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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1962/69

WILD RIVER/MILLSTREAM DAM SITE, GEOPHYSICAL SURVEY, QUEENSLAND 1960

by

W.A. Wiebenga and E.J. Polak

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SUMMARY

This Record describes a geophysical survey at a dam site which was undertaken in response to an application from the Irrigation and Water Supply Commission of Queensland. The dam will be used for water conservation.

The seismic method was used to measure the seismic velocities in different rock types and to determine the depth to rock discontinuities; some magnetic and resistivity work was done to determine the boundaries of a basalt flow, and to disclose the presence of shear zones.

Diamond drilling is recommended at several locations to check the geophysical results and to investigate whether rock formations in which the seismic velocity is lower than in the deepest refractor, could be used for dam foundations.

1. INTRODUCTION

The Irrigation and Water Supply Commission of Queensland is investigating a site for a dam close to the junction of the Wild River and The Millstream near Mount Garnet, Queensland. The dam is to be used for water conservation and flood mitigation. In response to the Commission's request, the Bureau of Mineral Resources, Geology and Geophysics carried out a geophysical survey to determine the type of bedrock and depth to bedrock at a site which covered both streams. The site is referred to as the 174.0M/2.5M Wild River/Millstream dam site; its approximate co-ordinates are 318781 on the Atherton sheet of the Australia four-mile series.

A preliminary geological investigation of the dam site has been carried out by the Commission.

The Bureau's geophysical party consisted of P.E. Mann (party leader), D.J. Harwood (geophysicist), and J.P. Pigott (geophysical assistant). Four field assistants were supplied by the Commission. Field work at the site lasted from the 3rd August to the 25th August 1960.

The Commission carried out the topographical survey of the site and provided gelignite, detonators, additional transport, and some supplies for the party.

2. GEOLOGY

A geological map is shown on Plate 1.

The dam site is located just above the junction of Wild River and The Millstream. The geology of the area has been described by Dunlop (1960).

The basement rock consists of a coarse-grained, pink, jointed granite and aplite (a fine-grained granitic rock in which quartz predominates). Granite forms the hill on the right* bank of the Wild River; the hill on the left bank of The Millstream consists of aplite.

Tertiary basalt, overlying the granitic basement, forms the narrow plateau separating the Wild River and The Millstream. The slopes of the plateau are covered by basalt blocks and boulders, generally less than 9 in. in diameter. The basalt has a blocky fracture, is slightly vesicular, and occasionally shows columnar jointing.

High-level alluvial terraces of gravel, sand, silt, and clay are at the base of both banks of the Wild River; the left-bank terrace, which is 370 ft wide, commences abruptly with a steep face 25 ft high. Smaller, low-level terraces, 50 to 100 ft wide, border the Wild River stream beds.

At The Millstream, high-level alluvial terraces are found up to 50 ft above stream level and the left-bank terrace is over 200 ft wide.

Stream beds of both rivers consist of alluvium. Eluvial hill-wash material covers the slopes.

* looking down-stream.

3. METHODS AND EQUIPMENT

Seismic

General descriptions of the seismic refraction methods are outlined by Polak and Mann (1959), and Heiland (1946, p. 522).

The seismic equipment used on the survey was a 12-channel portable seismograph, which was designed for shallow seismic reflection and refraction work and manufactured by the Midwestern Geophysical Laboratory of Tulsa, Oklahoma, and geophones with natural frequency of about 20 c/s to record the vertical motion of the ground.

The following types of geophone spread, based on the 'method of differences', were applied:

(a) Normal spreads - the geophones were spaced 50 ft apart in a straight line and shots were fired 50 ft and 200 ft beyond each end of, and in line with, the spread.

(b) Weathering spreads - these spreads were used to obtain the seismic velocity and thickness of the soil and near-surface layers. The geophone interval was 10 ft and shots were fired at distances of 10, 50, and 200 ft beyond each end of, and in line with, the spread.

On several traverses a shot was placed in the centre of a normal spread to provide additional information about the seismic velocity and thickness of the near-surface layers.

Past experience has shown that depth determinations in this type of terrain are probably not better than within 20 per cent.

Resistivity

In the resistivity method (Heiland, 1946, p. 741; Wiebenga, 1955) an electric current is applied to the ground through two current electrodes and the potential difference is measured between two additional electrodes which are located between the two current electrodes. The ratio of the measured potential to the applied current is a measure of the ground resistivity. In the Wenner configuration the electrodes are equally spaced. The depth of current penetration is of the same order as the electrode spacing. If the electrode arrangement as a whole is moved along a traverse, lateral resistivity variations are recorded.

