

1984/75. Seismic survey of a proposed dam site at Craigow University Farm, Cambridge

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Abstract

Two refraction seismic spreads were fired at a proposed dam site on Cross Rivulet. This site would be an alternative to the existing leaking dam on Craigow University Farm. The aim of the seismic survey was to compare the seismic velocities with those at the existing dam site. The upper two velocity layers were similar to those at the Craigow dam site. The third velocity layer was a low 2250 m/sec compared with the high dolerite velocity of 5000+ m/sec at Craigow.

Leakage similar to that occurring at the existing Craigow dam appears very likely at the proposed site. This site requires further investigation which should include diamond drilling and water pressure testing of drill holes.

INTRODUCTION

At the request of the Clerk of Works of the Agricultural Science Department, University of Tasmania, a refraction seismic survey was undertaken at a proposed dam site on Cross Rivulet on the University Farm at Craigow [EN355610] (fig. 1). The seismic survey was fired on 27 August and results plotted and interpreted on 10 September; the results were reported to the University Clerk of Works. This report is the formal completion of this survey as requested.

The proposed dam site was an alternative site chosen by the Rivers and Water Supply Commission to replace the existing dam at Craigow which has leakage problems (Matthews, 1984a). The Cross Rivulet site was investigated by the Rivers and Water Supply Commission with a series of back hoe trenches, most of which were on the north-eastern flood plain of the stream. The aim of the seismic survey was to identify the seismic velocities at the proposed site and to compare them with the velocities recorded in a seismic survey at the existing leaking dam (Matthews, 1984b).

Two refraction seismic spreads were fired. A 12 channel Geometric Nimbus ES 1210 signal enhancement seismograph was used in the survey, with gelignite for the energy input. Spread 1 was a 252 m long, NE-SW spread fired parallel with Cross Rivulet on the alluvial flood plain and sited between the series of exploration trenches. These trenches were all nearly full of water when the seismic survey was undertaken and were used for most of the shots fired in both spreads.

In Spread 1 15 m geophone intervals were used, with shot point distances of 15 m at each end and a mid-shot. An extended shot of 72 m was fired at the south-west end to look for any higher velocities at depths of 50-80 metres.

A NW-SE cross spread of 112 m length (Spread 2), located in the middle of the long spread, was also fired, with reduced geophone intervals of 7.5 metres. This kept the majority of the spread on the flood plain east of Cross Rivulet. The two spreads combined covered the area investigated by the Rivers and Water Supply Commission trenches.

SEISMIC RESULTS

Three velocity layers were recorded at the north-east end and mid shot of Spread 1 (Table 1), with a surface velocity layer (V_0) of 600-800 m/sec, an intermediate velocity layer (V_1) of 1300-1600 m/sec, and a third velocity layer (V_2) of 2200-2500 m/sec. Only two layers were present at the south-west shot point, with a surface velocity layer (V_0) of 2000 m/sec and a second velocity layer (V_1) of 2200-2500 m/sec. These two layers were the same for the extended 72 m shot, which recorded a remarkably consistent velocity of 2250 m/sec.

As both of the south-west end shots were fired at the bottom of two exploration trenches filled with water, the slow surface layer of 600-800 m/sec was probably missed. The calculated thickness (Z_0) of this surface layer was 4-5 m at the north-east end and five metres at the mid shot. Some slope on the velocity interfaces is apparent, with a high velocity of 2000 m/sec for the upper surface at the south-west end of the spread being recorded. A similar south-west slope is shown in the total depth to the top of the high velocity interface (V_1/V_2) with 13-16 m calculated at the north-east end and 7-11 m at the south-west end.

