Report as of FY2007 for 2006ID65B: "Evaluation of levels of success of diagnostic and remediation efforts for nitrate contaminated ground waters with application to the Ashton, ID area."

Publications

Project 2006ID65B has resulted in no reported publications as of FY2007.

Report Follows

ANNUAL REPORT: U.S. Geological Survey 104b Program
2005ID 55B and 55B(S): *Evaluation of temporal variation of the nitrate concentrations in ground-water of the Ashton, Idaho area and potential causative factors*
And
2006ID 65B: *Evaluation of levels of success of diagnostic and remediation efforts for nitrate contaminated ground waters with application to the Ashton, ID area*.

Project Summary

The two projects, *Evaluation of temporal variation of the nitrate concentrations in ground-water of the Ashton, Idaho area and potential causative factors* and *Evaluation of levels of success of diagnostic and remediation efforts for nitrate contaminated ground waters with application to the Ashton, ID area* are linked, and the status and progress of these two projects are therefore provided in this single report.

Beginning fall 2005, Mark Lovell received partial funding in support of a sabbatical leave from Brigham Young University-Idaho (BYU-Idaho). This leave provided the opportunity for Lovell to attend the University of Idaho, Idaho Falls campus full time for two semesters. In addition to completing course work, research time was focused on three main topics:

- Procedures and techniques used to identify ground water contamination problems caused by excess nitrates and associated mitigation efforts to remediate the contaminated aquifers.
- The successful components of developing an undergraduate research experience (URE) and the adaptation and development of an ongoing research hydrologic field study for undergraduates.
- Application of case studies for nitrate contamination and remediation to the Ashton, Idaho area.

The great majority of resources provided by the grants have been devoted to two parts of the proposals; first, establishing and performing field activities including collecting water samples from domestic wells, measuring water table elevations, and processing samples using an ion chromatograph to evaluate concentrations of fluoride, chloride, nitrate, and sulfate; second, working with undergraduate students, training them how to participate in data acquisition and processing of samples.

In addition to funding provided through these grants, BYU-Idaho has and continues to support this program in several ways. While on sabbatical leave, partial salary support was provided to Mark Lovell. In addition, approximately $20,000 dollars worth of lab & field equipment were purchased and additional lab consumables, leveraging the supplies and equipment provided through these two grants. Major equipment purchased through BYU-Idaho includes a bench top ion chromatograph (Dionex IC-90) with manual injection, a Hach multi-probe (Quanta) to monitor discharge water to allow verification of pumping fresh formation waters prior to collecting water samples, and an electric tape for measuring depth to water table.

In the Idaho Department of Environmental Quality's (IDEQ) ranking of Nitrate Priority (Neely, 2005) the Ashton, Drummond, and Teton area was identified to rank #8 on the State of Idaho's top twenty-five Nitrate Priority Areas. Located approximately 30 miles north of Rexburg, Idaho home for the campus of BYU-Idaho, this seemed to be an ideal area to establish a groundwater study focused on nitrate contamination (figure 1). The regional setting of the Ashton area consists primarily of agricultural activities growing grains, alfalfa, potatoes, and some canola, in addition to a few cattle operations where herds are fed through the winter and then transported to summer pastures. There are also a growing number of residential sites with septic systems including the small town of Marysville which is located up gradient to the direction of ground water flow that provides drinking water for the town of Ashton. This combination of potential sources for nitrates makes it difficult to identify a unique source for the observed contamination problems.

