9-1998

Iowa Water Pollution -- Iowa Environmental Issues Series

Iowa Association of Naturalists

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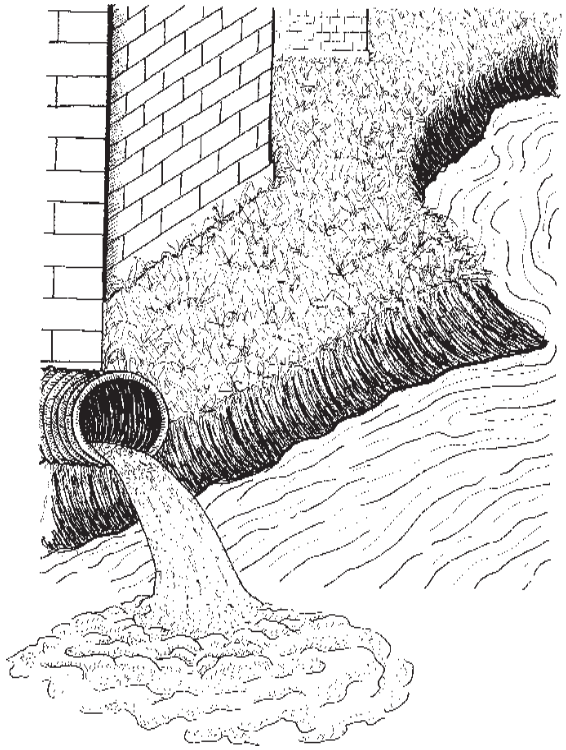


Iowa Environmental Issues Series

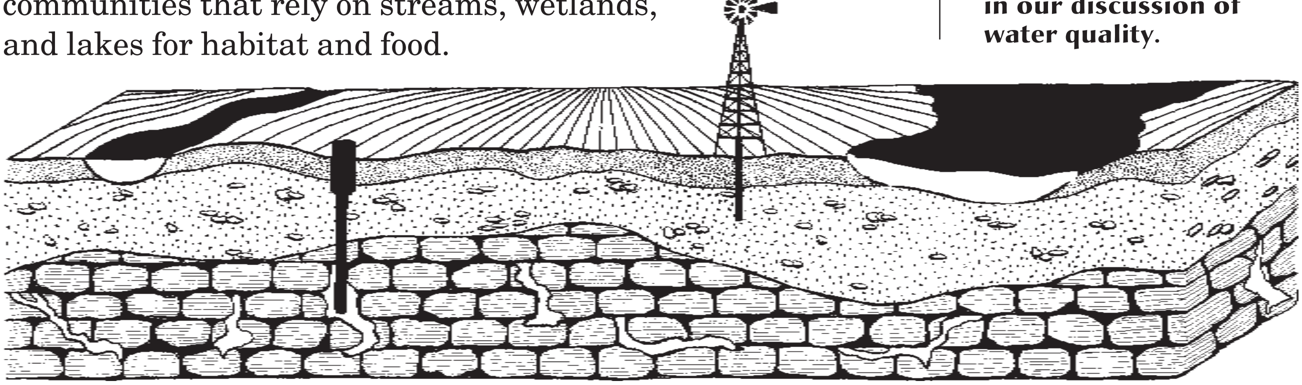
Iowa Water Pollution

The number one environmental concern

Ninety percent of Iowans say water quality is their number one environmental concern, according to a survey conducted in 1995 by Iowa State University. Iowans are more concerned about the quality of water resources and the quality of their drinking water than any other environmental issue facing the state.

Historically, people in Iowa looked at water pollution as a problem affecting people far away. Most people felt Iowa had clean, unpolluted water. However, during the 1970s and 1980s, the general public found that some of Iowa's water sources were, in fact, polluted. In some areas, the water was unsafe to drink due to high nitrate, pesticide, and bacterial levels. Contamination of water supplies was coming, not only from cities and industry, but from livestock and field runoff as well. Not only were there problems with water on the surface, but problems were beginning to show up in water deep below the surface.

To understand the problem of water pollution, one must look at the two major water systems: surface water and groundwater. Both systems are important to Iowans, since we rely on both systems to supply drinking water for people and livestock and for other uses such as irrigation and industrial production. In addition to human needs, quality surface water is necessary to support healthy wildlife communities that rely on streams, wetlands, and lakes for habitat and food.



Both surface water and groundwater systems are important in our discussion of water quality.

The surface water and groundwater systems

Surface water is the water we see in streams, rivers, wetlands, and lakes across Iowa. Every square mile of ground drains into one of these bodies of water. The area drained is known as a **watershed**. As smaller creeks and rivers feed into larger ones, the size of the watershed increases.

While surface water is found in the form of rivers and lakes, **groundwater** is stored in **aquifers**. Aquifers are formations of cracked rock, sand, or gravel that hold water and yield enough water to supply wells or springs. More than 95 percent of the world's usable water resources are stored in its groundwater.

Approximately one-half of all Americans depend on groundwater for their drinking water. In Iowa, 80 percent of all Iowans depend on groundwater for their drinking water, and more than 97 percent of all rural Americans, including rural Iowans, depend on groundwater for their drinking water supplies.

As people pump and use water from these underground aquifers, the water must be replaced. Aquifers are replenished or recharged by water seeping down through the soil from surface water supplies. In some parts of the country, groundwater supplies are very deep, and pollutants may be filtered out by layers of soil, sand, and gravel.

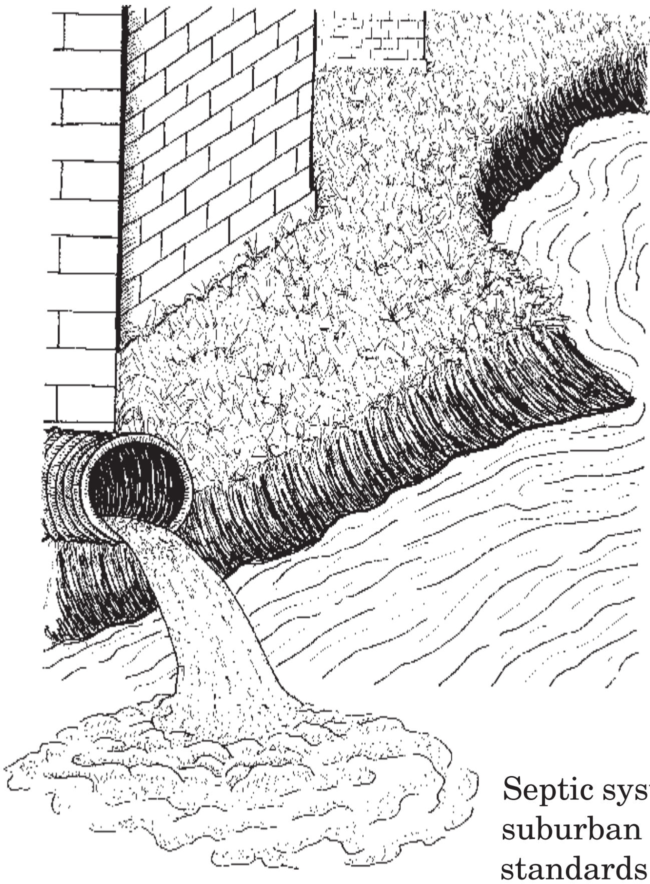
In parts of Iowa, there are more direct links to the groundwater. In some parts of north-central and northwest Iowa, the groundwater supply may come within a few feet of the soil surface. That's why this area of Iowa was once covered with wetlands and prairie potholes. In these areas, there is much less filtration by the soil and a greater risk of contamination by animal wastes, pesticides, and other pollutants. In other parts of Iowa, like the northeast corner, limestone sits just below the soil surface. This limestone layer, or karst, can crack, erode, and form caverns that allow water and any pollutants to travel with little filtering from the soil.

