DEPARTMENT OF MINES

GROZOGICAL RURVEY Mineral resources division

TARCOCLA-ALICE SPRINGS STANDARD GAUGE RAIDAY
BALLAST SULTIFIS
SITE INVESTIGATIONS AT STREET VELL

Client : Commonwealth Railways

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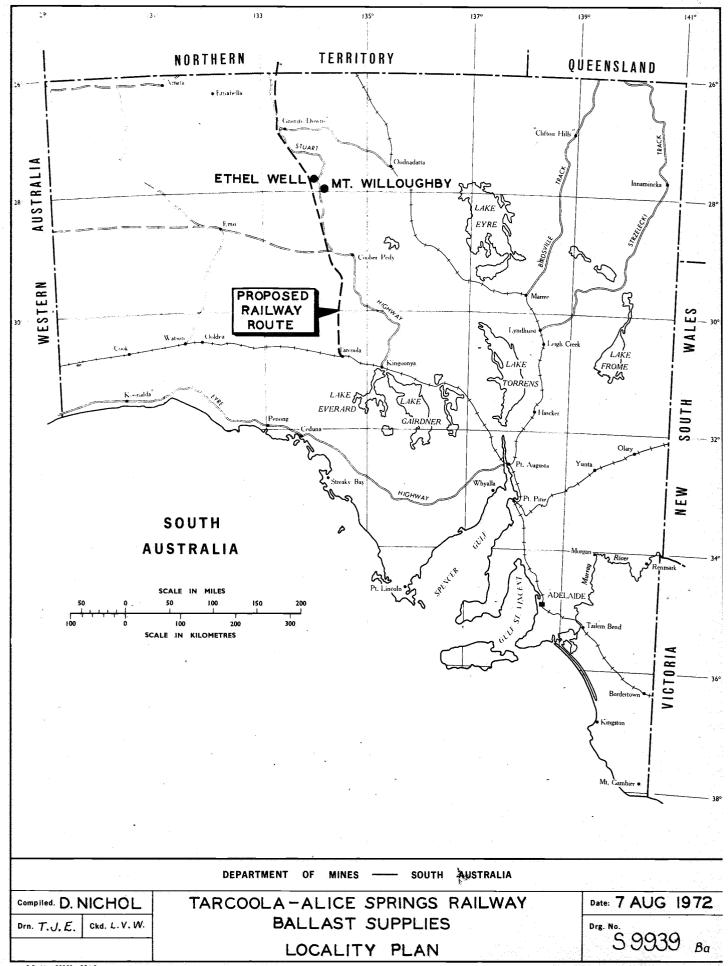
Rept.Bk.No. 72/183 G.S. No. 4948 D.M. No. 442/72

20th September, 1972.

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ABSTRACT			
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GEOLOGICAL SETTING	to the company of		
LINESTONS IN SERIOL SERVE			
CITE INVESTIGATIONS			
Diamond Drilling			
Rotary Air Drilling			
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COMMANY AND CONCLUSIONS			
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PLANS ACCOMPANYING REPORT

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71-748	Tarcoole-Alice Springe Reilw Limestone Deposit. Ethel Wel Area.		1142,240
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DEPARTMENT OF MINES SOUTH AUSTRALIA

Rept.Bk.No. 72/183 G.S. No. 4948 D.M. No. 442/72

TARCOCLA-ALICE SPRINGS STANDARD GAUGE RAILWAY
BALLAST SUPPLIES
SITE INVESTIGATIONS AT ETHEL WELL

Client : Commonwealth Railways

ABSTRACT

Geological mapping and drilling of two exploratory diamond core holes near Ethel Well led to the selection of an area of Mount Willoughby Limestone potentially suitable for the development of a ballast quarry.

Twenty-five rotary air holes were drilled which showed the presence of some 100,000 cubic metres (130,000 cubic yards) of material lying within 4 metres (13 feet) of the surface. Additional reserves exist outside of the area tested by drilling.

The material is of very low grade and would be suitable only as preliminary or bottoming ballast.

Pollowing consultation with Commonwealth Railways engineering personnel it was concluded that the site was not worth development.

INTRODUCTION

Construction of a standard gauge railway between Tarcools and Alice Springs (840 kilometres)(520 miles)) is proposed
to replace the existing narrow gauge track from Maree to Alice
Springs (870 kilometres (540 miles)).

The volume requirements, distribution of potential ballast sites and geology of the South Australian section of the route are described by Hiern (1970). A further reconnaissance carried out on the section between Mabel Greek and Marla Bore is described by Michol (1971a). During this reconvaissance potential ballast sites were selected in a freshwater limestone unit which crops out in the area of Mount Willoughby H.S. and in the vicinity of Ethel Well. (See locality Plan No. 5 9939).

Investigations carried out in the area of Mount Willoughby H.S. have been described by Michel (1972).

The present report is concerned with investigation of the Limestone unit referred to herein as <u>Mount Willoughby Limestone</u> (defined by Michol, 1971 b) in the vicinity of Ethel Well.

The work was shared by the authors as follows:-

Reconnaiseance mapping (D.N.) 22.3.72 to 31.3.71

Diamond drilling (D.N.) 12.7.71 to 17.7.71

Rotary air drilling (A.M.P.) 6.8.71 to 8.8.71

Stadia survey by N. Edwards (D.N.) 16.10.71 and 26.4.72

The authors are jointly responsible for the statements made in this report.

The oldest rocks exposed in the area are shales, sandy shales and siltstones of Lower Cretaceous age. The surface zone of these rocks was subjected to intense leaching and kaolinisation during the Tertiary period and a capping of hard siliceous rock (silcrete) was formed.

The silcrete and underlying kaolinitic zone are referred to as the durierust profile. The Mount Willoughby Limestone, a thin freshwater limestone deposit of Upper Cainosoic age, occurs along the headwater velleys of the main creeks. This unit rests with crosional unconformity on the durierust profile. Younger surficial deposits consist of gravel, sand spread, gibber and alluvial material.

The present day land surface is flat, channelled by occasional creeks which lie on the western margin of the Lake Eyre catchment area.

Linearone is the other well area

Mapping in the vicinity of Ethel Well revealed that the Mount Willoughby Limestone outcrops in an area of at least 100 square kilometres (40 square miles) along the headwater velley of Wintinna Greek (see plan No. 71-748). The unit varies between 1 and 13 metres (3 and 43 feet) in thickness. The strata are flat lying, are unconformably underlain by the duricrust profile and rocks of Lower Gretaccous age and are overlain by sand spread, gibber and alluvial material.

The sediments which compose the Mount Willoughby Limestone are weakly consolidated brown and pale brown siltatone,
calcareous siltatone and silty limestone which grade into off-white
and pale brown limestone. The carbonate content of the limestone
varies between 50% and 99%. The main carbonate component is calcite though up to 15% dolomite may be present. Other carbonate
minerals were not observed. Quartz, feldspar, manganese limonite
and iron stained clay minerals are also present.

Rapid lateral and vertical variation in lithology is a characteristic feature of the unit and an important factor in the selection of a potential ballast site.

A very hard, white chalcedony capping probably of secondary origin is often associated with the limestone. However it is discontinuous and is restricted to the upper 0.5 metres (1.6 feet) of the formation.

The only material below the chalcedony capping suitable for ballast occurs in thin lenses of more strongly cemented off-white and pale brown limestone which are intercalated with large amounts of soft, friable material. These lenses are generally restricted to depths of less than 4.0 metres (15 feet) below the surface.

Dissord Drilling

Cliff sections at Ethel Well and John Well were found to contain the best development of harder material and one dismond core hole was drilled vertically at each locality to obtain fresh material for examination (see plan No. 71-748).

The drill sites were located back from the escarpment faces and the holes were designed to show the thickness of hard limestone present and the degree to which cliff exposures had been affected by weathering.

The drill logs for the two dismond drill holes are included in Appendix A.

The quality of rock intersected by the two holes was generally poor. The thickness of better quality material was about 3.5 metres (14.5 feet) in each case with an additional 1.0 metre (3.3 feet) near the bottom of each hole. The hole at Sthel Well (DE1) contained marginally better material than the one at John Well (DE1) and the Ethel Well site was selected for a programme of rotary air drilling.

Rotary Air Drilling

A programme of rotary air drilling was devised to investigate quality and thickness of rock in the immediate vicinity of DEA. Twenty five holes were sited on a square grid at 90 metre (300 feet) centres as shown on plan No. 71-823.

The logs for the twenty four rotary air drill holes are included in Appendix B.

The quality of material intersected was generally poor.

In many of the holes, hard, white and pale brown limestones occur
in the upper 4.0 metres (43 feet) with patches of softer, more porous
silts and poorly consolidated limestone. Hard white chalcedony
occurs near the top of some holes as a solid but discontinuous
espring.

The sone containing siliceous material and relatively hard limestone is referred to as the sone of "better quality material" although much of this would undoubtedly disintegrate and be lost in extraction and crushing. This zone is depicted on the sections on plan No. 71-823 and was used in volume calculations.

Pescaves

It can be seen from sections BB*, GC* and DD* on plan
No. 71-825 that a drainage channel, now filled by Recent silts and
gravels, has been incised into the limestone in the southwest of the
grid area. This isolates the intersection of limestone in BE6
from the main body of "useable material" and this intersection was
diaregarded in volume calculations.

Although there are exposures of limestone on the margin of the escarpment, the thickness of limestone displayed was not used in volume calculations because selective meathering of the softer material has made them unrepresentative.

Intersections of "better quality material" are indicated on the sections in plan No. 71-823. Reserves have been determined by joining these intersections by straight lines and sultiplying the average area of adjacent sections by their separation and summing these volumes. The volume of "better quality material" thus outlined is approximately 90,000 cubic metres (120,000 cubic yards), that is, half that ideally required for a ballast site.

Of this, a considerable proportion would be lost during extraction and crushing.

Calculation of overburden by the same method indicates that some 9,000 cubic metres (12,000 cubic yards) are present.

The volumes quoted apply to the area tested by drilling. Exposures in the escarpment indicate that the limestone unit is of similar character beneath the whole of the plateau area shown on plan No. 71-823. Total reserves could thus be reasonably quoted to be in excess of 200,000 cubic metres (250,000 cubic yards). The overburden ratio would be similar. Further drilling would be necessary to confirm this statement.

