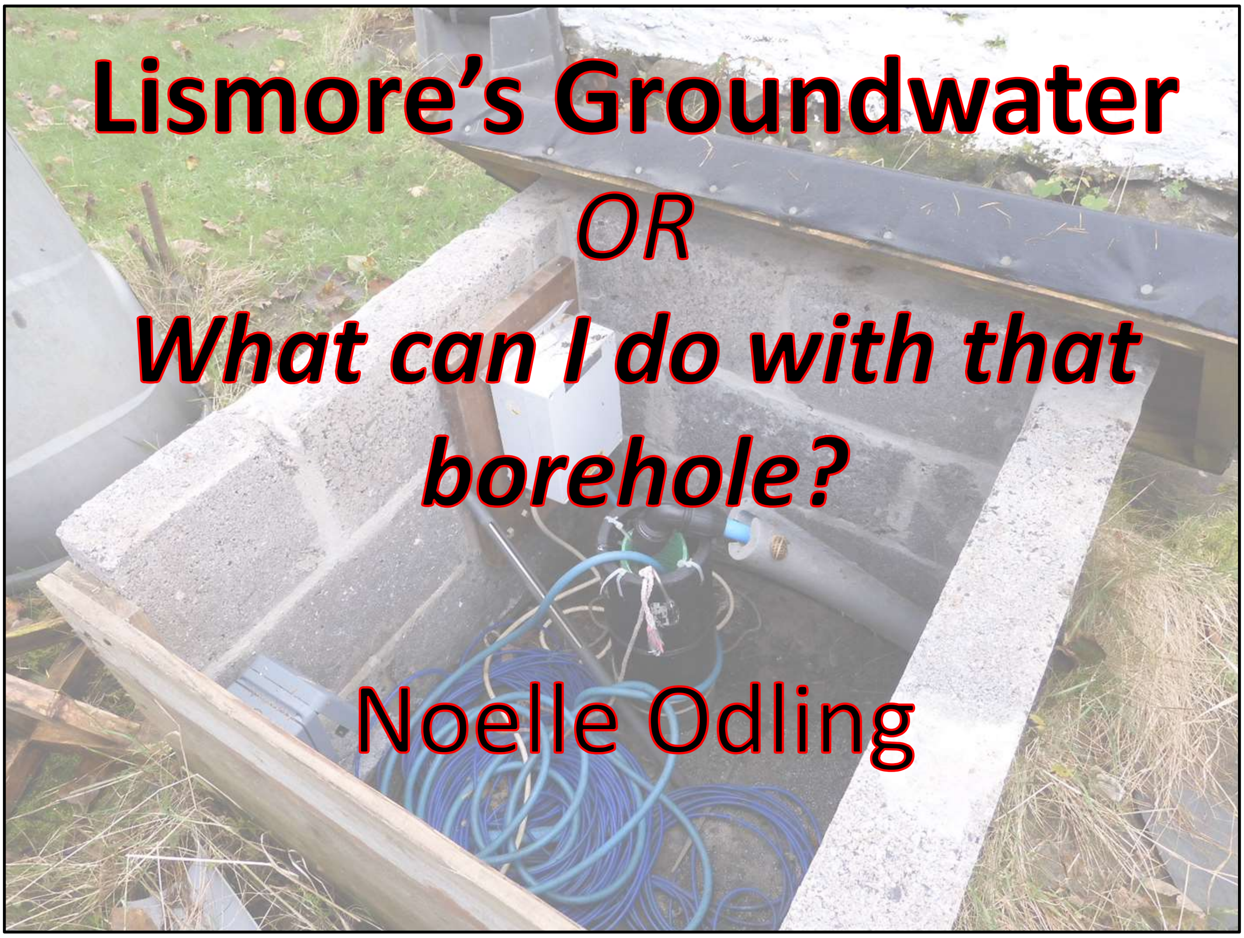


The last three summers have been good and last summer (2021) was very dry right up to the second half of September. Everyone on Lismore has a private water supply mostly from a well situated on a reliable spring. Many people on the island had water supply problems towards the end of the summer of 2021 and many others were very conservative in the use of water because of concerns over their water supply. Now people from the Glen Sanda quarry are coming in the summer of 2022 to drill more boreholes on the island for free – a tremendous offer to the people of Lismore. Glen Sanda have been over to the island to drill boreholes a number of times in the past.

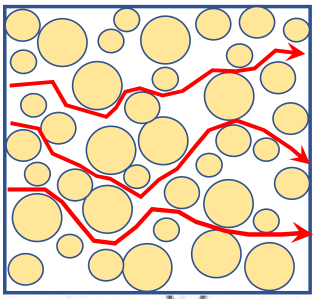
It seems of good time to give a talk about the groundwater resources of Lismore and about the use of boreholes to provide a domestic water supply.

A little about my background – I am a geologist and latterly a hydrogeologist (the geology of groundwater resources). I ran the MSc in Hydrogeology at the University of Leeds for 8 years. My research topic for many years was flow and contaminant transport in fractured rocks.

A FEW BASIC PRINCIPLES

We start with a few basic principles before moving on the talk about the groundwater of Lismore.

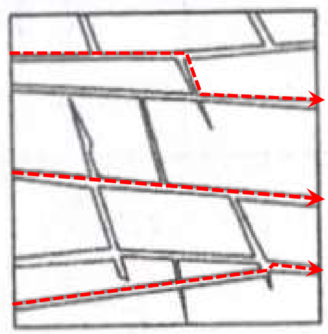
What is an Aquifer?
Types of Aquifer



POROUS SEDIMENTS AND ROCKS

Groundwater stored between grains
- flow through pore space

Generally **GOOD** aquifers



FRACTURED AQUIFERS

Rock impermeable – no flow
Fractures open
– provide storage and allow groundwater flow

Wide range from **GOOD** to **POOR** aquifers

What is an aquifer?
An aquifer is a rock or sediment in the subsurface that can store groundwater (i.e. is porous) and which allows flow of ground water (i.e. is permeable). If you can extract water from a borehole in rock/sediment then that rock/sediment is an aquifer.

Types of aquifer:
1) **Porous sediments and rocks:** These include sands, gravels, sandstones. Groundwater is stored in the pores and can flow through the sediment/rock. These can form very good aquifers.
2) **Fractured aquifers:** Here the rock/sediment is itself impermeable and does not allow flow. But the presence of fractures generates both porosity and allows flow of groundwater. An important example is fractured limestone but can also includes fractured sandstones and fractured crystalline rocks such as granite and gneiss. Fractured aquifers cover a wide range of aquifer quality from good to poor , but mostly form less good aquifers than porous sediments and rocks.

