1988/09. Evaluation of a proposed quarry extension at East Ridgley

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Abstract

Proposed extensions to Brambles East Ridgley basalt quarry have been investigated by drilling several series of boreholes. The data obtained on thickness of soil-like materials and depth to fresh basalt has been contoured. The results of a previous seismic survey are presented as contours of depth to top of main refractor. Volume calculations have been made from the contoured diagrams. Reserves of 675 000 cubic metres of fresh basalt are indicated in an area of approximately 25 000 square metres. Some 151 000 cubic metres of stripping is required to expose the fresh basalt. The stripping is estimated to comprise 60% soil-like materials and 40% weathered basalt.

INTRODUCTION

This report presents the results of an investigation into a proposed quarry extension at Brambles Equipment Division's East Ridgley quarry.

The quarry is developed in Tertiary-age basalt which exhibits strong, mainly vertical, columnar cooling joints.

Preliminary investigation of the proposed quarry extension was undertaken by the Hydro-Electric Commission in November and December 1987. A seismic refraction survey indicated a strong velocity contrast between the main refractor (velocity 5520 m/s to 6130 m/s) and the overburden materials (velocity 400 m/s and 590 m/s to 690 m/s). The depth to the main refractor was interpreted to occur from 12.5 to 3.5 m below natural ground surface, but is mainly less than seven metres (Wilson, 1987).

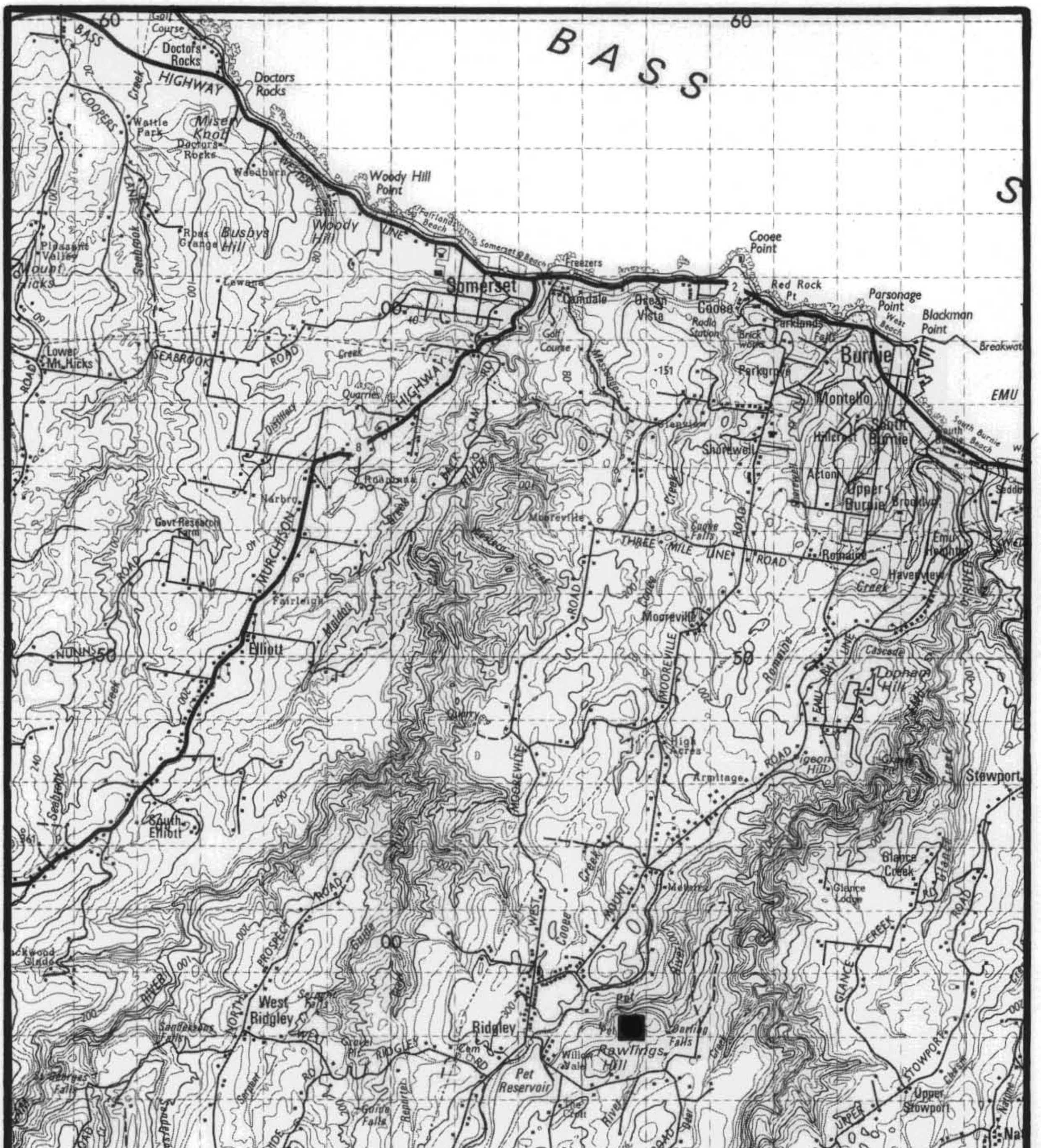
The present investigation involved drilling three series of boreholes. The first series was drilled to determine the thickness of the overburden materials and to provide data to confirm the seismic interpretation. The second series was to determine that the basalt extended to about 30 metres below natural ground level. The first and second series of boreholes were drilled with the hydraulic drill rig used for production pattern blasting. The third series of boreholes involved three diamond-drill holes drilled by a truck-mounted Longyear drill rig owned and operated by the Department of Mines. These diamond holes were made with a view to obtaining material for petrographic examination. This will allow some assessment of the quality of the material drilled through.