The Mount Willoughby Limestone of Upper Cainosoic age crops out in an area of at least 100 square kilometres (40 square miles) elong the headwaters of Wintings Creek in the area of Ethel Well and John Well.

A geological mapping programme was followed by dismond drilling in the limestone unit and the most promising area was selected for further testing. This area has been investigated by a programme of retary air drilling and 90,000 cubic metres (420,000 cubic yards) suitable only for low grade preliminary or bottoming ballast have been blocked out.

Overburden over this volume has been calculated to be 9,000 cubic metres (12,000 cubic yards).

Additional reserves exist outside of the eres drilled. Because the naterial is of poor quality no further work has been carried out. After consultation with Commonwealth Railways engineering personnel it was decided that the site should be abandoned.

Louglas Michel,

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20th September, 1972.

- Firman, J.B., 1971. Regional Stratigraphy of Surficial Deposite in the Great Artesian Basin and Frome Embayment in South Australia. Dept. Mines, unpublished report RB. 71/16.
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- 1971b. The Mount Willoughby Limestone. <u>Guart. Geol.</u>
 <u>Notes. Geol. Surv. S. Aust. No. 39.</u>
- 1972. Progress Report on Marcoole-Alice Springs Reilway Ballast Supplies. Limestone Deposit - Mount Willoughby Howesteed Area. Dept. Mines unpublished report RB. 72/16.

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EXPLANATORY NOTES AND LOGS OF DIAMOND DELLE HOLES

ATTENDED A

EXPLANATORY NOTES ON DRILLING PROCEDURES

End mont

The type of dismond drilling machine used was the Mindrill F.20.

All core was drilled at NAUC core size, the nominel diameter of core being two inches. The cores were obtained with "M" type stationary inner tube core barrels fitted with bottom discharge bits. The inner tubes were of the split type, ensuring minimum disturbance of the core during removal from the barrel.

Storing and marking of core

Cores were stored in wooden boxes, each compartment of which has been designed to contain one metre (3.28 feet) of core. The internal length for each compartment was actually 1.03 metres (3.38 feet), to allow for 100 per cent core recovery (roughness of the ends of the core, and small inaccuracies in measurement when breaking it to fit the box, make it difficult to fit one metre (3.28 feet) of core in a compartment of exactly that length). The boxes were marked with consecutive compartment numbers at one end, and the drilled depths from the surface in metres at the other.

The core was boxed in this manner at the drill site, the core being placed in its appropriate place in the box as soon as it was extracted from the core barrel.

an aluminium depth marker was placed at the end of each core run and the depth recorded on the upper surface of the marker in felt pen, immediately it was placed in the box. The measured depth of the hole in metres from the surface was painted on the side of the core box and on the core. Timber blocks cut to the correct length indicate core not recovered (red blocks) and core removed for testing (yellow blocks).

The core has been stored at the Department of Mines Drilling and Mechanical Branch, Dalgleigh Street, Thebarton, South Austrelia and is available for inspection.

The logs have been plotted on a vertical scale of one centimetre = 0.50 metres (1:50).

The descriptions given on the log sheet refer only to materials recovered as core. Core may be lost by the material being ground or washed away during the drilling process; it may usually be inferred that such material was relatively weak. Nowever, this cannot always be assumed, since even solid rock core may be ground away and lost during drilling operations under some conditions.

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

Geological age) Frinted vertically

Rock unit nume

Colour of material

Type of material

Classification of the rock substance in terms of its porosity, its condition and its hardness has been shown graphically in the appropriate columns. Such classification has been based on a qualitative estimate only.

TARCOOLA-ALICE SPRINGS DEPARTMENT OF MINES SOUTH AUSTRALIA PROJECT RAILWAY BALLAST PROJECT LOG OF DIAMOND DRILL HOLE FEATURE MOUNT WILLOUGHBY LIMESTONE DEPOSIT PLAN REFERENCE 71-748 COORDINATES COORDINATES ANGLE FROM HORIZ 90° DIRECTION —													
LOCA.	TION ETHEL WELL, WINTINNA CREEK	AN	GLE FI	ROM HORIZ90	DIREC	CTION	-						
	DESCRIPTION OF CORE	LOG	DEPTI (m.)	POROSITY H AND HARDN CONDITION L을 요 및 등 및 및 모양 호 플 =	IESS	STRUCTURES	CASING (LOSS (LL)						
	Off-white silicified limestone					,							
	Pale brown limestone				lomin	nar bedding							
	Brown silty limestone	出出出	. 		Thin	y bedded							
	Pale brown and off-white limestone	开开	2		Intra	aclastic							
	Brown limestone				Poor	ly developed							
			<i>3</i> _			hes of mangar	nese						
VE			, 				- -						
ESTONE		1 H H	4_		-								
10ZOIC LIMEST		-I					_15						
		1	_ 5_										
IPPER CANTLOUGHBY		I - I	<u> </u>										
UPPER WILLO	Brown calcareous siltstone	1 1	_ 6 _				- - - -20						
2 2		H				<u> </u>							
MOUN			ブ _										
- 2		H H H H H H				<u> </u>	-25						
	Brown limestone		9_		Intro	aclastic	-30						
	No core recovered		10	-									
L	DROSITY TERM CONDITION TE	ERM		HARDNESS TE	ERM »	MINERAL RESOU	RCES DIVISION						
р	Highly Porous Porous Moderately Porous Slightly Porous Non Porous Non Porous Presh Decompose Weathered Weathered Not application		VS S MH H	Very soft Soft Moderately Har Hard	rd .	DRILL Nº 9 TYPE MINORILL DRILLER D. WHITE START 13-7-71 FINISH 14-7-71	TRACED J.M.B. CHECKED R.4						
	Non Porous Not applica	ANIC	YH	Very Hard		SHEET 1. OF 2. D	RG Nº \$9527_Ba						

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	FEATURE MOUNT WILLOUGHBY LIMESTONE DEPOSIT PLAN REFERENCE 71-748 COORDINATES LOCATION ETHEL WELL, WINTINNA CREEK ANGLE FROM HORIZ. 90° DIRECTION -														LN	01	· ·
		ION ETHEL WELL, W			ርር	เกยกเพ	ATFS		***			TION					
		DESCRIPTION	N OF COI	RE	LOG	DEPT) (m.)	PORO LAN COND	SITY D ITIOI	/ HARD N \$.5 ₹	NES = =	S	STRUC	TURES		CORE LOSS	CASING	DEPTH (FT.)
Ì	BY	No core rec	overed		[<u> </u>		H	Mine								
	OZOIC 7 WILLOUGHB	Brown siltst	one														-3 5
	MOUN	No core reco			.					-							
	RUST	Pale brown fro	igmental orotile	zone of	19111	. /2_]]							-		40
	DURICRU									-					-		
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P.F. N° \$9411 MB

PR	OJE	DEPAR TARCOOLA - ALICE SPRINGS CTRAILWAY BALLAST PROJECT. LOG OF	- DI	AM	OND		_ HOL	E	HOLE NO SERIAL N		
1		RE MT. WILLOUGHBY LIMESTONE DEPOSIT	CO	DRDIN	ATES	71:: 7.90°		rion	- -		
		DESCRIPTION OF CORE			POROSIT			TRUCTURES	CORELOSS	CASING	DEPTH (FT.)
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		White limestone.				The state of the s					-5
4		Pale brown limestone.	上 上				intra	ly bedded: clastic nes of mangane	ese	~ ~	
-	- 当			- 3_	7						-10
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CAINOZOIC	- - -	*	I	5_							-15 '
Č	WILLOUGHEY	Brown calcareous siltstone.	I.	6_			intra	bedded :			
UPPER	WI		I. I.	-			patch	nes of mangane	ese.		-20
	MOUNT		I	7 <u>_</u> 		N. Carlotte		4			-25
-	Σ		I. I	8_	1						
			I I	9_						- ,-	-30
		Brown siltstone	エ					<u> </u>			
-	Pr	PROSITY TERM CONDITION T	FDM	10	17. 4	IESS TER	 ?M	MINERAL RESOU	IRCES D	IVIS	ION
N S	IP }	Highly Porous Porous Moderately Porous Slightly Porous Non Porous Non Porous Condition Fresh Decompos Weathered Not applic	ed	YS S M H H Y H	Very so	oft tely Hard		DRILL Nº 9 TYPE MINDRILL DRILLER Q WHITE START 12.7.71 FINISH 13.7.71 SHEET 1. OF 2. 1	LOG	GED _D_1 TE_1: CED CKEI	NICHOL S.J.C S.J.C S.J.C

	DEPARTMENT OF MINES SOUTH AUSTRALIA TARCOOLA - ALICE SPRINGS LOG OF DIAMOND DRILL HOLE PROJECT RAILWAY BALLAST PROJECT. LOG OF DIAMOND DRILL HOLE SERIAL Nº 609/72												
i		REMT. WILLOUGHBY LIMESTONE DEPOSIT	PI		ERENCE.			JOERIAL N					
LO	CAT	ION JOHN WELL, WINTINNA CREEK.	AN	IGLE FR	OM HORIZ POROSITY		DIRECTION_	 1:81	· - 1				
		DESCRIPTION OF CORE	LOG	DEPTH (m.)	POROSITY AND CONDITION Leases	HARDNESS	STRUCTURES	CORELOSS	ONS (F	PTH T.)			
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CAINC	OUGHBY	*Pale brown limestone					Occasional mangar coated intraclasts.	nese					
UPPER	WILL	Brown siltstone		12		18 4 18 4 14		,					
3	Σ.	No core					<u></u>		-40				
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1 1	IP	DROSITY TERM CONDITION Highly Porous Porous Moderately Porous Slightly Porous Non Porous Non Porous CONDITION Fresh Decompo Weathere Weathere Altered Not appli	sed cd	VS S MH H	Very sof	ely Hard	DRILL Nº 9 TYPE MINDRILL DRILLER D.WHI START 12-7-71 FINISH 13-7-71	LOGITE DAT	GED D. NICHO E J3-7-7 CED S.J. CKED - 8.	L C K			
<u></u>		9411 MB				***	SHEET_2_OF_2	- DRG NO	2577E	0 <u>0 B</u> 0			

EXPLANATORY NOTES AND LOGS OF ROTARY AIR DELLA ROLES

EXPLANATORY NOTES AND LOGS OF ROTARY AIR DRILL HOLES EXPLANATORY NOTES ON DRILLING PROCEDURES

All drill holes were put down using a truck mounted Mayhew 1,000 retary drill. Only highly disturbed air-blown samples were recovered during drilling, but these were sufficient to determine the type of rock material present at different depths.

