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1987/42. Groundwater prospects at the Stanley Golf Club

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Abstract

Quaternary-age sand deposits, from which appreciable quantities of groundwater can be extracted, underlie the Stanley Golf Club. The installation of a spear bore system is recommended. Close monitoring of output and water levels will be required to assess recharge. The salinity of the water is low but monitoring of salinity levels should be undertaken to ensure that serious saltwater intrusion does not occur.

INTRODUCTION

A request was made by the secretary of the Stanley Golf Club to assess prospects of obtaining groundwater to supply the course as an alternative to the present town water supply. From a brief preliminary inspection it was apparent that there were two possible sources; these were from a deep bore which would penetrate bedrock (probably basalt), and from a shallow spear system into the sand that underlies the course. A decision was made by the Golf Club committee to investigate the potential of the sand deposits.

LOCATION AND GEOLOGY

The Stanley Golf Course is located near the coastline on the eastern side of Green Hills. The course is generally flat with minor undulations, and rises to about five metres above sea level. Green Hills to the west rises to about 75 m above sea level.

Green Hills is underlain largely by Tertiary-age basalt and associated tuff while the golf course is underlain by Quaternary sand. The sand is probably underlain at depth by basalt.

The sand deposit on which the course has been developed extends beyond the course towards the north-east, where it underlies part of the town, and to the south where the deposit becomes a little narrower. The sand also extends east to the shoreline. The course itself is about one kilometre long and, in this location, the width of the sand body from its western margin to the shoreline is up to about 350 metres.

DRILLING RESULTS AND SPEAR INSTALLATIONS

The major part of the investigation involved the drilling of 13 holes to a maximum depth of 7.9 m. From this drilling it was possible to examine the nature of the material to the depth to which a spear would extend, to collect samples for sizing, and in a few of the holes to install spears so that output could be tested. The positions of these holes are marked approximately on Figure 1 and logs and other information are given in Appendix 1.

The sand is made up dominantly of angular quartz fragments (usually 90-95%) although shell fragments and small shells predominate in the coarser fractions. In addition to the quartz and calcite (shell fragments) there are small proportions of aragonite, pyroxene and ilmenite.