A series of boreholes had been drilled previously by the quarry operator using the hydraulic drill rig.

The location of the seismic survey transducers and the various boreholes is given in Figure 1.

SEISMIC SURVEY

The locations of the seismic transducers were surveyed and their positions plotted and digitized. The depth to the top of the main refractor was



Location of quarry site.

5 cm

scaled from the cross-sections provided in the HEC report (plan A2-5507). The surface of the top of the main refractor was then contoured using the General Purpose Gridding and Contouring suite of programmes (GPC) running on the Department of Mines Perkin Elmer mini-computer. The data used, and the results of the contouring, are presented in Appendix 1 and Figure 2 respectively.

OVERBURDEN DRILLING

The hydraulic drill rig employed by the quarry operators for production blasting was used to drill several boreholes about the perimeter of the existing quarry benches. The aim here was to determine if the rate of drilling and the dust and chips could be used to identify the soil-like materials, weathered basalt and fresh basalt. Direct comparisons were possible by measuring the depths to the various materials in the bench face. It was concluded that the drilling would enable the distinctions to be made.

The hydraulic drill rig was then used to drill adjacent to some of the HEC seismic transducer locations. In general the top of the refractor, as determined by the seismic survey, showed reasonable agreement with the depth recorded from the drilling to the top of the fresh basalt (fig. 3). There are locations where the seismic results over-estimate or under-estimate this interface. It was concluded that the seismic survey results provide a good first estimate to the depth of fresh basalt.

A pattern of boreholes was then made with the hydraulic drill rig. The operator recorded the thickness of soil-like materials (i.e. materials which should be capable of moving with either scrapers, grader or bulldozer blade) and the depth to the top of the fresh basalt. Fresh basalt was deemed to be encountered when the drill rate was constant and the colour of the dust and chip returns was consistently light to dark blue-grey over a depth exceeding 1.5 metres. It is noted that this is not a definitive measure on the top of the fresh basalt, as boulders, in excess of 1.5 m across, of fresh basalt with thin weathering skins (<5mm thick), have been obtained from the existing quarrying operations.

The material between the soil-like materials and the top of the fresh basalt (i.e. intermediate zone) is interpreted as weathered basalt. The drilling returns often indicated sound rock and then soil-like materials in this zone. This material is relatively thin and may have been "hidden" to the seismic interpretation thus accounting for the discrepancy between the seismic and drilling results. It is probable that this material will need to be moved by excavator or by scrapers after ripping.

The depth of the soil-like materials has also been contoured (fig. 4), as has the depth to the top of the rock as determined from the drilling (fig. 5).

DIAMOND-DRILL HOLES

Three diamond-drill holes were drilled to provide additional data points, as well as providing samples for petrographic examination. The results of this work will be reported seperately.

VOLUME DETERMINATIONS

It is possible, using the GPC suite of programmes, to determine the volume above (or below) a reference point or points. As the thickness of the soil, the depth to the fresh basalt, and the depth to the main refractor were contoured as depths below the surface (reference plane 0.0 m), it is possible to determine the volume of soil and intermediate rock which will need to be moved in order to expose the fresh basalt. In the case of the drilling results, the two materials can be distinguished, but they are combined for the seismic survey results. The area considered for these calculations is shown on Figure 1 and the results are given in Appendix 2.

It is estimated that the volume of stripping in the area outlined in Figure 1 (approximately 25 000 m^2) is 151 000 cubic metres. This is comprised of approximately 60% soil-like materials and 40% of intermediate zone materials. With a quarry floor at reduced level 66 m (local datum) and with vertical faces, some 675 000 m^3 of fresh basalt should be available for quarrying.

QUARRY EXTENSION

From the point of view of overburden stripping, it would appear that the quarry extension would be best made from the north-eastern corner of the site examined. Operations could then extend in a southerly direction, initially to the southern extremity of the area under consideration. The face could then be extended to the west, where the overburden thickness is greatest. By the time operations reach the area of greatest stripping, a second bench could be commenced from the original starting point. This pattern of expansion would also allow reasonable drainage of the pit. Environmental aspects, such as directing blasts towards the valley of the Pet River, need also to be considered.

REFERENCE

WILSON, D. R. 1987. Brambles Ridgley Quarry seismic survey. *Report Hydro-Electric Commission Tasmania*. 64-W-5.