Rock-outtings for each sample interval were collected in annular sample pans and placed in sample bags marked with the Location. Note No., and Interval.

The samples have been stored at the Department of Mines Drilling and Mechanical Branch, Dalgleish Street, Thebarton, South Australia and are available for inspection.

The logs are plotted on a vertical scale of one centimetre = 0.50 metres (4:50).

The penetration rate is an expression of the strength of the rock material and it is expressed graphically. Classification of rock substance in terms of its qualitatively estimated porosity and hardness are also shown graphically in order to explain penetration rate.

SABLE STRATE OF USABLE MATERIAL IN EACH ROLARY AIR DRILL HOLE

<u> </u>		Thickness ctimete (metres)	Nole No.	Chickness Columbs (metres)
	1	3.0	82. 44	0.5
			88 15	1.5
		1.0	11 16	2.5
	·	0.5	ME 17	1.0
		0.5	25. 18	5.5
	-	2.5	ME 19	1.0
		0.5		0
			XX 21	3.5
	9	0.5	1 22	1.5
	_			
			24 × · · ·	1.0
			1 1. 25	•
		1.5		

The interval selected for representation on graphic logs was 0.5 metres (1.6 feet). Variations in quality of material of less than 0.5 metres (1.6 feet) were actually recorded in the field; and explains small discrepancies between the generalised graphic logs and the sore accurate estimates of thickness of material which were made in the field.

OF ROTARY AIR DRILL HOLE HOLE NO MEI/ME 21. PROJECT RAILWAY BALLAST PROJECTLOG SERIAL Nº 905/72 PLAN REFERENCE __ JL- 823 FEATURE MT. WILLOUGHBY LIMESTONE DEPOSIT. COORDINATES ANGLE FROM HORIZ 90° DIRECTION LOCATION ETHEL WELL _ PENETRATION TIME DEPTH (FT.) PORO-HARD-LOG DEPTH DESCRIPTION OF CHIPS STRUCTURES SITY NESS (m.) (MINS.) G G G S S E E White silicified limestone White and off-white limestone soft silty interbands. White, off-white & brown limestone. White limestone interbands. White and brown limestone. LIMESTONE Brown silty interbands Brown silty limestone. CAINOZOIC 2 Brown and grey limestone. ВY Brown and grey limestone. WILLOL Brown and grey limestone. Brown Siltstone 4 Brown siltstone Brown siltstone 5 Brown siltstone 18 ft. END OF HOLE 5.5M. POROSITY TERM HARDNESS TERM MINERAL RESOURCES DIVISION Highly Porous Very Soft Soft **V**S DRILL Nº DM 67. LOGGED Р Porous AM PAIN
DATE 24 1.72.
TRACED DIEW.
CHECKED LVW. S TYPE MAYHEW 1000 Moderately Porous Slightly Porous MP DRILLER_W_BOYD__ MH Moderately Hard START G AUG 1972 FINISH GAUG 1972 SP Н Hard Non Porous Very Hard VН SHEET_LOF 1_ DRG Nº S9659 Ba

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		JRE MI. WILLOUGHBY LIMESTONE DEPOSIT.	PLI		ERENCE _					ich oc	<i>,</i> 0,,2_
	-	ION_ETHEL_WELL	AN	ORDINAT GLE FROI	es M Horiz_	90°	DIRECT	ION	- -		
		DESCRIPTION OF CHIPS	LOG	DEPTH (m.)	PORO- SITY	HARD- NESS Sort		UCTURES	PENETR TIM (MIN	E	DEPTH (FT.)
		Brown calcareous soil.	0_0				Silicifie	d limestone			
		Brown and white limestone	45				Silty I	r <u>ubble.</u> meștone			
		Pale brown calcareous siltstone.	I I					interbands.			
		Brown and white limestone.	I : I	1 1					+		
	坦	White and brown calcareous sittstone. Brown limestone.	12-12-1	 	4	5					- 5
ပ	5	White limestone.	异								
Ō	EST	White and pale brown silty limestone.	立	2_					كم		
CAINOZOIC	M	Brown limestone.		-			Silty	interbands			
7] —			- /	er a recommendation			•
	MR. WILLOUGHBY LIMESTON	Brown limestone.		3							
	5	Brown limestone	田								-10
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		Brown calcareous siltstone.	I I	-							Ì
		Brown calcareous siltstone.	I -			+-1+	<u> </u>		+++++	+	-15
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					TERM			MINERAL F	RESOURCE	S DIVISI	ON
		HP Highly Porous V P Porous S		Yery ?	2011		٠.	DRILL Nº DM		LOGGED A.M. PA	UN.
		MP Moderately Porous N	(H	Moder	ately Ho	ard		DRILLER W. B.	SQYP	DATE _6 TRACED	871
		MP Moderately Porous M SP Slightly Porous H NP Non Porous Y		Hard Very 1	lard			FINISH _6_8	71	CHECKED	<u>L.V.W.</u>
		in Monthonora	* 5	· ' '	,v			SHEET_I_ OF .	1_[DRG	No 236	42 Ba.

DEPARTMENT OF MINES SOUTH AUSTRALIA HOLE NO ME.3 TARCOOLA -ALICE SPRINGS PROJECT PROJECT ROTARY AIR DRIL SERIAL Nº 905/72 PLAN REFERENCE __71-823 FEATURE MT. WILLOUGHBYLIMESTONE DEPOSIT. COORDINATES LOCATION ETHEL WELL ANGLE FROM HORIZ 900 DIRECTION PORO-HARD-PENETRATION DEPTH (FT.) DESCRIPTION OF CHIPS LOG DEPTH STRUCTURES TIME SITY NESS (m.) (MINS.) A C C S S E = 3 Brown silty soil limestone rubble Patchy Silicification White limestone White calcareous siltstone Brown and white calcareous siltstone T- ~ I -I Pale brown calcareous siltstone. WILLOUGHBY LIMESTONE 5 [-I Pale brown calcareous siltstone. Ì-2 Pale brown calcareous siltstone. Pale brown calcareous siltstone. 3 10 Pale brown calcareous siltstone UPPER - H - H Pale brown calcareous siltstone. ī 4 I I I-I Pale brown calcareous siltstone. ------Pale brown calcareous siltstone. 5 Ι-Τ Ι-Ι Pale brown calcareous siltstone. Bft. END OF HOLE 5.5 METRES POROSITY TERM HARDNESS TERM MINERAL RESOURCES DIVISION HP Highly Porous 45 Yery Soft DRILL Nº DM 67 _ LOGGED P Porous Soft S TYPE MAYHEW 1000 A.M. PAIN Moderately Porous Slightly Porous MP MH Moderately Hard DRILLER W. BOYD DATE 68 71 START 6 8 71 TRACED S.J.C. CHECKED L.V.W SP Н Hard NP Non Porous YΉ Very Hard DRG Nº S9643 Ba SHEET_I_ OF 1_

OF ROTARY AIR DRILL HOLE HOLE NO ME.4 PROJECT RAILWAY BALLAST PROJECT LOG SERIAL Nº 905/72 PLAN REFERENCE 71-823 FEATURE MT. WILLOUGHBY LIMESTONE DEPOSIT. COORDINATES ANGLE FROM HORIZ 90° LOCATION ETHEL WELL _ DIRECTION_ PENETRATION TIME DEPTH (FT.) PORO-HARD-DESCRIPTION OF CHIPS LOG DEPTH STRUCTURES SITY **NESS** (m.) (MINS.) A C C S S E X S Silicified Red brown silty soil. limestone rubble. 3-4% quartz Red brown clay. grains Red brown clay. 3-4% quartz grains. LIMESTONE 5 Brown silts. CAINOZOIC 2 Brown silts. WILLOUGHBY Brown silts 3 -و_ق 10 Silty conglomerate. 101, 0111 0 10' ()pper Silty conglomerate. 4 Silty conglomerate _ 0._ 0010101 Silty conglomerate 5 Silty conglomerate 0 0 18 ft. END OF HOLE 55 METRES POROSITY TERM HARDNESS TERM MINERAL RESOURCES DIVISION HP Highly Porous Porous VS. Yery Soft DRILL Nº DM 67 LOGGED P Soft S TYPE MAYHEW 1000_ A.M. PAIN Moderately Porous Slightly Porous Non Porous MP Moderately Hard DRILLER WLBOYD ... HM DATE 687L _ . START 6.8 71 _ FINISH 6.8 71 _ TRACED SUC. SP Н Hard NP YH Very Hard DRG Nº S9644 80 SHEET_I_ OF 1_

FE	ATU	TARCOOLA-ALICE SPRINGS LOG OF CAT RAILWAY BALLAST PROJECT LOG OF	RO	FARY AN REFI	FS	DRII -823	LL HO)LE	- 1-	HOLE Nº M.E SERIAL Nº 90	
LO	CAT	DESCRIPTION OF CHIPS		DEPTH (m.)		HARD- NESS	DIRECTI	ictures		ETRATION TIME MINS.)	DEPTH (FT.)
		Red brown silt.		_			Silicifie rubble.	ed limeston			
3:	NOIVM	Slightly moist red clay. Slightly moist red clay.	H.P. P. P. P.				5% qu grair		Commission of the commission o		-5
ပ္	ALL	Slightly moist red clay. Red brown calcareous siltstone.	THE STATE OF THE S	2	الرا	الرا		· · · · · · · · · · · · · · · · · · ·			
AINOZOI		Red brown calcareous siltstone.	エニオニエニ								•
S	ONE	Buff to pale red calcareous siltsto		_3_				· · · · · · · · · · · · · · · · · · ·			
ËR	MEST	Buff to pale red calcareous siltstone	I - I	,			and the same of th	, <u> </u>			-10
UPP	BY 1.1	Buff to pale red calcareous siltstone.	I I	4		1 4					
	поисн	Buff to pale red calcareous siltston		_				•			
	WIL	Silty pale red conglomerate	-0-0				Silcre	te rubble			-15
	MŢ	Silty pale red conglomerate	0101	_			Silcret	e rubble			18 f1 .
	•	END OF HOLE 5.5 M.		_							10 11.
			11					**************************************			
				_				The state of the state of	-		
			1	_							
	e, Taylor, Samuel		-	-		+					•
				-					+-4	+	
	- ,	e de la companya de La companya de la co				Section of the sectio		or or			
								السريد سريد الرااد			
_		POROSITY TERM	HARI	L ONESS	TERM		1	MINERAL F	RESOU	RCES DIVISI	DN.
i e		HP Highly Porous V P Porous S MP Moderately Porous M SP Slightly Porous H	S IH	Yery Soft	Soft ately Har	d	;	DRILL Nº DM TYPE MAYHEM DRILLER W BS START _ 7-8- FINISH _ 7-8- SHEET L OF	67_ / 1000 PYD_ 7!	_ LOGGED	IN -7] 5.1.C. L.V.W.

