

1983/72. Groundwater investigations at coastal reserves on the East Coast of Tasmania

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Abstract

Sand bodies along the East Coast of Tasmania provide an easily accessible source of good quality groundwater. Four of these sand bodies have been investigated in order to supply water to Lands Department campsites at Coastal Reserves. At each site water was successfully obtained from shallow spear bores.

The analysis of total dissolved salts indicated that all the groundwaters were suitable for drinking, salinities ranging from 250 mg/l to 750 mg/l. One of the samples, obtained from Point Meredith, had a high iron concentration of about 4.0 mg/l. The iron content was not evident on sampling and is considered to be in an organically chelated form and therefore fixed in solution. The water is possibly suitable for drinking purposes and further advice from the Health Department has been requested. Groundwaters obtained at Cressy Beach, Denison Rivulet, and Chain of Lagoons are all suitable for human consumption.

INTRODUCTION

The Crown Land Warden at Swansea initially requested that the Lands Department consider the possibility of installing spears to provide drinking water at four Coastal Reserves on the East Coast. These Coastal Reserves are at Cressy Beach, Denison Rivulet, Lagoons Beach, and Point Meredith. If suitable water was obtained then each spear would be connected to a hand pump. The Lands Department subsequently requested the Department of Mines to conduct investigations and instal and test-pump sand spears in each area.

TOPOGRAPHY AND GEOLOGY

The sand bodies under investigation are close to sea level, have reasonable sized catchments, and are of significant size; each should be capable of supplying the small amounts of water required. The areas are composed of Holocene marine sand overlain by thin windblown sand sheets or frontal dune systems. Several geological and topographic features control the suitability of an area for obtaining groundwater. These are the nature and thickness of sand, depth and altitude of the local water table, areal extent of the sand body and related catchment, and the proximity to the sea. The features of each area are described below.

Cressy Beach [EP890307]

This is a small pocket sand deposit which has developed on the southern side of Webber Point. Inland coastal slopes are underlain by dolerite which is also exposed at either end of the beach. Holocene marine sand is overlain by a thin windblown sand sheet, which also forms a small dune ridge at the back of the beach. A small ephemeral stream drains from a hinterland catchment, towards the centre of the beach.

The most favourable location for a spear bore is where the underlying marine sand is considered to be thickest, and consequently a site was chosen in the deepest swale on the southern side of the creek, approximately in the centre of the sand body.

Denison Rivulet [FP048701]

Denison Beach is a narrow elongate sand body. Marine sand is overlain by windblown sand in the form of a large frontal dune some three kilometres in length. The largest of several small streams which have breached the dune is the Denison Rivulet. The river has been deflected by the sand body, behind which a lagoon has formed. A shingle deposit, well cemented with iron indurated sand, underlies the frontal dune on the southern side of the river. To the north, a gently sloping small terrace backs the dunes. The terrace is largely composed of clay and clayey sand and gravel. The terrace is considered to be largely an erosional feature, probably related to higher Interglacial sea levels.

A spear bore was sited adjacent to the car park on the northern side of the Denison Rivulet. Shingle outcrop is absent in this area, possibly removed by erosion as the course of the Denison Rivulet was deflected by the accretion of coastal sand.

Chain of Lagoons [FP077880]

The Coastal Reserve in this area is located at the northern end of Lagoons Beach, a narrow elongate sand body some five kilometres long. There is a single frontal dune at the rear of the present beach. The progradation of marine and aeolian sand has resulted in the deflection of several streams, forming lagoons at the rear of the dunes. The mouth of Lower Marsh Creek appears to have been deflected about one kilometre to the north, forming a narrow lagoon within the Coastal Reserve. The origin of a small, seaward-sloping terrace on the landward side of the lagoon is probably related to higher Interglacial sea levels. Granite is exposed on the steeper coastal slopes at the rear of the terrace. Footslope deposits are composed of clay and clayey gravel, derived from the weathered granite (Sloane, 1983). The marine terrace deposits may contain a silt and clay component derived from the hinterland slopes. The presence of silt and clay could considerably reduce the yield of underground water from spear bores in the terrace area.

Two favourable spear bore locations are evident. At the northern boundary of the Reserve a low-lying area behind the dune ridge appears suitable. Another area occurs at the southern end of the terrace and camping area, close to the lagoon and a small creek.

