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GEOLOGICAL EVALUATION OF THE PROPOSED DALTON TO CANBERRA NATURAL GAS PIPELINE, 1980

by

R. Evans

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ABSTRACT

The excavation conditions along the proposed route of the Dalton to Canberra Natural Gas Pipeline have been investigated. It is expected that 32 percent of the route will require blasting to allow excavation and about 83 percent of the route is covered by soil.

INTRODUCTION

The Dalton to Canberra natural gas pipeline project involves the construction of a buried pipeline 57 848 m long and 273 mm outside diameter. The pipeline will commence at Dalton, the main gas pipeline connecting the Moomba gas field to Wilton, N.S.W., and terminate in North Canberra (Fig. 1). The accommodating trench will be 1.25 to 2.00 m deep and about 600 mm wide.

The Bureau of Mineral Resources was requested by the Pipeline Authority to provide information relating to engineering geology along the proposed pipeline route, including:

(a) the approximate length of the trench to be excavated in soil;

(b) The approximate length of the trench to be excavated in rock which can be ripped by a bulldozer;

(c) the approximate length of the trench where blasting of rock will be required;

(d) the depth to the groundwater table;

(e) the possibility of landslip movements along the route; and

(f) the nature of the soil having regard to its characteristics when wet.

The proposed route was inspected during July and August, 1980.

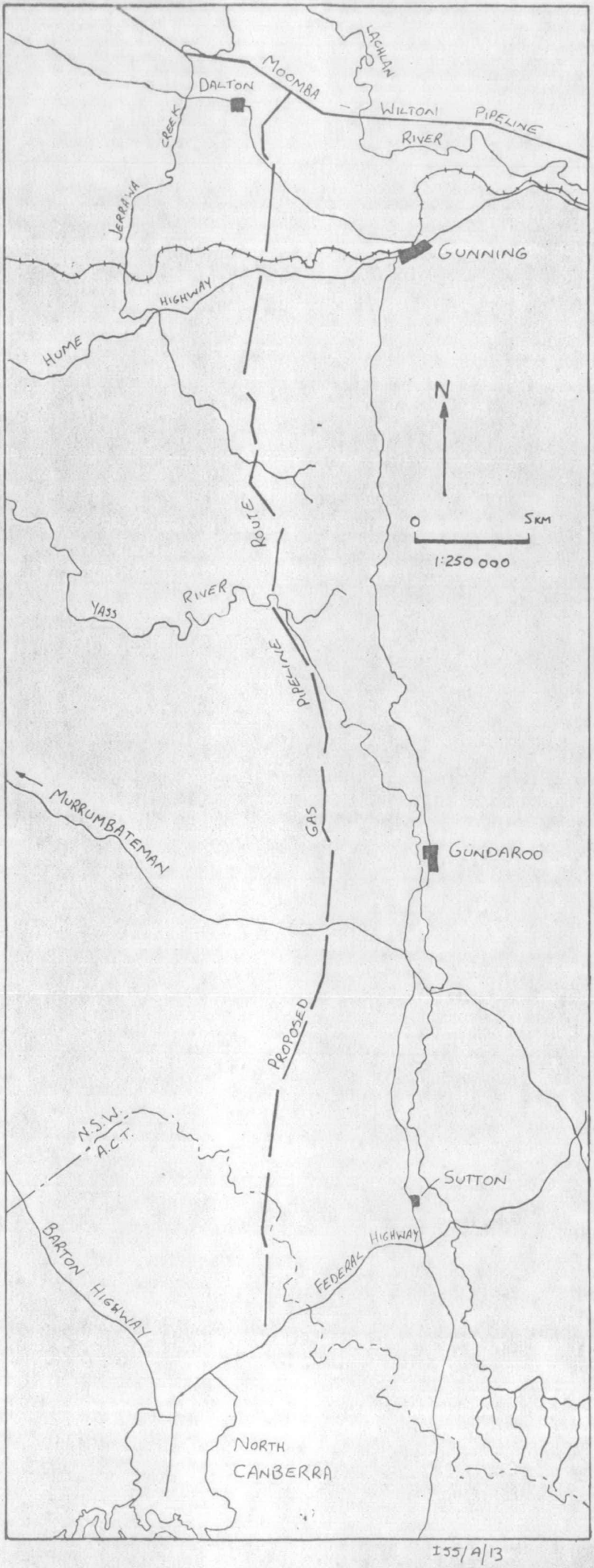
GENERAL GEOLOGY

The location of the proposed route is shown in Figure 1 and the geology in Plates 1 to 9.

