COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORDS 1961 No. 29

MERSEY-FORTH POWER SCHEME GEOPHYSICAL SURVEYS, TASMANIA 1960

by

E.J. Polak and M.J.W. Duggin

RECORDS 1961 No. 29

MERSEY-FORTH POWER SCHEME GEOPHYSICAL SURVEYS, TASMANIA 1960

by

E.J. Polak and M.J.W. Duggin

CONTENTS

ILLUSTRATIONS

ABSTRACT

Details and results are given of seismic refraction surveys carried out in response to an application from the Hydro-Electric Commission of Tasmania to investigate proposed dam sites on the Mersey River and the penstock line in the Lemonthyme Creek.

The purposes of the survey were to determine the depth to bedrock and the nature of bedrock and overburden. The overburden consists of soil, scree material, gravel, and weathered rock. The bedrock is quartz-mica schist of Cambrian age. Seismic velocities of 10,000 to 17,000 ft/sec were recorded in the bedrock.

1. INTRODUCTION

The Hydro-Electric Commission of Tasmania proposes to construct a dam on the Mersey River below its junction with the Fisher River, the impounded water to be taken by a tunnel to the Forth River valley where a power station is to be constructed.

Two possible sites for the dam were chosen by the Commission for further investigation, the up-stream site being called "Below Fisher" and the down-stream site the "Martha Creek" (See Plate 1). The outlet of the tunnel will be in Lemonthyme Creek.

In response to an application from the Commission, the Bureau of Mineral Resources carried out a geophysical survey to determine the nature of the overburden and the bedrock and the depth to the bedrock on the two dam sites on the Mersey River, and on the penstock line in the Lemonthyme Creek.

As used in this report, the term "bedrock" refers to unweathered rock, including jointed rock, in a refractor showing the highest recorded seismic wave velocity. The term "overburden" refers to river gravel, clay, scree material, and completely or partly weathered rock, all with a seismic wave velocity less than 8000 ft/sec.

The seismic refraction method was used. Tests were made to ascertain whether magnetic and resistivity methods might also be applied, but it was found that data obtained by these methods could not be interpreted.

The survey was made in April and May 1960, by a geophysical party consisting of geophysicists E.J. Polak (party leader) and M.J.W. Duggin. The Commission provided additional assistants, and carried out a topographical survey along the traverse lines.

Table 1 shows the total lengths of the surveyed traverses.

TABLE 1

Area	Seismic (ft)	Magnetic (ft)	Resistivity (ft)
Martha Creek	6000	2000	-
"Below Fisher"	4500	-	-
Lemonthyme	7500	1000	3000
Total	18000	3000	3000

2. GEOLOGY

The geology of the area has been described by Spry (1958), and is illustrated in Plate 1. A detailed geological examination of the dam site has been made by S.J. Paterson; his results are shown on Plates 2 and 5.

The stratigraphy of the area (after Spry) is shown on Table 2.

TABLE 2

Age	Group	Rock Type
Pleistocene		glacial till
Tertiary		volcanic breccia, tuff, basalt
Jurassic		dolerite
Permian		conglomerate, sandstone, siltstone
Precambrian	Dove Group	schist
	Magg's Group	quartzite
	Arm Group	schist
	Fisher Group	slate and quartzite
	Howell Group	mica schist, mica-quartzite, quartzite

The geology of the individual sites will be discussed in later sections.

3. METHODS AND EQUIPMENT

3.1 Seismic Method

The seismic method of exploration depends for its success on the contrast between the velocities of the seismic waves through different rock formations. Hard unweathered rocks have higher velocities than their weathered counterparts, and these in turn have higher velocities than soil and unconsolidated deposits. A detailed description of the method has been given in the previous reports to the Commission (see Polak and Moss, 1959).

The "method of differences" was used (Heiland, 1946, p.548) for traverses along the slope, but broadside spreads were used on steep banks.

The equipment in these surveys was an S.I.E. 12-channel refraction seismograph with T.I.C. geophones of natural frequency of about 20 cycles per second.

3.2 Magnetic Method

Magnetic test traverses on the Martha Creek and Lemonthyme surveys showed that the difference in magnetic susceptibilities between different rock types is too small for the magnetic method to be used in bedrock investigations. The tests were therefore discontinued. A Watts vertical force variometer was used for the tests.

3.3 Resistivity Method

Constant-spacing resistivity traversing was carried out along the Lemonthyme penstock line with a spacing of 100 ft. The rocks along the penstock line are of very low resistivity and the method did not reveal any worth-while features.

A "Tellohm" meter with full scale deflections rangeing from 0.03 to 10000 ohm was used.

4. MARTHA CREEK DAM SITE

4.1 Location and Geology

The site of the proposed Martha Creek dam is approximately 2 miles down-stream from the junction of Mersey and Fisher Rivers (Plate 1). The approximate co-ordinates are 419475 on the 4-mile military series.

The dam site is in a deep valley with very steep sides. The main rock in the area is quartz-mica schist of Precambrian age, belonging to the Dove Group. This rock outcrops in many places on the site (Plate 2), but elsewhere it is covered with scree material, and near the river bed, with gravel. Evidence for the existence of two faults has been found (Paterson, 1959).

The Commission drilled seven diamond drill holes on the dam site.

4.2 Seismic Results

Plate 2 shows the arrangement of the geophysical traverses. Table 3 gives seismic wave velocities on the Martha Creek dam site.

TABLE 3

Seismic wave velocities in ft/sec	Rock type
1000	Soil
3000 to 4500	Scree material
6000 to 8000	Weathered rock
13000 to 16000	Unweathered rock

The depth to bedrock was calculated by the use of apparent velocity values obtained from weathering spreads. The depths thus calculated are plotted on Plate 3 for cross-river traverses A, B, and C, where broadside arrangements of geophones were used. And on Plate 4 the results for traverses E, F, and G are shown; these traverses were calculated using the "method of differences".

It is very difficult to assess the accuracy of the seismic survey results, especially where the overburden is very thin and uneven. The Commission conducted a drilling programme in which both vertical and inclined holes were drilled at each drilling site. This showed that the thickness of overburden can be very different at points only a short distance apart. Table 4 compares the depths to bedrock as measured from drilling and from seismic data.

TABLE 4

Drill Hole No.	Direction	Depth of Weathering (from drilling)	Depth to bedrock (seismic)	Drilling started
5710	Vertical	60 ft	44 ft	on outcrop
5712	Inclined	14	27	" "
5711	Vertical	44	5	" "
5714	Inclined	11	5	" "
5709	Vertical	41	22	on Talus slope
5715	Vertical	42	32	" " "

4.3 Elastic properties

Table 5 shows the values of longitudinal and transverse wave velocities measured together on the Martha Creek dam site. The elastic properties of bedrock were calculated (Polak and Moss, 1959) assuming a density of 2.7 g/c.c. for quartz-mica schist.

TABLE 5

Station No.	Apparent velocity ft/sec		True velocity	Poisson's Ratio	Modulus in 10^6 lb/sq.in.		
	Long.	Trans.			Young's	Bulk	Rigidity
A3	9600	5600	11000	0.24	3.35	2.15	1.34
A13	14200	8500	15000	0.22	4.70	2.8	1.92
B1	9000	5300	11000	0.24	3.35	2.15	1.34
C2	12400	7000	13000	0.21	4.20	2.43	1.72
C9	10600	6200	13000	0.25	3.90	2.6	1.56

4.4 Conclusions

The geophysical survey provided information on the depth to the bedrock at the Martha Creek dam site. The overburden consists of soil, gravel, scree material, and partly weathered quartz-mica schist. The estimated maximum thickness of overburden is 74 ft near station C2. The bedrock consists of partly jointed quartz-mica schist with a seismic wave velocity of 11,000 to 16,000 ft/sec, and Young's Modulus between 3.3 and 4.7 x 10^6 lb/sq.in.

5. "BELOW FISHER" DAM SITE

5.1 Location and Geology

The site of the proposed "Below Fisher" dam is approximately 1 mile downstream from the junction of the Mersey and Fisher Rivers. Approximate co-ordinates are 420874 on the 4-mile military series.

The dam site is in a deep valley with very steep sides. The main rock in the area is the quartz-mica schist of Precambrian age, belonging to the Dove Group. This rock outcrops in several places (Plate 5) but elsewhere is covered with scree material, and in two places with terrace deposits of river gravel.