Resistivity variations from place to place may be caused by variations in rock porosityand in salinity of pore solutions. Hence resistivity variations may be correlated with variations in rock type; e.g. geological formation boundaries and shear zones may be indicated. On this survey, resistivity traversing with electrode spacing of 50 and 100 ft was used to indicate and confirm the presence of shear zones and geological formation boundaries.

Magnetic

The magnetic method (Heiland, 1946, p. 334) depends on the susceptibility contrast between geological formations, and should therefore provide a means of disclosing discontinuities between formations carrying different amounts of magnetic minerals. Magnetic methods may be used to estimate the depth to basement rock and to indicate the presence of dykes, orebodies, shear zones, basalt flows, etc.

Usually the vertical magnetic intensity is measured. The instrument used on this survey was a Watts variometer. The magnetic method, when used alone, is rarely adequate, but in combination with other geophysical methods, it will often render valuable information.

On this survey, magnetic work was done along Traverse XX to indicate the boundaries of the basalt flow.

4. RESULTS

Plate 1 shows the locality plan and the geology of the dam site, Plate 2 the traverse plan with topographical contours and bedrock velocities, and Plates 3, 4, and 5 the seismic profiles. Vertical magnetic intensity and resistivity profiles for Traverse XX are also shown on Plate 3.

Seismic Velocities

Table 1 was prepared from available geological information, recorded velocities, and general experience. Together with the available geological information, Table 1 may be used to interpret the seismic velocities in geological terms. Sometimes this interpretation may be ambiguous. For instance, a layer with a seismic velocity of 13,000 ft/sec could be either vesicular basalt or weathered granite. A layer with a velocity of 5000 ft/sec could be either very weathered granite or river-terrace material.

TABLE 1

Seismic velocity (ft/sec)	Rock type
1000 to 2000	Soil
2000 to 3000	Eluvium, hill-wash material; unconsolidated, near-surface sediments, un-saturated; clays.
3000 to 4000	Very weathered or decomposed igneous rocks; water-saturated alluvial sediments, predominantly clay.
4000 to 6000	Very weathered igneous rocks; water-saturated alluvial sediments or river-terrace material.
6000 to 10,000	Weathered, jointed, fractured, or sheared igneous rocks.
10,000 to 13,000	Vesicular basalt; jointed, fractured, or sheared, slightly weathered igneous rocks.
13,000 to 16,000	Jointed or fractured igneous rocks.
16,000 to 18,000	Unweathered igneous rocks.

Traverses XX, F, G, H, and J (Plates 3 and 5)

The following discussions of the geophysical results are given to assist interpretation of the cross-sections and profiles. Only points which may lead to ambiguous interpretation will be mentioned.

Between XX2 and XX27 the 10,400-ft/sec layer probably is slightly weathered granite; the 5000-ft/sec layer probably is water-saturated river-terrace material.

Between XX27 and XX34, the 12,000-ft/sec bedrock probably is fractured or sheared granite and not a remnant of basalt. If it were basalt, the magnetic profile would not be so smooth. The 5000-ft/sec layer probably is river-terrace material, but it could be very weathered igneous rock.

Between XX43 and XX68 the 11,000 to 13,000-ft/sec layer is interpreted as vesicular basalt as suggested by the geological report. This interpretation is confirmed by many irregular changes on the magnetic profile. The width of the basalt as suggested by the magnetic profile (approximately XX35 to XX75) is larger than that suggested by the seismic work. This can be explained by assuming that erosion caused basalt boulders to cover the sides of the basalt ridge. The 5000-ft/sec layer probably is very weathered basalt. The seismic results indicate that contacts between basalt and granite are near XX43 and XX68. Between XX68 and XX103 (near The Millstream) the bedrock probably consists of unweathered granitic rocks with a shear or fault zone between XX85 and XX87. The 8000 to 10,500-ft/sec layer most probably is a weathered or slightly weathered granitic rock, and not basalt, because the magnetic profile is relatively smooth. The 4000 to 6000-ft/sec layers may be either river-terrace material, alluvium, or very weathered material.

South of The Millstream, between XX108 and XX159, the 5000-ft/sec layer may be either river-terrace material or very weathered igneous rock; further south and on higher ground the 4000 to 7000-ft/sec material probably is weathered igneous rock. Bedrock profiles or bedrock velocities suggest the presence of shear zones between XX115 and XX118, between XX135 and XX137, between XX149 and XX152, and between XX171 and XX177.