Non-point source and point source pollution

Non-point source pollution refers to pollutants that come from a widespread area and cannot be tracked to a single point or source. Soil erosion, chemical runoff, and animal waste pollution are all examples of non-point source pollution. Non-point source pollution is Iowa's major water quality problem by sheer volume and in terms of current and future economic costs to the state.

Point source pollution – also known as "the end of the pipe pollution"– can be traced to a specific source, such as a leaking chemical tank, effluents coming from a waste treatment or industrial plant, or a manure spill from a hog confinement lagoon. Although this may seem easy to control, there are economic, political, and other factors involved.

For known point source pollution threats, households, communities, industry, and agribusiness must deal with the problem of disposing of wastes and by-products. There are various levels of treatment that prevent dumping raw waste products from being dumped into surface waters. Industrial wastes may require special treatment to remove harmful chemicals before reentering the water system. For the more common problem of organic wastes, the three main treatment methods for treating waste water are septic systems, lagoons, and sewage treatment plants. Each method must be properly sized so that the treatment system is able to handle the volume of waste entering it. Septic systems are designed for individual households, lagoons may meet the needs of small towns, and sewage treatment facilities are necessary for larger cities.



Septic systems

Septic systems are generally used in rural areas to handle household wastes. They usually use a large tank buried in the ground to contain and break down household sewage. Attached to the tank is a series of perforated pipes that are buried in a drain field and are usually surrounded by crushed rock or gravel to facilitate drainage. Fats, oils, and grease, as well as large waste particles, are stored and later pumped out of the holding tank, while the water and suspended solids in the water flow into the soil through the perforated pipes. The soil around the septic system filters many harmful compounds, and bacteria break down organic matter.

Septic systems are most popular in rural and suburban areas and must be located in soils that meet standards for **percolation** or the ability to drain away water. Iowa Department of Natural Resource (DNR) standards require a maximum percolation rate of one inch of water in 60 minutes. A slow percolation rate allows soil bacteria to break down wastes as they move into soil layers. In Iowa, an estimated 25 to 35 percent of all homes use septic systems.

Septic systems are generally a greater source of concern for groundwater pollution than for surface water pollution. However, septic systems are a real concern for surface water pollution when they are located near lakes, rivers, and streams. Of particular concern are lakes with high concentrations of tourist homes.

Lagoons

Many communities, feedlot operators, and industries use lagoons to control wastes. A **lagoon** is simply one or a series of shallow holding pits into which wastes are pumped and treated. In a well-designed lagoon system, the material is aerated so bacteria can break down the organic matter. In municipal lagoons, the water generally stays in the lagoon for at least 30 days for this process to be completed. Then the water is removed and treated with chlorine as needed to destroy remaining bacteria. The remaining solids must be disposed of by spreading on farm fields or burying.

Lagoons are inexpensive to construct and operate compared to other systems. However, poorly constructed lagoons and lagoons built where the water table is very high have been found to leak. The most often found contaminant tends to be nitrates.

Treatment plants

Iowa requires two levels of sewage treatment. **Primary sewage treatment** simply filters out unwanted items such as sticks, stones, garbage, and other debris that arrive at the treatment plant and allows time for the solid materials to settle out. **Secondary treatment** uses aeration and **aerobic**, or oxygen-using, bacteria to break down organic wastes. The water is then treated with chlorine to kill bacteria and discharged into adjacent rivers and streams.

Treatment plants remove approximately 90 percent of the organic waste and suspended solids, less than 70 percent of the toxic metals and synthetic organic chemicals, 50 percent of the nitrogen in the form of nitrates, and 30 percent of the phosphorus in the form of phosphates. This remaining discharge is still high in nutrients and is not pure water entering the surface water. More advanced treatment systems are available, but they are rarely used due to their high cost. The remaining sludge is sent to a landfill as waste or applied to the land as a soil additive.

Each of these systems is designed to reduce point source pollution from specific sources. However, poorly-constructed or old septic systems, overflowing or ruptured lagoons, and heavy rainfall and flooding of treatment plants all occur in Iowa and may cause serious point source pollution problems.

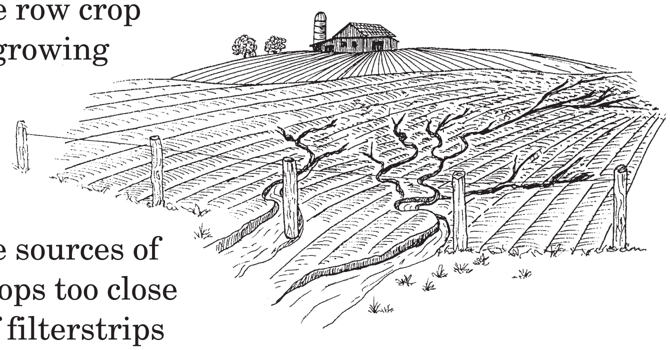
Erosion, pollution, and siltation of waterways

With point source pollution, treatments plants and monitoring can help deal effectively with the problem of water pollution. However, in Iowa, the number one source of surface water pollution by volume is soil erosion. Soil erodes into nearby streams, rivers, and lakes, causing numerous problems. When we think of erosion, we think of gullies and other visible signs. However, this is only a small, although important, part of the problem. Almost all tillable land in Iowa is susceptible to **sheet erosion** where heavy rain causes a thin layer of soil to wash off the field into ditches, lakes, or streams. The movement of soil into water supplies is known as **siltation**. The wind may also carry away and erode soil. This soil is often seen on winter snowbanks along Iowa roadsides near fields that have been tilled in the fall.

Iowa's landscape has changed greatly in the past 150 years.

Just a little more than 150 years ago, Iowa was a prairie state. Today, much of Iowa is an intensively-farmed agricultural complex. In 1860, fewer than one million acres of Iowa's land were planted in corn or soybeans. By the mid-1990s, more than 27 million acres – about 75 percent of the land– were crop land. This presents a particular problem as row crops traditionally tend to increase erosion compared to grassy areas.

In the first 100 years of farming, some portions of Iowa with steeply sloping lands lost about half of its topsoil to erosion. The problem began once the prairie cover was broken and land was laid bare to the effects of wind and rain. Between 1940 and 1970, larger farm equipment, federal farm policies, and



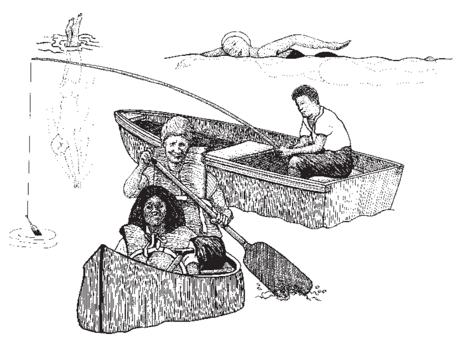
improved corn hybrids led to more intensive row crop farming, epecially on steep, marginal corn-growing land. Soybeans were also increasing in popularity as a row crop, replacing cover crops such as oats or alfalfa.

Of course row crop farming is just one of the sources of erosion and sediment pollution. Planting crops too close to rivers and streams without the benefit of filterstrips increases the likelihood of soil runoff from fields into waterways. Livestock grazing on pasture land with a stream or river running through it may increase erosion if the livestock have unlimited access to the waterway.

Agriculture, although a primary source of erosion problems, is not the only problem. Road ditches during periods of heavy rain or spring thaws may wash soil into nearby creeks and streams. Road construction and building sites in towns and cities are often sources of heavy runoff while the soil is left unprotected.