[11 April 1988]

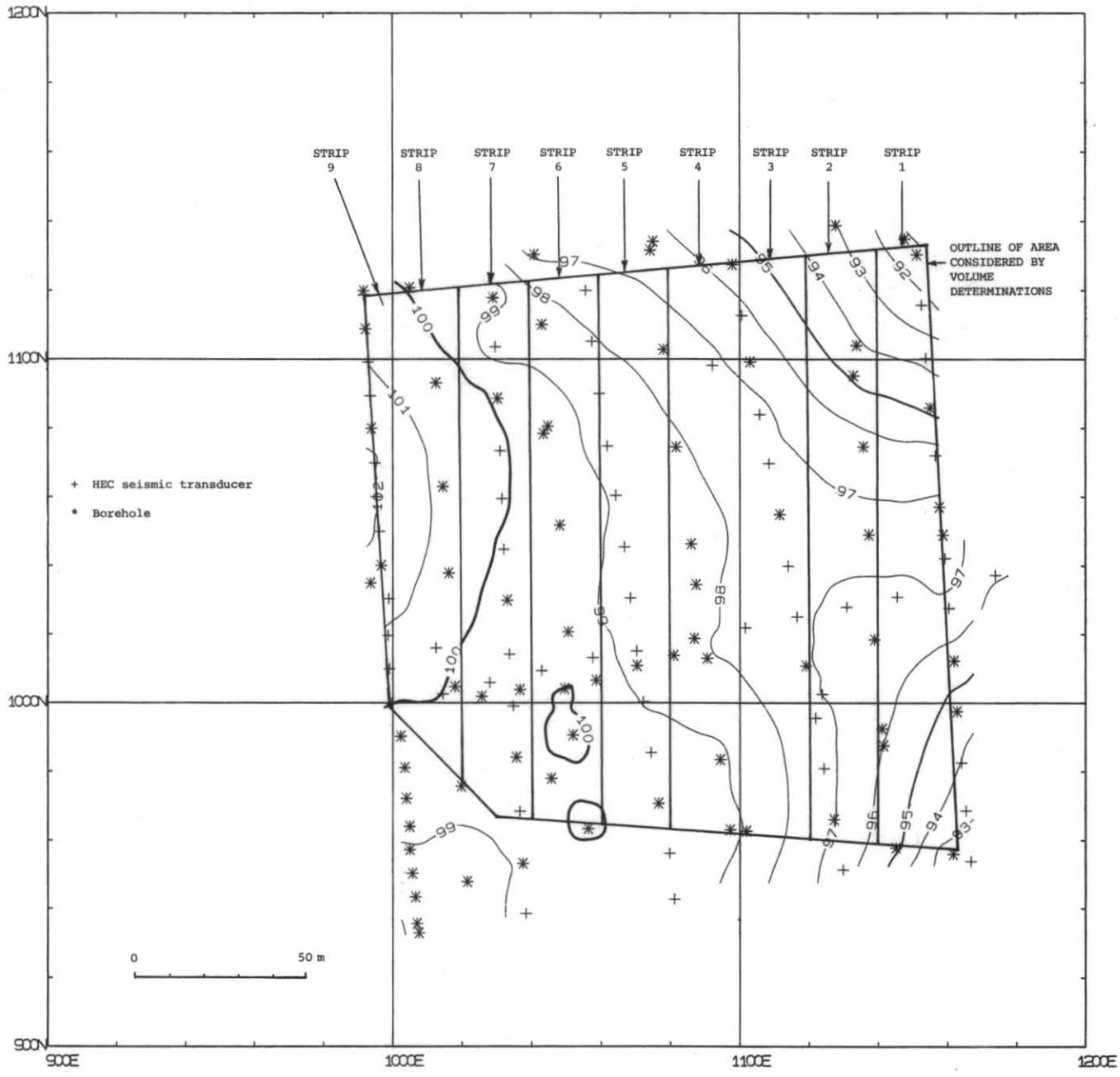


Figure 1. *Location diagram showing seismic transducers, drill holes, and strips (for volumetric calculation)*

