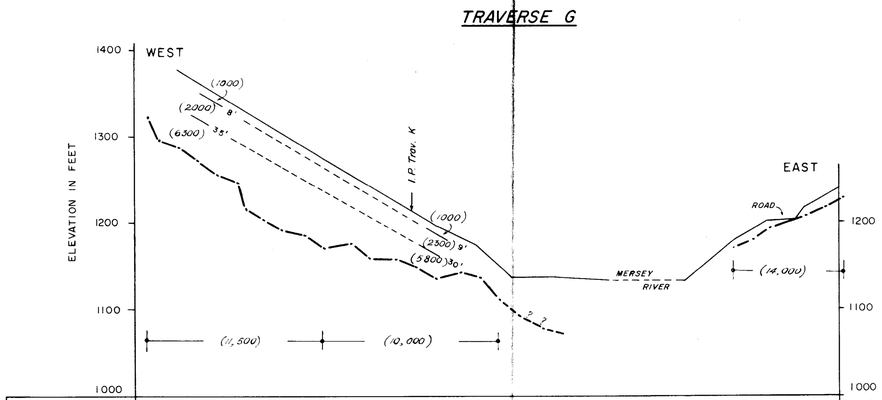
TO ACCOMPANY RECORD No 1963/118

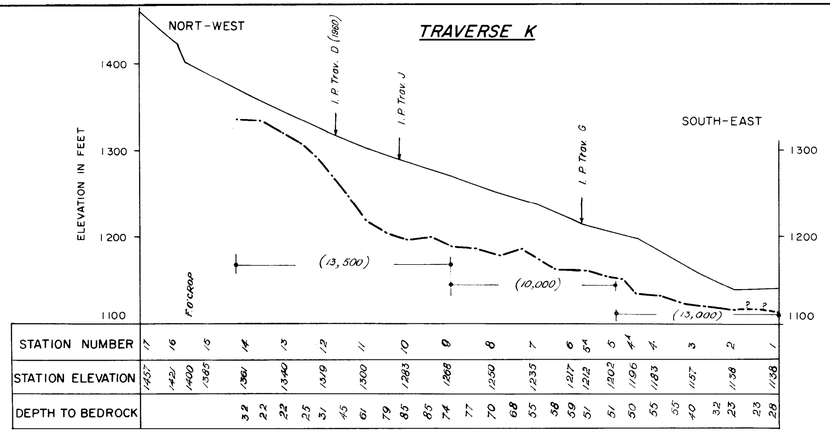


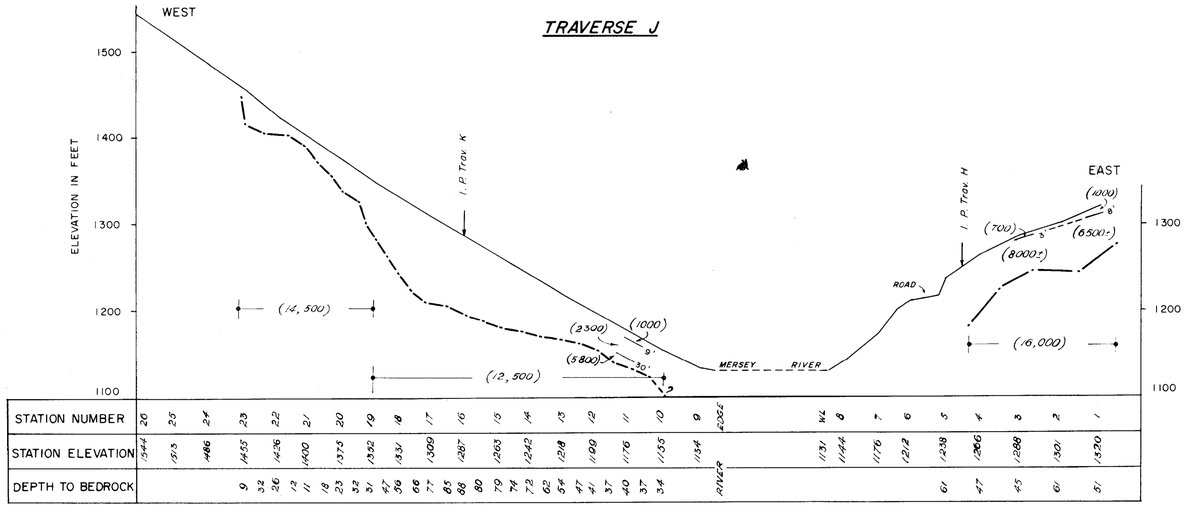

(Based on HEC maps A753, A8777, and S419 2/3 873)