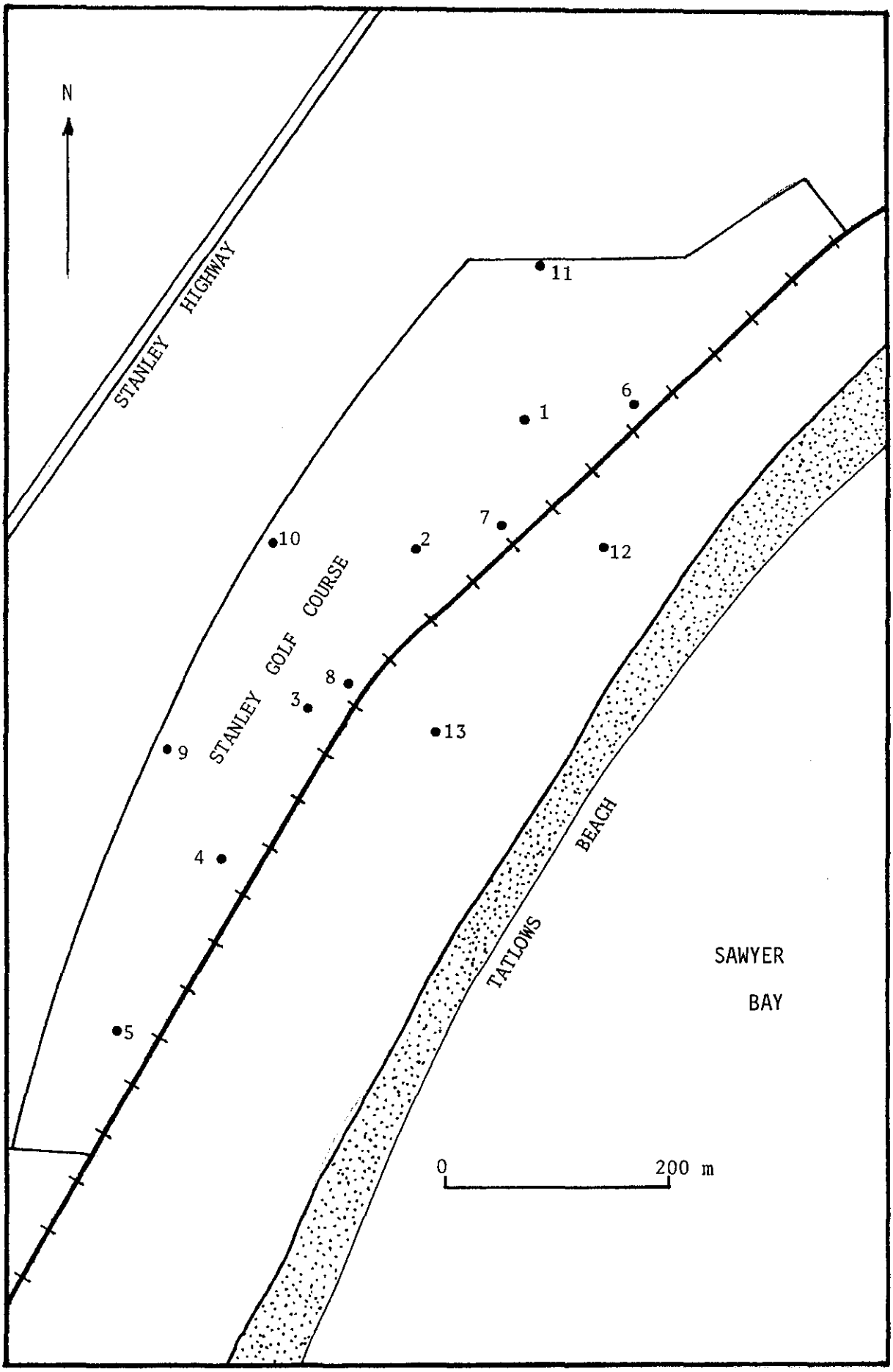

Figure 1. *Location of drill holes, Stanley Golf Course*

5 cm

The sand at the surface is clean and free from clay in each hole but at depth in some holes there appeared to be a small clay content and the colour of the sand changed from yellowish to grey towards the bottom. In Holes 1, 2, 3, 6, 7, 12 and 13 there appears to be little or no clay in the sand at the base, while in the remainder there are varying amounts. In Holes 9, 10 and 11, drilled along the western margin of the course, clay probably derived from *in situ* weathering of basalt was encountered in the base of the holes.

Sizing of the sand from several holes indicates that the majority of the material is in the size range of 150-220 μm in diameter. The sand is well sorted, with only minor proportions outside this range. The sizing results are shown on the accompanying plots.

Spears were installed in five holes (1, 3, 5, 9 and 12) so that short pump tests could be undertaken. The spears were pumped for periods of 30 to 120 minutes and outputs varied from 26 to 42 litres per minute (340-550 gallons per hour). The highest yields were obtained from Holes 1 and 12. These holes are in zones where there appears to be little or no clay in the sand at the base. By changing the position of the spears in some of the other holes, the output varied a little.

WATER QUALITY

Water samples were collected for chemical analysis from the five holes in which spears were installed. The results, as determined by the Department of Mines Laboratory, Launceston, are given in Table 1. The total dissolved solids content (TDS) in each sample was relatively low, with the highest values being from Holes 5 and 9. All of the water should be suitable for irrigating grass, particularly as the area to be watered has well-drained sandy soil. In general 1000 mg/*l* dissolved solids is about the limit used for irrigation water but in many cases much higher values have been found useful.