DALTON - CANBERRA GAS PIPELINE

FIGURE 1

Location Map



The pipeline route begins in metamorphosed Ordovician sandstone, siltstone and shale, near Dalton. It traverses southward, through increasing metamorphic grade*, into a granodiorite body. The Ordovician country rock at the contact, is metamorphosed to a high grade hornfels. The granodiorite is a massive uniform body cut by numerous aplitic and micro-granodioritic dykes. At the southern contact the route passes back into high grade Ordovician hornfels, and more gradually, into sandstone, siltstone and shale.

This sandstone-shale sequence continues to the south of the pipeline routes' crossing of the Yass River. At the crossing there is a small capping of Tertiary quartz gravel. Further to the south the route traverses through areas of silicified black shale and slate, interbedded within the sandstone-shale sequence, by now a very low grade hornfels. The percentage of shale within the sandstone-shale sequence decreases towards the south until a predominately sandstone unit is entered adjacent to the Gundaroo-Murrumbateman Road.

The pipeline route continues through the Ordovician sandstone unit into a Silurian shale, tuff and minor limestone sequence. The contact is characterised by shale breccia zones variably replaced by quartz and gossanous ironstone. The shale unit lies conformably under dacitic and rhyolitic tuffs and the proposed route follows the contact between the two units, through to the Canberra terminus.

DETAILED GEOLOGY AND EXCAVATION CONDITIONS

Ordovician Sedimentary Rocks (ch 000 - 2800, ch 16630 - 43967)

The Ordovician sedimentary rocks comprise two different lithological assemblages. For most of the route, the Ordovician

*Metamorphic grade is here used in the geologic sense, that is, increasing grade implies minerals produced in response to higher temperature or pressure.

consists of interbedded sandstone, siltstone, shale and minor quartzite and greywacke. This sequence is usually metamorphosed to low grade hornfels and is locally contact metamorphosed to higher grades.

In a small area between ch 38300 to 43967 the sequence consists of sandstone and minor shale, both relatively unmetamorphosed.

Minor interbedded silicified black shales and slates occur from chainage 21900 to 22110, and from 31510 to 33890.

Most of the Ordovician rocks traversed by the route are moderately weathered and jointed and, thus, hard. They will probably require blasting to obtain invert. However, the sandstone unit to the south is moderately to highly weathered and will probably be rippable (Table 1).

Silurian Sedimentary Rocks (ch 43967 - 57848)

The Silurian sequence can be divided into two units. A lower unit comprising highly weathered shale and fine grained sandstone with interbedded tuffaceous sandstone, dacitic and rhyolitic tuffs and minor calc-silicate hornfels and limestone; and upper conformable unit comprising a dacitic tuff and shale sequence, a rhyolitic tuff and shale sequence and an andesitic tuff sequence.

The lower unit is characterised by a gossanous ironstone alteration along joint planes within the shale. This lower unit should generally be rippable unless minor dacitic tuffs, calc-silicate hornfels, limestone or gossanous alteration layer are intersected. These areas would probably require blasting, refer Table 1.

The upper unit, part of the Ainslie Volcanics, consists of a basal dacitic sequence of agglomerate, ashflow tuffs and shale; a sequence of rhyolitic ashflow tuffs and shale; and andesitic tuffs.

SECTION	LENGTH IN METRES	PERCENTAGE OF TOTAL ROUTE	LITHOLOGY	SOIL			OUTCROP			RIPPABLE			BLASTING		
in chainage		%		% of		Metres	% of		Metres	% of		Metres	% of		Metres
				Sect'n	Total Route		Sect'n	Total Route		Sect'n	Total Route		Sect'n	Total Route	
57848 - 52500	5348	9.2	Silurian Volcanics	84.9	7.8	4541	15.1	1.4	807	56.8	5.3	3039	43.2	3.9	2309
52500 - 43967	8533	14.8	Silurian Shale	99.9	14.8	8523	0.1	-	.10	96.5	14.2	8233	3.5	0.6	300
43967 - 38300	5667	9.8	Ordovician Sandstone	95.6	9.4	5417	4.4	0.4	250	95.6	9.4	5417	4.4	0.4	250
38300 - 16630	21670	37.5	Ordovician Sandstone Shale	74.3	27.8	16100	25.7	9.7	5570	68.8	24.6	14250	34.2	12.9	7420
16630 - 2800	13830	23.9	Granodiorite	90.2	21.6	12470	9.8	2.3	1360	56.9	13.6	7870	43.1	10.3	5960
2800 - 000	2800	4.8	Ordovician Sandstone, Shale	23.9	1.2	670	76.1	3.6	2130	17.7	0.9	495	82.3	3.9	2305
TOTALS	57848	100.0			82.6	47721		17.4	10127		68.0	39304		32.0	18544

Table 1.

