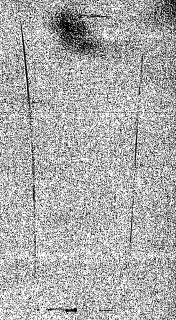
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Proposed Development

249 madras Street







SITE INVESTIGATION REPORT

PROPOSED DEVELOPMENT - 249 MADRAS STREET

PREPARED FOR:

Alan M. Reay Consulting Engineer 147 Kilmore Street CHRISTCHURCH.

PREPARED BY:

Soils & Foundations (1973) Limited Geotechnical Engineering Services 71 Armagh Street Christchurch.

REFERENCE:

299 186R2803d

DATE:

18th June 1986

SUBSURFACE INVESTIGATION REPORT

PROPOSED DEVELOPMENT: 249 MADRAS STREET

1. INTRODUCTION

As instructed at our meeting of 28th April, and your letter of 8th May 1986, investigations have been carried out to determine the subsurface conditions and practical foundation types for the proposed development at 249 Madras Street, Christchurch.

The proposed development is a six storey commercial building covering an area of 760 sq.m. and of reinforced concrete flat slab construction. The ground floor will be used for car parking.

2. SITE DESCRIPTION

The approximately square site at 249 Madras Street is presently being used as a car park with access from Madras Street. The site is flat with a ground level about 0.3 m above kerb level, and is completely covered with ashphalt. Before being used as a carpark, two houses occupied the site.

A single storey brick building adjoins the site on the south boundary. This will be about 4 metres from the proposed development. A two storey brick building is constructed up to the west boundary and will be immediately adjacent to the rear wall of the proposed development. The type of foundation for these buildings is not known, but is assumed to be shallow footings. A two storied concrete and masonry building on the north side is separated from the site by a 3.7 metre wide access lane. This building is constructed over a basement floor.

3. SUBSURFACE INFORMATION FROM ADJACENT STRUCTURES

The location of subsurface information from several other structures in the area is shown in Figure 299/1. To the northwest, boreholes on the site of the Occidental Hotel and AAC Building show interbedded soft sediments extending to about 8 metres below ground level. 2 metres of peat or "peaty clay" was found in two of these boreholes. A thick layer of dense sand was found underneath the soft sediments. This general profile extends for some distance to the northwest, and has been found in Hereford Street, Manchester Street and Gloucester Street.

One borehole on the AAC site showed fine sediments to 4.8 metres depth, overlying gravels.

Boreholes to the south and southeast of the site show fine sediments to a depth of between 4.5 and 6 metres, overlying a gravel layer about 6 metres thick. A layer of sand about 10 metres thick was found under the

gravels, with gravels and sands at greater depth.

From this information it would appear that a thick layer of sand underlies the area with the top surface gently sloping from about 8 metre depth at Hereford Street to 12 metre depth south of Cashel Street. A 6 m thick layer of gravel lies over the sand, in the vicinity of Cashel Street, but in the vicinity of the development site, it appears that there is a relatively abrupt change from gravel to soft sediments. The near surface layers above 4 m depth are silts to fine sand over the whole area.

4. SITE INVESTIGATIONS

Eight hand auger holes were carried out to determine the near surface soil profile across the site. These were supplemented by three machine auger holes to contact the gravel. Samples and SPT testing—were taken in these holes. One deep borehole to 25 m depth and second borehole to 10 m depth were drilled with a cable tool rig. The location of the investigation holes are shown on the site plan, Figure 299/2, and logs of the holes (299/1 to 299/15) are appended.

5. SUBSURFACE CONDITIONS

The investigations showed that subsurface conditions are not consistent over the whole site. The west, south and centre of the site has gravel at between 3.2 and 3.8 metre depth, and borehole 15 showed the gravel to extend to 9.2 m depth directly overlying a layer of dense sand. Auger hole 9 in the north-east corner located gravel at 4.6 m, but the cable tool hole 14 encountered only a 0.1 m thick layer of gravel at 6.0 m depth. 3 metres of firm silt and silty sand were found between this thin gravel layer and the grey sand at 9 m. It appears that the transition between the gravel and soft sediments overlying the sand layer referred to section 3 above, is quite abrupt and crosses the north east corner of the site. The gravel which is 5.7 m thick at borehole 15 has virtually disappeared at hole 14, only 11 metres away.

