

In cooperation with the Wyoming Department of Agriculture (WDA) and the Wyoming Department of Environmental Quality (WDEQ) with assistance from the Shoshone and South Big Horn Conservation Districts

Pesticides in Ground Water - Big Horn County, Wyoming, 1999-2000

In 1991, members of local, State, and Federal governments, as well as industry and interest groups, formed the Ground-water and Pesticide Strategy Committee to prepare the State of Wyoming's generic Management Plan for Pesticides in Ground Water. Part of this management plan is to sample and analyze Wyoming's ground water for pesticides. In 1995, the U.S. Geological Survey, in cooperation with the Ground-water and Pesticide Strategy Committee, began statewide implementation of the sampling component of the State of Wyoming's generic Management Plan for Pesticides in Ground Water. In 1999, baseline monitoring began in Big Horn County.

PESTICIDES IN GROUND WATER

Synthetic organic pesticides are used to control weeds, insects, and other organisms in a wide variety of agricultural and nonagricultural settings. The use of pesticides has helped to make the United States the world's largest producer of food (Barbash and Resek, 1996). Pesticide use, however, has also been accompanied by concerns about potential adverse effects on the environment and human health. A potential pathway for the transport of pesticides is through

hydrologic systems, which supply water for both humans and natural ecosystems. Water is one of the primary ways pesticides are transported from an application area to other locations in the environment (fig. 1) (Barbash and Resek, 1996).

Pesticide contamination of ground water is a national issue because of the widespread use of pesticides, the expense and difficulty of remediating ground water, and the fact that ground water is used for drinking water by about 50 percent of the Nation's population. Concern about pesticides in ground wa-

ter is especially acute in rural agricultural areas where over 95 percent of the population relies upon ground water for their drinking water (Solley and others, 1998), although application rates and the variety of pesticides used may be greater in urban areas.

WYOMING'S PESTICIDE MANAGEMENT PLAN

The Ground-water and Pesticide Strategy Committee (GPSC) has developed the generic State Management Plan for Pesticides in Ground Water for the State of Wyoming (SMP) (Wyoming Ground-water and Pesticides Strategy Committee, 1999). The SMP is required by the U.S. Environmental Protection Agency in order for individuals and organizations to continue using certain pesticides in Wyoming. The SMP includes information relating to individuals and organizations involved with the implementation of the SMP, methods of preventing ground-water contamination, ground-water monitoring, and what the responses will be if pesticides are detected in ground water.

One critical part of the SMP is ground-water monitoring. The ground-water monitoring program has two phases. The first phase involves baseline monitoring, which is an initial survey of pesticides in a county's ground water. The second phase is problem identification monitoring, which is used to gather more information about the ground water near wells with significant pesticide detections.

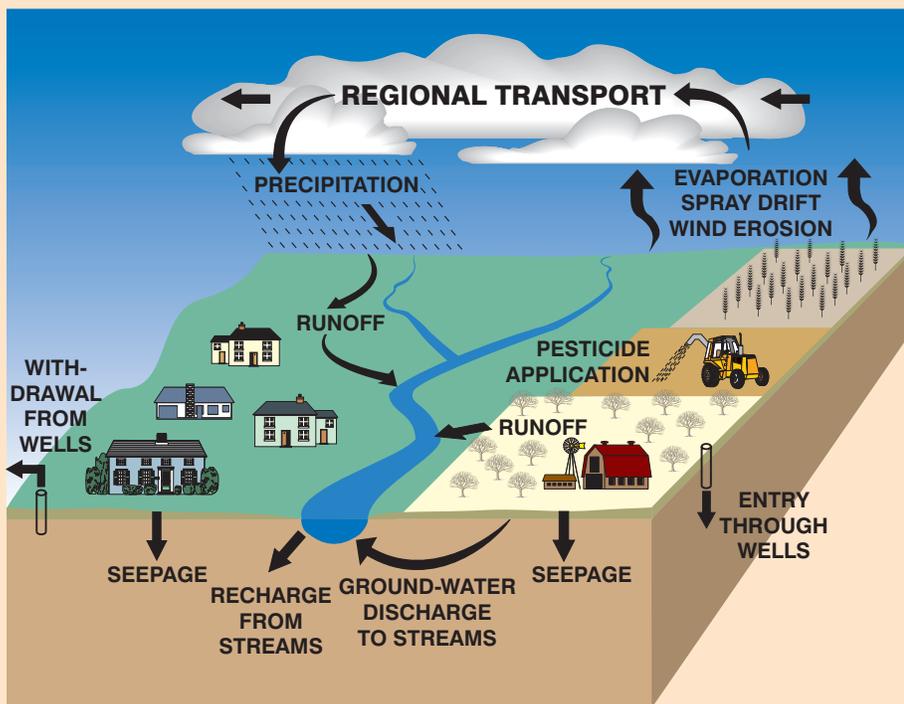


Figure 1. Pathways of pesticide movement in the hydrologic cycle (modified from Barbash and Resek, 1996).