The Commission has drilled 5 diamond drill holes in the area.

5.2 Seismic results (Plates 5, 6, and 7)

The seismic velocities in the overburden of the "Below Fisher" dam site are similar to those listed in Table 3 for the Martha Creek dam site. The bedrock velocities range between 12,000 and 13,000 ft/sec, indicating jointed bedrock of fair quality for dam foundation purposes.

The depth to bedrock (Plates 6 and 7) has been calculated using seismic velocities obtained by weathering spreads.

Table 6 compares the depths to bedrock as measured from drilling and from seismic data.

TABLE 6

Drill hole	Direction	Depth of weathering (from drilling)	Depth to bedrock (seismic)	Drilling started
5708	Vertical	62 ft	80 ft	on talus
5713	Vertical	75	85	" "
5719	Vertical	40	50	" "
5720	Vertical	30	25	in river bed
5722	Vertical	56	45	" " "

5.3 Conclusion

The geophysical survey provided information on the depths to bedrock at the "Below Fisher" dam site. The overburden consists of soil, gravel, and partly weathered quartz-mica schist. The overburden is up to 77 ft thick (maximum from seismic determination) near stations C16 and D17.

6. LEMONTHYME PENSTOCK LINE

6.1 Location and geology

The water diverted from the Mersey River will reach Lemonthyme Creek through a tunnel. From there the water will follow a channel or a pipeline along the contours to a point near station No. 36 (Plate 8), where it will enter the penstock. The penstock will convey it to a power station located near the Forth River. Approximate co-ordinates are 413,876 on the 4-mile military series.

Almost the whole area of the survey is covered with scree material of which the maximum thickness shown by drilling is 13 ft at DDH 5808. Rock outcrops are confined to the areas near the outlet of the penstock line, close to the Forth River, and near the inlet to the penstock. The outcropping rock there consists of quartz-mica schist of Precambrian age.

In some places scree material lies directly on the quartz-mica schist; in other places river gravel or glacial deposits lie between the bedrock and the scree material (see drilling logs, Plate 8).

Table 7 shows an interpretation of the seismic velocities in geological terms, deduced from drilling and seismic data.

TABLE 7

Seismic velocity in ft.	Rock type
1000 to 2000	Scree material
2000 to 4500	River gravels
4500 to 5000	Bedded varves (silt and clay)
4000 to 4500	Weathered or unconsolidated tillite
10,000 to 17,000	Unweathered, compact tillite
2300 to 5000	Highly weathered schist
5000 to 16,000	Weathered to slightly weathered schist

The geological cross-sections shown by drill holes DDH 5802 and 5808 suggest that the lower tillite, apparently protected by varve beds from the entry of water, would have very high seismic velocities, contrasting with the low seismic velocity in the upper tillite of DDH 5808. In DDH 5803 the drilling log does not show a protective layer of varves separating the upper tillite (of low seismic velocity) from the lower tillite (of high velocity); but as the core recovery in the relevant drilled section is only 50 per cent, a layer of varves may have escaped detection.

The depth to the bedrock has been calculated, and is shown on Plates 9 to 11.

Table 8 shows a comparison between the depth to the bedrock obtained from drilling and seismic data, together with the type of bedrock (from drilling).

TABLE 8

Drill hole No.	Direction	Depth to solid rock (from drilling)	Depth to Bedrock (seismic)	Bedrock velocity	Bedrock type
5802	Vertical	81 ft	86 ft	17000	tillite
5803	Vertical	104	45	10000	tillite
5804	Vertical	26	22	16000	schist
5805	Vertical	27	38	16000	schist
5808	Vertical	60	55	14000	mudstone
5809	Vertical	54	48	15000	schist

6.3 Conclusions

The geophysical survey provided information on the depth to bedrock on the Lemonthyme penstock line. The overburden consists of soil, scree material, gravel, and weathered rocks, and its maximum thickness is 101 ft, near station 135. The bedrock consists of unweathered quartz-mica schist or tillite with high seismic velocity.

7. REFERENCES

HEILAND, C.A. 1946 GEOPHYSICAL PROSPECTING Prentice Hall Inc., New York

PATERSON, S.J. 1959 Unpublished maps. Hydro-Electric Commission, Tasmania.

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

SPRY, A.H. 1958 Precambrian rocks of Tasmania; Part 3 - Mersey Forth Area. Pap. roy. Soc. Tasm. 92, 117-137.

REFERENCE

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

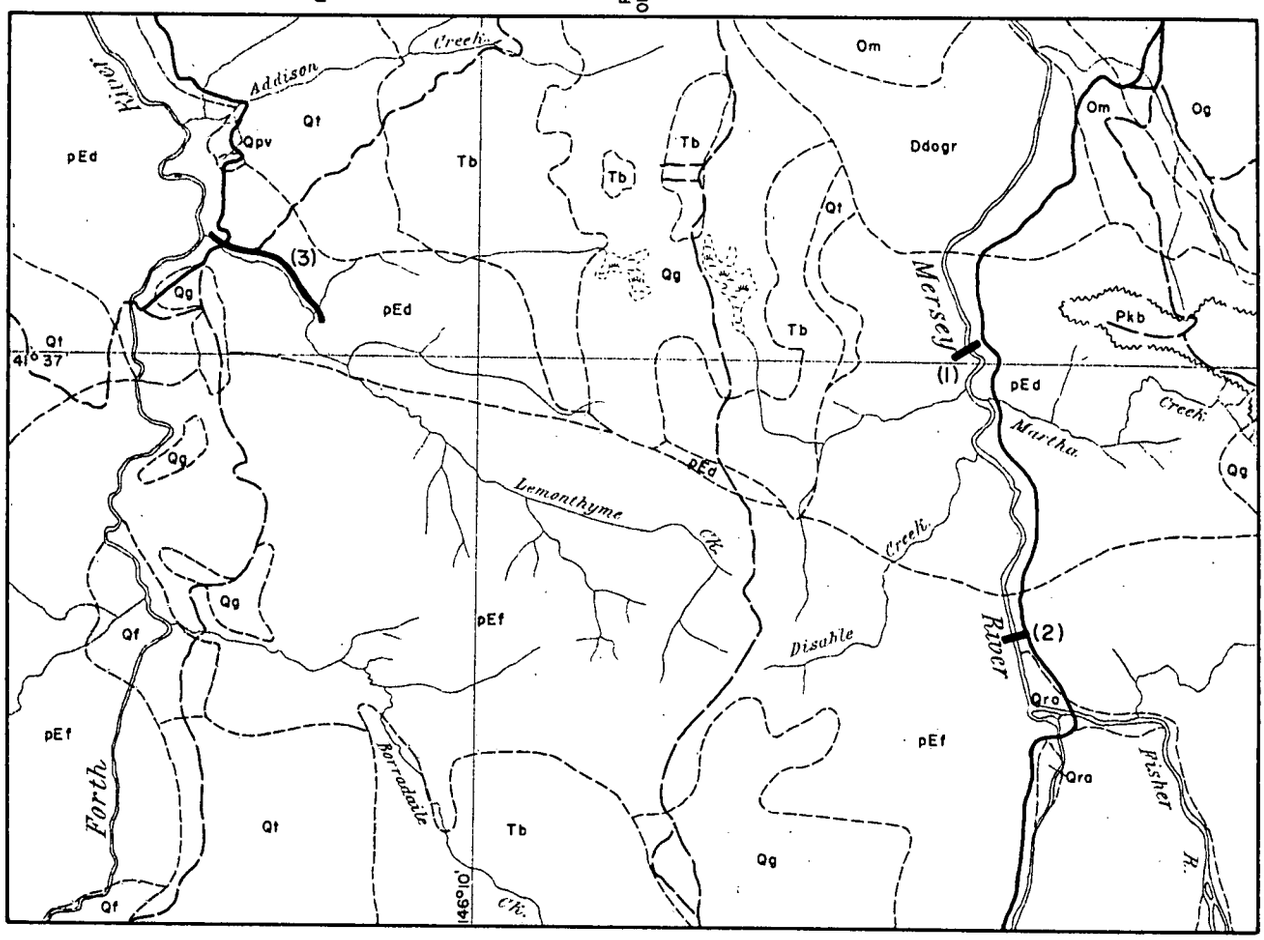
Tb — TERTIARY basalt

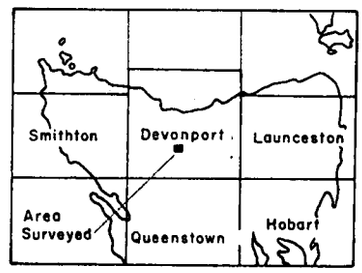
Palaeozoic PERMIAN
- Pkb — Kansas Creek beds