These combined sources cause serious sedimentation problems for Iowa and other midwestern states. First, many large cities depend on rivers and other surface water supplies for their drinking water. Many times, the soil brings along pesticides, nitrates, and other chemicals. The soil and chemicals must be removed from the water to make it safe to drink. This is especially a problem after heavy rains.

In addition, soil erosion is costly in terms of recreational value. Estimating damages to recreational areas is difficult, pollution and sedimentation do affect aquatic animals and fish. Without a doubt, muddy, polluted water is less desirable to swim in, but how can a cost be determined?



Many of Iowa's lakes are actually dammed-up rivers and streams. As the flowing river water slows down in a dammed reservoir, the soil particles drop out of the water, depositing a layer of silt on the lake floor. Over time, this silt builds up into thick layers. The only solutions, once an area has silted in, are to dig out the mud or raise the level of the dam—both costly undertakings.

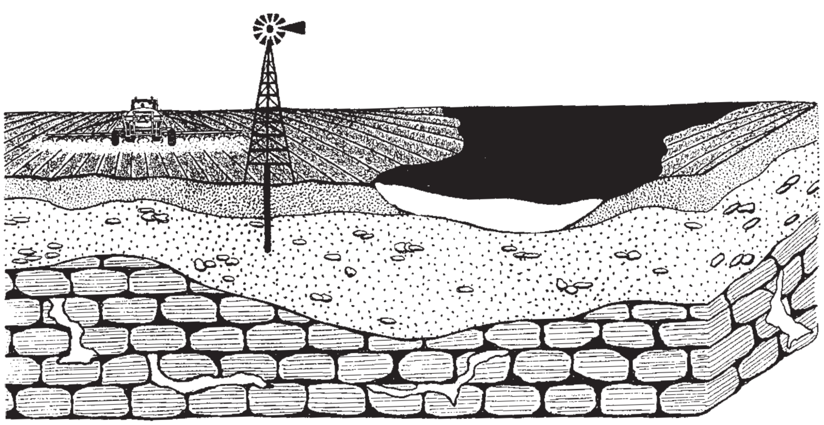
Pollution through pesticide contamination

The pathways for pesticides are different for surface water and groundwater. Surface water contamination may occur when pesticides are sprayed near water and drift over waterways. Contamination may also occur when soil and pesticides are washed into surface water by heavy rains. This contamination may come from urban areas, lawns, golf courses, parks, or agricultural fields.

Runoff pollution is difficult to control. The best method of control is limited use of chemical pesticides. Alternate methods, outlined later in this booklet, should be used whenever possible, with chemical solutions used as a last resort.

Groundwater contamination with pesticides tends to be more of a problem in rural areas. First, pesticides have been shown to percolate or move through the soils to groundwater supplies. The speed and amount of movement depends on whether the pesticide is water-soluble, the soil type, the amount of rain, and the proximity of the water table to the surface. Over time, nearly all pesticides break down to other chemicals as they are exposed to sunlight and air. Generally, it is these base chemicals that are detected in groundwater.

Wells are holes drilled to reach supplies of groundwater.



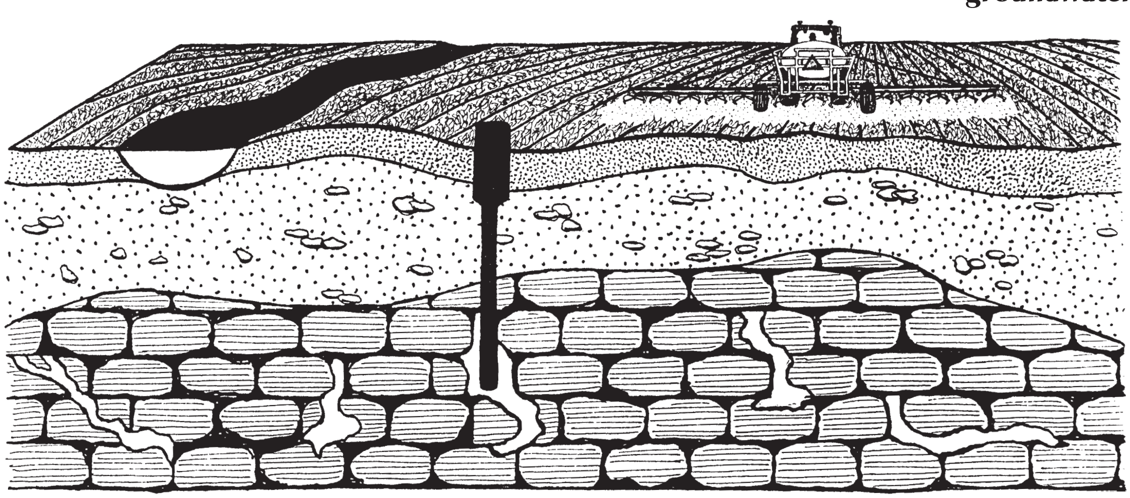
Pesticides may also move to groundwater through abandoned or poorly constructed wells. A **well** is simply a hole drilled to the water supply and lined with pipe or tile. Sometimes the slope of the land will cause water to run toward the well from areas that have been sprayed with pesticides. If the well is not protected properly or if the pipes or tiles are old or cracked, the pesticides may contaminate the well and reach the groundwater. This tends to be a problem with older wells that may have been abandoned and are no longer maintained.

Another source, especially in north-central Iowa, are **agricultural drainage wells**. Much of this area of Iowa was covered with wetlands. Because of the flatness of the land, early farmers dug deep wells to drain water from the wetlands to the groundwater. The water was drained from the soil so the land could be farmed. These agricultural drainage wells are generally located in prime agricultural land and surrounded by fields where chemical fertilizers and pesticides are applied.

Contamination depends on how the drainage system is constructed. In most cases, the water must filter through soil before reaching tiles that feed into the drainage well. This tends to remove silt and the majority, but not all, pesticides. The biggest problem is with nitrates which are soluble in water. One study indicates that 85 percent of the water samples taken from these wells exceed the safety standards set for nitrates.

Construction of these wells has been prohibited since 1957, but drainage wells existing before the law are still actively used. The only solution would be to block or cap the wells, but crop yields may decline or the land may not be suitable for farming as the land reverts back to wetlands.

Some agricultural drainage wells provide direct pathways for pollutants to enter groundwater.



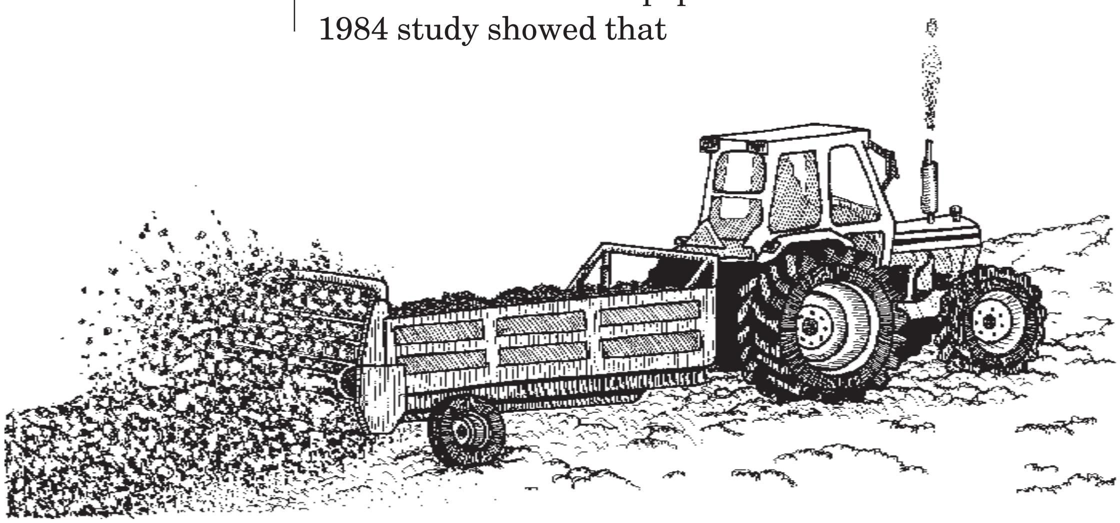
Fertilizer and manure : The nitrogen problem

The use of animal manure as fertilizer is a centuries-old practice that has helped increase farm production. By recycling waste products, essential nutrients and minerals are added to the soil. Primary among these nutrients is nitrogen, along with other minerals and trace elements that plants need. There are many forms of nitrogen found in the soil and it is essential for plant growth.

