BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

RECORD 1980/81

LANYON TRUNK SEWER, A.C.T.

ENGINEERING GEOLOGY OF PROPOSED PINE ISLAND TUNNEL

AND

EXCAVATION CONDITIONS FOR THE PIPELINE ROUTE UNDER

MURRUMBIDGEE PARK DRIVE

BY

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CONTENTS

SUMMARY

The Pine Island tunnel section of the Lanyon trunk sewer will be excavated through highly to moderately weathered ash-flow tuff and dacite; the hardest section is expected to be about 30 m of fresh to slightly weathered dacite near chainage 2140. A high percentage of clay-lined fractures is expected to facilitate overbreak, and support by steel sets with timber lagging will be required to restrain rock through most of the tunnel. The tunnel will be above the water-table and water in the tunnel will be confined to seepages after rain. The portals will require careful use of explosives to keep overbreak to a minimum, and the open-cut sections will require stabilisation.

The section adjoining, and passing under Murrumbidgee Park Drive is also expected to be in weathered dacite volcanics. The short tunnel under the road is expected to be in slightly weathered to fresh rock but with highly weathered rock close to the crown. Unfavourable joint directions in both the tunnel and the trench will require care to minimise overbreak and failure of the eastern wall of the trench.

PROPOSED PINE ISLAND TUNNEL

The report on the geological investigations for Lanyon Trunk Sewer (Goldsmith, 1975) included brief notes on three alternative tunnel routes, H, R, and Q beneath "Pine Island" homestead which is enclosed by a bend in the Murrumbidgee River known as University Bend (Figure 1). The alignment finally proposed, route J, lies to the west of all the alternatives previously considered. The tunnel length between the portals will be approximately 290 m, and the internal diameter of the lined tunnel will be approximately 1800 mm.

Investigation of route J for the Pine Island Tunnel was carried out during March and April 1976. A seismic refraction traverse was shot along the centre-line of the proposed tunnel by the Engineering Geophysics Group of the Bureau of Mineral Resources (BMR); and two diamond-drill holes were drilled to depths of 15.1 m (hole LTS 1) and 16.2 m (hole LTS 2) by Department of Housing and Construction during March 1976.

GEOLOGY

The geology of the site is shown in Figure 2. The rock units found belong to a suite of Silurian acid volcanics extending through the Tuggeranong valley.

At the tunnel site, dacite and interbedded pyroclastics dip 10°–20°NW. Outcrop is confined to the steepest banks and rocky knolls adjacent to the Murrumbidgee River. No outcrop was found on level ground away from the river but gravel and cobble fragments are scattered over the surface and represent remnants of an ancient alluvial terrace. The dacite is green-grey and has a porphyritic texture with phenocrysts of quartz and plagioclase 1–6 mm in size. Outcropping rock is moderately weathered to fresh and generally blocky with moderately spaced tight joints. Minor localised zones of closely spaced joints are associated with quartz and epidote veins.

The pyroclastics comprise a sequence of ash-flow tuff, ashstone, and agglomerate 50-60 m thick. The ash-flow tuff and ashstone are generally rubbly in outcrop, and rock fragments are sharp and angular. Scattered exposures show moderately close jointing at 55°N. In one exposure beside the river, ash-flow tuff dipping 15°NW overlies the dacite with scour structures along the line of contact. This contact is probably conformable, as the dacite is also relatively flat lying.

Agglomerate is exposed immediately to the north of the ash-flow tuff and ashstone. Alongside the river there is one exposure of bedded agglomerate with rounded abraded vitric and lithic fragments up to 3 cm in size.