Palaeozoic ORDOVICIAN DEVONIAN
- Ddogr — Dove granite
- Og — Gordon limestone

Palaeozoic ORDOVICIAN
- Om — Moina Sandstone

Pre-Cambrian
- pEd — Dove group
- pEf — Fisher group





(1) Martha Creek Dam Site
(2) Below Fisher Dam Site
(3) Lemonthyme Penstock Line

REFERENCE TO AUSTRALIAN 4-MILE MILITARY MAP SERIES

UPPER MERSEY-FORTH POWER SCHEME
GEOPHYSICAL SURVEY, TASMANIA, 1960

GEOLOGICAL AND LOCALITY MAP

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

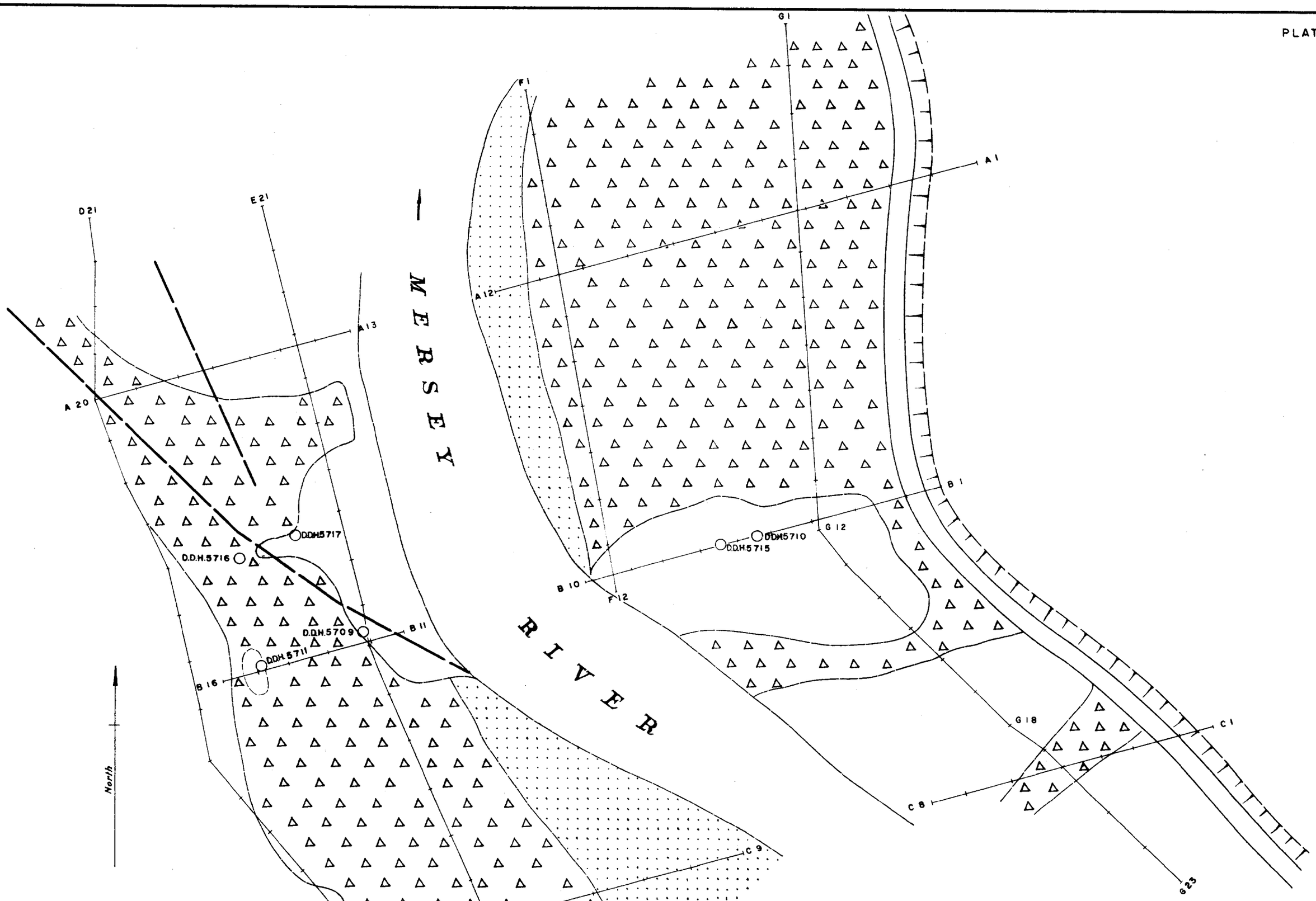
SCALE IN MILES

1 0 1 2 3

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G368 - 2

To Accompany Records 1961, No. 29

PLATE 2



LEGEND:

- GEOPHYSICAL TRAVERSE
- FAULT
- D.D.H.5711 DRILLHOLE
- RIVER GRAVEL
- TALUS
- QUARTZ-MICA SCHIST

MARTHA CREEK DAM SITE

GEOLOGY AND GEOPHYSICAL TRAVERSES

GEOLOGY AFTER S.T. PATERSON

FEET

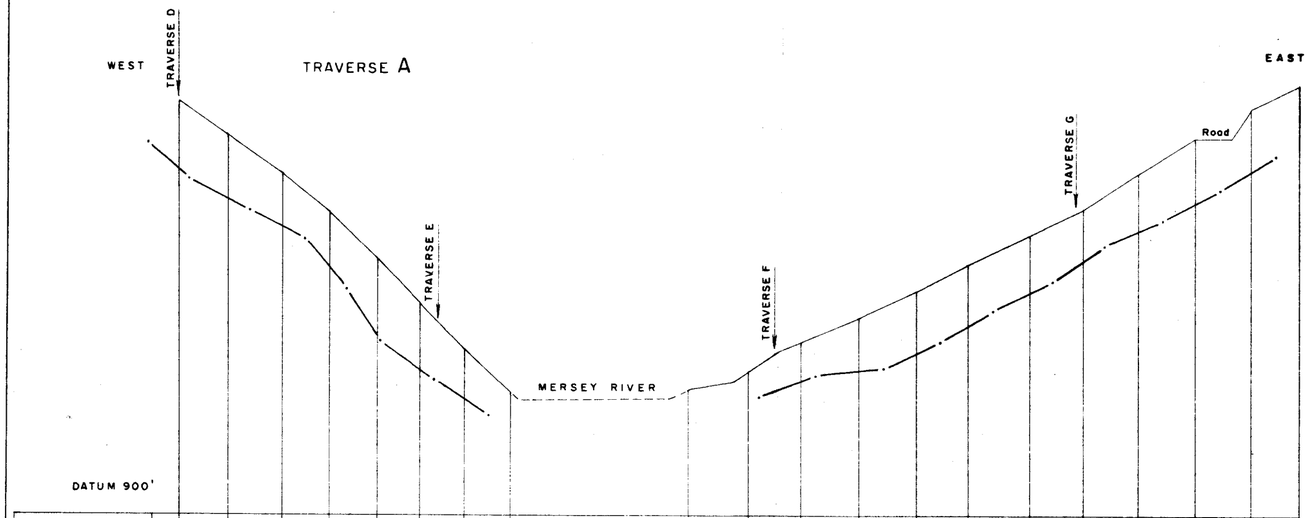
100 0 100 200 300

After H.E.C. Map A7468

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G368-1

To Accompany Records 1961, No 29

TRAVERSE A

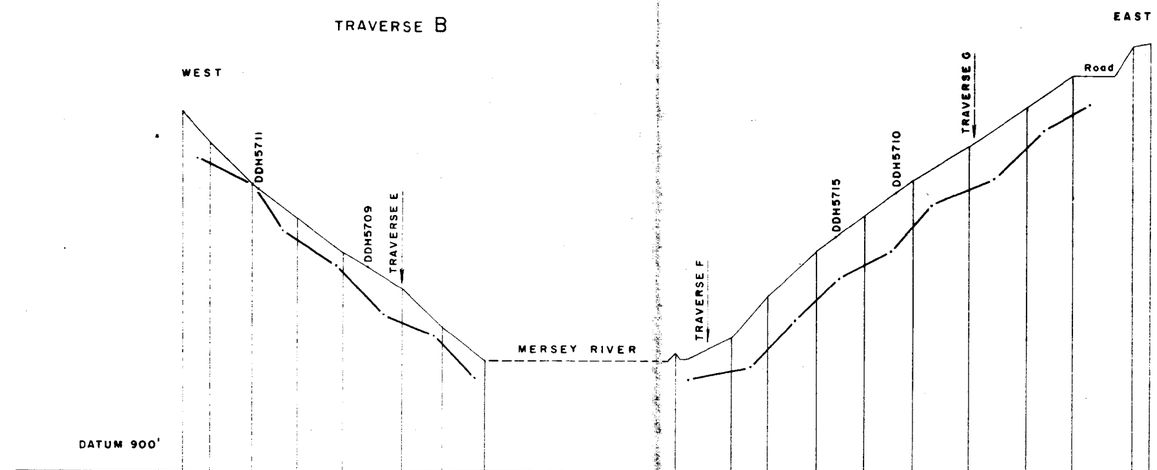


DATUM 900'

REDUCED LEVEL	1302·2		1274·2		1242·9		1213·6		1176·7		1140·9		1105·5		1070·2		1071·0		1034·3		1108·4		1127·7		1107·9
STATION	20		19		18		17		16		15		14		13		12		11		10		9		8
DEPTH TO BEDROCK	41		47		39		29		35		43		33		25				21		29		45		42

REDUCED LEVEL	1170·1		1193·4		1218·6		1243·8		1271·4		1292·8		1315·8												
STATION	7		6		5		4		3		2		1												
DEPTH TO BEDROCK	42		42		34		42		45		36														

TRAVERSE B

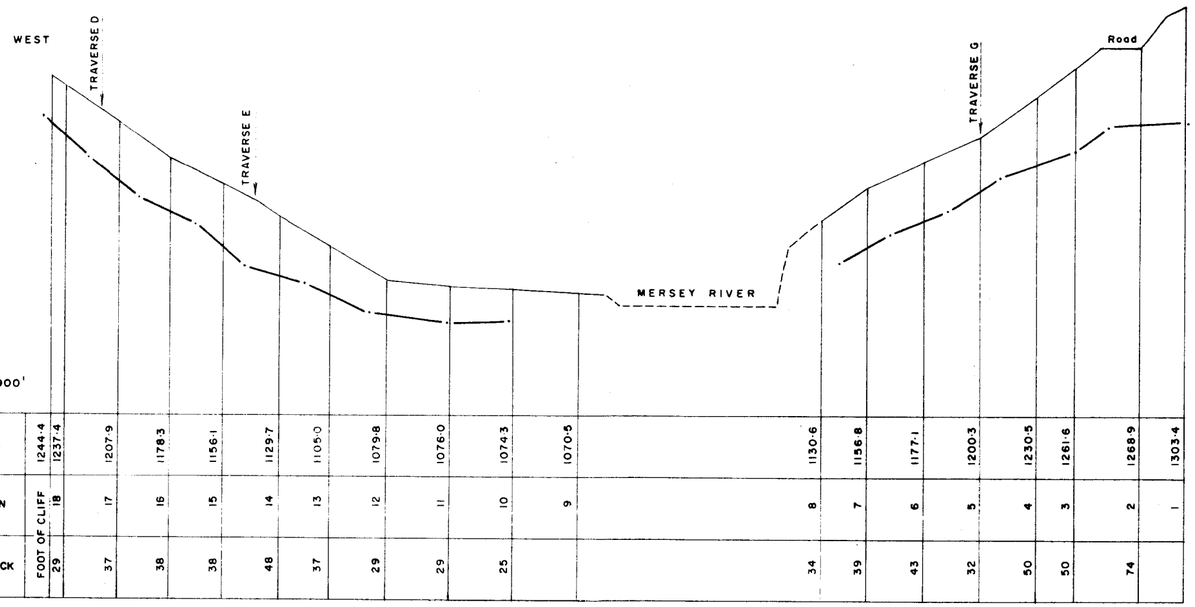


DATUM 900'

REDUCED LEVEL	1261·2		1237·0		1203·4		1176·7		1147·0		1123·1		1088·4		1061·1				1067·3		1079·0		1115·4		1408·7
STATION	17		16		15		14		13		12		11						10		9		8		7
DEPTH TO BEDROCK			16		10		16		12		10		24		26		24		8		16		27		29

REDUCED LEVEL	1177·9		1207·1		1233·7		1282·9		1291·8		1312·4														
STATION	6		5		4		3		2		1														
DEPTH TO BEDROCK	27		35		24		31		22		24														

TRAVERSE C



DATUM 900'

REDUCED LEVEL	1244·4	1237·4	1207·9		1178·3		1156·1		1129·7		1105·0		1079·8		1076·0		1074·3		1070·5				1130·6		1156·8
STATION	FOOT OF CLIFF 18		17		16		15		14		13		12		11		10		9				8		7
DEPTH TO BEDROCK	29		37		38		38		48		37		29		29		25						34		39

REDUCED LEVEL	1177·1		1200·3		1230·5		1261·6		1268·9		1303·4														
STATION	6		5		4		3		2		1														
DEPTH TO BEDROCK	43		32		50		50		74																