The forms of nitrogen that cause problems as pollutants are the nitrate and ammonium forms. The nitrate form is water-soluble and moves with the water into surface water or groundwater. The ammonium form attaches to soil particles. It is of less concern for groundwater pollution, but it will wash into surface water if the soil erodes.

In the early 1960s, several inexpensive artificial forms of nitrogen such as anhydrous ammonia became popular **amendments** or soil additives. The use of nitrogen increased yields, but it also increased the possibility of nitrogen in the nitrate form running off fields, leaching out of the soil, and into surface water supplies. Today, both synthetic and natural fertilizers cause nitrate problems if not managed properly.

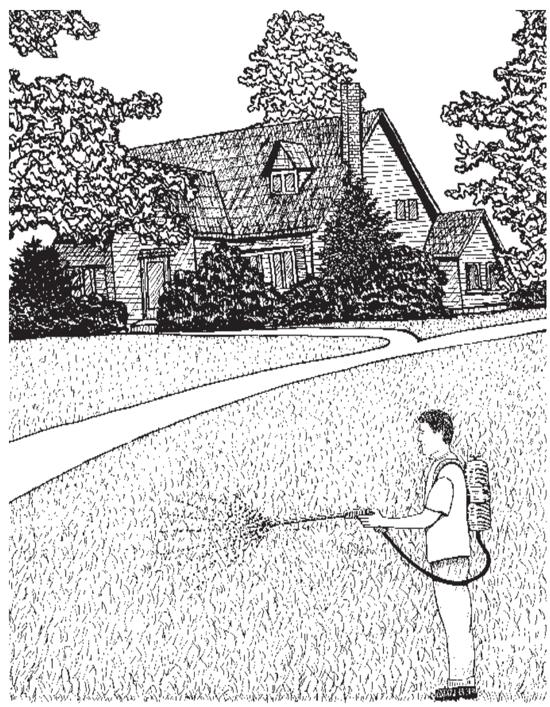
Groundwater contamination by nitrogen has also increased significantly since the 1960s. Again, this mirrors the time when cheap nitrogen fertilizers like anhydrous ammonia became available and popular. A 1984 study showed that



Pollutants in Iowa groundwater

Iowa has conducted regional studies throughout the state that clearly indicate the presence of pesticides in groundwater supplies. In 1988 and 1989 a statewide rural well water survey tested for 27 different pesticides. Of the 27 pesticides, 11 were detected, as well as five other chemicals that occur when pesticides break down. One or more pesticides were detected in nearly 14 percent of the wells tested. It is important to note that there is great uncertainty and difference of opinion as to the effect of these low levels of pesticides on human health. Some researchers suspect it as a source of increased cancers in rural populations, while others view it as relatively harmless. There is not enough current information to reconcile these different opinions, although Iowa health officials are conducting long-term studies to help answer the questions.

It's not just an agricultural problem



While people often point a finger of blame at farmers, urban dwellers also contribute to the problem of water pollution. Chemical fertilizers and pesticides are sometimes more heavily used on lawns, roadsides, golf courses, and parks.

The U.S. Environmental Protection Agency has found that 91 percent of American households use pesticides, while another report found that homeowners use more pesticides per acre than do agricultural users. Furthermore, while farmers and commercial applicators must be trained in the application of chemicals, most homeowners are not trained and are often more prone to over-apply chemicals.

To limit the use of chemicals, homeowners can take several measures. First, prevent weeds rather than use herbicides to kill them. The best way to prevent weeds is to develop a dense grass cover. When watering, soak the lawn occasionally to a depth of four to six inches to grow a deep-rooted grass. A strong turf will choke out weeds. Also, control weeds by allowing your grass to grow longer. Mow to a height of three inches or more. Longer grass will prevent weeds and crabgrass by robbing them of light.

Second, prevent household pests by robbing them of food and water rather than using chemical pesticides to control them. Fix leaky faucets and search out other forms of moisture such as water in trays under house plants. Damp areas attract pests. Keep flour and grains sealed tightly in glass or plastic containers to discourage insects. Don't leave pet food and bird seed where pests may find them. Plug holes around windows where pests may enter your home.

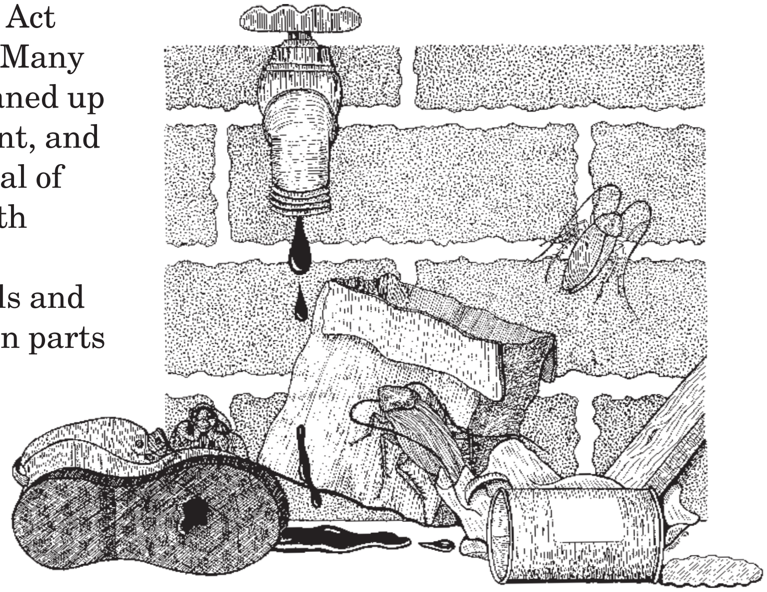
In addition to chemical use, urban areas contribute to water pollution through treatment plant discharge. As we saw earlier, most city treatment plants remove only a portion of chemicals like nitrates before discharging the water. While there are treatment systems available to remove more wastes, they are very expensive to install and operate.

Pollution from hazardous wastes, storage tanks, and pipelines

While the biggest potential threats to water quality in Iowa are from soil, nitrates, and pesticides, toxic chemicals may also contaminate water supplies. There are about 19,000 abandoned hazardous waste sites across the U.S. that have been identified, and there may be more that have not been discovered.

In addition to toxic waste sites, nearly every large city and most counties have landfills that are used to dispose and bury non-hazardous waste. However, there are no guarantees that no hazardous materials, such as paint or household pesticides, make their way into landfill areas. Each of these sites is a potential pollution problem.

Iowa's 1907 Groundwater Protection Act helps curb these pollution problems. Many hazardous waste sites have been cleaned up with help from the federal government, and there are strict regulations on disposal of hazardous wastes. However, with both hazardous waste sites and landfills, chemicals leach into surrounding soils and may reach groundwater - especially in parts of Iowa where the groundwater is very close to the land surface.