Table 1. Baseline monitoring for pesticides in Big Horn County, late summer and fall/winter 1999 and spring 2000.

[$\mu\text{g/L}$, micrograms per liter; NA, not applicable; E, estimated]

Pesticide	Pesticide trade name	Pesticide action ¹	Number of detections/number of samples ²	Laboratory minimum reporting limit ³ ($\mu\text{g/L}$)	Maximum concentration ($\mu\text{g/L}$)	Average concentration of detections ($\mu\text{g/L}$)	Safe drinking water standard ⁴ ($\mu\text{g/L}$)
Focal pesticides detected in Big Horn County ground water							
Atrazine	Aatrex	Selective herbicide	25/30	0.001	0.02	0.008	3
Bromacil	Hyvar XL	Herbicide	1/27	0.04	0.1	NA	⁵ 90
DCPA	Dacthal	Selective herbicide	1/30	0.002	0.002E	NA	⁶ 16
Metolachlor	Dual	Systemic herbicide	7/30	0.002	0.008	0.005E	70
Metribuzin	Lexone, Sencor	Herbicide	2/30	0.004	0.007	0.007	⁵ 100
Picloram	Tordon	Systemic herbicide	1/27	0.05	0.3	NA	500
Simazine	Princep	Selective herbicide	3/30	0.005	0.01	0.009	4
Tebuthiuron	Spike	Herbicide	2/30	0.01	0.2	0.2	⁵ 500
Non-focal pesticides detected in Big Horn County ground water							
Prometon	Pramitol	Non-selective herbicide	12/30	0.02	0.3	0.08	⁵ 100
Focal pesticides not detected in Big Horn County ground water							
2,4-D	Aldicarb	Aldicarb Sulfoxide ⁷	Aldicarb Sulfoxide ⁷		Cyanazine	Hexazinone	
Alachlor	Aldicarb Sulfone ⁷	Clopyralid			Dicamba	Telone	
Focal pesticides not analyzed in Big Horn County ground water (no method of analysis available)							
		Difenzoquat		Metsulfuron			

¹Meister (1996)

²Each of the 15 wells was sampled twice. Three wells had only one analysis for bromacil and picloram.

³The laboratory minimum reporting limit is the lowest concentration at which a pesticide concentration can be quantified without estimation.

⁴EPA Maximum Contaminant Level unless otherwise noted (U.S. Environmental Protection Agency, 1996).

⁵EPA Lifetime Health Advisory Level (U.S. Environmental Protection Agency, 1996).

⁶WDEQ Drinking Water Equivalent Level (Wyoming Department of Environmental Quality, 1993).

⁷Degradation product of aldicarb.

Baseline monitoring is prioritized by a county rank and the vulnerability of the county's ground water to pesticides. During the development of the SMP, the GPSC evaluated each county in Wyoming to determine the potential vulnerability of the county's ground water to pesticides. Each county was ranked based on the extent of cropland and urban areas in the county, as well as the amount of pesticides sold within the county in 1991 (Wyoming Ground-water and Pesticides Strategy Committee, 1999).

A ground-water vulnerability map was prepared for the uppermost or shallowest aquifer by the University of Wyoming Spatial Data and Visualization Center. A Geographic Information System was used to overlay seven layers describing hydrogeology and land use. The map was used to assist in the selection of monitoring sites in each

county. The monitoring focuses on areas where the ground water is most vulnerable.

The GPSC selected 18 pesticides (focal pesticides) and 2 degradation products to be sampled as part of the SMP (table 1). The chemical analysis used to detect the focal pesticides can also detect 66 other pesticides and degradation products. Any additional pesticides detected are listed in table 1 as non-focal pesticides. Ground water from all wells in the baseline monitoring program was analyzed for the pesticides listed in table 1, with the exception of difenzoquat and metsulfuron, for which analytical methods were not available.

The goal of the ground-water sampling part of the SMP is to collect ground-water samples for pesticide analyses in all 23 Wyoming counties. To date, sampling has been completed in Goshen (1995-96), Park (1997),

Washakie (1997-98), Fremont (1998-99), Lincoln (1998-99), Laramie (1998-99), Big Horn (1999-2000), Sheridan (1999-2000), Platte (2000-01), Johnson (2000-01), and Crook (2000-01) Counties. Sampling is currently being conducted in Natrona, Sweetwater, and Teton Counties.

