DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

ENGINEERING DIVISION

NATURAL GAS PIPELINE, MOOMBA-ADELAIDE

PORT RIVER CROSSING, TAPEROO

GEOLOGICAL INVESTIGATIONS - PROGRESS REPORT NO. 1

DESIGN STAGE

Hundred of Pt. Adelaide

Client: Bechtel Pacific Corporation

by

R.D. STEEL
ASSISTANT SENIOR GEOLOGIST
ENGINEERING GEOLOGY SECTION

SR11/5/238/5

25th April, 1968

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Rept. Bk. No. 750
G.S. No. 3978
S.R. 11/5/238/5

25th April, 1968

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SOUTH AUSTRALIA

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Hundred of Pt. Adelaide

Client: Bechtel Pacific Corporation

INTRODUCTION

It is proposed that the natural gas pipeline from Moomba to Adelaide, will cross the Port River at a site near Taperoo. The crossing line is parallel to and 80ft. south of the E.T.S.A. 60 KV. transmission line (suspended from two 350ft. high towers) and will link the Meter and Regulating Stations at Torrens Island on the eastern side and Taperoo on the western side. The 12 in. I.D. steel fabricated pipe will be buried up to 18ft. in sediments beneath the existing river bottom, but future widening and deepening of the shipping channel will decrease this depth to an average of 12ft. Minimum depth of cover ranges between 3 and 5ft. (Fig. 11)

A request for the Department to investigate the crossing area by cable-tool drilling was received in a letter dated 19th December, 1967, from Mr. J.W. Lair, Contracts Manager, Bechtel Pacific Corporation.

Five holes totalling 180ft. have been drilled, four from a pontoon in the river and the fifth on the western river bank (Fig. 11)

Geological work has been confined to the logging of samples from the drillholes (Figs. 6 to 10) and an examination of materials exposed on the western river bank.

The soil horizons have been logged geologically and also classified using the Unified Classification System (Ref. 1) Notes on cable-tool drilling procedures are given in Appendix A and descriptive terms used in the classification of samples are defined in Appendix B.

A continuous tube sample was taken at the top of each of holes CH2, CH4 and CH5. The tubes, 4in. diam. and up to 11ft. long, were sealed and delivered with minimum disturbance to the E. & W.S. Dept. Soils Section laboratories, Wakefield Street. Results of tests carried out on these samples will be presented in a separate report from the E. & W.S. Dept.

OUTLINE OF REGIONAL GEOLOGY

The geology of the region is shown on the ADELAIDE 1 mile to 1 inch geological sheet (Ref. 2) and is described in greater detail by FIRMAN (Ref. 3)

The area lies near the eastern margin of the St. Vincent Graben. Here marine, gulf, estuarine and litteral sediments of RecentAge, overlie progressively Pleistocene alluvial-valley flat deposits and Tertiary sediments of the St. Vincent Basin.

The sequence is outlined in Table 1

TABLE 1

Age	Unit	Depositional Environment	Description
RECENT	SEMAPHORE SAND	Wind-blown	White quartz sand of the coastal dunes.
"	ST. KILDA FORMATION	Shallow sea and shoreline	Finely comminuted shell sand and silty clay, with plant debris, stranded shell banks and shell sand as beach ridges
"	LIPSON FORMATION	Shoreline	Clay, silt and fine sand, with abundant plant fibre and shell
?			
PLEISTOCENE	GLANVILLE FORMATION	Shallow-sea	Sand and clay, with abundant shel - often has lime cemented crust.
"	HINDMARSH CLAY	Alluvial-Valley flat	Interbedded sands, clays and silts. Generally coarsely mottled. Lime pockets and nodules common.

SITE GEOLOGY

Topography

The site area is of generally low relief (Fig. 11, Section A-D).

Tide levels in the river vary from R.L. 101.1ft. at Indian Springs Low Water to R.L.103.9ft. at Mean High Water Spring. At these levels the river width is 1080ft. and 1680ft. respectively.

The existing dredged shipping channel is approximately 420ft. wide and 30ft. deep at low water and has a flat bottom. It is proposed in future to widen the channel to 720ft. and deepen it a further 6ft. (Fig. 11)

River bottom gradients are 1:20 (3 °) west of the channel and vary between 1:30 (2 °) to 1:80 (1 °) approaching the mangrove swamps of Torrens Island to the east (Fig. 11)

The western bank has been raised to R.L. 118ft. by the addition of fill material, placed over a number of years. The fill includes cinders, charcoal, sand gravel and calcareous residues from the nearby Imperial Chemical Industries Plant. The mass has become weakly to firmly cemented by lime, giving rise to a surface crust and a steep artificial river bank approximately 9ft. high.

Soil and Rock Types

The five drillholes show wide variations in the depth and nature of materials present, making it difficult to correlate individual soil horizons between successive holes. Table 2 shows the geological sequence revealed by the drilling.

TABLE 2

DEPTH (R.L. in feet)										GEOLOGICAL AGE	UNIT	DESCRIPTION
CH1		CH2		CH3		CH4		CH5				
From	To	From	To	From	To	From	To	From	To			
118	105	-	-	-	-	-	-	-	-	(50 years)	FILL	SAND, gravel, charcoal, slag and I.C.I. residues.
105	81	86	74.5	-	-	95	91	94	79	RECENT	ST. KILDA FORMATION (shallow sea)	Mainly SAND, fine grained, shelly, light grey. Pockets of organic clay and silt near top. Contains patches of decomposing plant matter (strong smell of H_2S)
81	76	74.5	73.5	-	-	-	-	-	-	"	LIPSON FORMATION Shoreline)	CLAY SOIL, high plasticity. Dark grey to blue grey. Contains up to 30% SAND, fine grained clayey, also numerous shell fragments and limestone lumps (Reworked Glanville Formation)
76	53	73.5	50	71.5	49	91	55	-	-	PLEISTOCENE	HINDMARSH CLAY (Alluvial-valley flat)	CLAY and SILT SOILS and SANDS, fine to coarse grained. Interbedded, possibly lenticular. Mottled grey, brown, yellow-brown and red-brown. Contains generally 10 to 20% GRAVEL (mainly lime nodules) and pockets of whitish earthy lime.

Groundwater

Below river level all sands are saturated and all clays and silts are generally at or greater than the plastic limit.

Water level beneath the western bank was measured at R.L.106.5ft. in Hole CH1, but this is probably subject to tidal influence.

DISCUSSION

Details of the position and depth of burial of the pipeline taken from the drawing of Bechtel Pacific Corporation (Fig. 3.7 Job. No. 5639) are shown on Fig. 11. The nature of the sediments in which the pipeline would be founded over various parts of the crossing axis are shown below.

WESTERN BANK		FILL MATERIAL
RIVER SECTION - West of Channel	→	Sands and clays of ST. KILDA and LIPSON FORMATIONS.
" " - Shipping Channel	-	Clays, silts and fine to coarse sands of HINDMARSH CLAY
" " - East of Channel	-	Rising through HINDMARSH CLAY into shelly sands of ST. KILDA FORMATION.

The fill material on the western bank has been weakly to firmly cemented by lime from I.C.I. Alkali residues. This material is highly corrosive.

The fine grained shelly sands of the ST. KILDA FORMATION are mainly very loose and form a very weak surface layer 3 to 11ft.deep both east and west of the river channel. The cable tool sampling assembly and tube (total weight 600 lbs.) penetrated this material almost under its own weight. Values of N, where recorded, averaged only 2 to 3.

The clay soils of the LIPSON FORMATION are only present west of the shipping channel and attain a maximum thickness of 5ft. These were mainly firm to stiff at moisture contents generally higher than plastic limit.

In the river channel both ST. KILDA and LIPSON FORMATIONS are absent and the HINDMARSH CLAY is present at the river bottom. The

materials comprising the HINDMARSH CLAY range from high plasticity clay soils to coarse grained sands. The clay soils mainly proved stiff to very stiff (readings by Soiltest Penetrometer from 3 to more than 4.5) the silt soils mainly compact and the sands dense to medium dense.