Point Meredith [FP018397]

This area has interesting geomorphological features. The sand body is possibly early Holocene in age and originally developed in a similar way to the beach ridge area at Nine Mile Beach. These beach ridge systems have developed as bay-head barriers, modified and adjusted to wave patterns. They are a feature of prograding coasts and consist of marine or estuarine sand overlain by windblown sand ridges. The barrier is developed by the addition of successive parallel beach ridges on alignments, like the curved outline of the present beach, which are a result of the refracted patterns of the dominant swell approaching the coast. The beach ridges are surmounted by parallel dunes, developed successively during progradation. Large amounts of sand are required to form these features. A likely origin is from sand, progressively moved into the bay as sea level rose from the Last Glacial minimum. The ridge system at Point Meredith has probably developed earlier than the Nine Mile Beach ridges, and is also possibly a relict of a much larger system. Moulting Lagoon has formed behind the barrier, with the lagoon entrance now deflected to the eastern end.

Dolerite crops out in the low lying areas behind Point Meredith and also at the southern end of the foreshore of Great Swanport. The Reserve camping area is located at the margin of the sand body where dolerite crops out. The basement dolerite surface is irregular and hollows have been filled with marine and aeolian sand.

The success of a spear bore at the camping area itself depends upon a sufficient depth of sand filling a dolerite basement hollow. Prospects are likely to improve away from the camp site, towards Point Meredith, where several households are using water from sand spears.

RESULTS OF INVESTIGATIONS

Seven auger holes were drilled by a Triefus trailer mounted auger drill. The four drill logs from the final groundwater production areas are given in Appendix 1. Groundwater was found in all holes. Stainless steel spears were jettted into the ground and pump tested, and groundwater was sampled. Chemical analyses are presented in Appendix 2. The results are summarised below.

Cressy Beach

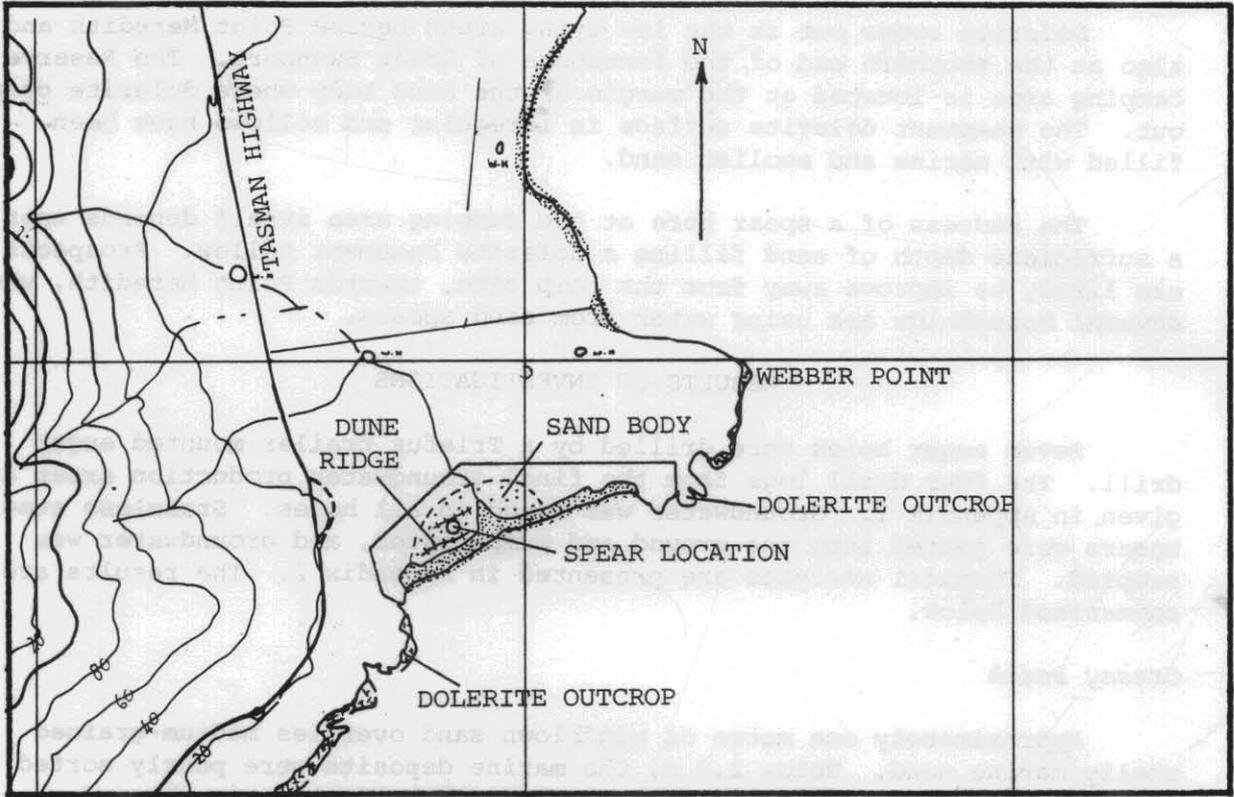
Approximately one metre of windblown sand overlies medium-grained shelly marine sand. Below 2.2 m, the marine deposits were poorly sorted and the medium to coarse sand contained abundant shell fragments and some dolerite pebbles to 40 mm diameter. Pebbles became more abundant towards the base, where at about four metres the hole passed into yellow-brown high plasticity sandy clay.