Underground tanks and pipelines also pose a problem. Many chemicals such as gasoline or other petroleum products are stored in underground tanks and moved through underground pipelines. In Iowa, there are more than 11,000 miles of pipelines carrying natural gas, petroleum products, and anhydrous ammonia. These pipelines are found in every county. Even relatively small leaks - as little as a gallon per day - have been known to contaminate the drinking water of 50,000 people or more. In Iowa, 85 percent of all reported underground leaks have resulted in contamination of shallow groundwater.

Iowa legislation requires that tanks have devices installed to prevent overfilling and spills, that owners take precautions to protect tanks from corrosion that could cause holes, and that tanks and piping have leak detection monitors.
The solutions are complex. The alternatives to underground pipes for transporting chemicals are trucks and trains. These methods consume more land and more fuel. They also pose the risk of chemical leaks or explosions if accidents occur. On the other hand, underground petroleum tanks reduce the chance of explosions but make leaks more difficult to detect and monitor.

The best solution is prevention

Just as there is no single source of water pollution, there is no single answer to solve the problem. Once water has become contaminated, it is very difficult, if not impossible, to clean. Surface water flows quickly, and a pollutant will generally be diluted as it enters larger bodies of water. However, even large bodies of water, such as the Gulf of Mexico near the mouth of the Mississippi River, cannot tolerate many years of eroded soils, increased nutrients, and chemical pollution.

Groundwater, however, moves very slowly. In heavy clay layers or in bedrock, water might only move several inches per year. Even in gravel and sand aquifers, groundwater may move only several hundred to a thousand feet per year. Once the water is polluted, it will spread out slowly over a period of many years.

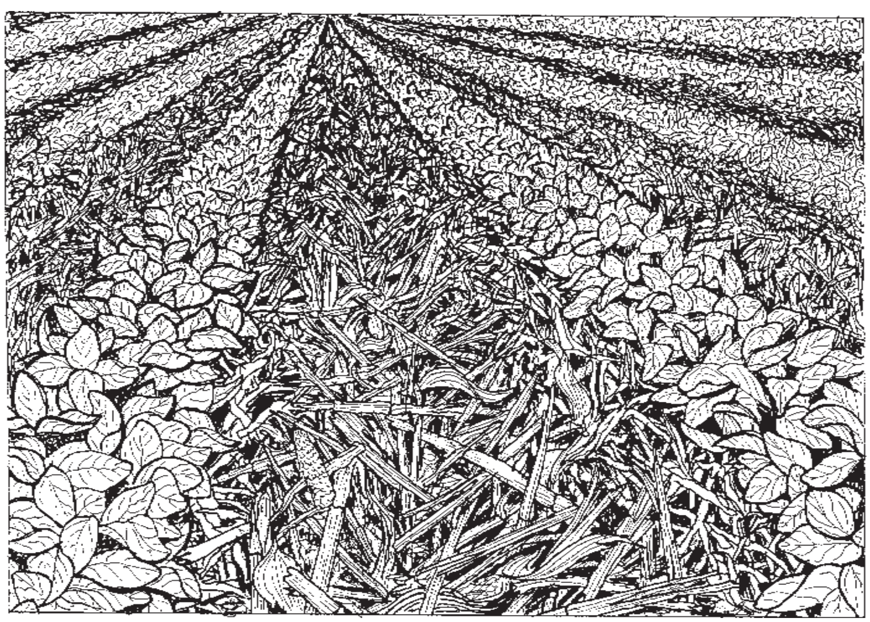
Some problems, such as hazardous waste sites, require massive, expensive clean-up procedures. With other problems, such as large manure spills, little can be done but let the wastes become diluted as they reach larger bodies of water.

However, there are steps to take to reduce some of the most serious problems such as siltation from erosion. In 1980, Iowa passed legislation commonly referred to as the Iowa Soil 2000 program. This legislation requires every farm to develop a soil erosion management plan. Working at the local level, soil conservation district commissioners and farmers determine a plan that will keep soil loss within acceptable limits. No one method of control will work for all erosion problems. A farm-by-farm and field-by-field analysis must be performed to find the best approach for controlling erosion. Often this may require a combination of practices. Hopefully, the Iowa Soil 2000 program will help ensure the long-term productivity of Iowa soils and safety of Iowa's waters.

Maintaining and improving water quality

No-till and minimum-till farming

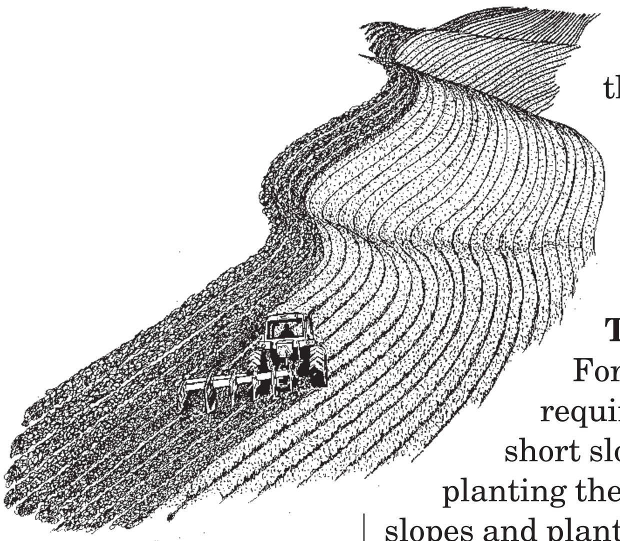
Most of the **crop residues -** the stalks and leaves of the harvested crop - are left on the surface of the field with no-till and minimum-till farming. Crops are planted into the crop residue the next year. This may reduce soil loss by up to 90 percent. The residue helps keep raindrops from directly hitting the soil and breaking it into small erodible particles. The residue also helps stop the soil from washing away. This practice will not stop erosion on steep hills, especially with lower residue amounts from soybeans. The most effective erosion control on these steep lands is planting the land in cover crops such as grasses, alfalfa, and small grains.



With no-till or minnimum-till farming, crop residue remains to protect the soil from rain or wind.

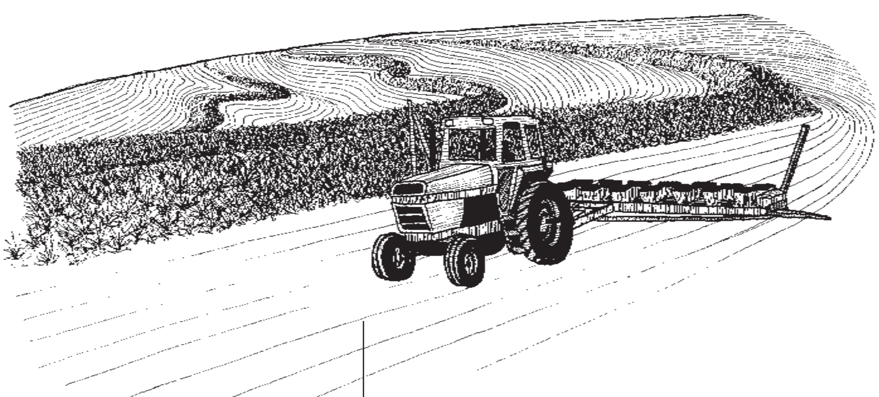
Contour farming

Contour farming involves planting crops in rows that circle around a hill in contours rather than in straight rows that go up and down the hill. These contours help break the water flow. With conventional farming methods, straight rows encourage the water to run down the row and wash along soil.



