GROUND WATER CONTAMINATION IN SOUTH DAKOTA

What Is Ground Water?

For legal and regulatory purposes in South Dakota, ground water is generally defined as water below the land surface that is in a *zone of saturation*. This "regulatory" definition encompasses all ground water, whether the water occurs in an *aquifer* or in nonaquifer sediments.

Ground water is commonly thought of as underground water that can be removed by wells. This general definition is most applicable to discussions involving *aquifers*. However, ground water also occurs in non-aquifer sediments, such as clay. Clay can contain more water per unit volume of sediment than an *aquifer*, yet the clay may not yield much water to wells.

What Is Ground Water Contamination?

Ground water contamination is the degrading of the natural quality of the ground water. Such contamination is usually thought of in the context of human activities, but it also can be naturally occurring. When determining the degree of contamination, both the presence of a substance and its concentration must be considered. The level at which a substance could be harmful is different for each substance.

Contamination can be divided into two general source types: **point** and **nonpoint**. Point source contamination, as defined in South Dakota Codified Law (Chapter 34A-2-2), is any discernible, confined and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, animal feeding operation, or vessel or other floating craft, from which pollutants are, or may be, discharged.

Nonpoint source contamination is caused by diffuse sources that are not regulated as point sources. In practical terms, nonpoint source contamination does not happen at a specific, single location (such as a single pipe), but generally results from land runoff, precipitation, airborne particles, or water percolating through contaminated materials (U.S. Environmental Protection Agency, 1987). Examples of nonpoint sources include runoff from agricultural land, forestry activity, urban areas, and construction sites. Such contamination results in the alteration of the chemical, physical, biological, or *radiological* quality of the water.

How Does Ground Water Contamination Occur?

Ground water contamination occurs, or can occur, when ground water in the

zone of saturation is *recharged* with contaminated water or other liquid contaminants, or when a contaminant is placed or buried in the saturated zone. For example, ground water contamination may result from rain water passing through sediment contaminated with industrial or agricultural chemicals. Water polluted while on the surface of the ground, such as runoff contaminated with de-icing chemicals applied to roads in the winter, can also percolate into ground water and pollute it. Contamination may also result from wells, improperly sealed or abandoned, that allow contaminated surface water to reach an *aquifer*. These same wells may also transmit water from one *aquifer* to another if the well is drilled through more than one *aquifer*. Where two *aquifers* are connected without the presence of a well, some natural contamination may result from the direct contribution of water from an *aquifer* with naturally poor quality water to an *aquifer* having water of naturally good quality.

Can Ground Water Contamination Be Prevented?

Naturally occurring contamination is virtually impossible to prevent. However, many of the human practices that have resulted in ground water contamination can be changed or eliminated to reduce or prevent future contamination. Prevention can be accomplished when people have an increased understanding of the vulnerability of some of the state's ground water resources, coupled with better management and handling of possible pollutant sources. The state's ground water protection strategy stresses pollution prevention, along with a comprehensive set of rules and regulations to deal with contamination after it has occurred.

A significant program, for which the state provides guidance, is the *wellhead protection* program. Through this program, municipalities, rural-water systems, or other governmental entities can establish land-use practices that will be allowed in the area of their water-supply wells or in the *recharge* area of their water supply. Part of this effort includes the identification of potential sources of contamination so they can be adequately monitored. Some land-use practices that might not be allowed over a shallow *aquifer*, for example, could be the operation of a chemical manufacturing or storage facility, or a landfill.

What Are Some Examples Of Ground Water Contamination In S.D.?

Although South Dakota is not a very populous state, it has its share of potential ground water contamination problems. Between 1973 and October 28, 1993, a total of 3,327 releases of contaminants to the environment were reported to the Department of Environment and Natural Resources. To put this number of releases in perspective, there were only two reported releases in 1973 and only about 30 to 40 reported releases prior to 1982. The increase in the number of reported releases is attributed to the implementation of regulations and a greater public awareness of potential environmental problems. Of the 3,327 reported releases, 1,346 are still being investigated and/or cleaned up.

Many routine day-to-day, human activities pose a threat to ground water and may result in the contamination of the ground water. Some examples of these routine activities are the application of fertilizer and pesticides to golf courses and private home lawns, the application of agricultural chemicals to crop land, the disposal of municipal solid waste in landfills, the use of septic systems where there is no centralized sewer system, and the discharge of storm-water runoff and treated sewage effluent into surface water. Other examples of common potential sources of contamination, which were identified near the Sioux Falls airport, are listed in Table 1.