R.D. STEEL
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ENGINEERING GEOLOGY SECTION

RDS:SMA:GB
25.4.68

REFERENCES

1. UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION 1966, Earth Manual, 2nd Edition

2. SPRIGG, R.C., WHITTLE, A.W.G., 1951 Geological Atlas of South Australia, Sheet ADELAIDE (1:63,360)

3. FIRMAN, J.B. - "Stratigraphic Units of Late Cainozoic Age in the Adelaide Plains Basin, South Australia" Geol.Surv. S.Aust. Quart. Geol. Notes. No. 17

APPENDIX A

LOGS OF CABLE-TOOL HOLES AND EXPLANATORY NOTES

APPENDIX A

LOGS OF CABLE-TOOL HOLES AND EXPLANATORY NOTES

NOTES ON DRILLING PROCEDURES

Equipment

The drilling is carried out with a Cable-tool drilling plant using "S" series sampling tools (Figs. 1 and 2)

Sampling Procedure

SA Samples

SA samples are obtained by driving an "S" tube, fitted with a Mark A shoe, into the material to be sampled. The number of blows per foot of penetration of the sampling tube are recorded by the driller. The sample, or core, is extruded fromthe sampling tube using an hydraulic ram. The extruded core is sealed in a plastic bag and stored in a core box, with a label showing the depth of the sample and the number of blows per foot of penetration. The hole is reamed out after each sample with a Mark B shoe.

SAL Samples

Sealed tube samples for laboratory testing (SAL) are taken at various intervals during drilling.

The drilling procedure is similar to that for obtaining SA samples, but in order to completely fill the sampling tube, it is driven 1.5ft. into the material to be sampled. On removal from the drill hole, both ends of the sampling tube are sealed with paraffin wax and screwed caps are fitted to the tube. The sealed tubes are labelled as in Fig. 3.

Standard Penetration Test

The standard Penetration Test (Ref. 1) is used to test the in situ density of sands and togive an indication of the consistency of clays and compactness of silts.

The equipment is illustrated in Fig.4 and consists of a 2in. diameter sampling spoon (tube) and a hammer of standard weight (140lbs.)

With the equipment assembled as in Fig. 4 the hammer is allowed to fall on to the drill rods until the sampling shoe has penetrated 6 in. into the soil. The Standard Penetration Test is the number of blows (N) required to produce the next foot of penetration.

NOTES ON DRILL LOG SHEETS

The logs are plotted on a standard Cable-tool log form.

Near the centre of the form a graphic log of the materials encountered is shown.

In the column to the right of the graphic log, the soils are classified and described according to the Unified Soil Classification (Fig. 5)

To the left of the graphic log is a geological description of the materials sampled. This includes:-

.....Geological age)
)
.....Soil unit name) printed vertically
)
.....Type of material)

.....Mineral composition

.....Grain shape

.....Cementation

.....Organic materials

Water levels are indicated by a small arrow with the date at which the observation was made.

In the blows per foot column, a continuous histogram is made of the number of blows required to drive the sampling tube through each foot of material. A hatching code is used to distinguish various types of sample. This code is reproduced at the bottom of each log sheet.

In the column on the far right of the log sheet, readings made with a Soiltest Penetrometer are plotted as a histogram. The Soiltest Penetrometer only gives true values of qu (unconfined compressive strength) when used in clays in which $\phi = 0$

REFERENCES

1. TERZAGHI, K. and PECK, R.B. 1948. Soil Mechanics in Engineering Practice. John Wiley and Sons.

2. UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION, 1966. Earth Manual, 2nd Edition.

APPENDIX B

DESCRIPTIVE TERMS

CLAY SOILS

CONSISTENCY

CONSISTENCY	SYMBOL	UNCONFINED COMPRESSIVE STRENGTH (kg/sq. cm)	FIELD TEST	N
Very soft	V.S.	less than 0.25	Easily penetrated several inches by fist.	2
Soft	S	0.25 to 0.5	Easily penetrated several inches by thumb	2 to 4
Firm	F	0.5 to 1.0	Can be penetrated several inches by thumb with moderate effort	4 to 8
Stiff	St	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort	8 to 15
Very Stiff	V. St	2.0 to 4.0	Readily indented by thumb nail	15 to 30
Hard (Extremely stiff)	H	over 4.0	Indented with difficulty by thumb nail	30 and over

Based partly on Terzaghi, K. and Peck, R.B. 1966
Soil Mechanics in Engineering Practice,
Wiley - New York

MOISTURE CONTENT

Abbreviation	Meaning
MC ≐ LL	Moisture Content near liquid limit
MC < LL	" " less than " "
MC > PL	" " greater than plastic limit
MC ≐ PL	" " Near " "
MC ≦ PL	" " less or equal to " "
MC < PL	" " less than " "
MC ≪ PL	" " much less than " "

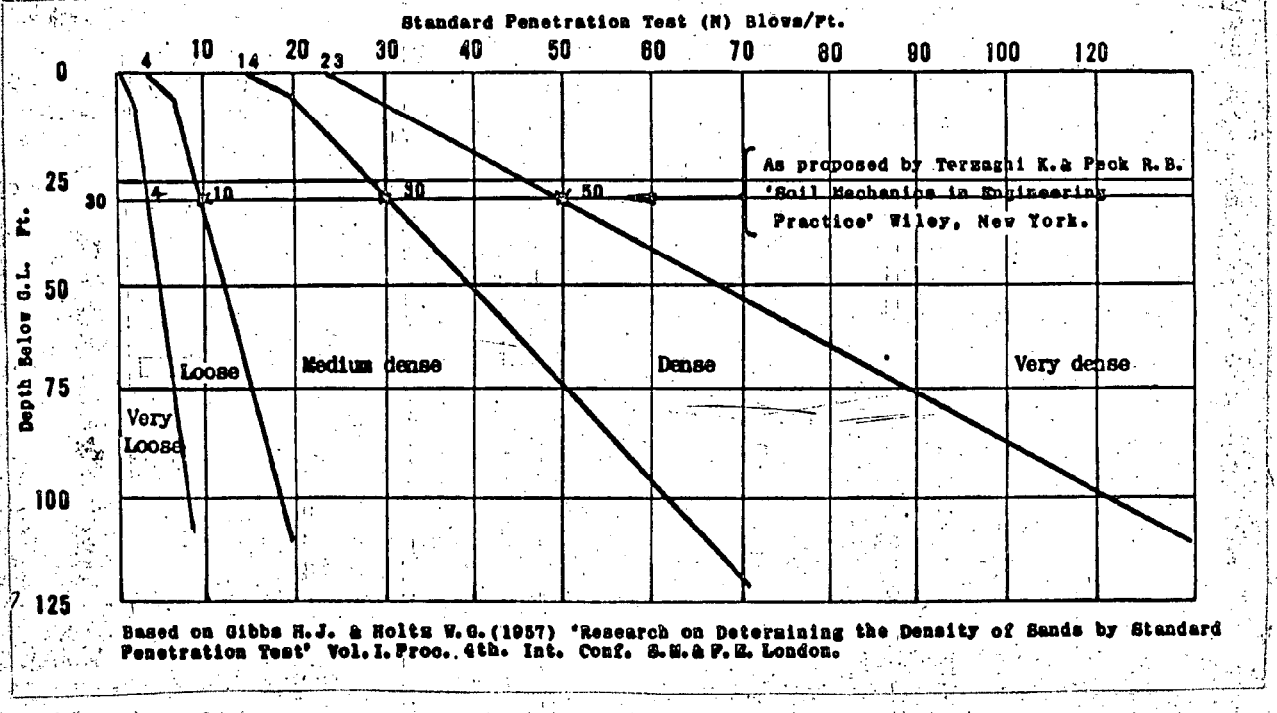
2. SILT SOILS

COMPACTNESS	SYMBOL	N
Loose	L	0 to 8
Moderately compact	MC	8 to 15
Compact	C	15 to 20
Very Compact	VC	greater than 30

CLASSIFICATION OF SANDS BY STANDARD PENETRATION TEST

The relative density of granular soils has been judged from the results of Standard Penetration Tests carried out by the procedure described by Terzaghi and Peck (Ref. 1) bearing in mind the limitations of the method as discussed by Gibbs and Holtz (Ref. 2). At all times the water in the drill hole was kept at the level of surrounding groundwater.