The near surface layers are consistent over the site. The asphalt is laid directly on either a thin layer of mottled yellow brown silt, or organic silt containing some debris. In places this disturbed topsoil extends to $0.9\,$ m depth. Below the surface silt and topsoil, yellow brown silt was found to $1.2-1.6\,$ m depth. Yellow brown silty fine to medium sand extends to between $2.5\,$ and $5.0\,$ m depth and overlies a thin layer of grey medium sand immediately above the gravel.

The gravel layer is water bearing, and the water table was located at 2.8 m depth.

A dense sand layer appears to underlie the whole site from 9 m to 13 m depth. Below this medium dense to dense sands extend to about 23 m depth, with silts containing lenses of organic material continuing to the full depth of 25 m investigated. The casing of hole 14 was driven on to 27.5 m depth without encountering any increase in driving

resistance, which indicates that silts extend to at least this depth.

6. FOUNDATION SYSTEMS

6.1 General

A major consideration for the design of the foundation system is the change in subsurface conditions in the north-eastern corner of the site. This affects settlements of a shallow foundation system and depth and capacity of a piled foundation.

6.2 Shallow Footings

6.2.1 Settlement

A shallow foundation system appears to be practicable on this site. Figure 299/3 gives estimates of the unfactored allowable bearing pressures on footings to limit settlement to less than 25 mm. The settlement limits are based on a foundation depth of 1.0 metre. The two sets of lines refer to:

- (a) foundations on the silts and sand overlying gravel at 3.5 m depth (as in borehole 15)
- (b) foundations on the silts and sand overlying silt between 6 and 8 m with sands below 8 m (as in borehole 14).

Narrow footings produce smaller pressure bulbs hence permitting increased bearing pressures for a given settlement. For footings less than 1 metre wide, the effective pressure bulb for settlement remains within the near surface sediments, and similar bearing pressures will produce similar settlements in both the soil profiles modelled. For wider footings, the pressure bulb extends into the relatively incompressible gravel for profile (a) and into the relatively compressible silt for profile (b) requiring different bearing pressures to limit settlements to similar amounts.

25 mm is commonly adopted as the limit on total settlement, on the basis that differential settlements are likely to be less than about 75% of the total settlement. For 25 mm total settlement, differential settlements should be less than 20 mm (1/300 x distance between columns at 6 m spacing).

It is apparent that to minimise differential settlements between the north- east corner and the remainder of the structure, bearing pressures must be reduced over the area without underlying gravels. The extent of this area is not well defined from the initial investigation, and further investigation work is recommended.

Settlement will take place during the period of construction of the building. Although settlement in the north-east corner will be slower than over the remainder of the site for footing widths in excess of about 1.5 metres, settlement should be largely complete by the time the building is finished.

It should be noted that settlements for a given bearing pressure will be reduced from the 25 mm indicated in Figure 299/3 if the footings are founded at a greater depth. This only applies for the footings over the area of underlying gravels, as the gravels are relatively incompressible when compared with the overlying sediments, or with the silts and sand encountered in the north east corner.

6.2.2 <u>Bearing Pressure</u>

Also shown in Figure 299/3 are the net allowable bearing pressures derived from bearing capacity considerations and incorporating a factor of safety of 3.

The values given in Figure 299/3 apply to footings over the whole site as the bearing capacity for shallow foundations is governed by the surface sediments which are uniform across the site.

6.2.3 <u>Seismic Loading</u>

The near surface fine sediments have only moderate resistance to seismic loading. For shallow footings no increase in allowable stresses governed by bearing capacity is recommended. When settlements govern, an increase in bearing pressure under seismic loadings will incur settlements additional to the static value.