LEGEND

BEDROCK

13,000 SEISMIC VELOCITY

DEPTHS CALCULATED FROM BROADSIDE SHOTS

MARTHA CREEK DAM SITE

TRAVERSES A, B & C

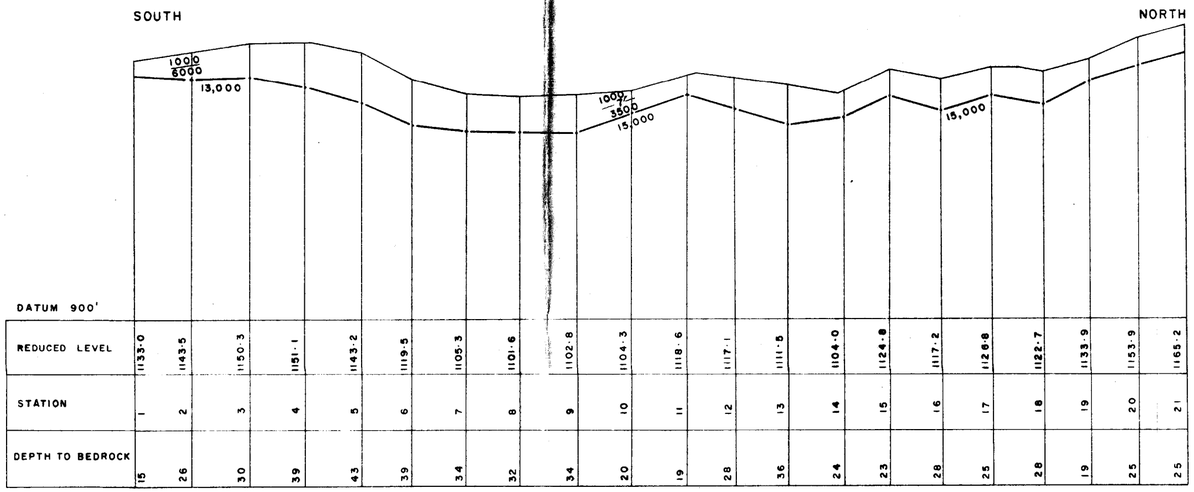
SCALE IN FEET

100 50 0 100 200

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 368·4

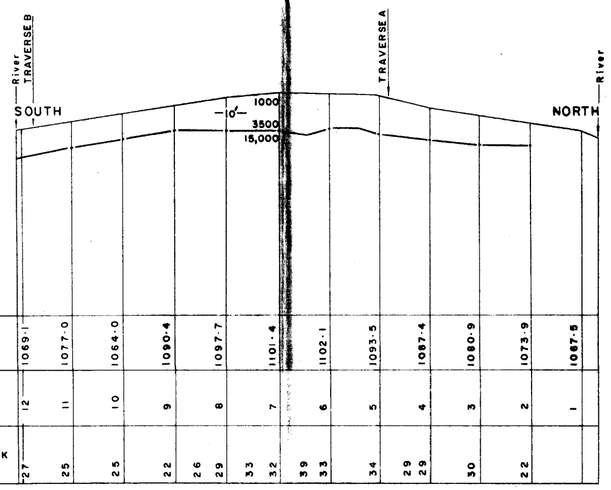
To Accompany Records 1961, No. 29

TRAVERSE E



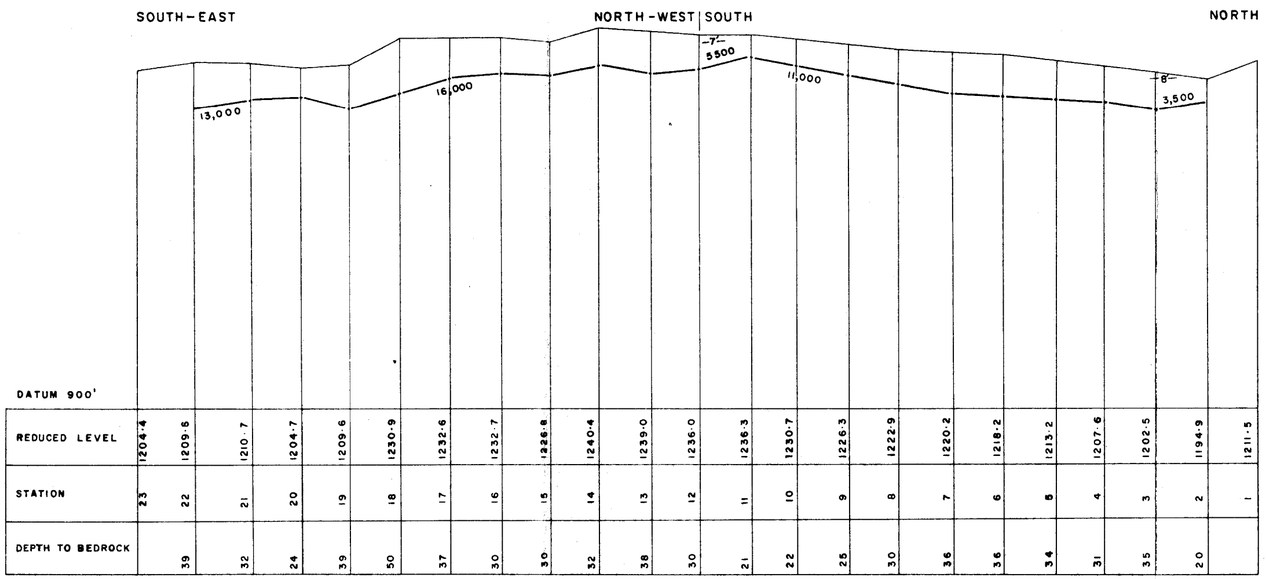
DATUM 900'																					
REDUCED LEVEL	1135·0	1143·5	1150·3	1151·1	1143·2	1119·5	1105·3	1101·6	1102·8	1104·3	1118·6	1117·1	1111·5	1104·0	1124·8	1117·2	1129·8	1122·7	1133·9	1153·9	1165·2
STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
DEPTH TO BEDROCK	15	26	30	39	43	39	34	32	34	20	19	28	36	24	23	28	25	28	19	25	25

TRAVERSE F



DATUM 900'											
REDUCED LEVEL	1069·1	1077·0	1064·0	1090·4	1097·7	1101·4	1102·1	1093·5	1087·4	1080·9	1073·9	1067·5
STATION	12	11	10	9	8	7	6	5	4	3	2	1
DEPTH TO BEDROCK	27	25	25	22	26	29	33	32	39	33	34	29	29	30	22	

TRAVERSE G



DATUM 900'																						
REDUCED LEVEL	1204·4	1209·6	1210·7	1204·7	1209·6	1230·9	1232·6	1232·7	1228·8	1240·4	1239·0	1236·0	1236·3	1230·7	1226·3	1222·9	1220·2	1218·2	1213·2	1207·6	1202·5	1194·9	1211·5
STATION	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
DEPTH TO BEDROCK	39	32	24	39	50	37	30	30	32	38	30	21	22	25	30	36	36	34	31	35	20		

15,000 SEISMIC VELOCITY (Ft./Sec.)