GROUND-WATER MONITORING IN BIG HORN COUNTY

The ground water in Big Horn County was ranked seventh most vulnerable to pesticide contamination in Wyoming (Wyoming Ground-water and Pesticide Strategy Committee, 1999). The vulnerability map (fig. 2), created by the Spatial Data and Visualization Center (Hammerlink and Arneson, 1998), identifies shallow alluvial and terrace deposits and some of the high mountain areas as the most vulnerable in the

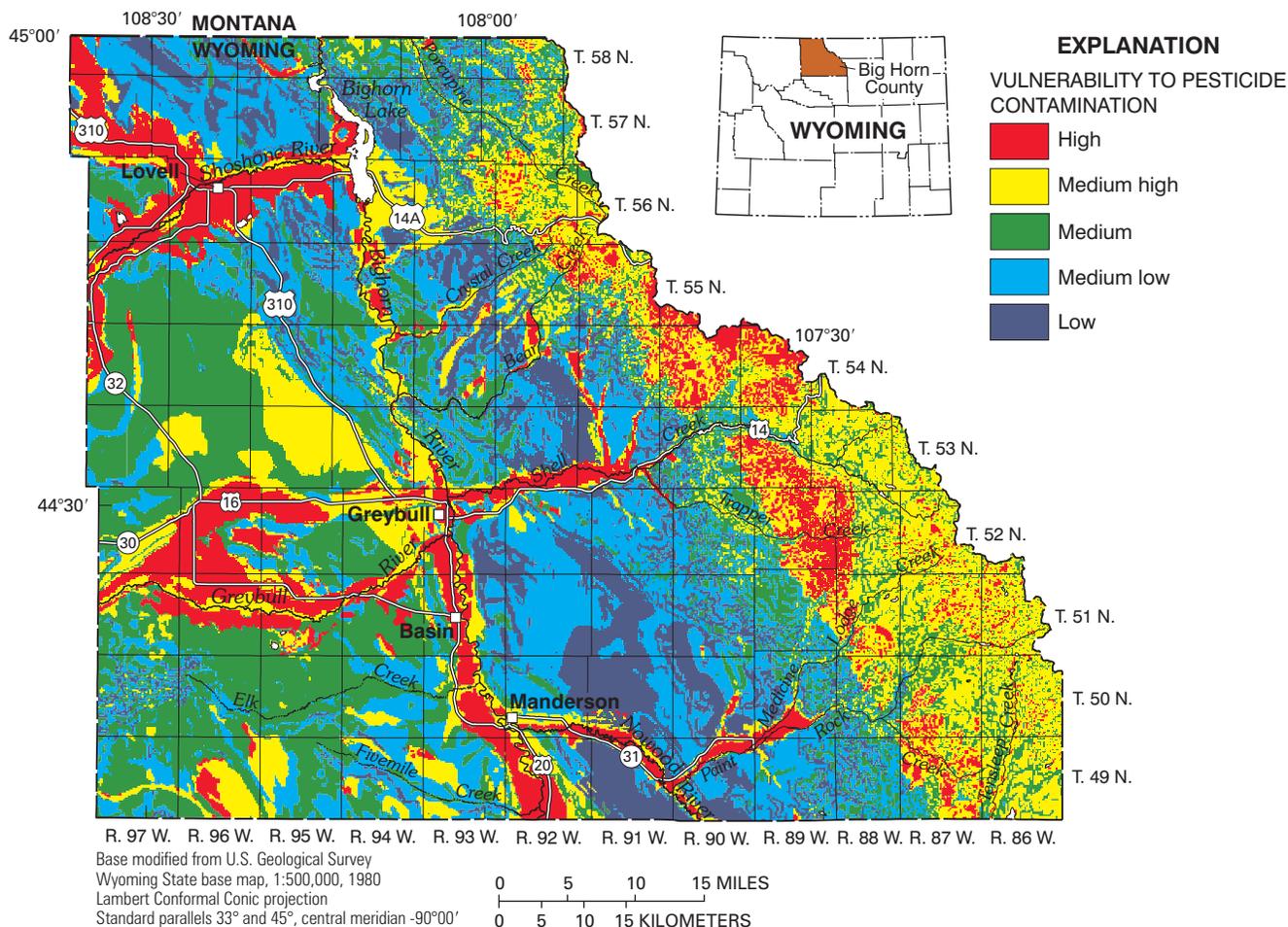


Figure 2. Vulnerability of Big Horn County ground water to pesticide contamination (from Hammerlink and Arneson, 1998).

county. The high mountain areas were not sampled, as pesticides are rarely used in those areas.