6.2.4 <u>Rart Foundation</u>

A raft foundation with a dead plus long term live load in the order of 50-60 kPa would be subject to differential settlement of the north east corner. The above loading would produce an average settlement of 5-10 mm over the gravels, and about 25 mm over the north-east corner.

6.3 Piles - bored or driven?, dianeter?

6.3.1 <u>Bearing Capacity</u>

The gravels extending below 3.5 to 4 metres should provide good bearing for driven or cast-in place piles over most of the site. An ultimate pile tip bearing pressure of 4.5 MPa has been assessed for piles founded at 7 m depth. This depth provides adequate penetration into the bearing layer, as well as maintaining a sufficient thickness of gravel between the pile tip and the less dense sands below.

In the north east corner where the gravel layer is very thin, piles would need to be founded in the layer of dense sand between 9 and 13.5 m depth. An ultimate pile tip bearing pressure of 1.8

1.5 m into bearing

MPa has been assessed for piles founded at 10.5 m depth. This depth again balances an adequate penetration depth into the bearing layer with sufficient thickness of dense sand below the pile tip to ensure the underlying material is not overstressed. For this reason piles should not be driven deeper than the above depths.

Confirmation of pile capacities will be required with the appropriate pile driving formula. Static factors of safety (F) should be at least 3, reducible to 2 if uniform driving conditions are encountered, and load testing is carried out.

6.3.2 <u>Pile Settlement</u>

Pile tip settlement may be estimated from the relationship $S=B/30\ F$, where B is the pile diameter, F is the factor of safety and S is settlement in the same units as B. Elastic shortening of the pile should be added to this settlement. The reduction in bearing pressure for piles founded in the same order as settlements for piles founded in the denser gravels.

Settlements of pile groups (pile spacing 2.5 - 5.0 pile diameters) should be checked when dimensions and loadings of the pile groups are known. We suggest that final dimensions and loadings be forwarded to this office for comment if a piled foundation is adopted.

