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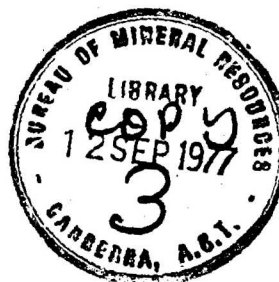
**DEPARTMENT OF
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**GOOGONG PIPELINE INVESTIGATION, 1975-76:
EXPECTED GROUND CONDITIONS FOR EXCAVATION**

by

J.M.M. Furstner

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SUMMARY

The excavation conditions along the proposed route of the Googong Pipeline were investigated by means of field inspections and a seismic refraction survey, and the route has been divided into a number of sections with different excavation conditions. It is expected that about 60 percent of the excavation length in New South Wales and 35 percent of the excavation length in the Australian Capital Territory will require drilling and blasting.

INTRODUCTION

The Googong Pipeline will carry water from the Googong Dam treatment plant 6 km southeast of Queanbeyan (NSW) to the Campbell Reservoir on the flank of Mount Ainslie in Canberra (A.C.T.) to supplement the water supply to Canberra and Queanbeyan (Fig. 1). The pipeline will be about 22 485 m long, and will decrease in diameter from 183 cm at the treatment plant to 72 cm at the Campbell Reservoir. The entire pipeline will be buried, and will require the excavation of a trench 3 to 5 m deep and rectangular in cross-section. The width of the trench, 245 cm to 130 cm, will vary with the pipeline diameter.

At the request of the Department of Construction, the Bureau of Mineral Resources, Geology and Geophysics (BMR) investigated the pipeline route to assess the excavation conditions. This assessment is based on field inspections of the entire route, seismic refraction surveys at 38 selected locations (Bennett & Polak, 1975), and the Canberra City 1:50 000 Geological Map and Explanatory Notes (Strusz & Henderson, 1971).

GENERAL

The excavation conditions expected along the pipeline route are described by four categories; they are:

SOFT GROUND, consisting of unconsolidated sediments such as topsoil, alluvium, colluvium etc., or highly to extremely weathered bedrock. Seismic velocities are generally less than 1200 m/sec. This material can generally be excavated by a backhoe without the use of explosives.

HARD GROUND, consisting of fresh to moderately weathered bedrock with less than 1 m overburden. Seismic velocities in this ground are generally more than 1200 m/sec. This material is generally not rippable by a backhoe and will require blasting.

PREDOMINANTLY SOFT GROUND, consisting of more than 50 percent soft ground.

PREDOMINANTLY HARD GROUND, consisting of more than 50 percent hard ground.

The pipeline route has been divided into sections according to the four categories. Sections range in length from 150 to 3730 m, and reflect variation in rock type, degree of weathering, and thickness of overburden along the route. The division presented here is a generalization of the ground conditions, and variation from the expected conditions is likely to be

encountered in some sections. However, a more detailed division is not appropriate as it would imply a higher degree of accuracy than can be expected from the investigation, and it is unnecessary for the purpose of construction planning.

A number of locations along the pipeline route as indicated below have been selected for testing the ground conditions of the various categories by auger drilling or the excavation of test pits.

THE NEW SOUTH WALES PORTION OF THE PIPELINE

About 9655 m of the pipeline route is in New South Wales. The depth of the excavation generally will vary from 3 to 5 m, the width of the trench will decrease from 245 cm near the treatment plant to 235 cm at the Australian Capital Territory border.

The geology and expected ground conditions for this portion of the excavation are presented in Plate 1. The stratigraphy of the area is presented in Table 1. The chainages of each of the sections, and the locations selected for field tests, are tabulated in Table 2.

The first 2250 m of the route is in the Googong Granite (Devonian) and dacite and sediments of the Colinton Volcanics (Silurian). The ground conditions over this interval are expected to be hard throughout except perhaps for about the last 100 m, where soft ground consists of thicker overburden and extremely weathered sediments.

From 2250 m to 5090 m the route crosses the Barrack Creek Adamellite (Devonian). Conditions in this rock type are variable, depending on the degree of weathering and thickness of overburden, but they are expected to be in the predominantly hard ground category.

Sediments of the Pittman Formation (Ordovician) underlie the pipeline route from 5090 m to 7050 m. Ground conditions in this formation are predominantly soft; some hard patches may be encountered where thick sandstone layers intersect the excavation.