ENGINEERING GEOLOGY

Seismic results and interpreted rock condition

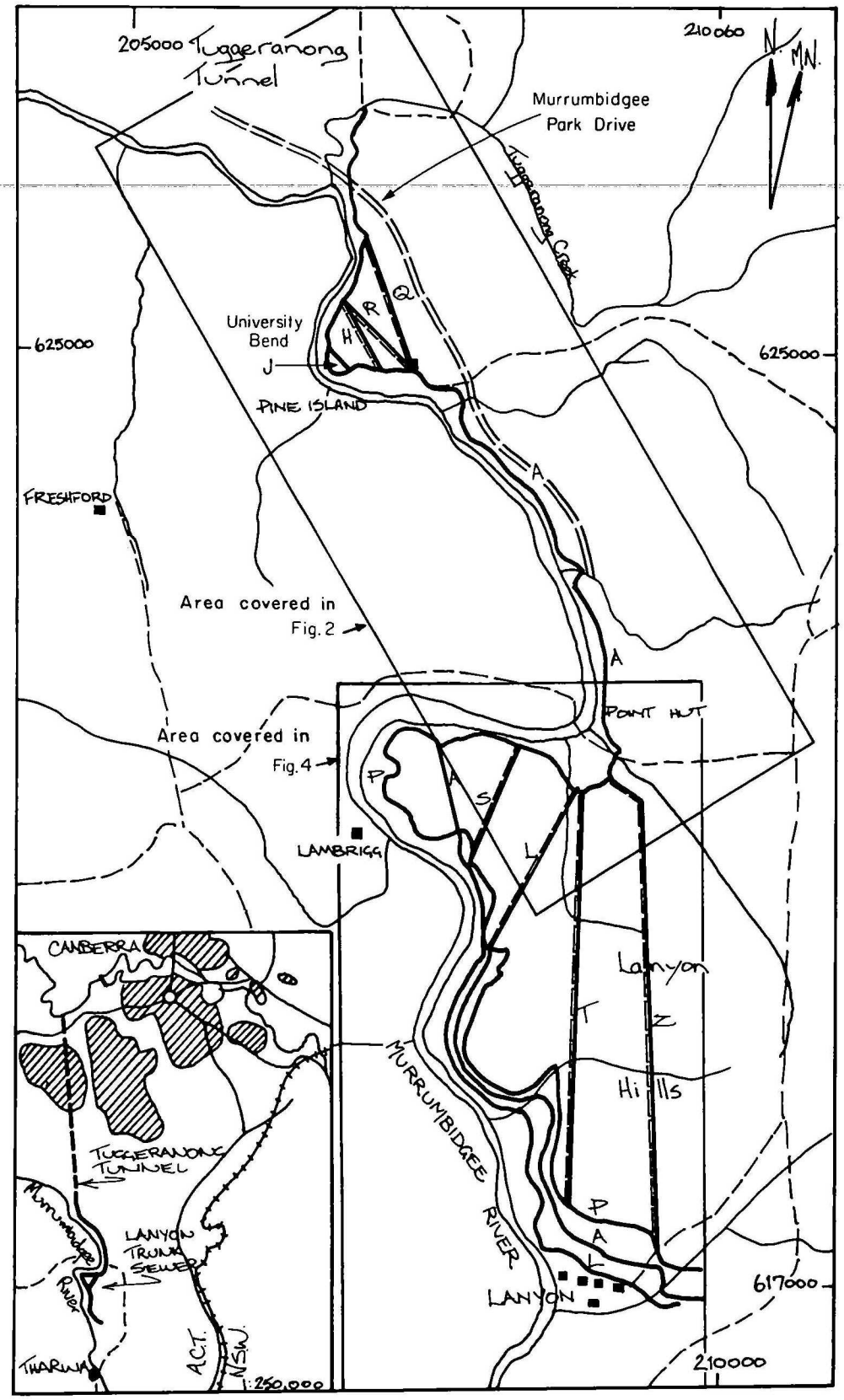
The seismic section along the tunnel line (Fig 3) shows that the tunnel, with the possible exception of about 30 m of its length, will be within the intermediate-velocity layer with seismic velocities between 800 and 1500 m/s, which probably represents highly to moderately weathered rock.

A prominent dip in the bedrock refractor probably represents the contact between dacite and ash-flow tuff and interacts the tunnel line at Station 2120 m. North of the contact the tunnel will pass through the sequence of pyroclastics. The inferred degree of weathering depends on the interpretation of the seismic data. A 1500-1700 m/s velocity layer was interpreted at the northern and southern ends of the traverse, but no such layer was detected between stations 1920 and 2090 m. This section may be highly weathered (800-1000 m/s) down to 30 m directly overlying fresh dacite (45000 m/s), as shown in Plate 2; or it may be highly weathered down to around 15 m and moderately weathered between 15 and 30 m.

No major faults are known to intersect the tunnel line, but faults and sheared zones striking 70°-100° do occur. One sheared zone probably marks the contact between ashstone and dacite and intersects the proposed pipeline 50 m north of Manhole 10 (MH10 in Plate 1).

