DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1974/180

PINE RIDGE SEWER TUNNEL SEISMIC REFRACTION INVESTIGATION, A.C.T.

1974

BY

D. C. RAMSAY.

RECORD 1974/180

PINE RIDGE SEWER TUNNEL SEISMIC REFRACTION INVESTIGATION, A.C.T.

1974

by

D.C. RAMSAY

<u>CONTENTS</u>

<u>ILLUSTRATIONS</u>

SUMMARY

A seismic refraction survey was carried out along part of the line of the proposed Pine Ridge sewer tunnel. The aim of the survey was to investigate rock conditions likely to be encountered at tunnel level.

The average bedrock velocity measured was about 4.5 km/s except in two regions where the values were approximately 3.5 and 3.8 km/s respectively. These latter regions may represent either bands of softer rock or sheared zones of harder rock: either would probably require extra support during tunnelling. The remainder of the tunnel should be through fairly sound, fresh rock.

1. INTRODUCTION

The Pine Ridge tunnel forms part of the proposed Molonglo Valley Interceptor Sewer, connecting the existing Weston Creek treatment works with the proposed Lower Molonglo Water Quality Control Centre situated near the confluence of the Molonglo and Murrumbidgee Rivers (Plate 1). The tunnel will be concrete lined, with an internal diameter of 2.59 m, and will be approximately 2 km long.

In response to an internal request, the Bureau of Mineral Resources, Geology & Geophysics (BMR) carried out a seismic refraction survey to investigate subsurface conditions along part of the tunnel line in order to locate any anomalous zones that might be deleterious to tunnelling.

The field work was carried out in April 1974 by a party from the Engineering Geophysics Group consisting of D.C. Ramsay (geophysicist), S.A. Green and M.J. Dickson (trainee technical officers), and A.S. Gleeson and C.L. Horsfall (field hands).

Seismic coverage of this same area was previously done in 1971 by Central Testing and Research Laboratories, Commonwealth Department of Works (CTRL), as part of a more extensive survey.

The term 'bedrock' as used in this report refers to the deepest refractor detected, and the term 'overburden' to the soil and weathered rock above this refractor.

2. GEOLOGY

The western end of the proposed Pine Ridge tunnel will be excavated through a gently southwest-dipping sequence of bedded porphyritic welded blue-grey dacitic crystal tuffs of the Upper Silurian Uriarra Volcanics. Scattered rubbly outcrops ranging from highly weathered to near-fresh rock occur along the route. Where the rock crops out the jointing is moderately closely spaced.

Drill hole MV11 (Plate 2) showed fresh rock below about 15 m from the surface; the fresh rock is hard and strong. Uniaxial compressive strengths of the rock core ranged from 167 MPa to 250 MPa.

More detailed information may be obtained from a BMR report on the geology of the proposed tunnel route (Purcell & Simpson, 1973).

3. METHOD AND EQUIPMENT

The seismic refraction method (Dobrin, 1952) was used to investigate subsurface conditions. Depths to refracting layers were calculated using intercept times and a modification of the reciprocal method (Hawkins, 1961). This gives the depths to intermediate refractors only at shot-points, and the depth to bedrock at each geophone.

A geophone spacing of 4 m was used throughout the survey and shots were fired in the centre of each spread and at 2 m and 46 m beyond each end. The spreads were laid end on end along the line of the tunnel, and a total of 920 m was covered.

Standard 24-channel SIE PSU-19 refraction equipment with 8 Hz GSC-20D geophones was used.

4. RESULTS

The seismic cross-section is shown in Plate 2. It will be noted that tunnel level is below the bedrock boundary for the whole distance surveyed. As portalling had already begun, the seismic traverse could not start any closer to the portal than chainage 6650 feet. It is possible that the bedrock boundary could come below tunnel level between this point and the portal.

Bedrock velocity ranges between 4.4 and 4.8 km/s with two exceptions. From ch. 4860 to 5120 there is a region with velocity 3.4 to 3.5 km/s: this is interpreted as either a band of different rock with softer properties or as the same rock type with extensive shearing or fracturing. Also, from ch. 3505 to 3960 the seismic velocity ranges from 3.8 to 4.1 km/s: this is probably another sheared zone with the most intense shearing at the higher chainage end of the zone. The remainder of the traverse is interpreted as being slightly weathered to fresh bedrock. It is possible there could be other shear zones with dimensions smaller than those detailed above. Zones of low seismic velocity narrower than the geophone spacing would not normally be detected by the method used.

The nature of the overburden is also fairly consistent along the length of the traverse. A layer with velocity 0.35 to 0.5 km/s and from 0.5 to 2.6 m deep is interpreted as surface soil and clay. This is underlain by material with velocity 2.1 to 2.75 km/s, ranging in thickness from 4 to 17 m, which is interpreted as being highly to moderately weathered bedrock. The overburden has neither a markedly lower seismic velocity nor markedly greater depth over the zones of low bedrock velocity. This would suggest that the rock type probably does not change in these zones; shearing or fracturing most likely accounts for the reduction in velocity of the bedrock.

At the time of writing, tunnelling has proceeded from the portal at ch. 6822 to approximately ch. 5000. From the portal to ch. 5200, the rock jointing ranges from moderately close to wide. Joints are mostly tight, but some zones with up to 0.5 cm of clay on joints are common. Three sheared zones up to 1 m wide were encountered. Rock bolts are used for support in a few regions, mainly close to the portal. From ch. 5200 conditions have deteriorated, requiring more rock bolts. At ch. 5112 the tunnel entered rock which is fractured and close-jointed with up to 2.5 cm of clay on joints. From here, steel rib supports are being used.