A specific example of contamination in South Dakota is at a petroleum-storage and pipe-line facility in Sioux Falls. Reported contaminants in the ground water at and near this facility include diesel fuel, fuel oil, gasoline, jet fuel, nitrate-nitrogen, ammonia-nitrogen, and pesticides. In past years, this facility handled liquid nitrogen fertilizer in addition to a variety of petroleum products. The fertilizer could account for the contaminants of nitrate and ammonia. Petroleum contamination does not occur only at large facilities. There are also numerous small businesses in South Dakota that have ground water contamination associated with their underground fuel tanks.

Another example of contamination in South Dakota is in the northern Black Hills area. Unusual levels of arsenic are found in the ground water along Whitewood Creek. Mine tailings (rock residue left over from the gold-extraction process) were discarded into Whitewood Creek for over 100 years. These tailings make up a large portion of the present day *flood plain* sediments. The tailings consist of finely ground rocks containing an arsenic-bearing mineral. The high arsenic concentration in the ground water is thought to result from direct *recharge* by the creek through the tailings and/or bacterial *oxidation* and *leaching* of the mine tailings deposited on the *flood plain* (Stach and others, 1978). The discharge of tailings into the creek no longer occurs, and the Homestake Mine, along with the towns of Lead and Deadwood, have worked to clean up Whitewood Creek. Unfortunately, removal of the residue of tailings in the *flood plain* is not practical. (For details of this clean-up effort, see the video, *The Rebirth of Whitewood Creek* available from the South Dakota State Library.)

The Big Sioux *aquifer*, which is at or near land surface in eastern South Dakota, has had incidences of nitrate-nitrogen concentrations above the 10 milligrams per liter regulatory limit established for public-water supplies. Several water supplies that draw water from the Big Sioux *aquifer* have been impacted by nitrate contamination. These include two rural water systems and several municipalities: Brookings-Deuel Rural Water System, Sioux Rural Water System, Alcester, Aurora, Elkton, and Fairview. Some pesticides have also been detected in the Big Sioux *aquifer*, but nearly all have been detected at concentrations below limits set in drinking-water regulations or health advisories. Research regarding the impacts of agriculture on shallow ground water is ongoing in South Dakota.

How Can Ground Water Be Cleaned?

Ground water can be contaminated in an instant, but cleanup of the same ground water usually is a slow and expensive process. Often, in a pollution incident, there is contaminated sediment above the ground water that can contribute contamination to the ground water for a long time. Cleanup methods include:

1. pumping and treatment of the ground water;
2. in-place treatment of the ground water;
3. excavation and disposal, or treatment of contaminated sediment to reduce the influx of contaminants to the ground water; and
4. in-place treatment of contaminated sediment to reduce the influx of contaminants to the ground water.

These methods are often used in combination to accomplish the cleanup of the ground water. Treatments include: aeration of the water or sediment; addition of chemicals to alter the contaminants or immobilize them; and accelerating the natural processes of bacteria that breakdown a particular contaminant.

Table 1. Common Sources Of Ground Water Contamination In Industrial And Commercial Areas Near The Sioux Falls Airport.

Commercial	Industrial
Agricultural equipment dealer	Chemical manufacture, warehousing and distribution services
Airport	Electrical and electronic products and manufacturing
Auto repair shops	Electroplaters and metal fabricators
Car washes	Fiberglass/plastic ware manufacturing
Cemeteries	Fire retardant and foam products manufacturing
Construction areas	Jewelry and metal plating
Gas stations	Manufacturing and distribution sites for cleaning supplies
Golf courses (chemical applications)	Petroleum products production, storage, and distribution centers
Laundromats	Pipelines (such as oil and gas)
Lawn care services	Quartzite quarry
Machine and metalworking shops	Railroad tracks and yards
Paint shops	Storage tanks and pipes (both above ground and underground)
Photography and printing shops	Toxic and hazardous spills
Road de-icing operations	
Road maintenance depots	
Toxic and hazardous spills	
Wells, operating and abandoned (such as water supply, injection, monitoring, and exploration)	

Data from Barari et al. (1992) from a study of areas near the Sioux Falls airport.