EFFECT OF OVERBURDEN PRESSURE ON STANDARD PENETRATION TEST



Based on Gibbs H.J. & Holtz W.G.(1957) 'Research on Determining the Density of Sands by Standard Penetration Test' Vol.I.Proc. 4th. Int. Conf. S.M.& F.E. London.

REFERENCES

1. Terzaghi K, and Peck, R.B. 1948 "Soil Mechanics in Engineering Practice". Wiley, New York.

2. Gibbs, H.T. and Holtz W.G. 1957 Research on determining the density of sands by standard penetrations tests. Proc. 4th Int. Conf. SM & FE, London Vol.9

DEPARTMENT OF MINES SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE NO **CH5**

SERIAL No 386-68

PROJECT *NATURAL GAS PIPELINE MOOMBA - ADELAIDE*

SECTION —

FEATURE *PORT RIVER CROSSING, TAPEROO*

HUNDRED *PT. ADELAIDE*

LOCATION *River Channel 885 ft. from W. Bank. On centreline.*

R.L. River Bottom 94.0

R.L. Collar .... 111.0 FT

Datum L.W.D=100.8 FT.

SOIL TYPE GEOLOGICAL DESCRIPTION		RL	DEPTH (FEET)	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME (Unified Soil Classification, U.S.B.R. Earth Manual 1st Edition 1963)	WATER LEVEL / CASING / MOISTURE CONTENT	Consistency / Compact. Density	FIELD TEST DATA: BLOWS PER FOOT (20 40 60 80)	SOIL TEST PENETROMETER Units *
RECENT ST. KILDA FORMATION — Tidal Sandy clays etc.	Contains abundant plant fibre		0–5	CH-OH	CLAY SOIL, high plasticity, silty to sandy, greyish, but dark grey and organic near top.	SAMPLES TAKEN BELOW RIVER BOTTOM. 6 inch.		No Blows	
Marine fossiliferous sands etc.	Sand grains mainly rounded quartz and shell fragments, occasionally mica	90, 85	5–11 (PIPELINE at ~7)	Some SC	SAND, fine grained, clayey in part, greyish.		V.L.	No Blows.	NOT APPLICABLE
		80	11–15		SAND, fine grained, few fines, brown to grey-brown.		L.	Slush Pump Samples.	
			15		15.0 ft. END OF HOLE				

Depth scale: 20, 25, 30, 35, 40, 45, 50

FIG 10

TYPE OF SAMPLE		CONSISTENCY	COMPACTNESS	RELATIVE DENSITY	MOISTURE CONTENT
A shoe (SA)	Water level, (date) 7 Dec. '66	VS — Very Soft	Ls — Loose	VL — Very Loose	H — Humid
D " (SD)	Casing	S — Soft	MC — Moderately Compact	L — Loose	D — Damp
E " (SE)	WC Water cut	SF — Soft to Firm	C — Compact	MD — Medium Dense	M — Moist
G " (SG)		F — Firm	VC — Very Compact	D — Dense	W — Wet
Sealed Tube - A Shoe - SAL		F St. — Firm to Stiff		VD — Very Dense	S — Saturated
Standard Penetration Test - SPT		St — Stiff			LL — Liquid Limit
		V St — Very Stiff			PL — Plastic Limit
		H — Hard			

* These values refer to clay soils only and provide an indication of their consistency

ENGINEERING GEOLOGY SECTION

DRILL No *8*
TYPE *Ruston*
DRILLER *D. Phillips*
START *5 Mar. 68*
FINISH *5 Mar. 68*

LOGGED BY *R. D. Steel.*
DATE *Mar. 68*
TRACED *R.D.S.*
CHECKED *W.R.P.B.*

SHEET *1* OF *1*

DRG No. **S 6489 Ha.1**

PF No. S 5026A

DEPARTMENT OF MINES SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE NO **CH4**
SERIAL No. 389 - 68

PROJECT NATURAL GAS PIPELINE MOOMBA-ADELAIDE
SECTION —
FEATURE PORT RIVER CROSSING, TAPEROO
HUNDRED PT ADELAIDE
LOCATION River Channel 696 ft. from W. Bank, 10 ft. N of centreline
R.L. River Bottom 94.8 FT
R.L. Collar 113.8 FT.
Datum L.W.L = 100.8 ft

SOIL TYPE GEOLOGICAL DESCRIPTION	R.L. FEET DEPTH	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME (Unified Soil Classification — U.S.B.R. Earth Manual 1st Edition 1963)	WATER LEVEL	COLOUR MOISTURE CONTENT	Consistency Density	FIELD TEST DATA: BLOWS PER FOOT (20 40 60 80)	FIELD TEST DATA: SOIL TEST PENETROMETER Units *
RECENT STKILDA FORMATION Marine sands etc.				Patches organic mud near top. Sand grains mainly rounded quartz and shell fragments. Contains fibrous plant matter.					
	99 5		OH						
			SP	SAND, fine grained, light grey, with pockets of organic SILT and CLAY near top.	6 INCH		V.L.	No Blows	NOT APPLICABLE
			ML Some GP	becoming SILT SOIL, low plasticity, clayey, light brown and grey. Contains numerous small gravel frags.			L.		
Gravel fragments are mainly strongly cemented lime nodules. Calcareous SILT SOIL pockets mainly earthy lime			ML	SILT SOIL, low plasticity, clayey, brown and greyish mottled. Contains few gravel fragments up to 20mm.			C		
	85 10		CL & ML	CLAY SOIL, high plasticity, sandy in part, grey and dark brown mottled. Contains 20% calcareous SILT SOIL and few gravel fragments up to 15mm size.		~PL	St to VSt	S.P.T. 14 Blows	4.5+
			ML	SILT SOIL, low plasticity, clayey, brown, red-brown and grey mottled. Contains few small gravel frags.	BOTTOM	~PL	C		
	80 15		CL & GP	CLAY SOIL, low plasticity, sandy. Brown, red-brown and grey mottled. 40 to 50% GRAVEL, max. 40 mm.		~PL	VSt F-S		4.5+
			ML	SILT SOIL, low plasticity, clayey, brown, greyish. Contains few light yellow calcareous patches.	RIVER	>PL	C		
						<PL		SPT 19 Blows	4.5+
Sand grains mainly subrounded quartz, some shell fragments and occasionally mica.	75 20		SW	SAND, medium to coarse grained, light brown to yellow-brown.	BELOW		MD	Slush Pump Samples.	NOT APPLICABLE
PLEISTOCENE HINDMARSH CLAY Fluvial clays, silts and sands.					TAKEN				
Gravel fragments mainly strongly cemented lime nodules.	63 30		CH	CLAY SOIL, high plasticity, sandy. Mainly grey with slight red-brown mottling. Contains 10% SILT SOIL, low plasticity, sandy and few small gravel fragments.	SAMPLES	>PL	F		4.5+
		PIPELINE				~PL	V.St	SPT 24 Blows	
	60 35		ML & SC	SILT SOIL, low plasticity, sandy to clayey, grades to SAND, fine grained, clayey. Coarsely mottled light blue-grey and dark yellow-brown.		W	F-C		NOT APPLICABLE
							C	SPT 20 Blows	4.5+
	55 40		CH	CLAY SOIL, high plasticity, silty, blue-grey, brown and red-brown mottled.		<PL	V.St		
				40.0 ft. END OF HOLE					
	45								
	50								

FIG. 9

TYPE OF SAMPLE	CONSISTENCY	COMPACTNESS	RELATIVE DENSITY	MOISTURE CONTENT
A shoe (SA)	VS — Very Soft	Ls — Loose	VL — Very Loose	H — Humid
D " (SD)	S — Soft	MC — Moderately Compact	L — Loose	D — Damp
E " (SE)	SF — Soft to Firm	C — Compact	M.D — Medium Dense	M — Moist
G " (SG)	F — Firm	V C — Very Compact	D — Dense	W — Wet
Sealed Tube - A Shoe - SAL	F St — Firm to Stiff		V.D — Very Dense	S — Saturated
Standard Penetration Test - SPT	St — Stiff			LL — Liquid Limit
	V St — Very Stiff			PL — Plastic Limit
	H — Hard			

Water level, (date) Dec. '68 — Casing — WC Water cut

* These values refer to clay soils only and provide an indication of their consistency.