Similar velocities were present in Spread 2, with surface velocities (V_0) of 600-750 m/sec at the north-west end and 1000 m/sec at the south-east end. The intermediate velocities (V_1) were 1200-1800 m/sec at the north-west end and 1600-1800 m/sec at the south-east end, with third layer velocities (V_2) of 2200-2500 m/sec. The difference in velocity between the ends of the spread is due to the slope on the interfaces (the slope rising towards the SE) combined with different shot point depths resulting from using a deep water hole on the south-east bank of Cross Rivulet for the south-east shot point. In this spread the surface layer is a consistent 3-4 m thick but the intermediate layer is 11-14 m thick at the north-west end and 5-7 m thick at the south-west end of the spread.

GEOLOGICAL INTERPRETATION

Three seismic layers are present at the proposed site. The surface layer has a velocity range of 600-1000 m/sec but with a most common velocity of 600-750 m/sec. This layer is interpreted as water-saturated clay, with gravel, silt and sand similar to that in the spoil heaps of the exploration trenches at the Cross Rivulet site and in the exploration pits at the existing Craigow dam site (Matthews, 1984a). The high 1000 m/sec surface velocity at the south-west end of Spread 2 is probably deeply weathered shale and mudstone of Triassic age, as is the 2000 m/sec surface velocity layer at the south-west end of Spread 1. Sediments of this age are reported as occurring in exploration trenches (Matthews, 1984a).

The surface velocity layer probably represents alluvial stream sediments and unconsolidated, water-saturated sediments of Tertiary age. These sediments, when more consolidated, may also occur in the intermediate velocity layer (within the lower part of the 1200-1800 m/sec velocity range). The most frequently recorded velocities in this middle layer are in the 1300-1600 m/sec range, which is thought to be weathered and open-jointed mudstone, shale and sandstone of Triassic age.

The third velocity layer comprises sediments similar in lithology and age, but which are more consolidated and tightly jointed mudstone, shale and sandstone. These sediments are only moderately hard and continue to have the same velocity and properties for a considerable depth (at least 60 m) without any change in velocity being recorded.

The high velocities characteristic of dolerite were not recorded at this site, unlike the existing dam at Craigow where dolerite velocities of 5180-6120 m/sec were recorded (Matthews, 1984b). There is unlikely to be any weathered dolerite in the intermediate velocities at Cross Rivulet as probably occurs at the existing Craigow dam.

This lack of dolerite is the major difference between the two sites. The lower velocities recorded in the surface layer at the existing Craigow dam site compared with the Cross Rivulet site, is accounted for by the firing of the shots below the water table, generally at the bottom of the exploration trenches, at Cross Rivulet.

CONCLUSIONS

- (1) The seismic velocities and thicknesses of the two upper velocity layers are of the same order and are thought to represent the same type of sediments at the two sites. The leakage problem associated with these sediments at the existing dam site at Craigow is likely to occur at the proposed Cross Rivulet site.
- (2) Dolerite which occurs at the existing dam at Craigow is not likely to occur at Cross Rivulet. No high velocities characteristic of dolerite were recorded, even though extended shots were fired giving greater investigation depth.
- (3) Any proposed dam at Cross Rivulet is likely to be built on Triassic sediments and the depth to unweathered, tightly-jointed sediments (giving high seismic velocities) is probably very deep.