LOCALITY MAP

FIG. 1

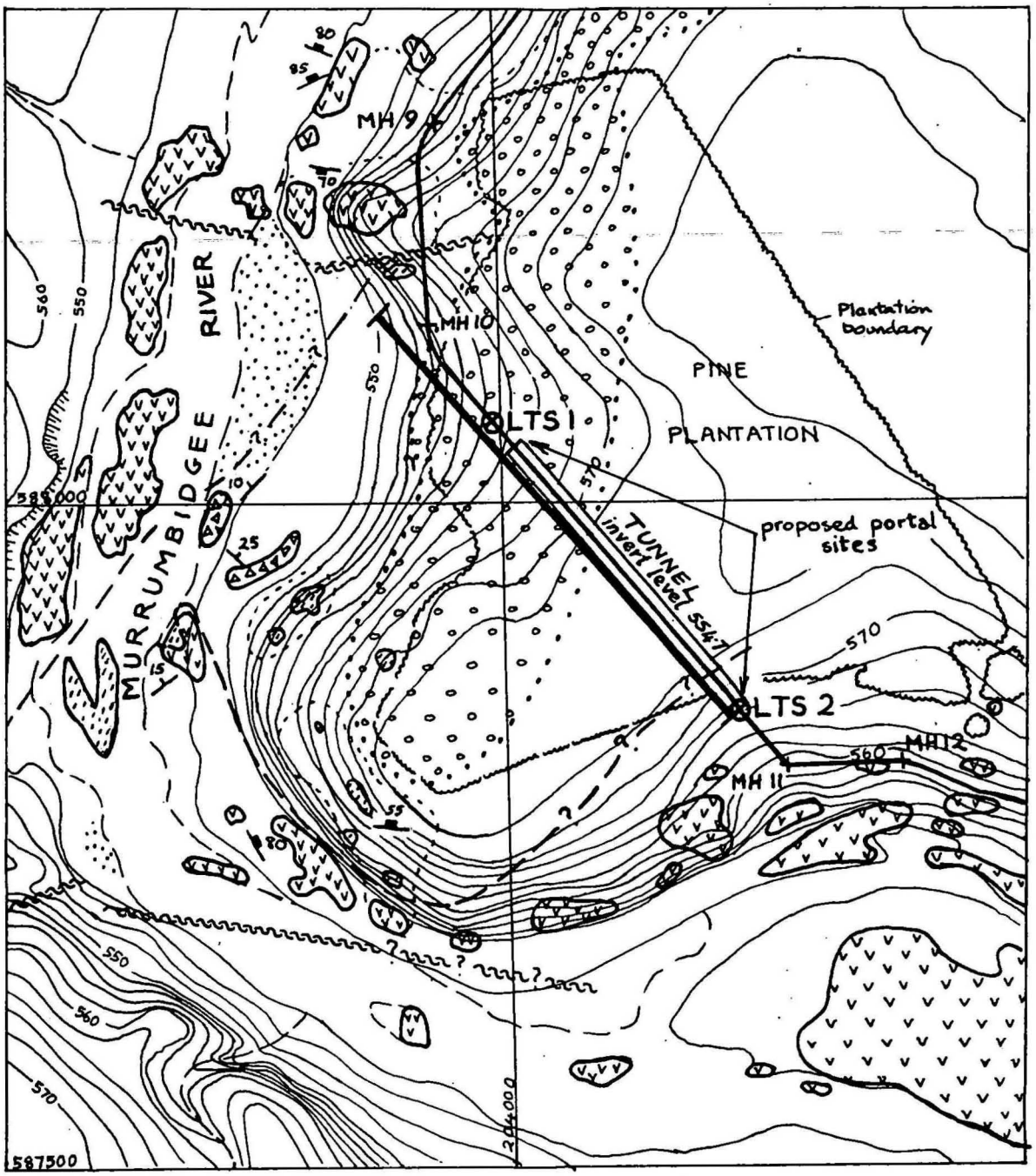


PROPOSED SEWER PIPELINE ALTERNATIVES A, P, L.

" " , TUNNEL ALTERNATIVES H, R, Q, L, S, T, Z.

SCALE 1:50,000

0 1 2 3 km.



GEOLOGICAL MAP OF THE TUNNEL SITE ~ UNIVERSITY BEND, PINE ISLAND, A.C.T. LANYON TRUNK SEWER

0 50 100 200 300
metres

SCALE 1:5000

MN
N

- Alluvial sand and gravel
- Terrace sand and gravel
- Grey dacite
- Ash flow tuff, ashstone
- Agglomerate
- geological boundary
- 15 bedding, showing dip
- 55 joint, showing dip
- sheared zone
- proposed pipeline, showing manholes. MH 9
- LTS1 diamond-drill hole
- Seismic refraction traverse

DRAWN RCMG.

GEOLOGY BY R.C.M. GOLDSMITH, ENGINEERING GEOLOGY SUB-SECTION, BMR, MAY 1976.

