Groundwater Samples AND MONITORING WELLS

ENVIRONMENTAL
Analysis

Author Details

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Are concentrations above certain pre-set limits one generally decides to drill deeper, install a monitoring well also in that layer and determine the situation in that layer. If an impermeable layer is drilled through the perforated layer must be repaired by using bentonite pellets or a bentonite-water grout. Since there is often very limited space available the bentonite often gets blocked on its way down and does not arrive at the required depth. This may cause serious and high risks of spreading of pollutants to deeper and up-till then unpolluted layers! A new way of installation of bentonite plugs can limit this risk.

Groundwater Research

When half-way the eighties the U.S. and some Northern European countries (mainly the Netherlands) developed techniques to sample groundwater it was clear from the beginning that this should be done from small diameter but classical type wells. Much attention should be paid to the cleanliness of the well material. Ordinary PVC (even for drinking water pipes) contains lead, zinc-calcium or tin in such a high concentration that it pollutes the water with that contaminant when the well is new. Monitoring well diameters may vary between 10 and 150 mm where 50 mm is normally the standard for wells where groundwater tables are deep. Wells that are not in regular use are purged (pumped) directly prior to sampling. Larger wells (100-150 mm) have the big disadvantage that large volumes of potentially toxic purging water must be pumped, collected and discarded off. A well of 50 mm allows for the use of impeller type sampling pumps. They can purge at a high speed and are constructed in stainless steel and teflon. If decontaminated correctly one can take good samples on any parameter.

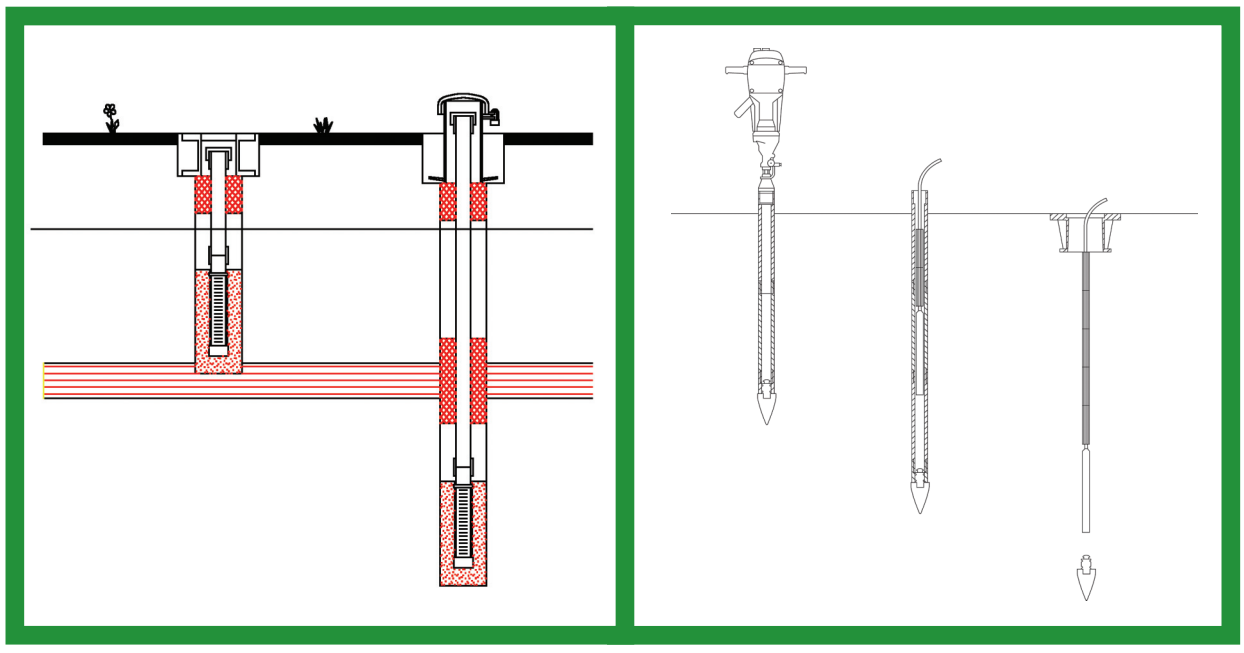
Old wells have often been constructed using the wrong materials. Therefore they cannot be used for general environmental sampling. One of the reasons is that often glue is used to connect PVC pipes. The contaminants of the glue are found in the samples.

Nowadays PVC pipes can be used with an organic not traceable purely organic stabilizer. These pipes can also be used for trace metal sampling. PVC will weaken and collapse in petrol polluted soil. Therefore HDPE pipes are a better option. The material is cheap and has also the advantage of not being brittle in cold weather. Simple screw connections result in water tight connections.

The filter sand used to install around the filter section of these pipes must be extremely clean too. Otherwise polycyclic aromatic hydrocarbons (PAH) or trace metals can be found. Generally filter sand from Scandinavia or Northern Germany is used to avoid any problems.