Fifteen wells were selected in Big Horn County (fig. 3) for baseline monitoring. All wells were located in Quaternary alluvial and terrace deposits deemed most vulnerable (shown as red on fig. 2). The wells were selected with the assistance of the Shoshone and South Big Horn Conversation Districts. All wells were sampled twice, in late summer or fall/winter 1999 and spring 2000.

Eight of the 18 focal pesticides and 1 non-focal pesticide were detected in Big Horn County (table 1). Pesticides were detected in all 15 wells sampled in Big Horn County; however, the concentrations of each pesticide detected were less than 1/100 of the applicable drinking-water standard (U.S. Environmental Protection Agency, 1996; Wyoming Department of Environmental Quality, 1993) (table 1). Many of the detections were less than the minimum reporting level at trace concentrations. A trace

concentration indicates that the pesticide was detected, but at a concentration too small to quantify without estimation. Trace concentrations are qualified with an "E".

The most commonly detected pesticide in Big Horn County was atrazine. Atrazine was also the most commonly detected pesticide in Goshen, Park, Washakie, Fremont, and Laramie Counties. Atrazine is an agricultural chemical typically used for weed control in corn and other crops (Meister, 1996).

The second most commonly detected pesticide was prometon (detected at 8 sites). Prometon is the active ingredient in Pramitol. Prometon is a general-use pesticide, and its detection is generally associated with urban land use (Barbash and others, 1999).

DATA DISTRIBUTION AND AVAILABILITY

The sampling results have been given to local groups interested in pesticides in

ground water in Big Horn County. The information can be used by citizens and local governments to help understand current conditions. Analytical results of the Big Horn County sampling can be found in Swanson and others (2000), and Mason and others (2001). Analytical results and fact sheets for all counties sampled to date are available from the U.S. Geological Survey in Cheyenne, either by phone, email, or the internet (<http://wy.water.usgs.gov/projects/pesticide/>).

REFERENCES

- Barbash, J.E., and Resek, E.A., 1996, Pesticides in ground water: Distribution, trends, and governing factors; in Gilliom, R.J., ed., Pesticides in the hydrologic system (v. 2): Chelsea, Mich., Ann Arbor Press, 588 p.
- Barbash, J.E., Thelin, G.P., Kolpin, D.W., and Gilliom, R.J., 1999, Distribution of major herbicides in ground water of the United States: U.S. Geological Survey Water-Resources Investigations Report 98-4245, 64 p.