FIG. 2
16/155-16/1

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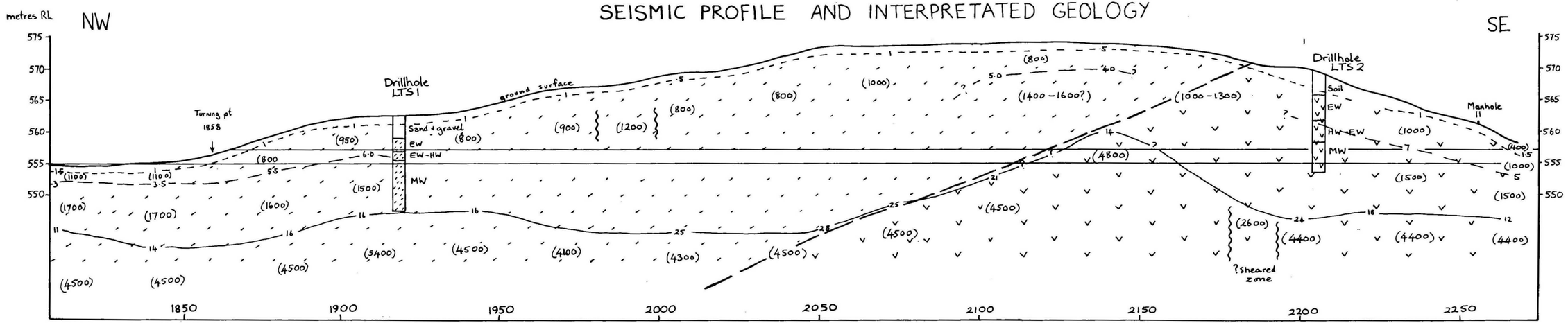
LANYON TRUNK SEWER
PINE ISLAND TUNNEL, UNIVERSITY BEND, TUGGERANONG, A.C.T.
SEISMIC PROFILE AND INTERPRETATED GEOLOGY



SEISMIC DATA

- Soil refractor, depth in metres
- Intermediate refractor, showing depth
- Bedrock refractor, showing depth
- (4500) Seismic velocity, metres per second
- Seismic discontinuity

ROCK TYPES

- Ash flow tuff, agglomerate, ashstone
- Grey dacite.
- Geological boundary

DEGREE OF WEATHERING

- EW - Extremely weathered
- HW - Highly weathered
- MW - Moderately weathered
- SW - Slightly weathered
- Fr - Fresh

SCALE HORIZ 1:1000
VERT 1:500

RCM GOLDSMITH MAY 76

FIG. 3

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16/155-16/2

Another sheared zone, observed in the seismic section, intersects the proposed tunnel between Stations 2180 and 2190. This aligns with a sheared zone on the western side of the river that strikes about 070°.

Drilling results

Geological logs form Appendix 1 of this report. In drillhole LTS 1 moderately weathered ashstone was intersected at 7 m and was found to be closely jointed, fractured and open, making the rock mass loose. Joints are weathered with infillings of clay and sand, and some infillings are up to 15 cm thick (spaced 1-1.5 m apart). The core from this drillhole correlates well with the seismic section, in which 1000 m/s velocity material is indicated at about 6 m depth and coincides with moderately weathered rock.

The core from drillhole LTS 2 consists of highly to extremely weathered dacite from 4-12.5 m and correlates with the 1500 m/s velocity layer of the seismic section. Moderately weathered dacite, from 12.5-16.2 m, is moderately hard and strong, but joints are open and joint faces are weathered to a friable sand. No clay was observed on the joint surfaces.

The seismic section shows 1500 m/s velocity material at 7 m depth, with no change in velocity for the layer at 12.5 m; this indicates that the 1500 m/s layer is probably an average velocity representing highly to moderately weathered rock.

Expected tunnelling conditions

Support. Nearly 90 percent of the tunnel is located in rock with a velocity in the intermediate range 800-1700 m/s, indicating mostly highly to moderately weathered closely jointed rock. Steel set support is likely to be required for all this section of the tunnel.

Only 30 m of the tunnel length lies entirely within the 4800 m/s velocity layer (slightly weathered to fresh rock). Because tunnel crown is only 3-4 m below the 4800 m/s refractor, tunnel support may still be required.

Groundwater. No groundwater inflows are expected. Owing to the poor rock condition some seepage or dripping can be expected after rain. In extremely weathered sections of the tunnel, any saturation of the rock after rain may reduce the stability of the tunnel and lead to some further disintegration of the extremely weathered rock behind timber lagging.

Overbreak. The tunnel line bears approximately 320°. Overbreak and slabbing in the crown can be expected as the bedding dips in approximately the same direction as the tunnel line. Joint sets observed in outcrop in the Pine Island area, 25° N/110 (Set 1) and 75° E/145 (Set 2), will facilitate slabbing of the tunnel crown (Set 1) and produce a ragged tunnel profile (Set 2), especially as most joints are clay coated (Goldsmith, 1976). With light blasting, a reduced advance per round, and prompt installation of support, overbreak in rock of this condition will be around 75 percent (calculated "B" line structural overbreak)* or 40 percent outside of "C" line. In extremely weathered rock jack-picking may be preferable to pattern drilling and blasting. See Purcell (1977) for details of overbreak calculations.