Groundwater and the Hydrological Cycle

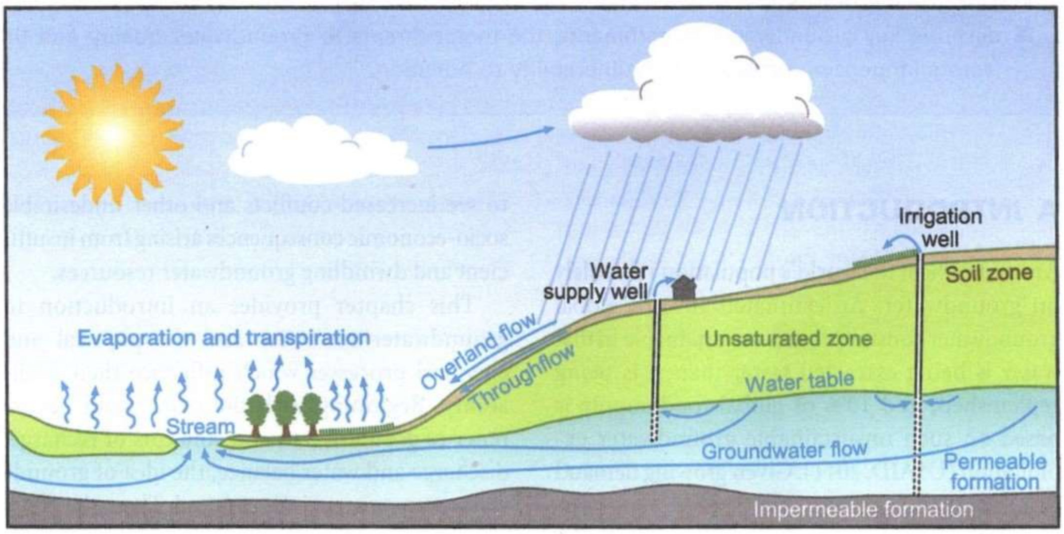


Figure 5.1 Role of groundwater in the hydrological cycle.

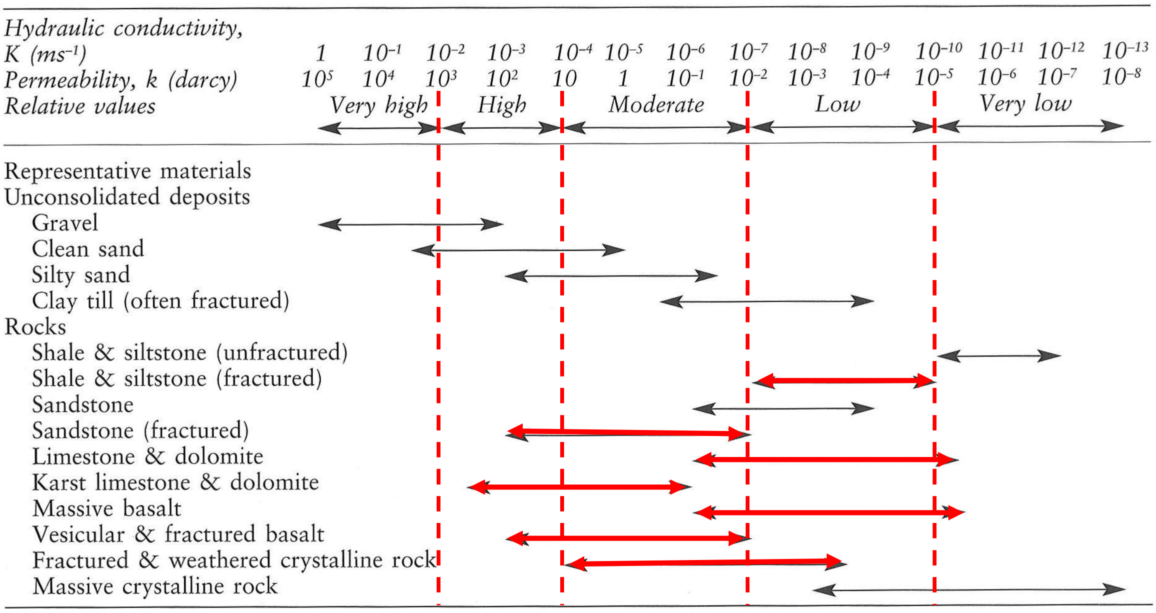
Water Resources, Ed. Holden

The Basics of Groundwater and the Hydrological Cycle.

Rain falls on the land surface. Some flows overland as streams and rivers (overland flow) and some soaks directly into the ground enters the **unsaturated zone** in which pores contain both air and water. Flow in the unsaturated zone is dominantly vertically downwards. Water in the unsaturated zone flows downward to the **water table** where it joins the **saturated zone** in which pores are filled entirely with water. Flow in the saturates zone is driven by gravity and is usually slow. The topography of the water table at the top of the saturated zone generally follows the topography of the ground surface but with more gentle slopes. Flow in the saturated zone is generally roughly parallel to the water table and groundwater flows downhill, eventually emerging in streams, rivers, lochs and finally the sea.

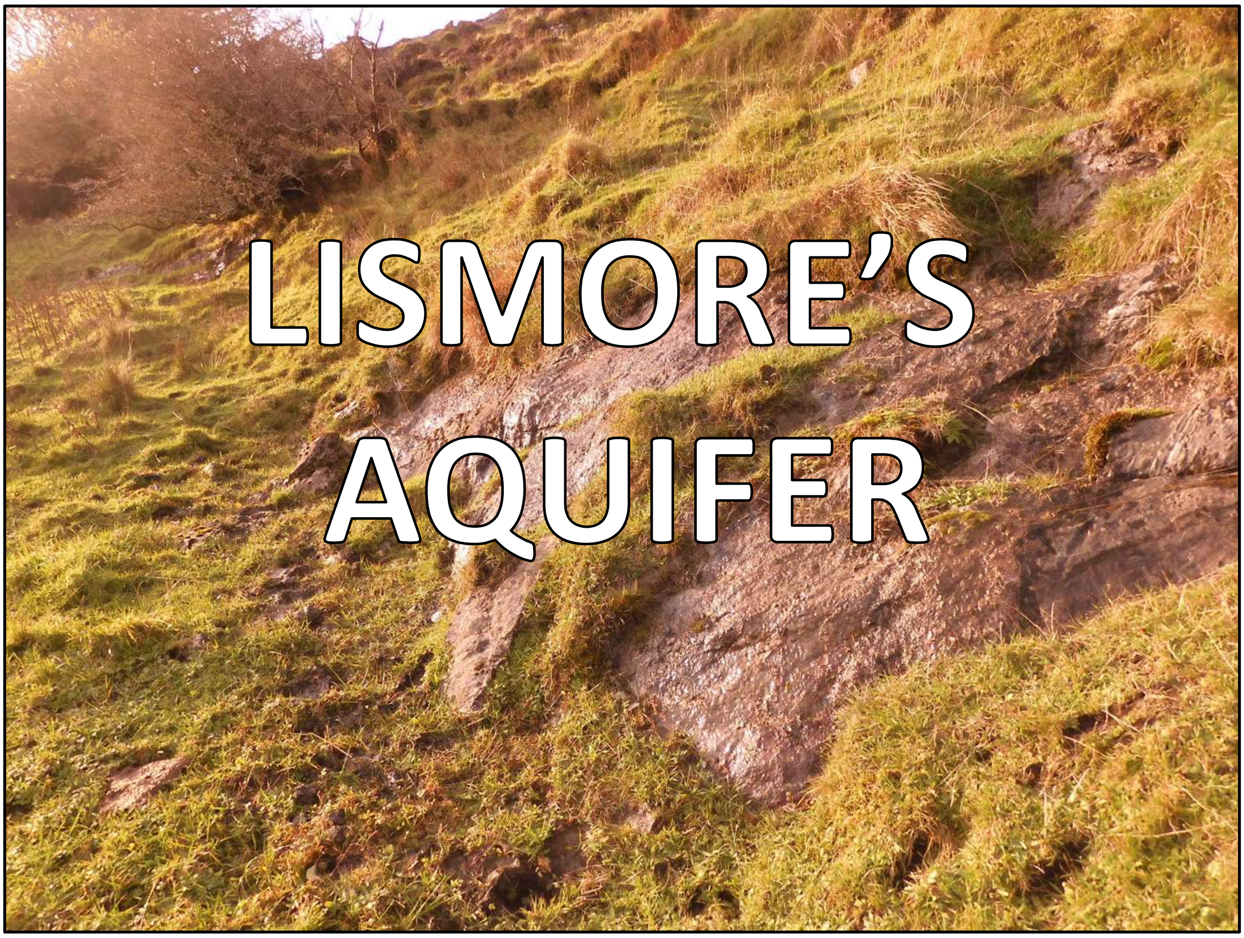
The Hydrogeological Cycle is completed by the evaporation of water from river, lochs and the sea to form clouds and rain.