ENGINEERING GEOLOGY SECTION

DRILL No. 8
TYPE Ruston
DRILLER D. Phillips
START 11 Mar. 68
FINISH 12 Mar. 68

LOGGED BY R. D. Steel.
DATE Mar. 68
TRACED R.D.S.
CHECKED W.R.P.B.

SHEET 1 OF 1
DRG No S 6488 Ho. 1.

PF No S 5026A

DEPARTMENT OF MINES SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE NO CH3
SERIAL No 396-68

PROJECT NATURAL GAS PIPELINE MOOMBA - ADELAIDE
SECTION —
FEATURE PORT RIVER CROSSING, TAPEROO
HUNDRED PT ADELAIDE
LOCATION River Channel 414 ft. from W. Bank, 100 ft. N. of centreline

R.L. River Bottom 7i·5 FT
R.L. 108·0 FT
Datum L.W.D = 100·8 ft.

SOIL TYPE GEOLOGICAL DESCRIPTION	R.L. FEET DEPTH	GRAPHIC LOG	GROUP SYMBOL	DESCRIPTION GROUP NAME	WATER	FIELD TEST DATA: BLOWS PER FOOT	FIELD TEST DATA: SOIL TEST PENETRATION Units *
Sand grains are mainly rounded quartz, some are shell fragments	70		SC	SAND, fine grained, excess fines, blue-grey, brown and red-brown mottled Pockets grey organic clay near top	W	F-C	
			CH	CLAY SOIL, high plasticity, sandy. gray and yellow-brown. Contains 10 to 20% fragments 2 to 3mm size and few gravels max. 20mm size	6 inch. / PL	Slush Pump Samples	
	5						
	65		SW	SAND, well graded medium to coarse grained, few fines. 10% grains 2 to 3mm brown to yellow-brown	S	MD	
	10					Sampled inside casing	NOT APPLICABLE
	60		SC	Grayish with excess clay fines.			
			SW				
PLEISTOCENE HINDMARSH CLAY Fluvial clays, silts and sands.							
Generally slightly calcareous.	15		CH	CLAY SOIL, high plasticity, silty to sandy, blue-grey with yellow-brown and slight red-brown mottling.	< PL	V.St	4.5+
	55	PIPELINE					
			MH	SILT SOIL, high plasticity, clayey to slightly sandy in part, blue-grey with yellow-brown mottling.	≈ PL	C-St	
	20					VC-VSt	
	50		CH	CLAY SOIL, high plasticity, very silty to fine sandy, light grey, yellow-brown and red-brown mottled.	≈ PL	VSt	4.5+
				22.5ft. END OF HOLE			
	25						
	30						
	35						
	40						
	45						
	50						

FIG. 8

TYPE OF SAMPLE	CONSISTENCY	COMPACTNESS	RELATIVE DENSITY	MOISTURE CONTENT
A shoe (SA)	VS — Very Soft	Ls - Loose	VL — Very Loose	H — Humid
D " (SD)	S — Soft	MC — Moderately Compact	L - Loose	D — Damp
E " (SE)	SF — Soft to Firm	C — Compact	MD - Medium Dense	M — Moist
G " (SG)	F — Firm	V C — Very Compact	D — Dense	W — Wet
Sealed Tube - A Shoe - SAL	F St — Firm to Stiff		VD — Very Dense	S — Saturated
Standard Penetration Test - SPT	St — Stiff	* These values refer to clay soils only and provide an indication of their consistency.		LL — Liquid Limit
	V St — Very Stiff			PL — Plastic Limit
	H — Hard			

Dec. '66 (Water level, (date)) WC (Water cut) Casing

ENGINEERING GEOLOGY SECTION

DRILL No 8
TYPE Ruston
DRILLER D. Phillips
START 17 Mar. 68
FINISH 17 Mar. 68

LOGGED BY R.D. Steel.
DATE Mar. 68
TRACED R.D.S.
CHECKED W.R.P.B.

SHEET 1 OF 1
DRG No S6487 Ha 1.

PF No. S5026A

DEPARTMENT OF MINES SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE No CH1

PROJECT NATURAL GAS PIPELINE MOOMBA-ADELAIDE

FEATURE PORT RIVER CROSSING, TAPEROO

LOCATION Western Bank. 140ft. from channel. 160ft N. of centreline

SECTION Harbors Board Block 3

HUNDRED Pt ADELAIDE

R.L. surface 118·0 ft; 114·5 ft; L.W.D.= 100·0ft. ; 385/68

SOIL TYPE / GEOLOGICAL DESCRIPTION		R.L. (FEET) / DEPTH	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME (Unified Soil Classification ... Earth Manual 1st Edition 1963)	WATER	MOISTURE	CONSISTENCY	FIELD TEST DATA
VERY RECENT (< 50 years) Heterogeneous fill material partially cemented	Sand grains are mainly quartz. Shell fragments and I.C.I. residues, weakly to firmly cemented. Few lumps charcoal	115; 5	SP & GW	SAND, poorly graded, medium to coarse grained, light grey. Contains numerous GRAVEL fragments up to 30mm size	Water cut 27 Feb. 68	H	6 inch; Weakly to firmly cemented	SPT. 29 Blows.
	GRAVEL fragments mainly charcoal, slag, cinders and occasionally shells. Contains also pockets of decomposing plant fibres.	110; 10		SAND, poorly graded, coarse grained, light grey. Contains 20 to 30% GRAVEL fragments max. 30mm size				
		105		SAND, well graded, fine to coarse grained, slightly clayey and organic, brown to dark grey		M; W		SPT. 3 Blows.
RECENT ST. KILDA FORMATION Marine fossiliferous sands etc.	SAND grains mainly rounded quartz with approx. 5% 10% shell fragments. Contains patches of dark grey, decomposing plant fibres. Strong smell of H_2S.	15; 100; 20; 95; 25; 90; 30; 85	SP	SAND, mainly poorly graded, fine to medium grained, light grey with brown and yellow-brown mottling. Somewhat organic in part. Contains 1 to 5% GRAVEL, max. 10mm size.		S	L	SPT. 2 Blows.; SPT. 3 Blows.; SPT. 14 Blows.; SPT. 2 Blows.
	Decomposing plant material very abundant. Strong smell of H_2S.	35						SPT. 3 Blows.
LIPSON FORMATION Estuarine clays sands, gravels.	Gravel fragments mainly broken shells or nodules of strongly cemented limestone	80; 40	CH to SP & GW	CLAY SOIL, high plasticity, silty, blue-grey, with 30% SAND, fine grained, clayey, grey to blue-grey. Contains 10 to 20% GRAVEL fragments, max. 30mm. size.		> PL	F - St	SPT. 50 Blows
PLEISTOCENE HINDMARSH CLAY Fluvial clays, silts and sands.	Gravel fragments are mainly strongly cemented nodules of limestone	75; PIPELINE; 45; 70; 50	CH	CLAY SOIL, high plasticity, silty, grey, brown and yellow-brown mottled. Contains 5% SILT SOIL, low plasticity, offwhite calcareous (in small pockets) and 5% GRAVEL, max. 20mm. size.		≤ PL	St - V St.	SPT. 25 blows.

