Groundwater Quality in Kentucky: Atrazine

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Introduction

Atrazine is an organic herbicide used for selective control of broadleaf and grassy weeds in crops such as corn, soybeans, sorghum, sugarcane, macadamia nuts, pineapples, pine trees, grasslands, and roses. Atrazine does not harm the crops, which can absorb and metabolize the herbicide, thereby removing the toxins. It controls targeted plants by inhibiting photosynthesis (Wilkes University Center for Environmental Quality, 2003). Atrazine is a white, odorless, crystalline powder that dissolves readily in water and does not occur naturally. It is widely used because of its low cost and ability to reduce crop losses from weed interference.

Atrazine enters the environment as an airborne spray on crops, and can be absorbed from soil by plants. It can be broken down over time (days to months) by microbial activity. It can also be washed from soil into streams or groundwater, where it takes much longer to degrade (Agency for Toxic Substances and Disease Registry, 2003). Fortunately, atrazine does not build up in the tissues of living organisms.

The health hazards of atrazine depend on two factors: the amount of toxin and the length of time over which a person is exposed to it. The U.S. Environmental Protection Agency has set a maximum contaminant level for atrazine of 0.003 mg/L. Acute exposure (a single incident of exposure higher than the MCL) can result in damage to the heart, lungs, and kidneys; low blood pressure; reduction of urinary volume; muscle spasms; and adrenal degeneration. Chronic or long-term exposure to atrazine at levels over the MCL may result in weight loss, cardiovascular damage, retinal degeneration, and mammary tumors (U.S. Environmental Protection Agency, 2005). Atrazine may cause cancer from long-term exposure at levels above the MCL.

Concentrations in Groundwater

Data Sources

Data for this report were compiled from the Kentucky Groundwater Data Repository, maintained by the Kentucky Geological Survey. The repository was established in 1990 to archive and disseminate groundwater data collected by various agencies in Kentucky. Major data sources for the repository include the Kentucky Division of Water, the Kentucky Geological Survey, the U.S. Geological Survey, the National Uranium Resource Evaluation Program, and the U.S. Environmental Protection Agency.

The database contained 2,166 analyses of atrazine from 129 water wells, 149 springs, and one swallet (a stream that sinks underground) throughout Kentucky as of November 2005. Results were excluded from the data set if they were from known or suspected sites of contamination, identified by regulatory programs such as the Resource Conservation and Recovery Act and the Solid Waste and Underground Storage Tank programs.

Of the 2,166 analyses, 2,137 were total atrazine (unfiltered groundwater) and 10 (all collected from the same site) were dissolved atrazine (filtered groundwater). The aqueous state of the remaining analyses was unspecified. Both dissolved and total values were included in the data set to improve statewide coverage.

Regional Variations in Atrazine Concentrations

Seventy-five percent of all measurements were less than analytical detection limits, and 99 percent of all reported concentrations were less than 0.003 mg/L (Fig. 1). The median value for atrazine in each of Kentucky's physiographic regions was less than 0.00006 mg/L. Atrazine was detected at 91 sites; 27 atrazine measurements at 10 sites were greater than the MCL of 0.003 mg/L (Table 1).

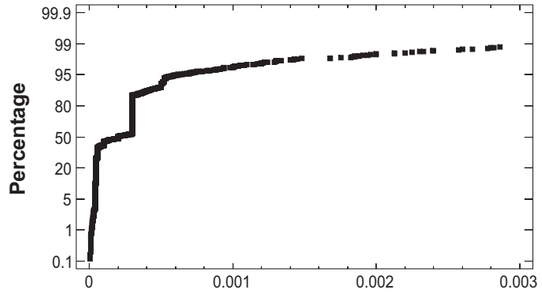

Figure 1. Cumulative plot of atrazine concentrations. Twenty-seven values greater than 0.003 mg/L were excluded.

Table 1. Summary of atrazine concentrations grouped by physiographic region.