Table 1. ***CHEMICAL ANALYSES OF WATER SAMPLES***

	Hole 1	Hole 3	Hole 5	Hole 9	Hole 12
pH	7.4	7.5	7.5	7.3	7.4
Conductivity (μS/cm)	520	580	810	880	600
Item (mg/l)					
CO_3	nil	nil	nil	nil	nil
HCO_3	220	260	230	340	260
Cl	44	48	110	100	39
SO_4	19	25	63	32	40
Ca	70	72	37	42	79
Mg	5.3	9.4	17.5	23	8.5
Fe	<0.1	<0.1	<0.1	0.7	<0.1
Al	<0.2	<0.2	<0.2	<0.2	<0.2
K	4.1	7.5	11.5	17.0	5.8
Na	23	31	125	140	29
TDS	330	360	520	650	370
Hardness - Permanent	15.5	5.5	nil	nil	16.5
Temporary	180	210	165	200	220
Alkalinity as $CaCO_3$	180	210	185	280	220

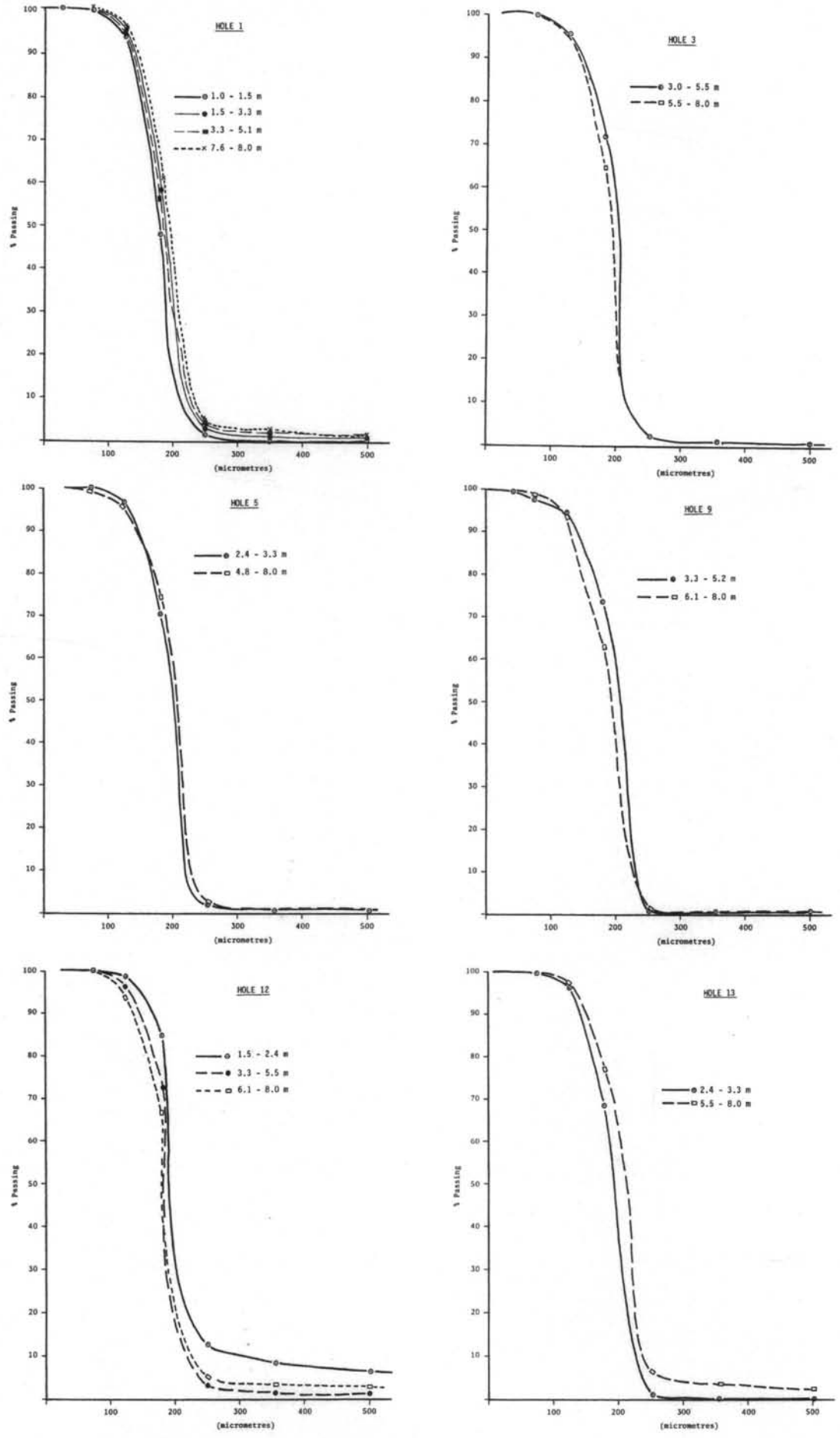

Figure 2. *Sizing curves of sand samples*

Chloride content is relatively low in each case, with bicarbonate being dominant in all analyses. Where bicarbonate is much higher than chloride (in Holes 1, 3 and 12) calcium reaches higher values, and this is presumed to be derived from the shell content of the sand.

DISCUSSION

Spears installed at varying locations on the golf course yielded appreciable quantities of water. The other drill holes indicated that similar materials occur, and that the whole area from the western boundary of the golf course to the shoreline is capable of yielding similar quantities of water.

Assuming the course is one kilometre long and the average width of sand between the western edge of the course and the shoreline is 300 m, for every one metre depth of saturated sand, some 90 000 m^3 (or about 20 million gallons) of water would be stored (assuming a porosity of 30%). Of this some 2/3 or 60 000 m^3 should be extractable.

The above figures deal with storage and do not relate to the long term safe yield. If 10% of the average annual rainfall of about 750 mm recharges the area, then about 22 700 m^3 would be available for extraction each year. This recharge figure might be conservative, and 15-20% of rainfall may be available for recharge, in which case a larger amount could be extracted. In addition a proportion of rain falling on Green Hills may seep into the sand body, providing added recharge. A guide to the actual recharge value will not be available until the area has been pumped for a year or so and water table measurements are monitored. The 22 700 m^3 figure is probably a minimum amount of water recharged each year. In practice it is likely that in dry years some additional water could be taken out of storage which would be made up by additional recharge in wet years.

