## 15. Water in coastal sands.

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### INTRODUCTION

Large quantities of fresh water are present in sand deposits along the Tasmanian coastline. Untapped and generally unsuspected by land owners, this valuable resource is suitable for both domestic and irrigation purposes. Lying at a shallow depth, it is readily accessible and can be economically extracted by simple methods. Because of its potential importance, especially in the drier areas of the east coast of Tasmania, the Department of Mines has for some years been investigating the occurrence, distribution and quality of water in coastal sands.

Most of this water is directly derived from rainfall which is rapidly absorbed by the sand. Surface runoff is consequently reduced and therefore streams or creeks are rare in sandy country. The rainwater percolates down to a level below which the sand is saturated and the water is then termed *groundwater*. Any deposit or rock capable of supplying groundwater in economic quantities is termed an *aquifer*. The upper surface of the saturated layer is known as the *water table*. In sandy areas the water table has a relatively uniform surface, but it rises under sand hills and falls under depressions following the contour of the land surface. Occasionally the water table intersects the land surface, producing springs, seepages and swamps (fig. 37, 38).

The depth at which water lies in a bore or well sunk in saturated sands, is known as the *standing water level*. During pumping, water is removed from both the bore and the surrounding sand, and the amount by which the water level drops is termed the *drawdown*. Drawdown decreases away from the pumped hole and at some distance from it, the level of the water table will be unaffected by pumping. This distance is called the *radius of influence* of the bore or well. In areas where bores or wells are spaced close together, it is important for the efficient operation of each that their radii of influence do not overlap. The overall effect during pumping is to produce a funnel-shaped zone, the *cone of depression,* in the sand around a bore, from which most of the water has been removed (fig. 37, 38).

Testing of samples from numerous localities has demonstrated that water in coastal sands is almost invariably of good to excellent quality and suitable for most purposes. Loose sand acts as an excellent natural filter, and except in the immediate vicinity of septic tanks and other outlets of effluent, the water is free of biological impurities.

Contamination can occur however, especially in *low lying* areas near the coast. The density of fresh water is less than that of salt water and under some circumstances fresh water may lie as a body or lens on top of a layer of salt water derived from the sea. Excessive pumping or deepening of a bore or well may cause the saline water to be drawn in. Once this has occurred, the situation is difficult and in many cases impossible to remedy. In some cases an impervious clay layer near sea level may separate the two water types and obviously clays encountered on drilling near sea level should not be penetrated (fig. 38).

The water table in coastal sands is generally close to the surface, often at about 3-4 m and commonly shallower than 2 m. Its purity, accessibility and ease of extraction make it a valuable resource.

RAINFALL

EVAPORATION

TRANSPIRATION

SURFACE
RUNOFF

WELL

PERCOLATION
TO WATER TABLE

PUMPED
BORE

STANDING
WATER LEVEL
IN WELL

DRY SAND

WATER TABLE

DRY SAND

SAND
AQUIFER

Cone of
depression

SATURATED SAND

DRAWDOWN

BEDROCK

WATER LEVEL
IN PUMPED
BORE

**Figure 37.** *Generalised groundwater conditions in sand aquifers.*

## DETECTION

Not all sand deposits contain water, or contain it in economic quant-
ities, and a geologist may need to utilise a variety of methods in ground-
water exploration.  He can try the obvious direct approach and simply dig
for it using a post-hole auger or other suitable tool.  Where the water table
is near the surface this method enables the geologist to obtain water and
sand samples for analysis.  The water is tested on site using a portable meter
and the sand is examined in the laboratory to determine its grain size char-
acteristics.

Unfortunately augering does not indicate how much water-saturated sand
is present and thus it is necessary to estimate the long-term potential of
the supply.  The reason for this is that running sand prevents the auger from
penetrating more than short distance below the water table.  Also, the fact
that augering fails to locate water in a particular spot does not mean that
it is not present; often it is simply below the reach of the instrument.
Clearly, other approaches are needed which can be used concurrently to com-
plement drilling.  Two of these indirect methods used most commonly by the
geologist are *seismic refraction*, and *electrical resistivity* prospecting.