From 7050 m to 8850 m the route transects a thick cover of alluvium and colluvium. Soft ground is expected throughout this interval.

The last portion of the route, from 8850 m to 9655 m, is predominantly underlain by dacite of the Mugga Mugga Porphyry (Silurian). Ground conditions are variable in this part depending on thickness of overburden and degree of weathering.

THE AUSTRALIAN CAPITAL TERRITORY PORTION OF THE PIPELINE

About 12830 m of the pipeline route is in the Australian Capital Territory. The depth of the excavation will generally be about 3 m; the width of the trench will decrease from 235 cm at the New South Wales border to 130 cm near the Campbell Reservoir.

The geology and expected ground conditions for this part of the excavation are presented in Plate 2. The chainages of each of the sections, and the locations selected for field tests, are tabulated in Table 3.

From the New South Wales border (9545 m) to 12100 m the route is in dacite and rhyodacite of the Mugga Mugga Porphyry and Mount Painter Porphyry (Silurian) and small patches of alluvium. The ground conditions are variable: predominantly hard and hard from 9800 m to 11000 m, and predominantly soft and soft over the rest of the interval.

Alluvium presenting soft ground conditions underlies the route from 12100 m to 13000 m.

From 13000 m to 15600 m the route is in sediments of the Fairbairn Group (Silurian), and tuff, rhyolite, and quartz porphyry of the Ainslie Volcanics (Devonian); both represent predominantly hard to hard ground conditions. The interval also includes two sections of alluvium shown as soft ground.

Alluvium and poorly consolidated Fyshwick Gravel (Permian) underlie the route from 15600 m to 19270 m. Soft ground conditions are expected throughout this interval, and from 17700 m to 19300 m the trench invert level is below groundwater-level (about RL556 m) and water will enter the excavation.

From 19270 m to the Campbell Reservoir (22500 m) the excavation is again in tuff, rhyolite, and quartz porphyry of the Ainslie Volcanics. Ground conditions are variable, but are expected to be predominantly hard from 19330 m to 19550 m and from 20300 m to 21200 m, and soft and predominantly soft for the rest of this interval.

CONCLUSION

Total quantities of the four ground condition categories for the pipeline excavations in New South Wales and the Australian Capital Territory are:

<u>CATEGORY</u>	<u>NSW</u>	<u>A.C.T.</u>
hard	20% (1900 m)	10% (1300 m)
predominantly hard	33% (3230 m)	23% (2900 m)
predominantly soft	28% (2725 m)	12% (1555 m)
soft	19% (1800 m)	55% (7075 m)

Assuming that blasting is required for all the hard ground, most of the predominantly hard ground and only little of the predominantly soft ground, the trench excavations will require blasting for about 60 percent or 5800 m of its length in New South Wales and for only 35 percent or 4500 m of its length in the Australian Capital Territory.

REFERENCES

BENNETT, D.G., & POLAK, E.J., 1975 - Googong pipeline route - rippability study, 1971. Bur. Miner. Resour. Aust. Rec. 1975/156 (unpubl.).

STRUSZ, D.L., & HENDERSON, G.A.M., 1971 - Canberra City, A.C.T. - 1:50 000 geological map and explanatory notes. Bur. Miner. Resour. Aust.

TABLE 1: STRATIGRAPHY

AGE	FORMATION	CHAINAGE (m)
Quaternary	alluvium	7050-8850, 10300-10350, 10400-10490, 10625-10650, 12100-13000, 13450-13770, 14350-14650, 15600-16350, 17600-19270
Permian	Fyshwick Gravel	16350-17600
Devonian	Ainslie Volcanics	13000-13050, 13770-14350, 14550-15600, 19400-22500
	Barrack Creek Adamellite	2250-5090
	Googong Granite	00-250
Silurian	Mugga Mugga Porphyry	8850(?) - 10300, 10350-10400, 10490-10625, 10650-11350
	Mount Painter Porphyry	11350-12100
	Yarralumla Formation	-
	Deakin Volcanics?	8850-9450
	Gladefield Volcanics	-
	Fairbairn Group	13050-13450
	Colinton Volcanics	250-2250
	Canberra Group	-
	Black Mountain Sandstone	-
	State Circle Shale	-
Ordovician	Pittman Formation	5090-7050