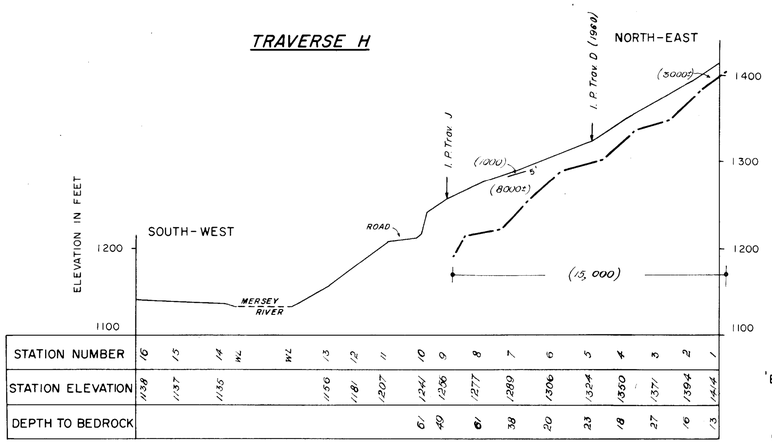
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics K55/B5-21

TO ACCOMPANY RECORD No 1963/118




'BELOW-FISHER' DAM SITE, TASMANIA 1962

TRAVERSES G, H, J, and K

# SEISMIC CROSS-SECTIONS

( Based on H.E.C. Plans A 9397, 9398.)

## LEGEND

(2300) Seismic velocity (ft/sec) in formation

—— 9' Depth to formation with different seismic velocity

I. P. Intersection point

—•—•— Unweathered bedrock boundary

Note:

Depths to highest velocity refractor plotted normal to ground surface

FEET

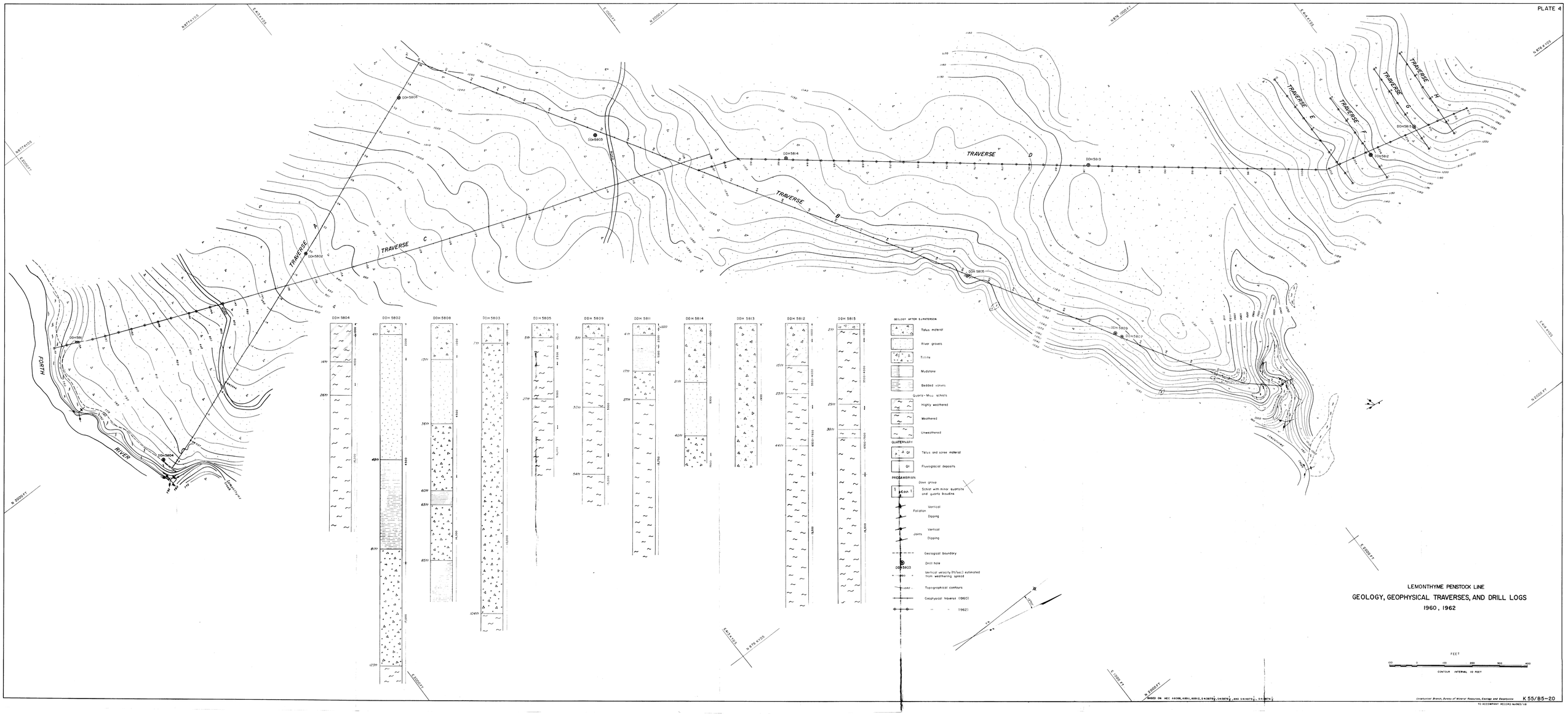
100 50 0 100 200 300

(Horizontal and Vertical)

MERSEY / FORTH POWER SCHEME, TASMANIA 1962

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics K 55/B5-6

TO ACCOMPANY RECORD No 1963/118




LEMONTHYME PENSTOCK LINE

GEOLOGY, GEOPHYSICAL TRAVERSES, AND DRILL LOGS

1960, 1962

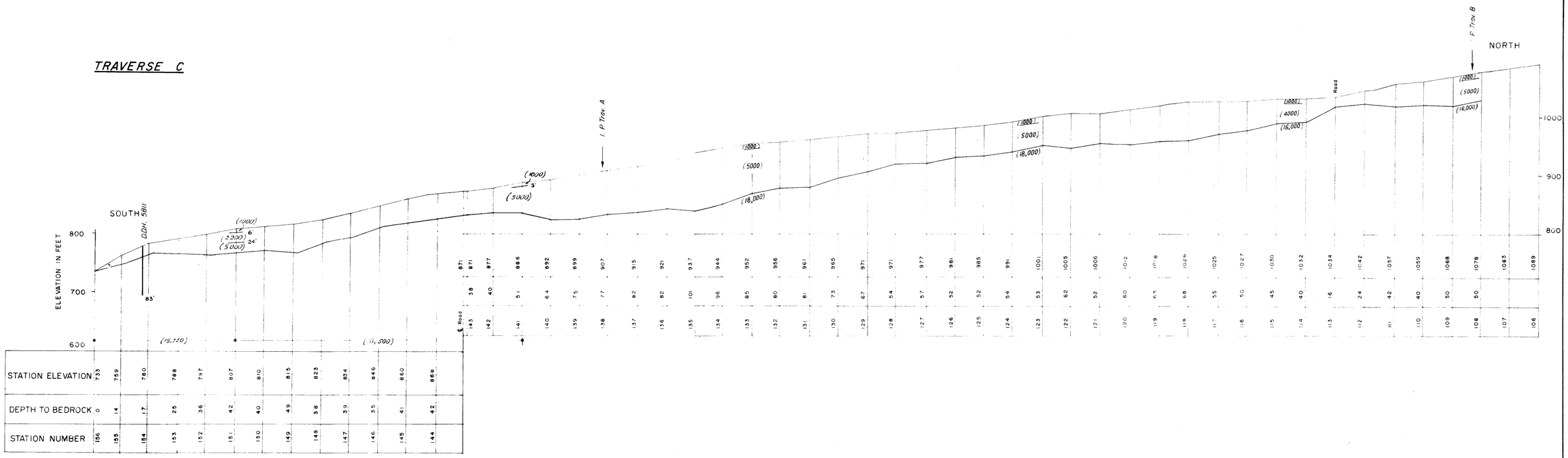
BASED ON MEC 5608A, 5891, 5892, E436755, E436756, AND E436757, E436758.