A 50 mm diameter, 0.04 mm stainless steel screen, 600 mm in length was jettted to a depth of 3.5 m. The standing water level (SWL) was measured at 2.2 m from the ground surface. A pumping rate of 9.1 l/min (120 gal/hour) was obtained from the spear. Chemical analysis of a water sample showed a salinity (TDS) of 750 mg/l. Dominant constituents were sodium chloride and calcium bicarbonate. These results indicate the water is suitable for drinking purposes.

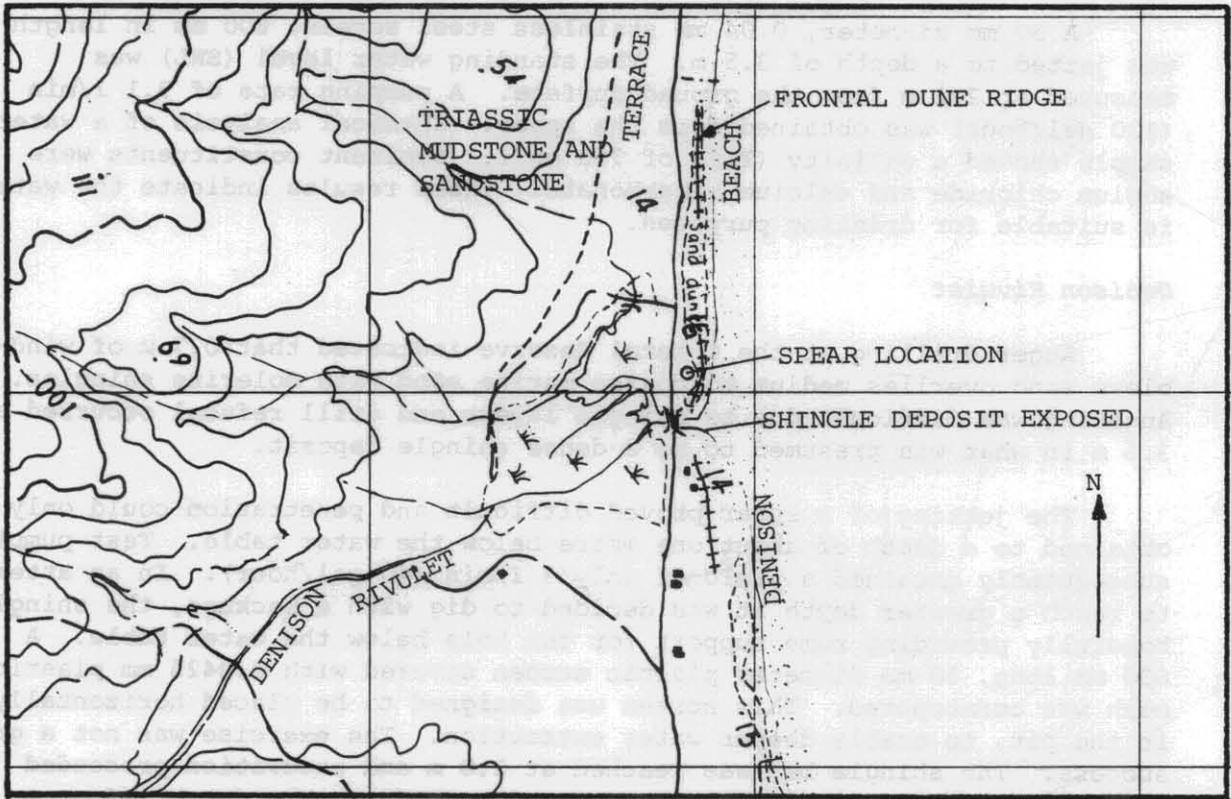
Denison Rivulet

Auger drilling at the Coastal Reserve indicated that 0.7 m of wind-blown sand overlies medium to coarse marine sand with dolerite shingles. Augering was difficult due to shingle layers and drill refusal occurred at 3.6 m in what was presumed to be a dense shingle deposit.