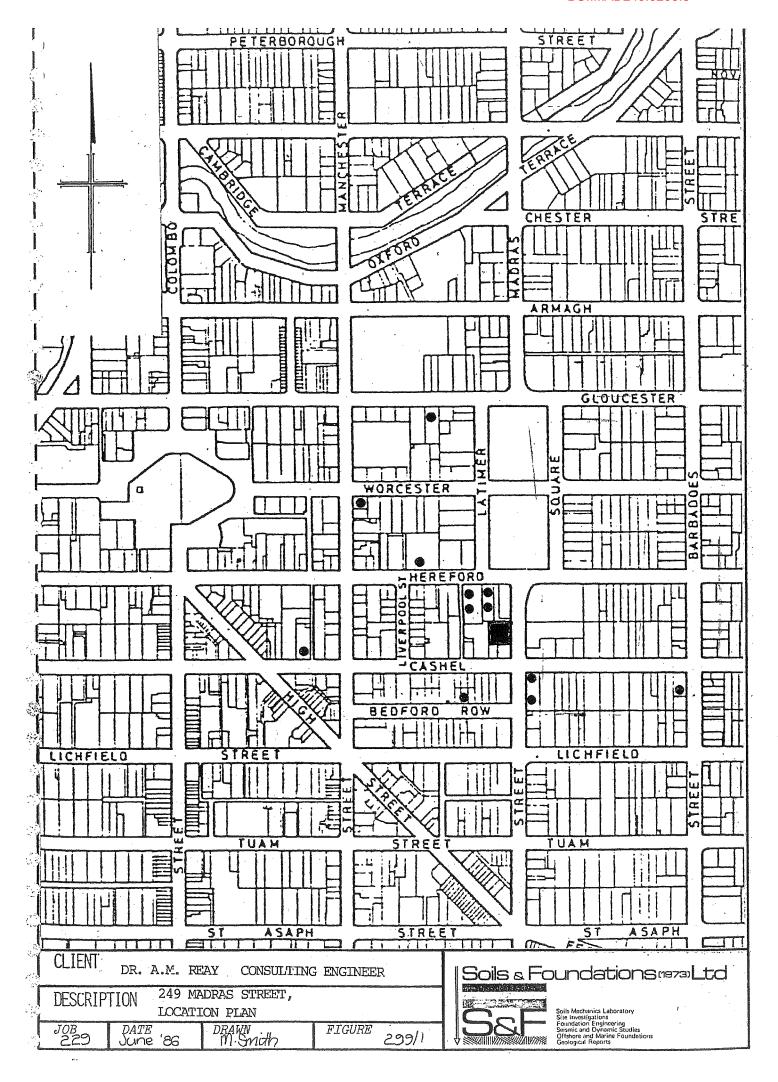
6.2.3 Uplift Capacity

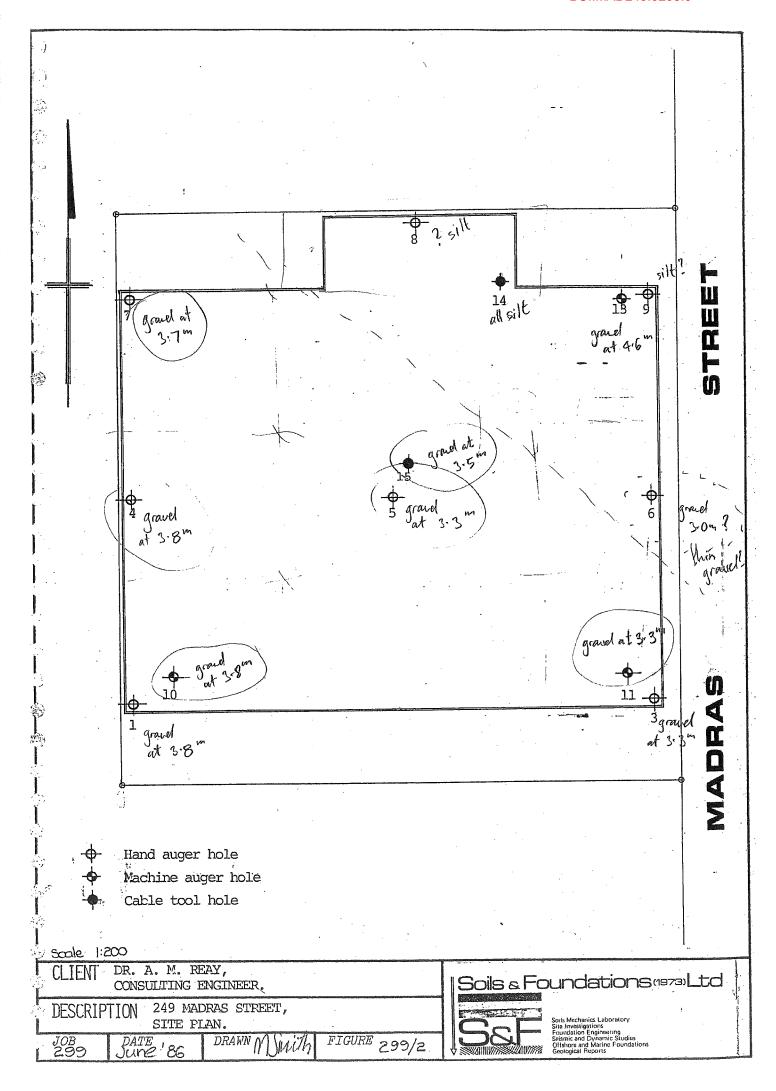
Uplift resistance can be supplied by cast-in-situ bulb piles. Ultimate capacities of 400 kN for a 0.5 m bulb with the pile founded at 7 m depth, or 750 kN for a similar pile founded at 10.5 m depth.

7. CONCLUSION

The subsurface conditions are not consistent over the whole site. However with an appropriate reduction of bearing pressures in the north east corner to limit settlements for a shallow foundation and to allow for a lower bearing capacity for a piled foundation, either a shallow foundation or piled foundation would be suitable.