The above figures relate to the whole golf course area and assume that extraction would be evenly distributed. Because of the shape of the sand body, extraction from one section of it will not influence the whole of the course area. The greatest danger would be if drawdown in the spear system becomes so great that sea water would contaminate the supply. Although some additional salt could be tolerated (perhaps somewhere in the range of 1000-2000 mg/*l* TDS) intrusion of sea water should not be allowed to occur.

CONCLUSIONS

The golf course is underlain by sand from which appreciable quantities of water could be extracted. It appears likely that the recharge from rainfall on the whole of the golf course area will at least approximate the estimated requirement.

The installation of a spear system is recommended and its performance closely monitored so that closer estimates of recharge can be made. Some water used for irrigation will probably return to storage. The spear system should cover an area as wide as possible so that a large area of the water under the golf course is influenced.

The water has a relatively low dissolved solids content for groundwater and it would be suited to irrigating grass. The salinity should be monitored to guard against saltwater intrusion.

It would be advisable to install some extra spears (perhaps using only slotted PVC pipe) so that water levels and salinity can be monitored. The spears measuring salinity would preferably be on the seaward side of the production spears.

[17 September 1987]

APPENDIX 1

Logs of drill holes, Stanley Golf Club

Hole 1

Depth (m)	*Description*
0 -0.6	Grey quartz sand
0.6-1.2	Yellow quartz sand
1.2-1.5	Yellow-cream sand
1.5-4.6	Cream-grey quartz sand
4.6-7.0	As above with shells
7.0-7.9	Darker grey sand with shells

Apparent standing water level at end of drilling 1.6 m

A spear was installed to about 7 m with a 1.2 m long No. 15 screen on the bottom. It was pumped for 2 hours at a rate of about 36 litres per minute (480 gallons per hour). The water level drew down to about 5 m from the surface. The standing water level in the spear was 2.56 m and the conductivity of the water was 450 µS/cm (a total salinity of about 320 mg/*l*).