Tunnel Portals

South Portal. The recommended site is at about Station 2230 m. The portal cut at this location would be 8 m above crown and would expose highly and extremely weathered rock, so substantial support will be necessary. Careful excavation, short rounds of less than 1 m advance, and immediate erection of steel set supports, will help restrain blocks that by failure constitute overbreak in crown and walls.

North Portal. Similar rock conditions are indicated between Stations 1900 and 1950 m. The height of a portal face between these stations ranges from 7.5 to 10 m and would expose soil and extremely to highly weathered rock. It is recommended that the portal be established at about Station 1940. Careful excavation of the portal will be necessary to reduce overbreak. The portal

---

* $\dfrac{\text{Actual tunnel profile after excavation}}{\text{design area inside B line}} \times \dfrac{100}{1}$

cut will be in extremely to highly weathered rock and will need to be stabilised to prevent erosion and slumping.

CONCLUSIONS

1. The tunnel is feasible but tunnelling conditions are generally expected to facilitate overbreak.

2. Steel set support will probably be required throughout the tunnel, and will need to be spaced at 1 m centres with complete timber lagging in places.

3. Recommended portal sites are Station 1940 (North Portal) and Station 2230 (South Portal). Portal cuts will need to be stabilised against erosion and possible slippage.

4. With careful excavation techniques, overbreak beyond the B line can be limited to 75 percent.

5. Groundwater inflows are not expected but some seepage after rain may occur.

PROPOSED PIPELINE ROUTE BENEATH MURRUMBIDGEE PARK DRIVE

INTRODUCTION

The pipeline route for the Lanyon trunk sewer between chainages 375.4 and 491 lies within a road cut section of Murrumbidgee Park Drive, adjacent to the southbound carriageway (Fig. 1). The proposed engineering work is shown on Figure 4. The roadway and associated cuts will be constructed first; it is then planned to excavate for the pipeline to an invert level of 551 m RL in a southerly direction and approach as close as is feasible to the top of the batter slope for the roadway (see Section A-B in Fig. 4). At this point trenching will cease and a tunnel about 15 m long beneath the road cut batter slope will be excavated from the north to Manhole 2. This procedure will leave the batter slope for the roadway in undisturbed material, thus maintaining the maximum possible stability.

ENGINEERING GEOLOGY

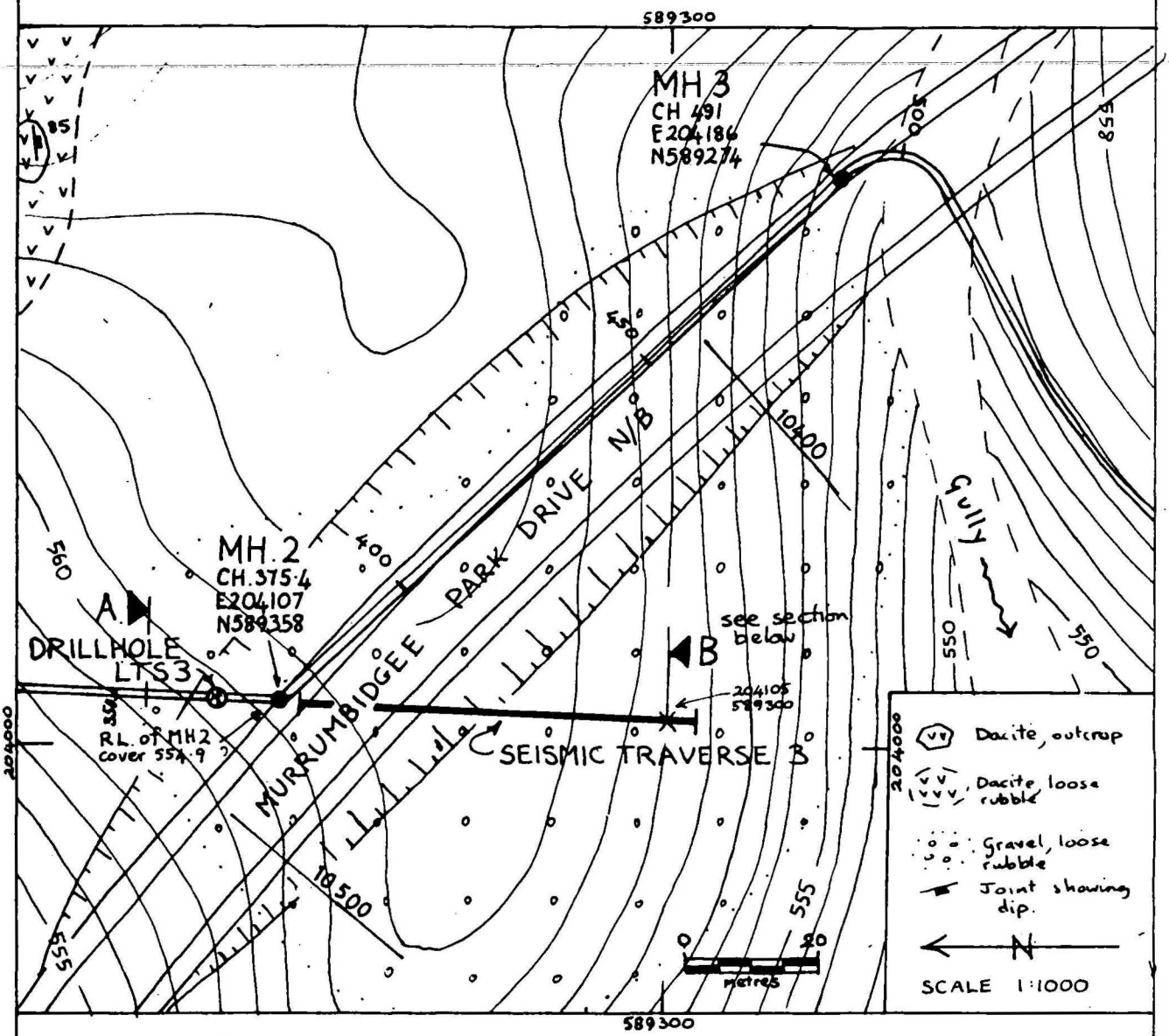
Rocks do not crop out over the immediate site, but moderately to slightly weathered dacite is present on a hill to the northeast. Joints are partly open and have a rough surface; two sets of vertical joints were observed, 90/070-080 and 90/165; shallow-dipping joints are present but could not be measured. Drillhole LTS3 indicated numerous joints dipping 45 degrees, which probably dip west.