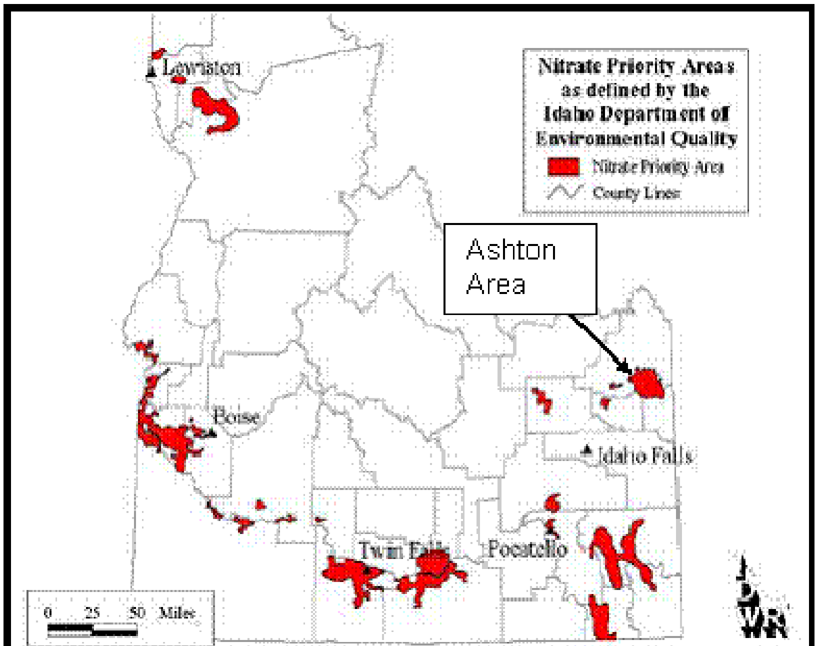

Figure 1. Nitrate Priority Areas modified from Neely 2005.

Funding was used to purchase two Hach Hydrolab-5 down-hole multi-probes, each with data-loggers, and probes for measuring nitrate, pH, specific conductance, and pressure transducers. The nitrate probes were known to have lower sensitivity (+/- 2 mg/l N as total Nitrogen) and a tendency to drift which required weekly calibration efforts. After deploying one of the probes in an abandoned well bore located approximately 10 feet from a small irrigation well, the data looked suspect (figure 2)

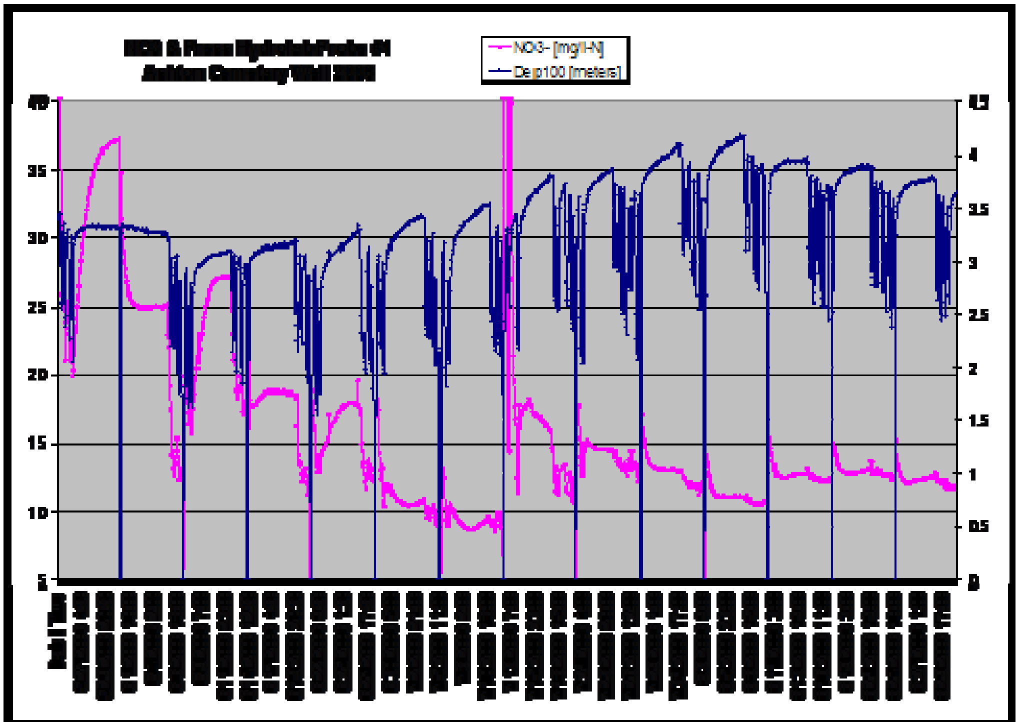

Figure 2. Nitrate and pressure data collected from probe #1.