RECOMMENDATIONS

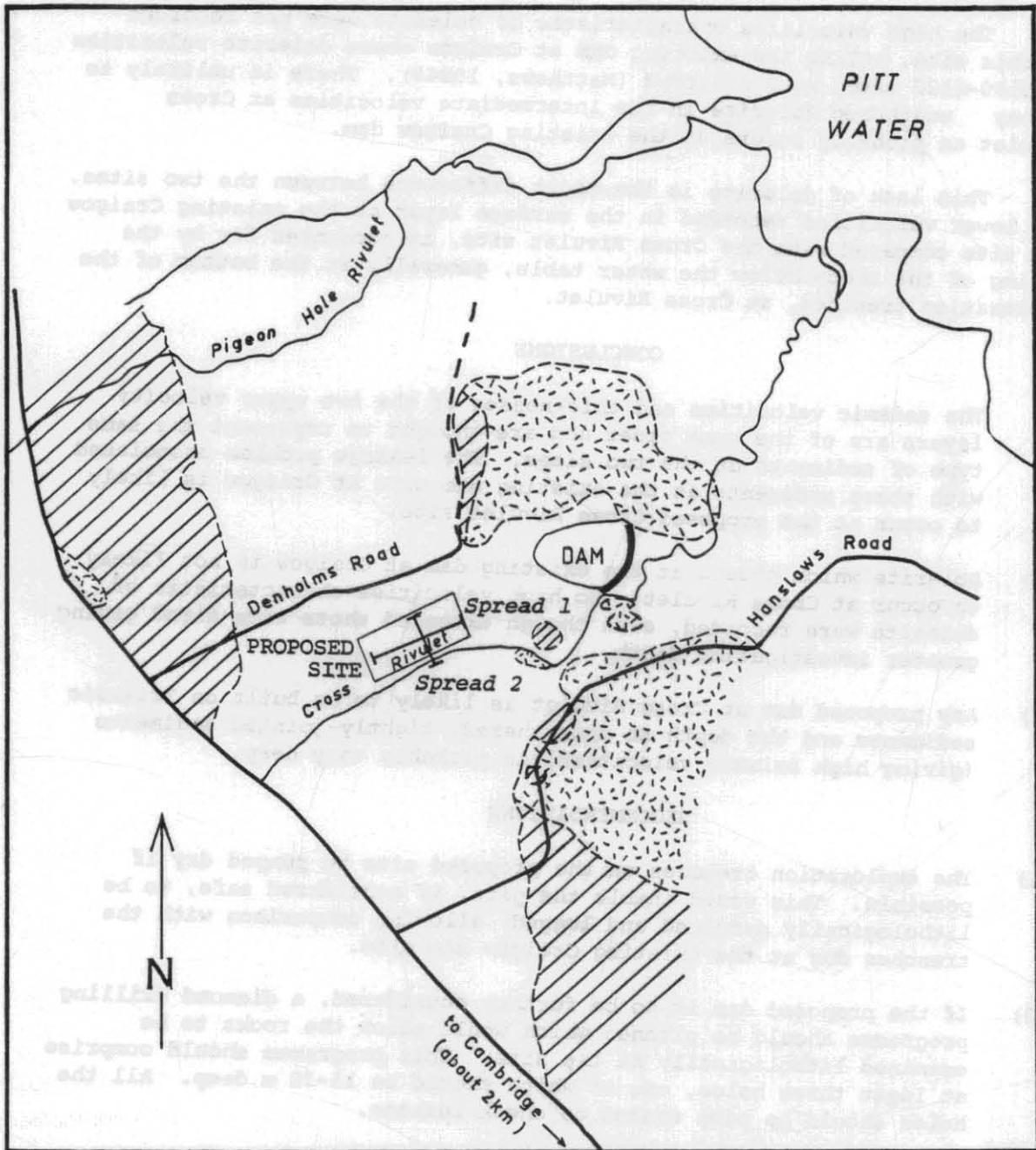
- (1) The exploration trenches on the proposed site be pumped dry if possible. This would enable the pits, if considered safe, to be lithologically examined and logged, allowing comparison with the trenches dug at the existing Craigow dam site.
- (2) If the proposed dam is to be further considered, a diamond drilling programme should be planned which would allow the rocks to be examined lithologically at the site. This programme should comprise at least three holes, one of which should be 15-20 m deep. All the holes should be pump tested to check leakage.

REFERENCES

MATTHEWS, W.L. 1984a. Investigation of a leaking dam at Cambridge.
Unpubl.Rep.Dep.Mines Tasm. 1984/24.

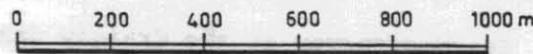
MATTHEWS, W.L. 1984b. Seismic survey at the Craigow dam, Cambridge.
Unpubl.Rep.Dep.Mines Tasm. 1984/44.