Excavation Along the Proposed Route

Within the dacitic and andesitic sequences densely welded crystal tuffs are common. Excavation within this unit will probably be by ripping except where the harder crystal tuffs are intercepted, and then excavation will be by blasting, refer Table 1.

Granodiorite Intrusion (ch 2800 - 16630)

Massive hornblende-biotite granodiorite intrudes the Ordovician sediments from chainages 2800 to 16630. This body shows typical irregular granitic weathering patterns and the rocks range from slightly weathered to extremely weathered in outcrop. Due to the irregular nature of granitic weathering, the pattern of distribution of moderately weathered material within the top 2 m is variable. This means that more resistant sections requiring blasting may be struck at any time during construction.

Veins and Dykes

Numerous quartz veins have been mapped, particularly in the region of chainage 3830. They are usually moderately jointed and should be rippable where they are not excessively thick. Gossanous replacement of shale breccia (shear zones) is also common within the same area. Again, excavation through these structures should be by ripping except where they are of excessive thickness or where they have been silicified.

Dykes of aplitic, microgranitic and granitic composition usually occur within the Ordovician sequence. These rocks are jointed but will need to be excavated by blasting.

Quartz Gravel

Tertiary quartz gravels lie along and adjacent to the pipeline route. These bodies form a capping up to 1 m thick in the Yass River

area usually within 50 m vertical height of the river bed. Despite the apparent minor nature of these bodies they have been described in the Gundaroo area as being silicified. If such a body is encountered it would require excavation by blasting.

Surficial Material

The surficial cover material consists of varying thicknesses of poorly sorted mixtures of clay, silt, sand and gravel. In the areas of thicker alluvial or colluvial accumulation, layering is evident. All surficial cover will be rippable. Most creek channels crossing the pipeline route are deeply incised (up to 3 m) within this material. The banks of these creeks are nearly always vertical indicating stable cohesive conditions. Layers with low clay and high silt content will, when in a near saturated to saturated condition, produce unstable conditions in a vertical cut. No layers of that composition were noted in any creek profiles.

Excavation Conditions

Excavation conditions are summarised in Table 1. About 82% of the route is covered by soil. The approximate length of trench in rippable material is 39304 m (or 68% of route), the remainder of the route (32%) being rock which will need blasting for excavation. The estimates are qualitative as no subsurface investigation was done, and the excavation percentages could vary.

GROUNDWATER

Excavations to a 2 m maximum depth will not be affected by regional water tables, except in close proximity to the Yass River. The excavation may, however, intercept perched aquifers within layered surficial material. The quantity of groundwater inflows will depend upon the prevailing moisture conditions during construction. Inflows will be larger during wetter periods. Areas where drainage problems are anticipated are listed in Appendix 1.

SEISMIC ACTIVITY AND CRUSTAL STRAIN RATES

Most of the pipeline route lies within seismic risk zone A, while the northern portion lies in risk zone 1, according to the Standards Association of Australia's earthquake risk map. The zones are defined as having a minimum return period for an earthquake of intensity VI (Modified Mercalli scale) of 300 years and 60 years respectively; and as having, for a return period of 5000 years, a maximum intensity of VIII and XI, respectively. A plot of seismic activity for the route area is presented in Figure 2.

Crustal strain rates for the Dalton-Gunning area have been measured at about 0.02 μradian per year (P. Wellman, BMR, personal communication). It is thought that this strain rate is accumulating uniformly through the area and that it is released along pre-existing major faults. Due to the small magnitude of the strain rate and its uniform accumulation it is considered insignificant in the context of pipeline stability. However, long term seismic risk should be considered in design.

CONCLUSIONS

1. The proposed route traverses soil for about 47721 metres, or 82% of its length. Rippable conditions exist for 39304 m, or 68%, and blasting may be required for the remainder, 18544 m or 32%.

2. The trench will lie above the regional water table, except adjacent to the Yass River, but will encounter inflows from perched lenses within the surficial cover.

