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Soil- and Groundwater-Quality Data for an Abandoned Cattle and Hog Feedlot in Henderson County, Kentucky

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Abstract

Groundwater samples collected from a livestock well in southwestern Henderson County, Ky., contained nitrate-N concentrations greater than 20 mg/L, two times the U.S. Environmental Protection Agency's maximum contaminant level. The well is located in an abandoned cattle and hog feedlot. The feedlot is located in an upland bedrock setting with Pleistocene loess overlying Pennsylvanian bedrock. One hundred twenty-one soil cores were collected to better define the areal extent of organic-rich soil believed to be the source of the elevated nitrate-N in the groundwater. Cores were collected on 25-ft centers to a depth of 4 ft below the land surface. Soil samples were analyzed for pH, bioavailable phosphorus, potassium, calcium, magnesium, zinc, organic matter, total nitrogen, and inorganic nitrogen (nitrate-N). Groundwater samples were analyzed for pH, specific conductance, temperature, oxidation-reduction potential, nitrate-N, chloride, herbicides, and nitrogen and oxygen isotopes. The resulting soil- and groundwater-quality data are presented in this report.

Introduction

Analysis of groundwater samples collected from a livestock well on a farm in southwestern Henderson County, Ky., revealed nitrate-N concentrations greater than 20 mg/L, which is above the U.S. Environmental Protection Agency's maximum contaminant level of 10 mg/L. After notifying the landowner about the elevated nitrate, we were informed that beneath this site was an abandoned cattle and hog feedlot, which was

suspected to be the source of the elevated nitrate in the local groundwater. How long the feedlot was in operation and how long it has been abandoned is unknown, but according to the landowner the feedlot was in operation for more than 30 years. Since abandonment, the feedlot has been incorporated into the surrounding pasture and is now hidden and cannot be visually defined. We therefore collected soil cores to better determine the location and areal extent of organic-rich soil typically as-

sociated with animal feeding lots. This report presents the soil- and groundwater-quality data associated with this project.

Because of health and family issues, the landowner asked us not to continue our research after the data in this report were collected, which explains the limited data obtained at this site. Funding for this research was provided in part by the University of Kentucky College of Agriculture through the Senate Bill 271 Research and Education Program.

Site Description

The study area is located on a farm (referred to as the Dixon farm) in southwestern Henderson County, approximately 3 mi south of Corydon (Fig. 1), in the Poole 7.5-minute quadrangle (Fairer, 1973). The Dixon farm is located in the Western Kentucky Coal Field, in

an upland bedrock setting with Pleistocene loess (15 to 30 ft thick) overlying Pennsylvanian bedrock (shale and channel-fill sandstone). Upland bedrock settings in the Western Kentucky Coal Field are characterized by broad ridges with shallow, wide valleys. The soil type at the abandoned feedlot is a loess-derived, well-drained Memphis silt loam (Converse and Cox, 1967).

Soil-Core Collection and Data Analysis

One hundred twenty-one soil cores were collected on 25-ft centers to a depth of 4 ft below land surface (Fig. 2). At the time of collection, soil cores were subdivided into 1-ft increments and placed in brown paper bags to be transported to a freezer, where the samples remained until analyzed. Cores were analyzed for pH, bioavailable phosphorus, potassium, calcium, magnesium, zinc,

organic matter, total nitrogen, and inorganic nitrogen (nitrate-N). All laboratory analyses were performed in accordance with analytical methods widely accepted in the literature. Table 1 lists the methods used to analyze each soil-quality parameter and the laboratory where each analysis was performed.

Appendix A (all appendices are available for download at kgs.uky.edu/kgsweb/olops/pub/kgs/water/IC20_12) contains chemical data for each core, divided into increments, for each of the 121 cores. The top 2 ft of each core were analyzed for pH, phosphorus, potassium, calcium, magnesium, zinc, organic matter, and total nitrogen. Phosphorus, potassium, calcium, magnesium, zinc, and total nitrogen were measured in parts per 2 million, which is equivalent to pounds per acre. Organic matter was calculated as percentage of carbon multiplied by 1.72, which gives the percentage of organic matter in the soil sample. The entire length of each core (0 to 48 in.) was analyzed for nitrate-N, which was measured in parts per million. The "<" symbol means the concentration was below the indicated method detection limit. Empty cells in the data table mean the soil sample was not analyzed for that chemical constituent.