A problem that often occurs is that a monitoring well already gets plugged by soil particles during installation. Plugged monitoring wells or wells in clay soils can be purged (and sampled) only with patience. It was worthwhile to see if plugging of well screens during installation could be avoided.

Another problem is plugging perforated impermeable layers with bentonite. Activated bentonite swells in water (not in hydrocarbons !) and is a non-toxic strongly water absorbing natural clay variety. During use, the pellets often get stuck in the small space between drill-casing and the blind section of the monitoring well. When preparing a grout by mixing bentonite powder with water an extremely sticky mud is pumped down the hole which in reverse will also “plug” all tubes and the pump used, if this is not cleaned directly after use. Of course this causes a lot of waste and work and a lot of side equipment at the drilling site.

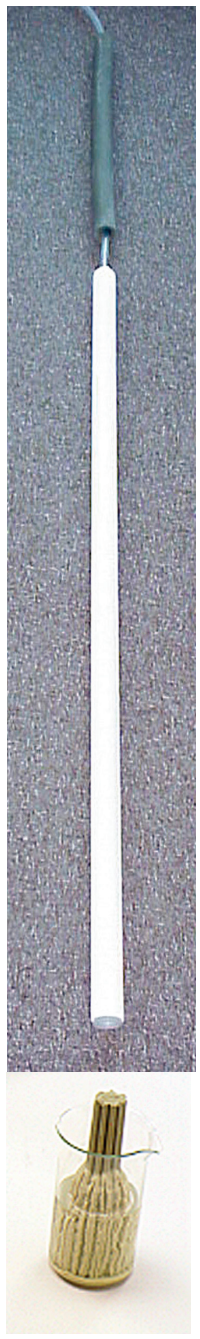


Bentonite Collar

The discovery that bentonite can be extruded has lead to new developments in monitoring wells and well installation techniques. Now bentonite can be extruded in collars that can be fixed firmly on the blind pipe section or can be slipped over the blind pipe during installation. Swelling time is longer (a few days instead of one day) but one can be sure that it is located were it is needed. Of course one cannot pour filter sand along the bentonite collar so a special pre-fabricated filter section was developed that is mounted below the pipe section fitted with the bentonite collars. No loose filter sand is used in the field anymore which makes installation of a well much easier and less messy.

The bentonite collar principle was developed in two diameters: The smallest diameter bears the name Direct Well and the largest diameter Quality Well. The Direct Well has a 34 mm outside diameter pre-fab filter. The blind “pipe” is a PE tube of 10x12 mm. The diameter allows water level measurements and not only pumping by suction but also pumping with a foot-valve pump. This simple and cheap purging and sampling pump enables water levels of at least –30 m to be pumped! Bentonite collars are slipped over the tubing to plug the hole over the full length to assure integrity of the system and conformity to the standards. Since the bentonite swells to 70 mm, the Direct Well system can be used in a bore hole up till 7 cm diameter. However, generally the system is used in combination with a narrow (40x54mm) diameter casing with a lost non-toxic cast iron point which is hammered or vibrated into the soil. Depths of 50 meters can be reached very quickly using a small Sonic (vibrating) drill rig.

Besides the Direct Well there is the Quality Well. The Quality Well is also a combination of a pre-fab filter section



Direct Well with bentonite collar slipped on riser tubing

with a bentonite collar. Now the pre-fab filter and the bentonite collars have a larger diameter (65 mm). The inner diameter of the well is 25 mm which allows the use of larger measurement equipment like larger foot-valve pumps, floating (oil) or heavy liquid layer detection equipment or traditional water level measurement devices. All elements used in the Direct Well and Quality Well products are tested on leaching characteristics (volatiles, trace metals, PAH and many more).

The Quality Well is meant to be used in boreholes up till 90 mm. Because of this, the Quality Well material cannot be used in a hollow stem auger since the diameter of the augered hole is too large. Larger holes cannot be filled completely with the swollen bentonite. The Quality Well can also be used in a casing that is vibrated or pushed down for instance with a Sonic drillrig. The outer diameter of the casing may go up to 100 mm.

Of course the use also has some limitations: One must use pre-fab filter sections because no sand can be poured along the bentonite collars. Also, but this only counts for the larger diameter Quality Well, when back-filling the borehole with soil material, this soil material should not go down along the bentonite collar. It simply would prevent the correct swelling of the bentonite and it could even go down to the filter section and pollute the water there. Therefore a sand catcher/barrier has been developed that is mounted with a stapler at the top of the collar. The catcher swells instantly in contact with water allowing the section of the well below the catcher to stay open and clean. This will allow the bentonite to swell and plug the hole. Once the bentonite is swollen the catcher is superfluous. One remark must be made in addition to this: If the bentonite needs to plug a clay layer laying below a fluid (=saturated) sand layer then the catcher must be situated on the collar at the top level of the clay layer. This will prevent the sand from filling up the annular space before the bentonite has swollen.