Hydraulic conductivity of fractured and unfractured rock



(After Singhal and Gupta, 1993, table 8.2)

This plot compares aquifers in different sediments and rocks in terms of aquifer quality. Hydraulic conductivity and permeability are different ways of quantifying the ability of the sediment or rock to conduct water flow. Here we will just look at the relative values which range from ‘very high’ on the left to ‘very low’ on the right.
The highest quality aquifers are sediments - gravel and clean sand. At the other end of the spectrum are massive crystalline rocks, shales and siltstones at ‘very low’ aquifer quality. These rocks are called ‘aquicludes’ as oppose to ‘aquifers’.
All aquifers where fractures are important are outlined in red and include limestone & dolomite (a type of limestone) and fractured sandstone. Comparing ‘sandstone’ to ‘fractured sandstone’, and also ‘massive crystalline rock’ with ‘fractured and weathered crystalline rock’ you can see how fractures enhance aquifer quality.
Note that the whole range of aquifer quality covers 13 orders of magnitude in hydraulic conductivity – a huge range.


LISMORE'S
AQUIFER

LISMORE LIMESTONE FORMATION

Dalradian (560-600 Myrs) – limey, muddy silty sediments in a deep basin

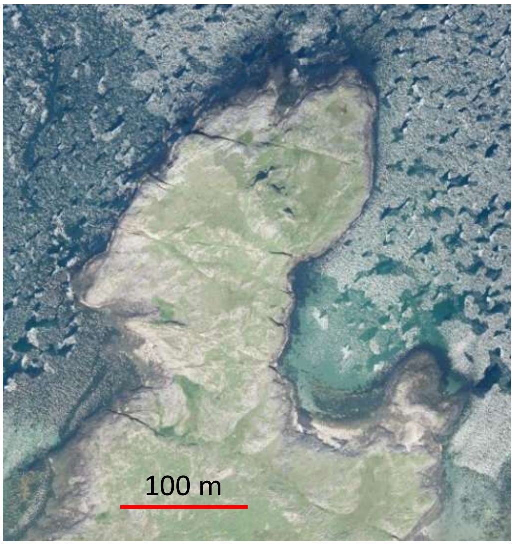
Deformed and metamorphosed during **Caledonian Orogeny , 400 myrs ago** – folds and schistosity.

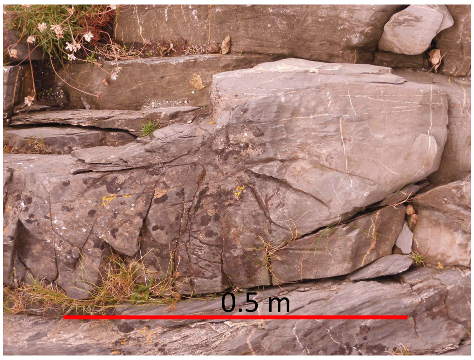
Outcrops mainly in Lismore!
- Massive pale grey limestone to impure slatey, dark grey calcareous schists. Original sedimentary bedding structures.

Now a metamorphic rock with **no** porosity or permeability BUT…
Many **fractures and faults**:
- Early calcite filled veins (white) abundant
- Many open fractures open to storage and flow of groundwater

Lismore is composed of the **Lismore Limestone Formation** overlain by small amounts of glacial sediments, raised marine deposits and a little peat. We will focus on the limestones of Lismore as aquifers, because the Glen Sanda quarry people will only drill boreholes into the limestone. It is possible to drill boreholes into glacial and marine sediments but these holes would need to be 'cased', i.e. lined with a rigid, perforated tube, to keep the borehole from collapsing.
The Lismore Limestone Formation is very old (560-600 Myrs) and belongs to the Dalradian Group of metamorphic rocks which are wide spread in SW Scotland. The Lismore Limestone Formation began as limey mud which was laid down in a deep basin. Gradually the basin filled and the buried sediments were lithified (turned to rock). The rocks then underwent metamorphism (cooking at high temperatures) and deformation (forming folds) during the Caledonian orogeny at around 400 Myrs ago. The Lismore Limestone Formation occurs dominantly in Lismore with a few small outcrops on the adjacent mainland. The limestone varies from massive, pale grey, relatively pure limestones to dark grey, impure, finely banded limestones where the original sedimentary structures can be seen. It is obvious that the rock itself has negligible porosity and that groundwater cannot flow through it. However, the limestones are intensely fractured and faulted. Some fractures are now filled with calcite (see as white streaks in the rock) but where the fractures are open, they can form storage and pathways for groundwater.

A RANGE OF FRACTURE SCALES





Fractures on Lismore occur over a wide range of scales. Fractures and faults that traverse the whole width of Lismore (scale of kms) can clearly be seen on satellite images available on the internet. Fractures on the scale of metres can be seen in the cliffs that border the raised beaches (the oonie) surrounding Lismore. Small fractures on the scale of centimetres are seen in outcrops of limestone. This is a range of scales over 4 orders of magnitude and all these fractures can form possible pathways for groundwater flow.