How Can We Protect Ground Water Resources?

There are many precautions the average South Dakotan can take to protect ground water from contamination. The following list includes the major precautions we should all take.

- Do not dispose of oil or other hazardous chemicals by pouring them on the ground.
- Read labels on pesticides and fertilizers carefully and apply the chemicals only if absolutely necessary and only as directed.
- Make sure your septic tank or sewage system is functioning properly and never dispose of hazardous chemicals by pouring them down the sink or flushing them down the toilet.
- Manage land wisely to minimize soil erosion and runoff into surface water supplies.
- Dispose of hazardous solid waste, such as batteries and cans from paint, cleaning fluids, or toxic chemicals, by contacting the Department of Environment and Natural Resources (DENR) Office of Waste Management (773-3153) to locate the nearest hazardous waste facility.
- Report any contamination immediately to the DENR (see phone numbers below).

Glossary

Aquifer – any rock or sediment with spaces that hold water in sufficient quantities to yield economically valuable amounts of water to wells and springs.
Flood plain - the nearly level land that borders a stream and is subject to flooding.
Leaching – the removal of soluble matter from soil or other materials by percolating water.
Oxidation – the combining of an element with oxygen.
Radiological – pertaining to radiant energy such as X-rays, gamma rays, etc.
Recharge – the addition of water to the zone of saturation; also, the amount of water added.
Wellhead protection – the concept or practice of protecting the quality of a ground water supply. It involves the establishment of land-use practices in the areas near water-supply wells and areas which provide water to the wells.
Zone of saturation – typically referred to as the area below the water table where pore spaces in the sediment or rock are filled with water.

Glossary terms are adapted from Driscoll, F.G., 1986, *Groundwater and Wells*: St. Paul, Minnesota, Johnson Division, second edition.

References

Barari, A., Iles, D.L. and Cowman, T.C., 1993, Wellhead protection and monitoring options for the Sioux Falls airport wellfield, South Dakota, *in* Moore, B.A., editor, Case studies in wellhead protection area delineation and monitoring: Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Las Vegas Nevada, Contract Number 68–CO–0049.

Stach, R.L., Helgerson, R.N., Bretz, R.F., Tipton, M.J., Beissel, D.R., and Harksen, J.C., 1978, Arsenic levels in the surface and ground waters along Whitewood Creek, Belle Fourche River, and a portion of the Cheyenne River, South Dakota: Water Resources Institute, South Dakota State University, Brookings, South Dakota, Completion Report, Project Number A–054–SDAK, Agreement Number 14–34–0001–6043.

U.S. Environmental Protection Agency, December 1987, Nonpoint source guidance: Office of Water, Office of Water Regulations and Standards, Washington, D.C.

Selected Resources For Teachers

South Dakota Recycling Directory published by the S.D. Department of Environment and Natural Resources and S.D. Solid Waste Management Association, Pierre, SD. This brochure includes addresses and phone numbers for all solid waste disposal and recycling organizations in South Dakota.

Videos:

Nonpoint Source Pollution–Community, State Library of South Dakota, Pierre
Nonpoint Source Pollution–Rural, State Library of South Dakota, Pierre
The Rebirth of Whitewood Creek: I.D. Weeks Library, University of South Dakota, Vermillion
Global Dumping Ground: I.D. Weeks Library, University of South Dakota, Vermillion

Outreach (Resource Agency Personnel)

(See Natural Source directory for phone numbers)

Department of Earth Sciences/Physics, University of South Dakota, Vermillion, SD 57069.
Division of Geological Survey, Department of Environment and Natural Resources, Vermillion, SD 57069.
Division of Environmental Regulation, Department of Environment and Natural Resources, Pierre, SD 57501. This Division includes the following programs:

Exploration and Mining	605–773–4201
Drinking Water	605–773–3754
Ground Water Quality	605–773–3296
Point Source Control	605–773–3351
Waste Management	605–773–3153

Geology Department, South Dakota School of Mines and Technology, 501 East St. Joseph, Rapid City, SD 57701.
Water Resources Research Institute, S.D. State University, Brookings, SD 57007.
U.S. Geological Survey, Rm. 408 Federal Bldg., 200 4th Street, SW, Huron, SD 57350.

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