Drillhole LTS3 intersected moderately weathered dacitic tuff at 4 m depth, but a closely fractured zone between 6.5 m and 8.4 m is highly to extremely weathered. Hard and strong, slightly weathered to fresh rock occurs from 8.4 m to the end of the hole at 14.05 m. Joints are moderately to widely spaced; many joints dip at 45° and are parallel to veins of sericite and epidote and their weathering products: some are clay.

Seismic traverse 3 (Fig. 4) is one of a number of traverses completed along the line of the Lanyon trunk sewer (Koelle, 1975). Results indicate fresh rock at 8-9 m which agrees

LANYON TRUNK SEWER

SECTION OF PIPELINE ROUTE (CH. 350 - 550)
BENEATH MURRUMBIDGEE PARK DRIVE



SECTION A-B SHOWING PROPOSED WORKS

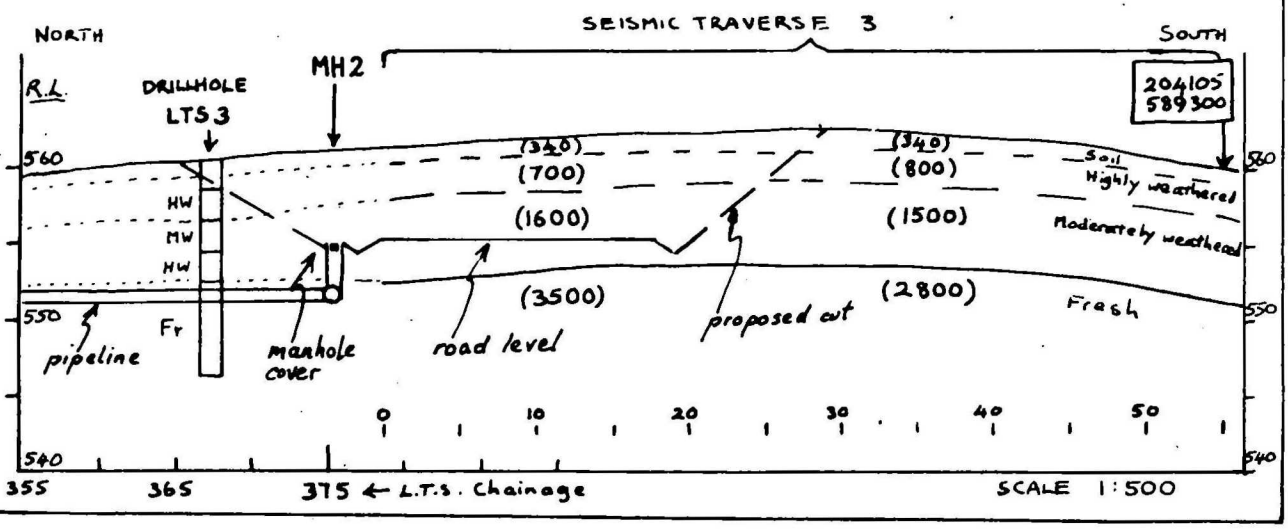


FIG. 4

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with the drilling results, and moderately weathered rock with a seismic velocity of 1500-1600 m/s between 3.5 and 9 m.