4	TARCOOLA-ALICE SPRINGS LOG OF ROTARY AIR DRILL HOLE PROJECT RAILWAY BALLAST PROJECTLOG OF ROTARY AIR DRILL HOLE SERIAL Nº 905/72											
			LOUGHBYLIMESTONE DEPOSIT.	PL COI AN	AN REFI ORDINAT GLE FROI	erence _ es u horiz_		DIRECT	10N_=	 	4.	
10	VAI		RIPTION OF CHIPS		DÉPTH (m.)	PORO- SITY	HARD- NESS ダッ葉ェゔ		UCTURES	TIP	RATION ME NS.)	DEPTH (FT.)
			own silty soil.	0 - 0 -				Silicifie rubble	ed limestone			
			rown clay. limestone.	日				Some	pale brown			
	크		silty limestone.	北北	_		ل					-5
200	LIMESTONE	Brown	silty limestone.	声	2_							
CAINOZOI	/ LIM		silty limestone.	出出	-				s and some section of			Ţ.
ن ا	UGHBY		silty limestone.	膨	_3_							_10
UPPER	WILLO		rown calcareous siltstone.						·,			
l D	MT. V		rown calcareous siltstone.	I _ I	4							. ,
-			rown calcareous siltstone 	I - I - I - I - I -		++	-1+	<u> </u>			+ + + +	-15
-		to the same of	rown calcareous siltstone.	エニエ	5	-		/ -				
			OF HOLE 5.5 M	1=					· ·			18 ft.
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			· · · · · · · · · · · · · · · ·						, <u>,</u>	•		
					-							
_		make s Soundard here =		r =								
_ ,		8 A S A	e e e e e e e e e e e e e e e e e e e	~				-	· · · · · · · · · · · · · · · · · · ·			
	· - -	· · · · · · ·										
\vdash		POR	OSITY TERM	HAR	DNESS	TERM		J	MINERAL F	RESOURC	ES DIVISI	ION T
		HP P MP SP NP	Highly Porous Porous Moderately Porous Slightly Porous	VS S MH H VH	Very Soft	Soft ately Ho	árd	X.	DRILL Nº DM TYPE MAYHEM DRILLER W. B START _ 7-8- FINISH J - B- SHEET_L OF	67 / 1000_ .0YD .7L 7L	LOGGED A.M.PA DATE J: TRACED CHECKED Nº S96	S.JC.

	$\mathcal{F}_{i} = \{ i, j \in \mathcal{F}_{i} \mid i \in \mathcal{F}_{i} \mid i \in \mathcal{F}_{i} \} $		e4				1.5%	
	TARCOOLA-ALICE SPRINGS LOG OF	MENT	OF MIN	VES - SOL	TH AUSTI	LL HOLE	HOLE Nº ME. 7	
	ECT RAILWAY BALLAST PROJECTLUG UT	PL.	AN REF	ERENCE	71-8	323	SERIAL Nº 905/	72
	ION_ETHEL_WELL	CO!	ORDINAT GLE FRO	es M Horiz	90°	DIRECTION		
	DESCRIPTION OF CHIPS	LOG	DEPTH (m.)	PORO- SITY	HARD- NESS	STRUCTURES	PENETRATION DE TIME (F	PTH T.)
	_Brown _silty_soil_	0				Silicified limestone rubble Fine quartz		 ,
	Slightly moist red clay	\equiv	1_			grains		
ONE	Slightly moist red clay		-				-6	
CAINOZOIC	Red to buff silt		2_					v
CAIN	Pale brown sitty canglomerate					,		
1_1	Pale brown silty conglomerate	100	3			Silcrete_pebbles Silicifled	-10	
UPPER F. WINALO	Pale_brown_silty_conglomerate	<u></u>				limestone pebbles Silicified		
D T	• •	000	4		++-	limestone pebbles Silcrete,		٠.
	Pale_brown_silty_conglomerate	0000			+++	limestone and semi	15	
	. Pale brown silty conglomerate		5			indurated silt pebbles Silcrete and		
	Pale brown silty conglomerate	<u>_</u>				limestone pebbles	18 f	L
EN	ID OF HOLE 5.5 m.		_					r
			-	7		*		
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· - ,								
•			NESS		<u> </u>	MINERAL	RESOURCES DIVISION	
<u>.</u>	HP Highly Porous VS P Porous S MP Moderately Porous MP SP Slightly Porous H NP Non Porous VH	: 	Very Si Soft Modera Hard Very Hi	tely Ha	ırd	DRILL Nº DM TYPE MAYHEM DRILLER W B START 118 FINISH 118 SHEET 1 OF	1000	<u>v. </u>

OF ROTARY AIR DRILL HOLE HOLE NO MES PROJECT RAILWAY BALLAST PROJECTLOG SERIAL Nº 905/72 PLAN REFERENCE 71-823 FEATURE MT. WILLOUGHBY LIMESTONE DEPOSIT. COORDINATES ANGLE FROM HORIZ 900 _DIRECTION___ LOCATION _ ETHEL WELL _ _ DEPTH (FT.) PORO-HARD-PENETRATION LOG DEPTH DESCRIPTION OF CHIPS STRUCTURES TIME SITY NESS (m.) (MINS.) A S B S O 볼 프 글 Silicified 0 limestone ALLUVI Red-brown silty soil rubble.... Slightly clayey brown silt Pale brown and white siltstones calcareous エニ LIMESTONE and white Pale brown ーエ calcareous siltstones エニ Pale brown and white ~_ calcareous siltstones 工 **ICHBY** I Pale brown calcareous I siltstones. 3 ニエ WILLOU Pale brown calcareous 10 I siltstones. ニェ Pale brown calcareous \mathcal{I} siltstones. Pale brown calcareous siltstones. I I Pale brown calcareous -15 siltstones 三 5 ェニ Pale brown calcareous siltstones. 18ft. END OF HOLE 5.5 m. POROSITY TERM HARDNESS TERM MINERAL RESOURCES DIVISION HP Highly Porous Yery Soft VS. DRILL Nº DM 67 LOGGED p Porous Soft S TYPE MAYHEW 1000 A.M. PAIN MP Moderately Porous DRILLER W_BOYD__ DATE _118 [7] _ MH Moderately Hard TRACED_SLJ CHECKED LYW Slightly Porous SP Н Hard Non Porous NP Very Hard YH SHEET_LOF_LDRG Nº S9648 Bo

	TARCOOLA-ALICE SPRINGS LOG OF ROTARY AIR DRILL HOLE PROJECT RAILWAY BALLAST PROJECT OF PLAN REFERENCE 11-823 PLAN REFERENCE 11-823												
	EMT. WILLOUGHBY LIMESTONE DEPOSIT.	CO	ORDINAT	ES		Direction =	· = * ·= =						
LOCKITO	DESCRIPTION OF CHIPS'		DEPTH	PORO- SITY	HARD- NESS	STRUCTURES	PENETRATION TIME (MINS.)	DEPTH (FT.)					
UPPER MT. WILLOL	Red-brown silty soil Red-brown silt Brown calcareous siltstone Pale brown silty conglomerate Pale brown silty conglomerate	0110 1110				Silicified limestone rubble Silicified limestone rubble Silicrete pebbles Silcrete pebbles Silcrete pebbles		-10 -15					
	Pale brown silty conglomerate	0 0				Silcrete pebbles		18f l .					
	ND OF HOLE 5.5 m.												
· — — —													
	POROSITY TERM HP Highly Porous P Porous MP Moderately Porous SP Slightly Porous NP Non Porous YH	. ; { }	NESS Yery So Soft Modera Hard Yery Ho	oft tely Har	⁻ d	DRILL Nº DM TYPE MAYHEW DRILLER W.EX START _ Z B FINISH _ Z B	DATE J	ў. ўл. ө†л.					

PROJI	TARCOOLA-ALICE SPRINGS LOG DEPART	RO	OF MIN	AIR	DRI	LL HOLE	HOLE NO M.E SERIAL NO 90	
	IRE MT. WILLOUGHBY LIMESTONE DEPOSIT.	COC	AN REFI	FS	7]-823	DIRECTION_	· = • · = •	
LOCAT	DESCRIPTION OF CHIPS		DEPTH (m.)	PORO- SITY	HARD NESS	STRUCTURES	PENETRATION TIME (MINS.)	DEPTH (FT.)
	Red - brown silty soil	250				Silicified limestone rubb		
	Pale pink & off-white limestone	片				Patchy silicification		
	White silicified limestone		1_			Banded		
	Pale brown siltstone		_					
STONE	Pale brown siltstone		2			****		-5
CAINOZOIC BY LIMESTO	Pale brown siltstone		_					
る一章	Pale brown siltstone	三	_					
UPPER CAINOZOIC MT. WILLOUGHBY LIMESTONE	Pale brown siltstone		3_					-10
UPPER .	Pale brown siltstone							
∑ F.	Pale brown siltstone		4		++			
				+	+++		▋ ┠┦┾┨┿┨┿╏┤	-15
	Pale brown siltstone		5					
	Pale brown siltstone		-					18 fl .
	END OF HOLE 5.5m							_
			_					
	The second of th		<u> </u>			<u> </u>		
				TERM		MINERAL	RESOURCES DIVISION	ON.
	HP Highly Porous V P Porous S MP Moderately Porous M SP Slightly Porous H NP Non Porous Y	(H	Yery S Soft Modern Hard Very 1	ately Ho	ird	DRILL Nº DM TYPE MAYHEY DRILLER W. E START _ 7-8- FINISH _ 7-8- SHEET_L OF	N 1000 A.M. PAI BOYD DATE _ 7. 71 _ TRACED CHECKED	8-71 5 L.T. L.Y.W.