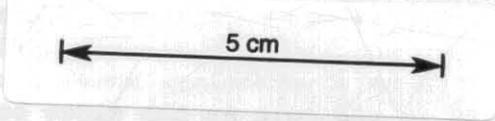
The jetting of a spear proved difficult and penetration could only be obtained to a depth of about one metre below the water table. Test pumping subsequently obtained a yield of only 3 l/min (40 gal/hour). In an attempt to reach a greater depth it was decided to dig with a backhoe, the shingle hopefully providing some support for the hole below the water table. A 600 mm long, 50 mm diameter plastic screen covered with 0.0425 mm plastic mesh was constructed. This screen was designed to be placed horizontally in the pit, to enable deeper water extraction. The exercise was not a great success. The shingle bed was reached at 2.0 m and excavation proceeded below this depth. Flowing water was encountered at this depth and progressive deepening caused caving of the sides and enlarging of the hole. The exercise was terminated before sideward caving reached the Tasman Highway, and both the plastic horizontal screen and a vertical 0.04 mm, 50 mm diameter stainless steel screen 600 mm in length, were quickly placed in the hole as the sides began to collapse. Both screens were pump



CRESSY BEACH COASTAL RESERVE. Outline of sand body and spear location indicated.



DENISON RIVULET COASTAL RESERVE



tested before the hole was backfilled. The plastic screen yielded about 4.5 l/min (60 gal/hr) and the stainless steel screen yielded about 7.2 l/min (95 gal/hr). After backfilling the hole the pumping rates dropped to about 3.4 l/min (45 gal/hr) and 6.0 l/min (80 gal/hr) respectively. A decision was made to connect both screens to the hand pump to produce about 9.0 l/min (120 gal/hr) which is the hand pump capacity. Subsequent water analysis showed the water to be of excellent quality, dominantly sodium chloride and calcium bicarbonate in type, and with a salinity (TDS) of 220 mg/l.

Chain of Lagoons

Two investigation holes were drilled at the southern end of the camping area. The first encountered clayey soil and gravel with organic clay at depth. This hole was located on the side of the southern access track some 50 m from the lagoon and was abandoned due to the absence of suitable water-bearing sand. A second hole was drilled 50 m to the south and closer to the lagoon. Here, one metre of clay sand overlies fine to medium-grained quartz sand extending to a depth of 3.4 metres. Dark brown, sandy and organic clay occurred below 3.4 metres.

A 50 mm diameter, 600 mm long, 0.04 mm stainless steel screen was jettied into the auger hole to a depth of 2.8 m. The measured standing water level was 1.1 m and test pumping produced 9.8 l/min (130 gal/hr) of clear water. Later chemical analysis of a water sample proved the good quality with a salinity (TDS) of 510 mg/l. The predominant constituent is sodium chloride and the water is fit for drinking.