Hole 2

0 -0.3	Dark grey-black sand
0.3-0.6	Light grey sand
0.6-3.4	Yellow sand
3.4-4.0	Light grey-brown sand
4.0-7.3	As above with shells and shell fragments
7.3-7.9	Dark grey sand with shells

Hole 3

0 -0.3	Dark grey quartz sand
0.3-0.6	Light grey-brown sand
0.6-2.4	Light brown sand
2.4-3.7	Light grey-brown sand
3.7-5.5	As above with shells and shell fragments
5.5-7.9	Dark grey sand with shells

Apparent standing water level 2.34 m. A spear (as in Hole 1) was installed and pumped for one hour at 27 *l*/min. The spear was pulled back to 6.4 m depth and pumped for half an hour at 30 *l*/min. Conductivity 600 µS/cm or about 420 mg/*l* dissolved solids.

Hole 4

0 -0.3	Dark grey sand
0.3-0.9	Light grey-cream sand
0.9-1.5	Brown sand
1.5-2.4	Coffee coloured sand
2.4-4.0	Light cream-brown sand
4.0-5.3	As above with shells
5.3-7.9	Dark grey sand with shells

Apparent standing water level 2.62 m.

Hole 5

0 -0.3	Dark grey-black sand
0.3-0.9	Light grey sand
0.9-1.5	Brown and grey sand
1.5-2.4	Coffee brown sand
2.4-3.4	Creamish brown sand
3.4-7.9	Grey sand with shells, becoming darker in colour with depth.

Apparent standing water level 2.24 m.

A spear was installed (as in hole 1) to 7.0 m. It was pumped for about 2 hours at 30 *l*/min. The spear was withdrawn to 6.4 m and pumped for a further half an hour at 26 *l*/min. Conductivity 800 µS/cm (560 mg/*l*).

Hole 6

0 -2.1	Light brown sand
2.1-6.1	Light brown sand with shell fragments
6.1-6.9	Mid-grey coloured sand with shells

Apparent standing water level 2.0 m.

Hole 7

0 -0.3	Grey sand
0.3-1.5	Yellow sand
1.5-3.4	Light grey-brown sand
3.4-7.0	As above with shells
7.0-7.9	Light to mid-grey sand with shells

Apparent standing water level 2.94 m.

Hole 8

0 -0.3	Light grey sand
0.3-0.6	Dark grey sand
0.6-1.5	Brown sand
1.5-3.4	Light brown changing to light grey-brown sand
3.4-5.8	Light grey-brown sand with shells
5.8-7.9	Grey sand with shells

Apparent standing water level 2.86 m.

Hole 9

0 -0.3	Grey-black sand
0.3-1.5	Light grey sand
1.5-3.4	Chocolate brown sand
3.4-5.2	Darker brown sand with shells
5.2-7.9	Dark grey sand with shells

A little clay at final depth. Apparent standing water level 2.34 m.

A spear with a 1.8 m long screen was installed to 7.3 m and pumped for 2 hours at 27 litres per minute. Conductivity 840 µS/cm indicating about 600 mg/*l* dissolved solids. The water has a brown colour.

Hole 10

0 -0.3	Dark sand
0.3-1.5	Light grey sand
1.5-3.4	Grey and brown sand
3.4-5.2	Dark grey-brown sand
5.2-6.7	Dark grey-brown sand with shells
6.7-7.9	Grey and brown clay (weathered basalt probably)

Apparent standing water level 2.0 m.

Hole 11

0 -0.3	Dark grey sand
0.3-1.5	Light cream-brown sand
1.5-3.4	Light grey-brown sand with shells
3.4-4.3	Darker cream-grey sand with shells
4.3-6.7	Grey sand with shells, possibly a little clay
6.7-7.9	Greenish clay with basalt-like texture

Apparent standing water level 2.45 m.