The principle of *seismic refraction* relies on the fact that shock
(seismic) waves travel through different earth materials; dry sand, wet sand,
clay or rock; at different velocities:  the denser and more rigid the material
the higher the velocity.  Experience has shown that dry sand transmits these
waves at velocities of about 600 m/s (roughly twice the speed of sound in
air), wet sand and clay at approximately 1500 m/s, and hard rocks much faster.
The shock wave itself may be produced by a number of methods, but most comm-
only by exploding a charge in a shallow hole, or by striking the ground with
a heavy weight.

The resulting wave travels in all directions out and downwards from
the source.  A wave transmitted through dry sand into a layer of wet sand
beneath it will travel faster in the latter.  Sensitive microphones placed
at known distances from the source each detect the various waves travelling
at different velocities through the various materials.  The times of arrival
of each of these at a microphone are recorded on photographic film in a
*seismograph*.  From this record geologists can calculate the velocities of
the waves and can estimate the depth to, and thickness of, various subsurface
layers.

*Electrical resistivity surveying* involves the measurement, on the ground
surface, of the resistance of the underlying earth materials.  Generally,
four metal stakes are placed in the ground and electric current applied ac-
ross two of them.  The voltage across the remaining two is measured, and the
resistance of the earth transmitting the current can be readily calculated.
By increasing the distance between electrodes the method 'feels' to greater
depths.  Experience has shown that dry sand has a higher resistance (*i.e.* is
a poorer conductor) than wet sand and clay.  Hard dense rocks also have a
high resistance.

Ideally, and commonly in practice, the geologist will use both the
direct drilling approach and the above indirect methods concurrently:  each
complements the other and aids him in his interpretations.

## EXTRACTING THE WATER

Once the presence of groundwater has been established, a decision must
be made as to the most appropriate method of extraction to be used.  Obviously
cost is an important item but other factors, such as the geological and

topographical conditions, ease of access, the quality and quantity of water needed and its intended use, must all be considered. A number of methods, described below, are available, and fortunately all but one are relatively inexpensive.

*Open excavations* such as dams and soaks are mainly confined to larger rural properties, and are dug by back-hoe or bulldozer to a metre or so below the water table. Generally they are used only for stock purposes. The method is probably the simplest quickest and least expensive available. However, shallow water table conditions are required and the soak may occasionally dry up because seasonal fluctuations in rainfall may cause the water level to rise and fall. Open pits in residential areas present obvious dangers to small children. In addition they are prone to pollution and the stability of their sides may often present a problem.

*Collector systems* may be more suitable. The method involves trenching into sand below the water table, laying agricultural piping or slotted plastic casing, and backfilling. A back-hoe is ideal for the excavation work, although problems will occur with running sand and a small pump may be necessary to remove excess water. Trenches may be as long as desired, or conditions permit, and any type of arrangement in plan is permissible. However, the trenches should be excavated below the summer water table level, and extreme caution is necessary in laying the pipes because of the very real danger of trench collapse. On completion, the water is collected in a sump (similar to a concrete-lined well) and pumped from it.

*Spear points,* which are in effect small-diameter wells, can economically deliver large quantities of water under favourable conditions. Each spear consists of an appropriate screen attached via galvanised iron riser and header pipes to a simple suction pump at the surface (fig. 39). Most spears are about 50 mm in diameter.

Because of friction losses in the riser and header pipes, the normal lift of a suction pump is about 4-5 m. If the water level is deeper than this, other types of pumps must be used.

Points are installed by hammering, jetting or with the aid of a boring plant to about 2-3 m below the summer water table level. Installation may be difficult, especially if small patches of clay or even clayey sand are present, and the job is made easier if an open hole is augered to the water table prior to lowering the spear point. Jetting involves forcing a high velocity stream of water down a pipe inserted in the spear and out of a self-closing valved bottom. The point is thus washed under its own weight into the sand. The jetting method is probably the easiest way of installing spears, but it involves purchasing a special point (available in Hobart) for the instrument, and having a pump capable of delivering about 400 *l*/m through a 12 mm jetting pipe.