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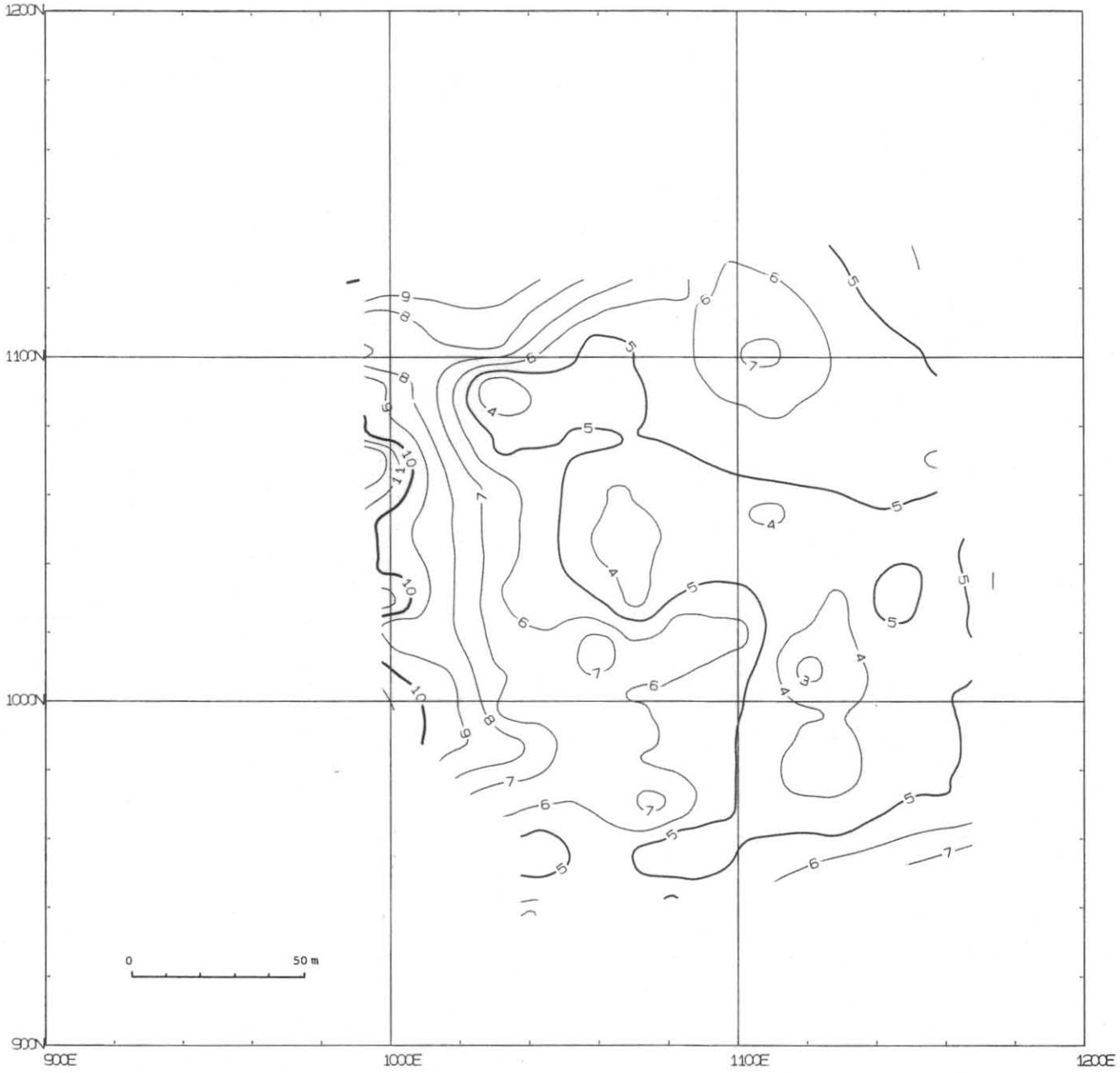

Figure 2. *Contoured depth to main seismic refractor. Depths derived from H.E.C. plan A2-5507*