	ECT RAILWAY BALLAST PROJECTLOG OF	ROT	ROTARY AIR DRILL HOLE PLAN REFERENCE _ 71- 823						HOLE Nº M.E. 11 SERIAL Nº 305/72		
	JRE MT. WILLOUGHEY LIMESTONE DEPOSIT.	CÓC	RDINAT	FS			TION				
LUUKI	DESCRIPTION OF CHIPS		DÉPTH	PORO- SITY	HARD- NESS	STI	RUCTURES	1 1	TRATION IME	DEPTH (FT.)	
	White limestone					Poi	tchy				
	White Ilmestone		1			Sinc	ification.				
	White limestone	開開	1_			#5/					
OIC	White limestone	HIII								∽ 5	
01C ST0	White limestone	出	2]			l	jes				
AINOZ	White and brown calcareous					54.					
CA JGHBY	White and brown calcareous silt	HIHHH	_3_			į.					
UPPER F. WILLOL	Brown calcareous silt.	HIHH HIHH	- 							- -10	
MT. V	Brown calcareous silt	H H H	4				-1				
	Brown calcareous silt								++++	⊢ 15	
-	Brown silt		<u>5</u> _			en e	· · · · · · · · · · · · · · · · · · ·	-			
	Drown silt ND OF HOLE 5.5 m.						· · · · · · · · · · · · · · · · · · ·			18 ft.	
L,	ND OF HOLE 5.5 m.		-								
			-		+	· · · · · · · · · · · · · · · · · · ·					
						*					
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					-	+++++					
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						10.00					
			NESS		,		MINERAL R	ESOUR	CES DIVISION	N	
HP Highly Porous VS Yery Soft P Porous S Soft MP Moderately Porous MH Moderately I SP Slightly Porous H Hard NP Non Porous YH Yery Hard						•	DRILL Nº DM TYPE MAYHEW DRILLER W B START 118 FINISH 118 SHEET L OF		LOGGED _A_M_PAI DATE _7,4 TRACED _ CHECKED Nº S96	5171 _ S1√w_	

TARCOOLA -ALICE SPRINGS LOG OF	MENT RO	OF MIN	IES · SOUT	TH AUSTR	ALIA H	IOLE		LE Nº M.E	
FEATURE MT. WILLOUGHBY LIMESTONE LOCATION LETHEL WELL			RENCE _ ES W HORIZ_			TION		: 	
DESCRIPTION OF CHIPS	LOG	DÉPTH	PORO- SITY \$a\$\$\$	HARD- NESS		RUCTURES	PENE"	TRATION ME INS.)	DEPTH (FT.)
TOTAL					Time rub friab	ifled stone/ ble silty or bands			-5 -10
END OF HOLE 5.5 m.	14.70	NESS	TEDM			MINEDAL	DESCUIDE	ES DIVISION	18 ft.
HP Highly Porous VS P Porous S MP Moderately Porous M SP Slightly Porous H NP Non Porous YH	1 1	Very S Soft	oft tely Hai	rd	*	MINERAL DRILL Nº DM TYPE MAYHEY DRILLER W E START 1 B FINISH 1 B SHEET J OF	67 v 1000 SOYD 71	LOGGED _A.M.PAI DATE _TI TRACED_ CHECKED	N O[][_ SLT_ L.V.W.

TARCOOLA-ALICE SPRINGS LOG OF	ROI	TARY		ULL H	OLE		LE Nº ME	
FEATURE MT. WILLOUGHBY LIMESTONE DEPOSIT.	000	RDINAT	ERENCE71- ES M HORIZ_90°					
DESCRIPTION OF CHIPS		DEPTH	PORO- HARE	STI	RUCTURES	TH	RATION ME NS.)	DEPTH (FT.)
Brown silty soil	0-0-			Silic	cified			
White calcareous silt	풀루				ble			
Brown and white limestone		<u> </u>			· · · · · · · · · · · · · · · · · · ·			
Brown and white limestone DO S Brown and grey limestone Brown and grey silty		,		den da, de				-5
ON Brown and grey Ilmestone		2_	<mark>│</mark>	i			+ +	
Brown and grey silty limestone	HILL				*			
Brown and grey silty	HIHHH	3_						-10
Brown silt	14-14-14-14-14-14-14-14-14-14-14-14-14-1	_						
Brown silt		4						
Brown silt	畫			·	· · · · · · · · · · · · · · · · · · ·		$\downarrow \downarrow \downarrow \downarrow \downarrow$	- 15
Brown silt	=======================================	5						
Brown silt	==	_						16 ft.
END OF HOLE 55m.		_						10 11.
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		_			-			
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	<u> </u>							
POROSITY TERM	HARI	NESS	TERM	! . 	MINERAL R	ESOURC	ES DIVISI	ON
HP Highly Porous VS P Porous S MP Moderately Porous M SP Slightly Porous H NP Non Porous VS	5 H	Yery S	oft ately Hard	•	DRILL Nº DM TYPE MAYHEW DRILLER W. B START _ TIOL FINISH _ TIOL SHEET_L OF _	71 11 1000	LOGGED A.M.PA DATE TIT TRACED CHECKED Nº S.96	SLI J.V.W.

OF ROTARY AIR DRILL HOLE HOLE NO M.E. 14 PROJECT RAILWAY BALLAST PROJECT LOG SERIAL Nº 905/72 PLAN REFERENCE ____71-823 __ FEATURE MT. WILLOUGHSYLIMESTONE DEPOSIT. COORDINATES ANGLE FROM HORIZ 90°__ _ DIRECTION_ LOCATION ETHEL WELL DEPTH (FT.) PORO-HARD-PENETRATION LOG DEPTH STRUCTURES TIME, (MINS. DESCRIPTION OF CHIPS SITY NESS (m.) A CO CO SO E = 3 Brown silty soil Silicified limestone rubble Brown and white limestone Brown limestone Brown limestone LIMESTONE Brown limestone. Brown limestone ō CAINOZ 7 Brown calcaneous siltstone WILLOUGHBY ェニ ェエ 3 Brown calcareous siltstone =Ξ 10 Brown_calcareous siltstone 4 Brown _siltstone _ Brown siltstone Brown siltstone Brown siltstone 18 ff. OF END HOLE 5.5 m. POROSITY TERM HARDNESS TERM MINERAL RESOURCES DIVISION Yery Soft HP Highly Porous YS. DRILL Nº DM 67 LOGGED p Porous Soft A.M. PAIN
DATE _ STIBITE S TYPE MAYHEW 1000 DRILLE W BOYD Moderately Porous MP Moderately Hard MH START 7 [8]71 FINISH 18]71 TRACED SLT CHECKED LYW. Slightly Porous SP H Hard NP Non Porous Very Hard YH SHEET_LOF 1 DRG Nº S9654 Bo.

PROJ	TARCOOLA -ALICE SPRINGS LOG O			NES SOUTH AUS		HOLE Nº M.E. 15 SERIAL Nº 905/72
	JRE MT. WILLOUGHBY LIMESTONE DEPOSIT.	PL CO	AN REF	ERENCE _71-82 [ES	3 Direction =	
LOCAT	DESCRIPTION OF CHIPS		DEPTH (m.)	M HORIZ_900 PORO- HARD SITY NESS Lagge y s ま	STRUCTURES	PENETRATION DEPTI
	Silicified white limestone.		-			
	White limestone	臣				
	White limestone.					
VOZOIC IMESTONE	White limestone.		2			-5
CAINOZ 3Y LIMES	White limestone		-			
CA	Brown limestone		3		Ka .	
IH	Brown limestone.		-			-10
UPPER MT. WILL(Brown limestone					
2	Brown limestone		,			
	Buff to pale brown siltstone.	=======================================	- 5			-15
	Buff to pale brown siltstone.				= = = = = = = = = = = = = = = = = = =	
	END OF HOLE 5.5 M		-		s' .	18ff.
			-			
			-			
			-		-	
	ਨੇ ਨੇ ਨੇ ਵਾਲਤ ਦੇ ਦੇ ਜਾਵਾ ਦਾ ਜਾਵਾਜ਼ ਜਾਵਾਜ਼ ਦਾ ਸ਼ਹੂਰ ਹ					
		f= - 1 . m == - 1				
		** **				
· —						
	POROSITY TERM		NESS Yery S	TERM	MINERAL	RESOURCES DIVISION
	HP Highly Porous P Porous MP Moderately Porous SP Slightly Porous NP Non Porous	M 67 _ LOGGED A.M.PAIN DATE 7/6/7! _ TRACED S.J.C. CHECKED L.V.W.				