The efficiency and yield of a spear point are determined by a number of factors, but the selection of the correct screen mesh size is critical. Ideally the mesh size should be chosen so that initial pumping removes about 50% of the sand from the immediate vicinity of the bore or spear. This creates a natural coarser-grained packing which filters the water and removes finer material from it. It is for this reason that the geologist obtains sand samples during his field observations, for only by analysing the proportions of various grain sizes within them can a suitable screen be selected. In practice the sample is dried, weighed and agitated through a series of different mesh sieves. The weight of sand retained by each sieve indicates the proportion of material of that particular size range present. The most appropriate screen mesh size can consequently be calculated.
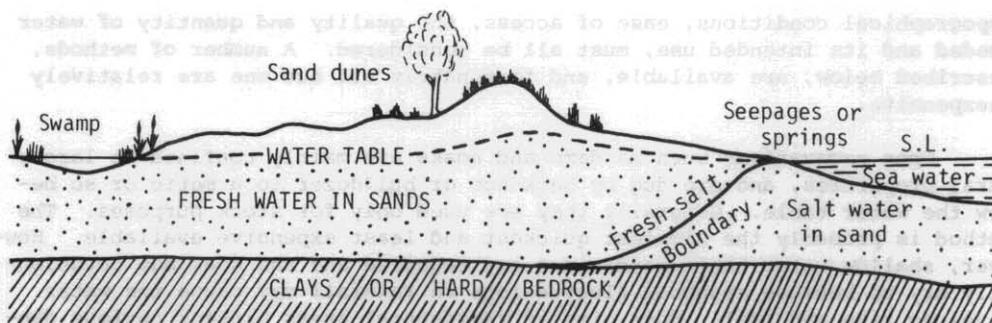
*(a)* Sand, saturated with fresh water to below sea level, and lying on impermeable clay or hard bedrock (*e.g.* Nine Mile Beach and parts of Seven Mile Beach).
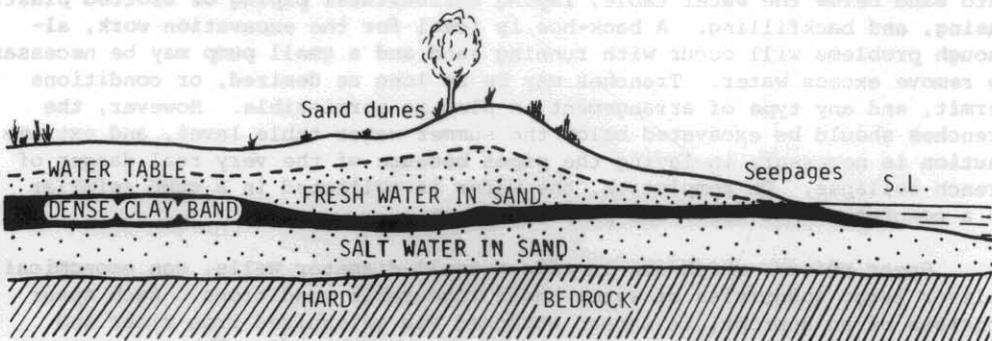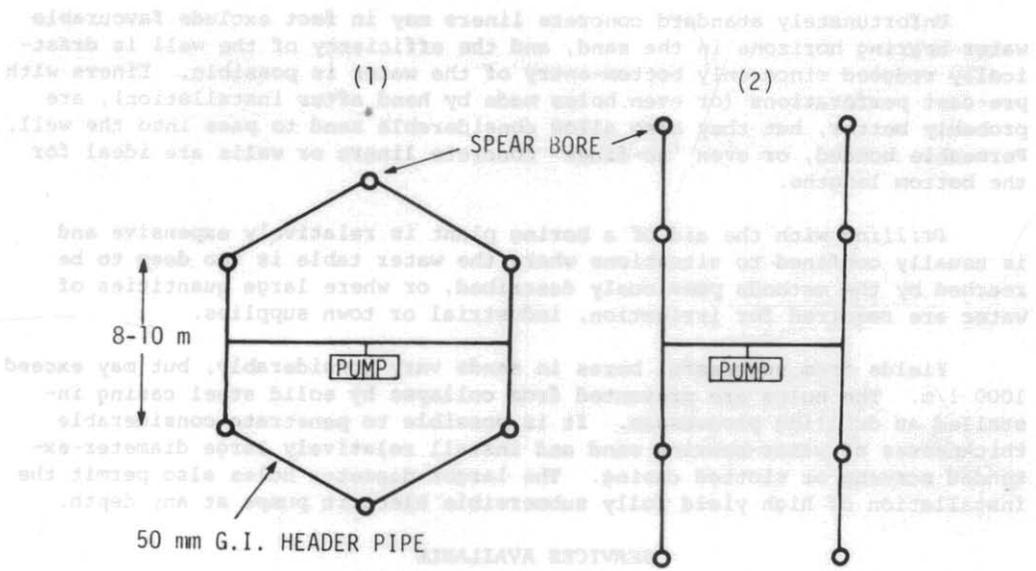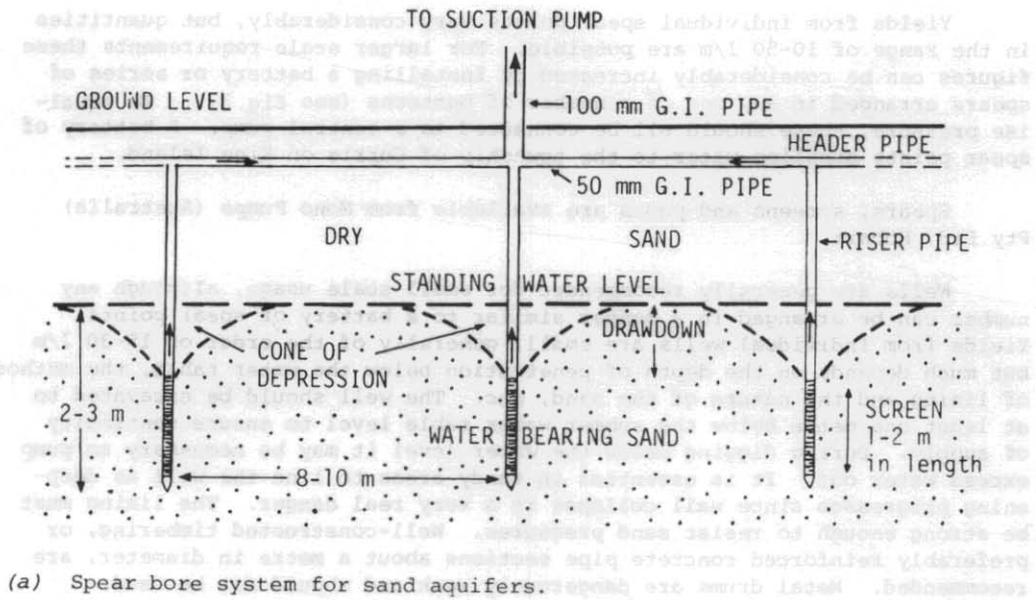