TABLE 2: GROUND CONDITIONS FOR THE PIPELINE EXCAVATIONS IN NSW

CHAINAGE (m)	GROUND CONDITION	LENGTH (m)
00 - 250	Hard	250
- 600	Predominantly hard	350
-2250	Hard	1650
- 4400	Predominantly hard	1500
- 5070	Predominantly soft	670
- 5500	Predominantly hard	430
- 7050	Predominantly soft	1550
- 8850	Soft	1800
- 9000	Predominantly soft	150
- 9300	Predominantly hard	300
- 9655	Predominantly soft	355

RECOMMENDED TEST LOCATIONS IN NSW

SITE NO.	CHAINAGE (m)	GROUND CONDITION
1	400	Predominantly hard
2	1300	Hard
3	2000	Hard
4	2800	Predominantly hard
5	3300	Predominantly hard
6	4000	Predominantly hard
7	5800	Predominantly soft
8	6500	Predominantly soft
9	8400	Soft
10	9400	Predominantly soft

TABLE 3: GROUND CONDITIONS FOR THE PIPELINE EXCAVATIONS IN THE
A.C.T.

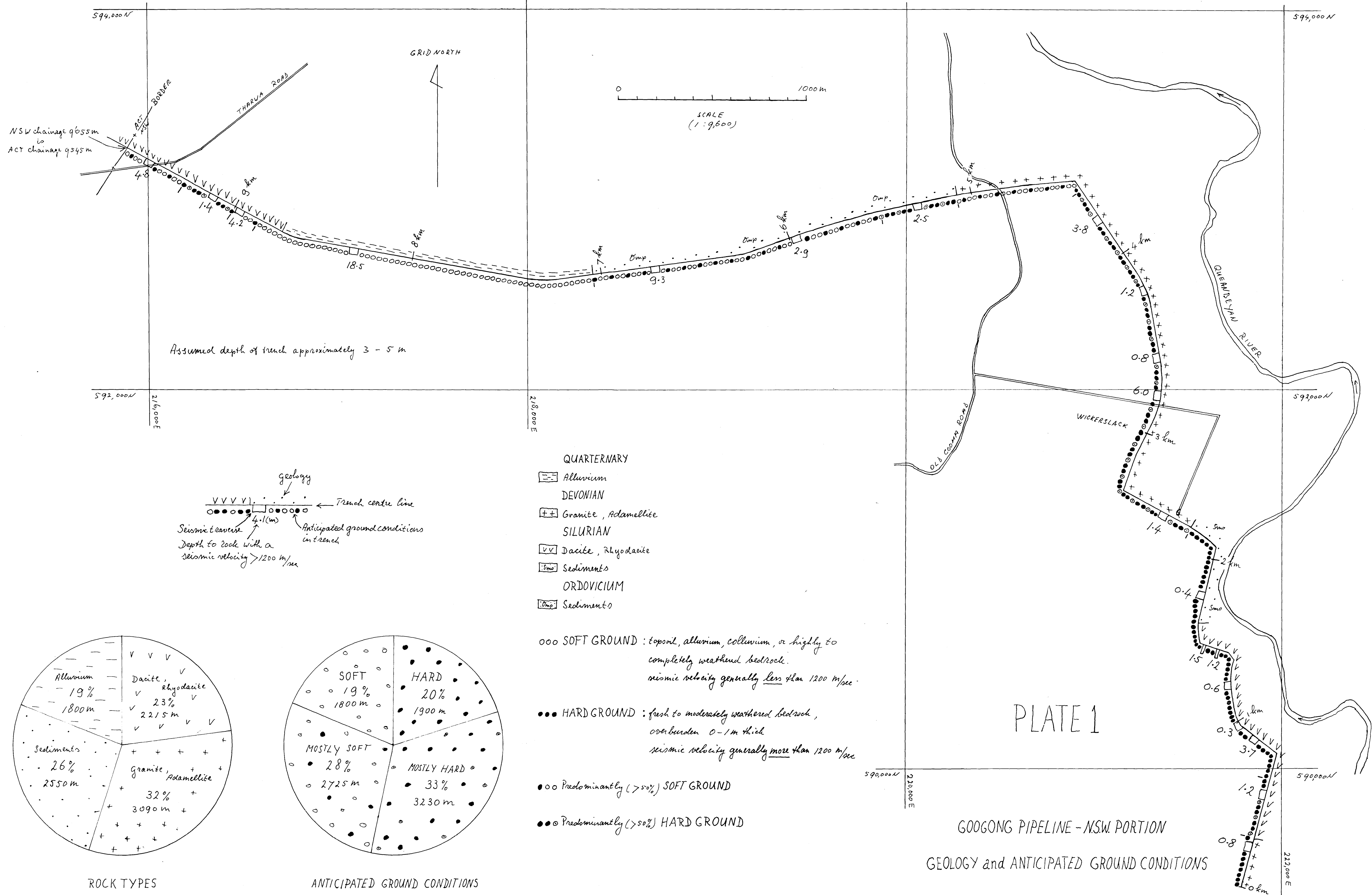
CHAINAGE (m)	GROUND CONDITION	LENGTH (m)
9545 - 9800	Predominantly soft	255
- 10650	Predominantly hard	850
- 11000	Hard	350
- 11800	Predominantly soft	800
- 13000	Soft	1200
- 13450	Hard	450
- 13770	Soft	320
- 14350	Predominantly hard	580
- 14550	Soft	200
- 14900	Predominantly hard	350
- 15400	Hard	500
- 15600	Predominantly soft	200
- 19330	Soft	3730
- 19550	Predominantly hard	220
- 20000	Soft	450
- 20300	Predominantly soft	300
- 21200	Predominantly hard	900
- 22500	Soft	1175

