Drill Stem Tests Versus Packer Testing

	Packer Test	Drill Stem Test	Pulsed DST
PARAMETER			
Formation fluid pressure / Head	✗	✓	✓
Permeability / Hydraulic conductivity	✗	✓	✓
Well bore loss	✗	✓	✓
Radius of investigation	✗	✓	✓
Storage Parameters	✗	✗	✓
Directional permeability	✗	✗	✓
Inhomogeneity	✗	✗	✓

Table 1. A comparison of information derived from packer testing, drills stem testing and pulsed DST tests.

Real Well Behaviour

Flow in and out of a section of a borehole is dependent on:

- The pressure difference between the fluid in the well bore and that in the formation being tested
- The permeability of the formation being tested
- The viscosity of the fluid that is flowing
  The permeability and viscosity are frequently bundled together in a term called hydraulic conductivity
- The variation in the properties the formation around the well bore that affect fluid flow. These are frequently brought about by drilling fluid invasion but may also be caused by stress concentrations around the well bore. They are usually lumped into the term called near well bore losses. They can be very important.

The Packer Test

The packer test was originally developed by Maurice Lugeon in 1933 measures the flow of water injected into a section of a borehole. It does not enable the determination of permeability, hydraulic conductivity or the initial fluid pressure within the section being tested. It is an only an index test in which the mixed parameters of hydraulic conductivity, initial fluid pressure, and near well bore loss cannot be separated. Its assumptions of steady state flow make proper analysis impossible.

The Drill Stem Test (DST)

The drill stem test is a long established test of the oil and gas industry. It enables the determination of:

- Fluid pressure in the formation
- Permeability
- Near well bore loss terms
- The size of the area being tested - the mean effective radius of investigation.

It involves:

- Sealing a section of a borehole in the rock mass to be tested
- Waiting for pressure stabilisation
- Opening a down-hole valve to permit inflow to the drill string. Injection may also be used
- Shutting the down-hole valve
- Recording the pressure build up (or decline if injection is used).

The great advantage of the test is that separates the flow period from that when the pressure transient is measured. This removes problems associated with local pressure drop around the well bore due to flow.

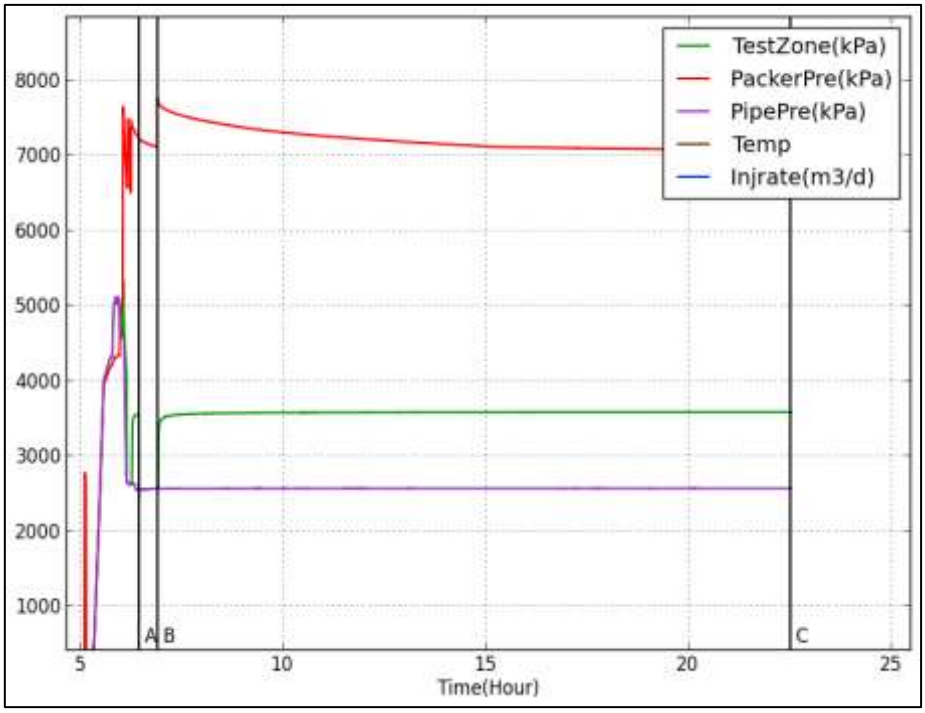

Figure 1. The record of pressure and time from a drill stem test.