5. CONCLUSIONS

Extra support during tunnelling will probably be required between about ch. 3500 and 3960 and also between about ch. 4860 and 5120. The remainder of the tunnel route surveyed indicates good tunnelling conditions through fairly sound, fresh rock. This is borne out by actual tunnelling completed to date.

6. REFERENCES

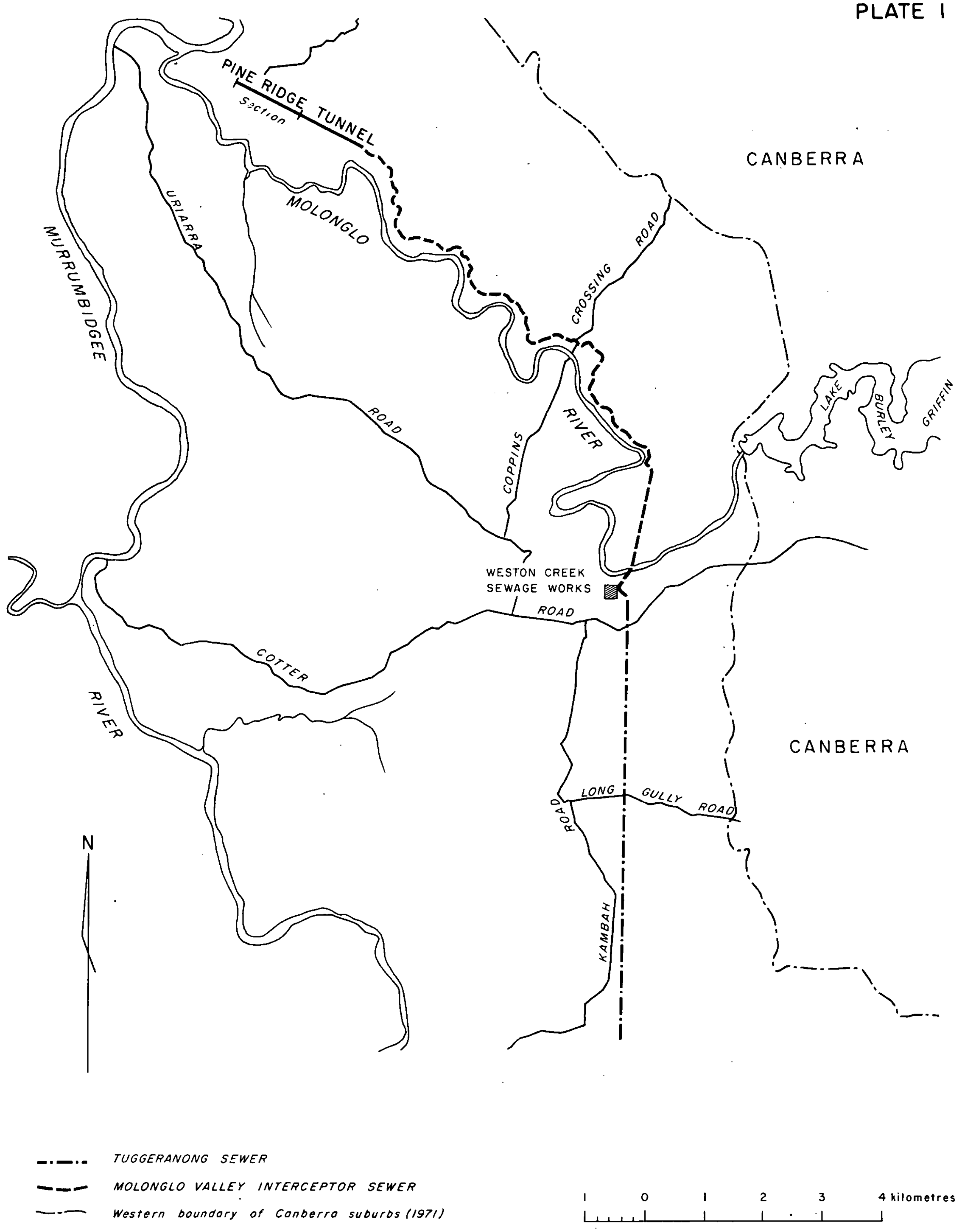
DOBRIN, M.B., 1952 - INTRODUCTION TO GEOPHYSICAL PROSPECTING, New York, McGraw-Hill Inc.

HAWKINS, L.V., 1961 - The reciprocal method of routine shallow seismic refraction investigations. Geophysics, 26(6), 806-819.

PURCELL, D.C., & SIMPSON, G.B., 1973 - Molonglo Valley Interceptor Sewer, Canberra, A.C.T., geological investigation. 1970-1972. Bur. Miner. Resour. Aust. Rec. 1973/173 (unpubl.)

COMMONWEALTH DEPARTMENT OF WORKS, 1971 - Molonglo Outfall Sewer Seismic report. Central Testing and Research Laboratories, Technical Report No. 80.

PLATE I



PINE RIDGE SEWER TUNNEL

LOCALITY MAP

Record No. 1974/180

I55/B5-239A

SEISMIC CROSS-SECTION