DISCRIPTION OF CHIPS LOG DEPH SITY NESS STRUCTURES Minisco M	ľ		ECT RAILWAY BALLAST PROJECTLOG OF	RO	IARY	AIR	DRI	LLŀ	HOLE		DLE Nº M.E	
DESCRIPTION OF CHIPS LOG DEPTH SITY PORD SITY TERM White silicified limestone. White silicified limestone. White not brown limestone. White pole grey and brown limestone. White, pole grey and brown limestone. Brown to buff silty limestone. Brown to buff silty limestone. Brown to buff siltstone.				CO(AN	ORDINAT	ES			TION -	- - -		
White limestone. White and brown limestone. White, pale grey and brown limestone. White, pale grey and brown limestone. White, pale grey and brown limestone. Brown to buff silty limestone. Brown to buff silty limestone. Brown to buff silty limestone. Brown to buff siltstone. Brown to buff silts					DEPTH	PORO- SITY	HARD- NESS			ŢI	ME	DEPTH (FT.)
White, pale grey and brown limestone. White, pale grey and brown limestone. Brown to buff silty limestone. Brown to buff silty limestone. Brown to buff siltstone. Brown					_	Π		Patchy	y silicification.			
White, pale grey and brown limestone. Brown to buff silty limestone. Brown to buff silty limestone. Brown to buff siltstone. Brown to buff silts			White and brown limestone.		1	_			and the second second			
White, pole grey and brown limestone. 2		إليا	White, pale grey and brown limestone.									
White, pale grey and brown limestone Brown to buff silty limestone. Brown to buff siltstone. END OF HOLE 5-5 M HARDNESS TERM HP Highly Porous P Porous S Soft MP Moderately Porous MP Moderately P	OIC	STON	White, pale grey and brown limestone.		2_				,			-5
Brown to buff silty limestone. Brown to buff siltstone. END OF HOLE 55 M POROSITY TERM HP Highly Porous P Porous S Soft MP Moderately Porous MP Moderately Porous MP Moderately Porous MP Moderately Porous MH Moderately Hard MINERAL RESOURCES DIVISION DRILLER MED OF AMPAIN DRILLER MED OF DR	ZONI	LIME	White, pale grey and brown limestone.		_							
POROSITY TERM HP Highly Porous P P P Porous P P P P P P P P P P P P P P P P P P P	3	JOHBY	landa da anticolar de la companya de		_3_			·				
Brown to buff siltstone Brown to buff siltstone Brown to buff siltstone Brown to buff siltstone END OF HOLE 5:5 M POROSITY TERM HARDNESS TERM HP Highly Porous P Porous S Soft MP Moderately Porous SP Slightly Porous H Hard Hard Hard Hard Hard Hard Hard Hard	PER	VILLOL						ر سند سد	, 			-10
POROSITY TERM HP Highly Porous Porous Porous Porous Porous Porous Porous MP Moderately Porous MP Moderately Porous NP Sighthy Porous NP Moderately Marc NP Sightly Porous NP Moderately Marc NP MODERATE #925 NATE PORITIES NATE PORITIES NATE NATE NATE NATE NATE NATE NATE NATE	J.	MT. V	Brown to buff silty limestone	HILL	_ 4			· · · · · · · · · · · · · · · · · · ·				
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POROSITY TERM HARDNESS TERM HP Highly Porous P Porous S Soft MP Moderately Porous SP Slightly Porous H Hard MINERAL RESOURCES DIVISION MODERATE OF THE MAYNEW 1000 A M.PAIN DRILLER W.POYD DRILLER				111111	_							18 ft.
POROSITY TERM HARDNESS TERM HP Highly Porous P Porous P Porous MP Moderately Porous MP Moderately Porous SP Slightly Porous H Hard MINERAL RESOURCES DIVISION DRILL Nº DM @T. TYPE MAYHEN 10:00 A.M. PAIN DRILLER W. EVYD. DRILLER W. EVYD. DRILLER W. EVYD. DRILLER W. EVYD. TRACED 5. TRACED 5.			END OF HOLE 5:5 M	-	-							
POROSITY TERM HARDNESS TERM HP Highly Porous P Porous P Porous MP Moderately Porous MP Moderately Porous SP Slightly Porous H Hard MINERAL RESOURCES DIVISION DRILL Nº DM @T. TYPE MAYHEN 10:00 A.M. PAIN DRILLER W. EVYD. DRILLER W. EVYD. DRILLER W. EVYD. DRILLER W. EVYD. TRACED 5. TRACED 5.												
HP Highly Porous P Porous S Soft MP Moderately Porous MH Moderately Hard SP Slightly Porous H Hard DRILL Nº DM 67 LOGGED TYPE MAYHEW 1000 AM PAIN DRILLER W. BOYD DATE 3/8/1 TRACED 5.	-								*			
HP Highly Porous P Porous S Soft MP Moderately Porous MH Moderately Hard SP Slightly Porous H Hard DRILL Nº DM 67 LOGGED TYPE MAYHEW 1000 AM PAIN DRILLER W. BOYD DATE 3/8/1 TRACED 5.		· - <u>-</u> ,			: -							
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HP Highly Porous P Porous S Soft MP Moderately Porous MH Moderately Hard SP Slightly Porous H Hard DRILL Nº DM 67 LOGGED TYPE MAYHEW 1000 AM PAIN DRILLER W.BOYD DATE 3/8/1 TRACED 5.			en e			.=, -: -						
HP Highly Porous P Porous S Soft MP Moderately Porous MH Moderately Hard SP Slightly Porous H Hard DRILL Nº DM 67 LOGGED TYPE MAYHEW 1000 AM PAIN DRILLER W.BOYD DATE 3/8/1 TRACED 5.		5 24			-				· 			
HP Highly Porous P Porous S Soft MP Moderately Porous MH Moderately Hard SP Slightly Porous H Hard DRILL Nº DM 67 LOGGED TYPE MAYHEW 1000 AM PAIN DRILLER W.BOYD DATE 3/8/1 TRACED 5.			POROCITY TERM		1			***************************************				
P Porous S Soft MP Moderately Porous MH Moderately Hard SP Slightly Porous H Hard TYPE MAYHEW 1000 A.M. PAIN DAILER W. BOYD DATE 9/8/71 TRACED 5.			HP Highly Porous VS								1)N
NP Non Porous YH Very Hard SHEET_OF1_DRG Nº S.965			P Porous S MP Moderately Porous M SP Slightly Porous H	: 	Soft Modera Hard	tely Har	rd	•	TYPE MAYHEM DRILLER W. BC START_8/8/71 FINISH_8/8/71	0000 1000	_A.M.PAI DATE 8/8 TRACED S CHECKED	/7 <u> </u>

PROJ	TARCOOLA-ALICE SPRINGS LOG OF	RTMENT RO	TARY A	R DRIL	L HOLE	HOLE NO M.E SERIAL NO SC	
FEAT	URE MT. WILLOUGHBY LIMESTONE DEPOSIT.	PL	AN REFERENC	E_71-823			20112
LOCAT	DESCRIPTION OF CHIPS		DEPTH SIT	0- HARD-	STRUCTURES	PENETRATION TIME (MINS.)	DEPTH (FT.)
	White limestone.	片					
	White limestone.	臣					
ليا _	White limestone						_
NOZOIC LIMESTONE	White and brown limestone.	耳	2				-5 ~
CAINOZOIC BY, LIMESTO	Brown limestone				The part of the second		
CAII	Brown to buff silty limestone.	- I	3				
10	Brown calcareous siltstone.	エニエ					-10
UPPER MT. WILL	Brown calcareous siltstone.	III	4				
	Pale brown siltstone	丰					
	Pale brown siltstone	161	5				-15
	Pale brown siltstone.	1641444			e an		10.61
	END OF HOLE 5.5 M		_				18 ft.
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	POROSITY TERM		NESS TER	M 	MINERAL	RESOURCES DIVISI	ON
•	HP Highly Porous P Porous MP Moderately Porous SP Slightly Porous NP Non Porous	VS S MH H	Yery Soft Soft Moderately Hard	Hard	DRILL Nº_ DM TYPE MAYHEY DRILLER W B START _ 8/8/1 FINISH _ 8/8/2	V 1000 A.M.PA DYD DATE 8/8	77
- NAC	NP Non Porous 9410 MB	YH	Very Hard	· · · · · · · · · · · · · · · · · · ·	SHEET_L_OF	I	

OF ROTARY AIR DRILL HOLE HOLE Nº ME.18 PROJECT PAILWAY BALLAST PROJECT SERIAL Nº 905/72 PLAN REFERENCE __71-823 _ FEATURE MT. WILLOUGHBY LIMESTONE DEFOSIT. COORDINATES LOCATION ETHEL WELL ANGLE FROM HORIZ 90° DIRECTION PENETRATION TIME (MINS.) DEPTH (FT.). PORO HARD-DESCRIPTION OF CHIPS LOG DEPTH STRUCTURES NESS (m.) White, off white and brown limestone Brown limestone Brown limestone WILLOUGHBY LIMESTONE CAINOZOIC Brown limestone. Off-white and pale grey limestone Off-white and pale grey limestone. 3 Soft silty interbands Soft silty interbands Brown limestone Brown silty limestone. Brown siltstone Brown siltstone 5 Brown siltstone 18 ft. END OF HOLE 5.5 M POROSITY TERM HARDNESS TERM MINERAL RESOURCES DIVISION Highly Porous Porous HP VS. Yery Soft DRILL Nº DM 67 LOGGED A.M. PAIN Soft S TYPE MAYHEW 1000 Moderately Porous Slightly Porous MP DATE 8/8/71 TRACED S.J.C. CHECKED L.V.W. Moderately Hard DRILLER W BOYD MH START_8/8/7/ FINISH 8/8/7/ SP H Hard NP Non Porous Very Hard YH SHEET_LOF 1 DRG Nº S9658 B