Soil-Core Coordinates and Elevations

Latitude and longitude for each soil core were determined by using a survey-

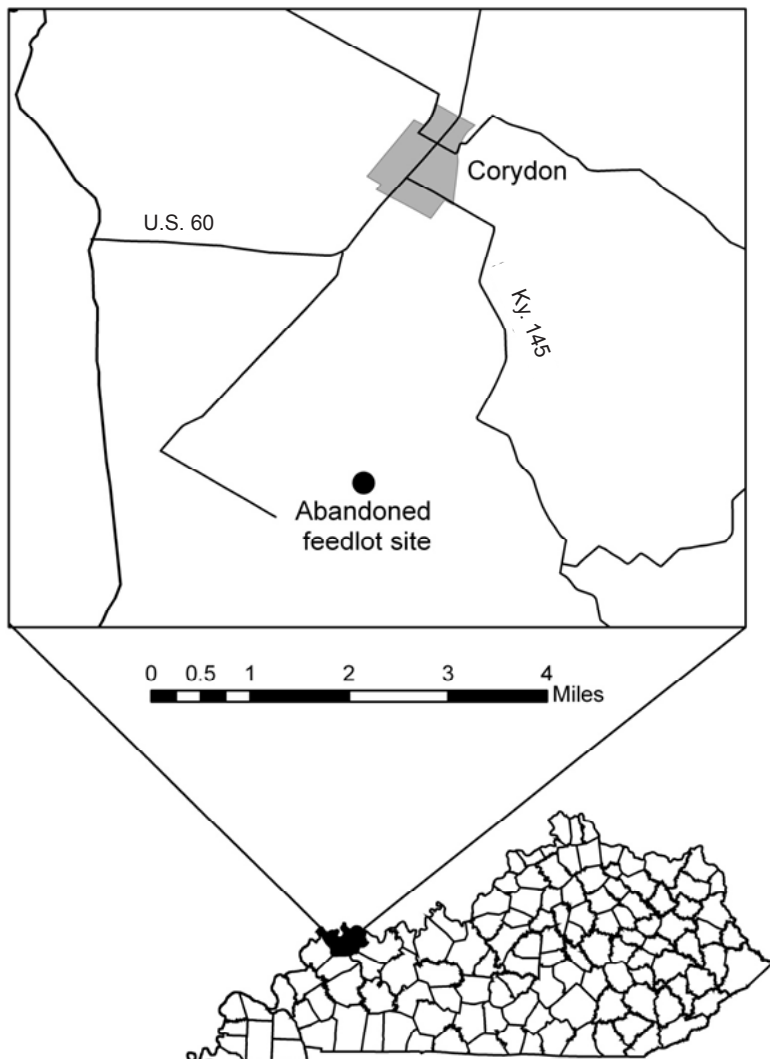


Figure 1. Location of the Dixon farm abandoned feedlot in Henderson County.