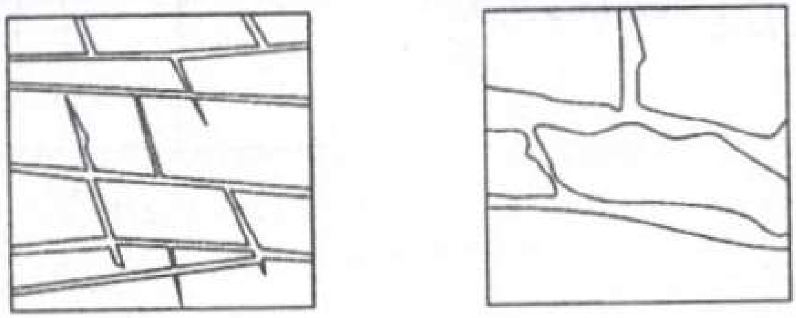
DISSOLUTION OF FRACTURES

Lismore Limestone contains mineral **CALCITE** (Ca CO_3)

Calcite is soluble (slowly) in rain water

THIS CAUSES:

- Hollows and cavities in rock surface
- Sink holes in land surface
- Widening of fractures open to flow



Limestone dissolves slowly in rain water because the rock is composed chiefly of the mineral calcite. Dissolution of the limestone forms the knobbly surfaces that can be seem all over Lismore. Groundwater flowing along fractures dissolves the fracture walls widening them so that they become more effective pathways for groundwater flow. Occasionally an area where fractures are greatly widened can collapse and form a sink hole which appears as an abrupt depression in the ground surface. Such sink holes do occur on Lismore but are not common. Dissolution of fracture walls in the limestone enhances aquifer quality.

Lismore's Aquifer

FRACTURED AQUIFER - relies on fractures widened by dissolution

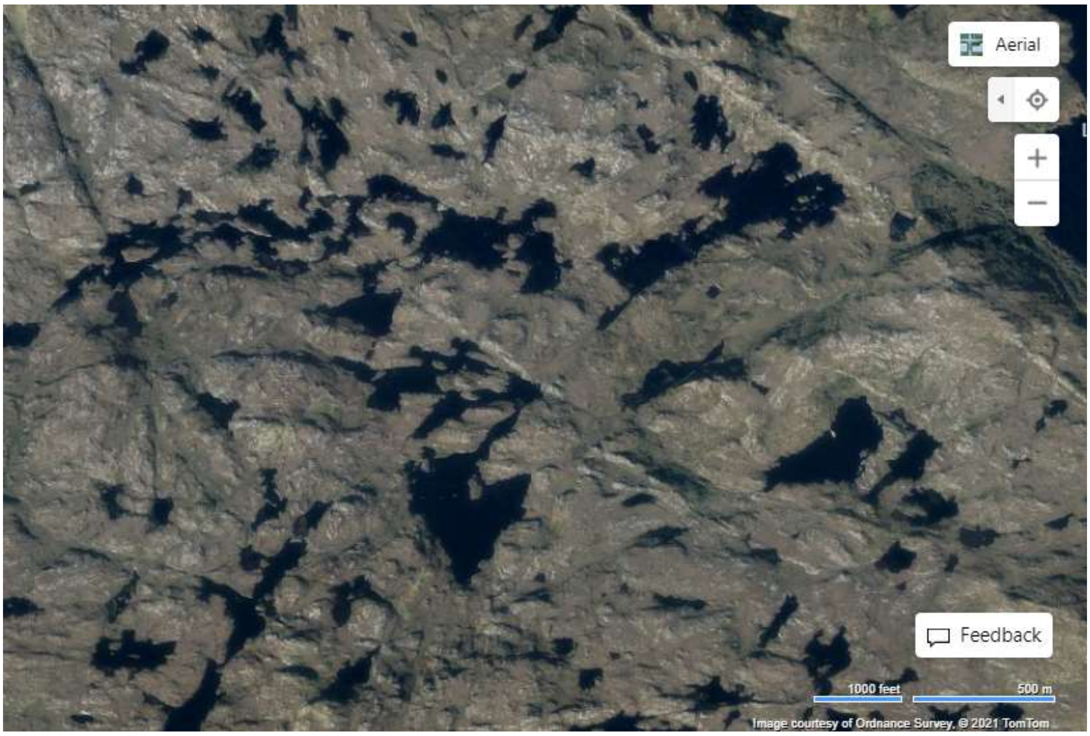
BUT - need a well **connected** network of fractures to allow flow

Observations suggest this is the case for Lismore's Aquifer:

- Land is free draining – water levels subside rapidly after rain
- Few permanent streams – rain soaks into ground rather than overland flow
- Seepages on cliff surfaces – the oonie
- Many springs over the whole island – where groundwater comes to the surface
- Many ephemeral spring active after heavy rain – due to raised groundwater table

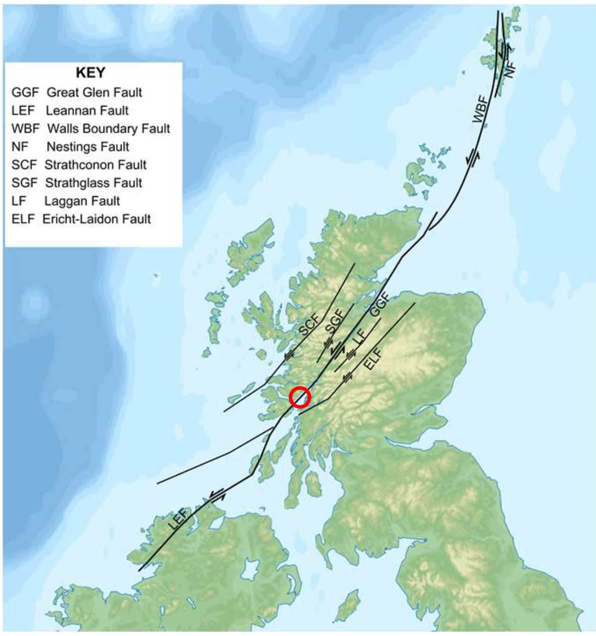
The aquifer formed by the Lismore Limestone Formation is a fractured aquifer where fracture widths are enhanced by dissolution. In addition to open fractures, it is also necessary to have a network of well connected fractures which allows groundwater to flow throughout the aquifer. There are several observations that suggest this is so for the Lismore limestone. After a period of heavy rain the water table rises and reaches the ground surface in places forming many ephemeral springs and streams. However, the land is very free draining so that water levels subside rapidly when the weather becomes drier. This means that rain soaks directly into the ground rather than forming streams. There are very few permanent streams in Lismore. The raised beach than surrounds Lismore (the oonie) is generally rather boggy caused by emerging groundwater and many seepages of water can be seen in the cliffs that border the raised beaches, marked by patches of green or black algae. These observations indicate that groundwater is able to flow through networks of fractures in the Lismore Limestone Formation.

Lewisian Gneiss, near Lochinver



This is an aerial view of an area close to Lochinver in NW Scotland. The width of the photo is comparable with the width of Lismore. This is an area of massive crystalline rocks known as the Lewisian Gneiss. These rocks form large parts of NW Scotland and the Outer Hebrides. What is noticeable is the many small lochans which appear black in the photo. The Lewisian rocks are fractured but these fractures are not widened by dissolution and many are filled with mineral deposits and not open to groundwater flow. The result is that rain here cannot soak into the ground and remains on the surface forming many lochans and streams. This is in sharp contrast to Lismore where lochs and streams are very few.