Hole 12

0 -0.6	Light brown sand
0.6-2.4	Light grey-brown sand with shells
2.4-7.6	Grey sand with shells

Apparent standing water level 0.9 m.

A spear was installed to 6.7 m and pumped for about half an hour at about 42 *l*/min. The drawdown was to about 3.7 m, i.e. 3 m of water remained in the spear. Conductivity 600 µS/cm or about 420 mg/*l* dissolved solids.

Hole 13

0 -2.1	Light brown-grey sand
2.1-5.5	Light brown-grey sand with shells
5.5-7.9	Mid-grey sand with shells

Apparent standing water level 1.2 m.

APPENDIX TO UNPUBLISHED REPORT 1987/42.

Spear installation - Stanley Golf Club

INTRODUCTION

Eight production spears have been installed on the Stanley golf course at the request of the Stanley Golf Club. These spears consist of stainless steel screens 1.5 m and 1.8 m long, the shorter ones having an opening of 0.25 mm while the remainder have a smaller opening. A description of the spears is given in the table below.

The spears have been installed in a relatively elevated part of the course, which has resulted in a low water table in most of the spears. This will limit the amount to which the water table can be lowered as extraction proceeds. It has advantages in that it will not be possible to draw the water level very far below sea level (perhaps only 1-2 m) whereas in a lower lying location, such as just east of the railway line, it would be possible to obtain drawdowns up to about 5 m below sea level. In this latter situation, sea water intrusion would be more likely with prolonged pumping.

In addition to the production holes, three observation holes have been installed. These consist of a 6 m length of slotted PVC tube, and are to be used to monitor water levels and salinity.

RATE OF PUMPING FROM THE SYSTEM

The short term pump tests as described in the table should not be taken as the likely output from the system as a whole in the long term. There will be some mutual interference between the spears as pumping proceeds that will produce a greater drawdown in each spear at a given output than if the spears are pumped individually at that rate. An average output of 23-26.5 *l*/min from each spear would appear to be a more appropriate rate (or 180-210 *l*/min from the whole system).

MONITORING

It will be important to monitor the effect of withdrawal of water on the water table level. To achieve this an accurate record should be kept of the amount of water pumped and levels monitored in the observation holes. To obtain a consistent result, the water levels should be measured at a similar time, e.g. at a set period after pumping stops or just before a period of pumping. It would be useful to have recordings of these measurements at about weekly intervals, particularly in the first year of pumping.

As well as monitoring water levels, salinity (total) levels should be measured. This could be undertaken with a conductivity meter which would give an approximate total salinity value. The water being discharged into the dam should be measured as well as the water in the two observation bores on the eastern side of the course. The water in the observation spears should preferably be pumped or bailed for a short (standard) period but if this is inconvenient, water at the base of the spear should be tested. Again weekly intervals are suggested, particularly for the first year of use.

[21 October 1987]