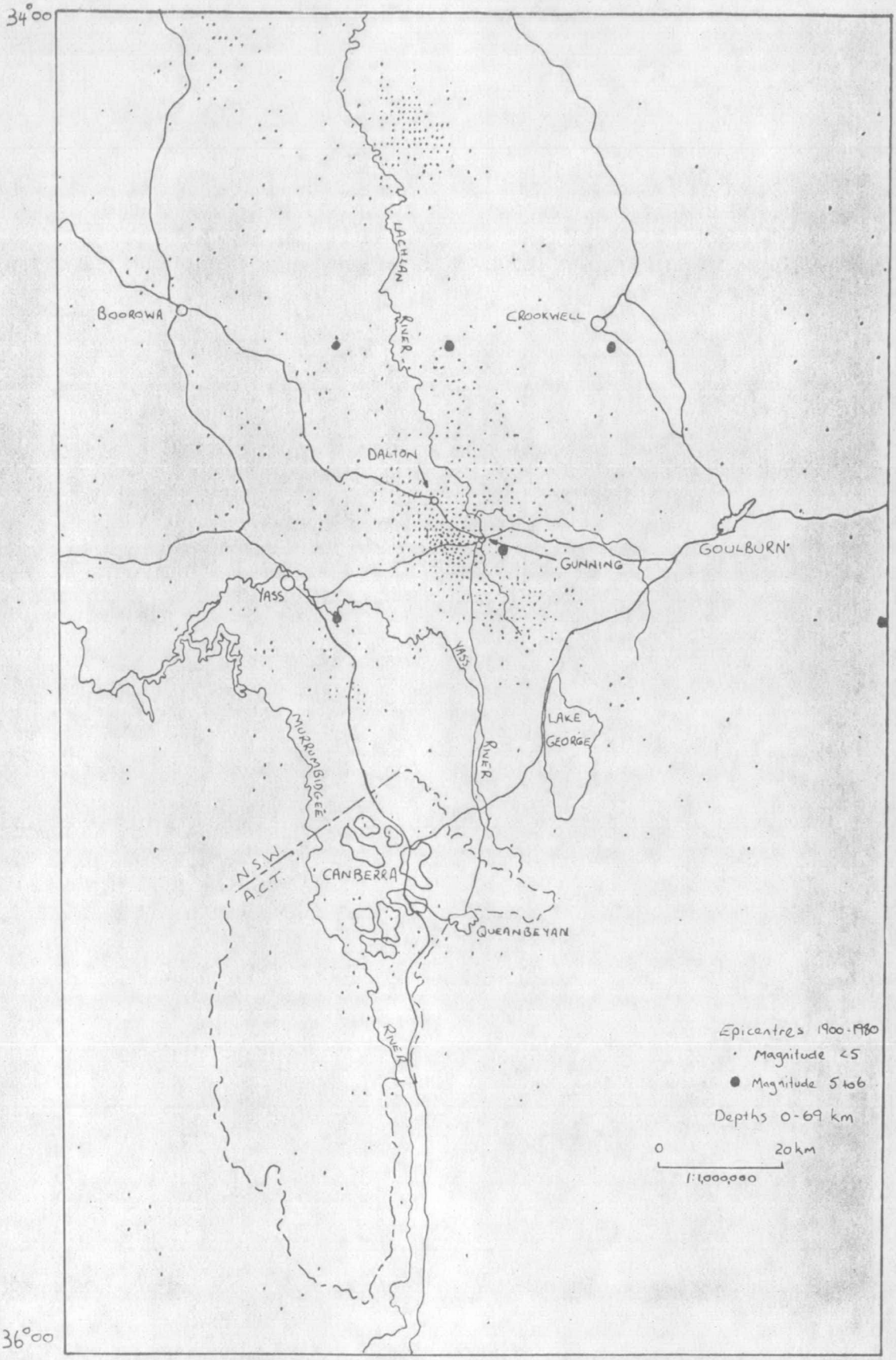


FIGURE 2

SEISMIC ACTIVITY

3. It is considered unlikely that any land slippage will occur along the trench line. The trench should be stable and stand alone, except in areas where the surficial material has a high moisture content and a low clay and high silt content.

4. The crustal strain rate, though relatively high, is not considered significant for this particular pipeline. The pipeline joins the main Moomba to Wilton pipeline within an area of relatively high seismic risk for Australia.

REFERENCES

STANDARDS ASSOCIATION OF AUSTRALIA, 1979 - The Design of Earthquake Resistant buildings. Australian Standard Rules AS 212-1979.

APPENDIX 1

GROUNDWATER CONDITIONS

Chainage	Condition
378 - 391	Flowing River, creek or swamp
3695 - 3701	" " "
4474 - 4485	" " "
3050 - 5100	Possible major inflows, plus minor seepage
6250 - 6663	Minor seepage from isolated lenses
6663 - 6678	Flowing river, creek or swamp
7250 - 7500	Minor seepage from isolated lenses
7500 - 7740	Flowing river, creek or swamp
7740 - 8700	Minor seepage from isolated lenses
11034 - 11043	Flowing river, creek or swamp
11400 - 11850	Minor seepage from isolated lenses
11950 - 12200	" " "
12250 - 12600	" " "
13400 - 13700	" " "
15248 - 15271	Flowing river, creek or swamp
15100 - 16100	Possible major inflows, plus minor seepage
16984 - 16990	Flowing river, creek or swamp
16500 - 17010	Minor seepage from isolated lenses
18030	Spring
18350	Minor seepage from isolated lenses
20590 - 20650	" " "
20800	" " "
21000	Spring
21150 - 21320	Minor seepage from isolated lenses
22000 - 22300	" "
22850 - 22875	" "
23180 - 23220	" "
23400 - 23900	Flowing river, creek or swamp
24100 - 27980	Possible major inflows, plus minor seepage
28260 - 28350	Minor seepage from isolated lenses
28450 - 28700	" "
28970 - 29180	" "
30600	" "
31200 - 31300	" "

