POTENTIAL SOURCES OF GROUNDWATER POLLUTION IN BARRON COUNTY, WISCONSIN

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Introduction

Barron County does not have serious, large-scale pollution problems at this time. However, the aquifers in this county are close to the land surface and their limited natural protection in many places leaves them vulnerable to pollution. Some land uses provide a source of pollutants and threaten to degrade groundwater quality. Possible sources of pollution can be grouped into the following four general categories:

1) Waste disposal
- solid wastes (sanitary landfills)
- municipal and industrial wastewater (lagoons, spray irrigation)
- land application of sludge, septage, and dairy waste (whey)
- septic systems (household wastewater)

2) Agricultural activities
- feedlot and turkey range management
- animal-waste storage (manure pits)
- fertilizer and pesticide application

3) Chemical storage
- petroleum products
- fertilizers and pesticides

4) Other sources
- spills and leaks of hazardous substances
- storage and use of salt for road deicing
- improperly constructed or abandoned wells

The large map, which shows the location of some activities that have a potential to pollute the groundwater of Barron County, was compiled on the basis of an inventory of potential sources of pollution conducted in 1985. Data were collected from the Wisconsin Department of Natural Resources (DNR) and U.S. Soil Conservation Service (SCS) files and field information. DNR personnel of the Spooner and Cumberland offices assisted in the collection of data on landfills, sewage lagoons, land spreading of sludge and whey, and spills; the staff of the SCS District Conservationist office in Barron provided data on manure pits, dairy farms, turkey farms, and chemical storage. Their help is sincerely appreciated.

Mechanisms of pollution

The mechanisms of pollution involve interactions between the source of pollution and earth materials, soil moisture, and groundwater. Groundwater in shallow aquifers is the most susceptible to pollution. Pollutants can enter shallow aquifers by percolating downward through the unsaturated zone or through improperly constructed or abandoned wells. Each type of pollutant enters and moves in the subsurface in a unique way. Some of the most common ways for pollutants to enter groundwater are illustrated in figure 1. In the subsurface, pollutants first travel downward within the unsaturated zone; after reaching the top of the saturated zone (the water table), they move in the same direction as groundwater. There they travel in relatively compact slugs or "plumes" along the flow paths.

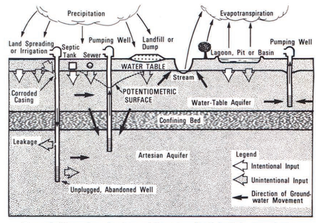


Figure 1. General mechanisms of the entry of pollutants to groundwater.

Waste disposal

Disposal of solid and liquid wastes on the land, in sanitary landfills, and in holding ponds can, if not located and managed properly, result in groundwater pollution. However, waste-disposal sites are regulated in the county, and there is no evidence that they have caused groundwater problems. Approximately 2,040 acres of agricultural land in Barron County are approved by the DNR for the application of municipal and industrial sludge. Most of the sites are located near communities to minimize the cost of transporting sludge (see map). Agricultural land is also used for spreading whey (dairy processing waste) by four cheese factories. These factories use approximately 2,390 acres around their plants in the southwestern, central, and northeastern parts of the county (see map). The DNR has approved the use of another 635 acres for spreading either sludge or dairy waste, provided the fields are covered with only one waste type per growing season. Spreading sludge and whey probably has only a minimal impact on groundwater in Barron County because sites are approved according to established state criteria. However, spreading septage (septic tank pumpings) is unregulated and uncontrolled. If septage is dumped in ditches or spread in vulnerable areas, it may create groundwater problems.

Septic tanks are common sources of groundwater pollution. Proximity of a disposal system to a well can create a serious pollution hazard. When a septic system fails to adequately treat the household wastewater before it reaches groundwater, pollutants can enter a nearby well. Proper location, installation, and maintenance can minimize these unnecessary cases of pollution. The Wisconsin Well Code requires a minimum distance of 25 feet between a well and septic system.