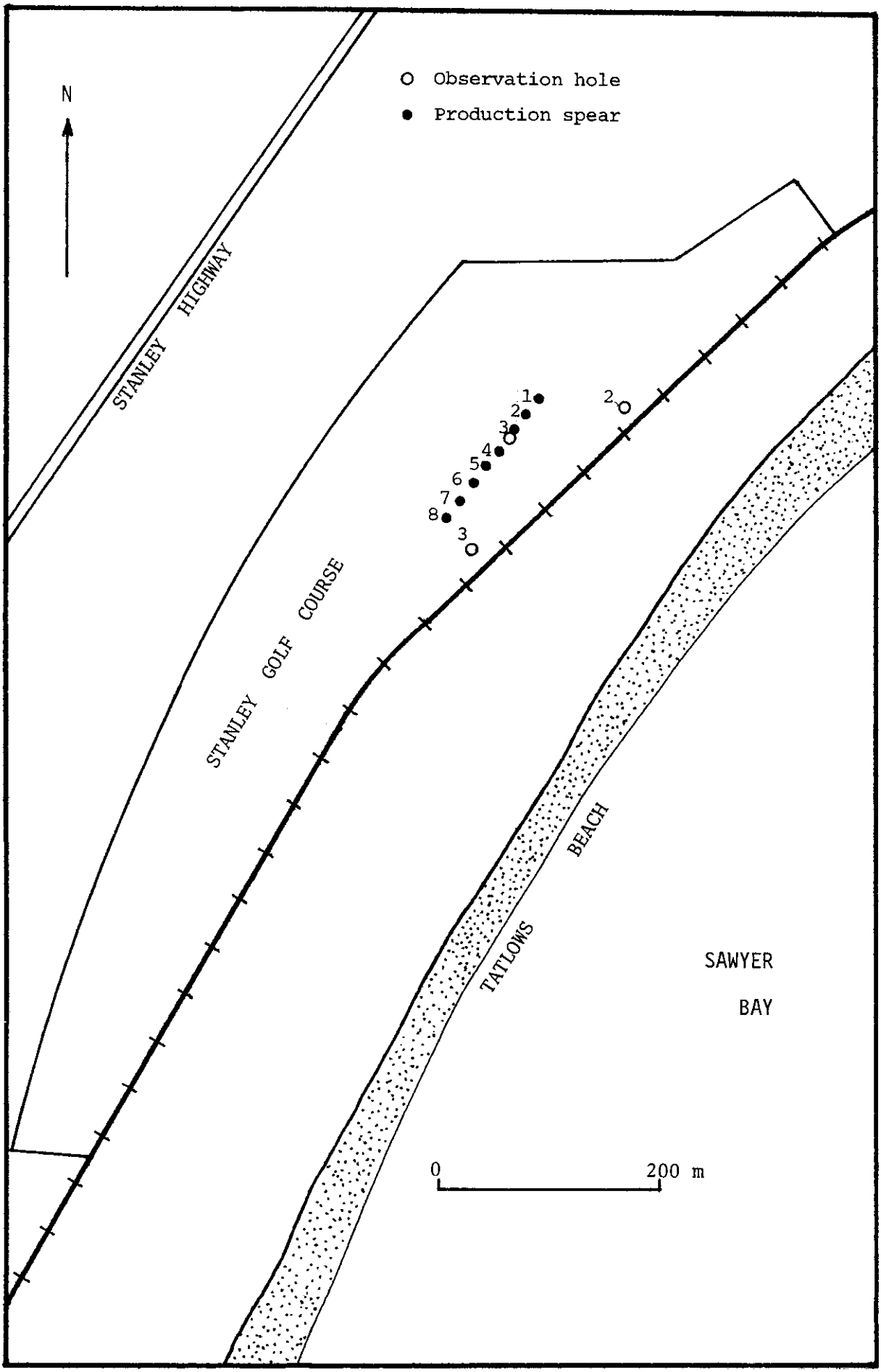

Figure 1. *Location of drill holes, Stanley Golf Course*

5 cm

Table 1. *DETAILS OF SPEAR BORES, STANLEY GOLF COURSE*

Production Hole no.	Depth below ground (m)	Screen length (m)	Standing water level (m)	After 15 minutes pumping	
				Output (*l*/min)	Water depth (m*)
1	7.27	1.5	3.78	34	1.15
2	7.56	1.8	3.67	36	1.5
3	7.42	1.5	2.92	34	2.2
4	7.45	1.8	3.32	34	2.1
5	7.55	1.8	3.87	34	1.6
6	7.46	1.5	4.07	34	1.1
7	7.60	1.8	3.92	34	1.6
8	7.56	1.8	4.07	36	1.3
Observation holes					
1	6.0		3.00	19	
2	6.0		2.14	15	
3	6.0		3.80	8	

* Depth of water remaining in hole after 15 minutes pumping.