PE	OJE	TARCOOLA-ALICE SPRINGS LOG OF	MENT RO	OF MIL	Es sou	des .	LL HO	LE	ننا	LE Nº ME	
FE	ATU	RE MT. WILLOUGHSYLINESTONE DEPOSIT.	PLI COC	AN REFI ORDINAT GLE FROM	ERENCE _ ES M HORIZ		DIRECTION	 N			
130	UAT1	DESCRIPTION OF CHIPS		DEPTH (m.)	PORO- SITY	 	STRUC	TURES	TI	ration ME US)	DEPTH (FT.)
		Brown silty soil.	E								
		White limestone.									
		White limestone.					Patci silicific	hy ation			
	IJ.	Pale brown silty limestone		_							-5
၁၉	S	Pale brown silty limestone		2_							,
INOZOIC	LIME	Pale brown to buff calcareou limestone.		-				e and a second second second second			-
3	GHBY	Red-brown to buff siltstone.		3							-10
ER	叧	Red-brown to buff siltstone.		_							
UPPER	AT. W	Red-brown siltstone.		4							
		Red-brown siltstone		-			L				- 15
		Red-brown siltstone.		5							-15
		Red - brown siltstone		-				 , .			
		Red-brown siltstone.		- - <u>6</u>							20
		Red - brown siltstone.		- - -							-20
		Red-brown siltstone.		- 				e .			
		Red - brown siltstone.		-				~			
	_	Red - brown siltstone.		- ع				en a energy in			- 25
		Red-brown siltstone.		-							-
_	-	Red - brown siltstone.		. 9			<u></u>	· · · · · · · · · · · · · · · · · · ·			30
		Red - brown siltstone.		-					+-		
		Red-brown siltstone.		lo			¥ .				
		POROSITY TERM			TERM	l		MINERAL	RESOUR	CES DIVIS	ION
		P Porous S MP Moderately Porous 1	rs NH I	Yery Soft Moder Hard	Soft rately H	lard	T	RILL Nº_DA YPE MAYHE PRILLER_W_ TART_8_8 INISH_8_8	BOYD _ - 11	_A.M.P.	AIN - 8 - 71 A.R.
		NP Non Porous	/ H	Very	Hard		s	HEET_L OF	2_ DR		

PROJECT RAILWAY BALLAST PROJECT OF FEATURE MT. WILLOUGHBY LIMESTONE DEPOSIT.	RO1	TARY IN REFI	IES SOUT AIR ERENCE	DRII	L HO	LE			E Nº		19 15/ 7 2
LOCATION ETHEL WELL	LOC AN(RDINAT GLE FROI	es M horiz_	90°	DIRECTIO	N					
DESCRIPTION OF CHIPS	LOG	DEPTH (m.)	PORO- SITY Lagag	HARD- NESS \$°o \ ≅ = ₹	STRU	CTURES	PEI	TIN (MI)	RATIONE NS.))N ~ ø	DEPTH (FT.)
Red-brown siltstone. Red-brown siltstone. Red-brown siltstone.											25
.] [11									- 35
Pale grey shale.		-			<i>-</i> /	<u>.</u>					
OZOSOS Pale grey shale. Pale grey shale. Pale grey shale.		12_			,					-	-40
Pale grey shale. Pale grey shale.		-			· · — · — · · · · · · ·	,		-			
END OF HOLE 13.0m.		13									42.6ft
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POROSITY TERM	HARE	NESS	TERM			MINERAL R	ESO	JRCI	ES DI	VISI	DN
HP Highly Porous VS P Porous S MP Moderately Porous M SP Slightly Porous H NP Non Porous YI	S H	Yery S Soft	Soft ately Ho	ird	T S F	ORILL Nº DM TYPE MAYHEW ORILLER W.BO START 8-8- FINISH 8-8- OHEET 2. OF 2	67 100 YD 72 72	ō_ 	LOGO _A_A DATE TRAC CHEC	SED M.PA E.B. CED KED	

		TARCOOLA -ALICE SPRINGS LOG OF	RO	TARY	' AIR	TH AUSTE DRII	LLH	OLE		\vdash		Nº 90	20 25/72
		IRE MT. WILLOUGHBY LIMESTONE DEPOSIT.	0.0	DRDINAT	FS	<u></u>		TION	 				
10	UA!	DESCRIPTION OF CHIPS		DEPTH	PORO- SITY	HARD- NESS So≣=5	STI	RUCTURES	P	TI	rrat Me Ins.)	ION	DEPTH (FT.)
	Σ	Red-brown silty soil.		_				ied lime- Lrubble.					
	UNU.	Red-brown silty soil.		1									
	ALI	Red-brown silty soil.		_			v						- 5
		White and grey limestone		2				atchy		-	+		> 4
		White limestone.			-		silici	fication. atchy					
_		White and pale brown limestone. White and pale brown silty limestone.		_3		+	silici	fication.	Г				-10
		Pale brown to buff silty								+			
		limestone. Brown silty calcareous siltstone.		4				- ::	÷				
-	JNC	Brown silty calcareous siltstone.		_						H	+	-	-15
AINOZOIC	LIMESTONE	Brown silty calcareous siltstone.		<u> </u>	- 1		isas es su	بين چې چې	-	-	***************************************		
CAIN	Y	Brown silty calcareous siltstone.		6									
-A	пенв	Brown siltstone.							-				− 20
UPPER	WILLOUGF	Brown siltstone			7			·	·				
1	MT.	Brown siltstone.		4	4			-					-25
	: 	Brown siltstone.		<u>8</u>	1	+	. e	2 - 1 0					- ຜ
_		Brown siltstone.						<u> </u>	!		+-		·
		Brown siltstone.		9		- 1		· · · · · · · · · · · · · · · · · · ·	-				-30
		Brown siltstone. Brown siltstone.		-			*						
	I	POROSITY TERM	HART	LLIO DNESS	TERM			MINERAL R	LS0	URC	ES I	IVISI)N
		HP Highly Porous P Porous MP Moderately Porous SP Slightly Porous	VS S MH H	Yery S Soft	oft utely Ho	ırd		DRILL Nº DM TYPE MAYHEW DRILLER W.BO START 8-8- FINISH B-8- SHEET L OF 2	67 100 YD 72	>o	LOC _A DAT TRI CHE	GGED M. PA TE B- ACED - CKED	N 8-72 A.R. L.Y.W.

DEP	ARTMENT	OF MI	JES SOUTH AUST	RALIA	HOLE Nº ME20
PROJECT RAILWAY BALLAST PROJECT OF	• RO 1	[AR]	AIR DRI	LL HOLE	SERIAL Nº 905/72
FEATURE MT. WILLOUGHBY LIMESTONE DEPOSIT.	000	ROINAT	ERENCE 71.82 ES M HORIZ 90°		
DESCRIPTION OF CHIPS		DEPTH	PORO- HARD-	STRUCTURES	PENETRATION DEPTH TIME (MINS)
Brown siltstone.					
Brown siltstone.		11			-35
In Brown siltstone.		-			
Brown siltstone.		12			
ng Pale grey shale.					-40
14+1 5 1-		13			
ชื่ออี Pale grey shale. รัฐม					
Pale grey shale.		14			-45 46ft.
END OF HOLE 14.0m.					
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POROSITY TERM			TERM	MINERAL	RESOURCES DIVISION
HP Highly Porous P Porous MP Moderately Porous SP Slightly Porous NP Non Porous	S MH H	Very S Soft Modera Hard Very H	ately Hard	DRILL Nº 1 TYPE MAYH DRILLER W START 8- FINISH 8- SHEET 2 (EW 1000 A.M. PAIN

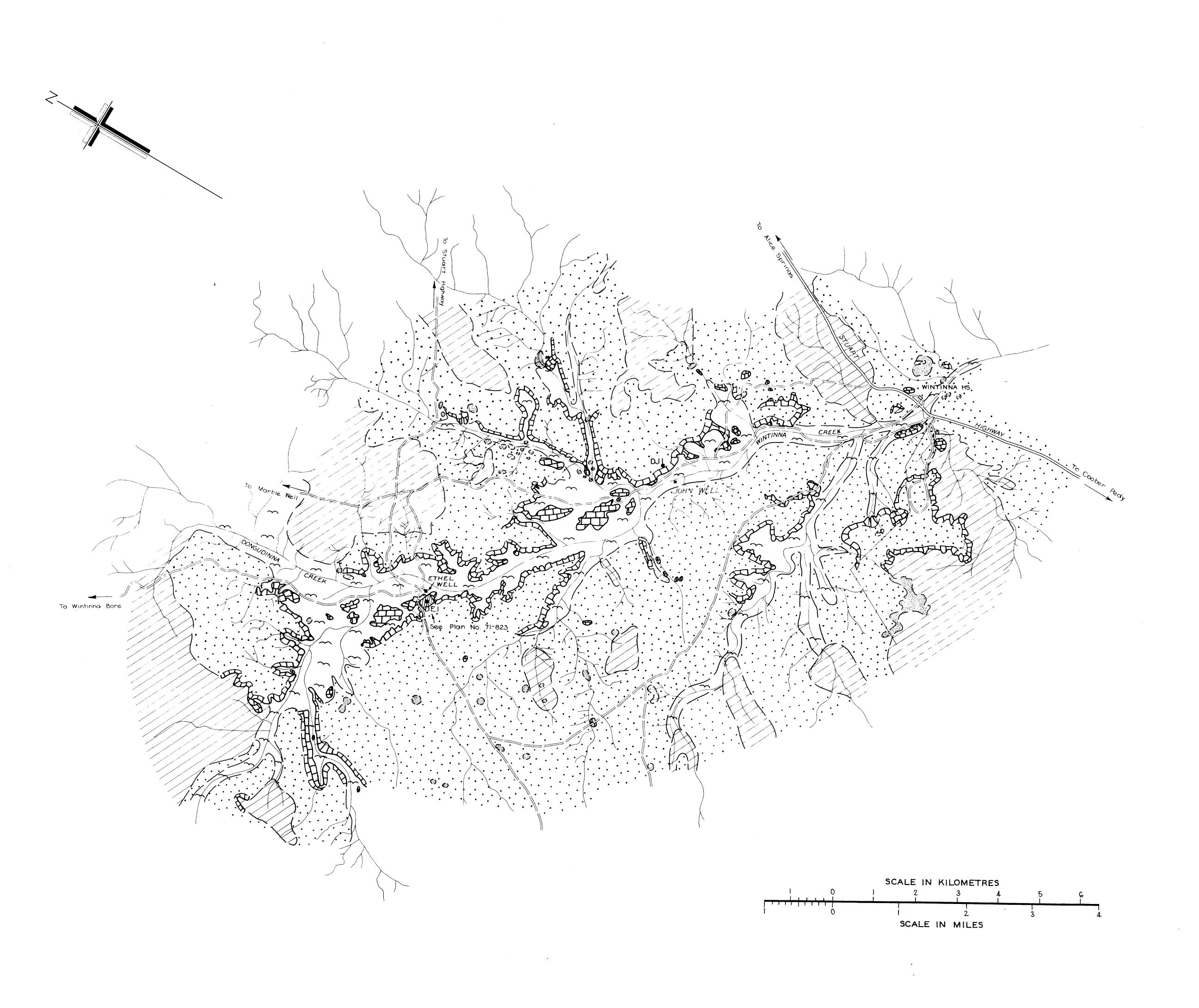
OF ROTARY AIR DRILL HOLE HOLE NO MEI/ME 21. PROJECT RAILWAY BALLAST PROJECT LOG SERIAL Nº 905/72 PLAN REFERENCE ___ 7L- 823 COORDINATES _____ FEATURE MT. WILLOUGHBY LIMESTONE DEPOSIT. ANGLE FROM HORIZ 900 DIRECTION LOCATION ETHEL WELL _ DEPTH (FT.) PORO-HARD-PENETRATION LOG DEPTH DESCRIPTION OF CHIPS STRUCTURES TIME SITY NESS (m.) (MINS.) White silicified limestone White and off-white limestone soft silty interbands. White, off-white & brown limestone. White limestone interbands. White and brown limestone. LIMESTONE Brown silty Brown silty limestone CAINOZOIC interbands. 2 Brown and grey limestone. **ICHBY** Brown and grey limestone. Brown and grey limestone. UPPER WIL Brown siltstone Brown siltstone Brown siltstone 5 Brown siltstone 18 ft. END OF HOLE 5.5M. POROSITY TERM HARDNESS TERM MINERAL RESOURCES DIVISION Very Soft Soft Highly Porous ٧S DRILL Nº DM 67 LOGGED Porous S TYPE MAYHEW 1000 A.M. PAIN Moderately Porous Slightly Porous Moderately Hard DATE 24 1.72 MP DRILLER_W_BOYD__ MH TRACED QWW. START_G AUG 1972 FINISH GAUG 1972 SP Н Hard Non Porous Very Hard ٧Н SHEET_LOF_ DRG Nº S9659 Ba

