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Groundwater in the wheatbelt

by E. P. O'Driscol, Chief Hydrogeologist, Geological Survey of Western Australia

The source of all underground water in the wheatbelt, and indeed everywhere in the State, is rain. By international standards four-fifths of W.A. is either arid or semi-arid, and half of the remainder is in the Kimberleys.

Much of the wheatbelt, with an annual rainfall of less than 380 mm and evaporation exceeding 1.5 metres is semi-arid, but how and when the rain falls are important.

Ours is a high winter rainfall with dry summers, a great advantage over agricultural areas in the eastern states which have a high proportion of summer rain.

Groundwater occurrence

In general, six factors affect the occurrence of groundwater; rainfall, topography, rock type, rock structure, vegetation, and local evaporation.

Variation in even one of these can affect the potential yield of a bore or well, the groundwater salinity, and even whether any groundwater occurs at all.

There is a common misconception that groundwater flows in underground streams, although more usually it saturates a whole layer of rock, so far as possible, through which it very slowly moves downhill.

Even in clean, permeable sands, the rate of movement is generally only a few metres per year, and in the rather impermeable sandy clays of the wheatbelt the rate is even slower.

It is true that the water moves much more readily through some parts of a rock mass than through others. For example, a layer of sand or gravel is much more permeable than a clay; and hard rocks are usually intersected by numerous cracks or joints through which water can move, even though these are mostly blocked or partly blocked by clay.

Our wheatbelt is underlain by very ancient (Archaean) rocks which have been so compressed and distorted by crustal movements, and so changed by weathering, that the original rock types usually are not determinable. What we now have is loosely called...
granite or granitic gneiss. This has been intruded by dolerite (blue metal) dykes, now forming long narrow vertical walls of hard blue grey rock. We refer to all these rocks as “basement” or “bedrock”.

The upper part of these rocks has been for a very long time so exposed to rain, percolating water, frost, wind and weather that the minerals have decomposed and changed in form. The hard basement is now covered by a blanket of weathered material rarely more than about 40 metres thick.

From the surface downward this blanket comprises a thin covering of sand; a laterite or ironstone gravel never more than 5 metres thick and usually much less; then a red brown dense clay a few centimetres to a metre or two; and then the “pallid zone” comprising clays and sandy clays we know as kaolin.

This pallid zone may be as thick as 35 metres or so, and although relatively impermeable, it is capable of allowing a little surface rainwater runoff to penetrate downward through it, particularly when intersected by relict joints and cracks with a quartz infilling.

Some tree roots go far downward into this zone, from which they can extract water even though to us the clayey material may seem dry.

The kaolin rests either directly on hard basement or partly weathered basement, although there may be a thin intervening zone of angular quartz and feldspar known to drillers as “the gravel”. It is not always present, but where it does occur it is quite permeable and often produces good water supplies when drilled. For this reason drilling should always go as deep as the basement rock, unless salty water has already been intersected.

Drilling into hard rock

When the type of drilling equipment available will permit, a dry bore should continue into the hard rock for some distance, but in general not into more than 10 metres of hard rock and not to an overall greater depth from the surface than about 40 to 45 metres.

The purpose of drilling into the hard rock in an otherwise dry bore is to try to intersect the more or less flat-lying sheet joints that sometimes form in the hard rock by removal of a weight of overlying rock by weathering and erosion. Because compressed air will force cuttings sideways into the cracks and block off any small water supply, any bore drilled into hard rock should be thoroughly flushed clean before being abandoned as dry.

Previous drought relief drilling

During the Government’s drought relief drilling program of 1969-1970, drilling was always continued into the hard rock unless there was some reason not to do so.

Drilling was restricted to fifteen poorly-supplied areas, usually those with lower rainfalls, and often to properties where previous drilling had been unsuccessful, or to sites where chances of success were remote. Despite this the drilling did show up differences in prospects of obtaining groundwater in the various districts.

South Yilgarn provided only one successful bore out of 106 (less than 1 per cent), and Mount Marshall-Koorda provided only ten out of 166 (6 per cent).

On the other hand North Stirling had a 25 per cent success rate and Holt Rock 21 per cent. That these differences are caused by factors other than rainfall was evident from the results of Government drilling in the Kalannie district in the 1950’s, where one tract of country was found where almost every bore was a failure, although results in nearby areas were reasonable.

Origin of the salt

About two-thirds of the salt in groundwater is sodium chloride (ordinary table salt). This is not dissolved out of the mineral in the rocks, but comes from the rainwater itself, which contains the same proportion.

Only a little of the rainwater soaks downward below the surface, where it provides moisture for the tree roots which remove the fresh water but leave the salt behind.

As more and more water is removed, the remaining fluid increases in salinity until even the trees cannot use it.

Unfortunately, this salinity limit is too high for stock use. Some salts such as fluoride, lime, iron, gypsum are of course dissolved out of the rocks, as well as a little sodium chloride, but the rocks are not only deficient in chloride-bearing minerals, but the very soluble chlorides have already been dissolved and flushed out.

Effect of vegetation

The native vegetation which has developed over millions of years and adjusted itself to local conditions can be expected (before the land was cleared) to use all the surface and underground water available from the average rainfall in a year.

This suggests that downward percolation of water past the root zone is likely only in more than usually wet seasons, which are fairly infrequent. Frequent replenishment should keep the groundwater fairly fresh, and probably the brackish water so often obtained from bores is fairly old.

As the groundwater moves downslope away from an intake area its salinity increases. This is why a bore high on a gentle slope, or on a broad hillslope, may have fresher water than one farther downslope.

In “breakaway” country, for example, it is safer to drill on the gentle backslope within 0.5 km or so of the crest, rather than right along the foot 1.5 km away where there may be a more permanent supply, but the water is likely to be more saline.

Water in sand

Some areas are fortunate because gentle slopes may be covered with beds of sand 3 metres or more in thickness. These readily soak up and store the rainwater, often providing a supply of fairly fresh water for a well or a trench. Such sand beds are known in areas such as Dale River, Gabbin, Coorow, and Yerecoin, for example.

Very deep sand plain country, however, may not provide usable supplies of groundwater unless
there are relatively shallow (less than 50 m) layers of clay to support a groundwater body.

Another type of sand occurrence is the fringe of sandy and gritty material often found encircling or close to a bare granitic rock outcrop. The bare rock sheds all its rainwater into the surrounding soil, from which low-salinity supplies can often be recovered at shallow depth. However, the water level may decline and the supply may become smaller in dry seasons.

**Hard rock supplies**

Sometimes a bore into hard rock will give a much larger supply than usual when tested. There is always some geological reason for this, although it is not always apparent.

However, pumping at a high rate is a temptation to be resisted unless you are reasonably sure the rate can be maintained. It is often the cause of the rocks becoming dewatered and the supply failing. In such a case the supply may eventually be re-established if the bore is rested for a number of years to allow recharge from rainwater to build up.

**Drilling for water**

Five types of drilling rig are commonly used in drilling for water.

- **Auger.** This will detect any shallow water but will not go through boulders or anything very hard. Its use is therefore restricted.

- **Percussion cable tool.** This is the most common type of rig, at least until recently. Comparatively slow but sure, the drill will detect any water intersected and enable a sample to be collected for testing. Depth range is extensive depending on the plant, but 100 to 150 metres is usual. It will not drill into very hard rock.

- **Down-hole hammer drill, using compressed air.** This will drill quickly even in hard rock, but tends to force pulverized rock particles into the water bearing cracks or openings and block off the supply. Always have the driller spend some time pouring in water, and

The “blanket” of weathered material typical of wheatbelt soils
surging and washing to clear out this debris and restore the supply. The heavy plant is likely to become bogged in wet soil. It may have difficulty in drilling through damp clay.

- Rotary mud drill. This is best used for deep artesian or pressure-water bores in sediments such as the Perth Coastal plain, but can be used in hard rock or clay. Tends to “mud-off” small supplies, so that the bore has to be “developed” that is, cleaned out before use.

- Diamond drill. The small diameter hole is for exploration only, to determine the depth to hard rock and the presence and salinity of water. Usually the cheap scout bore is then redrilled to obtain a water supply.

The contractor has his living to make, and cannot be expected to drill on a “no water, no pay” basis.

If possible, engage a reliable local contractor with a suitable rig, or one whose work is known in the district to be satisfactory. Have a contract (which can be by word of mouth if there is a witness) with him, so that you both clearly understand what is expected. It is best in writing.

This contract should specify:

- Latest date of completion.
- Establishment cost. The contractor has to bring in his plant and set it up.
- Rate per metre charged for
  — drilling uncased bore
  — supply of casing—6-inch (152 mm) or 5-inch (127 mm) are the usual sizes
  — slotting and insertion of casing
  — supply and placing of extras (if used) such as screen, gravel pack
  — developing and testing the supply
  — drilling a straight hole. The pump rods in a crooked hole will break continuously, and you are required to pay only for a satisfactorily straight hole, provided the driller knows of this condition.
- Any water supply reported by the driller as probable should be tested continuously for at least 4 hours using a plunger-type or other pump, not the bailer. Time the pumping rate into a tank or 200 litre (44-gallon) drum. A short bailer test is of very little use.

The driller should provide the pump unless otherwise agreed, but is entitled to charge for his time and equipment.

- Delays caused by plant breakdown are not charged for. Waiting time while the driller obtains a screen (or meets some unexpected requirement) should be at a reduced rate as the plant is not working.

- Don’t agree to gravel packing in the clayey soils usual in the wheatbelt. To be effective, only a very fine sand should be used.

- Before buying your pumping equipment, have the water salinity tested. It may be saltier than you hope.

It is quite unusual in the wheatbelt for a bore to provide enough water to irrigate a sports oval or school ground, or to sustain a swimming pool. Furthermore, the groundwater salinity is usually too high for plant use.

Advice on choosing a bore site

Far too much money is wasted by landholders drilling on unsuitable sites. In the wheatbelt, nobody can really be sure of what is underground, but you should remember that the usual result of random drilling is salty water in small supply.

The Geological Survey specialises in inspecting properties and advising the owners on what the prospects are thought to be. A written report is made, and the charge to the landholder is currently $25, a nominal fee designed to discourage frivolous requests.

There are also several consultant hydrogeologists in Perth, whose services may be retained at fairly short notice.