MARTHA CREEK DAM SITE

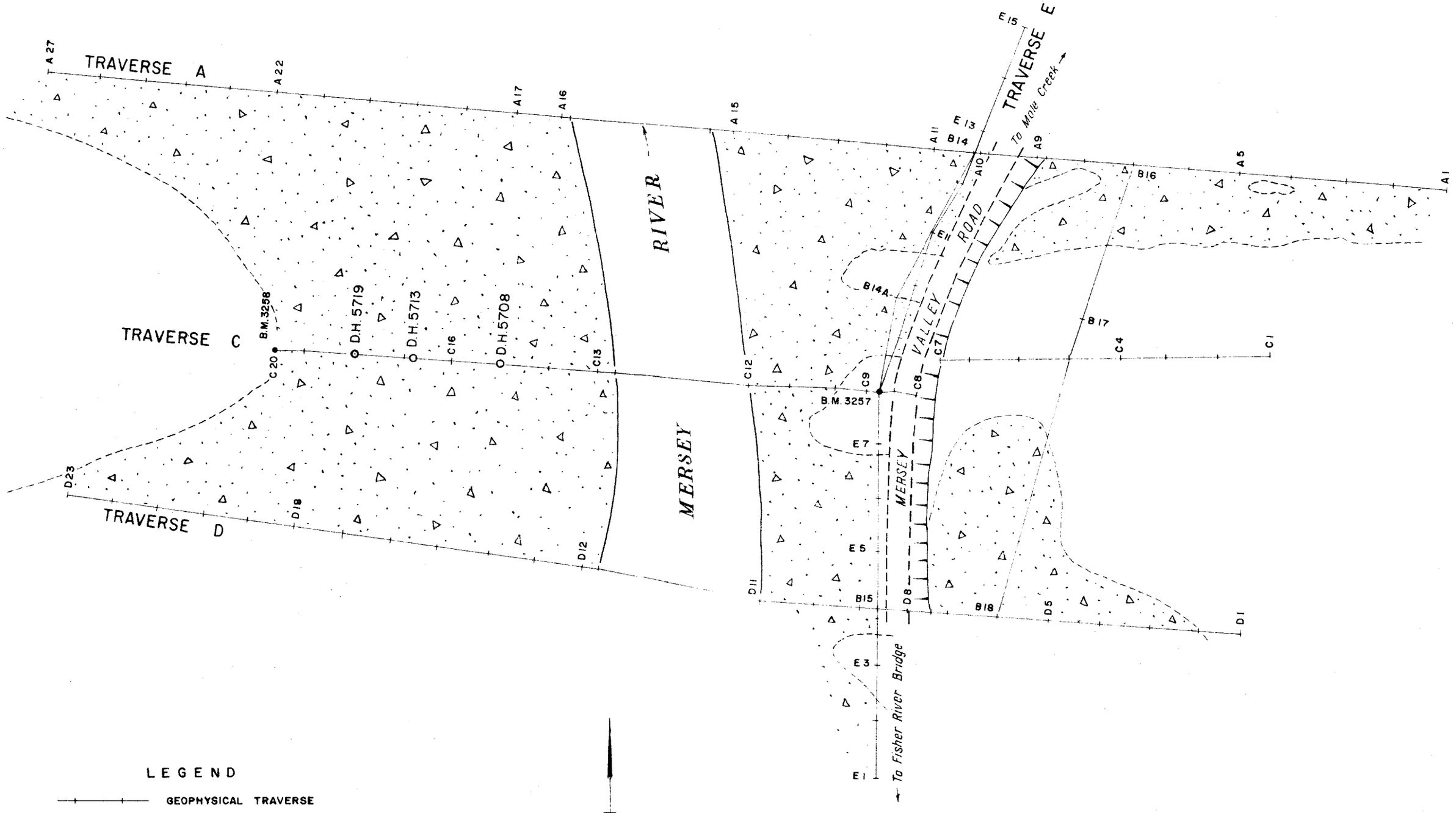
GEOPHYSICAL TRAVERSES E, F, G

SCALE IN FEET

100 0 100 200

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 368-3

To Accompany Records 1961, No. 29



"BELOW FISHER" DAM SITE
GEOLOGY AND GEOPHYSICAL TRAVERSES

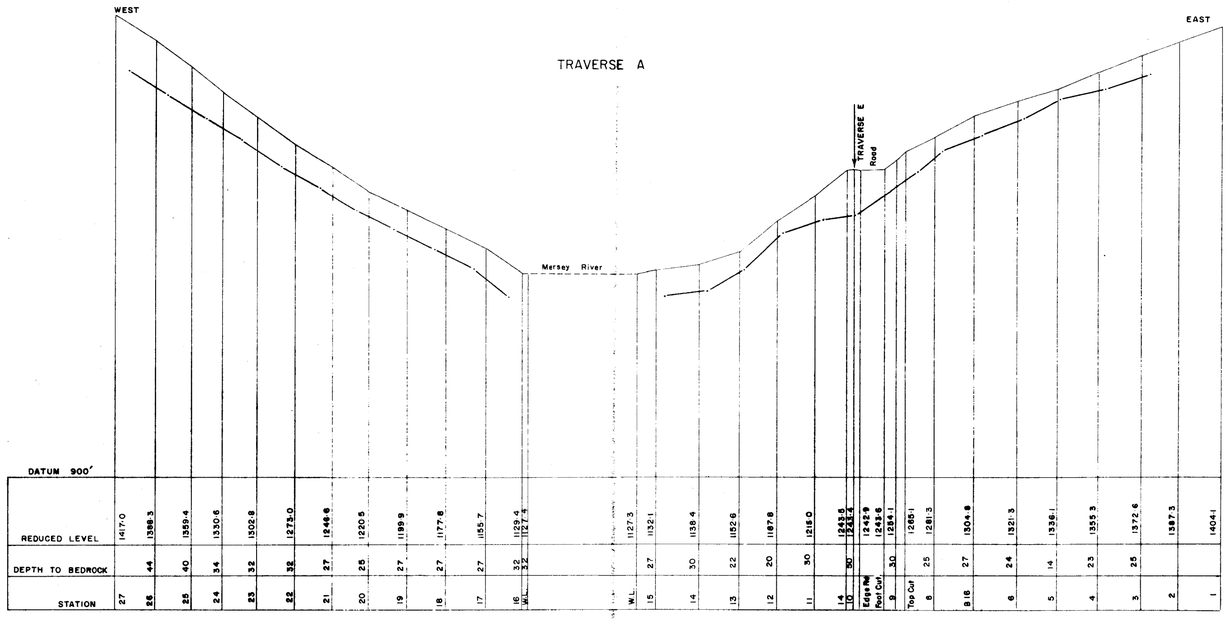
GEOLOGY AFTER S.T. PATERSON

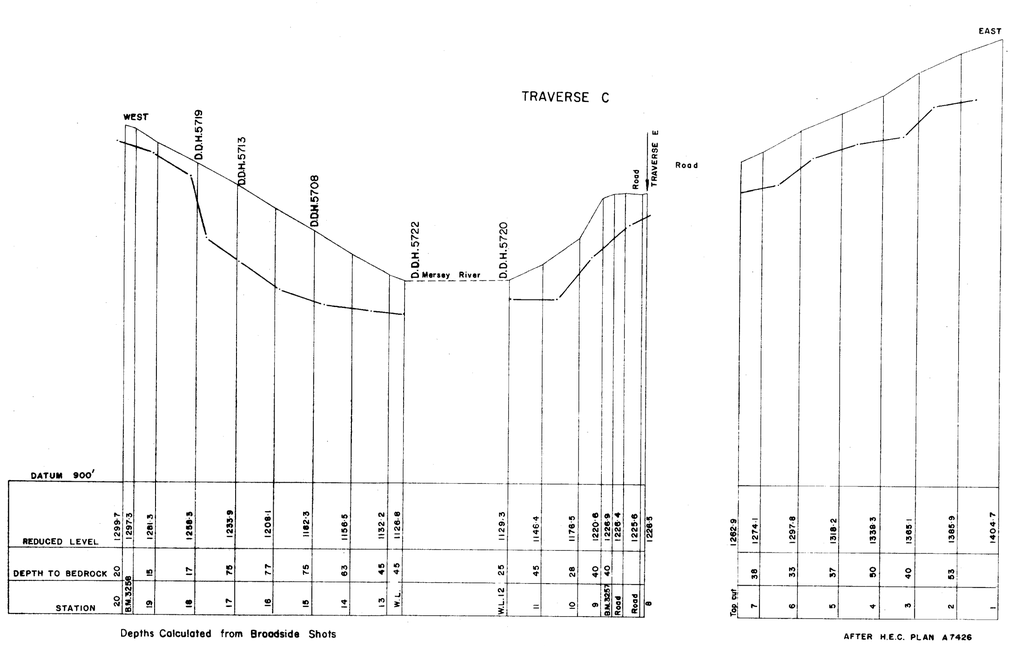
FEET
100 0 100 200 300

After H.E.C. Map A 7532

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 368 – 5

To Accompany Records 1961, No 29





LEGEND

——·——·—— BEDROCK

13,000 SEISMIC VELOCITY (ft./sec.)

"BELOW FISHER" DAM SITE
TRAVERSES A AND C

SCALE IN FEET

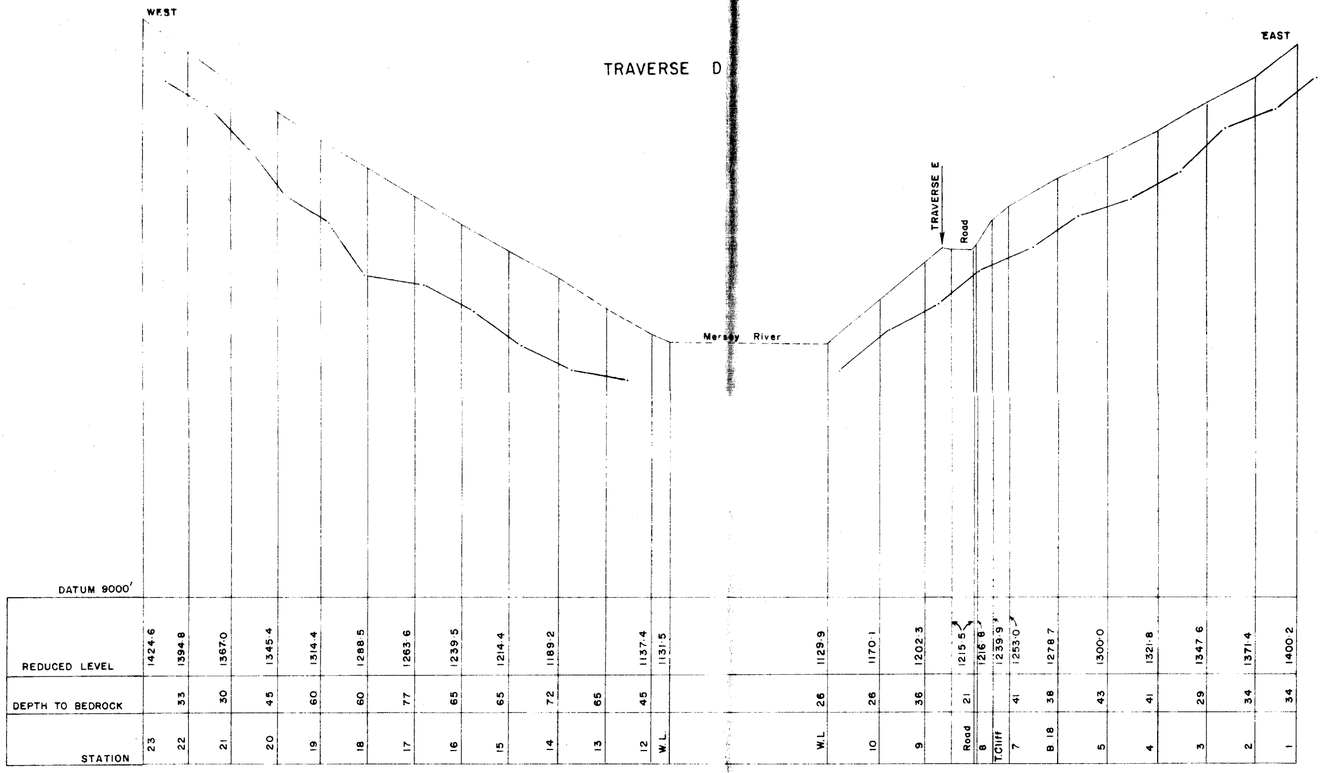
100 0 100 200 300

UPPER MERSEY, TAS.