5 cm

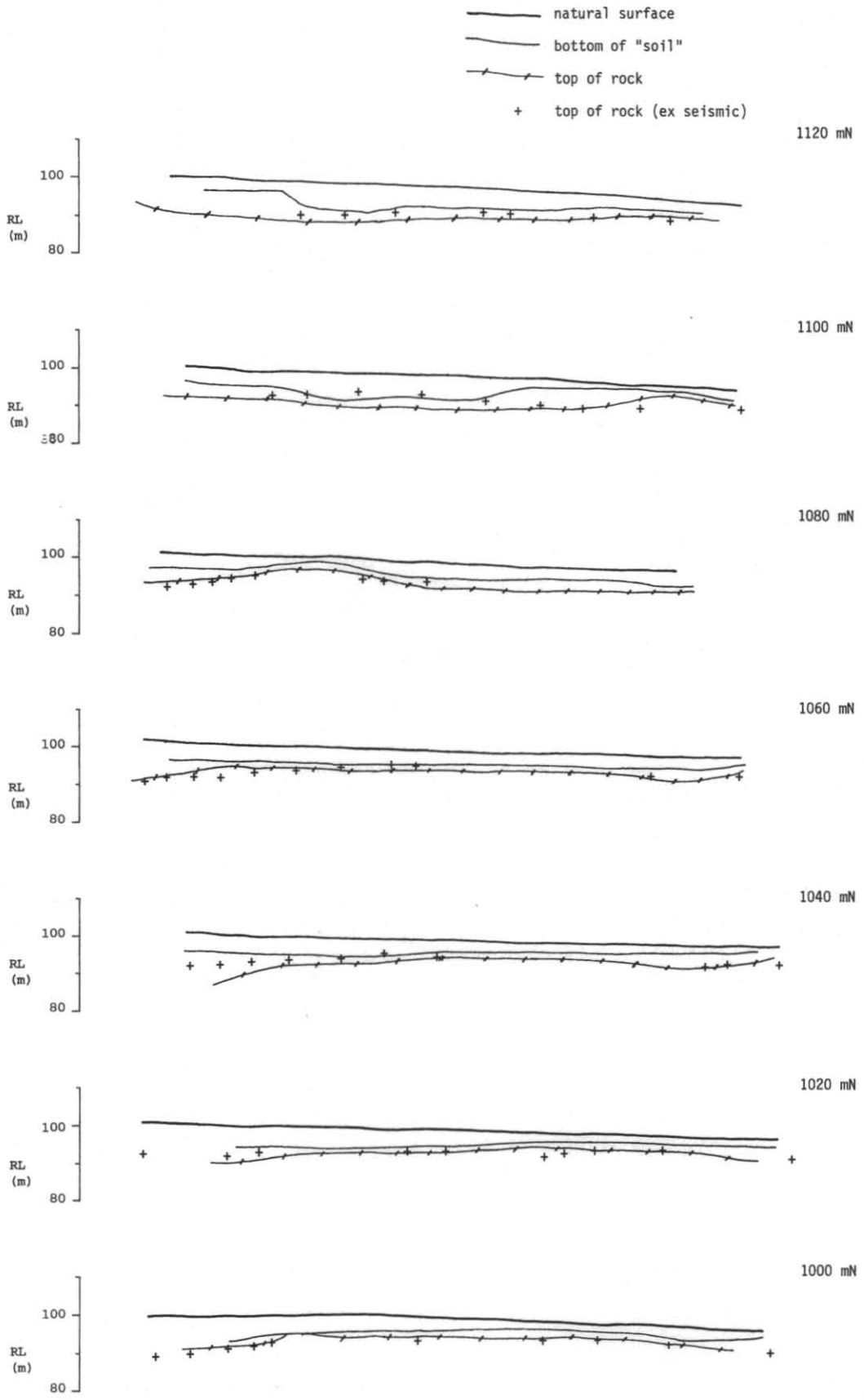

Figure 3. *East-west cross-section through proposed quarry extension, showing depth of soil-like materials and top of fresh basalt. Top of main refractor as determined by seismic survey is shown for comparison.*

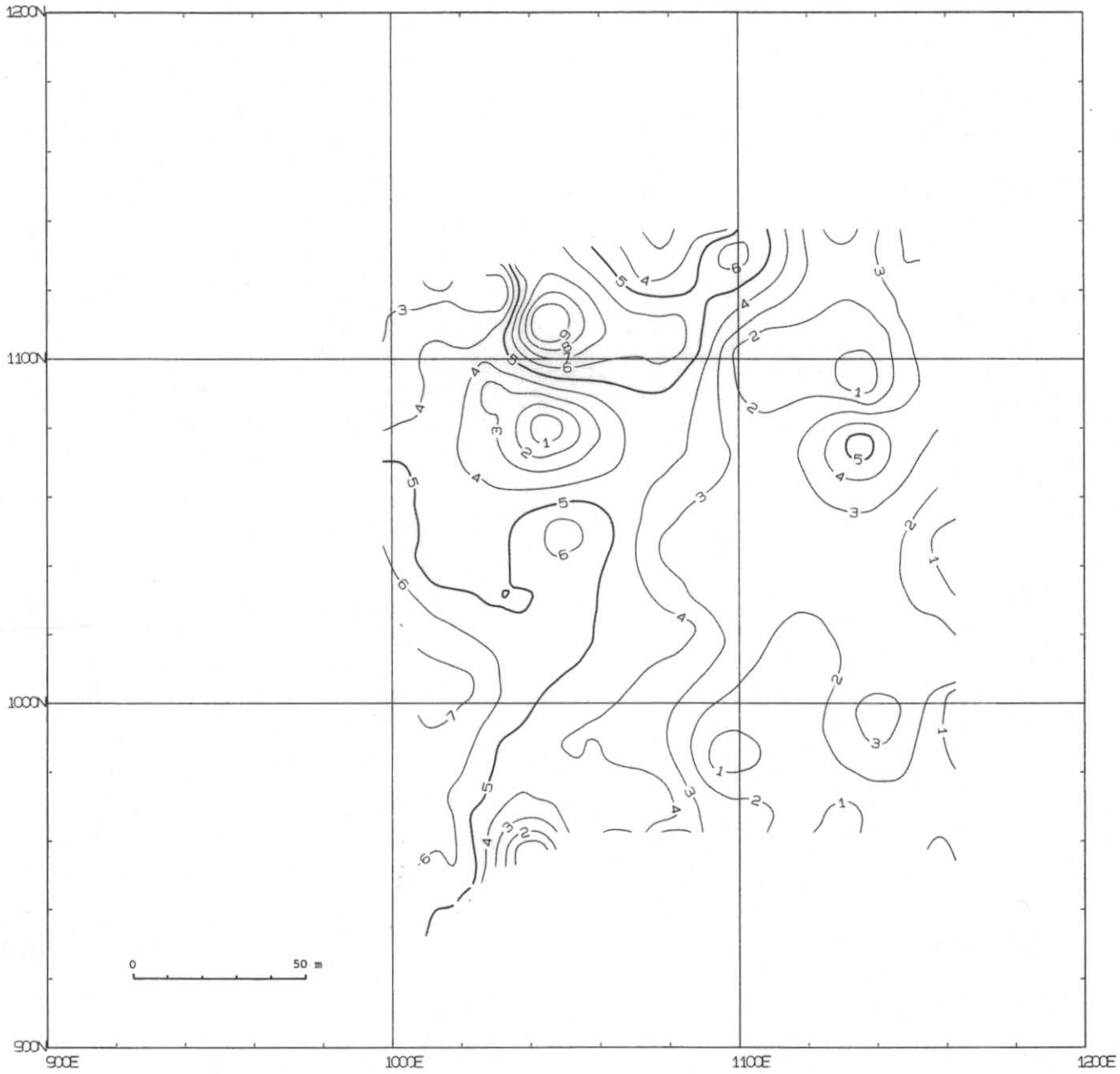

Figure 4. *Contoured depth of soil-like materials. Data derived from hydraulic drill rig holes.*