TABLE 3 (continued)

<u>RECOMMENDED TEST LOCATIONS IN THE A.C.T.</u>		
SITE NO.	CHAINAGE (m)	GROUND CONDITION
11	10 000	Predominantly hard
12	10 800	Hard
13	11 400	Predominantly soft
14	13 300	Hard
15	14 000	Predominantly hard
16	15 500	Predominantly soft
17	16 000	Soft
18	16 700	Soft
19	20 100	Predominantly soft
20	20 600	Predominantly hard

LOCATION MAP





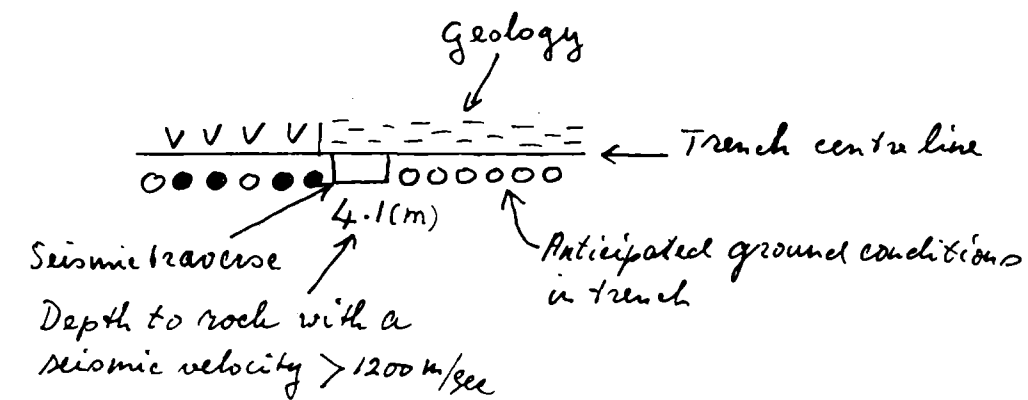
- QUATERNARY
- ≡ Alluvium
- PERMIAN
- Gravel
- DEVONIAN
- ▲▲ Tuff, rhyolite, quartz porphyry
sporadic interbedded sediments
- SILURIAN
- V.V. Dacite, rhyolacite ■■■ Sediments

ooo SOFT GROUND: topsoil, alluvium, colluvium, gravel, or highly to completely weathered bed rock.
seismic velocity generally less than 1200 m/sec