It is recommended that when footing positions and loads are known further investigation holes be carried out to define the limits of the area in the north east corner of the site which is not underlain with gravel and thus define the area where deeper piles or wider footings are required.





TASMANIA HOUSE, 71 ARMAGH ST, P.O. BOX 451, CHRISTCHURCH, N.Z. TELEPHONE 798-432

Site Investigation Unit
Geomechanics Laboratory
Foundation Engineering
Subdivision Stability
Roading Investigations

Ref:

Date 18 JUNE '86

Reference: Ours Yours

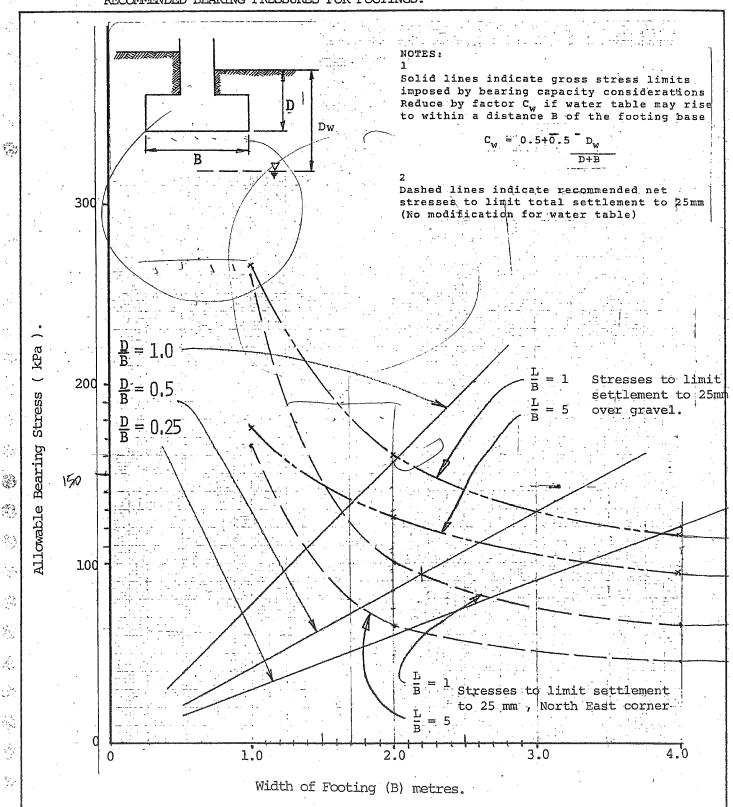
Soil Stabilisation

299

SITE: 249 MADRAS STREET.

RECOMMENDED BEARING PRESSURES FOR FOOTINGS.

FIGURE 299/3



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Mottled yellow brown silty fine to medium sand.									
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SEDIMENTS		<u> </u> ::::.							1		1	4
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SOILS & FOUNDATIONS LOG OF DRILLHOLE DRILLHOLE No. 299/10 (1973) LIMITED											
FEATURE : 249 MADRAS	STREET		OCATION: SOUTH WEST CORNER								
COORDINATES . SEE PLAC ATTITUDE,	DIRECTION: VE	TAP GRID:	· ·								
GEOLOGICAL UNIT DESCRIPTION 0 % 1,1,1	Graphi Graphi	ESCRIPTION OF MATERIAL,	Drill method Samples and Tests Date depth (m) Samples and Tests Date depth (m) Date occurrence of the control occurrence of the control occurrence occurre								
DISTURBED SEDIMENTS AND FILL	Da A X OL as A X A — A X A — A X A —	SPHALT ark brown organic silt with sh, brick, glass & bone. moist, soft to very soft.									
RECENT	1-XXML -	ottled yellow brown silt. moist, firm to soft, grades coarser with depth.									
ESTUARINE	SM -	ottled yellow brown silty ine to medium sand. moist, compact grades coarser with depth.									
SEDIMENTS	1 10/21/10/0	rey medium sand. wet, compact.	3.								
	G:	rey sandy gravel.	Togged: If Driller: W. Swith								
Water Difference Comments			Date: Started: 6 May 6 Date: Finished: 3.8 Sheet of sheets								