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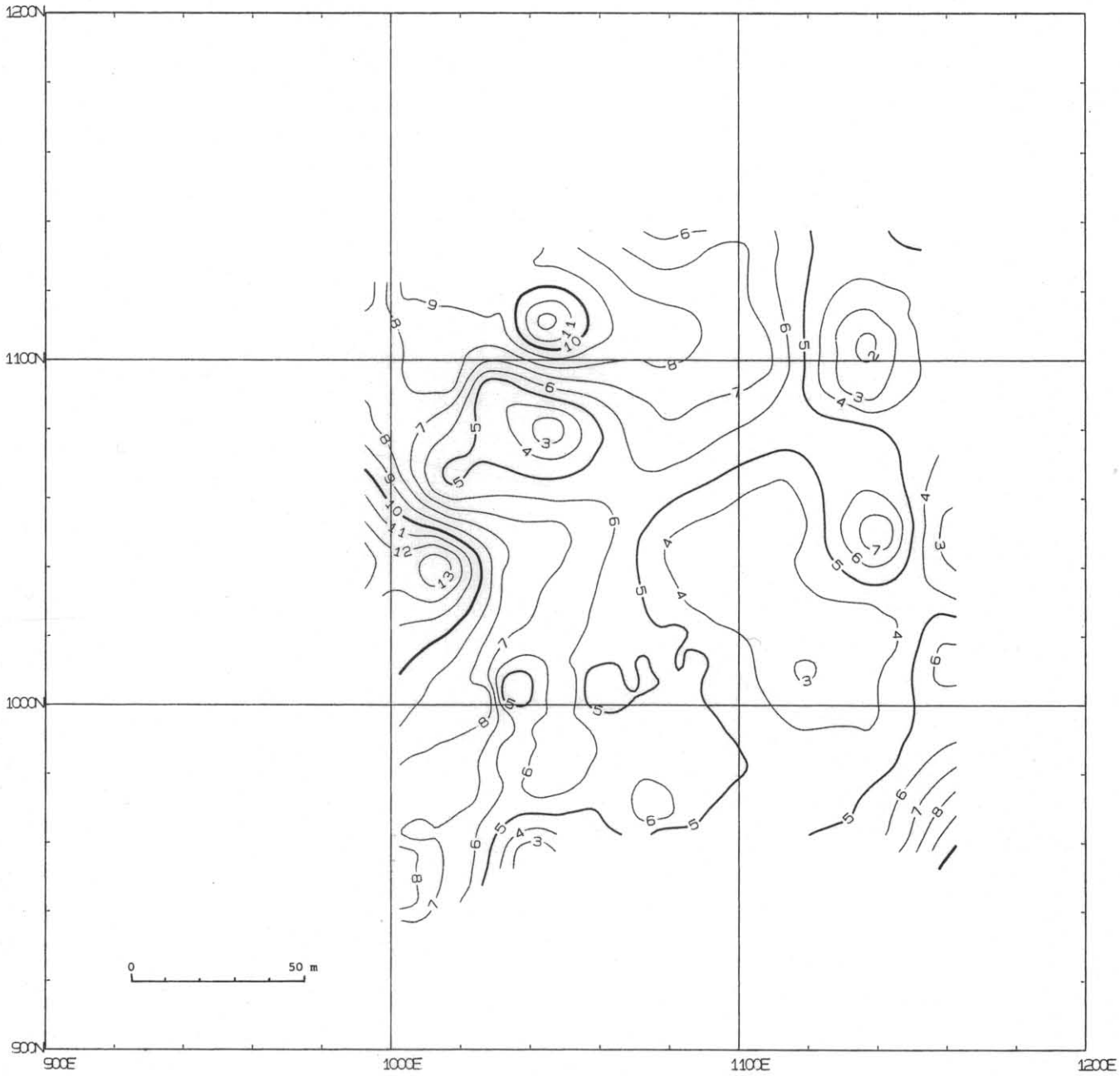

Figure 5. *Contoured depth to top of fresh basalt. Data derived from hydraulic drill rig holes.*

