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Advanced Technology Used to Monitor Ground Water in a Restricted Access Area of Fort Riley, Kansas

--J.D. Breedlove, P.J. Finnegan, and N.C. Myers

The purpose of this fact sheet is to describe how advanced communication technology is being used to overcome difficulties in collecting reliable ground-water data in areas with restricted access, such as at Fort Riley in northeast Kansas.

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Problem

Volatile organic compounds (VOCs) were identified in ground water from monitoring wells and in water from an intermittent spring in the Open Burn/Open Demolition (OB/OD) area at Fort Riley, Kansas. In 1997, Fort Riley requested that the U.S. Geological Survey (USGS) monitor ground-water levels and precipitation in an effort to determine the directions of ground-water flow and the hydraulic response of ground water and streamflow to precipitation. The area contains a complex hydrologic system where it is difficult to determine ground-water flow direction, if groundwater-bearing zones are interconnected, and where ground-water discharge points are located. The data collected will be used to help evaluate the fate and transport of VOCs in the OB/OD area.

The OB/OD area lies within a "buffer" area on the edge of artillery and mortar ranges at the post. The OB/OD area is used by Army personnel to destroy unserviceable ordnance. During detonation, some ordnance may be cast into the surrounding area where it poses a potential explosive hazard to personnel entering the area. This hazard is mitigated by having qualified ordnance personnel inspect and clear the OB/OD work areas prior to access by USGS and other personnel.

It is difficult to service traditional hydrologic data-collection instruments in a timely manner at restricted access areas. Traditional instruments, such as chart recorders or nontransmitting electronic data loggers, need to be serviced at regular intervals to collect recorded data and to ensure that the equipment is working properly and the data collected is of the highest quality.

Solution

Hydrologic data-collection platforms (DCPs) equipped with satellite telemetry and cellular-phone technology (fig. 1) are currently (March 1998) in use at the OB/OD area located at Fort Riley. During 1997, piezometers and monitoring wells were equipped with DCPs to measure and transmit ground-water-level data. Each piezometer was set to a different depth (nested, fig. 2) to allow monitoring of five or six water-bearing zones. The use of these technologies allow USGS personnel to overcome the difficulties inherent in collecting data at restricted access areas.

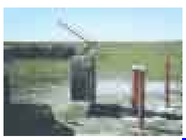

Figure 1. Hydrologic data-collection platform (DCP) using satellite telemetry and cellular-phone technology allow remote data collection in restricted access areas.

Figure 2. Nested piezometers.

Another benefit of using this advanced technology is the near-real-time availability of data. This availability allows surface- and ground-water sampling at the OB/OD area to be closely coordinated with changing hydrologic conditions.

Equipment

Equipment was selected on the basis of compatibility with the monitoring needs and restricted access conditions. Monitoring and data-transmission challenges included: finding sensors small enough to fit inside small-diameter piezometer casings; facilitating communication between the sensors and the data logger; and programming the data logger for satellite communication and cellular-phone capabilities. The equipment is housed in a 36-inch x 30-inch x 12-inch aluminum shelter (fig. 1). Precipitation data are collected with a tipping-bucket rain gage near one of the piezometer nests.

Because of the small (0.75-inch) inside diameter of the piezometers, a sensor that was smaller than 0.75 inch was required to measure ground-water levels. The only sensors available that were small enough to fit in the piezometers were those that send an analog signal. These sensors send a continuous direct current, the amperage of which varies according to the water pressure at the sensor's measurement port. The sensors' analog signals are converted to digital signals using a small converter wired between each sensor and the data logger.

The data logger used to record measurement values from the sensors can communicate with several analog-to-digital sensors over a single wire using Standard Device Interface (SDI-12) communication protocol. The SDI-12 communication protocol assigns individual addresses to each submersible sensor, simplifying the retrieval and storage of data.

Versatility was a primary requirement in selecting the data logger. It was necessary that the data logger collect and store data from several sensors, have the capability to be programmed and to transmit data over the cellular-phone connection, and transmit stored data once a day by GOES (Geostationary Orbiting Environmental Satellite) transmitter. The data logger was programmed to store data values hourly and transmit the data daily.

Data Transmission and Storage

USGS personnel can query and retrieve data from the data logger using the cellular telephone. Programming instructions and data corrections can also be sent by telephone. Without this capability and because of restricted access to the OB/OD area, the quality of the data could be less than satisfactory.

The U.S. Army at Ft. Riley limits transmissions at the OB/OD area so that there are no unexpected radio transmissions that could interfere with the demolition of ordnance. For this reason, a timer activates the cellular telephone for troubleshooting, reprogramming, or data retrieval between midnight and 1:00 a.m. The timer and cellular telephone are powered independently of the DCP so that the DCP can be programmed even if it stops functioning properly.

The DCP transmits hourly data once a day during a 2-minute window around midnight. The data are received by a USGS ground station and transmitted to the USGS office in Lawrence.

Preliminary Data

Currently (March 1998), data are being collected from piezometers and monitoring wells at the OB/OD area. Data collection at two piezometers began in September 1997. Collection at the third piezometer and the three monitoring wells began in December 1997.

Preliminary ground-water measurements from a piezometer are shown in figure 3. The observed ground-water-level fluctuations in the piezometer may be related to changes in barometric pressure and to flucutations of the water level in the aquifer. An increase in barometric pressure causes water levels in the piezometer to decline, whereas a decrease in barometric pressure has the opposite effect (fig. 3). This is typical of ground-water response in confined aquifers.

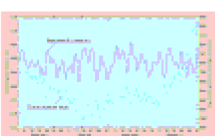

Figure 3. Hourly ground-water levels measured in a piezometer and mean daily barometric pressure measured at the Manhattan, Kansas Municipal Airport, September-December 1997. Ground-water-level data on file with U.S. Geological Survey, Lawrence, Kansas. Barometric pressure obtained from the National Climatic Data Center, Asheville, North Carolina.

For more information please contact:

District Chief
U.S. Geological Survey
4821 Quail Crest Place
Lawrence, Kansas 66049-3839

(785) 842-9909
email: waucott@usgs.gov