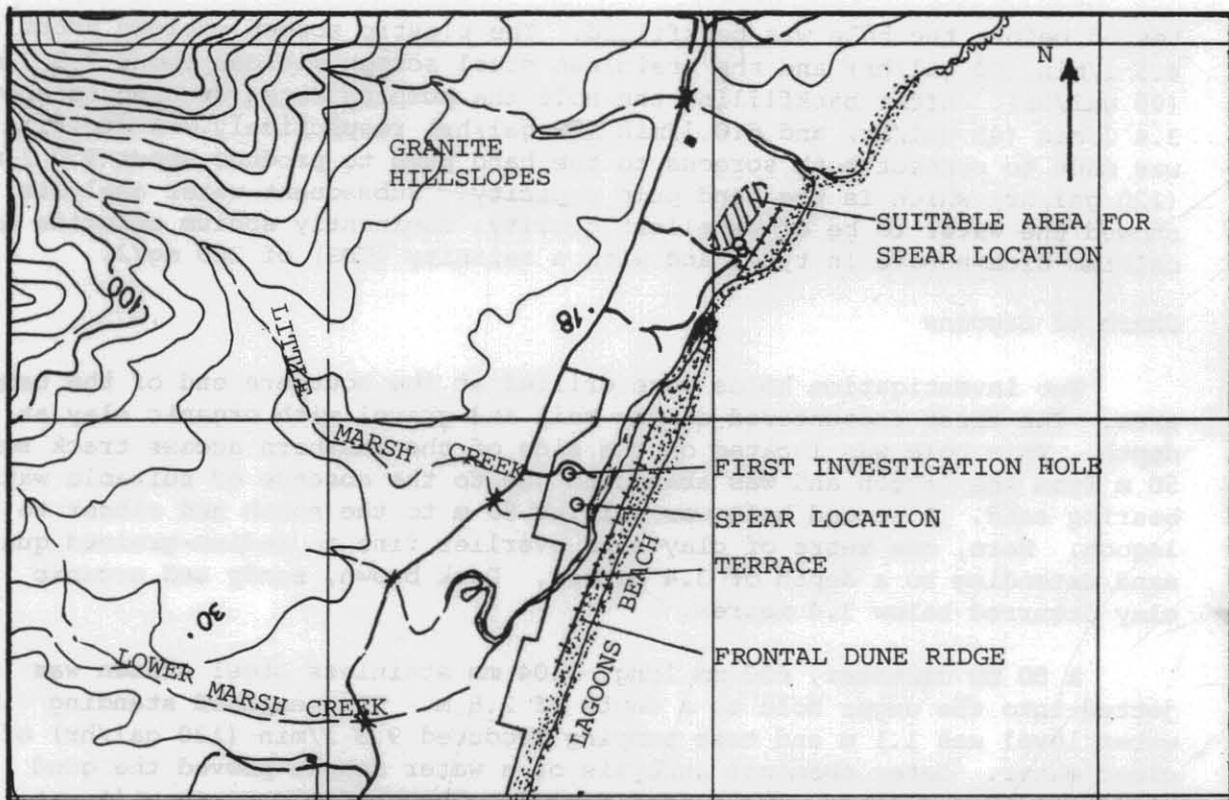
Point Meredith

Three shallow auger holes were drilled. The first was located in a campsite hollow in the hope that the sand overlying the dolerite basement was sufficiently thick. Sand was drilled to a depth of three metres, below which weathered dolerite occurred, with drill refusal at 4.2 metres. The SWL was measured at 3.6 m and the hole was abandoned. Other holes were drilled along the track to Point Meredith and showed a thickening of the sand in this direction. Approximately 75 m from the main campsites 3.2 m of medium to fine-grained sand overlies medium to fine-grained grey estuarine sand which extends to a depth of 6.5 metres.

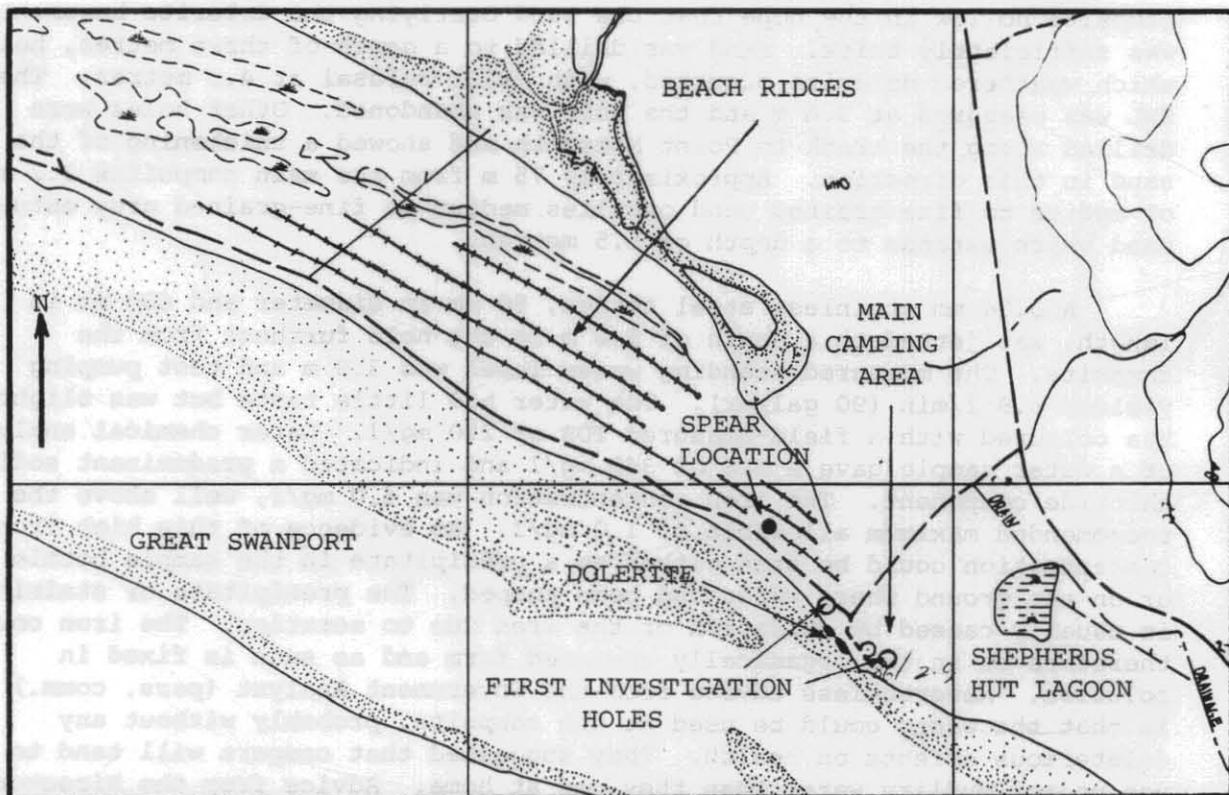
A 0.04 mm stainless steel screen, 50 mm in diameter and 600 mm in length, was jettied to a depth of 5.8 m in the hole furthest from the campsite. The measured standing water level was 3.9 m and test pumping yielded 6.8 l/min (90 gal/hr). The water had little taste but was slightly tea coloured with a field-measured TDS of 210 mg/l. Later chemical analysis of a water sample gave a TDS of 340 mg/l and indicated a predominant sodium chloride component. The iron concentration was 4.0 mg/l, well above the recommended maximum allowable of 1.0 mg/l. No evidence of this high iron concentration could be seen either as a precipitate in the sample bottle or on the ground where water had been pumped. The precipitate or staining is usually caused by oxidation of the iron due to aeration. The iron could therefore be in the organically chelated form and as such is fixed in solution. Nevertheless advice from the Government Analyst (pers. comm.) is that the water could be used at the campsite, probably without any deleterious effects on health. They suggested that campers will tend to use poorer quality water than they use at home. Advice from the Director of Health has been sought and research into the matter is in hand.