Chainage	Conditions
32750	Minor seepage from isolated lenses
33010 - 33140	" " "
33750 - 33900	" " "
33950 - 33975	" " "
34040 - 34050	" " "
34910	Spring
35750	Minor seepage from isolated lenses
36500	" "
36700	" "
38450 - 38500	" "
38750 - 38800	" "
38850 - 39000	" "
39500 - 41000	Possible major inflows, plus minor seepage
44900 - 44500	" "
46020 - 48600	" "
48900 - 53000	Minor seepage from isolated lenses
53912 - 54465	" "
56020 - 56112	" "
56293 - 56412	" "
57512 - 57848	" "

PLATE 1

DALTON TO CANBERRA NATURAL GAS PIPELINE
GEOLOGICAL PLAN OF ROUTE
ch. 000 – ch. 6250

- Pipeline route station in metres
- Alluvium, Colluvium
- Quartz Gravel
- Granodiorite, microgranodiorite, quartz porphyry
- Andesitic tuffs
- Rhyolitic tuffs
- Dacitic tuffs
- Shale, fine grained sandstone limestone
- Dacitic tuffs
- Rhyolitic tuffs
- Black shale, silicified siltstone, shale, sandstone
- Sandstone
- Hornfels
- Geological boundary
- Continuous Rock Outcrop
- Scattered Rock Outcrop and Boulders
- Bedding with dip
- Joint with dip
- Cleavage with dip
- Fault, position approximate
- Vein q-quartz, Fe-ironstone, sh-shale breccia, ap-aplite, mg-microgranite

SCALE

0 500 metres

(To accompany Record 1980/59)

I55/A/15

PLATE 2

DALTON TO CANBERRA NATURAL GAS PIPELINE

GEOLOGICAL PLAN OF ROUTE

ch. 6250 — ch. 13040

- *Pipeline route station in metres*
- *Alluvium, Colluvium*
- *Quartz Gravel*
- *Granodiorite, microgranodiorite, quartz porphyry*
- *Andesitic tuffs*
- *Rhyolitic tuffs*
- *Dacitic tuffs*
- *Shale, fine grained sandstone limestone*
- *Dacitic tuffs*
- *Rhyolitic tuffs*
- *Black shale, silicified siltstone, shale, sandstone*
- *Sandstone*
- *Hornfels*
- *Geological boundary*
- *Continuous Rock Outcrop*
- *Scattered Rock Outcrop and Boulders*
- *Bedding with dip*
- *Joint with dip*
- *Cleavage with dip*
- *Fault, position approximate*
- *Vein* q-quartz, Fe-ironstone, sh-shale breccia, ap-aplite, mg-microgranite

SCALE

0 500 metres

(To accompany Record 1980/59)

I55/A/16

214
654
215
217
652
651
650
648
14 000
15 000
16000
17000
18000
19 000
M F
OR
Berrebangalo
Scattered
Forest
Moatown

PLATE 3

DALTON TO CANBERRA NATURAL GAS PIPELINE
GEOLOGICAL PLAN OF ROUTE
ch. 13040 — ch. 19150

- *Pipeline route station in metres*
- *Alluvium, Colluvium*
- *Quartz Gravel*
- *Granodiorite, microgranodiorite, quartz porphyry*
- *Andesitic tuffs*
- *Rhyolitic tuffs*
- *Dacitic tuffs*
- *Shale, fine grained sandstone limestone*
- *Dacitic tuffs*
- *Rhyolitic tuffs*
- *Black shale, silicified siltstone, shale, sandstone*
- *Sandstone*
- *Hornfels*
- *Geological boundary*
- *Continuous Rock Outcrop*
- *Scattered Rock Outcrop and Boulders*
- 60 *Bedding with dip*
- 60 *Joint with dip*
- 80 *Cleavage with dip*
- *Fault, position approximate*
- *Vein* q-quartz, Fe-ironstone, sh-shale breccia, ap-aplite, mg-microgranite

SCALE

0 — 500 metres

(To accompany Record 1980/59)