According to the geological plan, the southern end of Traverse XX is on aplite. However, because aplitic and granitic rocks are very similar and belong to the same family, seismic velocities cannot be used to determine the boundary between these two rock types. Between XX187 and XX202 the seismic data suggest the presence of a high-velocity layer (18,000 ft/sec) at about 240 ft depth.

Traverses R and K (Plates 4 and 5)

According to the geological plan, Traverses R and K are located on basalt except for the part between R122 and R160.

Between R7 and R46, most of the 11,000 to 13,500-ft/sec velocity layer probably consists of basalt, the 9000-ft/sec layer of jointed basalt, and the 5000-ft/sec layer of weathered basalt.

Farther north-east, e.g. between R70 and R94, the intermediate layer with 7000 to 10,000-ft/sec velocity may be jointed basalt, overlying higher-velocity granitic rocks. The profile along Traverse K may be explained in the same way.

Between R94 and R101 the seismic velocity in bedrock (11,500-ft/sec) is considerably lower than in the neighbouring area. This suggests the presence of a shear zone in the elongation of a valley, marked by the 2150-ft contour line (see Plates 1 and 2).

Other shear zones are suggested between R112 and R122, between R127 and R132, and between R143 and R145.

5. CONCLUSIONS AND RECOMMENDATIONS

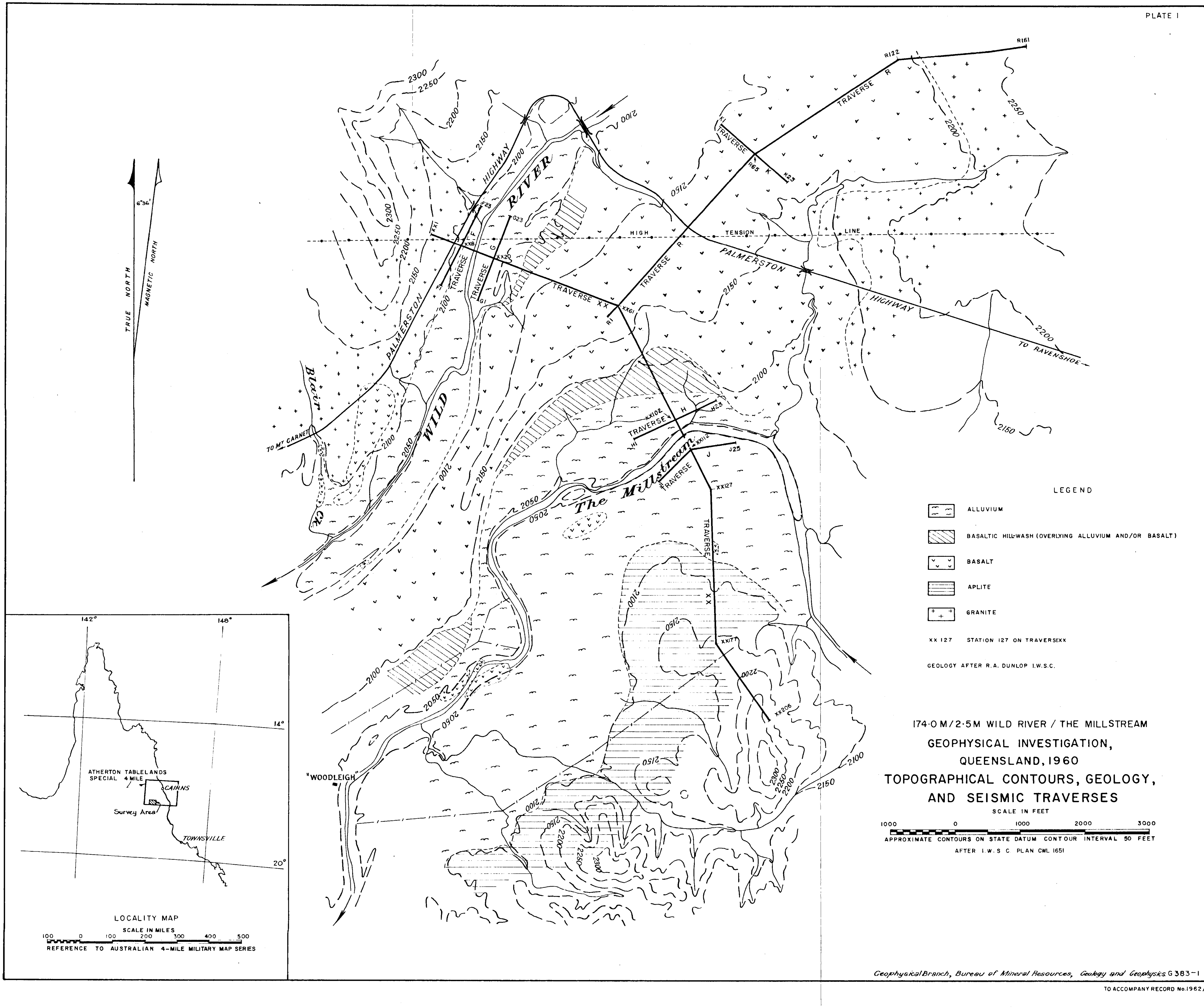
With the exception of the area between XX186 and XX202, the deepest refractor detected has been called bedrock. However, it may be possible to use a shallower refractor as a foundation rock. Seismic velocity can be used as an indicator of rock strength: in general, the higher the velocity the stronger the rock. In many places weaker rocks in which the seismic velocity will be lower than in unweathered rock, may still serve as good foundation rocks, depending on the design requirements and engineering techniques used. Therefore, the velocities of the rock layers above the deepest refractor (bedrock) are shown on the cross-sections wherever possible. For instance, a rock of 10,000-ft/sec velocity may be suitable for foundations, but this should be checked by drilling and laboratory tests. Several diamond-drill holes are recommended to check the results of the geophysical survey and to provide cores for the laboratory investigation of some relevant rock properties. Table 2 shows the location of these drill holes and the information it is expected the holes would provide.