*(b)* Clay or hard bedrock may occur at sea level. Drilling through the clay layer may contaminate the fresh water above it (*e.g.* the western end of Seven Mile Beach).
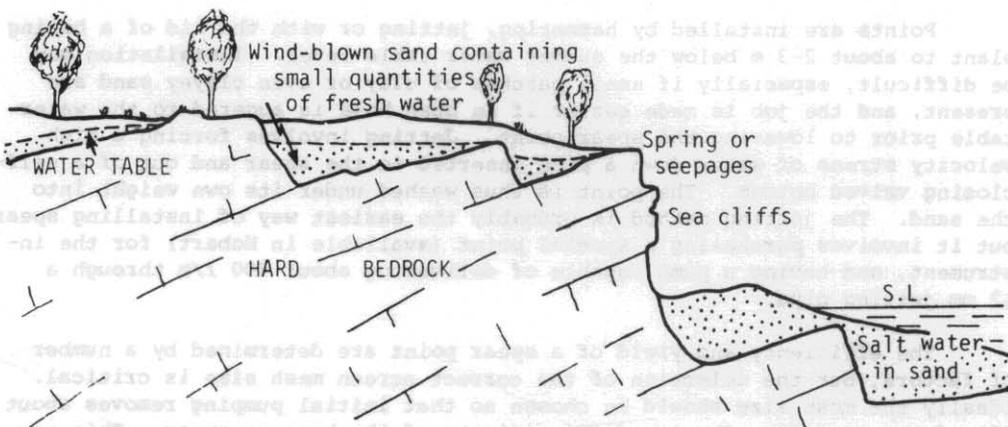


*(c)* Isolated pockets of windblown sand may occur well above sea level. Water yields are often small but may be sufficient for domestic purposes. This type of coastal situation is common in Tasmania (*e.g.* Carlton, Primrose Sands, South Arm).

Figure 38. *Groundwater conditions in some types of coastal sand aquifers.*

TO SUCTION PUMP

GROUND LEVEL

← 100 mm G.I. PIPE

HEADER PIPE

50 mm G.I. PIPE

DRY          SAND          ← RISER PIPE

STANDING WATER LEVEL

DRAWDOWN

CONE OF
DEPRESSION

2-3 m          WATER BEARING SAND          SCREEN
1-2 m
in length

← 8-10 m →

*(a)* Spear bore system for sand aquifers.