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 368 - 6

To Accompany Records 1961, No 29

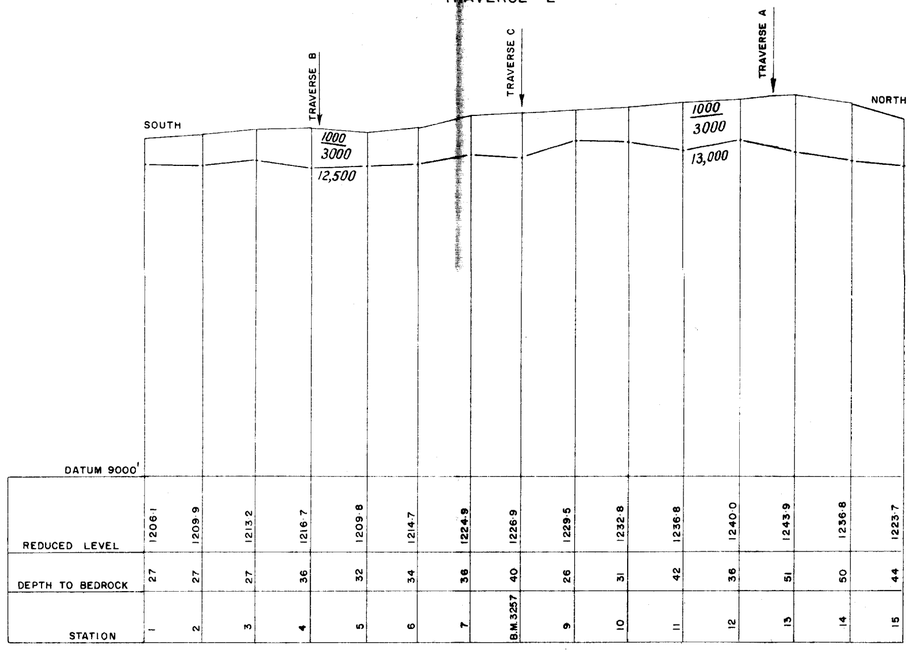
TRAVERSE D



DEPTHS CALCULATED FROM BROADSIDE SHOT

AFTER H.E.C. PLAN A 7427

TRAVERSE E



AFTER H.E.C. PLAN A 7428

"BELOW FISHER" DAM SITE
TRAVERSES D AND E

LEGEND

BEDROCK

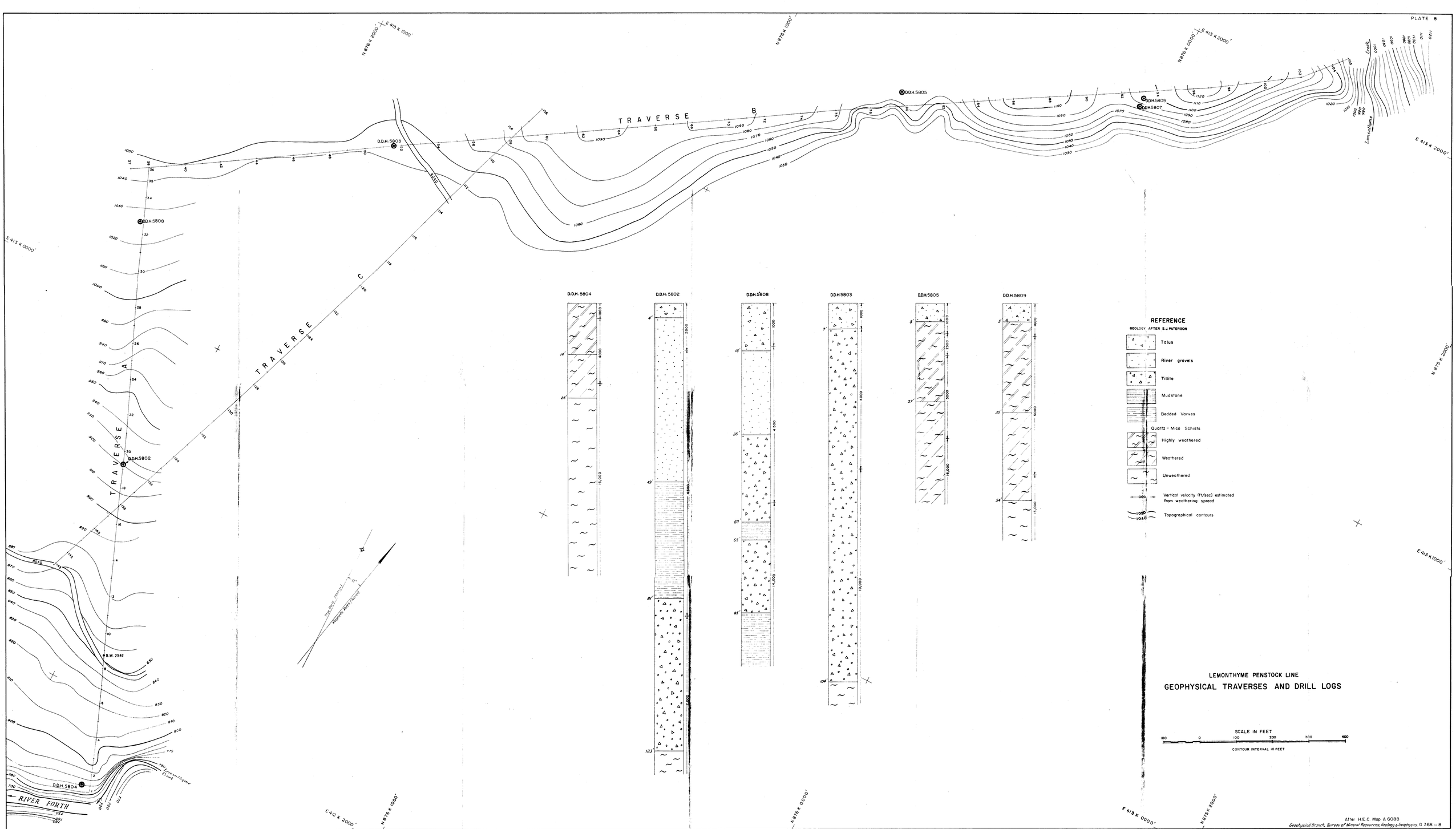
13,000 SEISMIC VELOCITY (ft./sec.)

SCALE IN FEET

100 50 0 100 200

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 368-7

To Accompany Records 1961, No. 29



REFERENCE

GEOLOGY AFTER S.J. PATERSON

- Talus
- River gravels
- Tillite
- Mudstone
- Bedded Varves
- Quartz - Mica Schists
- Highly weathered
- Weathered
- Unweathered
- 1000 — Vertical velocity (ft/sec) estimated from weathering spread
- 1050 / 1040 — Topographical contours