CONCLUSION

Sand bodies at four Lands Department Coastal Reserves on the East



LAGOONS BEACH COASTAL RESERVE



POINT MEREDITH COASTAL RESERVE

Coast have been investigated for the presence of groundwater which can be used for drinking purposes. In each area investigation auger holes have indicated the presence of suitable thicknesses of water-bearing marine sand. Spear installations at Cressy Beach, Denison Rivulet and Chain of Lagoons Coastal Reserves will provide yields of up to 9.0 l/min (120 gal/hr) of clear water suitable for drinking purposes. Salinities range between 220 mg/l and 750 mg/l. A spear installed at Point Meredith Reserve yielded 6.8 l/min (90 gal/hr) of water with an analysed salinity of 340 mg/l. The iron concentration of 4.9 mg/l obtained from this sample may make the water unfit for human consumption. The iron is probably fixed in solution in an organically chelated form. It is considered that better quality water could be obtained from a location further along the track to the north-west. This is, however, further from the main camping area. Bacteriological samples have not been taken. Pollution problems are considered to be remote but each installation should be carefully sampled. Advice on taking samples for bacterial analysis can be obtained from the Department of Health, who are also currently investigating the effect on health of the high iron content of the Point Meredith water.

REFERENCE

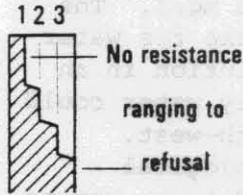
SLOANE, D.J. 1983. The erosion of granite-derived soils in eastern and north-eastern Tasmania, with reference to forestry operations. Part 2 : Investigation of erosion at forestry coupe EL1, Chain of Lagoons. *Unpubl.Rep.Dep.Mines Tasm.* 1983/12.

[22 December 1983]

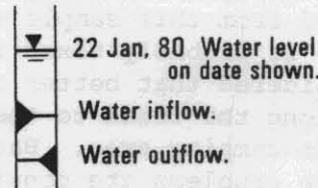
EXPLANATION SHEET FOR ENGINEERING LOGS

Borehole and excavation log

Penetration



Water



Notes - samples and tests

- U50 Undisturbed sample 50mm diameter.
- D Disturbed sample.
- N Standard penetrometer blow count for 300mm.
- N* SPT + sample.

Material classification

Based on Unified Soil Classification System.
In Graphic Log materials are represented by clear contrasting symbols consistent for each project.