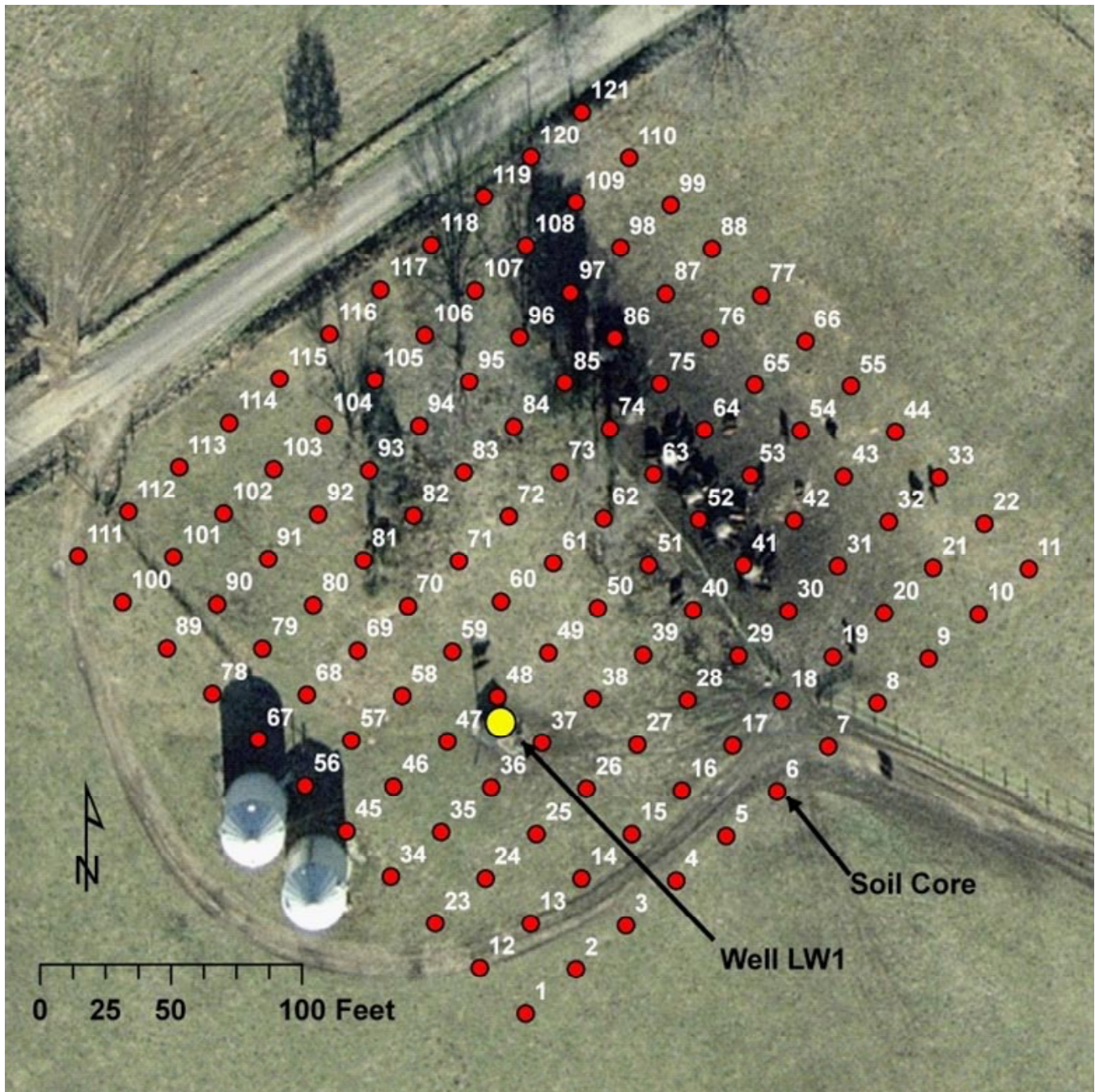


Figure 2. Soil core and livestock well (LW1) locations at the Dixon farm abandoned feedlot.

grade Trimble¹ GPS unit and ArcView GIS. The GPS unit was set up over four core locations in the field, and latitude and longitude coordinates were recorded for each site. These coordinates were used to digitize and project a base map into ArcView GIS. Latitude and longitude coordinates for each of the remaining core locations were recorded directly from ArcView GIS. Coordi-

nates for each core are in decimal degrees and based on the North American datum of 1983 (Appendix B).

Surface elevations were determined by using elevations from the four GPS sites. These sites were used as base stations from which the elevations for the other core sites were surveyed using an automatic level and rod. Surface elevations, bottom of corehole elevations,

¹The use of trade or product names is for descriptive purposes only and does not imply endorsement by the Kentucky Geological Survey.

Table 1. Methods used to analyze soil samples.