The Quality Well filter section is based on a normal slotted pipe section one meter long with slots 0.3 mm. The open area is 5%. A polyester gauze or sock holds the filter sand firmly around the pipe. No glues or cements have been used to mount this section allowing research on all chemical parameters. It has very good hydraulic characteristics and does not get plugged. Very important seen the fact that it is essential to purge the well while respecting a minimum level of water in the well (equivalent to the length of the filter section). Wells that are completely emptied during purging (or even sampling) will give non-representative analysis results on volatiles (because of volatilization) and trace metals (because of co-precipitation in contact with air in the well).

Wells that give little water take much time for purging which makes it worth while to consider placing a well that gives more water per minute.

Multilevel Well Material

If one wants to do vertical or 3D groundwater profiling, more wells are needed in the same location. Making one large bore-hole and installing a complex well which consists of a number of ports / screens is an option. Disadvantages are that settling or wrong application of filter sand and bentonite may cause wrong layers that are sampled, or cause plugging of the screen, or cause cross (vertical) flows in the borehole or even spreading of the pollutants in question. Of course installation is also a complicated and time consuming work which also demands quite some expertise within the drill-team. A clear advantage of Multilevel well installation is that only one borehole is sufficient to sample different soil levels. With the Direct Well and Quality Well, multilevel assembling is not possible. It is not efficient either, since installation with a Sonic drill rig of the Direct Well is so quick that installing for instance five Direct Wells (placed closely together) is done in half the time or less of the time needed to install a Multilevel well. Generally, Multilevel wells are avoided or even not allowed if a standard needs to be respected. Integrity of these systems may be low (reasons mentioned above) since complexity and needed skills to install and use them are high.

Micro-Purging

A well that gives ample water also allows to apply the micro-purging technique. Normally after purging some three wet well volumes of water from a well, the water becomes representative for the formation water around the well. Of course this is the objective. The field-determined pH, electrical conductivity, temperature and, often, dissolved oxygen and redox potential have stabilized as well as the laboratory determined parameters like volatiles, mineral oils and trace metals. By locating the pump tubing or pump in the filter section and reducing the speed of the pump in order to get a very limited drawdown of the water level in the well, one avoids the need to replace the water in the blind section of the well. Literature mentions water flows for micro-purging of maximum 1 ltr/min in large well water producing wells. In bad wells (plugged or in a clay layer) much smaller flows must be used. In all cases the water level should never drop below the top of the filter section.

Samples for trace metals are filtered under anoxic conditions on a 0.45 micron filter to remove any soil particles. Remaining soil particles would strongly increase the values obtained for trace metals. Anoxic conditions cannot be achieved when collecting a sample in a bottle so filtration is done directly in the field by mounting a filter on-line with a peristaltic pump and collecting the filtered water in a sample bottle for further analysis in the laboratory. Samples for volatiles are collected un-filtered. Samples for larger polar molecules like pesticides and PAH are not filtered either although they also sorb to soil particles. The molecules are so large that they will be filtered out and also sorbed to the plastic of the filter. Here slow purging prior to sampling is essential to get water without soil particles that have sorbed PAH, pesticides and other colloids like non- volatiles.

About the Author

Gerard van Dijk (53 years) is a hydrologist / environmental expert. After having worked in Africa on land and water management items (mainly erosion control) he started working at Eijkelkamp Agrisearch Equipment in Giesbeek the Netherlands as product specialist environmental research equipment. Currently he works as a trainer and consultant within the same company. Gerard van Dijk is member of the Dutch Standardisation Institute Committee on environmental field sampling standards.

Installation of a Quality Well filterpack + bentonite collar in a bailer bored casing

Literature Overview

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Arsenic Kit Now Approved for Use in Arizona

Industrial Test Systems Inc. (USA), is proud to announce that its Arsenic Quick II Test Kit, part number 481303, is now approved for regulatory use by small water systems in the state of Arizona. Arsenic Quick II offers users rapid on-site analysis of arsenic concentration in water without the need for expensive, cumbersome instrumentation. Detecting levels from 1 – 100 ppb, Arsenic Quick II offers sensitivity, accuracy, and safety that are unmatched by similar testing kits.

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Royce Technologies (USA) Announces Series 8500 Multi-Parameter Chemical Analysers

The Royce 8500 Series Multi-parameter UV chemical analyzers are manufactured and patented by **S::CAN** (Austria). These systems have a unique Xenon based optical sensor. ROYCE/S::CAN systems have been in use for years in Europe in the water and wastewater industries, both industrial and municipal applications. The only multi-parameter UV sensor available for insitu applications today, the 8500 Series system has been designed and built for the rugged applications found in plant process control and environmental monitoring. Designed to be mounted insitu, with the sensor continuously in the water being sampled, these rugged Royce sensors can be completely trouble free if the Royce JC Series Jet Clean system is utilized. The Jet Clean system has been proven over many years on all Royce insitu optical and electrochemical sensor systems. See us at WEFTEC 2005 in booth 8748 along with the “Power of One” at ITT. Royce Technologies is a leading worldwide manufacturer of water quality instrumentation. ITT Industries, Inc.(USA) supplies advanced technology products and services in key markets including: fluid and water management including water treatment; defense communication, opto-electronics, information technology and services; electronic interconnects and switches; and other specialty products.

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