In figure 2 we see the pressure response indicating water column thickness above the probe allowing identification of pumping events due to the associated drawdown. A zero value was added to the pressure data each time the probe was removed from the well for calibration. The observed nitrate concentrations appear to be diminished each time a pumping cycle occurs. This observation could possibly represent a type of mixing where shallow contaminated waters are being mixed with fresher water drawn in during the pumping cycle. Other observations of the data indicate that overall, nitrate concentrations were seen to decline throughout the year with the exception of the nitrate spike that occurred in mid July. In the small building which encloses the open well there is a sack of lawn fertilizer that is open. The spike may represent an inadvertent spill of some of the fertilizer on the floor that found its way into the well.

A second observation made possible from the data in figure 2 is the seasonal variation of the water table. The lowest observed water table is indicated to have occurred in early-June while the highest occurred in mid-August. It is interesting to note that maximum water-table elevation only persisted for about one week before beginning to decline.

To try and validate the nitrate response as seen by probe #1, the second Hydrolab was also deployed in the same well. Efforts were made to calibrate the probes on different days to allow one probe to be in the well monitoring when the second probe was pulled out, calibrated, data-downloaded, and then re-deployed. Figure 3 shows the data accumulated using probe #2 for nitrate concentration and for pressure/water table.

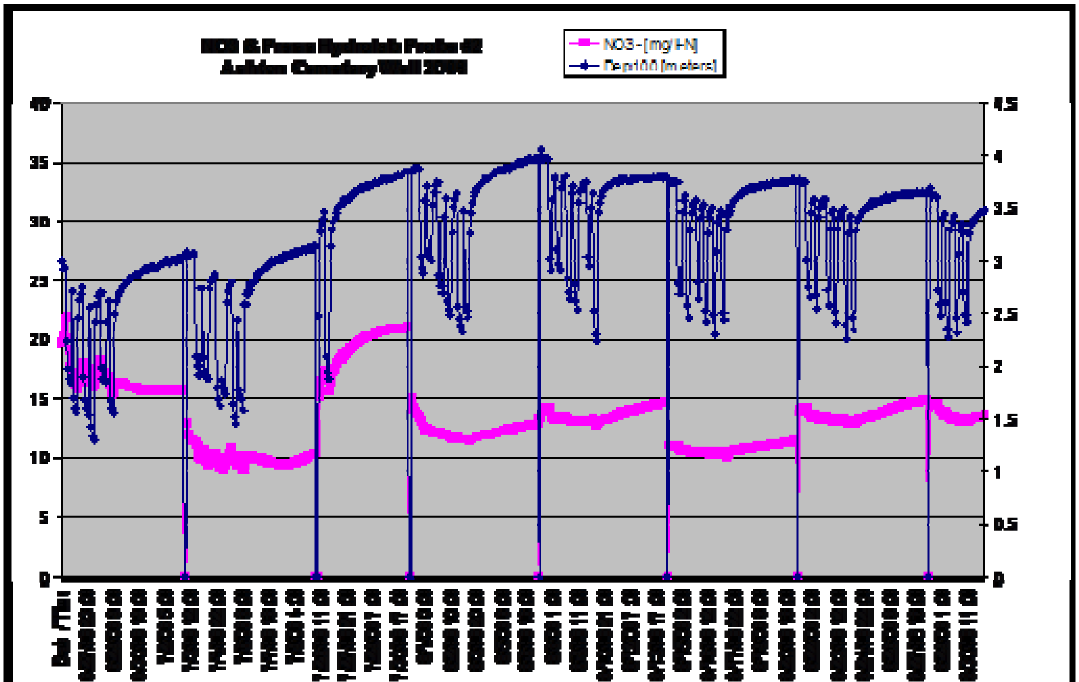

Figure 3. Nitrate and pressure data collected from probe #2.

Unfortunately, probe #2 experienced a mechanical (electronics) failure and several weeks worth of data were lost due to inability to communicate with the probe to download data and for the time lost while the probe was sent to the manufacturer for repairs. Figure 4 shows the nitrogen values for both probes compared on one chart. With the exceptions of the first week that probe #2 was used and the first week of use after probe #2 was repaired, the concentration of nitrates observed by the two probes is similar but there are differences in the shape of the responses that still needs to be evaluated.