Penetrometer Units*: NOT APPLICABLE (sands); Mainly 4.0 to 4.5+ (clays)

FIG. 6

TYPE OF SAMPLE: A shoe (SA); D " (SD); E " (SE); G " (SG); Sealed Tube - A Shoe - SAL; Standard Penetration Test - SPT

Water level, (date) — Dec. '66; Casing; WC — Water cut

CONSISTENCY	COMPACTNESS	RELATIVE DENSITY	MOISTURE CONTENT
VS — Very Soft	Ls — Loose	VL — Very Loose	H — Humid
S — Soft	MC — Moderately Compact	L — Loose	D — Damp
SF — Soft to Firm	C — Compact	MD — Medium Dense	M — Moist
F — Firm	VC — Very Compact	D — Dense	W — Wet
F St — Firm to Stiff		VD — Very Dense	S — Saturated
St — Stiff			LL — Liquid Limit
V St — Very Stiff			PL — Plastic Limit
H — Hard			

* These values refer to clay soils only and provide an indication of their consistency

ENGINEERING GEOLOGY SECTION

DRILL No 8; TYPE Ruston; DRILLER D. Phillips; START 27 Feb. 68; FINISH 29 Feb. 68

LOGGED BY R.D. Steel; DATE Mar 68; TRACED R.D.S.; CHECKED W.R.P.B.

SHEET 1 OF 2; DRG No S6485 Hol

PF No S 5026A

DEPARTMENT OF MINES SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE No CHI
SERIAL No 385/68

PROJECT NATURAL GAS PIPELINE MOOMBA - ADELAIDE
FEATURE PORT RIVER CROSSING, TAPEROO
LOCATION Western Bank, 140ft. from channel. 160ft. N. of centreline.
SECTION Harbors Board Block 3
HUNDRED PT. ADELAIDE
R.L. Surface 118·0 FT
R.L. Collar 114·5 FT
Datum L.W.D = 100·8ft.

SOIL TYPE / GEOLOGICAL DESCRIPTION		R.L.	DEPTH (FEET)	GROUP SYMBOL	SOIL DESCRIPTION / GROUP NAME (Unified Soil Classification System, Earth Manual 1st Edition 1963)	WATER	MOISTURE	CONSISTENCY / DENSITY	FIELD TEST DATA: BLOWS PER FOOT (40 60 80)	FIELD TEST DATA: POCKET PENETROMETER Units
PLEISTOCENE HINDMARSH CLAY Fluvial clays, silts and sands.	GRAVEL fragments are mainly broken shells or strongly cemented nodules of limestone	65		CH	CLAY SOIL, high plasticity, silty, grey, brown and yellow-brown mottled. Contains 5% SILT SOIL, low plasticity, calcareous, offwhite and 5% GRAVEL, max 20mm size.		6 inches / M. or P.L.	St. - V.St.	SPT 53 Blows	MAINLY 3.5 to 4.5+
	Gravel fragments are mainly strongly cemented nodules of limestone	60	55	CH	CLAY SOIL, high plasticity, silty, yellow-brown, red-brown and greyish mottled.				SPT 14 Blows	
	Sand grains mainly subangular quartz	55	60, 65	SC	SAND, fine grained, excess clay fines, grey with red-brown and yellow-brown mottling.		W.	D.	SPT 24 Blows	NOT APPLICABLE
					65·5ft END OF HOLE					

Depth scale: 70, 75, 80, 85, 90, 95, 100

FIG. 6A

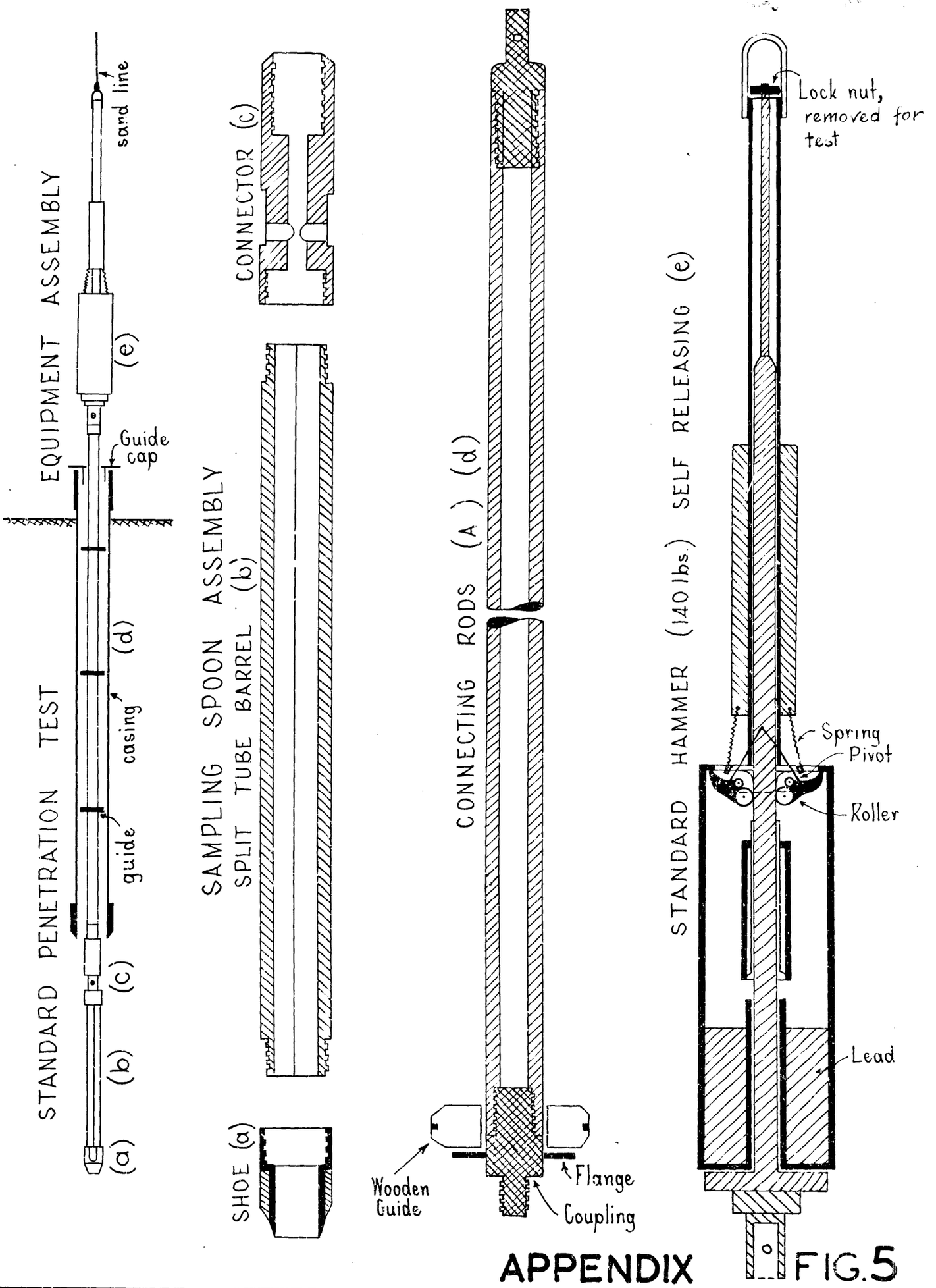
TYPE OF SAMPLE		CONSISTENCY	COMPACTNESS	RELATIVE DENSITY	MOISTURE CONTENT
A shoe (SA)	Water level, (date) Dec '66	VS — Very Soft	Ls — Loose	VL — Very Loose	H — Humid
D " (SD)	Casing	S — Soft	MC — Moderately Compact	L — Loose	D — Damp
E " (SE)	WC Water cut	SF — Soft to Firm	C — Compact	MD — Medium Dense	M — Moist
G " (SG)		F — Firm	VC — Very Compact	D — Dense	W — Wet
Sealed Tube - A Shoe — SAL		F St — Firm to Stiff		VD — Very Dense	S — Saturated
Standard Penetration Test — SPT		St — Stiff			LL — Liquid Limit
		V St — Very Stiff			PL — Plastic Limit
		H — Hard			