Geotechnical Branch, Bureau of Mineral Resources, Geology and Geophysics

K 55/B5-20

TO ACCOMPANY RECORD No 1965/108

PLATE 5




| STATION ELEVATION | 733 | 759 | 780 | 788 | 797 | 807 | 810 | 815 | 823 | 834 | 846 | 860 | 868 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DEPTH TO BEDROCK | 0 | 14 | 17 | 25 | 36 | 42 | 40 | 49 | 38 | 39 | 35 | 41 | 42 |
| STATION NUMBER | 156 | 155 | 154 | 153 | 152 | 151 | 150 | 149 | 148 | 147 | 146 | 145 | 144 |

| STATION NUMBER | STATION ELEVATION | DEPTH TO BEDROCK |
|---|---|---|
| 143 | 871 | 38 |
| 142 | 871 | 40 |
| 141 | 877 | 51 |
| 140 | 886 | 64 |
| 139 | 892 | 75 |
| 138 | 899 | 77 |
| 137 | 907 | 82 |
| 136 | 915 | 82 |
| 135 | 921 | 101 |
| 134 | 937 | 96 |
| 133 | 944 | 85 |
| 132 | 952 | 80 |
| 131 | 956 | 81 |
| 130 | 961 | 73 |
| 129 | 965 | 67 |
| 128 | 971 | 54 |
| 127 | 971 | 57 |
| 126 | 977 | 52 |
| 125 | 981 | 52 |
| 124 | 985 | 54 |
| 123 | 991 | 53 |
| 122 | 1001 | 62 |
| 121 | 1005 | 52 |
| 120 | 1006 | 60 |
| 119 | 1012 | 63 |
| 118 | 1018 | 68 |
| 117 | 1026 | 55 |
| 116 | 1025 | 50 |
| 115 | 1027 | 45 |
| 114 | 1030 | 40 |
| 113 | 1032 | 16 |
| 112 | 1034 | 24 |
| 111 | 1042 | 42 |
| 110 | 1057 | 40 |
| 109 | 1059 | 50 |
| 108 | 1068 | 50 |
| 107 | 1078 | |
| 106 | 1083 | |
| | 1089 | |

## LEGEND

| | |
|---|---|
| (5000) | Seismic velocity (ft/sec) in formation |
| ——— 5' | Depth to formation with different seismic velocity |
| I. P. | Intersection point |
| ——— | Unweathered bedrock boundary |
| D.D.H. | Diamond drill hole |

LEMONTHYME PENSTOCK LINE, TASMANIA 1962

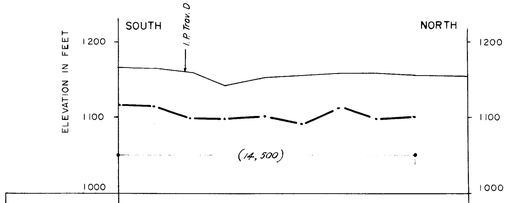
# TRAVERSE C
# SEISMIC CROSS-SECTION

SCALE IN FEET
100 0 100 200 300

AFTER H.E.C. DWG A7752
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. K 55/B5-9

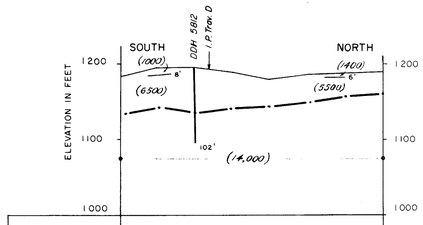
TO ACCOMPANY RECORD No 1963/118

MERSEY/FORTH POWER SCHEME, TAS, 1962



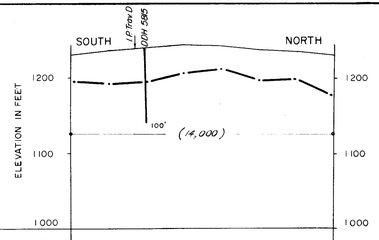

| STATION NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| STATION ELEVATION | 1169 | 1167 | 1161 | 1144 | 1154 | 1157 | 1159 | 1159 | 1166 | 1155 |
| DEPTH TO BEDROCK | 31 | 31 | 69 | 49 | 53 | 63 | 44 | 61 | 56 | 10 |

