Real-Time Nitrate Monitoring in Illinois Groundwater

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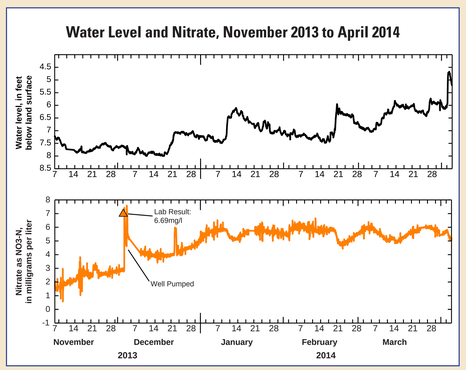
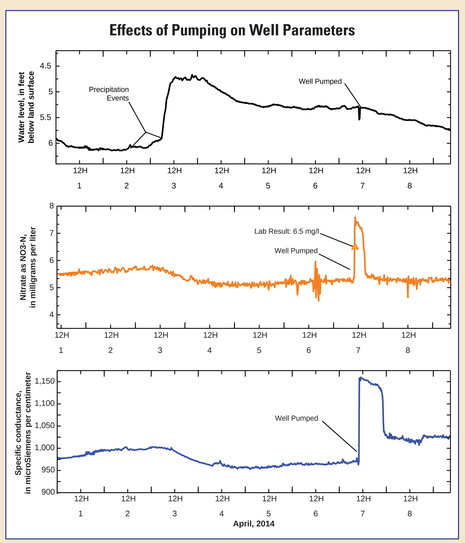
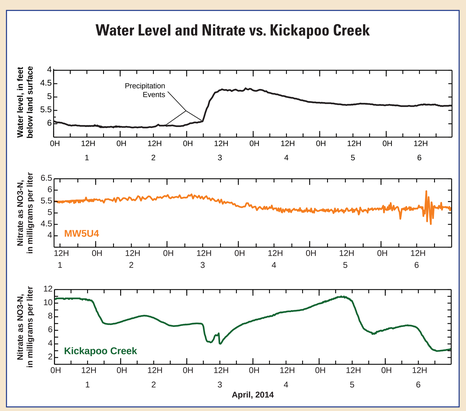
Abstract

Variability of nutrient concentrations in groundwater in response to seasonal or other temporal variability in nutrient applications and precipitation may play an important role in nutrient loading in streams. Collection of groundwater nitrate data at the frequency and duration necessary to best understand the mechanics and significance of the groundwater contribution to stream loads has been hampered by the approaches of typical data collection. Samples must be collected by a manually or automatically operated pump, often followed by laboratory analysis. Among other issues, manual collection can be labor and(or) travel intensive; automated collection can be restricted by limits on number of samples and holding times for analysis. Recent availability of an automated photometric sensor that can provide long-term, near-continuous groundwater nitrate data with real-time broadcast through satellite telemetry should greatly advance groundwater nitrate monitoring capabilities. The sensor determines concentrations by measurement of ultraviolet light adsorption by nitrate.

The capability of the automated sensor in a groundwater application is under evaluation at a 640 acre, agricultural/residential/prairie-wetland parcel at the lower end of a 9,000 acre, predominantly agricultural watershed near Bloomington, Illinois. The timing and stressors driving periodic fluctuations in groundwater nitrate concentrations are not well understood, nor the relation of these fluctuations to the variability of nitrate loads in the nearby streams. The largest nitrate loads in the streams occur in conjunction with larger precipitation events, particularly when near the time of field nutrient applications. The automated sensor has initially been installed in a site well that is located between the newly establishing residential neighborhood and the stream; subsequent installation is planned at a location downgradient of a field cultivated in row crops. Along with assessment of the performance and maintenance requirements of the sensor, it is anticipated that its use will prove valuable to better understanding of nitrate loading in the watershed.