Region	No. of Measurements	No. of Sites	No. of Sites Where Atrazine Was Detected	No. of Sites > 0.003 mg/L
Inner Bluegrass	198	27	11	0
Outer Bluegrass	202	41	14	0
Knobs	67	12	3	0
Eastern Ky. Coal Field	428	60	5	0
Western Ky. Coal Field	177	17	2	0
Jackson Purchase	176	35	2	2
Eastern Pennyroyal	84	15	2	0
Western Pennyroyal	834	72	52	8

The map shows locations where groundwater was collected for atrazine analysis; different symbols show concentration ranges. Sites that have been sampled more than once may have more than one symbol, and symbols may overlap if the sites are close to each other. Values reported as less than analytical detection limits indicate that atrazine was tested for but not found. Atrazine was detected in 75 springs, 15 wells, and one swallet throughout Kentucky, primarily in the Western Pennyroyal, Inner Bluegrass, and Outer Bluegrass Regions. Atrazine concentrations exceeded the MCL of 0.003 mg/L at eight springs in the Western Pennyroyal and two shallow wells in the Jackson Purchase.

The highest atrazine concentrations were found in groundwater from springs rather than wells. Figure 2 compares concentrations from wells and springs. In this plot, boxes enclose the central 50 percent of the values. The median values are shown by notches and vertical lines through the box, and lines extend from each edge of the box a distance of 1.5 times the atrazine range represented by the central box. Values beyond this range are shown as individual squares.

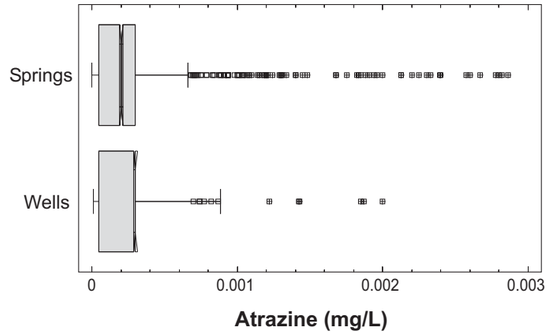

Figure 2. Comparison of atrazine concentrations in groundwater from wells and springs. Higher values were excluded to better show the majority of the data.

Water-Quality Concerns

Atrazine in Kentucky groundwater rarely exceeds the MCL. Most sites where atrazine exceeds the MCL are in the Western Pennyroyal Region, where extensive farming leads to widespread atrazine application and karst terrain allows rapid transport of atrazine from crop fields to the groundwater system.

Although not a major health threat, atrazine has been detected in nearly one-third of the sampled sites throughout Kentucky, mostly in springs but also in wells that are less than 200 ft deep. Detection of a man-made chemical such as atrazine indicates that nonpoint-source chemicals have entered the groundwater system. Best management practices have been developed to assist farmers in the most efficient application of herbicides to prevent weed growth as well as to protect the environment. Continued monitoring is needed to determine the extent of atrazine contamination and the need for additional best management practices.

These findings should be viewed as general patterns. Individual wells or springs should be tested for the occurrence of atrazine and other potential contaminants before being used as drinking-water supplies. Citizens with concerns about the quality of water in private wells or springs should contact their local health department or the Groundwater Branch of the Kentucky Division of Water, a division of the Kentucky Natural Resources and Environmental Protection Cabinet. The Groundwater Branch can provide literature on maintaining private wells and springs and information on sampling for water-quality analysis. Atrazine can be removed from water by treatment systems that use activated charcoal filters. The Kentucky Groundwater Data Repository receives new results of analyses periodically. To view the latest data, visit kgsweb.uky.edu/DataSearching/watersearch.asp.

The Kentucky Interagency Groundwater Monitoring Network

This publication is a product of the Kentucky Interagency Groundwater Monitoring Network, which was established in 1998 by legislation (KRS 161.625) to collect groundwater quality data, characterize groundwater resources, and distribute the resulting information. The network is assisted by an Interagency Technical Advisory Committee on Groundwater, which was also created by statute (KRS 151.629). Additional information and a list of member agencies can be found at www.uky.edu/KGS/water/gnet/gnet.htm.