* These values refer to clay soils only and provide an indication of their consistency

ENGINEERING GEOLOGY SECTION

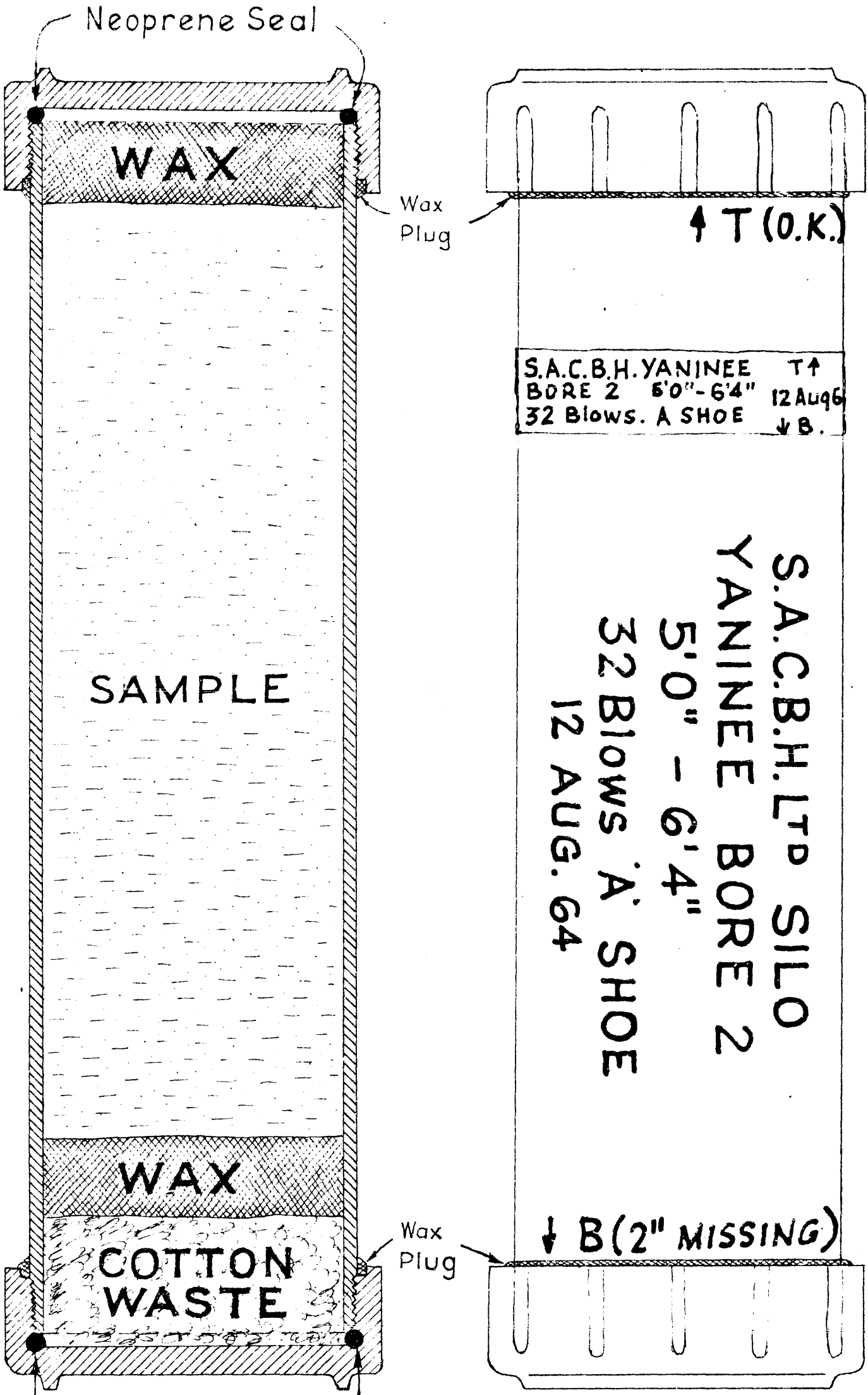
DRILL No 8
TYPE Ruston
DRILLER D. Phillips
START 27 Feb. 68
FINISH 29 Feb. 68
LOGGED BY R.D. Steel.
DATE Mar. 68
TRACED R.D.S.
CHECKED W.R. P.B.
SHEET 2 OF 2
DRG No S6485a. Hal

Pl No S5026A



APPENDIX FIG.5

ENGINEERING DIVISION	DEPARTMENT OF MINES - SOUTH AUSTRALIA	Scale: Not to scale
Compiled: W.R.P.B.	STANDARD PENETRATION TEST EQUIPMENT	Date: 22 Dec 1969
Drn. R.H. | Ckd.		Drg. No S4420 MB