Pulsed DST Testing

The simple DST test is conducted in a single borehole and it cannot therefore be used to measure directional permeability or the storage behaviour of the formation. In addition to a well which is either produced from or injected into it requires at least one monitoring piezometer. If a normal well test is used with three piezometers then it is theoretically possible to determine the anisotropy but not to adequately separate this from inhomogeneity.

The use of pulsed DST testing involves conducting a DST and either leaving the tool in the hole to measure pressure or installing a piezometer in that hole. Another hole is then drilled and tested by DST and the values from this test and the record from the monitoring hole are gathered. This then gives two values of mean permeability, one of directional permeability and one measurement of storage behaviour. If a piezometer is put in the second hole and a third hole is tested by DST it yields another value of mean permeability, two directional and two storage values. This type of testing is ideal for determining inhomogeneity.

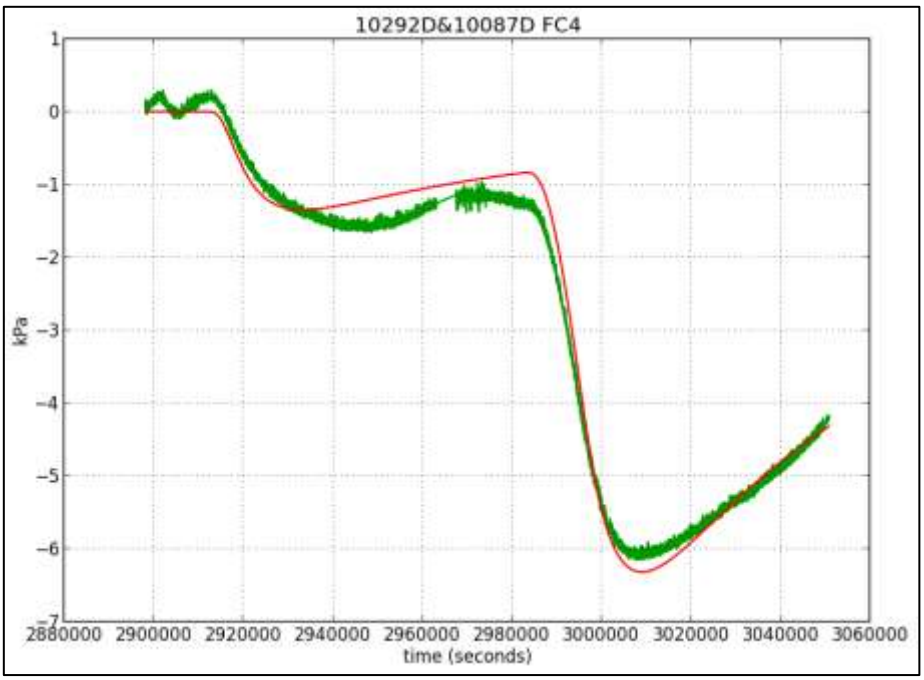

Figure 2. Transient pulse in green and match in red.

The civil engineering industry clings to the packer test despite the fact that it can only really only provide information on whether the zone will accept flow or not. It would benefit greatly from adopting transient test processes. The drill stem test is one of the easiest and most useful tests to determine the parameters relating to groundwater movement. Extending this test to a pulsed test system also enables the determination of directional permeability, storage and inhomogeneity of the rock mass.

Sigra provides all manner of testing for ground fluids, the analysis and interpretation of results. We have the tools to suit all manner of ground conditions and the techniques to get the most out of the measurements.