5 cm

APPENDIX 1

Drilling data, Brambles East Ridgley Quarry

SITE I.D.	EASTING (m)	NORTHING (m)	REDUCED LEVEL (m)	ROCK DEPTH (m)	SOIL DEPTH (m)
Seismic survey lines					
a0	1000.037	999.865	100.0	11.0	
a1	1014.856	1002.666	100.0	9.5	
a2	1028.314	1005.983	99.7	7.5	
a3	1043.278	1009.493	99.7	6.5	
a4	1057.915	1013.190	99.3	7.5	
a5	1070.526	1015.153	98.6	6.5	
a6	1087.223	1018.825	98.2	6.5	
a7	1101.949	1021.959	97.8	6.0	
a8	1116.879	1025.165	97.1	5.0	
a9	1131.242	1028.028	96.8	4.0	
a10	1145.785	1030.963	96.8	5.5	
a11	1159.957	1034.365	96.8	5.0	
a12	1174.195	1037.333	96.1	6.0	
b0	1038.754	938.547	99.2	6.0	
b1	1037.885	953.258	99.1	4.5	
b2	1036.954	968.530	99.3	6.0	
b3	1036.008	984.235	99.5	8.0	
b4	1035.093	999.125	99.7	6.5	
b5	1033.979	1014.198	99.7	6.5	
b6	1033.366	1029.997	99.6	6.0	
b7	1032.373	1044.812	99.9	6.5	
b8	1031.836	1059.540	100.1	6.5	
b9	1031.330	1073.452	100.1	5.0	
b10	1030.603	1088.719	99.9	3.5	
b11	1029.969	1103.654	98.7	8.0	
b12	1029.293	1117.901	99.2	9.3	
c0	1081.457	942.740	99.7	5.0	
c1	1080.076	956.216	99.9	4.5	
c2	1076.814	970.831	99.6	7.0	
c3	1074.675	985.547	99.5	6.0	
c4	1072.411	1000.392	99.0	6.0	
c5	1070.526	1015.153	98.6	6.0	
c6	1068.685	1030.650	98.7	4.0	
c7	1067.006	1045.508	98.8	3.5	
c8	1064.542	1060.460	98.9	4.0	
c9	1062.089	1074.878	98.7	5.0	
c10	1059.859	1090.079	98.6	4.5	
c11	1057.755	1105.227	98.1	5.0	
c12	1055.973	1120.010	97.4		
d0	1130.144	951.449	96.4	6.5	
d1	1127.572	966.175	97.0	4.5	
d2	1124.646	980.960	97.3	3.5	
d3	1122.200	995.683	97.4	4.0	
d4	1119.436	1010.872	97.1	3.0	
d5	1116.879	1025.165	97.1	3.5	

SITE I.D.	EASTING (m)	NORTHING (m)	REDUCED LEVEL (m)	ROCK DEPTH (m)	SOIL DEPTH (m)
d6	1114.283	1039.942	97.5	4.5	
d7	1111.869	1054.894	97.7	4.0	
d8	1108.741	1069.760	97.4	5.5	
d9	1106.056	1084.031	97.2	6.0	
d10	1103.368	1099.243	96.7	7.0	
d11	1100.946	1112.743	96.2	6.5	
d12	1098.223	1127.575	95.6	6.0	
e0	1167.160	953.946	92.2	7.5	
e1	1165.708	968.696	93.3	5.5	
e2	1164.364	982.654	94.0	5.0	
e3	1163.069	997.604	94.6	5.0	
e4	1162.226	1012.314	95.6	4.5	
e5	1160.712	1027.677	96.8	4.0	
e6	1159.561	1042.241	97.2		
e7	1157.984	1057.121	97.2	4.5	
e8	1156.817	1072.119	96.4	6.0	
e9	1155.319	1086.004	94.9	5.5	
e10	1154.111	1100.316	93.8	5.0	
e11	1152.854	1115.799	92.3	4.0	
e12	1151.475	1130.420	91.4	4.0	
f0	1002.707	990.304	100.0		
f1	999.365	1010.013	100.4		
f2	998.987	1019.722	100.9	9.0	
f3	999.167	1030.436	101.3	11.0	
f4	997.085	1040.135	101.6	10.0	
f5	996.611	1050.050	101.9	10.0	
f6	995.631	1060.104	102.0		
f7	995.281	1069.914	102.0	12.5	
f8	994.276	1079.994	101.6	10.0	
f9	993.920	1089.524	101.3	9.5	
f10	993.288	1099.239	101.0	8.0	
f11	992.579	1108.905	100.8	7.5	
f12	992.002	1118.822	100.4	9.5	
Hydraulic drill rig					
g1	1005.302	1120.820	99.9	9.0	2.8
g2	1012.879	1093.142	100.5	8.3	4.6
g3	1014.853	1063.028	100.8	5.6	4.5
g4	1016.540	1037.911	100.6	13.0	4.6
g5	1018.316	1004.823	99.8	8.3	7.2
g6	1020.112	975.757	99.2	7.6	5.8
g7	1021.885	947.888	98.4	6.1	5.3
h1	1056.671	963.448	100.1	4.5	4.3
h2	1052.288	990.692	100.2	6.4	4.0
h3	1050.898	1020.741	99.2	6.3	5.4
h4	1048.489	1051.833	99.5	7.1	6.2
h5	1045.083	1080.582	99.5	2.8	0.8
h6	1043.375	1110.104	98.6	11.8	9.7
h7	1041.189	1130.345	97.0	9.1	6.9
i1	1075.288	1134.210	96.3	6.2	3.1
i2	1078.351	1102.848	97.6	8.4	6.4