Moisture content

- D Dry, looks and feel dry.
 - M Moist, no free water on hand when remoulding.
 - W Wet, free water on hand when remoulding.
 - LL Liquid limit.
 - PL Plastic limit.
 - PI Plasticity Index.
- eg. $M > PL$ - Moist, moisture content greater than the plastic limit.

Consistency

- | Consistency | hand penetrometer (kPa) |
|-----------------|-------------------------|
| VS Very soft. | < 25 |
| S Soft. | 25 - 50 |
| F Firm. | 50 - 100 |
| St Stiff. | 100 - 200 |
| VSt Very stiff. | 200 - 400 |
| H Hard. | > 400 |
| Fb Friable. | |

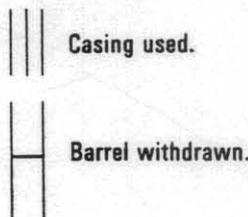
Notes: X on log is test result
— is range of results.

Density index

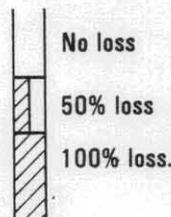
- | Density index | % |
|------------------|----------|
| VL Very loose. | 0 - 15 |
| L Loose. | 15 - 35 |
| MD Medium dense. | 35 - 65 |
| D Dense. | 65 - 85 |
| VD Very Dense | 85 - 100 |

Cored borehole log

Case - lift



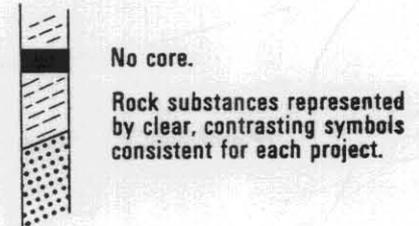
Fluid loss



Lugeons

Lugeon units (μL) are a measure of rock mass permeability. For a 46 to 74mm diameter borehole 1 Lugeon is defined as a rate of loss of 1 litre per metre per minute. 1 Lugeon is roughly equivalent to a permeability of 1×10^{-4} mm/sec.

Graphic log



Weathering

- Fr Fresh.
- SW Slightly weathered.
- HW Highly weathered.
- EW Extremely weathered.

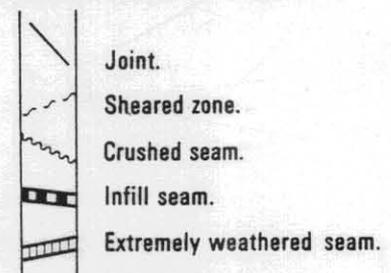
Strength

- | Strength | point load strength index $I_{s(50)}$ (MPa) |
|--------------------|---|
| EL Extremely low. | < 0.03 |
| VL Very low. | 0.03 - 0.1 |
| L Low. | 0.1 - 0.3 |
| M Medium. | 0.3 - 1 |
| H High | 1 - 3 |
| VH Very high. | 3 - 10 |
| EH Extremely high. | > 10 |

Note: X on log is test result.

Significant defects

Significant defects shown graphically.



ENGINEERING LOG - BOREHOLE

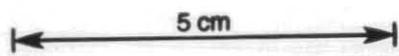
9/13

borehole no. 1
sheet 1 of 1

project	LANDS DEPARTMENT	location	CRESSY BEACH
co-ordinates	EP890307	drill type	Triefus
R.L.	≈ 3 m	drill method	Auger screw
inclination	90°	drill fluid	
bearing		hole commenced	
		hole completed	
		drilled by	B.C.
		logged by	D.J.S.
		checked by	

penetration 1 2 3	support water	notes samples, tests	metres R.L. depth	graphic log classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetr- ometer kPa	structure, geology
			0	///	SAND: Medium to fine-grained. Dark brown. Root fragments. Organically enriched.	D	L		Al soil horizon
			1	•••••	SAND: Medium to fine-grained quartz particles. Dull yellow-orange. Moderately sorted.	M	L		
			2	•••••	Some shell fragments to 15 mm diameter.				
			3	•••••	SAND AND PEBBLY SAND: Medium to coarse quartz sand. Dolerite pebbles to 40 mm. Low sphericity, well rounded. Dull yellow-orange.	M	L		
			4	•••••	SANDY CLAY: Moderate plasticity. Yellow-brown. Approximately 30% medium sand.	M	St		