Terraces

For very steep hillsides, terraces may be required. Terraces are constructed by planting a short slope with grass or other cover crops and then planting the level area with crops. This pattern of short slopes and planting areas follows the hillsides. This practice breaks up the steep hill into a series of shorter slopes and level areas and slows down the water flow. Since the terraces are planted in grass, they hold the slope in place and reduce erosion. Terracing provides good protection for steeper slopes, especially if combined with low-till or no-till farming.



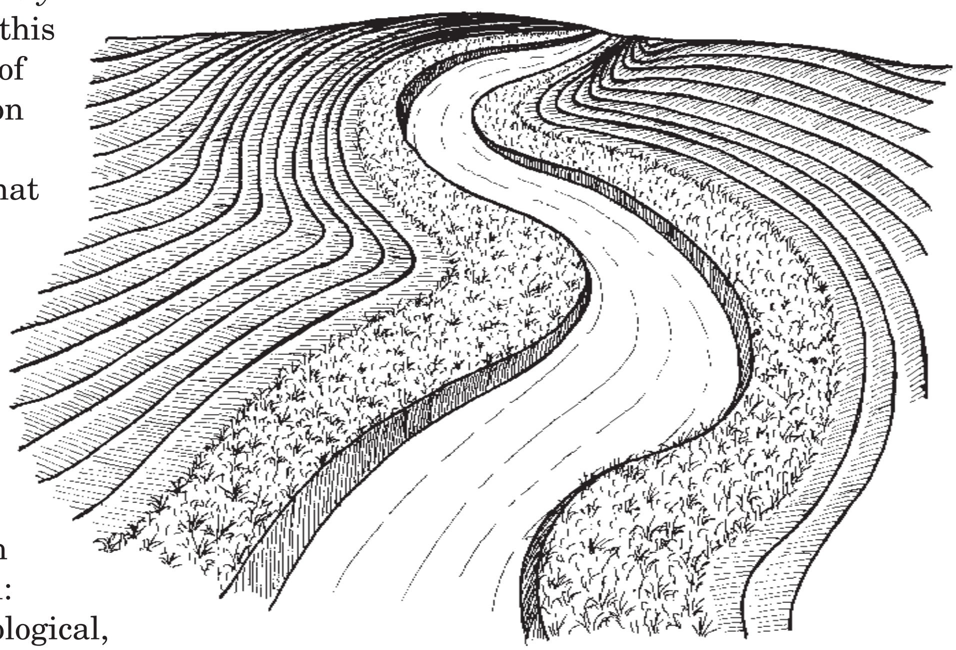
Grassed waterways

Where concentrated water runoff occurs due to the sloping of several hills or along bottom slopes, planting grass or hay is recommended. As water collects and runs along these erosion-prone areas, the denser root systems of the grasses help hold the soil in place to prevent these areas from washing out and forming gullies.

Grasses and filterstrips

Stream banks and road ditches also need to be protected. Plants growing on banks and slopes help hold the soil. Along stream and river banks, filter-strips of grasses and trees help slow down water run-off and help prevent soil from washing into waterways.

Filter strips help reduce erosion along stream and river banks.



Since polluted groundwater is nearly impossible to clean, prevention is the *only* solution. For pesticides, this means reducing the use of chemicals and focusing on an integrated pest management program that controls weeds and insects by more natural means whenever possible and resorting to pesticides only as a last resort.

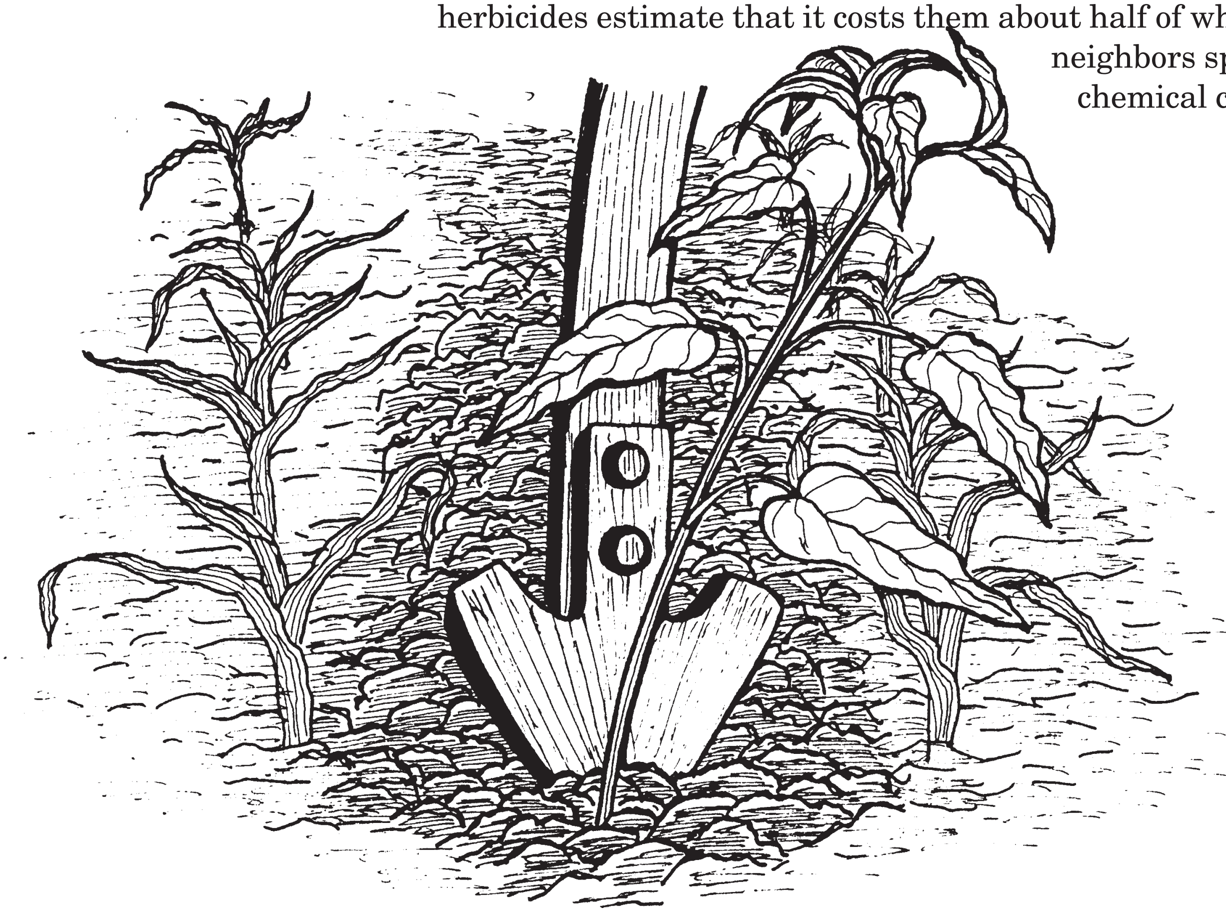
Good pest management depends on four methods of s control: cultural, mechanical, biological, and chemical.

Cultural control

Cultural control relies on planting factors such as crop rotation and planting after weeds have been killed following grerminatin. Good management starts with scouting fields on a regular basis. Keeping records of past problem areas helps control pests, as well as the need for chemical means of controling pests. The first step is to determine the seriousness of the infestation of weeds or insects. This is where trade-offs take place. Will the potential loss of crop yield be greater than the cost of chemical treatment? Are there other options that might be cheaper and less environmentally dangerous? There are no set answers since each farm is different and each year brings new challenges.