## TRAVERSE E



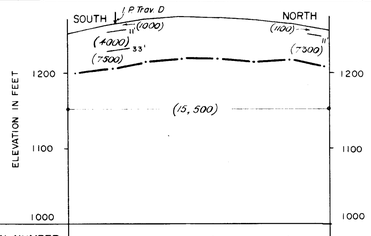

| STATION NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| STATION ELEVATION | 1163 | 1185 | 1195 | 1188 | 1179 | 1186 | 1187 | 1199 |
| DEPTH TO BEDROCK | 31 | 53 | 61 | 48 | 36 | 37 | 32 | 31 |

## TRAVERSE F



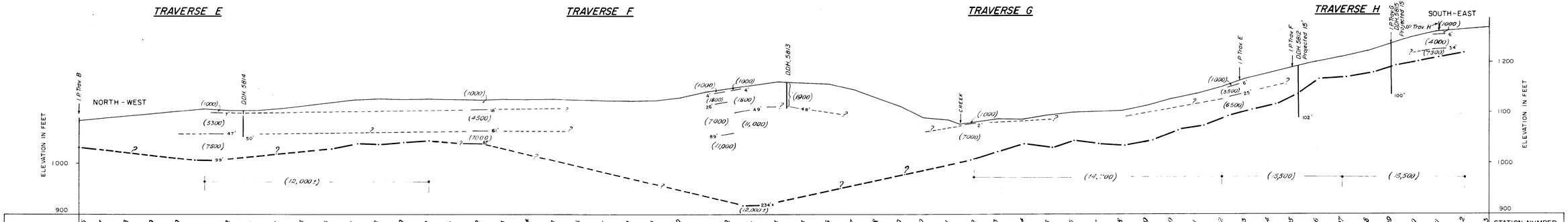

| STATION NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| STATION ELEVATION | 1227 | 1234 | 1238 | 1245 | 1241 | 1236 | 1234 | 1227 |
| DEPTH TO BEDROCK | 36 | 44 | 46 | 30 | 32 | 42 | 37 | 53 |

## TRAVERSE G




| STATION NUMBER | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| STATION ELEVATION | 1249 | 1262 | 1260 | 1273 | 1272 | 1268 | 1263 | 1254 |
| DEPTH TO BEDROCK | 53 | 58 | 50 | 50 | 56 | 50 | 40 | 42 |

## TRAVERSE H




| STATION NUMBER | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STATION ELEVATION | 1086 | 1098 | 1094 | 1100 | 1103 | 1109 | 1106 | 1103 | 1108 | 1116 | 1121 | 1126 | 1128 | 1128 | 1129 | 1127 | 1126 | 1128 | 1127 | 1128 | 1126 | 1124 | 1123 | 1124 | 1130 | 1140 | 1140 | 1155 | 1161 | 1161 | 1156 | 1146 | 1131 | 1111 | 1090 | 1086 | 1096 | 1093 | 1094 | 1095 | 1102 | 1103 | 1108 | 1116 | 1128 | 1138 | 1135 | 1118 | 1179 | 1191 | 1203 | 1213 | 1223 | 1237 | 1232 | 1262 | 1266 | 1270 |
| DEPTH TO BEDROCK | 34 | | | | | | | | | | 92 | 86 | 90 | 84 | 82 | | | | | | | | | | | | | | | | | | | | | | 40 | 63 | 49 | 65 | 41 | 65 | 68 | 53 | 63 | 65 | 47 | 38 | 61 | 63 | 54 | 57 | 42 | 44 | 41 | 57 | 46 | |

## TRAVERSE D

### LEGEND

| | |
|---|---|
| 4500 | Seismic velocity (ft/sec) : formation |
| 18' | Depth to formation with different seismic velocity |
| I.P. | Intersection point |
| | Unweathered bedrock boundary |
| ? | Possible refractor boundary |
| D.D.H. | Diamond drill hole |

LEMONTHYME PENSTOCK LINE, TASMANIA 1962

**TRAVERSES D, E, F, G, and H**

# SEISMIC CROSS-SECTIONS

(Based on HEC Plans A9294 and 9382)

FEET

100 50 0 100 200 300

(Horizontal and Vertical)

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics K 55/B5-7

TO ACCOMPANY RECORD No. 1963/118

MERSEY/FORTH POWER SCHEME, TASMANIA 1962