Origin of fractures – The Great Glen Fault



Wikipedia

HUGE FAULT!

- 500 km long
- 430 Myrs old
- Strike-slip fault displacement of 200-300 km and possible more

- Main movement in Silurian (430-400 Myrs)
- Late movements:

- Carboniferous (~300 Myrs)
- Late Cretaceous (65 Myrs)
- Recent tremors

If we are looking for a cause of the fractures in the Lismore Limestone Formation, we need look no further than the Great Glen Fault on our door step! There are two strands of the Great Glen Fault – the main one to the west between Lismore and Morvern and a lesser strand to the east of Lismore in the Firth of Lorne. The Great Glen Fault is 430 myrs old and has had 3 main periods of movement at 430-400, 300 and 65 Myrs ago. It is no longer active but the Great Glen Fault and other faults in the area can form a focus for the release of stress caused by post-glacial uplift. These tremors are small, usually 3 or less on the Richter scale.
The Great Glen Fault has also caused extensive fracturing of the granites in Morvern. It is this fracturing that makes the granite easy to quarry and is the reason for the siting of the Glen Sanda quarry.

Lismore's Aquifer – Summing Up

- A **fractured aquifer** – relies on fractures for storing groundwater and enabling groundwater flow
- Dense network of fractures – generated by the Great Glen Fault
- Fractures form a well connected network
- Fractures further enlarged by dissolution
- Many wells - the people of Lismore have always exploited groundwater

Observations suggest that we have a reasonable aquifer!

Conclusions are that Lismore has a fractured aquifer in the Lismore Limestone Formation. In fact the people of Lismore have always exploited groundwater through siting their wells on the more permanent and reliable springs on the island.

Now we move on to talk about the boreholes on Lismore and the results of recent testing.

BOREHOLES ON LISMORE

Boreholes drilled for the community by Glen Sanda :

- Summer 1998, July 2012, another round scheduled for 2022
- Earlier rounds of borehole drilling have also happened.
- Total numbers around 60-100 now – maybe more
- To date relatively few have been set up to extract water
- Little borehole testing done

THE BOREHOLE AT TIGH NA LOCHAN

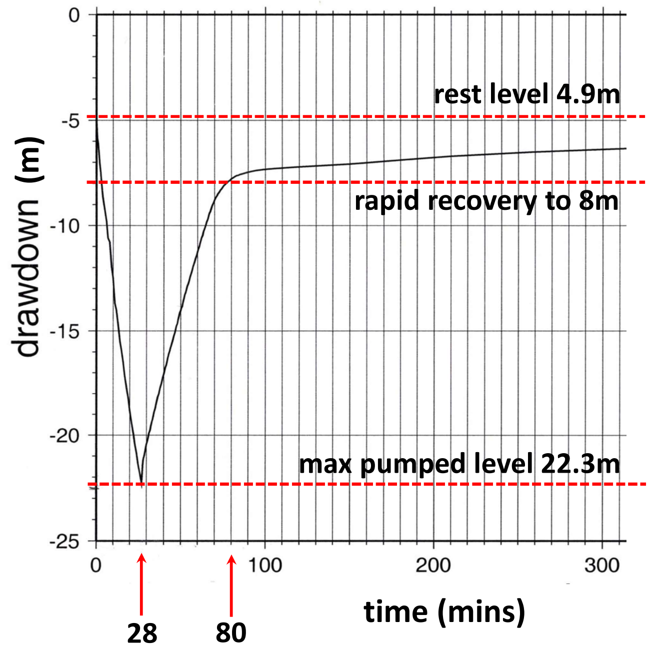
- Drilled summer 1998
- Fitted with downhole pump in 2004
- Has supplied cottage with an adequate domestic water supply since then

Boreholes on Lismore

There are a number of boreholes on the island that have been drilled by the people at the Glen Sanda quarry. There have been two recent rounds of borehole drilling (1998, 2012) as well some earlier rounds and a another round is planned for summer 2022. Although the number of boreholes on the island must number oat least 60 to 100 and possibly more, relatively few have been set up with a down hole pump to extract water. There has also been very little borehole testing for productivity on the island.

I have a borehole at the back of the cottage, Tigh na Lochan, which has supplied the cottage with a domestic water supply since 2004. I did a pump test on this borehole and will present the results as an illustration of how a borehole on Lismore is likely to perform.
In 2013-14, I carried out a series of simple borehole tests (slug tests) on 17 boreholes across the island and will present the results.

A PUMPING TEST AT TIGH NA LOCHAN



- Borehole diam 16cm (=6”)
- Depth 30 m
- Pump at 25m depth
- Pump rate 0.94 m^3/hr
- 0.42 m^3 pumped
  (= 92 gallons)
- Rapid recovery for 50 mins
- Slow recovery after

Gurgling sounds at 8 m
– large conductive fracture

The pumping test at Tigh na Lochan

I borrowed a portable down hole pump and hose pipe and a generator from the University of Leeds (where I worked at the time) and conducted a borehole pumping test in September 2001. The pump was placed near the bottom of the borehole which is 30 m deep. The borehole was pumped at a rate of 0.94 m^3/hr. The plot shows the changes in the level of the water in the borehole (known as drawdown) during the test. The water level initially fell rapidly and had reached 22.3 m depth below casing top in 28 minutes after which the pump was switched off. It was important to avoid letting the pump go dry. The water level in the borehole then recovered rapidly to a depth of 8m after which recovery continued more slowly. There were gurgling noises when the water level fell below 8m which suggests that there is a cavity or wide fracture at that depth. A total of 0.42 m^3 of water was pumped. This is 92 gallons or nearly twice the volume of a domestic water tank (50 gallons or 227 litres).

BOREHOLE TESTING ON LISMORE

Very little testing done. During 2013 -2014, I carried some simple tests for borehole productivity.

Total of 17 boreholes tested across the island:

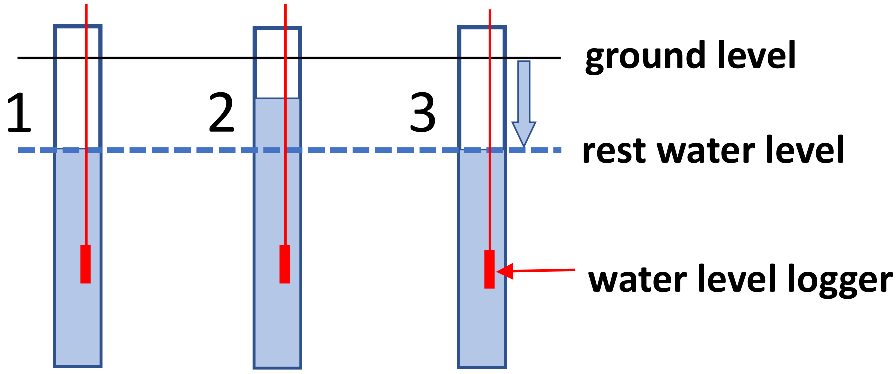
- Point (2)
- Port Ramsay (3), Park (1)
- Achuran (1)
- Balimackillichan (2)
- Balevoelan Croft (2)
- Crossroads (1)
- Craignich (2)
- Kilcheran (3)

There has been very little borehole testing done on the island to date. I used simple techniques to test 17 boreholes in 2013-14. The borehole were situated all over the habited parts of the island.