FEAT	TARCOOLA-ALICE SPRINGS LOG OF ECT RAILWAY BALLAST PROJECT OF URE MT. WILLOUGHBY LIMESTONE DEPOSIT. TION ETHEL WELL	RO PL	AR) AN REF DRDINAT	AR AR ERENCE _ ES M HORIZ_	DRI _ 21= 9	B23 .	IOLE		LE Nº M.: RIAL Nº 90	
	DESCRIPTION OF CHIPS	T	DEPTH (m.)	PORO- SITY	HARD- NESS	1	RUCTURES	TI	TRATION ME, INS.)	DEPTH (FT.)
L	Brown Silty Soil	0.00		- all	- GJ.	Silicifie	d I mestone Rubble			Î
	white silicified limestone		-							
- -	White limestone	田]	F	F]			! - - -	∤ .
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1	White limestone		‡ _ !			Patch	y silification		4444	
			1 -			-	· · · · · · · · · · · · · · · · · · ·			
.] u	White limestone									_ '
NOZOIC	Brown silty limestone	計	1							-5
싫	Silly ilmestone	1=1=	2			ŀ				•*
CAINOZOIC AV IMESTO	Commenter l'agretage	===	-						7 [[]]	1
	Brown silty limestone		-			1				
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2 5	Brown silty limestone		3			e .				
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UPPER WILL	Brown and buff silts		-		1					
		=	4			L				1
[Brown and buff silts	臺	i _							
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77	Brown and buff silts	三								-15
	brown and our sins		5							
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	END OF HOLE	3.5	<i>m</i> -							1
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	POROSITY TERM	HARI	NESS	TERM		·	MINERAL R	ESOURC	ES DIVISI	ON
	and the second s	S	Yery S					· · · · ·	4	
	P Porous S	•	Soft				TYPE MAYHEW	1000	LOGGED A.M.PA	IN
	MP Moderately Porous M SP Slightly Porous H NP Non Porous Y	(H	Moderi	ately Ha	rd	•	DRILLER W BO	DYD	DATE_B	Tapr _
:	SP Slightly Porous H		Hard	-			START_8[8] FINISH_8[8]	<u> </u>	TRACED	L.V.W.
	NP Non Porous Y	H	Very 1	lard			SHEET_L OF	000		660 Ba

OF ROTARY AIR DRILL HOLE HOLE Nº ME. 23 PROJECT RAILWAY BALLAST PROJECTLOG SERIAL Nº 905/72 PLAN REFERENCE __ 71-823 FEATURE MT. WILLOUGHBYLIMESTONE DEPOSIT. COORDINATES ANGLE FROM HORIZ 90° _DIRECTION_ LOCATION_ETHEL_WELL_ DEPTH (FT.) PENETRATION PORO-HARD-LOG DEPTH STRUCTURES TIME (MINS.) DESCRIPTION OF CHIPS SITY NESS White and pale brown limestone Brown, slightly sitty limestone Brown, slighty silty limestone Brown, slighty silty limestone Brown silty limestone エー **JCHBY** Pale brown calcareous siltstone THE THE 3 Pale brown calcareous siltstone _ _ _ _ Pale brown calcareous siltstone Ī Pale brown calcareous siltstone <u>-</u>-Pale brown calcareous siltstone <u>-</u>-5 === Pale, brown calcareous siltstone 18 ft. End of Hole 5.5 M. POROSITY TERM HARDNESS TERM MINERAL RESOURCES DIVISION Highly Porous Yery Soft **V**S DRILL Nº DM 67 _ LOGGED Soft Porous S TYPE MAYHEW 1000 A.M. PAIN Moderately Porous Slightly Porous Non Porous DRILLER F. PIGGNITTER DATE 8-8-71
STARY 8-8-71 TRACED D.M.
FINISH 8-8-71 CHECKED L.W. MP MH Moderately Hard SP Hard Н YH Very Hard DRG Nº S966L SHEET_L OF 1_ P.F. Nº S 9410 MB

PF	ROJE	TARCOOLA-ALICE SPRINGS OF OF	RTMENT	ARY	' AIR	TH AUSTE DRI	LL HOLE			Nº M.E	
		RE MY. WILLOUGHBY LIMESTONE DEPOSIT.	PLI	RDINAT	ES	_71.823 			<u>-</u>		
Lo	CAT	DESCRIPTION OF CHIPS		DEPTH (m.)	PORO- SITY	HARD- NESS	STRUCTUR	1 5	ENETI MIN)	RATION E IS.)	DEPTH (FT.)
		Brown sitty soil	100000		ш		Silicatied limestone	rubble		TIII	
		White limestone					Pertury silisifie	ation .		_	
		White limestone					Potchy silicities			. +	
	ONE	Brown, slighty silty limestone		,, <u>-</u>	-						-5
၁၉	LIMESTONE	Grey, brown and white limestone	_ 	_2_						 	*
CAINOZOIC	<u>5</u>	Grey, brown and white limestone		_				J			
ဒ	SCHE EASI	Brown and buff silty limestone		_3_				· .			-10
ĨR R	WILLOUGHBY	Brown and buff silty limestone	基			i - i	,				-10
UPPER	MT. V	Buff calcaneous silt		4							
		Buff colcareous silt	1384								
		Buff calcareous silt		5					- 4		-16
		Buff colcoreous silt						S		2	18 ft.
		END OF HOLE: 5.50 m									10.1.
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-		POROSITY TERM	HAR	DNESS	> TERM		MIN	ERAL RE	SOURC	ES DIVIS	ION
		HP Highly Porous P Porous MP Moderately Porous SP Slightly Porous	VS S MH H	Yery Soft Moder Hard	Soft rately H		DRILL TYPE DRILLI		1.67 1.000 1.000 1.972 1.972	LOGGED _ A.M. DATE _ TRACED CHECKEI	PAIN BAUG 72 LLE LYW.
		NP Non Porous	ΥH	Very	Hard		SHEET	J_ 0F 1	DRG	Nº S.	662 Bo

	TARCOOLA-ALICE SPRINGS LOG OF CT RAILWAY BALLAST PROJECTLOG OF	PL	OF MINES S TARY A AN REFERENCE OPPOINTES	E7L 823		HOLE Nº ME SERIAL Nº 90	
LOCATI	DESCRIPTION OF CHIPS	1	DEPTH SIT	O- HARD-	DIRECTION	PENETRATION TIME (MINS.)	DEPT (FT.)
L	Brown silty sail	983773					Ì
	Grey and brown limestone						
	Grey and brown lines tone						
	Grey and brown limestone	H			.=		
	Grey and brown limestone						
		岸					-5
SIS	Brown, and grey limestone		2		,		,
NOZOIC LIMESTONE	Brown to buff silty limestone						
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CA	Brown to buff silty limestone	· EE	3		·		
	<u>.</u>	<u> </u>					-10
뛰게	Brown to buff silty limostone				4.		
UPPER . WILL(1][e transition en en		
⊃ ¥	Brown siltstone		4				
	Brown sillstone		_				
- -				+ +++			-15
	Brown siltstone	是	_				
- -		三	5				ŀ
	Brown siltstone				4		
,	END OF HOLE 5.50 m.						18 ft.
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	POROSITY TERM		DNESS TER	M	MINERAL	RESOURCES DIVIS	ON
	HP Highly Porous P Porous	V S S	Yery Soft Soft		DRILL Nº DI	M 67 _ LOGGED	111
	MP Moderately Porous	MH	Moderately	Hard	DRILLER _W	BOYD _ DATE &	AUG 197
	MP Moderately Porous SP Slightly Porous NP Non Porous	H	Hard		START_8 A		T-7.77
	NP Non Porous	ΥH	Very Hard		SHEET_I_ 01	FI_ DRG Nº S.9	663 B



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LEGEND

 Alluvial material
Gibber
Telford Gravel
Mount Willoughby Limestone
Siliceous duricrust
Lower Cretaceous Shale and Siltstone
 Track
Irack
Main road
Main road
Main road Fence
Main road Fence Drill hole location and number
Main road Fence Drill hole location and number River or creek

DEPARTMENT OF MINES - SOUTH AUSTRALIA

TARCOOLA - ALICE SPRINGS RAILWAY

LIMESTONE DEPOSIT

ETHEL WELL AREA

NON-METALLIC MINERALS SECTION GEOLOGIST Tcd. SLT 71-748

Ckd. R. H. Date: | OCT 1971

