

Go with the Flow

Low-flow sampling techniques improve sample quality and reduce monitoring program costs

By David Kaminski

Ground water is often sampled to determine its water chemistry, to see if the water is acceptable for human consumption, or to see if industrial activity may have caused contamination.

Sampling ground water from monitoring wells has traditionally involved “purging” the well to remove stagnant water that may not be representative of in situ ground water quality. Regulatory guidance often recommends purging a fixed volume of water from the well, usually three to five times the volume of water stored in the well casing and screen. This commonly results in tens or hundreds of gallons of water being purged from each monitoring well on a site and can exceed several hundred gallons per well where wells are deep or large in diameter.

To remove these large volumes efficiently, many practitioners resort to high pumping rates. In shallow wells, devices called bailers are repeatedly dropped into the well and retrieved to remove the purge volume required.

When Purging Isn't Best

While fixed-volume purging by bailing or high-rate pumping can adequately remove the overlying stagnant water from a well, allowing for representative samples in some cases, researchers have determined that these practices pose significant scientific and practical concerns (Figure 1). These include:

- ◆ High pumping rates and bailers can greatly increase the turbidity of samples, which can cause biased or “false-positive” analytical results for many common analytes and interfere with sample analysis. Filtering samples to remove turbidity can further alter sample chemistry (Puls et al. 1992; Heidlauf and Bartlett 1993).
- ◆ Bailers, while inexpensive to purchase, can introduce further bias or error in sample results due to aeration, sample agitation, surging, and accidental contamination caused by handling of the bailer at the well-head.
- ◆ In low-yield wells, complete dewatering of the well can aerate the sample water, stripping out volatile organic compounds and precipitating dissolved metals from samples, affecting sample chemistry (Giddings 1983). Dewatering can also lead to plugging of the well screen slots in highly mineralized waters, further reducing well yield over time.
- ◆ High pumping rates can cause mixing of chemically distinct water zones within the aquifer, diluting or averaging the sample over large vertical zones and often further spreading contaminants within the aquifer.
- ◆ Field technicians must properly handle the large volumes of purged water generated. Where the purge water is contaminated or regulatory requirements specify, it must be contained in tanks or drums and often removed for off-site treatment or disposal, increasing sampling costs.

- ◆ Excessive high-rate pumping of monitoring wells can lead to damage to the sand pack and annular seal, increasing the need for well maintenance at a minimum and possibly damaging the well beyond repair.

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Low-Flow Purging and Sampling

In contrast to traditional well-volume purging and dewatering, low-flow purging and sampling is a methodology that does not require removing large volumes of purge water from the well, avoiding the pitfalls of the traditional purging approaches.

Ground water is pumped at low-flow rates (less than 1 liter/minute or 0.25 gpm) from within the well screen, purging only the sampling zone rather than the entire well. This approach minimizes disturbance to the water in the well and surrounding formation, reducing turbidity in samples (Robin and Gillham 1987; Kearl et al. 1992; Powell and Puls 1993; Puls and Barcelona 1996).

Completion of purging using low-flow methods can be verified and documented using two approaches: (1) stabilization of selected water chemistry indicator parameters, or (2) comparison of data from conventional sampling and low-rate sampling.

In the first approach, selected water quality parameters such as pH, conductivity, and dissolved oxygen are monitored during low-rate purging, with stabilization of these parameters indicating when the discharge water represents aquifer water (Barcelona et al. 1994). In the second approach, data resulting from low-flow samples is compared to data from conventional fixed-volume purging, with comparable data verifying the equivalency of the two methods (Powell and Puls 1993; Shanklin et al. 1993; Kearl et al. 1994).



Figure 1. Common problems encountered in ground water sampling can lead to samples that don't reflect the true chemistry of the water.

This latter approach is typically used only in very low yield wells that don't produce sufficient water to allow continuous water chemistry measurements. While less than ideal, this approach is often viewed as being less intrusive than complete dewatering of very low yield wells.