Analyte	Method	Laboratory
pH	Glass electrode in a 1:1 soil:water suspension	Division of Regulatory Services
Bioavailable phosphorus, calcium, potassium, magnesium, zinc	Mehlich III extraction (Mehlich, 1984)	Division of Regulatory Services
Organic matter and total nitrogen	Dry combustion (Bradstreet, 1965; Nelson and Sommers, 1996)	Division of Regulatory Services
Inorganic nitrogen (nitrate-N)	Colorimetry (Technicon Corp., 1965) and Greiss-Ilosvay method (Keeney and Nelson, 1982)	Chemical and Physical Edaphology

Table 2. Identification and construction data for the Dixon farm livestock well (LW1).

AKGWA Number ¹	Casing Type	Year Installed	Total Depth (ft)	Well Diameter (in.)	Water Level (ft)	Latitude	Longitude	Surface Elevation (ft above sea level)
0005-1533	steel	1940's	unknown	6	unknown	37.69530	-87.71977	458

¹Assembled Kentucky Ground Water Database

Table 3. Analytical methods conducted on groundwater samples. ELISA=enzyme-linked immunosorbent assay.

Analyte	Method	Preservative	Laboratory
Chloride and nitrate-N	SW846-9056	4°C	KGS
Pesticides	ELISA	4°C	KGS
Nitrogen 15 and oxygen 18	Flatt and Heemskerk (1997)	Filtered, HgCl ₂	University of Waterloo
Chloride	ion selective electrode (Orion, 1996a)	4°C	Western Kentucky office
Nitrate-nitrogen	ion selective electrode (Orion, 1996b)	4°C	Western Kentucky office

and corehole depths are listed in Appendix B. Surface elevations were recorded as feet above sea level.

Groundwater Sampling and Data Analysis

Table 2 presents construction information related to a livestock well (LW1) at the abandoned feedlot (Fig. 2). Well LW1 was sampled for pH, specific conductance, temperature, oxidation-reduction potential (recorded as Eh), nitrate-N, chloride, herbicides, and nitrogen and oxygen isotopes, all in accordance with U.S. Geological Survey guidelines for sampling and collecting groundwater (U.S. Geological Survey, 1980). The well was purged and sampled using the existing submersible pump.

Specific conductance, pH, and temperature were recorded using a Horiba U-10 water-quality monitoring system with a flow-through chamber. Oxidation-reduction potential was recorded using an Orion ORP electrode and field meter. Field measurements were recorded after purging three well volumes and after measurement stabilized. All field instruments were calibrated

daily during sampling using procedures prescribed by the manufacturers.

All laboratory analyses were performed in accordance with either U.S. Environmental Protection Agency methods or analytical methods widely accepted in the literature. Sample splits were prepared in the field and transported to the laboratory in properly sterilized bottles. If the analysis protocol required sample preservation, it was done at the time of collection, and a temperature of 4°C was maintained until the sample was delivered to the appropriate laboratory.

Water analyses were performed at the Kentucky Geological Survey laboratory, Environmental Isotope Laboratory at the University of Waterloo (Ontario, Canada), and the KGS Western Kentucky office laboratory. Table 3 lists the analyses performed, methods used, and required sample preservation for each laboratory.

Groundwater Data Format

Appendix C contains all groundwater-quality data collected at this site. The "<" symbol means the concentration was below the indicated minimum detection level. Chloride and nitrate-N samples were analyzed

using two different methods, which are identified in Table 3. Shaded cells in the chloride and nitrate-N columns indicate that the samples were analyzed using an ion selective electrode. Nitrogen ($^{15}\text{N}/^{14}\text{N}$) and oxygen ($^{18}\text{O}/^{16}\text{O}$) isotope ratios were analyzed from the ground-water nitrate molecule and are represented as $\text{NO}_3\text{-}\delta^{15}\text{N}$ and $\text{NO}_3\text{-}\delta^{18}\text{O}$, respectively. An empty cell in the data table indicates that water samples were not analyzed for those chemical constituents.

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