LEMONTHYME PENSTOCK LINE
GEOPHYSICAL TRAVERSES AND DRILL LOGS

SCALE IN FEET

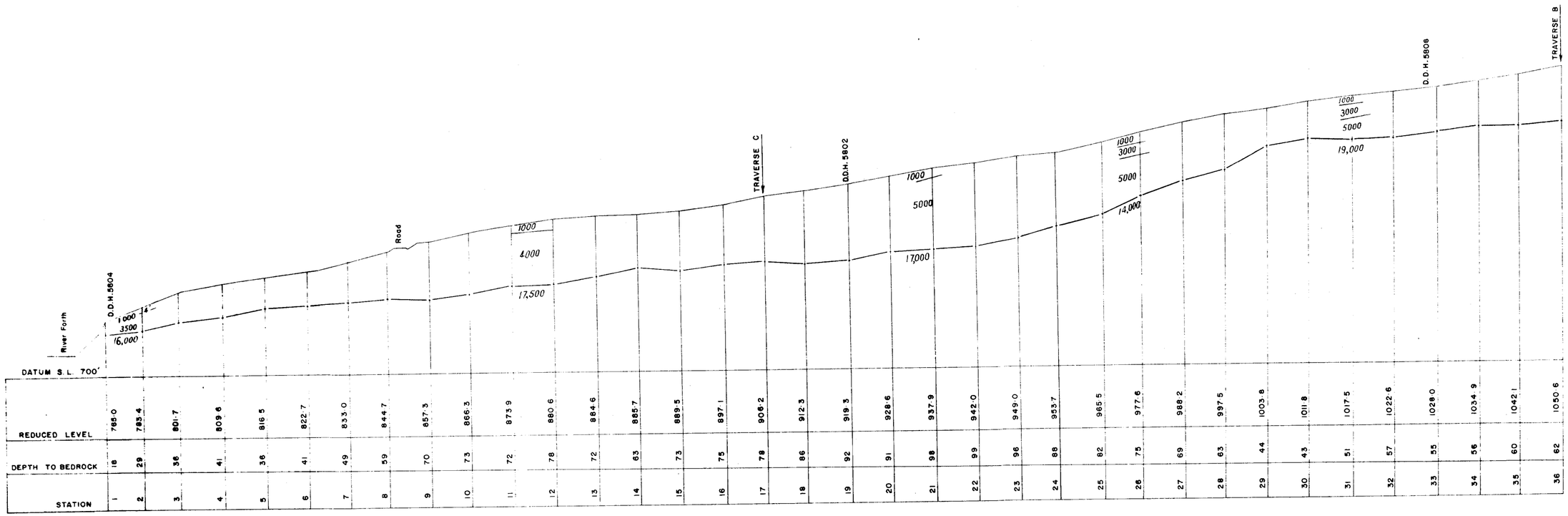
100 0 100 200 300 400

CONTOUR INTERVAL 10 FEET

After H.E.C. Map A 6088

Geophysical Branch, Bureau of Mineral Resources, Geology & Geophysics G 368 – 8

To Accompany Records 1961, No 23



DATUM S.L. 700'

STATION	REDUCED LEVEL	DEPTH TO BEDROCK
1	785.0	18
2	783.4	29
3	801.7	38
4	809.6	41
5	816.5	36
6	822.7	41
7	833.0	49
8	844.7	59
9	857.3	70
10	866.3	73
11	873.9	72
12	880.6	78
13	884.6	72
14	885.7	63
15	889.5	73
16	897.1	75
17	906.2	78
18	912.3	86
19	919.3	92
20	928.6	91
21	937.9	98
22	942.0	99
23	949.0	96
24	953.7	88
25	965.5	82
26	977.6	75
27	988.2	69
28	997.5	63
29	1003.8	44
30	1011.8	43
31	1017.5	51
32	1022.6	57
33	1028.0	55
34	1034.9	56
35	1042.1	60
36	1050.6	82

LEGEND

BEDROCK

19000 SEISMIC VELOCITY (ft./sec.)

LEMONTHYME PENSTOCK LINE
TRAVERSE A

SCALE IN FEET

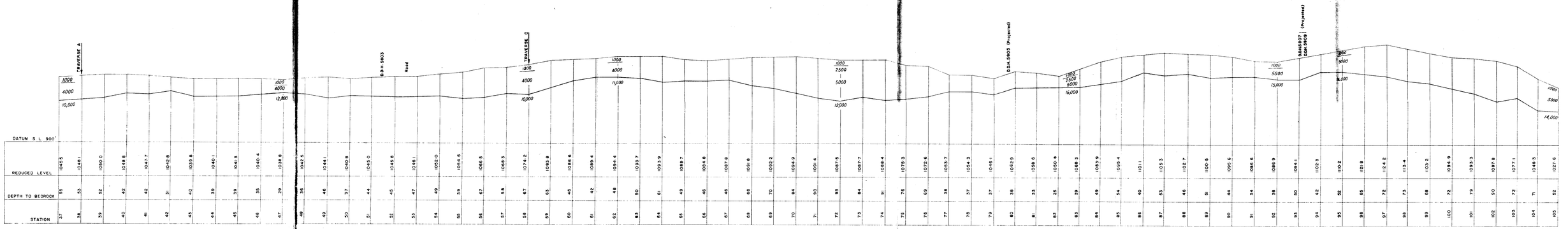
100 0 100 200 300

AFTER H.E.C. DWG. A 7749

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 368-9

To Accompany Records 1961, No 29

UPPER MERSEY, TAS.



LEGEND

BEDROCK

12,000 SEISMIC VELOCITY (ft./sec.)

LEMONTHYME PENSTOCK LINE
TRAVERSE B

SCALE IN FEET

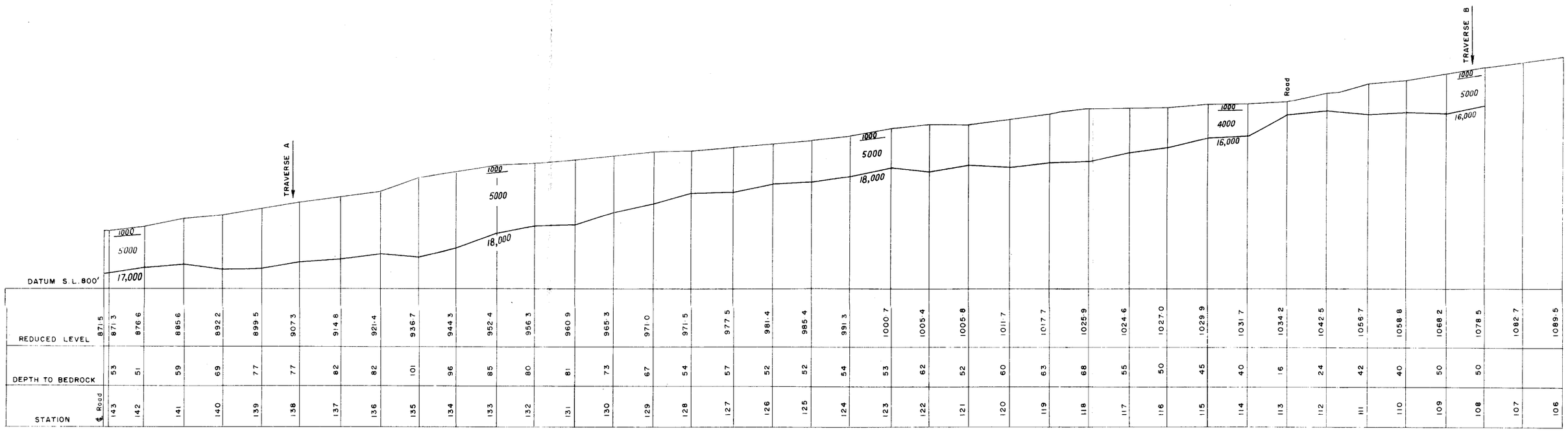
100 0 100 200 300

AFTER H.E.C. PLAN A7750

Geological Branch, Bureau of Mineral Resources, Geology and Geophysics. G 368 - 10

To Accompany Records 1961, No 29

PLATE II



STATION	REDUCED LEVEL	DEPTH TO BEDROCK
℄ Road	871.5	
143	871.3	53
142	876.6	51
141	885.6	59
140	892.2	69
139	899.5	77
138	907.3	77
137	914.8	82
136	921.4	82
135	936.7	101
134	944.3	96
133	952.4	85
132	956.3	80
131	960.9	81
130	965.3	73
129	971.0	67
128	971.5	54
127	977.5	57
126	981.4	52
125	985.4	52
124	991.3	54
123	1000.7	53
122	1005.4	62
121	1005.8	52
120	1011.7	60
119	1017.7	63
118	1025.9	68
117	1024.6	55
116	1027.0	50
115	1029.9	45
114	1031.7	40
113	1034.2	16
112	1042.5	24
111	1056.7	42
110	1058.8	40
109	1068.2	50
108	1078.5	50
107	1082.7	
106	1089.5	

LEGEND

BEDROCK

17,000 SEISMIC VELOCITY (ft./sec.)

LEMONTHYME PENSTOCK LINE
TRAVERSE C

SCALE IN FEET

100 0 100 200 300

AFTER H.E.C. DWNG. A 7752

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 368 - 11

To Accompany Records 1961, No 29