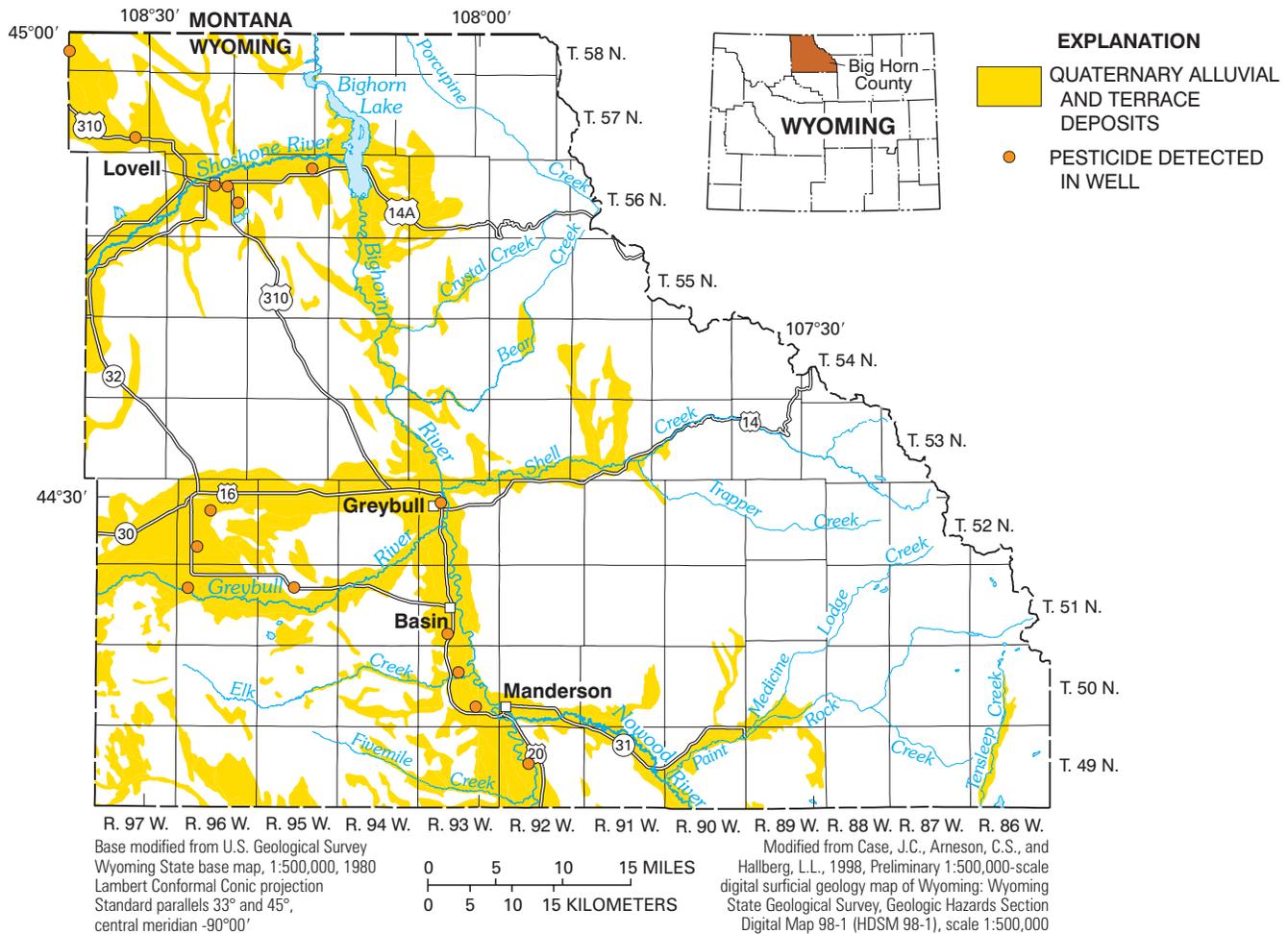


Figure 3. Location of wells sampled in Big Horn County, Wyoming, and notation of pesticide detection in each well.

Hammerlink, J.D., and Arneson, C.S., editors, 1998, Wyoming ground water vulnerability assessment handbook: Volume 2. Assessing ground water vulnerability to pesticides: University of Wyoming, Laramie, Spatial Data and Visualization Center Publication SDVC 98-01-2, variable pagination.

Mason J.P., Swanson, R.B., and Roberts, S.C., 2001, Water resources data, Wyoming, water year 2000, Volume 2. Ground Water: U.S. Geological Survey Water-Data Report WY-00-2, 117 p.

Meister, R.T., 1996, Farm Chemicals Handbook: Willoughby, Ohio, Meister Publishing Co., variable pagination.

Solley, W.B., Pierce, R.R., and Perlman, H.A., 1998, Estimated use of water in the United States in 1995: U.S. Geological Survey Circular 1200, 71 p.

Swanson, R.B., Mason, J.P., and Miller, D.T., 2000, Water-resources data, Wyoming, water year 1999, Volume 2. Ground Water: U.S. Geological Survey Water-Data Report WY-99-2, 125 p.

U.S. Environmental Protection Agency, 1996, Drinking water regulations and health advisories: EPA 822-B-96-002.

Wyoming Department of Environmental Quality, 1993, Procedures for establishing environmental restoration standards for leaking underground storage tank remediation actions, WDEQ/WQD Rules and Regulations, Chapter XVII.

Wyoming Ground-water and Pesticides Strategy Committee, 1999, generic state management plan for pesticides and ground water: prepared for Wyoming Department of Agriculture, Cheyenne, Wyoming, 103 p.

- Prepared by Cheryl A. Eddy-Miller and Jodi R. Norris
- Layout prepared by Suzanne C. Roberts

This document was prepared by the U.S. Geological Survey (USGS), the Wyoming Department of Agriculture (WDA), and the Wyoming Department of Environmental Quality, Water Quality Division (WDEQ). All agencies are members of the Ground-water and Pesticide Strategy Committee.

FOR MORE INFORMATION, CONTACT:

Jim Bigelow
Wyoming Department of Agriculture
2219 Carey Avenue
Cheyenne, Wyoming 82002
(307) 777-7324

Kevin Frederick
Wyoming Department of Environmental Quality, Water Quality Division
4th Floor, Herschler Building
Cheyenne, Wyoming 82002
(307) 777-7781

Cheryl Eddy Miller
U.S. Geological Survey, WRD
2617 E. Lincolnway, Suite B
Cheyenne, Wyoming 82001
(307) 778-2931
Email: cemiller@usgs.gov

This project has been funded in part with a Section 319 grant from the U.S. Environmental Protection Agency to Wyoming Department of Environmental Quality's Non-Point Source Program.

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