Agricultural activities

Animal waste produced, stored, and disposed of on farms is the major potential source of groundwater pollution in Barron County. Feedlots and turkey ranges are common here. In 1984, there were about 102,500 cattle in the county (2,900 beef cows, 50,700 calves, and 48,900 milk cows). The milk cows were held at 181 dairy farms, one-third of which had installed animal-waste storage facilities. The largest farms without storage facilities are shown on the map. Barron County is a leading producer of turkeys in Wisconsin; over 80 million pounds of turkey are produced and processed annually. Turkeys are raised on 20 farms around Barron and Cameron and in the southern part of the county (see map). The impact of feedlots and ranges on water quality depends on the volume of waste produced and the management practices at a given site.

As rainfall and runoff percolate through decomposing waste (on temporary manure piles in barnyards or on exposed exercise yards) and infiltrate into soil, bacteria and other potential pollutants (primarily nitrogen and chloride) are also carried into the ground. Moderate amounts of the pollutants are removed by the soil filtration process. If the source of pollution is concentrated--such as a manure pit--the soil filter can become overloaded and the excess pollutants will leach through the soil to shallow groundwater (fig. 2).

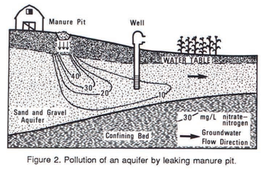


Figure 2. Pollution of an aquifer by leaking manure pit.

Earthen animal-waste storage facilities (by F.W. Madison). In recent years, earthen animal-waste storage pits have become increasingly popular on farms in Barron County. Storing manure allows farmers to spread when they have time and can avoid the problems associated with spreading on frozen ground, in deep snow, and during cold weather. In 1985 there were more than 210 animal-waste storage facilities in Barron County; 70 percent of them were lined with earthen materials (see map). As the number of earthen storage pits has increased, so has concern about whether or not they are leaking pollutants that might enter the groundwater system and pose a threat to that resource. Installation of animal-waste storage systems has been regulated by county ordinance since 1983.

Concern about earthen storage pits is twofold. First, does a seal form on the sides and bottom when animal waste is added and does the seal reduce leakage? Second, what happens to the seal, particularly on the sidewalls, when the pits are pumped out once or twice a year? Previous studies of a variety of earthen storage facilities, primarily in the southeastern United States, have shown that all pits leak when they are initially filled, and that eventually a seal--probably a biological one--forms and reduces leakage, but does not stop it entirely.

Investigations of manure pits lined with earthen materials have been conducted at several locations in Wisconsin. Monitoring wells were installed upgradient and downgradient from manure pits. Total nitrogen (three nitrogen species: ammonium, nitrate, and organic nitrogen) and chloride concentrations were chosen for study because of their mobility in soil and groundwater. Generally, total nitrogen and chloride concentrations were higher in downgradient than upgradient wells, and these concentrations increased after the pits had been emptied and were being refilled. Figure 3 shows seepage patterns observed around a manure pit in Shawano County. The changes in concentration indicated that the seal had broken as the pit was being emptied. When the pit was refilled, leakage was rapid until the seal formed again. Then leakage was reduced and concentrations of nitrogen and chloride dropped.

The study in Barron County focused on five pit (numbers 1 to 5 on the map) in relatively coarse-textured subsoil materials. Monitoring wells were installed around the pits; samples were collected monthly for approximately 2 years and analyzed for nitrogen species and chloride. The monitoring results for sites 2 and 4 were inconclusive because of equipment failures. The pit at site 1 was found to be leaking continuously. Funds were provided to enlarge the pit and improve the liner. Following reconstruction, however, the dairy herd was sold and monitoring was stopped because the pit was no longer in use. Cyclical fluctuations in nitrogen and chloride concentrations associated with pumping and refilling were apparent at site 3. At the last site monitored (site 5), no impact of the manure pit on groundwater was observed.