TABLE 2

Location Drill Hole	Information expected from drill hole
XX 173	Depth and quality of faulted or sheared bedrock.
XX 150	Depth and quality of the 12,000-ft/sec layer.
XX 116	Quality of the 12,000-ft/sec layer and presence of fault or shear zone.
XX 87	Depth and properties of the 6000 and 10,500-ft/sec layers, and the presence of shear or fault zone.
XX 31	Quality of the 7200-ft/sec layer, and the fractured or sheared bedrock.
R 113	Depth and quality of the 9000-ft/sec bedrock.
R 129	Depth and quality of the 7000-ft/sec bedrock.
R 53	Depth and quality of the 8000 and 11,000-ft/sec layers.
R 97	Quality of the 11,500-ft/sec bedrock and the presence of shear or fault zones.

6. REFERENCES

DUNLOP, R.A.	1960	Wild River/Millstream 174.0M/2.5M dam site. Memo to the Senior Planning Engineer, Irrigation and Water Supply Commission, Queensland.
HEILAND, C.A.	1946	GEOPHYSICAL EXPLORATION. Prentice Hall, New York.
POLAK, E.J. and MANN, P.E.	1959	A seismic survey at the Moogerah dam site near Kalbar, Q'ld. Bur. Min. Resour. Aust. Record 1959/62.
WIEBENGA, W.A.	1955	Geophysical investigations of water deposits, Western Australia. Bur. Min. Resour. Aust. Bull. 30, pp. 4 - 7.