‘SLUG’ TESTING

Simple test easy to carry out:

1) borehole at rest
2) a ‘slug’ of water is introduced (10 L)
3) fall of water level back to rest level monitored



4) Analysis with software (Aquifer Win32) gives hydraulic conductivity

Slug Testing

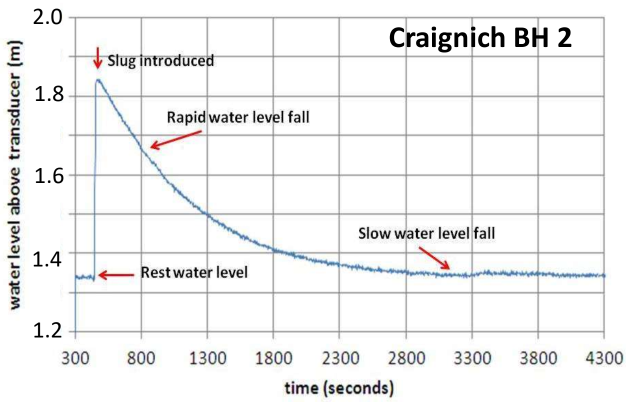
The boreholes were tested using ‘slug’ tests. This is where a ‘slug’ of water is introduced into the borehole and the water levels monitored as the water level returns to normal. These techniques were developed in the 1940s and 50s. They are still in use today and are easy and simple to carry out.

Water levels are most easily monitored using a level logger which records pressure at prescribed time intervals. The logger is suspended in the borehole below the rest water level. The slug (I used 10 litres of clean water) is introduced as fast as possible and pressure measured by the logger as the water level subsides to normal. It is best to also monitor barometric pressure throughout the test. The pressure due to water above the logger is then the total pressure minus the barometric pressure. The data on changes in water level during the test are then used in software (Aquifer Win32) to apply the slug test analysis techniques and obtain an estimate for hydraulic conductivity which is a measure of how easily groundwater can flow through the rock.

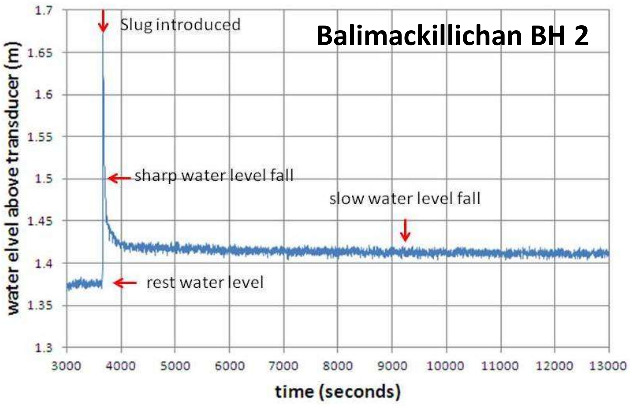
WATER LEVEL LOGGERS

- Records pressure
- Set recording interval
- Download data after test

Water level loggers
Level loggers are 14 cm long and can be suspended by a cord or wire under the water in the borehole. They contain a pressure sensor, a battery and a memory card to store data. They can be programmed to record pressure at specific times intervals. The data can then be downloaded to a laptop using the reading out unit shown on the right of the picture.



Good borehole
Hydraulic conductivity 0.08 m/d



Less good borehole
Hydraulic conductivity 0.00045m/d

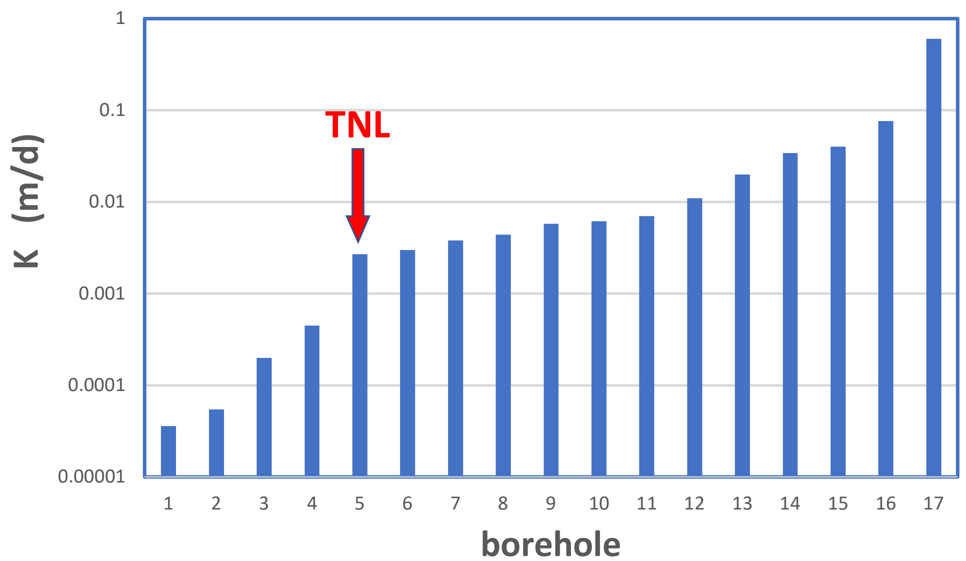
For reference : TNL borehole
Hydraulic conductivity 0.0027 m/d

Here are two examples of the data recorded by the level loggers (also called ‘transducers’) shown as graphs of water level (Y axis) versus time (X axis).

Top - a example of a relatively good borehole at Craignich. There is a sharp initial rise in water level of around 50 cm from the rest water level when the ‘slug’ is introduced and then the water level subsides to normal over a time period of about 3000s (50 mins). The calculated hydraulic conductivity is 0.08 m/day which is around 30 times higher than that for Tigh na Lochan’s borehole. (0.0027 m/day)

Bottom – an example of a rather poor borehole at Balimackillichan. There is a sharp rise in the water level of around 30 cm as the ‘slug’ is introduced and then a sharp fall to around 5 cm about the initial rest water level. The water level then subsides extremely slowly and drops by only 1 cm in 9000 s (150 min). It is likely that some open fractures (possibly caused by drilling) near the surface and above the natural rest level filled rapidly when the slug of water was introduced causing the level to drop sharply initially. Then the drop in water level slowed dramatically showing that the rock around the borehole has low hydraulic conductivity. Analysis of the data gave a hydraulic conductivity of 0.00045 m/day which is 6 times lower than the hydraulic conductivity at Tigh na Lochan (0.0027 m/day).