Mechanical control

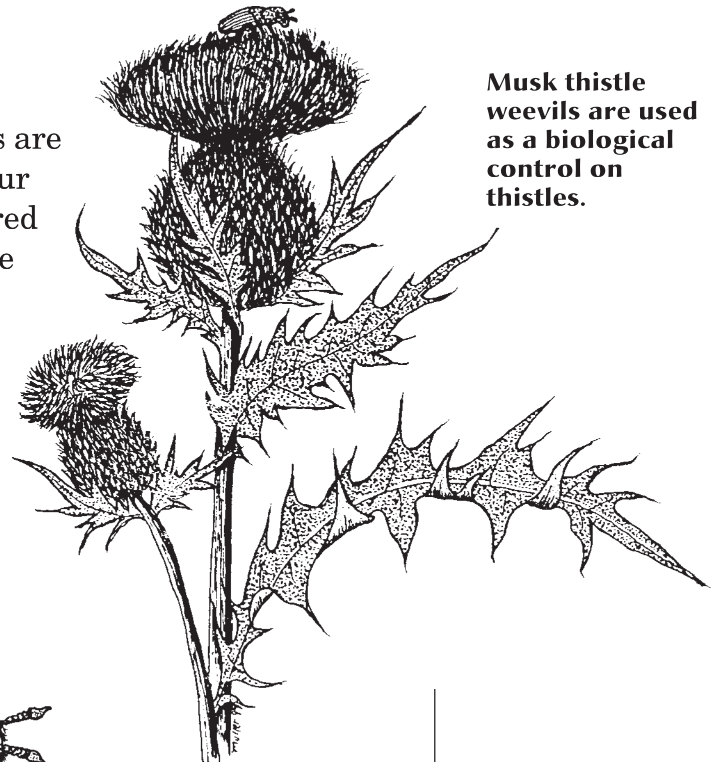
Mechanical weed control or cultivation is one of the oldest forms of control. Tools like the rotary hoe are used when plants are small, while a cultivator is used on larger plants. Although mechanical control requires the use of fuel to pull the implement across the fields, it results in reduced chemical control. Most farmers substituting mechanical control for herbicides estimate that it costs them about half of what their neighbors spend on chemical control.



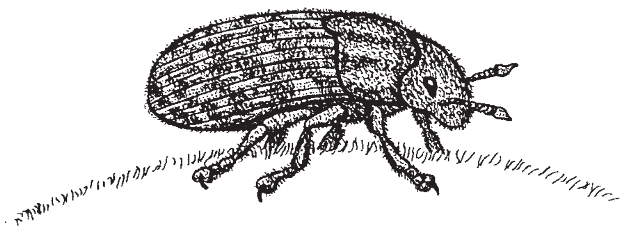
Biological control

Biological control introduces insects and plant diseases that target specific weed or other pest populations. One example in the Midwest is the introduction of the musk thistle weevil which feeds on musk thistles. Thistles are tough weeds to control, and the weevil appears promising in controlling pest populations. Insect control is best suited for pasture land rather than crop land Cultivation tends to disrupt the life cycle of the insects.

Researchers are also developing microbial controls. These microbes are essentially plant diseases that occur naturally. The microbes are cultured in labs and sprayed on fields where they select the weeds but not the crops. One major advantage of biological control is that the diseases can adapt to changing weeds so they can't build up resistance or tolerances, which has occurred with herbicides and insects.



Musk thistle weevils are used as a biological control on thistles.



Chemical control

Farmers using other controls methods must occasionally resort to chemical control for tough cases. However, even when chemical control is required, it's possible to reduce the amounts of chemicals used. Careful calibration or setting of the sprayer is essential to not over-apply chemicals.

In addition, many farmers use banding techniques that spray chemicals in a narrow band over the crop row and rely on cultivation for the weeds between rows. An Iowa State University research study shows that this method reduces the amount of chemicals used by 50 to 67 percent, while maintaing the corn yield on 99 percent of the fields tested.

Controlling nitrate pollution

General management practices may help ease the problem of nitrate pollution, but they also rely on trade-offs that protect both the economic interests of the farmer and the natural environment. The bottom line is not to apply more nitrogen-based fertilizers, either artificial or natural animal byproducts, than the crops need for that growing season. Since ammonia may be lost to the air and nitrates may be moved with the water, it is economical for the farmer to apply only the amount of nitrogen needed and only at the time it is needed by the plants.

For more information on nitrogen management and manure management, see the ag practices booklet in this series.

Big Spring: A Case Study

The case of Big Spring illustrates that the problems and solutions connected to water pollution are complex. Land formations, land use, farming practices, and weather can all impact water quality.

Big Spring watershed

(Adapted from Iowa Geology 1995, a publication of the Iowa Department of Natural Resources)

One of the nation's longest running and most detailed records of the agriculture and groundwater connection is found at Big Spring in northeast Iowa. The spring is Iowa's largest and is found at the base of a big bluff about 500 feet from the Turkey River.

Large sinkholes sometimes provide a direct pathway for groundwater contamination in the Big Spring watershed of northeast Iowa.

The Big Spring groundwater basin drains approximately 100 square miles or 64,000 acres in Clayton County. This area of Iowa is part of the Galena aquifer with fractured, soft rock under the soil layer. This soft, broken rock allows water to pass through it quite readily and many times dissolves away, leaving caverns and paths for the water. Occasionally, these caverns collapse, leaving large sinkholes that provide a path for surface water to drain directly to the groundwater supplies.

Shallow aquifers such as these are quite susceptible to contamination from nitrates and pesticides. Since 1981, the discharge from Big Spring, as a natural sample of the groundwater in the aquifer, has been tested for water quality.

During the 1960s and 1970s, the use of chemical nitrogen fertilizer in the basin increased almost three-fold and nitrate concentrations at Big Spring increased a similar amount. By the early 1980s, nitrate concentrations commonly approached the unsafe limits set by the U.S. Environmental Protection Agency. Higher levels were commonly seen during periods of heavy rains that recharged the aquifer.

The flow of nitrates

As monitoring of the Big Spring Basin began, it was calculated that in typical years one-third of the chemical fertilizers that farmers applied had appeared in surface and groundwater. If additional losses such as uptake by aquatic plants were also calculated, it was estimated that fully one-half of the chemical fertilizers applied by farmers were being lost into local water supplies. Both nitrates and herbicides were found and, atrazine was found all year in low, but detectable levels.

These findings at Big Spring led to the creation of the Big Spring demonstration project. This project involved federal, state, and local cooperation to expand water testing and to provide educational and demonstration programs to improve the economic and environmental performance of agriculture in the drainage basin.

Improved nitrogen management was a first priority. Between 1981 and 1993, nitrogen fertilizer input decreased by one-third from 174 pounds per acre to 115 pounds per acre. Two million pounds of nitrogen were not applied and provided approximately $360,000 annually in savings for local farmers. There was no negative effect on crop yields.

Unfortunately, the effect of nitrates in the water supply is hard to determine due to unusual weather during the monitoring period. From 1982 to 1989, nitrate concentrations declined but so did the total discharge from Big Springs, indicating that there might be less leaching of nitrogen from the soil. It reached its lowest point in both discharge and nitrates in 1989, the second year of drought. Several wet years culminated in the floods of 1993, and nitrate concentrations increased dramatically during this period. It may be that increased rainfall leached out excess nitrogen that was not moved into water supplies during the drought.

Important lessons have been learned from the Big Springs demonstration. Agricultural inputs do have an impact on Iowa surface water and groundwater supplies. Reducing the amounts of nitrogen to optimal levels did not significantly reduce the crop yields and saved farmers money. And water contamination should be reduced once there is less nitrogen to move into water supplies. This project also shows that water quality changes slowly in relation to chemical inputs, especially when those chemical inputs decrease slowly. Finally, this project demonstrates the increasing need to monitor and evaluate the chemicals we apply to the land that ultimately travel into our water supplies.