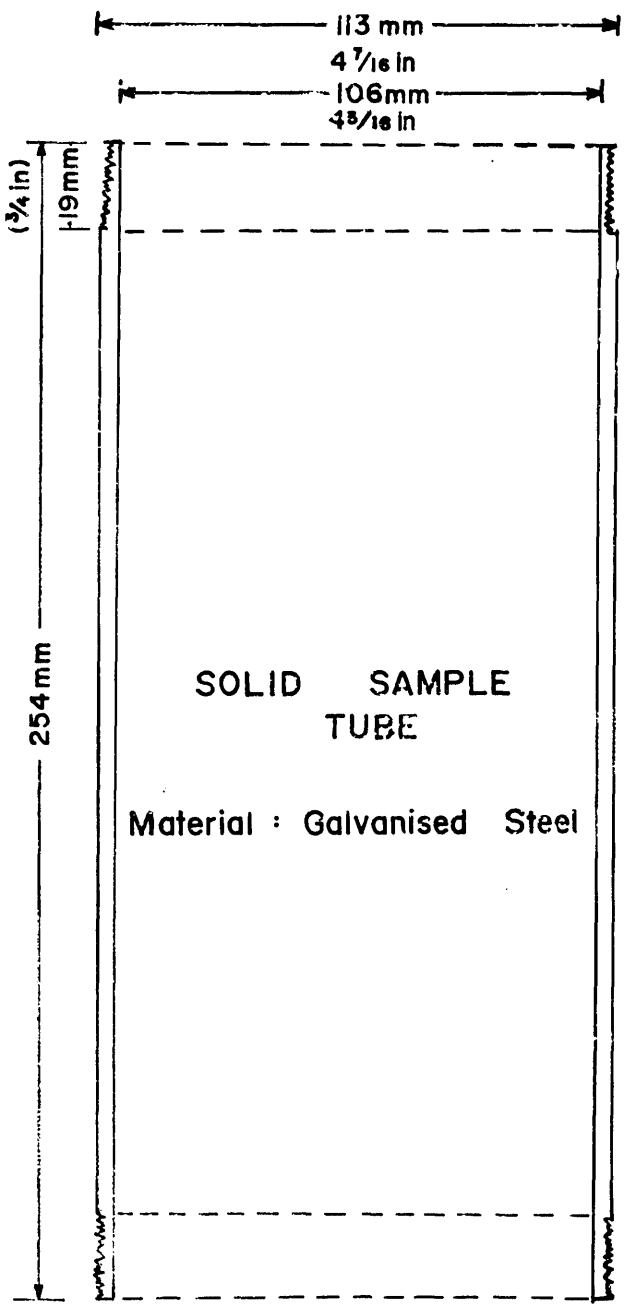
SEALING

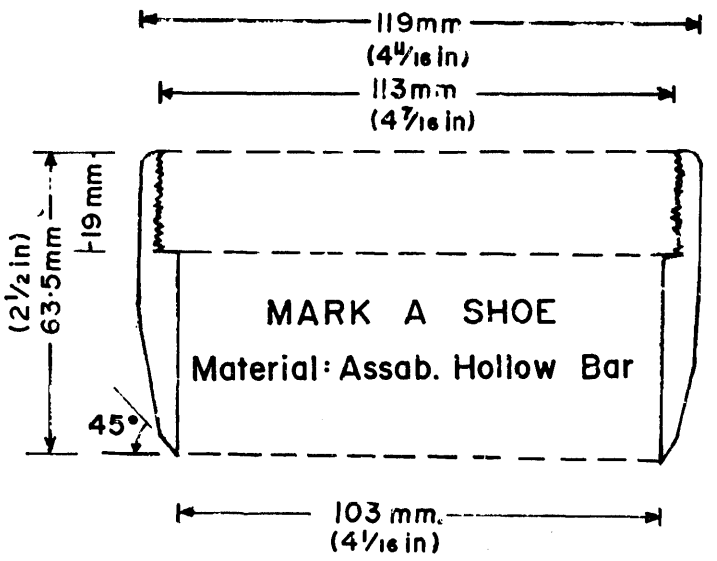
LABELLING

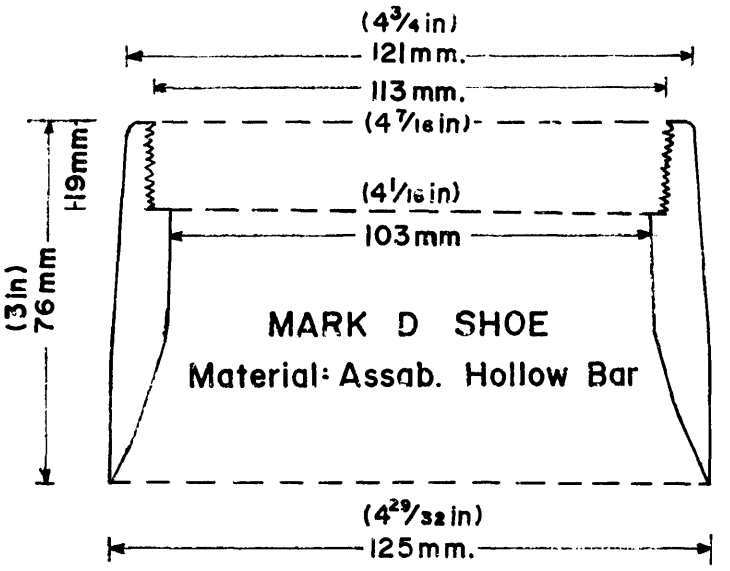
APPENDIX FIG. 3

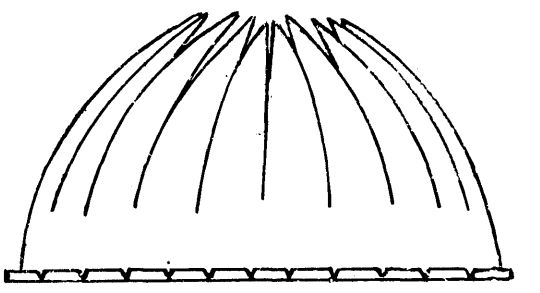
DEPARTMENT OF MINES — SOUTH AUSTRALIA

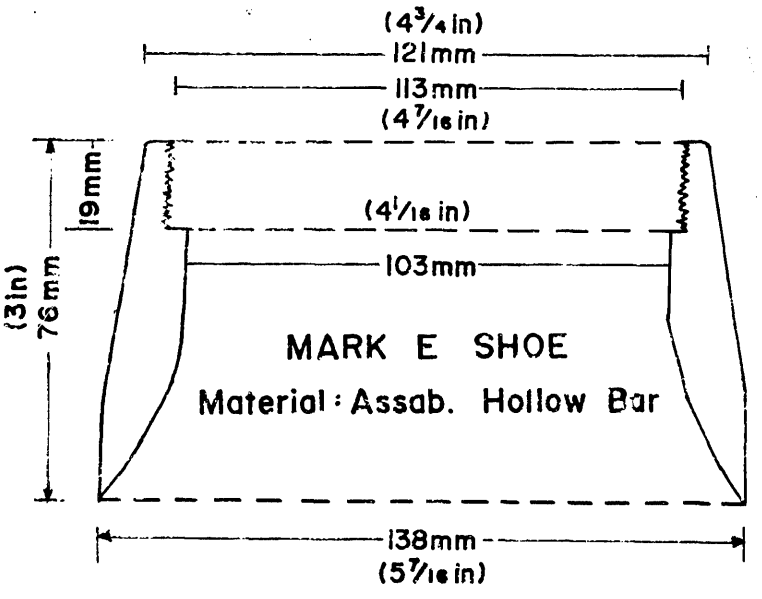
ENGINEERING GEOLOGY	Drn. R.D.S.	CABLE-TOOL DRILLING	SCALE: NOT TO SCALE
	Tcd. R.D.S.	SEALED TUBE SAMPLE	S4419 MB
DIRECTOR OF MINES	Chd. D.H.S.		DATE: 29 JUNE 65
	Exd.		





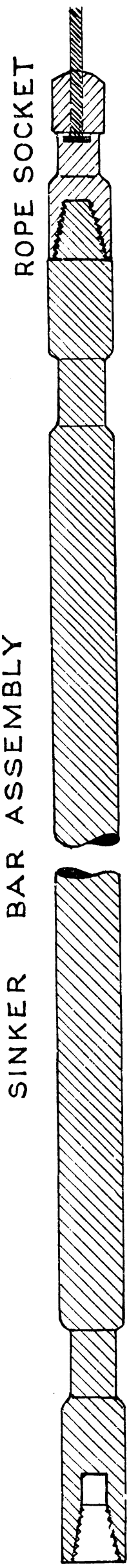


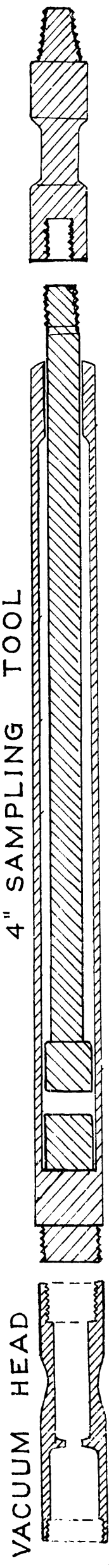

(COPPER BASKET RETAINER)



	DEPARTMENT OF MINES – SOUTH AUSTRALIA	SCALE Not to Scale
COMPILED R.G.S.	CABLE – TOOL DRILLING	DATE 12 April 1978
DRN T.E. CKD	S SERIES SAMPLING TUBE AND SHOES	PLAN NUMBER S 4418