SITE I.D.	EASTING (m)	NORTHING (m)	REDUCED LEVEL (m)	ROCK DEPTH (m)	SOIL DEPTH (m)
i3	1081.997	1074.552	98.1	6.4	4.2
i4	1086.306	1046.343	98.3	3.4	2.2
i5	1087.223	1018.825	98.2	4.9	3.9
i6	1094.719	983.487	99.1	5.3	0.8
i7	1097.537	963.129	99.2	4.2	1.6
j1	1145.458	957.930	95.1	6.9	1.7
j2	1141.796	987.652	96.0	4.3	2.9
j3	1139.255	1018.543	96.5	3.4	2.6
j4	1137.596	1049.082	97.3	7.3	2.6
j5	1136.023	1074.680	96.3	5.8	5.1
j6	1134.083	1104.106	94.2	2.1	1.1
j7	1128.126	1138.899	93.0	4.4	1.8
hd1	992.000	1120.000	100.4	6.4	2.9
hd2	1074.489	1131.633	96.6	6.7	3.1
hd3	1148.000	1135.000	91.2	5.2	4.0
hd4	1043.813	1078.499	99.6	2.9	0.8
hd5	1133.184	1095.268	94.9	2.4	0.6
hd6	994.000	1035.000	101.5	12.7	6.7
hd7	1087.701	1034.522	98.2	3.3	2.7
hd8	1159.000	1049.000	97.2	2.9	0.7
hd9	1046.000	978.000	99.8	6.7	4.2
hd10	1141.430	992.574	96.1	4.4	3.5
hd11	1008.000	933.000	98.2	7.2	5.4
hd12	1102.259	962.760	98.9	4.8	3.3
hd13	1162.000	956.000	92.4	10.3	2.0
Pre-1988, hydraulic drill rig					
a	1007.401	935.710	98.1	6.6	
b	1006.951	943.461	98.4	8.1	
c	1006.048	950.356	98.6	8.1	
d	1005.350	957.323	98.9	8.1	
e	1005.284	964.122	99.2	6.9	
f	1004.335	972.266	99.4	7.8	
g	1003.886	981.137	99.6	7.8	
h	1002.707	990.304	99.8	8.8	
j	1026.000	1002.000	99.8	8.8	
k	1037.000	1004.000	99.9	4.4	
l	1049.866	1004.243	100.0	6.3	
m	1058.929	1006.699	99.5	4.4	
n	1070.630	1010.975	98.8	5.0	
o	1081.279	1013.851	98.4	5.0	
p	1090.899	1013.034	98.1	5.0	
Diamond-drill holes					
ddh1	1012.838	1016.080	100.2		
ddh2	1092.459	1098.258	97.2		
ddh3	1124.097	1002.639	97.0		

NOTE 1. Local survey, assumed datums for reduced level and grid origin.

APPENDIX 2

Volume determinations at Brambles East Ridgley quarry.

The General Purpose Gridding and Contouring suite of programmes allows the determination of the volume above or below a reference plane. The volume of soil and total volume of materials above the fresh basalt, as determined from the hydraulic-drill rig results, has been calculated, together with the volume of material above the main seismic refractor.

It should be borne in mind that the contouring process can be strongly influenced by point sources of data such as used in this case. This has produced some "target" contours which have a strong influence on the volume calculations. Possible reasons for the targets are highly weathered zones, such as those seen in the existing quarry faces (producing large depth to fresh basalt targets), and massive boulders which have not been completely drilled through (producing shallow depth to fresh basalt targets). The targets also arise because of the coarse spacing (up to 40 m) between data points.

It is considered that the volume calculations should be treated with an uncertainty of at least 5%. It would be prudent to use a larger range of overburden materials in any financial projections of the viability of the proposed quarry extensions.

	(m^3)
A. Volume of soil-like materials	90 000
B. Volume of intermediate zone materials (weathered basalt)	61 000
C. Total volume of material above fresh basalt	151 000
D. Total volume of material above main seismic refractor	149 000
E. Volume of fresh basalt above R.L. 66 m (local datum)	675 000
F. Volume of materials in strips noted on Figure 1	

STRIP NO.	SOIL		INTERMEDIATE		TOTAL		AREA	
	In strip	*Total*	*In strip*	*Total*	*In strip*	*Total*	*In strip*	*Total*
1	7000	7000	8000	8000	15000	15000	3000	3000
2	8000	15000	7000	15000	15000	30000	3300	6300
3	7000	22000	8000	23000	15000	45000	3400	9700
4	10000	32000	8000	31000	18000	63000	3300	13000
5	14000	46000	6000	37000	20000	83000	3100	16100
6	16000	62000	5000	42000	21000	104000	3300	19400
7	14000	76000	7000	49000	21000	125000	3000	22400
8	12000	88000	11000	60000	23000	148000	2400	24800
9	1000	89000	2000	62000	3000	151000	200	25000

NOTE 1. Volume in cubic metres has been rounded to nearest 1000

NOTE 2. Area in square metres has been rounded to nearest 100

NOTE 3. Soil columns refer to soil-like materials
Intermediate columns refer to weathered basalt
Total columns refer to total material above fresh basalt.