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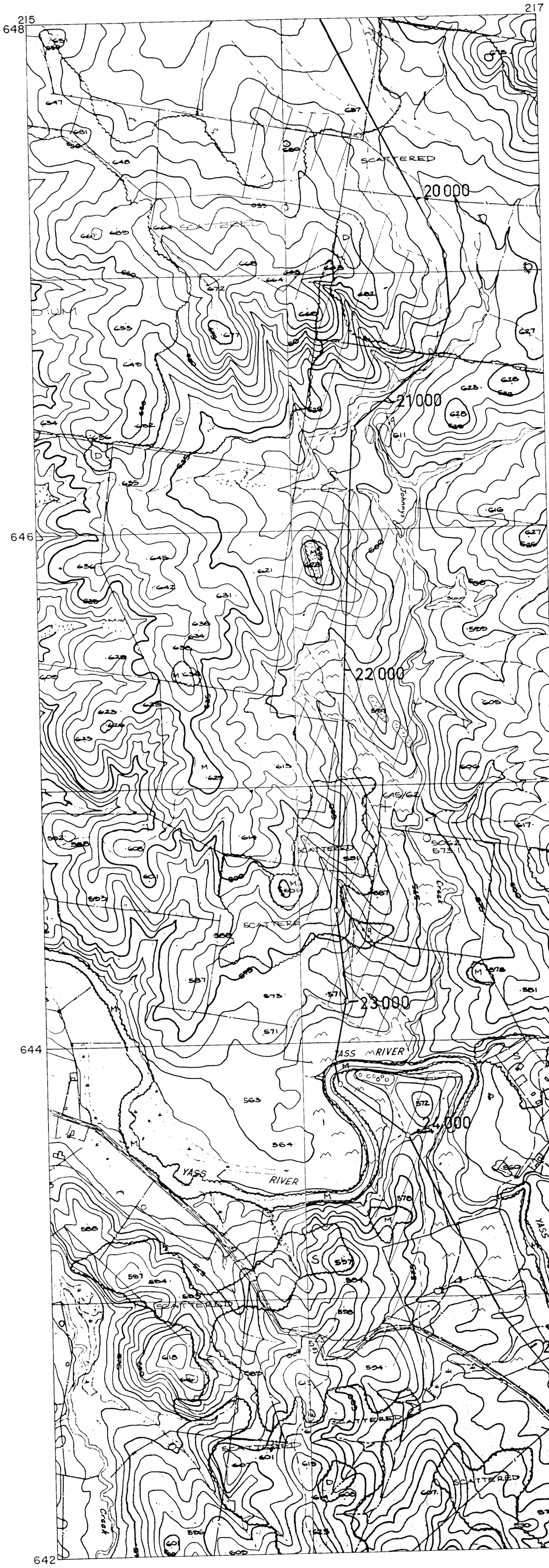

PLATE 4

DALTON TO CANBERRA NATURAL GAS PIPELINE

GEOLOGICAL PLAN OF ROUTE

ch. 19150 — ch. 25940

Pipeline route station in metres

Alluvium, Colluvium

Quartz Gravel

Granodiorite, microgranodiorite, quartz porphyry

Andesitic tuffs

Rhyolitic tuffs

Dacitic tuffs

Shale, fine grained sandstone limestone

Dacitic tuffs

Rhyolitic tuffs

Black shale, silicified siltstone, shale, sandstone

Sandstone

Hornfels

Geological boundary

Continuous Rock Outcrop

Scattered Rock Outcrop and Boulders

Bedding with dip

Joint with dip

Cleavage with dip

Fault, position approximate

Vein q-quartz, Fe-ironstone, sh-shale breccia, ap-aplite, mg-microgranite

SCALE

0 — 500 metres

(To accompany Record 1980/59)