[9 November 1984]



GEOLOGY AROUND CRAIGOW DAM

W.L. MATTHEWS



-  Deep soil, recent alluvium and Tertiary sediments
-  Dolerite
-  Sandstone and shale

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Figure 1.

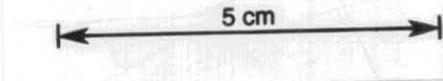


Table 1. REFRACTION SEISMIC RESULTS

Spread No. & location	Length & direction (m)	Geophone spacings (m)	Shot point distances (m)	Velocity layers (m/sec)	Thickness velocity layers Z ₀ (m) Total depth (m)	Slope	Geological interpretation of velocity layers
1 Parallel with Cross Rivulet	252 NE - SW	15	SPNE = 15	<u>NE end & mid SP</u>	<u>NW end</u>	Assymetrical. V ₀ = 600-800, lenses out SW end of spread	<u>Mid SP; NE end</u>
			Mid SP	V ₀ = 600-800	Z ₀ = 4.3-4.5		V ₀ - alluvial sediments
			SPSW = 15	V ₁ = 1300-1600	Z ₁ = 8.4-9.7		below water table
			Extended	V ₂ = 2000-2400	TD = 13-15		V ₁ - deeply weathered
			shot 72 m	<u>SW end</u>	<u>SW end</u>		Triassic sediments
			V ₀ = 2000	Z ₀ = 3-7	- sandstone & shale		
			V ₁ = 2200-2500	TD = 7-11		<u>SW end</u>	
			Long shot = 2250			V ₀ - partially weathered	
						Triassic sediments	
						V ₁ - unweathered Triassic	
						sediments	
2 Cross spread from SE bank of Cross Rivulet across flood plain	112.5 NW - SE	7.5	SPNW = 15	<u>NW end & mid SP</u>	<u>NW end</u>	Assymetrical. Slope on interfaces shallows towards stream	V ₀ - alluvial sediments
			Mid SP	V ₀ = 600-750	Z ₀ = 3.6-3.8		below water table
			SPSE = 15	V ₁ = 1200-1600	Z ₁ = 11.4-13.5		V ₁ - weathered Triassic
				V ₂ = 2200-2500	TD = 14-16		sediments
				<u>SE end</u>	<u>Mid SP</u>		V ₂ - unweathered Triassic
			V ₀ = 1000	Z ₀ = 2.5-3.0	sediments		
			V ₁ = 1600-1800	Z ₁ = 4.0-6.0		<u>SE end</u>	
			V ₂ = 2200-2500	<u>SE end</u>		V ₀ - possibly deeply	
				Z ₀ = 2-3		weathered Triassic	
				Z ₁ = 5-7		sediments	

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Table 2. COMPARISON OF EXISTING AND PROPOSED DAM SITE

Craigow dam site (Matthews, 1984a, b)				Cross Rivulet proposed site (this report)			
Layers	Velocity (m/sec)	Calculated thickness (m)	Geological interpretation	Layers	Velocity (m/sec)	Calculated thickness (m)	Geological interpretation
Surface	400-500	3	Clay with silt, sand and gravel in clay	Surface	600-750	3-5	(a) Quaternary alluvial clay, sand and gravel; water saturated (b) Possibly some unconsolidated Tertiary sediments (c) Higher 1000 m/sec surface layer deeply weathered Triassic mudstone and sandstone
Intermediate	1475-1575	12-18	(a) Saturated unconsolidated Tertiary sediments (b) Deeply weathered Triassic sediments; shale and sandstone (c) Deeply weathered dolerite	Intermediate	1300-1600	4-14	(a) Water saturated and weathered mudstone, shale and sandstone of Triassic age (b) Possibly some consolidated Tertiary sediments overlying the above sediments
Third	5180-6120	Depth to interface 6-20 (thickness not calculated)	Dolerite	Third	2000-2250	7-16 Thickness not calculated 72 m extended shot shows thickness to be in excess of 50 m	(a) Unweathered Triassic sediments; shale, mudstone and sandstone (b) No dolerite of any thickness

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