(1)                    (2)

SPEAR BORE

8-10 m

PUMP                    PUMP

50 mm G.I. HEADER PIPE

*(b)* Alternative arrangements for spear bore systems.

Figure 39. *Spear bore systems and arrangements.*

|← 5 cm →|

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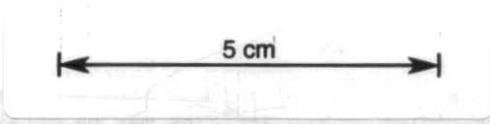
Yields from individual spear points vary considerably, but quantities in the range of 10-50 *l*/m are possible. For larger scale requirements these figures can be considerably increased by installing a battery or series of spears arranged in any one of a number of patterns (see fig. 39). To equalise pressure, these should all be connected to a central pump. A battery of spear points supplies water to the township of Currie on King Island.

Spears, screens and pumps are available from Mono Pumps (Australia) Pty Ltd, Hobart.

*Wells* are generally recommended for small-scale usage, although any number can be arranged in a manner similar to a battery of spear points. Yields from individual wells are small, generally of the order of 15-30 *l*/m but much depends on the depth of penetration below the water table, the method of lining and the nature of the sand, etc. The well should be excavated to at least one metre below the summer water table level to ensure continuity of supply. During digging below the water level it may be necessary to pump excess water out. It is essential in sandy areas to line the well as deepening progresses since wall collapse is a very real danger. The lining must be strong enough to resist sand pressures. Well-constructed timbering, or preferably reinforced concrete pipe sections about a metre in diameter, are recommended. Metal drums are dangerously weak and should not be used.

Unfortunately standard concrete liners may in fact exclude favourable water bearing horizons in the sand, and the efficiency of the well is drastically reduced since only bottom-entry of the water is possible. Liners with pre-cast perforations (or even holes made by hand after installation), are probably better, but they also allow considerable sand to pass into the well. Permeable bonded, or even 'no-fines' concrete liners or walls are ideal for the bottom lengths.

*Drilling* with the aid of a boring plant is relatively expensive and is usually confined to situations where the water table is too deep to be reached by the methods previously described, or where large quantities of water are required for irrigation, industrial or town supplies.

Yields from successful bores in sands vary considerably, but may exceed 1000 *l*/m. The holes are prevented from collapse by solid steel casing installed as drilling progresses. It is possible to penetrate considerable thicknesses of water-bearing sand and install relatively large diameter-extended screens or slotted casing. The larger diameter holes also permit the installation of high yield fully submersible electric pumps at any depth.

## SERVICES AVAILABLE

The Department of Mines is actively engaged in underground water investigations in coastal sands. Advice on groundwater prospects is provided free of charge to the public. An enquiry on such a matter to the Director of Mines results in a visit from a geologist who will make an on-site assessment of the situation. A typewritten report containing recommendations and other relevant information is provided to the enquirer.

## FURTHER READING

The Department of Mines library contains a number of published and unpublished reports concerning groundwater investigations in coastal sands in Tasmania. Some of these are listed below. They are available for reference reading only. Xerox copies of the articles may be obtained at the prices indicated.

LEAMAN, D.E. 1972.  Underground water resources, Arm End-Gellibrand Point, South Arm.  *Tech.Rep.Dep.Mines Tasm.* 15:129-132. [60¢].

LEAMAN, D.E. 1973.  Underground water prospects from unconsolidated aquifers in the George Town area.  *Tech.Rep.Dep.Mines Tasm.* 16:216-217.  [12¢].

MATTHEWS, W.L.; CROMER, W.C. 1973.  Groundwater investigations at Currie, King Island.  *Unpubl.Rep.Dep.Mines Tasm.* 1973/94.  [$1.68].

CROMER, W.C. 1974.  Groundwater prospects, Greens Beach.  *Unpubl.Rep.Dep. Mines Tasm.* 1974/32.  [60¢].

STEVENSON, P.C. 1973.  Water in coastal sands.  *Tasm.J.Agric.* 44:182-185. [Reprints, ref. 31/73, obtainable from the Department of Agriculture].

[12 July 1974]