I55/A/18

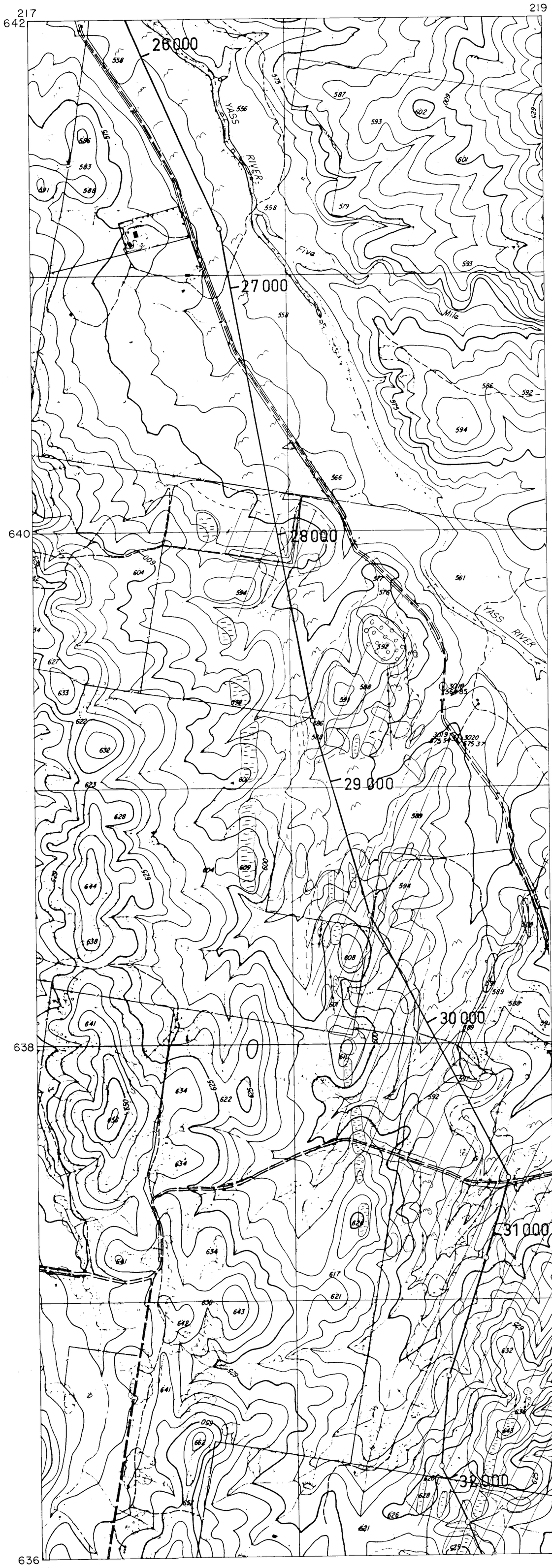

PLATE 5

DALTON TO CANBERRA NATURAL GAS PIPELINE

GEOLOGICAL PLAN OF ROUTE

ch. 25940 — ch. 32320

Pipeline route station in metres

Alluvium, Colluvium

Quartz Gravel

Granodiorite, microgranodiorite, quartz porphyry

Andesitic tuffs

Rhyolitic tuffs

Dacitic tuffs

Shale, fine grained sandstone limestone

Dacitic tuffs

Rhyolitic tuffs

Black shale, silicified siltstone, shale, sandstone

Sandstone

Hornfels

Geological boundary

Continuous Rock Outcrop

Scattered Rock Outcrop and Boulders

60 *Bedding with dip*

60 *Joint with dip*

80 *Cleavage with dip*

Fault, position approximate

Vein q-quartz, Fe-ironstone, sh-shale breccia, ap-aplite, mg-microgranite

SCALE

0 — 500 metres

(To accompany Record 1980/59)

I55/A/19

218
636

220

634

632

630

32 000

33 000

34 000

35 000

36 000

37 000

38 000

PLATE 6

DALTON TO CANBERRA NATURAL GAS PIPELINE

GEOLOGICAL PLAN OF ROUTE

ch. 32320 — ch. 38480

Pipeline route station in metres

Alluvium, Colluvium

Quartz Gravel

Granodiorite, microgranodiorite, quartz porphyry

Andesitic tuffs

Rhyolitic tuffs

Dacitic tuffs

Shale, fine grained sandstone limestone

Dacitic tuffs

Rhyolitic tuffs

Black shale, silicified siltstone, shale, sandstone

Sandstone

Hornfels

Geological boundary

Continuous Rock Outcrop

Scattered Rock Outcrop and Boulders

60 *Bedding with dip*

60 *Joint with dip*

80 *Cleavage with dip*

Fault, position approximate

Vein q-quartz, Fe-ironstone, sh-shale breccia, ap-aplite, mg-microgranite

SCALE

0 500 metres

(To accompany Record 1980/59)

ISSN 120

218 219

630 628 626 624

39 000 40 000 41 000 42000 43000 44000

PLATE 7

DALTON TO CANBERRA NATURAL GAS PIPE

GEOLOGICAL PLAN OF ROUTE

ch. 38480 — ch. 44860

Pipeline route station in metres

Alluvium, Colluvium

Quartz Gravel

Granodiorite, microgranodiorite, quartz porphyry

Andesitic tuffs

Rhyolitic tuffs

Dacitic tuffs

Shale, fine grained sandstone limestone

Dacitic tuffs

Rhyolitic tuffs

Black shale, silicified siltstone, shale, sandstone

Sandstone

Hornfels

Geological boundary

Continuous Rock Outcrop

Scattered Rock Outcrop and Boulders

Bedding with dip 60

Joint with dip 60

Cleavage with dip 80

Fault, position approximate

Vein q-quartz, Fe-ironstone, sh-shale breccia, ap-aplite, mg-microgranite

SCALE

0 500 metres

(To accompany Record 1980/59)