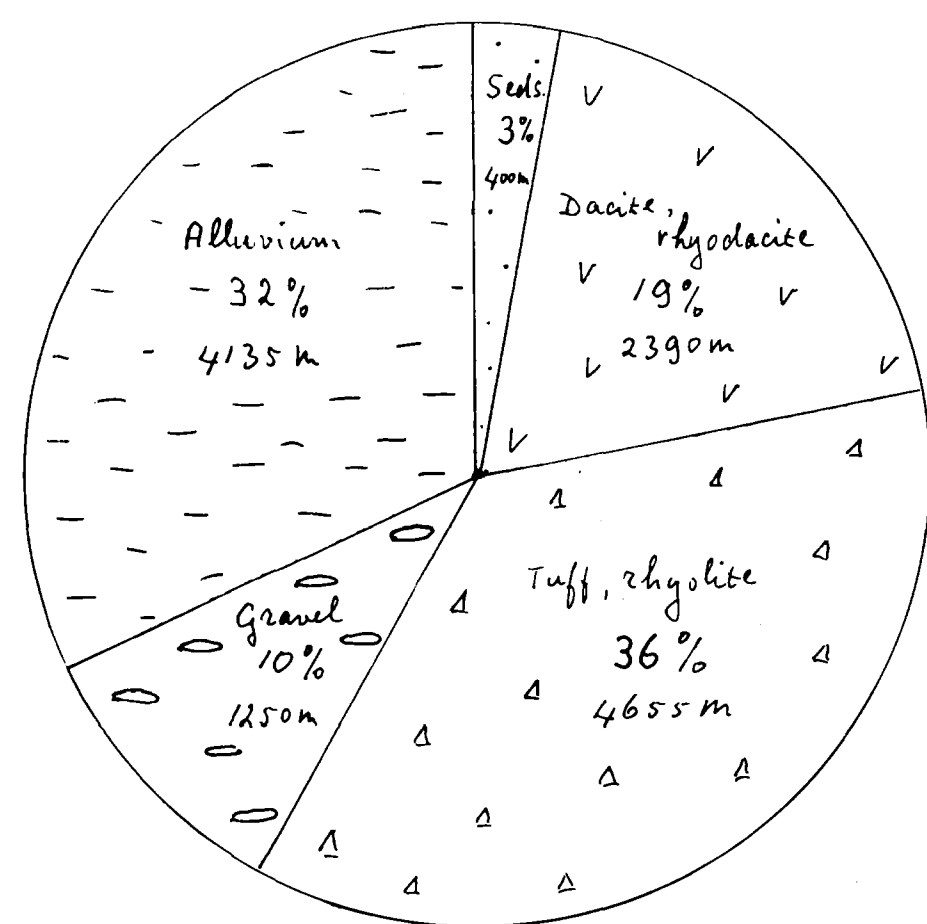
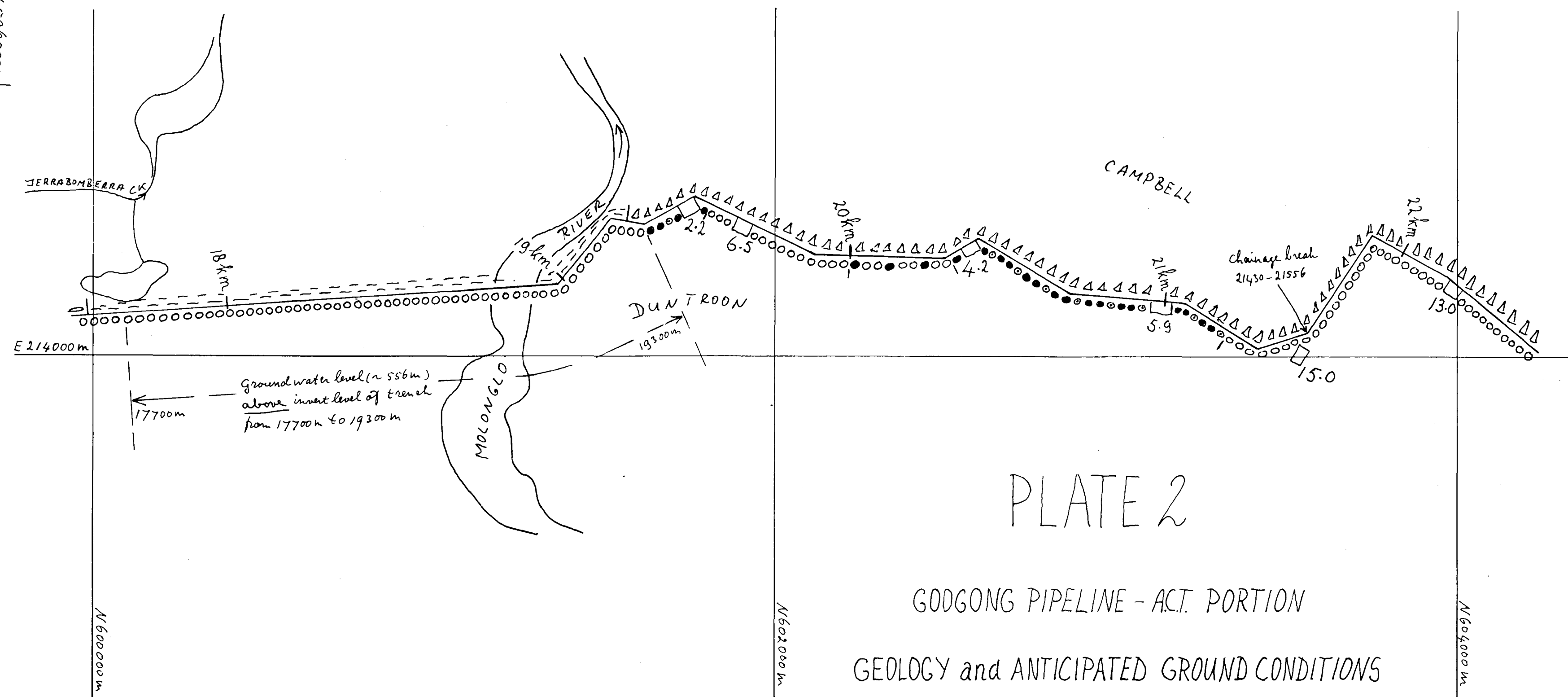
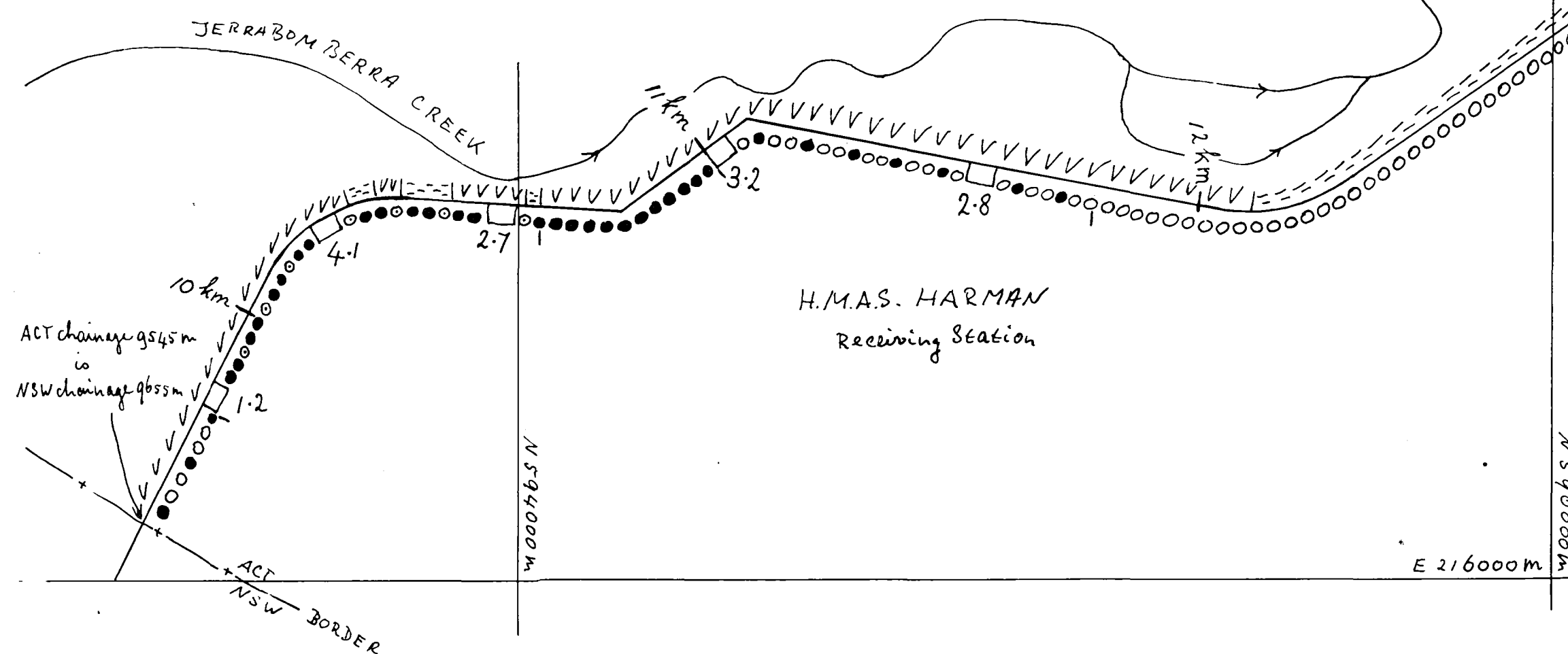
●●● HARD GROUND: fresh to moderately weathered bed rock, overburden 0-1m thick
seismic velocity generally more than 1200 m/sec