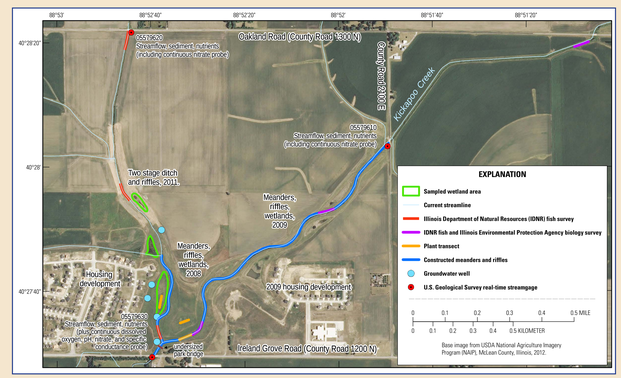


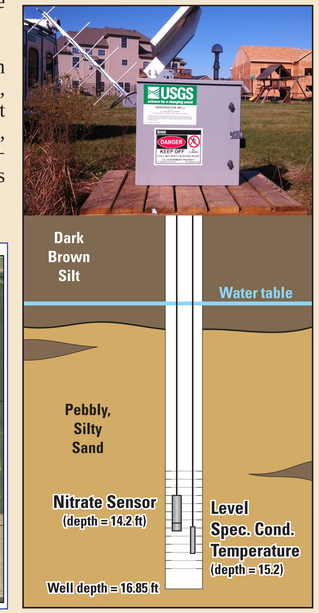
Site Description

The observation well is located downgradient of an establishing suburban housing development bordering a wetland and about 120 yards east of a tributary to Kickapoo Creek. The well depth is about 17 feet (ft), with a screened interval of about 12 to 17 ft. Lithology in the vicinity of the well consists of organic rich silt to about 10ft, with underlying pebbly silty sand. The water table is at an average depth of about 8 ft.

Nitrate is monitored by use of a HACH Nitratax* SC plus sensor. An In-Situ Aqua Troll* is used for measurements of water level, temperature, and specific conductance. The nitrate sensor is placed at a depth of about 14 ft, and the Aqua Troll at a depth of about 15 ft. These programmable, independently logging sensors are connected to a Water Log H522+ data logger* with GOES transmitter, which allows for near-continuous transmission of data for web accessibility.

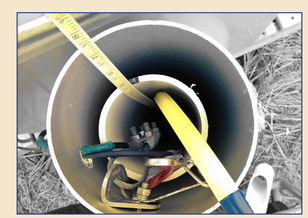
* Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

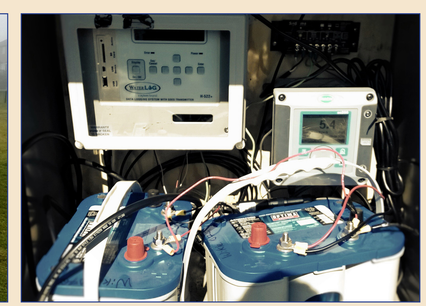




Deployment Requirements and Technical Issues

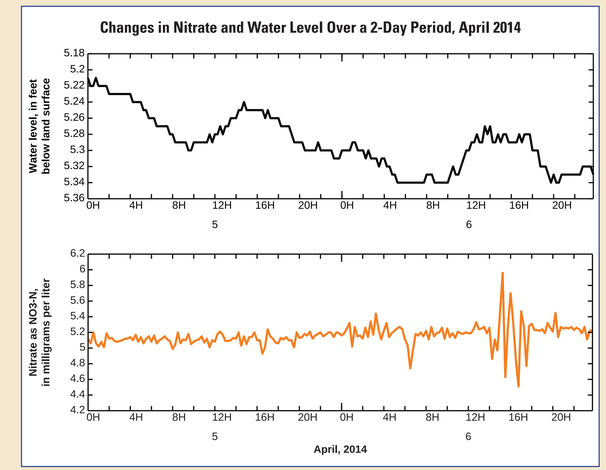
- 24 Volt power source to operate the nitrate sensor.
- A 4 inch or greater well diameter.
- Periodic sample collection and field measurements for instrument calibration.
- Equipment housing appropriately sized to allow ease of access while accommodating footprint concerns in sensitive settings.
- Limited memory for nitrate sensor to fully log values.
- Loss of power to instruments causes gaps in data.





Lessons Learned

- Adjust frequency of sensor measurements to smooth the data, thus reducing artificial sensor noise in nitrate readings.
- Develop a sampling schedule to capture comparative concentrations of nitrate during peak nutrient application periods.
- Changes in periodicity can signal a need for recalibration or removal of fouling.
- Optimize operational access of secured equipment by use of smaller batteries or larger housing.



Preliminary Implications

- Near continuous in-situ nitrate monitoring shows water quality changes in the well, but possibly not necessarily in the aquifer.
- Nitrate can vary by as much as +/- 2 mg/L in a single day.
- Depth to groundwater appears inversely related to nitrate concentration and specific conductance.
- Nitrate concentrations in the observation well show less variability than those found in nearby Kickapoo Creek over a several month period.
- Nitrate concentrations in the well likely are influenced predominantly by landscape application of fertilizers in the adjacent housing development.
- Derive a relation between nitrate loading in the nearby creek, and nitrate concentrations in groundwater at the well resulting from suburban application of nutrients.

Acknowledgments

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