FIG.9-5





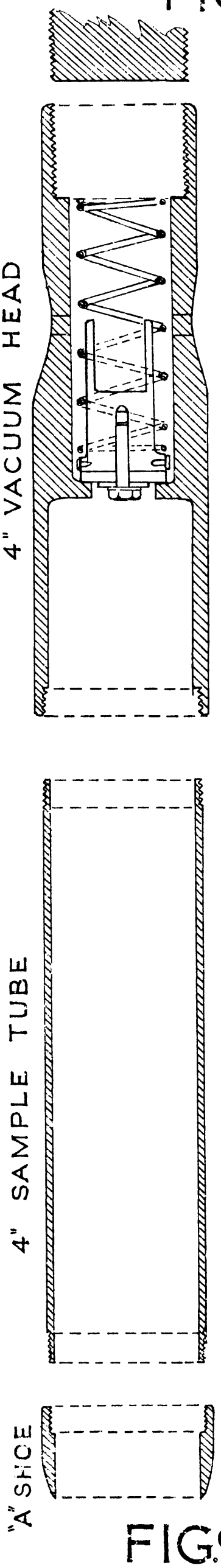
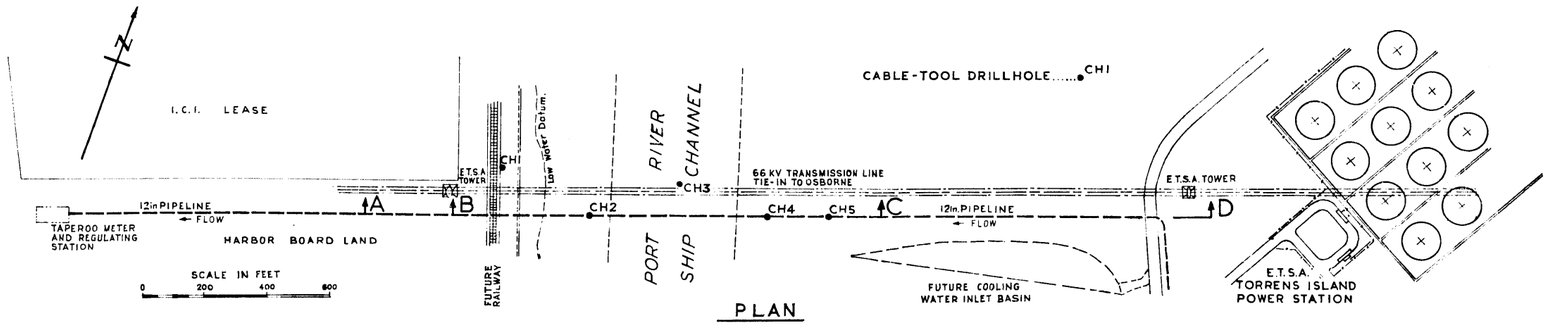


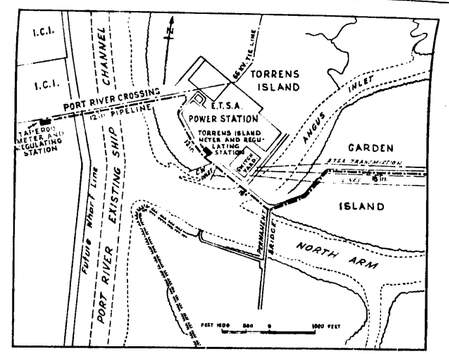
FIG.9-5

DEPARTMENT OF MINES — SOUTH AUSTRALIA

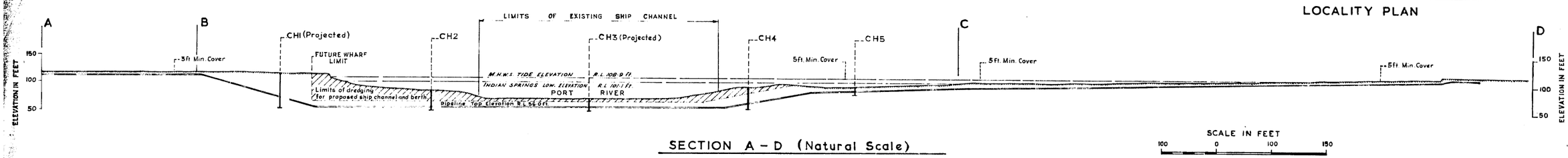
ENGINEERING SERVICES SECTION	Drn. R.D.S.	PERCUSSION DRILLING SAMPLING TOOL ASSEMBLY WITH "S" SERIES SHOES	SCALE: NOT TO SCALE
DIRECTOR OF MINES	Tcd. R.D.S.		S 4416 a. MB
	Ckd. D.H.S.		DATE: 29 June 65
	Exd.		



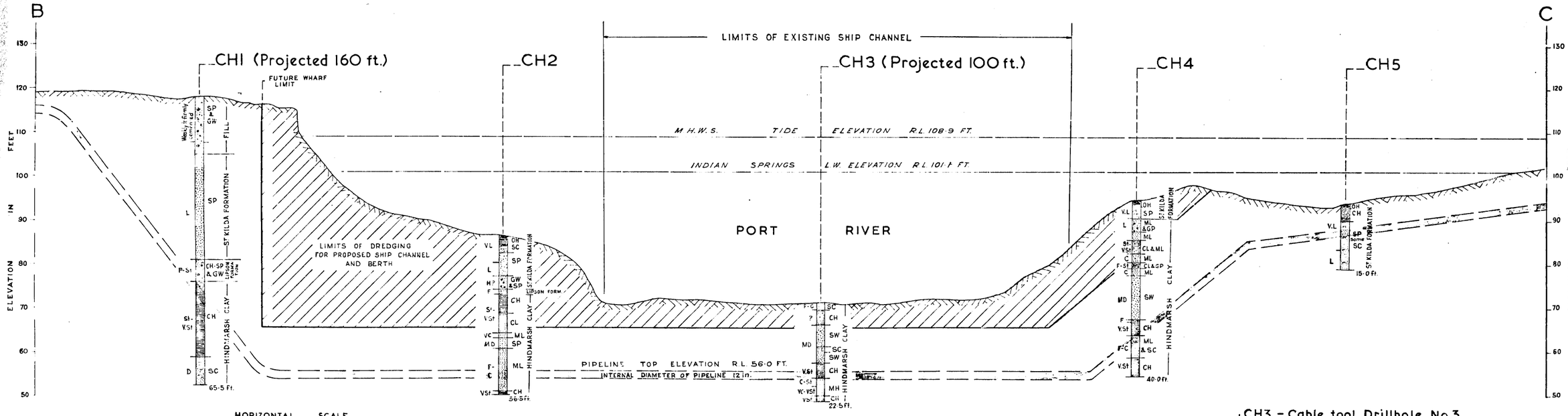
PLAN



LOCALITY PLAN

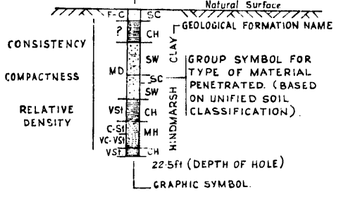


SECTION A – D (Natural Scale)



SECTION B–C Vertical Exaggeration $\frac{V}{H} = \frac{4}{1}$

CH3 – Cable tool Drillhole No.3
(showing depth and materials penetrated.)



UNIFIED SOIL CLASSIFICATION

GRAPHIC SYMBOL	GROUP SYMBOL	SOIL DESCRIPTION
	CH	Clay soil, high plasticity
	CL	Clay soil, medium to low plasticity
	MH	Silt soil, high plasticity
	ML	Silt soil, medium to low plasticity
	SP	Sand, fine grained, poorly graded
	SP	Sand, medium grained, poorly graded
	SP	Sand, coarse grained, poorly graded
	SW	Sand, well graded, gravelly, little or no fines
	SC	Sand, excess clay fines, poorly graded sand-clay mixtures
	SM	Sand, excess silt fines, poorly graded sand-silt mixtures
	GW	Gravel, well graded, gravel-sand mixtures.
	GP	Gravel, poorly graded
	OH	Organic soil

CONSISTENCY (CLAYS)

Vs – Very Soft
S – Soft
F – Firm
St – Stiff
V.St – Very Stiff
H. – Hard

COMPACTNESS (SILTS)

LS – Loose
MC – Moderately Compact
C – Compact
VC – Very Compact

RELATIVE DENSITY (SANDS)

V.L – Very Loose
L – Loose
MD – Medium Dense
D – Dense
VD – Very Dense

N.B.
Details of position and depth of pipeline, surface elevations, river depths etc., based on Bechtel Pacific Corporation.....Drg. No. 3-7
Job No. 5639

FIG. 1

DEPARTMENT OF MINES – SOUTH AUSTRALIA

NATURAL GAS PIPELINE
MOOMBA-ADELAIDE
PORT RIVER CROSSING
PLAN AND GEOLOGICAL SECTION

ENGINEERING GEOLOGY SECTION	K.L. Stott GEOLOGIST	Drn. R.D.S.	SCALE: AS SHOWN
		Tcd. R.D.S.	68-349 Hal
for Director of Mines	W.R. Brennan SEN. GEOLOGIST	Ckd. W.R.B.	
		Exd. D.H.S.	DATE: 26 APRIL 1968