GROUNDWATER MONITORING

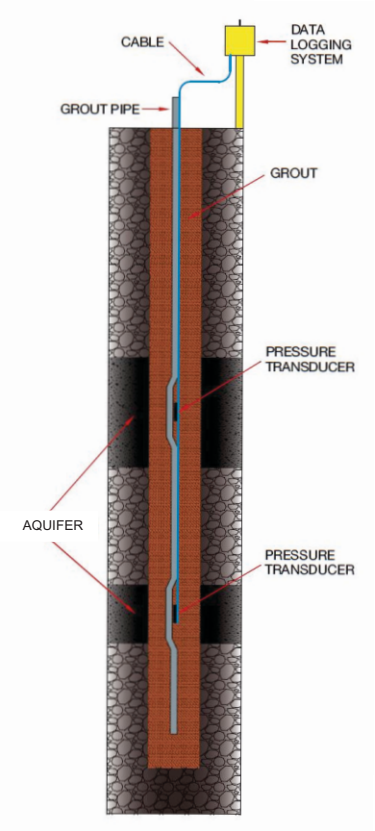
Sigra designs and installs groundwater monitoring systems for the civil, mining and petroleum industries. Sigra excels in deep-well monitoring systems using proprietary technologies and installation techniques. Some of these may be advantageously used in shallow applications.

With a range of transducer and cable types along with cementing design and pumping capabilities, Sigra can design appropriate and economical groundwater monitoring solutions in most environments. Sigra can supply a service, design or license its proprietary installation methods. It can also supply specialist equipment for piezometer installation, including packers, transducers and data acquisition systems.

Requirements of Piezometric Monitoring

Piezometric monitoring involves the measurement of fluid pressure within the ground at a known location.

The prime requirement of any monitoring system is the certainty of the measurement. This means that the system used to measure must be fundamentally sound. It also needs to be testable to ensure that it is operating correctly. Most piezometer installations are compromised because the measurement is not accurate due to poor connectivity to the fluid in the ground. This can be due to intra-connection between formation fluid and borehole fluid within standpipes, or inability to test the pressure sensing device.

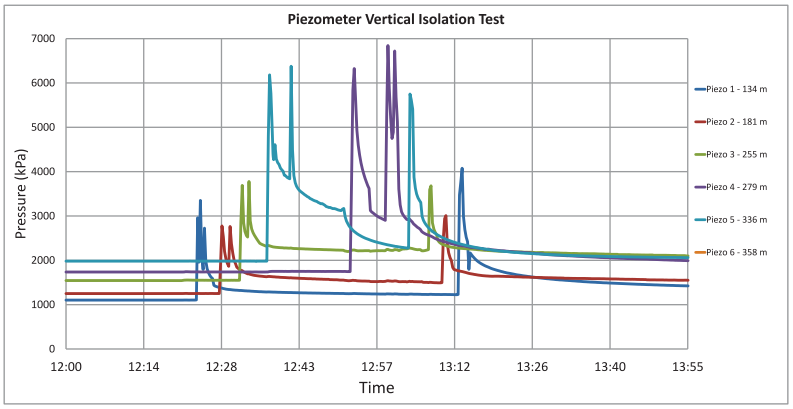


Sigra's multi-transducer installation well schematic

Types of Piezometers

Standpipe Piezometer

Typically, standpipe piezometer installations involve the installation of a tube with a filter tip within a borehole. This is set within a gravel or sand pack, which is typically sealed with bentonite pellets, and grout above this. This system may usually be tested for connectivity to the formation (or leakage up the hole) by a falling head test. In low permeability ground, or piezometers with poor connection to the ground, the volume of the standpipe serves to damp any transient piezometric changes. While such installations are simple in shallow holes they become difficult in deep ones. Where multiple standpipes are installed in a borehole, the sequential installation process makes them very difficult and expensive. In cases where groundwater sampling is required, a standpipe piezometer is useful; the piezometer response to pressure changes can be dramatically improved by sealing a pressure transducer into the standpipe using a packer.



Hydraulic connectivity testing with Sigra's grout fracturing technology. Grout fracture lines are pressurised sequentially and the results from the test provide data on the degree of hydraulic connectivity vertically between the transducers. Hydraulic connectivity between the individual transducer and the formation is evident by the smooth pressure fall off curve after pressurisation.

www.sigra.com.au
Sigra Pty Ltd
93 Colebard St West, Acacia Ridge, QLD, Australia, 4110
+61 7 3216 6344 info@sigra.com.au

Types of Piezometers Continued.

Sigra 5MPa vibrating wire transducer paired with Sigra's cement displacement technology

Grouted in Pressure Sensors

To overcome the problems of installing multiple standpipes in a borehole, the procedure of suspending pressure transducers in the borehole and cement grouting them in place exists. The basis for this system to work is that the grout has sufficient permeability to enable fluid connection from the transducer to the ground but insufficient permeability to permit significant fluid connection within the borehole. This is difficult to achieve. It also frequently has problems with water loss from the grout into the ground. This leaves a denser grout at the water loss location, which is very impermeable. Typically in areas of dense grout the fluid pressure drops dramatically during hydration of the grout and pressure may take a long period, sometimes months, to re-establish. This means that the measurement of transient pressure variations cannot be achieved. Another problem of this installation method is that the installation cannot be tested.

Grouted In Piezometers with Cement Displacement – Transducer or Standpipe

To overcome the problems of the grouted in pressure sensor, Sigra has developed an alternative approach. This involves lowering pressure sensors to the required depths in a borehole and cementing the hole with a low permeability, dense grout. When the grout is plastic, water is pumped through a capillary tube from surface through the filter tip, so as to displace cement, thus forming a connection to the ground. The grout is then permitted to set and the installation can then be tested by pumping more water through the capillary tube and watching the associated pressure decay. When this test is conducted sequentially in adjacent sensing locations within the borehole, the lack of pressure response along the hole indicates a lack of fluid intra-connection.

This type of installation is frequently used with pressure transducers that are cemented into the borehole. Sigra has installed six pressure transducers into a 96 mm borehole (HQ cored) to 600 m depth using this system.

Alternatively where the piezometric level is close to the surface, pressure transducers may be set below this level in standpipes connected to the capillary tube in the shallow zone of the borehole. In this case the transducers are used with packers to seal them into the standpipe, thus enhancing their transient response capability. This installation permits the withdrawal of the transducer for testing or maintenance. capillary tube and watching the associated pressure decay. When this test is conducted sequentially in adjacent sensing locations within the borehole, the lack of pressure response along the hole indicates a lack of fluid intra-connection.

Packer Piezometers

In rock containing open joints, grouting may be difficult. Frequently, the best installation technique for piezometers utilises packers on either side of the fracture zones. In temporary installations inflatable packer systems are best, while swell packers are more suitable for permanent installations. The latter are made of elastomers that swell when in contact with water. Multiple packer systems can be built to monitor varying levels in open rock or cased and perforated holes.

Piezometers and Settlement Monitoring for Soft Ground

There is frequently a need to monitor fluid pressure simultaneously with settlement in soft ground. Sigra has developed a system which allows multiple piezometric sensing points to be jacked into the wall of a borehole which is then cemented with a plastic grout. The helical form of the tubing and cabling system enables this system to deform greatly with settlement. This system can be enhanced to measure relative measurement from surface by pressure transducers that measure the depth from surface by water pressure. The system is designed to be installed in PQ diameter (123 mm) holes.