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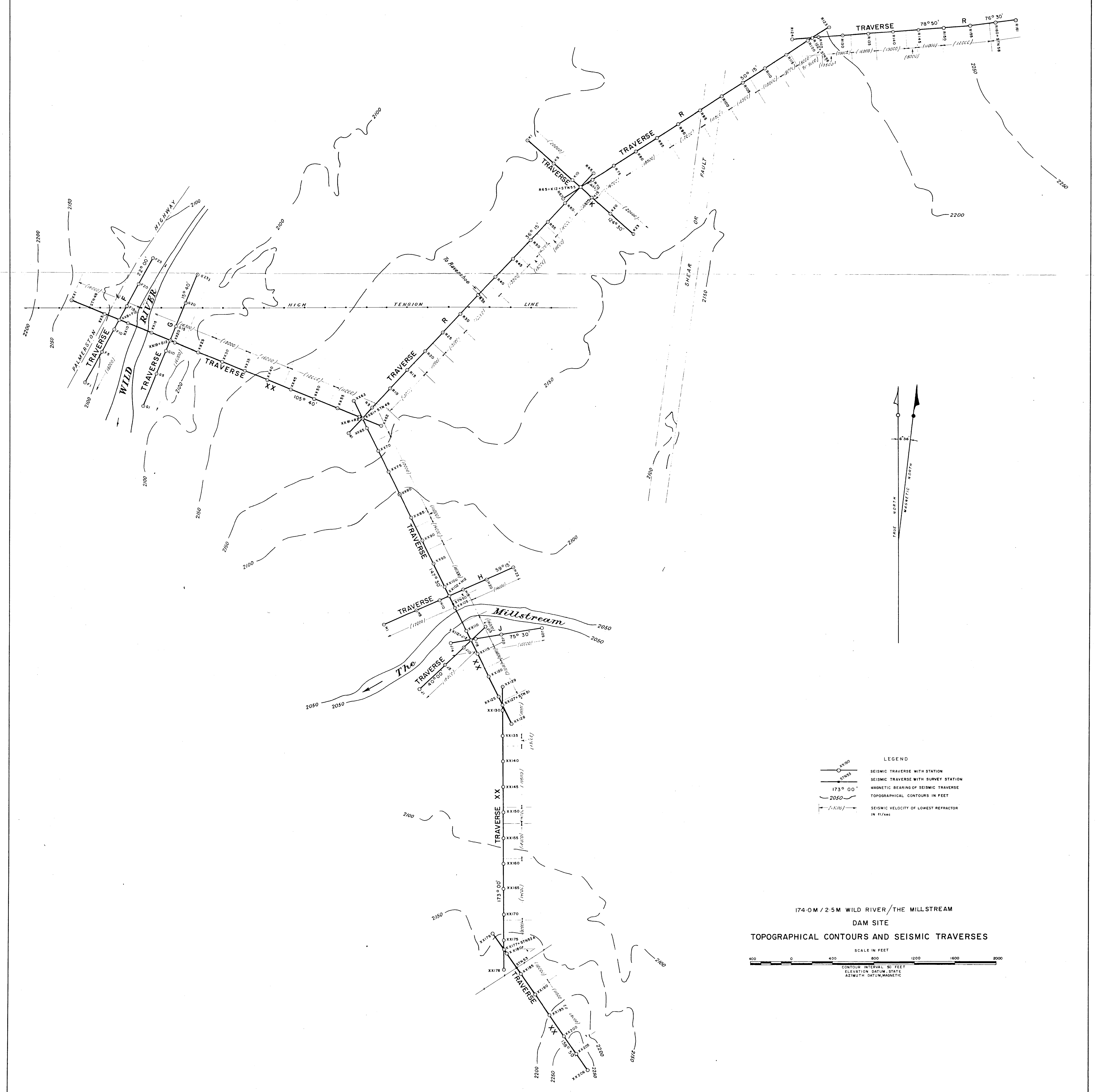

174·0M / 2·5M WILD RIVER / THE MILLSTREAM

DAM SITE

TOPOGRAPHICAL CONTOURS AND SEISMIC TRAVERSES

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PLATE 3
N.W.
SE.
APPARENT RESISTIVITY OHM. METRE
VERTICAL MAGNETIC INTENSITY, GAMMAS
ELEVATION, FT
MAGNETIC
RESISTIVITY Electrode spacing 100 ft
RESISTIVITY: Electrode spacing 50 ft
Wild Riv. W.L. 2057'
High-level terrace
The Millstream W.L. 2051'
BASE LINE
Electrode spacing 50 ft
Electrode spacing 100 ft
STATION NUMBER
STATION ELEVATION
DEPTH TO BEDROCK
TRAVERSE XX
LEGEND
(15,000) FORMATION WITH SEISMIC VELOCITY 15,000 FT/SEC.
—15' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY
I.P. Trav. H INTERSECTION POINT
UNWEATHERED BEDROCK BOUNDARY
RESISTIVITY TRAVERSING 50' ELECTRODE SPACING
" " 100' " "
VERTICAL MAGNETIC INTENSITY PROFILE
174·0M/2·5M. WILD RIVER / THE MILLSTREAM
TRAVERSE XX
SECTIONS SHOWING DEPTH TO UNWEATHERED BEDROCK, APPARENT RESISTIVITY AND VERTICAL MAGNETIC INTENSITY PROFILES
HORIZONTAL AND VERTICAL SCALES IN FEET
ELEVATIONS IN FEET ABOVE STATE DATUM
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 383-3
TO ACCOMPANY RECORD No. 1962/69

STATION NUMBER	STATION ELEVATION	DEPTH TO BEDROCK
1	2168	
2	2169	
3	2169	
4	2169	
5	2170	97
6	2170	98
7	2170	93
8	2170	96
9	2170	88
10	2171	86
11	2171	82
12	2172	83
13	2172	88
14	2172	83
15	2172	85
16	2172	90
17	2172	95
18	2172	110
19	2172	93
20	2171	85
21	2172	93
22	2172	90
23	2172	97
24	2172	93
25	2172	93
26	2172	98
27	2171	104
28	2172	106
29	2171	101
30	2170	95
31	2170	95
32	2170	86
33	2169	88
34	2169	85
35	2168	86
36	2169	95
37	2168	88
38	2169	
39	2169	108
40	2168	93
41	2168	104
42	2168	88
43	2167	88
44	2167	87
45	2167	95
46	2168	
47	2168	112
48	2169	117
49	2169	120
50	2168	118
51	2167	126
52	2167	126