ooo Predominantly (>50%) SOFT GROUND

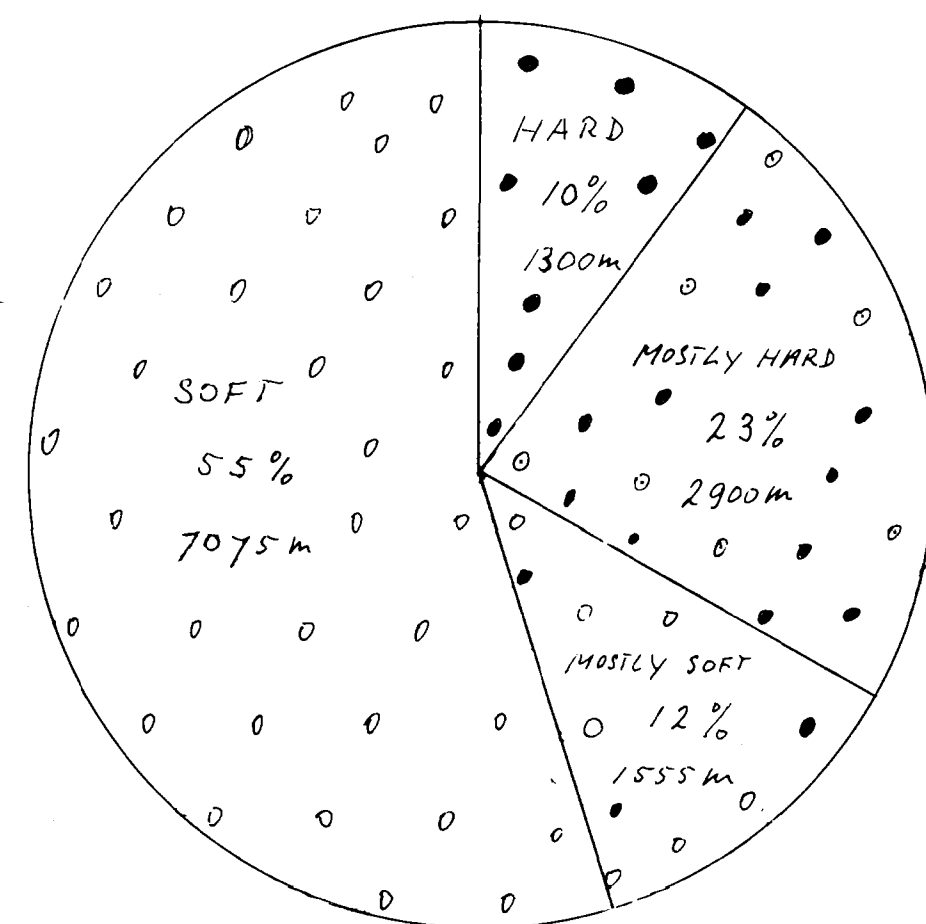
●●● Predominantly (>50%) HARD GROUND



Assumed depth of trench approximately 3 m.



ROCKTYPES



ANTICIPATED GROUND CONDITIONS

PLATE 2

GODGONG PIPELINE - ACT. PORTION
GEOLOGY and ANTICIPATED GROUND CONDITIONS