The future of our water

Iowans are concerned about the quality of their water. In 1987, the Iowa legislature passed the Groundwater Protection Act to help preserve and improve the quality of water. However, there are still serious problems. Numerous studies conducted around the state indicate that groundwater supplies are still being contaminated with pesticides and nitrates. Surface water supplies continue to be contaminated by city and industrial treatment plants and through livestock and agricultural runoff. And chemical leaks and spills still occur.

More and more farmers realize that many modern farming practices are not always cost effective. Ever-increasing costs of fuel, energy-derived fertilizers, and expensive herbicides and insecticides add up to marginally-profitable operations.

As we have seen, there are no easy solutions. There are trade-offs every step of the way. Reduced chemical control of weeds requires more mechanical control and more trips across the field which in turn uses more fuel for equipment. Planting cover crops - commonly called green manure - adds natural soil fertility and provides wildlife cover but takes land out of production and may reduce profits for the farmer. Animal wastes may be important to help soil fertility and increase production but excessive quantities may cause water and air pollution problems. In nearly all cases, there are both short-term and long-term benefits and potential problems.

For cities, the high concentration of people makes waste disposal a problem. Landfills store wastes and protect against trash-related disease, but burying wastes leads to potential groundwater contamination. Ames is one Iowa city that recovers usable material from the garbage and burns the rest to produce power. However, equipment is expensive and burning emits some pollutants into the air. And wastewater and human wastes must be treated, but at what cost? More efficient treatment plants than those required by law are available, but the expense of equipment and operation may raise taxes.

Finally, some trade-offs are difficult to assess. Should property owners have the right to raise animals any way they want on their farms? What if there are thousands of animals? What if the farm is near a popular lake that might be affected? What if it has an impact on the surrounding property?

In most cases, there are positive and negative consequences. The best solution seems to be to reduce the use of chemicals whenever possible to reduce the risk that chemicals will eventually end up in our water supplies. The final solutions will come from individual Iowans. How much are we willing to change our lives and how much are we willing to spend to ensure that the water we use every day is clean and pure?

Useful resources

Iowa State University Extension Publications
http://www.exnet.iastate.edu/Pages/pubs/
Hundreds of bulletins and brochures dealing with sustainable agriculture, farm practices, pest management, and more

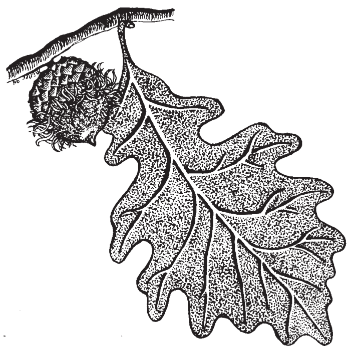
Conservation Technology Information Center
http://www.ctic.purdue.edu/
Includes an interactive "Know your Watershed" section that allows students to find their watershed area, as well as information on resource management and protection

ESCAN: The Environment, Science, Communication, Activities, and News
http://www.public.iastate.edu/~jlmc/escan/ESCANHome.html
Includes specific information about water in Iowa
http://www.public.iastate.edu/~jlmc/escan/WaterwaysHome.html
• Many of the booklets in the Iowa Association of Naturalist series are the basis for this on-line service.

Internet Resources for Environmental Journalists
http://www.sej.org/env_home.htm
Links to hundreds of resources on environmental issues, including water pollution, as well as a searchable database for specific topics

Groundwater Protection Through Prevention: A Curriculum for Agricultural Education in Secondary Schools
Iowa Association for Vocational Instructional Materials Center
208 Davison Hall
Iowa State University
Ames, IA 50011
Printed water curriculum and two videoßtape programs

Sustainable Agriculture and Wildlife: Piecing Together a Habitat Puzzle: A Curriculum for Teachers (# EDC-3; December 1992)
Iowa State University Wildlife Extension
103 Science II
Iowa State University
Ames, IA 50011
Curriculum guide for teachers



Iowa Association of Naturalists

The Iowa Association of Naturalists (IAN) is a nonprofit organization of people interested in promoting the development of skills and education within the art of interpreting the natural and cultural environment. IAN was founded in 1978 and may be contacted by writing the Conservation Education Center, 2473 160th Rd., Guthrie Center, IA 50115, 515/747-8383.

Iowa Environmental Issues Series

In order to make wise decisions, people need a basic understanding of the factors involved in current environmental issues. They need to understand how their lifestyle is tied to these issues and how changes in lifestyle can impact the environment. The Iowa Association of Naturalists has created this series of booklets to offer a basic understandable overview of Iowa environmental issues. These booklets will assist educators in teaching students about topics that affect the Iowa environment. The seven booklets in this series are:

Iowa Habitat Loss and Disappearing Wildlife (IAN-101)
Iowa Air Pollution (IAN-102)
Iowa Water Pollution (IAN-103)
Iowa Agricultural Practices and the Environment (IAN-104)
People, Communities, and Their Iowa Environment (IAN-105)
Energy In Iowa (IAN-106)
Iowa Waste Management (IAN-107)

The *Iowa Environmental Issues Series* is published by IAN with major funding from the REAP Conservation Education Board (September 1998).

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Text: Joel Geske
Illustrations: Mark Müller
Design and Layout: Ames Best Communications
Published by: Iowa Association of Naturalists

Iowa Water Pollution is one in a series of seven booklets that are part of the *Iowa Environmental Issues Series*. The booklets in the series include:

Iowa Environmental Issues

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Iowa Air Pollution	(IAN-102)
Iowa Water Pollution	(IAN-103)
Iowa Agricultural Practices and the Environment	(IAN-104)
People, Communities, and Their Iowa Environment	(IAN-105)
Energy In Iowa	(IAN-106)
Iowa Waste Management	(IAN-107)

The Iowa Association of Naturalists also has produced five other booklet series that provide readers with a clear, understandable overview of topics concerning the Iowa environment and conservation. The booklets included in each of the other five series are listed below.

Iowa Wildlife Series

Iowa Mammals	(IAN-601)
Iowa Winter Birds	(IAN-602)
Iowa Nesting Birds	(IAN-603)
Iowa Reptiles and Amphibians	(IAN-604)
Iowa Fish	(IAN-605)
Iowa Insects and Other Invertebrates	(IAN-606)

Iowa's Natural Resource Heritage

Changing Land Use and Values	(IAN 501)
Famous Iowa Conservationists	(IAN 502)
Iowa's Environmental Laws	(IAN 503)

Iowa Wildlife and People

Iowa Wildlife Management	(IAN-401)
Keeping Iowa Wildlife Wild	(IAN-402)
Misconceptions About Iowa Wildlife	(IAN-403)
State Symbols of Iowa	(IAN-404)
Iowa Food Webs and Other Interrelationships	(IAN-405)
Natural Cycles In Iowa	(IAN-406)
Iowa Biodiversity	(IAN-407)
Adapting To Iowa	(IAN-408)

Iowa Plants

Iowa's Spring Wildflowers	(IAN-301)
Iowa's Summer and Fall Wildflowers	(IAN-302)
Benefits and Dangers of Iowa Plants	(IAN-303)
Iowa's Trees	(IAN-304)
Seeds, Nuts, and Fruits of Iowa Plants	(IAN-305)
Iowa's Mushrooms and Other Nonflowering Plants	(IAN-306)
Iowa's Shrubs and Vines	(IAN-307)

Iowa's Biological Communities

Iowa's Biological Communities	(IAN-201)
Iowa Woodlands	(IAN-202)
Iowa Prairies	(IAN-203)
Iowa Wetlands	(IAN-204)
Iowa Waterways	(IAN-205)

These booklets are available to download via PDF on the ISU Extension Store:

store.extension.iastate.edu

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