15th February, 1963
G.S. 2544
DM.1221/62
HYD. 1420
Rept. Bk. 56/34
RB 56/34

THE PRESSURE WATERS OF THE LOWER SOUTH EAST

by

Eugene P. O'Driscoll, B.E., M.Sc., A.M.I.E. Aust.
Senior Geologist, Hydrology
Department of Mines, South Australia

Some thirty five years ago, wildcat drilling by small oil exploration companies proved that good quality water existed in deep sandbeds in the area east and south of Kingston S.E. Indeed some of the bores are flowing at the present time, and it may seem a little surprising that no local interest was taken in the irrigation possibilities they afforded, and for many years no attempts were made to exploit the pressure water by further drilling.

The area over which this good quality pressure water occurs is quite extensive, including as it does most of Hundreds Lacepede, Murrabinna, Minecrow, Woolumbool and Lochaber in Count Macdonnell, and the western two-thirds of County Robe. It does occur farther south, but is probably not worth drilling for both, because of its great depth, and because large supplies are usually obtainable at shallower depth from the Gambier Limestone. It also occurs farther east, but in this area also is not regarded as a source of irrigation water because the gradually rising land surface reduces the flows available, until in the more easterly districts the water does not flow at all, but has to be pumped, rendering its use relatively uneconomic. Also, once again, large volumes of water are available from the limestones at much shallower depth.

Water bearing beds

(1) The deep sands

It should be explained that in almost the whole of Counties Robe and Grey and the extreme southwestern corner of County Macdonnell there are two separate water-bearing beds.

The older and deeper of the two is known to geologists as the Knight Group sands because these particular beds are exposed at the surface in Knight's Quarry near Mt. Gambier, where they have been examined and described. They are very near the surface in the vicinity of Great Dismal Swamp area Penola, but Knight's Quarry is the only place they can be actually seen. The sequence is a quite thick waterwashed sand laid down under water, probably in an alternatively fresh and salt water lake which gradually filled up until it became a shallow swamp with plants and waterweeds growing in it, and around the edges. The result is that the topmost beds of the Group are lignitic clays and peaty silts with shells, pyrite, and large grit grains. This upper section may be as much as a hundred feet in thickness and is known locally as "the black clay". Sometimes it is absent, as may be the case near Kingston. It acts as a seal bed, confining under pressure the water which occurs in the sands below.

The Knight Group sands usually do not occur in most of the central and western parts of County Macdonnell, because when they were being laid down under water, the bedrock floor there was much higher, forming a chain of islands on which no sands were deposited.

Nor do we know for sure what was the quality of the water they originally contained, although it was probably fairly saline. At various levels in the sands, minute sea shells are found, suggesting that the sea occasionally invaded the lake. This would have turned the lake water salty, and as the lake filled up and the sands became thicker and thicker, they would have been completely filled with salt water.

Why then, should this water now be fresh? Well, the answer is simple, although a lot of investigation was needed before it was known. The sandbeds are in a huge saucershape, with the edges tilted up near to the surface, where fresh surface water can percolate downwards into them. This fresh water has for many centuries been working its way downwards and sideways, pushing out the original salt water as it does so, the salt water moving gradually ahead and escaping at outlets now under the sea. The process is now so complete that very little of the original salt water is left, except in backwaters from which it cannot be displaced because there is no outlet. One such backwater, enclosed on three sides by a bedrock high, is in southeast Hundred Marcollat and parts of the adjoining Hundreds Woolumbool and Glenroy.

There are several intake areas. Some, for certain, are in Victoria. Another is in the Great Dismal Swamp area, and another is a buried one in Hundreds Peacock and Minecrow, where water from the surface drains is believed to percolate down to the shallower bedrock and flow sideways over it until it reaches the edges of the sandbed, into which it flows.

All these intakes are at levels well above the low inter-dune flats to the westward where the present flowing bores are drilled, and their difference in level provides the pressure that causes the water to flow.

It follows, of course, that the lower the area where a bore is drilled, the bigger will be the flow, because the pressure difference is greater. That is why one should not drill on a ridge, where the elevation may be high enough to bring the borehead above the pressure level of the water, so that the bore will not flow or if it does, will flow in very small supply.

(11) The shallow limestones

After the deposition of the black clay described above (which incidentally looks very oily, although it is not, and has in the past wrongly raised the hopes of persons following the operations of wildcat drillers) the area was inundated by a shallow sea in which enormous numbers of little organisms called bryozoa (or "coral") lived and died, their skeletal remains accumulating on the bottom in great thickness, and forming the Gambier Limestone, which of course is very permeable and originally contained sea water. The sea became shallower, and culminated in the area rising gradually above sea level and forming a succession of shore lines, one after the other, each one to the westward being lower than the next one eastward.

A lot of beach sands and shallow sandy limestones were deposited above the underlying Gambier Limestone so that now we have several hundred feet thickness of sands and sandy limestones with th Gambier Limestone or its equivalents at the bottom, then a black cla sequence, and under this the Knight sands.

The picture is not quite as simple as it sounds, because with shallow water or shoreline deposition it is quite common for swamps to form, and in fact there are places where swampy sediments, sometimes black peaty silts, do occur in the limestones.

Also the Gambier Limestone itself changes in character, and as a result of environmental conditions may not be a cream limestone

Kingston?

at all, but a green marl, for example, as happens near Kingscote.

The important thing is that the shallow limestones (which may be several hundred feet thick in, for example, Hundred of Waterhouse, contain different water ~~growths~~ from the deeper Knight Group sands. Mostly, it is not under pressure, and is derived from local intake from rain, surface drains and swamps. The volume and the quality of this intake controls the groundwater salinity. In some areas, such as Hundreds of Lacepede and Murrabinna, saline swamps have caused almost all the limestone waters to be salt, in many cases too salty even for sheep.

In this the limestones contrast with the underlying Knight sands, the quality of the waters found in them varying quite strongly over short distances because of local differences in surface intake, whereas the pressure waters in any one locality normally show very little variation in salinity.

The limestones have another characteristic not shared by the sands. Lime, as we all know is fairly soluble, and it is not uncommon to find that surface water percolating down into the limestone will gradually dissolve away the sides of the cracks and joints down which it is percolating. The groundwater itself, particularly where its level fluctuates seasonally, may also have a solvent effect, and in some places caverns gradually form as a result. The larger ones (known in South Australia as "runaway holes") may later become blocked with clay and form swamps, such as many of those small circular ones in Hundred of Comaum, but this is only a local blockage, and below the surface an inter-connecting cavern system still exists. Bores drilled in such neighbourhoods may intersect solid limestone all the way, and be comparative failures, which other bores may intersect a cavern below the level of the water table and obtain a large supply. This is impossible to predict.

However, although such caverns may exist anywhere, usually their local presence is suggested by the existence of small circular depressions in the natural surface, readily visible on aerial photos even when not very apparent on the ground itself, and where possible, drilling for large irrigation supplies in the limestones should be confined to such areas.

Landholders in the Lower South East are particularly fortunate in that so many areas have large supplies of good quality groundwater readily available.

Groundwater may be expected to have a constant salinity and temperature, it is often available by drilling a bore on whatever part of a property it is needed most, there are no water rates to pay, and the landholder has to meet charges only for what he actually uses.

However, there are other factors which must be considered. A question often asked is "What long term effect will be caused by all this pumping? Are supplies going to drop off?"

The answer is in two parts. In the writer's opinion, pumping from the shallow limestones will in general not cause a significant long-term decrease in available supplies. In some areas it may, but generally the intakes are huge, and a lot of the pumped water is coming from shallow depth and is only being re-circulated anyway.

Pressure waters from flowing bores drilled into the Knight sands in, for example, the Kingston district, will decline in level and in supply.

What may not generally be realised by landholders is that when an artesian bore is first drilled there is a "flush flow" which may be very large, and may continue for quite some time. However, it will gradually decrease, a process which may take a number of years, until it stabilises at a much smaller flow which will continue indefinitely unless other bores are drilled nearby which affect it.

The rate and amount of decline depend on several factors which cannot be fully known in advance, one being the amount of compaction which the sands in the water bearing bed will undergo because of the activation in hydrostatic pressure. But the characteristic shape of the curve, when yield is plotted against time, does not vary - a relatively quiet decline at first, gradually flattening out to a stable value. Fig. I shows the usual type of flow curve, and Fig.II a curve from a bore which, after flowing for some time, is adversely affected by a new bore nearby.

The phenomenon has been very aptly likened to a rubber bladder full of water, from which the water is escaping through the teat.

There is a finite limit to the amount of water which will flow from bores in the deep Knight sands, and once this limit has been reached, the total discharge from all bores will gradually lessen, no matter how many bores there are.

It is, therefore, important that no flows be wasted, because every gallon wasted now is really being lost, not by the individual bore owner, but by all the surrounding landholders.

There may be, and probably is, a very large quantity of water available, but landholders who flood irrigate their pastures also use large volumes. If the water is wasted or used unwisely the time is merely being hastened when the total flows available will not be enough for all, and the bores will have to be pumped. Pumping is expensive, and if and when it becomes necessary, the irrigated areas will have to be very substantially reduced.

The rate of decline of the present flows may not be large, although it will increase as new bores are drilled. It can be measured, and the measurements will tell us just what is happening, so that the future can be predicted. Once the behaviour of the pressure waters is established, landholders will be in a position to calculate the economics of drilling and of farm lay-out for irrigation, balancing capital outlay against prospective returns, the latter being dependent not only on the water available at the start, but on the number of years a usable supply will continue to be available.

The Department of Mines is now proposing to establish a gauging unit, which will read the flows and pressures of a selected grid of bores, and enable the future of the pressure water supply to be predicted with some certainty. The work will take several years for results to become apparent, and will be continued probably for many years. Unfortunately, not all bores can be gauged, because some have been poorly or improperly constructed and cannot be closed down even temporarily.

<u>Bore Construction</u>:

This raises the whole question of proper drilling practice. Drilling a bore may cost a landholder anything up to £1,000, and the landholder should see that this money is spent to the best advantage. There are various points to consider, if we propose to have a bore drilled for you.

First engage a reliable contractor, preferably one who has an established business in the district and a good operational record. He should know his business, because you, the landholder, do not know the mechanics of drilling, and you have to rely on his advice. A skilled driller is entitled to good pay, and at the start it should be clearly understood between you just what you expect him to do, and what he expects to be paid. In other words, have a contract, even if only by word of mouth, preferably with a witness.

Six inch casing can be used, but eight inch is better because if and when a pump has to be used in the bore, you can pump a larger supply. Actually, the free flow from an 8 inch bore, without pumping, is very little larger than that from a 6 inch bore. The difference comes when a pump is used.

The bore should be drilled straight. This is where you have to rely on your driller, and the straightness is very important if a pump is to be used. An artesian flow from a crooked bore is just as much as from a straight one. But if you have got a bore shaped like a corkscrew, no spindle-type deep well turbine pump will operate properly in it.

The casing should in all cases be taken down to below the depth where a pump will be set. In actual fact, all bores should be fully cased, but the above is the irreducible minimum.

In the Kingston district where bores are drilled into the sands, it is, of course, quite necessary to case bores for the full depth, although it is known that this has not always been done in the past.

There are several reasons why these bores should be properly cased.

Firstly, they probably cannot successfully have closing valves fitted and the flows shut down when not being used, if only partly cased. At least one bore is known in which, when the valve is closed, the water bubbles up through the soil surrounding the bore, a state of affairs which should never be permitted.

Secondly, the sands and gravelly sands that form the water-bearing bed are often loosely consolidated and tend to "blow" up the bore, especially if a pump is used. The proper method of developing a supply from these sands is by use of a screen. If one is not used, there is always a danger of aquifer collapsing either all at once, or progressively over a period, in which case of course, the bore becomes unusable, and usually cannot be restored.

Some contractors have not learned the proper techniques needed for sampling the sands, deciding on the screen mesh openings, and inserting the screen - a procedure which is not difficult but involves a certain amount of "know-how." Also, since screens are fairly expensive, landholders are often only too easily talked into not insisting on one being used.

This, in my opinion, is a serious mistake, which is sometimes costly in the future, even if not immediately. Look at it this way. If a landholder merely agrees with a driller to have a bore drilled "down to the water bearing sands," all the driller legally has to do is drill to the required depth and insert such casing as is needed for the hole to stay open. Whether there is or is not a properly developed water supply from the bore does not really matter, provided there is some water in the hole. If the sands collapse after he leaves, that is your fault for not insisting on proper construction methods, not his.

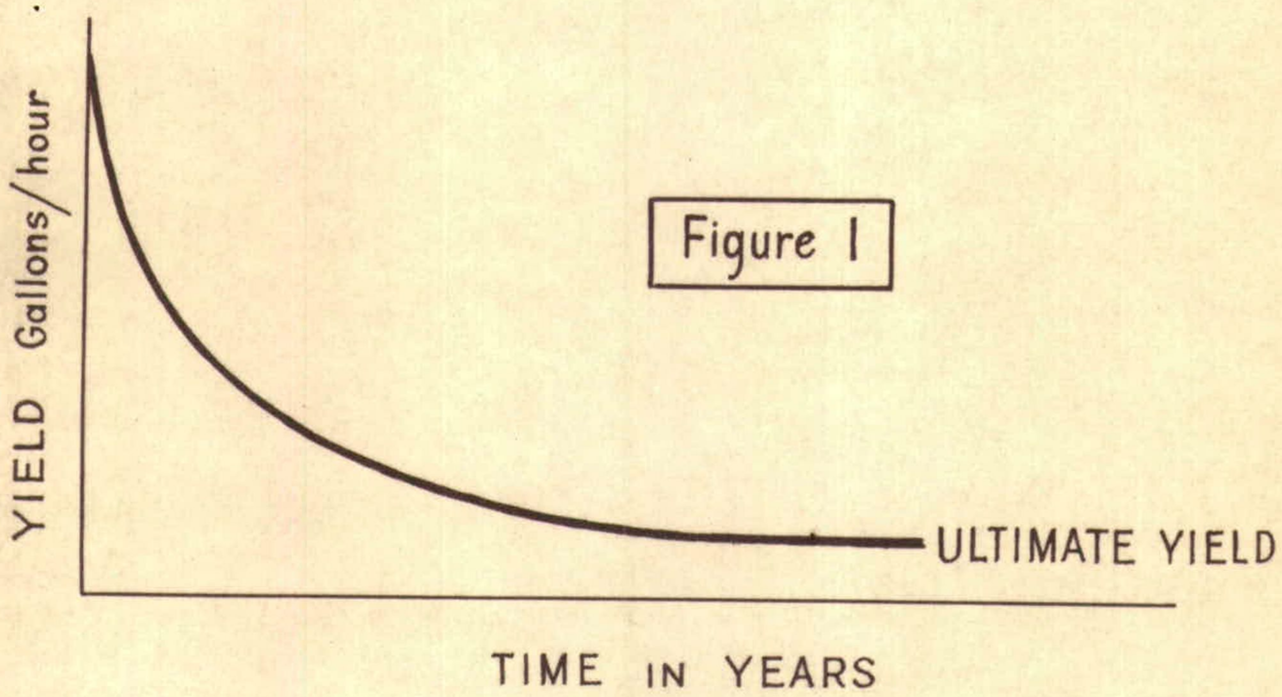
But if from the outset the driller has agreed to sample the sands for size grading, insert an appropriate screen, and develop the supply properly, both he and you know what is to be done, and have the satisfaction of seeing a good workmanlike job through to a satisfactory conclusion. Cutting down on construction costs by using not enough casing, or refusing to let the driller use a screen (if needed) because of expense, is false economy.

So far as is known, no artesian bores in the Kingston district have been pressure cemented, although this is compulsory for artesian bores in other Australian States. It is not a technique familiar to most contractors, and involves a fair amount of expense. It is the only satisfactory way of handling bores that have water flowing up outside the casing, and is something that may have to be insisted on in the future, as a measure to preserve the pressure supplies for as long as possible.

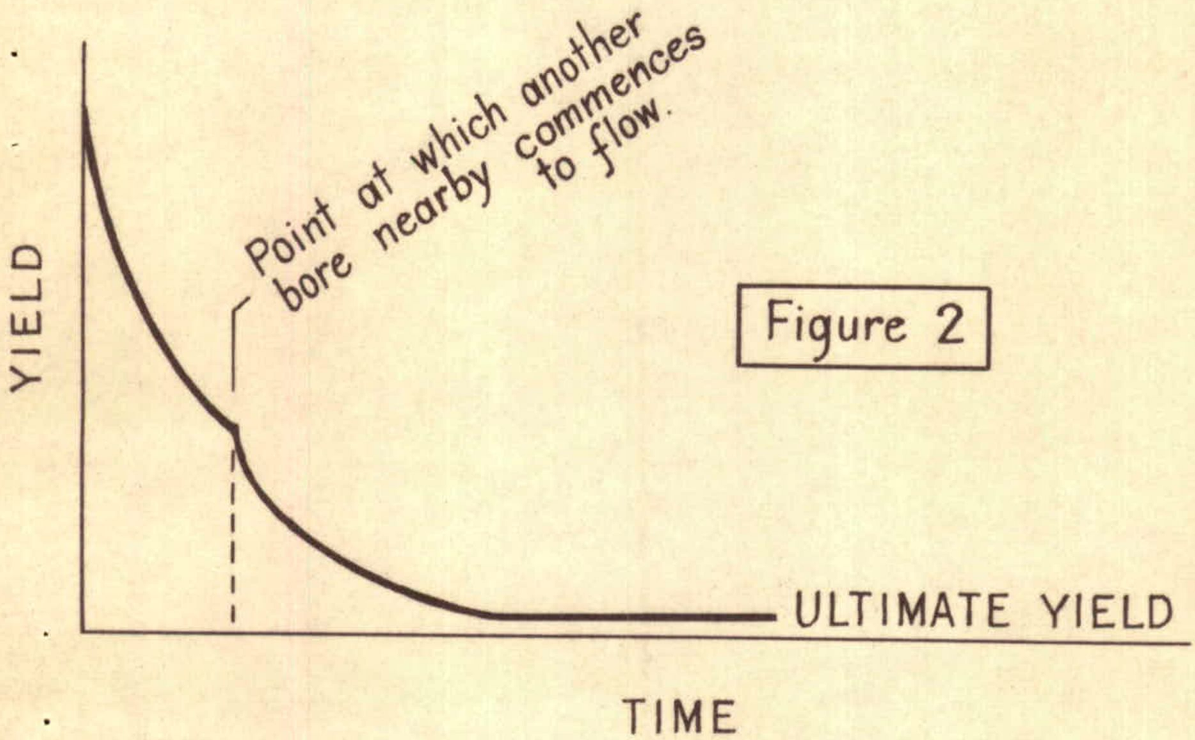
One final word of caution to landholders. If you want a flowing bore, drill at the lowest possible site on your property. Every foot of extra surface elevation takes a foot off the pressure head at the bore. And remember that while for a start there may be enough flow to flood irrigate, in a few years time there will be a lot less water available, perhaps not enough for flooding.

When that time arises, either a spray irrigation system has to be bought, or the bore written off as of no further irrigation use. In the latter case, it will need to have paid for itself with the flood irrigation accomplished during its working life.

To accompany article by E. P. O'Driscoll in Agric. Journal.



DIVIDE HERE FOR TWO BLOCKS ←



Reduce to column width