Do these studies imply that we should not build earthen animal-waste storage pits? No, they do not. Because we know how the pits and their liners function, we can site and design them properly. Pits should be installed where there is sufficient soil around the sides and bottom to attenuate those substances that seep out; pits should not be installed in areas where groundwater or fractured bedrock occur near the bottom of the pit. Careful site investigation and design by trained personnel are critical to the proper installation of earthen animal-waste storage facilities.

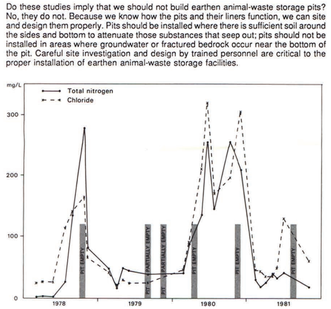


Figure 3. Chloride and nitrogen fluctuations in a downgradient observation well at a manure pit in Shawano County.

Fertilizers and pesticides are a significant part of the cost of crop production for a farmer. Loss of these chemicals to groundwater is an economic loss as well as a health hazard. In Barron County the impact of fertilizer and pesticide application may be significant because the application is concentrated on 200,170 acres of the total of more than 415,000 acres of farmland.

In 1985 approximately 85,000 acres in the county were planted with crops that require nitrogen fertilization. If too much nitrogen-based fertilizer is applied to agricultural land, the plants may not use it all, and the excess may be flushed into the groundwater, leading to its pollution (fig. 4). Leaching of nitrate is a problem, especially on sandy soils.

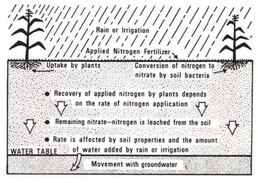
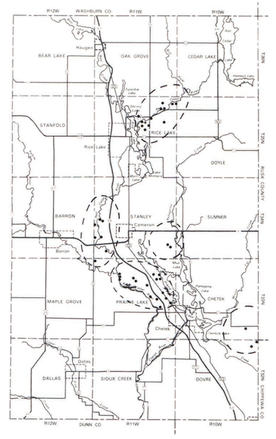


Figure 4. The path of nitrogen fertilizer in the soil.

Pesticide pollution of groundwater from agricultural uses is a relatively recent discovery. Most pesticides are held in the surface layer of the soil, where they degrade to harmless substances after they have accomplished their purpose. However, sometimes pesticides move into groundwater before they degrade. To assess the impact of pesticides in Barron County, the DNR is conducting two sampling programs on 55 wells in five rural areas of the county (fig. 5). Sampling is not randomly distributed; it is targeted toward the most susceptible areas where problems can be expected.

The first program is focusing on aldicarb, a pesticide used primarily on potatoes. Aldicarb presents a particular threat to groundwater because of its high solubility. Since 1981 Union Carbide has been analyzing well-water samples taken by the DNR for aldicarb; the DNR analyzes a limited number of split samples to assure accuracy. Twelve wells sampled in 1985 had detectable amounts of aldicarb, with one having more than the health advisory limit of 10 parts per billion (ppb). In 1986 an aldicarb-moratorium circle with a 2-mile radius was established by the Wisconsin Department of Agriculture, Trade & Consumer Protection (DATCP) around this well in the town of Prairie Lake. Eight of the twelve wells that had detectable amounts of aldicarb were also analyzed for nitrate, which was found in high concentrations. This indicates the impact of irrigated agriculture on the quality of groundwater.

In the second program, begun in June 1983, the DNR has been testing for several other pesticides. A small amount of atrazine, a herbicide used primarily on corn, was found in a well in the town of Prairie Lake. It apparently resulted from runoff from an unprotected storage area (David Herrick, DNR Northwest District, personal communication, 1986).



- Monitored well
- Well with aldicarb detected (1-11 ppb)

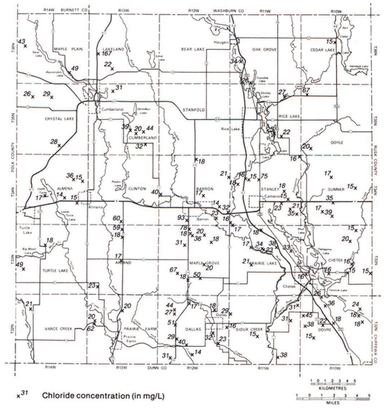
Figure 5. Aldicarb monitoring areas in Barron County, 1985 (Source: DNR aldicarb monitoring program).