Advantages of Low-Flow Purging and Sampling

The low-flow purging and sampling methodology offers several advantages over traditional purging methods. These include:

- ◆ Sample quality is improved through reduced turbidity and minimized degassing and volatilization. Since turbidity no longer measurably affects sample chemistry, sample filtration can be eliminated, further reducing sampling costs and analytical expenses (Figure 2).
- ◆ Sample accuracy and precision are also improved, allowing users to identify true trends in geochemistry and avoiding regulatory issues with suspected contamination and costly resampling to explain erroneous results.
- ◆ Sampling systems are simpler and less expensive, as the need for high-flow purging pumps is eliminated.
- ◆ Low pumping rates preserve the integrity of the filter pack and well seal and reduce the movement of fine sediments into the well, extending the useful life of the well and reducing the need for well maintenance.

Three Easy Steps to Proper Low-Flow Sampling

While low-flow purging and sampling methods may appear more complicated than simply pumping well volumes, it can be easily accomplished in three steps:

1. Adjust the flow rate of the pump to match the rate at which the well produces water (the yield rate).
2. Measure the water level in the well to achieve a stabilized level and avoid dewatering the well.
3. Monitor the selected water quality indicator parameters to determine stabilization and completed purging.

The equipment used for low-flow purging and sampling applications has evolved into automated, easy-to-use systems that are lightweight and highly portable. Where traditional well-volume purging required the user to carry heavy high-rate pumps, hoses, connecting wiring harnesses, and cumbersome generators, low-flow sampling can be accomplished using simple air-powered bladder pumps with small-diameter plastic tubing and microprocessor controls that can be powered by a small electric compressor or 5-pound CO₂ cylinder.

Water level control can be accomplished automatically through tie-in with the controller, and purging indicator parameters can be measured and automatically recorded, with advanced systems indicating when stabilization has been achieved.

Regulatory Acceptance and Operating Guidelines

Low-flow sampling, a new approach in the early 1990s, has since gained wide regulatory acceptance in the United States and other countries. More than 40 states currently have sites with approved low-flow sampling plans, and there are a number of state and federal guidance documents that offer information on proper low-flow purging and sampling procedures. In addition, the standards organization ASTM has just released their standard D6771 on low-flow sample purging and sampling methods. The practice is now in use at hundreds of sites including solid water landfills, power plants, manufacturing facilities, and military bases.

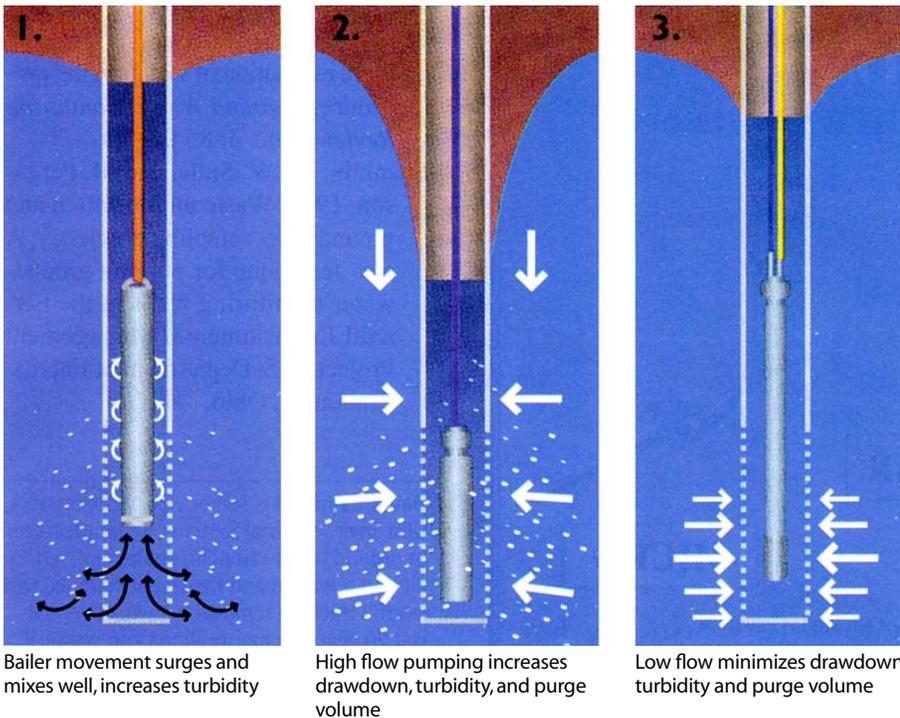


Figure 2. Samples obtained using low-flow methods show improved quality because of reduced turbidity and minimized degassing and volatilization.

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