Tunnelling conditions

The short tunnel will be excavated in slightly weathered to fresh rock, but zones of highly weathered rock will be close to the crown. The closely jointed zone, seen in drillhole LST3, is estimated to dip west at about 45° which is an unfavourable orientation for the trench and short tunnel. In the tunnel some steel supports will be necessary, but careful excavation and the minimum delay in setting supports will reduce overbreak.

Trench stability

Temporary shoring on the east wall of the trench north of chainage 375 will be necessary in places (Goldsmith, 1975, page 9). The section of trench southeast of chainage 375 m and parallel to the Murrumbidgee Park Drive is better oriented with respect to regional joints, but precautions should be taken against failure on the eastern trench wall, and also in the road cut.

Road cut conditions

It is recommended that the batter for the road cut be no steeper than 45° on the eastern side, because of the frequency of joints dipping 45° west. The batter on the western side may be cut to a steeper angle, about 60-70°, as the joints dip into the slope.

Recommendation

A more accurate prediction of tunnelling conditions should be made after sheared zones and joint sets exposed during excavation of the road cut and the pipeline trench north of chainage 375 have been geologically mapped.

Reference

Goldsmith, R.C.M., 1975 - Lanyon Trunk Sewer, geological investigation, 1975. Bureau of Mineral Resources, Australia Record 1975/173 (unpubl.).

Koelle, A., 1975 - Lanyon Trunk Sewer, seismic survey. Department of Housing and Construction Central Testing and Research Laboratories Report No. 156.

Purcell, D.C., 1977 - Tuggeranong sewer tunnel, A.C.T., Engineering geology completion report, 1977. Bureau of Mineral Resources, Australia, Record 1977/68 (unpubl.).

APPENDIX 1

DRILL LOGS LTS 1, 2, AND 3

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GEOLOGICAL LOG OF DRILL HOLE

PROJECT LANYON TRUNK SEWER
LOCATION PINE ISLAND TUNNEL SITE – TUGGERANONG A.C.T.
ANGLE FROM HORIZONTAL (θ) 90 DIRECTION
COORDINATES E 704000 N 588000 R.L. OF COLLAR 566m

HOLE NO. 1
SHEET 1 OF 1

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
SAND, GRAVEL AND EW ROCK	Fragments of gravel up to 5cm (broken) of quartz and lithic fragments.			ROCK ROLLER 30	1–3						
TUFF EW	Core compact but soft, light tan, medium grained. some decomposed "sandy" layers.		TT	25	3–5				Limonite stained joints are preserved in the core, but it crumbles in hand.		
ASHSTONE EW–HW	Light tan, fine grained, thinly bedded, with banding 2–5 mm thick, dip 0–5°. Rock weak and soft.		TT	90	5–6		10		Extensively fractured, with many EW zones, joints coated in clay and Fe + Mn oxides.		
ASHSTONE MW (EW ZONES)	Greenish tan and light grey colour, grainsize very fine and even; rock has weak strength and is soft – most core can be broken by hand. Banding is mostly absent, but minor bands dip 5–10°.			100	6–7		10				
				100	7–8		0		The rock is very closely fractured; joints and fractures coated in clay, epidote and Fe + Mn oxides. Crushed zones with clay and sand infillings are up to 15cm thick (spaced 1–1.5 m). Core lengths up to 15 cm long, but easily crumbled. Rock weak and loose as a mass and is also inherently weak. Open closely spaced joints, poor tunneling conditions.		
				100	8–9		0				TUNNEL INVERT
				100	9–10		10				
				100	10–11		0				
				100	11–12		10				
				100	12–13		10				
				100	13–14		0				
Band of cherty ashstone 20cm thick				100	14–15		10				
END OF HOLE 15.1m.				100							
										DRY 17/5/76	

NMLC

Drill type MOLE PIONEER
Feed CROWD PRESSURE
Core barrel type ROCK ROLL
0–2.5m, NMLC 2.5–15.1m
Driller D.H.C. (W. HART)
Commenced 22-3-76
Completed 31-3-76
Logged by R. Goldsmith
Vertical scale 2-4-76
Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.
Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.
Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.
Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

EW – Extremely weathered.
HW – Highly weathered.
MW – Moderately weathered.

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.

Core Photograph Negative No.