STATION NUMBER	STATION ELEVATION	DEPTH TO BEDROCK
52	2167	126
53	2165	130
54	2164	126
55	2164	129
56	2163	129
57	2162	127
58	2161	108
59	2161	112
60	2161	112
61	2160	104
62	2160	90
63	2160	
64 65	2161 2161	
68	2162	
69	2163	
70	2163	73
71	2164	74
72	2164	82
73	2165	84
74	2165	91
75	2166	95
76	2166	90
77	2166	95
78	2167	101
79	2168	93
80	2168	95
81	2168	101
82	2168	101
83	2169	
84	2169	95
85	2169	95
86	2170	97
87	2170	100
88	2170	106
89	2169	98
90	2169	94
91	2169	
92	2169	86
93	2170	82
94	2170	67
95	2170	65
96	2171	56
97	2172	54
98	2172	66
99	2173	66
100	2174	79
101	2175	83
102	2176	90
103	2177	
104	2178	75
105	2179	73
106	2179	81
107	2181	86

STATION NUMBER	STATION ELEVATION	DEPTH TO BEDROCK
107	2181	86
108	2183	97
109	2184	86
110	2186	90
111	2187	95
112	2188	
113	2190	99
114	2191	66
115	2193	75
116	2194	61
117	2195	67
118	2196	84
119	2197	55
120	2198	48
121 122	2199 2199	51
125	2199	55
126	2200	58
127	2201	69
128	2202	77
129	2203	88
130	2204	84
131	2205	78
132	2207	67
133	2208	55
134	2210	49
135	2212	54
136	2214	52
137	2215	52
138	2217	59
139	2219	59
140	2221	62
141	2223	62
142	2225	67
143	2227	67
144	2229	76
145	2231	65
146	2233	67
147	2234	61
148	2236	68
149	2238	67
150	2239	63
151	2241	63
152	2242	63
153	2244	65
154	2245	63
155	2247	65
156	2248	57
157	2249	59
158	2251	68
159	2252	63
160	2253	
161	2258	

LEGEND

(11000) FORMATION WITH SEISMIC VELOCITY 11000 ft./sec.

45' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY

I.P. Trav. K INTERSECTION POINT

UNWEATHERED BEDROCK BOUNDARY

174·0 M/2·5 M WILD RIVER/THE MILLSTREAM

TRAVERSE R
CROSS-SECTIONS

HORIZONTAL AND VERTICAL SCALES IN FEET

100 50 0 100 200 300

ELEVATION IN FEET ABOVE STATE DATUM

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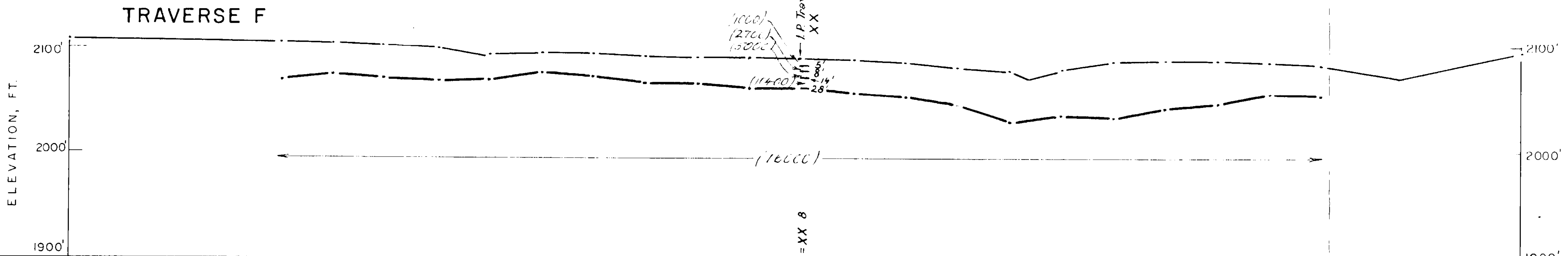
TO ACCOMPANY RECORD No. 1962/69