The specific conductance of the water as measured by the Hydrolabs over the season showed a continuous trend to fresher waters from the start of measurements until about the end of July. Measurements by probe #1 show a step-wise patter because the wrong scale was selected for recording the data allowing the instrument to record 600 or 700 µS/cm (see figure. 5).

In addition to work related to using the down-hole Hydrolabs, water samples were also collected during the 2006 field season. Over 90 samples were collected from 21 sites using the Hach multi-probe to monitor water parameters at the time of pumping. Titrations using sulfuric acid were performed in the field to establish concentration of $CaCO_3$, and all samples were analyzed within 48 hours using the ion chromatograph (IC) to establish concentrations of fluoride, chloride, nitrate, and sulfate. The IC runs also analyzed samples for nitrite, bromide, and phosphate but these compounds were not detected.

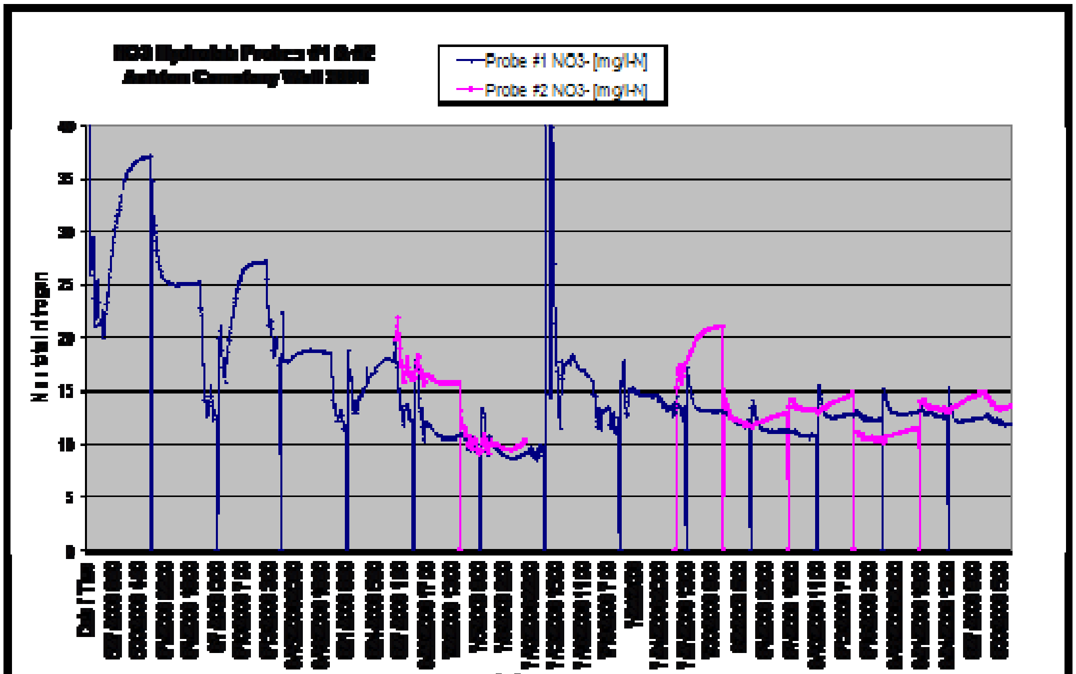

Figure 4 Nitrate values compared for both probes #1 and #2.