0.04 SCREEN
50 mm dia.
0.04 mm screen
Pumping 9.1 l/min.
END



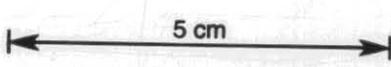
ENGINEERING LOG - BOREHOLE

10/13

borehole no. 1
sheet 1 of 1

project	LANDS DEPARTMENT	location	DENISON RIVER COASTAL RESERVE
co-ordinates	FP048701	drill type	Triefus
R.L.	≈ 2 m	drill method	Auger screw
inclination	90°	drill fluid	
bearing		hole commenced	
		hole completed	
		drilled by	B.C.
		logged by	D.J.S.
		checked by	

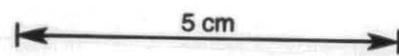
penetration	support	water	notes samples, tests	metres R.L. depth	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetr- ometer kPa 25 50 100 200 400	structure, geology
1 2 3				0			SILTY SAND: Fine quartz sand. Brownish grey. Organic enrichment.	D	L		A1 soil horizon
	0.04 mm SCREEN		Combined pump rate 9.0 l/min	1			SAND: Medium-fine quartz sand. Dull yellowish-brown. Some dolerite shingle to 200 mm diameter.				Marine sand
			Plastic screen	2			SAND: Medium to coarse-grained quartz particles. Some shell fragments. Abundant dolerite shingles - low sphericity, high roundness to 200 mm diameter. Occasional quartz pebble.				Marine beach Shingle and sand
			Refusal	3							
				4							



ENGINEERING LOG - BOREHOLE

project	LANDS DEPARTMENT	location	CHAIN OF LAGOONS
co-ordinates	FP077880	drill type	Triefus
R.L.	≈ 3 m	drill method	Auger screw
inclination	90°	drill fluid	
bearing		hole commenced	
		hole completed	
		drilled by	B.C.
		logged by	D.J.S.
		checked by	

penetration 1 2 3	support water	notes samples, tests	metres R.L. depth	graphic log classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetr- ometer kPa			structure, geology
								25	50	100	
	50 mm, 0.04 mm SCREEN		0		SAND: Medium-fine quartz particles, brownish black at surface - organic enriched. Grading to clayey sand - brownish grey.	D	L				
			1		SAND: Medium to fine-grained. Quartz particles. Light grey and well sorted.						
			2		SAND: Fine to medium-grained quartz sand. Brownish grey. Occasional quartz pebble.						
		Pump rate 9.8 l/min	3								
			4		SANDY CLAY: Moderate plasticity. Dark brown with medium quartz sand approximately 30%.						



ENGINEERING LOG - BOREHOLE

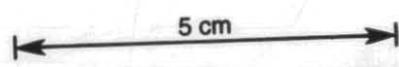
project	LANDS DEPARTMENT		location	MEREDITH POINT	
co-ordinates	FP018397		drill type	Triefus	
R.L.	≈ 4 m		drill method	Auger screw	
inclination	90°		drill fluid		
bearing			hole commenced		
			hole completed		
			drilled by	B.C.	
			logged by	D.J.S.	
			checked by		

penetration 1 2 3	support water	notes samples, tests	metres R.L. depth	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetr- ometer kPa 25 50 100 200 400	structure, geology
			0			SAND: Medium-grained quartz sand. Top - grey-brown organic enriched. Dull yellow-orange. Well sorted	D	L		A1 soil horizon
			1			Some shell fragments	M	L		
			2							
			3							
			4			SAND: Medium to fine grain size quartz sand. Grey with abundant shell fragments	M	L		
			5							
			6							
			7							

SCREEN

Test pump
6.8
l/min

END



APPENDIX 2

Chemical analyses of water samples

Registered No.	830711	830712	831192	831190
Location	Cressy Beach	Denison Rivulet	Point Meredith	Chain of Lagoons
pH	7.5	7.2	6.9	6.1
Conductivity ($\mu\text{S}/\text{cm}$)	1120	340	480	720
	<i>Item (mg/l)</i>	<i>Item (mg/l)</i>	<i>Item (mg/l)</i>	<i>Item (mg/l)</i>
CO_3	Nil	Nil	Nil	Nil
HCO_3	310	110	60	12
Cl	240	51	140	240
SO_4	37	6	8.6	25
SiO_2	37	9.7	16	9.4
Ca	35	22	7.5	6.0
Mg	26	7.6	8.8	16
Fe	<0.1	<0.1	4.0	1.0
Al	<0.2	<0.2	0.6	4.4
K	3.2	3.3	5.0	6.4
Na	205	38	96	130
TDS	750	220	340	480
Hardness - permanent	Nil	Nil	16	100
- temporary	195	86	49	9.8
Alkalinity (as CaCO_3)	255	89	49	9.8