Chemical storage and spills

Storage and transmission of a wide variety of fuels and chemicals is necessary for many industrial, commercial, agricultural, and individual activities. Storage tanks, mostly above ground, are used in Barron County for petroleum products and agricultural chemicals (see map). These substances are not a major source of potential pollution in the county. A total of 20 spills have been recorded in Barron County by the DNR from 1982 to 1985. Most of the spills were small (less than 200 gallons). Petroleum products are the pollutants by far most commonly involved in spills (65% of the cases); the pesticide atrazine was involved in four cases. Most of the spills were caused by careless handling or poor maintenance practices at storage sites and by accidents during transportation. The large volume and high concentration of hazardous substances that can be released from a storage tank in a small area always constitute a very high on-site pollution risk. Therefore, better management of all facilities and equipment used for storage of hazardous materials, careful transport of these materials, and immediate handling of spills by trained personnel can help minimize the risk of polluting the groundwater in the county.

Storage and use of salt for road deicing

Salt is commonly used in Barron County to deice roads and improve winter driving conditions. Barron County currently has six salt-storage sites; all are protected by sheds. Use of salt for road deicing may result in high salt concentrations in groundwater (measured by the content of chloride). Chloride concentrations currently do not pose any problems in Barron County; they are below the established standard of 250 milligrams per liter (mg/L). However, the results of a study conducted by the WGNHS in Barron County in 1983-85 suggest that salting roads may have an effect on groundwater. A total of 657 samples were collected from wells in Barron County and analyzed for chloride. Even though the amounts found are not alarming (mostly between 15 and 40 mg/L), about half of the 110 samples that had concentrations of 15 mg/L or greater were taken from wells along roads (fig. 6). Only long-term monitoring can confirm if gradual degradation of groundwater quality occurs along county roads.



x31 Chloride concentration (in mg/L)

Figure 6. Chloride concentrations in Barron County greater than 15 mg/L.

Poorly constructed and improperly abandoned wells

Water wells sometimes can serve as conduits for groundwater pollution. Typical examples are wells that have corroded or ruptured casings, or wells that have an inadequate seal in the annular space between the casing and the borehole (fig. 7). Serious pollution can also result from abandoned wells. If left unplugged, they permit water to migrate freely from one aquifer to another or from the land surface into an aquifer. The Wisconsin Well Code governs well construction and plugging of abandoned wells and prohibits the use of any well for disposal of waste or sewage, or for surface drainage.

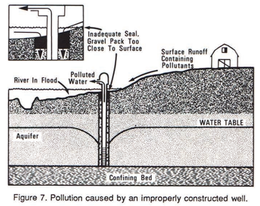


Figure 7. Pollution caused by an improperly constructed well.

Base from U.S. Geological Survey
1:100,000 map--Barron County, Wis. (1979)

SCALE 1:100 000
KILOMETRES
MILES

Potential groundwater pollution sources in Barron County

Land disposal of waste
- Landfills: existing, abandoned, monitored
- Sewage lagoons: municipal, industrial
- Areas approved for sludge application (* = abandoned)
- Areas approved for whey waste application
- Land spreading of industrial wastewater

Animal waste
- Manure pits: lined, unlined, monitored
- Dairy farms with herds of more than 70 animal units without waste storage facilities
- Turkey farms

Chemical storage and spills
- Petroleum product storage
- Agricultural chemicals storage
- Salt sheds
- Recorded spill incidents

Note: Location of sources is approximate. For details, see files of the Wisconsin Department of Natural Resources in Spooner and the U.S. Soil Conservation Service in Barron.

Map 87-2g
A part of the Barron County Atlas

Cartography by B.R. Haskins-Grahn

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