GEOPHYSICAL INVESTIGATION QUEENSLAND 1960

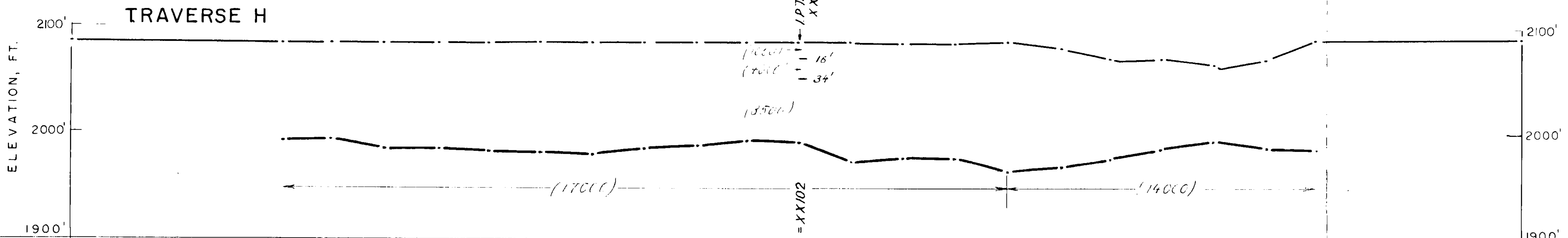
TRAVERSE F



STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
STATION ELEVATION	2106	2104	2103	2101	2098	2092	2094	2093	2091	2090	2090	2088	2087	2085	2081	2077	2077	2085	2086	2086	2085	2083	2094
DEPTH TO BEDROCK		35	30	32	30	24	18	18	24	24	26	28	30	30	34	46	40	52	44	40	26	28	

Station 12 = XX 8

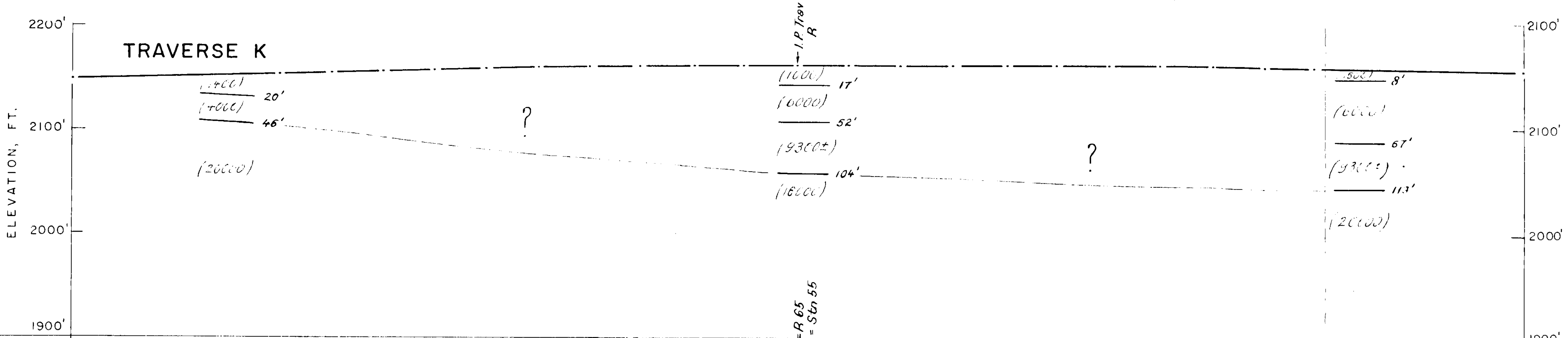
TRAVERSE H



STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
STATION ELEVATION	2085	2085	2085	2085	2085	2085	2085	2085	2086	2086	2086	2086	2086	2085	2085	2086	2080	2072	2071	2065	2070	2087	2089
DEPTH TO BEDROCK		95	95	102	102	104	104	106	102	100	98	96	114	108	108	122	114	96	89	74	83	104	