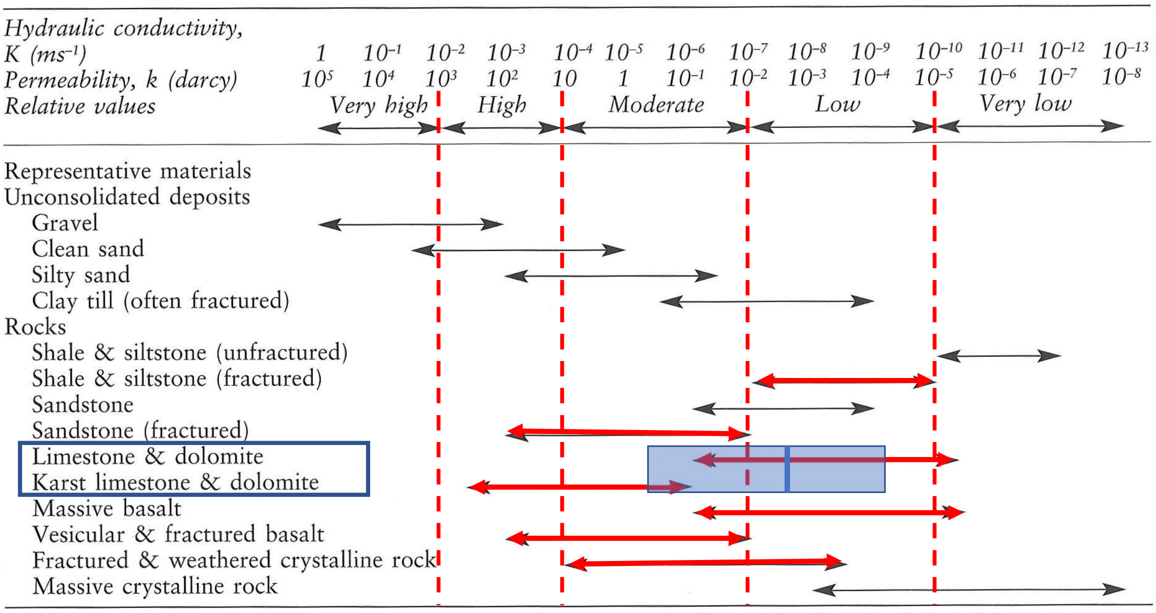
'SLUG' TESTING RESULTS



NOTE! Logarithmic scale for hydraulic conductivity (K)
Results over wide range - 4 orders of magnitude
For reference : TNL borehole hydraulic conductivity 0.0027 m/d

The results of borehole slug testing of 17 boreholes on Lismore.
Note that the Y axis (hydraulic conductivity, K) is plotted on a logarithmic scale! This shows the lower end of the data range in more detail. There are some 8 boreholes with K values between 0.001 and 0.01 m/day. There are 5 borehole with higher K values than this middle range, and 4 boreholes with lower K values.
Note the position of Tigh na Lochan's borehole (0.0027 m/day) 5th from the bottom! Since this borehole gives a good domestic water supply, this suggests that the majority of the boreholes tested would also give an acceptable domestic water supply. Although the data sample is small at just 17 boreholes, this suggests that there is about an 80% chance of getting a usable borehole drilled into the limestone anywhere on the island.

Hydraulic conductivity of fractured and unfractured rock

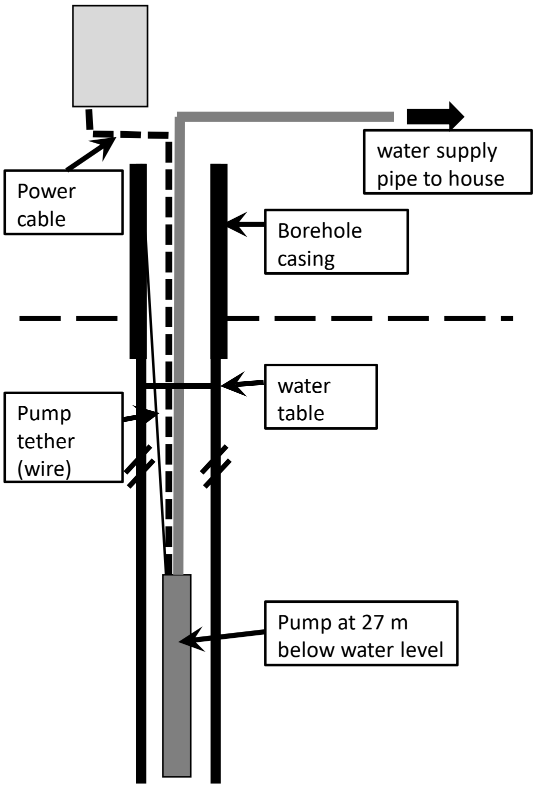


(After Singhal and Gupta, 1993, table 8.2)

Comparing the data from boreholes on Lismore with the diagram previously shown on aquifer quality.

The range of hydraulic conductivity values from Lismore boreholes is shown by the pale blue box with the drker blue line showing the position of Tigh na Lochan's borehole. It compares sensibly with the range shown for limestones and fractured limestones, giving a range from moderate to low in aquifer quality. Although Tigh na Lochan's borehole comes in the 'low' category, it is still able to provide a good domestic water supply.

PUMP CONFIGURATION AT TIGH NA LOCHAN

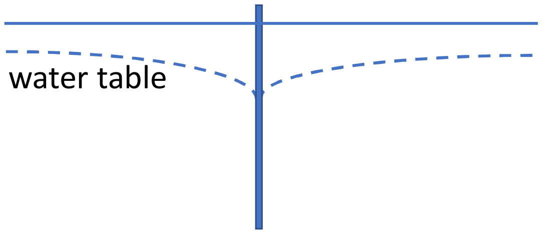


- Pump placed near **BOTTOM** of borehole at 27 m
- Suspended by wire tether, inside agricultural perforated drain pipe
- **Avoid** pumping the downhole pump dry!
- **Pump: Grunfos SQ1-35** (single phase)
- Many other makes now available
- Pumps water to tank in attic 8 m up.

Borehole pump installation at Tigh na Lochan.
The borehole has a length (around 0.5 m) of thick black plastic pipe wedged through the soil to the top of the solid rock. This provides a useful support for pipes as well preventing soil from falling down the borehole. The pump is placed near the bottom of the 30 m borehole at 27 m. It is best to keep the pump a few metres above the bottom to avoid sucking up silt left from the drilling. The pump is suspended from a wire tether and the water pipe and electrical cable go down to the pump. A length of agricultural drainage piping which is light, flexible and perforated, is also placed in the bore hole (not shown above) and the pump installed inside it to protect it from any stones that may become dislodged from the borehole walls.
The pump is a Grunfos SQ1-35 which is quite expensive. A spare pump I bought recently cost £740. However there now many more makes of pump on the market, many of them cheaper. My pump has been very reliable and the original pump installed around 2004 is still going strong. Water is pumped up to my water tank in the attic of the cottage 8m above the top of the borehole. The pump is switched on and off using a float switched in the water tank. Around one third of a tankful is pumped at a time (74 litres, 16.7 gallons) which takes around 2 minutes. Originally I fitted two probes in the borehole: one near the pump to switch it off preventing the pump from drying out and another near the top to switch it on when water levels recovered. However, these were never used in practice and I have removed them.