and a second	(1973) LIMIT	ED 2. 249 MA					UTH EAST CORNER
	FEATURE : COORDINATES	SEE P	LAN		MAP GRID: R VERTICAL MACHINE:	R.L. GROUND (HAND AUGER	m): DATUM:
7 V	GEOLOGICAL UNIT DESCRIPTION	Core loss/	Depth (m)	USC Symbol	DESCRIPTION OF MATERIAL RECOVERED	ill method e/depth (m) ples and ts ts e	PENETRATION (SPT) uncorrected for overburden overburden
		N 8 8				San	0 00 20 40 60
	anyangan mananan da kamanan da ka A			×	ASPHALT Mottled yellowish brown and		
	•		<u> </u>	X	orange silt moist, firm.		
	RECENT		- X	× ML	Mottled yellow brown silt moist, - firm.		
				X	-		
~	· · · · · · · · · · · · · · · · · · ·		J×				
	ESTUARINE		- :\ - :\ 2 - :\	SM	Mottled yellow brown silty fine to medium sand moist, - compact.		
				X. SM	Grey silty fine sand wet,		
	SEDIMENTS		3 - 3	X	- loose, - grades coarser with depth.		
, t					Grey sandy gravel.		
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The second second	(1973) LIMITE FEATURE : 24 COORDINATES :	D .9 MAI	DRAS	STR AN /DIR	EET FCTI	ON:	MAP GRID: R VERTICAL MACHINE:	OCI	ATIC	N: OUN AUG	NO D ER	PRT (m)	D	AST ATU		RNE	R
	GEOLOGICAL UNIT DESCRIPTION	•	S Core loss/ so Lift %	Depth (m)	Graphic Log	. USC Symbol	DESCRIPTION OF MATERIAL RECOVERED	Drill method	Date/depth (m) Samples and	Tests	Wate Water level (m)	Casing (nm)	& Fluid Loss	1	(S	PT)	ION ted len
L		جر المراجعة		0			ASPHALT	П			T	П	\prod			П	
	RECENT'				x x x x x	ML	Mottled yellowish brown and orange silt moist, firm.		-								
				1 -	X	ML	Mottled yellow brown silt moist, - firm.							•			
		•		-	Â.X.	ML SM	Blue green grey sandy silt to silty sand moist to we - soft	† †									
	ESTUARINE SEDIMENTS			3 -		SW	Mottled yellow brown fine to medium sand wet, - compact										The second secon
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SOILS & FOUNDATIONS (1973) LIMITED	LOG OF	DRILLHOLE	DRILLHOLE	No. 299/14
FEATURE . 249 MADRA	AS STREET in E/DIRECTION:	MAP GRID:	OCATION: NORTH.E R.L. GROUND (m):- Hand Auger	AST.CORNER
GEOLOGICAL SS O S O S O S O S O S O S O S O S O S	epth traphi usc	DESCRIPTION OF MATERIAL RECOVERED	Drill method Date/depth (m) Samples and Tests Date Tater level (m) Sasing (mm)	PENETRATION (SPT) uncorrected for overburden 80 20 40 60
		ASPHALT		
	-X X ML -X X	Mottled yellowish brown and orange silt. - moist, firm.		
RECENT		Mottled yellow brown silt moist, - firm.		
	- X X X X X X X X X X X X X X X X X X X			
	2	Blue green grey sandy silt to silty sandmoist to wet		
			MAY '86 ⋈ 2.8 m	
ESTUARINE	Sw	Mottled yellow brown fine to medium sand wet - compact	31 M	
				97
SEDIMENTS	5			
	sw	Grey fine to medium sand - wet - dense		
	6			
Water D COMMENT	'S:		Date: Fir	iller: B.Bunk arted: 31M9486 nished: 2.June 166
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SOILS & FOUNDATION (1973) LIMITED	NS .	LOG	OF	DRILLHOLE			Di	RII	JH	OL	E 1	<u>ю.</u>	299,	/14	-
COORDINATES :		IRECTIO	ON:	. MAP GRID: R	.L.	. (ND	(r	n) ;	. D	ATU	1:		h 6
GEOLOGICAL UNIT DESCRIPTION	Core loss/ Lift %	Graphic Log	USC Symbol	DESCRIPTION OF MATERIAL RECOVERED	11 method	(depth (m)	oles and s		r level (m)	ng (mm)	uid Loss	PEN	ETR (SP Orr	ATIO T) ect r	ON ed
	40591		_30		Dri	Bath	Samp Test	Date	Mate	ası O	[≫] 8	OVE	erbu 20	rdei 40	n €0