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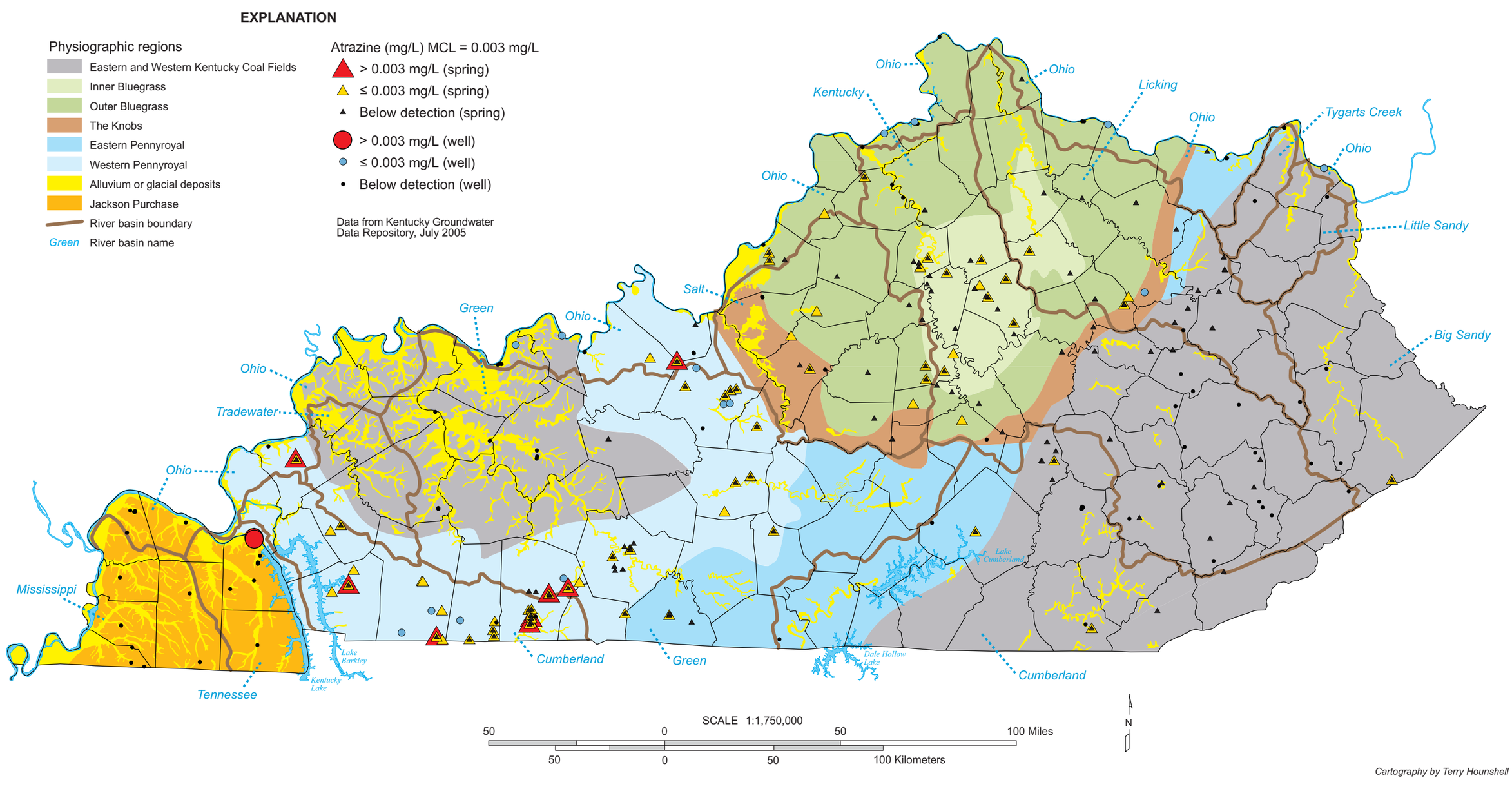
ATRAZINE CONCENTRATIONS IN WELLS AND SPRINGS IN KENTUCKY



Cartography by Terry Hounshell