Depth (m)	Black & White	Colour

M(Pf)146

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16/155-16/3 Sheet 1 of 2

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: LANYON TRUNK SEWER
LOCATION: PINE ISLAND TUNNEL SITE - TUGGERANONG, A.C.T.
ANGLE FROM HORIZONTAL (θ): 90 DIRECTION:
COORDINATES: E 204190 N 587823 R.L. OF COLLAR: 568

HOLE NO. 2
SHEET 1 OF 1

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
SOIL + EW DACITE				AUGER / ROCK ROLLER	0 6 12 18+						
DACITE EW	Completely friable, but original rock fabric seen in core (in situ weathering). Sandy texture at 6-7 m. Yellow-brown colour.			100 / 40 / 45	NMLC				some core pieces up to 15cm long, but can be broken by hand		
DACITE HW-EW	About 50% of core is highly weathered, remainder is extremely weathered friable material. Some broken pieces of core, much softer material washed away in drilling water. Rock foliated at 45°			50 / 75 / 100 / 100					Core pieces 2-3cm, up to 12-15 cm. Joints generally flat dipping and closely spaced and even. Limonite staining on joint faces, little or no clay		
DACITE MW	Greenish brown, porphyritic texture with quartz and plagioclase phenocrysts 3-6 mm in size. Xenoliths of dark red Fe-oxides up to 2-3 cm. Irregular texture.			100 / 100 / 100 / 100 / 100			65 / 100 / 60		10cm crushed zone, open EW sandy material, no clay. From 12.5 m rock is generally mod. hard and strong, but joints open + rough with some up to 10cm thick silty sand and Fe oxides line joint faces, little or no clay. Core lengths 10-30cm, up to 55cm. 2cm crushed joint, sand. v. minor clay.	▽ 14.58 m 22/3/76 TUNNEL INVERT	
END OF HOLE 16.20 m				100						▽ DRY 17/3/76	

Drill type: MOLE PIONEER
Feed: CROWD PRESSURE
Core barrel type: AUGER + R.R
0-4 m, NMLC 4-16.2 m
Driller: DHC (W. HART)
Commenced: 17/3/76
Completed: 22/3/76
Logged by: R. Goldsmith
Vertical scale: 1cm = 1m
Checked by:

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

EW - Extremely weathered
HW - Highly weathered
MW - Moderately weathered

Water Pressure Tests

* *Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

M(Pf)146

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT LANYON TRUNK SEWER
LOCATION TUGGERANONG – SECTION OF SEWER WHERE IT ALIGNS WITH MURRUMBIDGEE PARK DRIVE
ANGLE FROM HORIZONTAL (θ) – 90° DIRECTION ——
COORDINATES E 20408 N 589367 R.L. OF COLLAR 560.5 m

LTS HOLE NO 3
SHEET 1 OF 1

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
					0 6 12 18+						
DACITIC TUFF HW	Light tan to mid brown, med. weak, soft – plagioclase phenocrysts weathered to white.			100	1 2		0		Joints mod. closely spaced, weathered up to 10 cm thick (no clay on faces – but limonite stains on rough joint faces. Dip 70–90°, some 0–30°.		
				100	3		55				
DACITIC TUFF MW				100	4		60		Joints open and limonite stained, some clay and grit in weathered-out joints. Some smooth widely spaced clay-coated joints dip 60°.	▼ 4.6 m. 8/4/76	
				100	5		60				
				100			40				
				100	6						
DACITIC TUFF HW, some EW	Light tan to yellow brown, core can be broken by hand, gen. soft and crumbly.			40	7		20		Zone of closely fractured rock, joint faces clay coated. Mass is open and loose.		
				100	8		60				
SW	Grey-green dacitic tuff – phenocrysts of quartz, light green plagioclase and red-brown stained quartz and Fe-oxide patches. Rock welded to form a very hard and strong mass. A network of v. thin sericite/epidote			100	9		80		From 8.4m the rock mass is hard and strong with mod. to widely spaced joints. Joint faces contain sericite and epidote – some weathered to clay (minor). Faces smooth to slightly rough. Dip 45° and some parallel to veins.		
DACITIC TUFF Fresh				100	10		100				invert level of pipeline
				100	11		80				
				100	12		95				
				100	13		90				
					14						

END OF HOLE 14.05 m.

Drill type MOLE PIONEER
Feed CROWD PRESSURE
Core barrel type ROCK ROLL – 0–2 m, NMLC 2–14 m
Driller D. of C.
Commenced 1/4/76
Completed 6/4/76
Logged by R. GOLDSMITH
Vertical scale 1cm = 1m
Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in
Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis
Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range
Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date

EW – Extremely weathered
HW – Highly weathered
MW – Moderately weathered
SW – Slightly weathered
Fr – Fresh

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.

Core Photograph Negative No

Depth (m)	Black & White	Colour

Record No. 1980/81

16/155-16/8