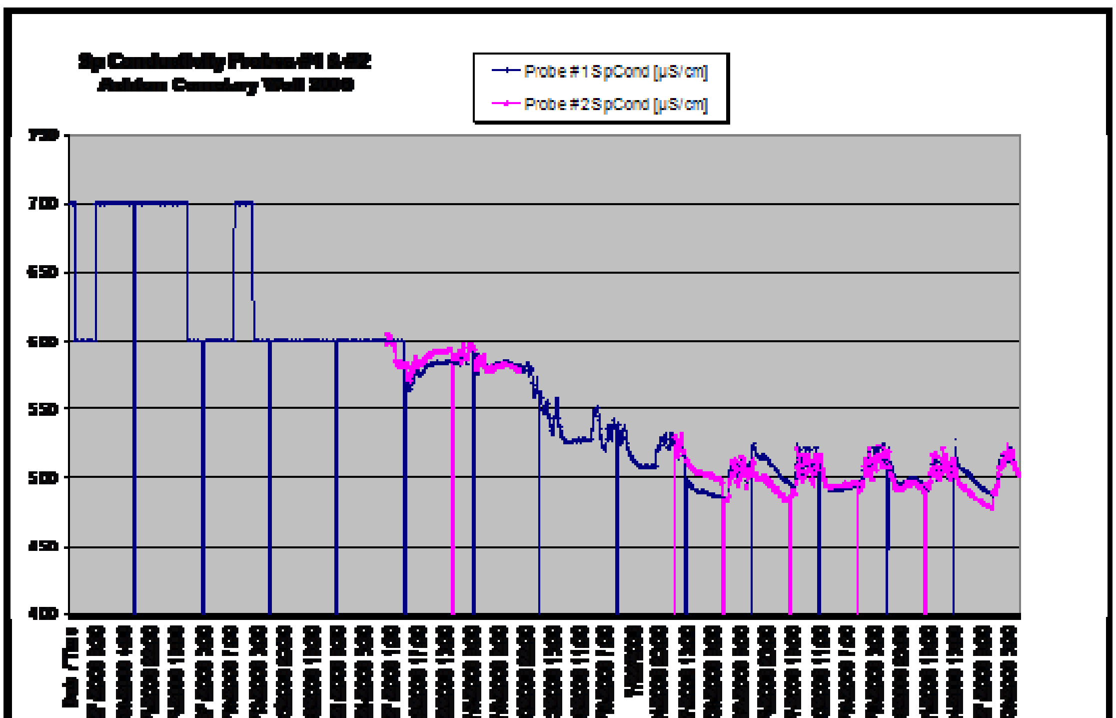

Figure 5. Probes #1 and #2 showing values for specific conductance.

After the first couple of weeks of sampling it became apparent that water table elevation information was highly desirable causing the abandonment of monitoring in some wells in favor of other wells which could be accessed for measuring water table elevations. Thirteen of the twenty-one sites sampled provided access to measure water table elevations. Work continues creating maps of the water table trying to represent the changes of elevation through time for the 2006 water season. The water table appears to act somewhat like a trap door, hinged along the Henrys Fork of the Snake River where the river has downcut into the aquifer. Numerous springs located along the south side of the river and projected elevations of the water table to the canyon wall based upon well measurements support this interpretation. To the south side of the valley, closer to Fall River, changes in water table elevation throughout the summer varied by nearly 10 feet while wells closer to the Henrys Fork showed only two-three feet of seasonal change.

Publications Resulting from the Project

None to date

Undergraduate and Graduate Student Researchers Supported

One PhD graduate student at the University of Idaho, Mark Lovell, has been funded by and participated in this research. Mr. Lovell has served as advisor and directed the work of multiple BYU-Idaho undergraduates in this project.

Undergraduate student participation has been one of the highlights of the project. For the 2006 sampling season, three undergraduate students at BYU-Idaho participated. One student graduated in geology in Dec. 2006. A second student, majoring in geology with a minor in chemistry will graduate Dec. 2007. The third student of the 2006 group is an agriculture major who was working part-time for the US Soil Conservation District in Fremont County.

These students help plan which wells to sample, contacted well owners asking permission, collected and processed samples. Water table and results from the IC analyses were also used in classes during the 2006/2007 school year. Equipment was used by the BYU-Idaho Geol 435 (Hydrology) course to collect samples from wells within the Ashton program as part of major projects for the class. Other students in the hydrology class also worked with the water table data trying to determine the extent of change through time and possible implications for direction of water flow in the subsurface and how it might change throughout the water season. Figure 6 shows one of the students who worked to process samples using the IC machine located in the George S. Romney Science building at BYU-Idaho.

Three additional students have been participating in the Ashton project in 2007.

Figure 6. BYU-Idaho student using the IC

Notable Achievements or Awards

None