Station 12 = XX 102

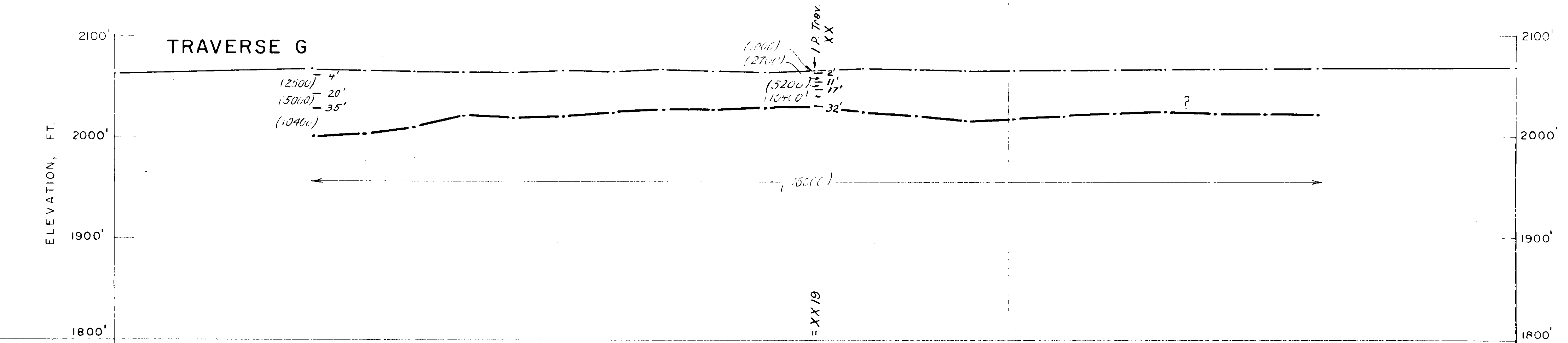
TRAVERSE K



STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
STATION ELEVATION	2147	2153	2155	2156	2157	2158	2159	2160	2160	2160	2161	2161	2161	2161	2161	2161	2161	2161	2161	2160	2159	2158	2154
DEPTH TO BEDROCK	NO ACCURATE DEPTH MEASUREMENT																						

Station 12 = R 65 = Stn 55

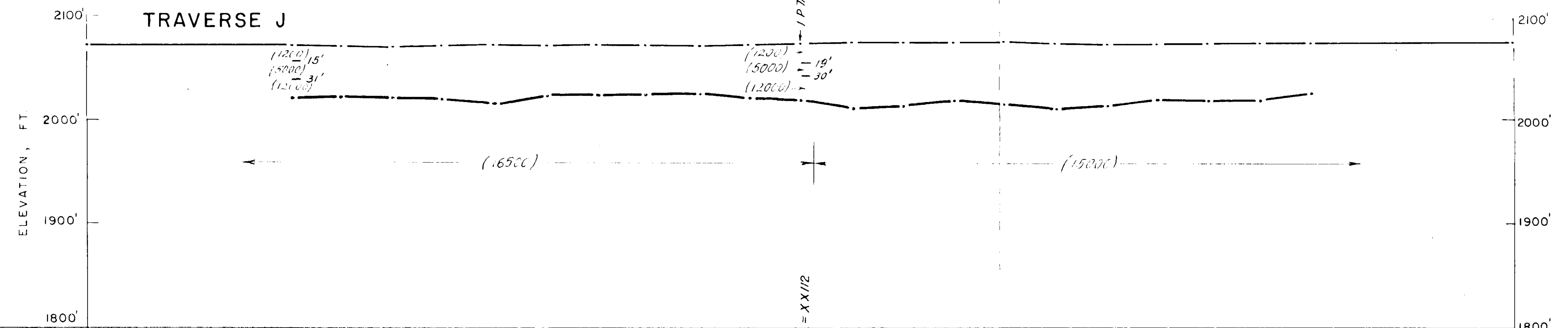
TRAVERSE G



STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
STATION ELEVATION	2061	2066	2064	2064	2063	2063	2064	2064	2065	2065	2064	2065	2066	2066	2065	2065	2066	2065	2066	2067	2066	2067	2068
DEPTH TO BEDROCK		64	61	53	42	45	43	39	38	37	32	32	43	44	48	46	42	42	39	42	44	44	

Station 12 = XX 19; I.P. Trav XX

TRAVERSE J



STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	15	16	17	18	19	20	21	22	23	24	25
STATION ELEVATION	2071	2071	2071	2070	2071	2071	2071	2072	2072	2071	2072	2074	2075	2074	2075	2075	2074	2074	2074	2074	2074	2074	2076
DEPTH TO BEDROCK		50	48	48	52	56	46	48	46	44	49	52	62	57	54	57	60	57	54	53	53	48	

Station 12 = XX 112

LEGEND

(20,000) FORMATION WITH SEISMIC VELOCITY 20,000 FT/SEC.
——— 37' DEPTH TO FORMATION WITH DIFFERENT SEISMIC VELOCITY
I.P. Trav XX INTERSECTION POINT
UNWEATHERED BEDROCK BOUNDARY

174·0M/2·5M. WILD RIVER / THE MILLSTREAM
TRAVERSES F, G, H, J AND K
CROSS-SECTIONS

HORIZONTAL AND VERTICAL SCALES IN FEET

100 0 100 200 300 400

ELEVATIONS IN FEET ABOVE STATE DATUM

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 383-5

TO ACCOMPANY RECORD No. 1962/69

Geophysical Investigations Q'land 1960