I55/A/2.1

624 216 218

622

620

618

45000 46000 47000 48000 49000 50000 51000

Creek

SCATTERED

SCATTERED

GUNDAROO

GUNDAROO

GOOROOYARROO

ROAD

P.D

PLATE 8

DALTON TO CANBERRA NATURAL GAS PIPELINE

GEOLOGICAL PLAN OF ROUTE

ch. 44860 — ch. 51100

Pipeline route station in metres

Alluvium, Colluvium

Quartz Gravel

Granodiorite, microgranodiorite, quartz porphyry

Andesitic tuffs

Rhyolitic tuffs

Dacitic tuffs

Shale, fine grained sandstone limestone

Dacitic tuffs

Rhyolitic tuffs

Black shale, silicified siltstone, shale, sandstone

Sandstone

Hornfels

Geological boundary

Continuous Rock Outcrop

Scattered Rock Outcrop and Boulders

Bedding with dip

Joint with dip

Cleavage with dip

Fault, position approximate

Vein *q-quartz, Fe-ironstone, sh-shale breccia, ap-aplite, mg-microgranite*

SCALE

0 500 metres

(To accompany Record 1980/59)

I55/A/22

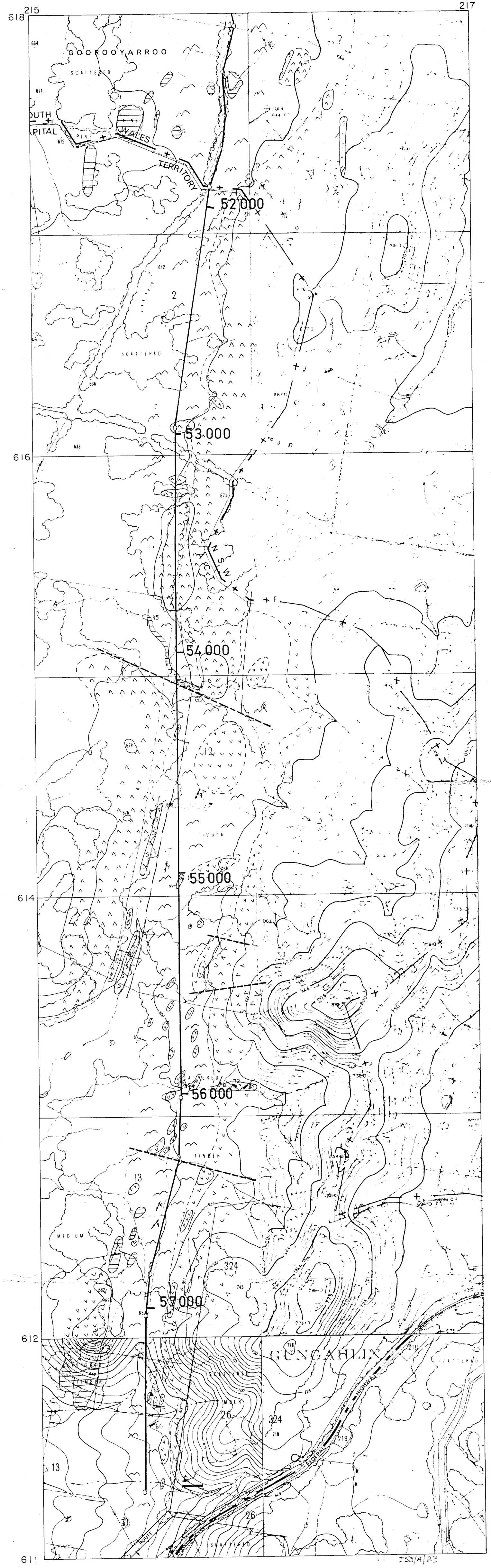

PLATE 9

DALTON TO CANBERRA NATURAL GAS PIPELINE

GEOLOGICAL PLAN OF ROUTE

ch. 51100 — ch. 57848

- *Pipeline route station in metres*
- *Alluvium, Colluvium*
- *Quartz Gravel*
- *Granodiorite, microgranodiorite, quartz porphyry*
- *Andesitic tuffs*
- *Rhyolitic tuffs* shale
- *Dacitic tuffs* shale
- *Shale, fine grained sandstone limestone*
- *Dacitic tuffs*
- *Rhyolitic tuffs*
- *Black shale, silicified siltstone, shale, sandstone*
- *Sandstone*
- *Hornfels*
- *Geological boundary*
- *Continuous Rock Outcrop*
- *Scattered Rock Outcrop and Boulders*
- *Bedding with dip* 60
- *Joint with dip* 60
- *Cleavage with dip* 80
- *Fault, position approximate*
- *Vein* q-quartz, Fe-ironstone, sh-shale breccia, ap-aplite, mg-microgranite

SCALE

0 — 500 metres

(To accompany Record 1:80/59)

I55/A/23