RECENT	7	スメメメメメメメメメメメメンと言言に	[-]	Grey sandy gravel - wet - dense - Gravel - poorly graded. Subrounded greywacke - sand - medium Grey silt - wet - firm to stiff - trace roots - grades coarser with depth Grey silty fine to medium sand - wet - dense - grades coarser with depth	· · · · · · · · · · · · · · · · · · ·										
ESTUARINE	1		SP	Grey medium sand - wet - dense to very dense - trace silt Grey silty fine to medium sand - wet										THE THE STATE OF THE PROPERTY	
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SOILS & FOUNDATION (1973) LIMITED	SMC		LOG	G OF	DRILLHOLE			DI	RILI	LHO	LE 1	<u>10.29</u>	9/14	
FEATURE :	TTUDE/	DIRI	ECTI	ON:	MAP GRID:	. R	.L.	GROU	MD	(m)	: .	ATUM:		
GEOLOGICAL UNIT DESCRIPTION	S Core loss/ So Lift %	N Depth (m)	Graphic Log	USC Symbol	DESCRIPTION OF MATERIAL RECOVERED		Drill method: Date/depth (m)	Samples and Tests	Date	Casing (mm)	& Fluid Loss	PENET (S uncor f overk	RATI PT) rect or ourde	ON ed n
RECENT ESTUARINE SEDIMENTS Water HOLY COM		13	では、100mmので	SPSW	Grey medium sand - wet - dense to very dense - trace silt Grey silty medium sand - wet - loose to medium dense Grey fine to medium sand - wet - dense			ged:			Dri	ler:		
Water post		-					Dat				Stai	ted: .shed:		
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SOILS & FOUNDATION (1973) LIMITED	NS .	*	· LO	GOF	DRILLHOLE	٠,		D	RI	LLE	OI	E 1	₹O.	299/	14	Savotana pu
FEATURE :			•													
COORDINATES	TUDE	/DIR	ECTI	ON:	. MAP GRID: RACHINE:	 	. ·(GROU	מאוי	, (I	n) :	D	ATUM			
	,	r - T	· -										100			
GEOLOGICAL UNIT	loss/ %	(E)	Fraphic Log	Symbol.	DESCRIPTION OF MATERIAL RECOVERED	tho	h C	ınd			冒	SO	PEN	ETRA (SPI orre for rbur	TIC ')	DIVI
DESCRIPTION	₩ ₩	E)	ni c	Sy	RECOVERED	1	lept	SS 6		lev	3	ro T	unc	orre	cte	ed
-	Core Lift	Depth	capl	USC		H)/a:	mole sts	ą	er.	Ä.	17	ove	for rbur	der	า.
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				SW	Grey silty fine to medium sand			,.					ĺ			
		_			- wet	SATSTERMENT	ŀ									
			,		- medium dense - silt lense @ 18.75m						.		- Constitution			
					(100-200mm thick) & @ 20m	AND TRANSPORTER	-									
ESTUARINE		21									.					
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		-			- occasional lenses of silt < 50mm thick									.		
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SEDIMENTS		23_	نشية	i												
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· ·						Non-Additional Principles										
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			TXXX	ML	Grey silt with some to rare organic material.		:			-						
				X	- wet to saturated,											
Water INN COMM	ENTS	- <u>- </u>			- peaty silt @ 24	11 I	00	iged	o 6		R		.ler			
level					100-200 mm thic	TH	6 9		6 6 1				ted .she			
Water Of						1	MT.	e:	6 9		L.	1.I	.5H&	ı		
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SOILS & FOUNDA (1973) LIMITED			• *	DRILLE	HOLE No. 299/14
FEATURE :		4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	MAP GRID: R	OCATION: .L. GROUND (1	m) :
GEOLOGICAL UNIT DESCRIPTION	S Core loss/ Depth (m)		DESCRIPTION OF MATERIAL RECOVERED	Drill method late/depth (m) samples and lests late later level (m)	PENETRATION (SPT) uncorrected for overburden
	24	~~~~	Grey silt with some to rare organics - wet - organics-roots - peaty silt @ 24m,100-200 thick		
				To establish	
	26 -				
	28 _				
	- 				
Water IV	30 COMMENTS:			Logged:	Driller:
Water Sign				Date: Sheet 5 of	Finished:m