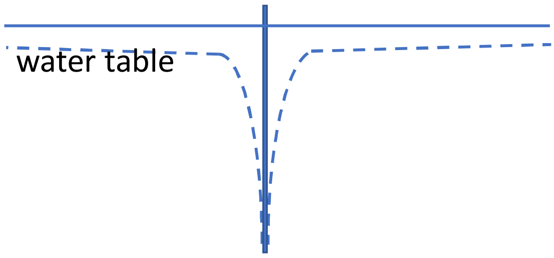
Pumped Boreholes and Cones of Depression

VERY GOOD AQUIFER



- Wide shallow cone of depression
- Draws in water from far afield
- Water level in borehole shallow

LESS GOOD AQUIFER



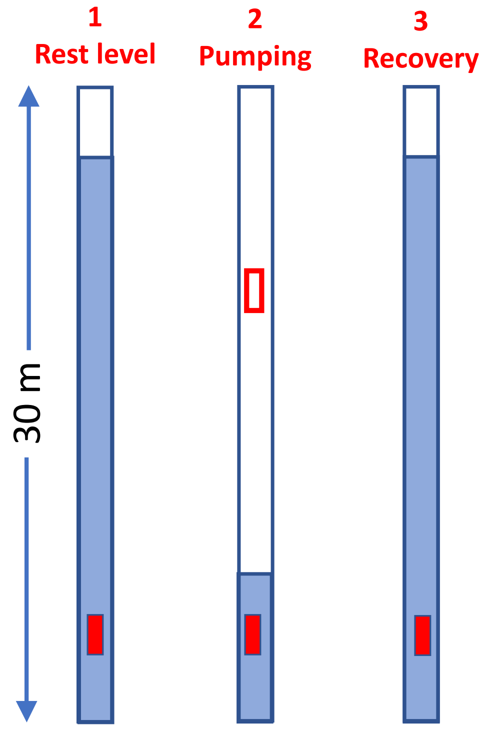
- Narrow deep cone of depression
- Draws in water from nearby only
- Water level in borehole deep

THIS IS LISMORE!

Cones of depression

When a borehole is pumped it draws water in from the aquifer in the vicinity of the borehole and created a fall in the water table near the borehole. This is called a cone of depression. The area surrounding the borehole where the water table is depressed and the depth of the cone of depression at the borehole depend on the pumping rate, the duration of pumping and the hydraulic conductivity of the rock.
In the case of a good aquifer, water is drawn from a large volume of the aquifer that reaches far from the borehole and the cone of depression is shallow and wide. However, in the case of a poorer quality aquifer, water is drawn from relatively close to the borehole and the cone of depression is narrow and deep. The later case is most relevant for Lismore's aquifer. This has consequences for the way in which a borehole on Lismore should be pumped.

Pumping a borehole for a water supply



Borehole diameter 16 cm (6 inches)
1 m of borehole contains 20 litres (4.4 gallons)

To fill a 50 gallon water tank need 11.4 m of borehole
Boreholes usually 30 m deep so PLENTY water

BUT

Need to allow recovery before pumping again

- **Avoid water level reaching pump**
- **Probes to detect water level**

Tigh na Lochan's borehole:

- **Rest level 5 m below top**
- **Pump at 27 m (3 m above base of borehole)**
- **Pump 73 litres (16 gallons, 1/3rd 50 gal tank) around once per day**
- **= 3.6 m of borehole**
- **Takes about 30 min to recover**

Pumping a borehole on Lismore

A simple calculation shows that 1 m length of a borehole with a diameter of 16 cm (6 inches) contains 20 litres (4.4 gallons). So 11.4 m section of borehole contains enough water to fill a 50 gallon domestic water tank. Lismore boreholes are normally 30 m deep, so there is plenty of water in the borehole to fill a normal domestic tank. However, it is then necessary to allow time for the water level in the borehole to recover before pumping starts again. Placing the pump near the bottom of the borehole means the pump can use much of the borehole as a storage unit for water. This contrasts with the situation where the pump is placed at a shallow level, in which only a small art of the borehole is being used as water storage.

In the case of the borehole at Tigh na Lochan, around one third of a tank (73 litres or 16 gallons) is pumped at a time. This represents 3.6 m of borehole length. Since the pump is placed at 27 m depth, this means that there is plenty water in the borehole to support this degree of pumping. It then takes the water level in the borehole about 30 minutes to recover. As long as this recovery time is allowed between episodes of pumping, the borehole can provide a good domestic water supply. Under normal circumstances the borehole is pumped once or twice a day, leaving ample time for the borehole water level to recover.

FINAL SUMMING UP

- Lismore has a **fractured aquifer (the Lismore Limestone)** – fractures enlarged by dissolution of limestone promote groundwater flow.
- Fractures form a **connected** network and allow ground water flow all over Lismore – indicated by few lochs and permanent streams, land is free draining.
- Results of slug testing of 17 boreholes show a range of hydraulic conductivities over **4 orders of magnitude.**
- Borehole at Tigh na Lochan is near lower end of range but still supplies good domestic water supply. **Suggests there is around 80% chance of any borehole drilled on Lismore providing a domestic water supply.**
- **Need to take aquifer properties into account when pumping!** Important to place pump toward bottom of borehole - use borehole as groundwater storage.
- **Pump little and often**, giving borehole chance to recover between pumping intervals.
- **Contact**: *noelle.odling@gmail.com, Tigh na Lochan, Isle of Lismore, Argyll PA34 5UQ*

Final summary is outlined. My plans for the future are to test more boreholes on Lismore to increase the existing sample of 17. People can get in touch with me (contact noelle.odling@gmail.com, Tigh na Lochan, Isle of Lismore, Argyll PA34 5UQ) if they wish a borehole to be tested.

Discussion: There was a session of questions after the talk on the 5th February 2022. One of the main questions and concerns was if a borehole can interfere with an existing well and cause that well to dry up. The presence of a borehole alone will not affect the performance of a nearby well. However if that borehole is pumped there is the possibility that it will lower the water table in the vicinity of the well and cause it to dry up. It is not possible to say exactly how far from an existing well a borehole should be placed to avoid this happening as it depends on the width and orientation of the fractures at depth in the vicinity of the borehole and well. However, the above slide showing cones of depression formed when a borehole is pumped showed that, in the case of Lismore's aquifer, cones of depression will tend to be narrow and deep. Thus most boreholes will draw water from relatively close to the borehole. The problem will be worst in the case of boreholes which show especially high hydraulic conductivity where pumping will lower the water table over a wider area. It should also be remembered that boreholes will not be continuously pumped and so any depression of the water table around a borehole will be temporary and the water table will return to its normal level when pumping stops. Considering these points above suggests that the chance of interference between pumped boreholes and existing wells is likely to be fairly low unless the two are very close (say a few tens of metres). However, the chances of such interference will be greatest after a prolonged period of low rainfall when the water table is at its lowest. This is also the time when wells and permanent springs are most at risk even if there are no pumped boreholes present in their vicinity.

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Some basic reference texts used in the writing of this talk.