SOILS & FOUN (1973) LIMIT	ED DAT, TOV	IS.		IO	GOF	DRILLHOLE			LD:		TH(*******		-	2/1	<u> </u>
FEATURE :	249	MAI	ORAS	STR		I		AT.	ION:		CEI	ITR	E (OF S	SIT	E	
COORDINATES	ATTIT	πnn. Trf4	AN .	المالية. مومو		MAP GRID: F VERTICAL MACHINE:	R.L Cz	ÅBI	GROU E T	MD IOC	_(m);		TUP.			
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GEOLOGICAL	ŀ	8		Log	∞ 1	DESCRIPTION OF MATERIAL	g	Œ	Samples and Tests		耳	ű	3]	PENI	TR	LTA	ON
UNIT		loss/ %	Œ		Symbol	RECOVERED	method	친	ä	1	9	į č	3		(SP	T)	
DESCRIPTION				hic			I E	dep	53	,	el c	ן יכ	- I	unco	orr		ed
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		\prod				ASPHALT	T				T	\prod	\prod		T	T	
			-	* * * * * *	ML	Mottled yellowish brown and orange silt moist, firm.										1	
Language			-			ording birth more year.	-										
RECENT		Ш		XXX							ŀ						
			l _	x ^x x	ML	Mottled yellow brown silt moist,											
	.			x ×	17111	- firm.										1.	
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ESTUARINE			· _	. x.			-				+			-			
1	·					Mottled yellow brown silty		۱.									11
i N			-	X	SM	fine to medium sand.								1		Ì	.
			2-	- X	J.	- moist,	-	\mathbb{I}				Ш					
1			-			- compact.							$\ \ $	1			
•	·		-					1					$\ \cdot\ $				
SEDIMENTS					-	Grey silty fine sand.	1				Ì					•	1
j ·			7	 `` '	SM	- wet,						-					
			-	/ x		- loose to compact,											
			3		·	- grades finer with depth.			· .								
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RECENT		$\ \ \ $	_	M													
				M	1	Grey sandy fine to coarse gravel.											
1			-	M	1	graver. - wet,											
<u>.</u>			-	N	GW	- dense to very dense,											
ALLUVIUM			5 -		H	- Gravel - round to subrour greywacke.	nd										
	•		-	M		- Sand - fine to medium.											
				Log-				and									1.1.
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SOILS & FOUNT (1973) LIMITE	DATIONS ED	LOG OF					299/15
FEATURE :		IRECTION:	MAP GRID: MACHINE:	R.L. G		n): DAT(M:
GEOLOGICAL UNIT DESCRIPTION	S Core loss/ to Lift %		DESCRIPTION OF MATERIAL RECOVERED	Drill method Date/depth (m)	Tests Date Mater level (m)	Fluid Loss	NETRATION (SPT) accorrected for rerburden & 40 60
RECENT	7		Grey sandy fine to coarse gravel wet, - dense to very dense, - Gravel - round to subrour greywacke Sand - fine to medium.				
	9	SP SW	Grey sandy fine to medium gravel wet,	411			
Water cut	COMENTS:			Logg Date Shee			ed: ned: