United States
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Agency

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Report Findings

Ground Water Quality in the United States

Ground water is a vital national resource. In many parts of the Nation, ground water serves as the only reliable source of drinking water. Unfortunately, this vital resource is vulnerable to contamination resulting from human activities, and increasing numbers of ground water contamination problems are being discovered throughout the country.

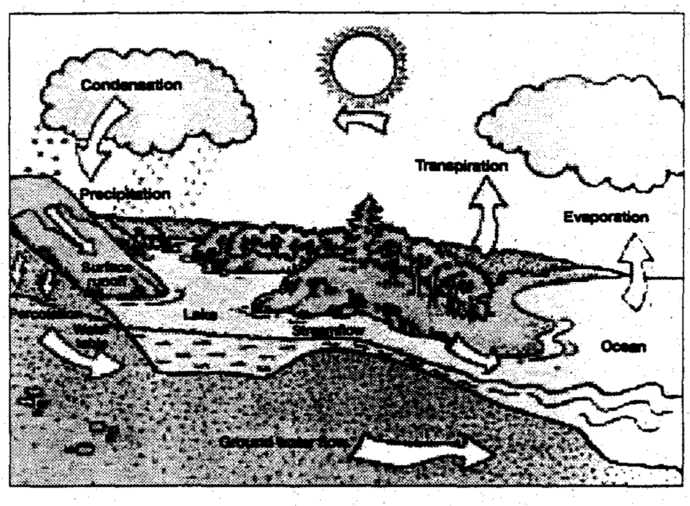
This report summarizes major sources of ground water contamination and the activities that are being implemented to protect this valuable resource for future generations. Most of this information was obtained from reports submitted in 1996 to the U.S. Environmental Protection Agency (EPA) by States, American Indian Tribes, and Territories in fulfillment of requirements set forth in Section 305(b) of the Clean Water Act. These reports, referred to as the "Section 305(b) reports," identified contaminant sources and the associated contaminants that threaten the integrity of State, Tribe, and Territory ground water resources. Information from the Section 305(b) reports are combined into a National Water Quality Inventory: 1996 Report to Congress.

What is Ground Water?

First and foremost, ground water is water that is out of sight, below the land surface. Because ground water is unseen, it is commonly misunderstood. Many people envision ground water as flowing in underground rivers. Only in rare cases, such as places where caverns exist, does ground water move in that fashion. Normally, ground water moves slowly through open spaces between sand grains below the earth's surface. Subsurface geologic materials that provide storage for ground water are called aquifers.

Water enters aquifers as precipitation falling to the earth that does not evaporate or get taken up by plants and trees, but rather seeps into the soil of our yards, parks, and other unpaved areas, filling the open spaces below the ground surface. This water moves at slow rates, often at only fractions of a foot per day, and is discharged to surface water bodies as part of the hydrologic cycle.

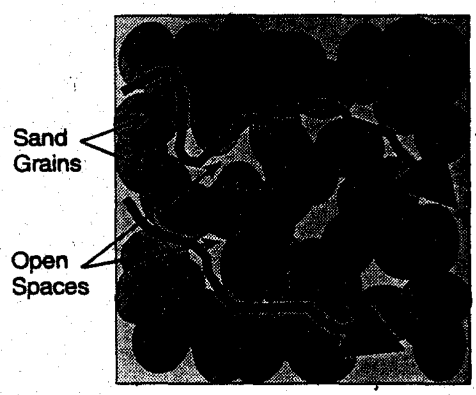
Hydrologic Cycle



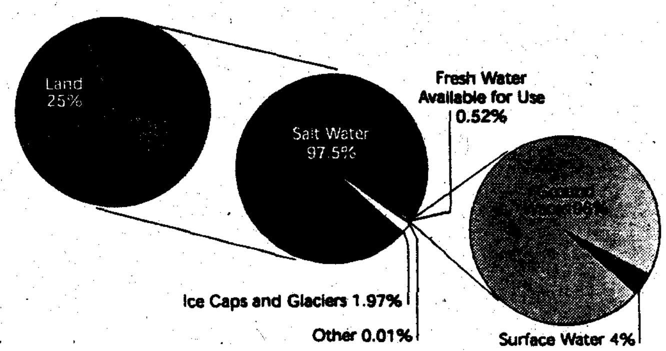
Is Ground Water Important?

Although 75% of the earth's surface is covered by water, less than 1% is fresh water that is available for our use. It has been estimated that more than 95% of the world's fresh water reserves are stored in the earth as ground water.

Ground Water Flow Through the Subsurface



Distribution of Water on Earth's Surface



In the United States, ground water is used for agricultural, residential, industrial, and commercial purposes. Ground water provides water for drinking and bathing, irrigation of croplands, livestock watering, industrial and commercial uses, and thermoelectric cooling applications. In 1990, ground water supplied 51% of the Nation's overall population with drinking water. In rural areas of the Nation, ground water supplied 95% of the population with drinking water.

Ground water is also often directly connected to rivers, streams, lakes, and other surface water bodies, with water flowing back and forth from one resource to the other. In some areas of the country, ground water contributes significantly to the water in streams and lakes. The quality of the ground water can have an important effect on the overall condition of the surface water and its use.

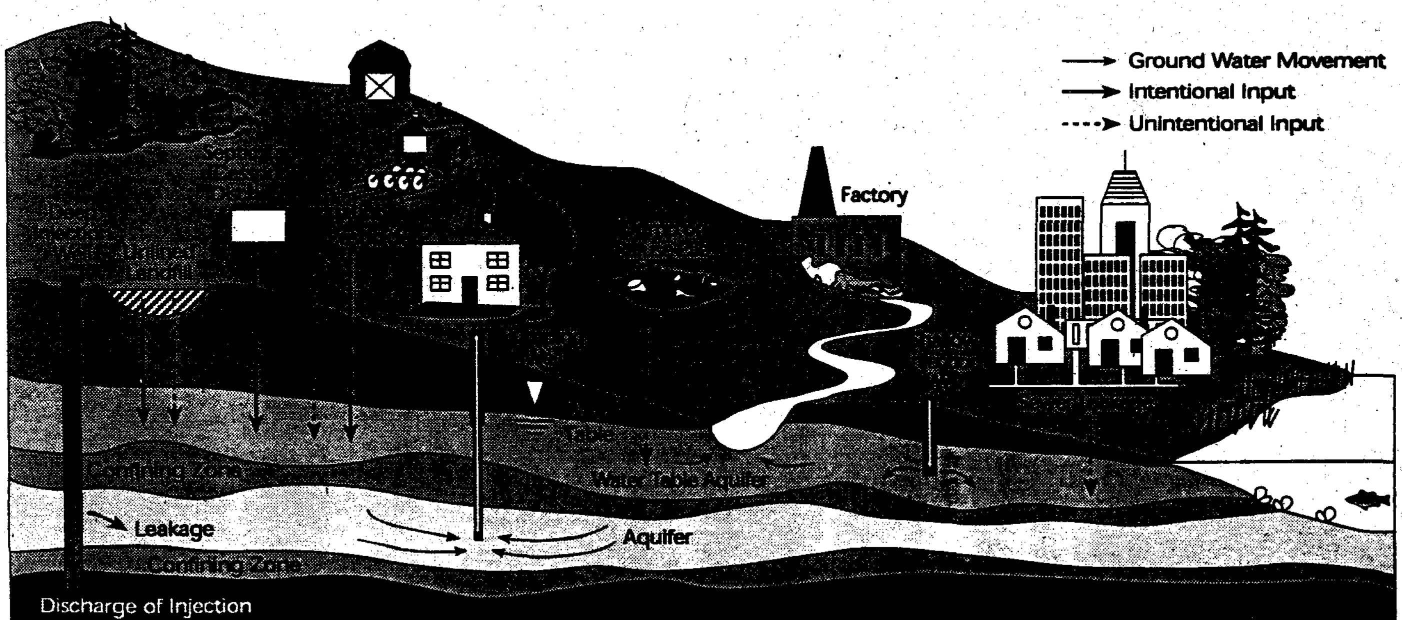
It is evident that ground water is a very important resource. Preserving the quality of our ground water resources ensures that our needs as a Nation will be met now and into the future.

Is Our Ground Water Contaminated?

Prior to the mid-1970s, it was thought that soil provided a protective "filter" or "barrier" that stopped the downward movement of contaminants spilled on the land surface and thus prevented ground water resources from being contaminated. However, the discovery of pesticides and other contaminants in ground water showed that ground water resources were indeed vulnerable to contamination resulting from human activities. The potential for a contaminant to affect ground water quality is dependent upon its ability to move through the overlying soils and reach the underlying ground water aquifer.

Ground water contamination is most common in highly developed areas, agricultural areas, and industrial complexes. Ground water contamination is usually found in relatively well-defined, localized "plumes" originating from specific sources such as leaking underground storage tanks, on-site disposal systems, spills, landfills, or industrial facilities. Contamination also occurs as a general deterioration of ground water quality over a wide area due to diffuse nonpoint sources, such as agricultural fertilizer and pesticide applications, and urban runoff. When large areas are degraded, it makes it difficult to specify the exact sources of contamination.

Sources of Ground Water Contamination



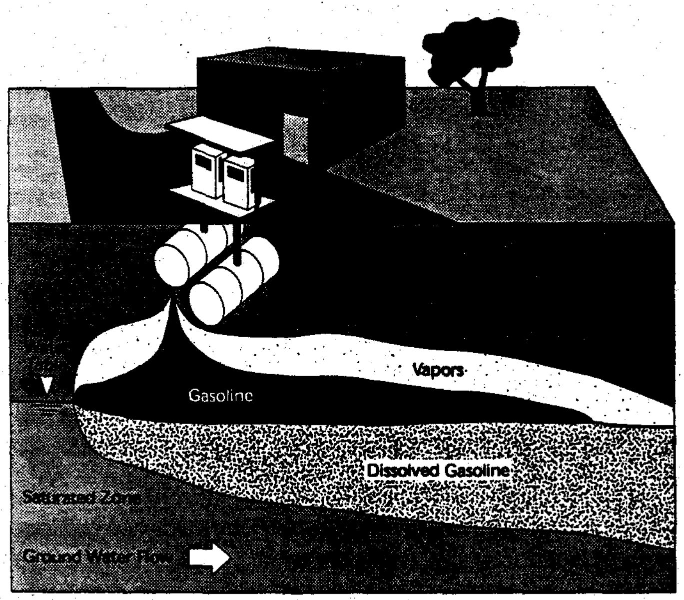
Frequently, ground water contamination is discovered long after it has occurred. One reason for this is the slow movement of ground water through aquifers, sometimes moving as little as fractions of a foot per day. Contaminants in the ground water may persist for many years. In some cases, contaminants introduced into the subsurface decades ago are only now being discovered. This also means that the environmental management practices of today will have effects on ground water quality well into the future.

What Are The Most Common Sources of Ground Water Contamination?

The three most common sources of ground water contamination are leaking underground storage tanks, landfills, and septic systems. These findings are based on data reported by States in their *1996 Water Quality Reports*. States also indicated that fertilizer applications, pesticide applications, agricultural chemical facilities, and agricultural activities were sources of potential ground water contamination. When these latter categories are aggregated, it becomes clear that agriculture also constitutes a major source of ground water contamination.

Leaking Underground Storage Tanks (USTs). Although underground storage tanks are found in all populated areas, they are generally most concentrated in heavily developed urban and suburban areas. USTs are primarily used to hold petroleum products such as gasoline, diesel fuel, and fuel oil. Because they are buried underground, leakage can be a significant source of ground water contamination that may go undetected for long periods of time.

Ground Water Contamination as a Result of Leaking Underground Storage Tanks



Organic chemicals associated with petroleum products are one of the most common ground water contaminants. The most significant effects generally occur in the uppermost aquifer, which is frequently used by homeowners of private wells. Organic chemicals threaten the use of ground water for human consumption because some of them are known to cause cancer even at very low concentrations.

The primary causes of leakage in USTs are faulty installation and the corrosion of tanks and pipelines. As of March 1996, more than 300,000 releases from USTs had been confirmed. EPA estimates that nationally 60% of these leaks have affected ground water quality, and, in some States, the number is as high as 90%.

The number of new releases continues to outpace the number of sites where cleanup has been completed. EPA anticipates that the total number of confirmed releases could reach 400,000 in the next several years. After this peak, EPA expects fewer releases as UST owners comply with EPA's release prevention and detection requirements.

EPA seeks to prevent another generation of leaking USTs by working to ensure that the regulatory requirements for upgrading, replacing, or closing tanks are met. Where leaks have already occurred, EPA is promoting cleanup activities at the sites posing the greatest risk to human health and the environment.

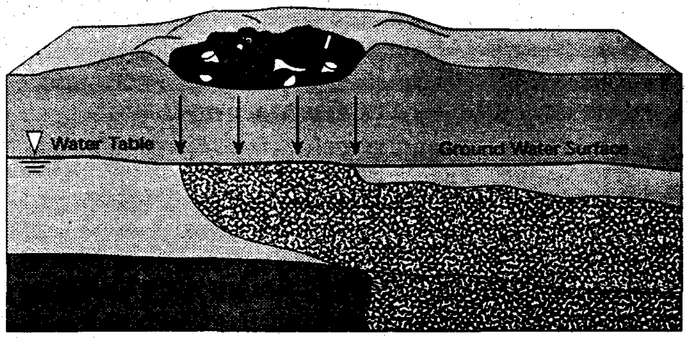
Landfills. Landfills, generally used to dispose of municipal and industrial wastes, are one of the most significant sources of ground water contamination. This can be attributed to the fact that landfills historically have been sited on lands considered to have no other useful purpose. The potential for ground water contamination at these sites was rarely considered in the site selection.

Unlined abandoned sand and gravel pits, old strip mines, marshlands, and sinkholes were often used for landfills. In many cases, ground water was very near the land surface, and the potential for ground water contamination was high. Although regulations involving landfills have changed dramatically, past practices continue to threaten ground water quality.

The two most common types of landfills are those which dispose of municipal and industrial wastes. Although a municipal landfill may contain some industrial wastes, the most frequently disposed wastes are household products, such as paper products, diapers, plastics, and cleaning products. Materials disposed in industrial landfills are generally site specific. Common materials include plastics, metals, fly ash, sludges, coke tailings, foam containers, and construction materials. The possible ground water contaminants include metals, sulfates, nitrates, and organic chemicals.

Recognizing the problems associated with old, inactive landfill sites, States and the Federal government are taking action to ensure that current and future landfills are less of a threat to ground water. Federal requirements under the solid waste laws address siting and operating concerns. The potential for ground water contamination can be reduced if the landfill is sited in an area with clay soil, or with a clay or plastic liner, or in locations where the ground water aquifer is not immediately below the landfill. Furthermore, active landfills can be required to be licensed to accept only certain types of wastes. In some States, landfills licensed to accept municipal wastes and/or special wastes are secure landfills with leachate collection systems and treatment, thereby greatly reducing the risk of ground water contamination.

Ground Water Contamination as a Result of Unlined Landfill Disposal



Septic Systems. Septic systems include buried septic tanks with fluid distribution systems, or leachfields. Designed to release fluids or wastewaters into constructed permeable leach beds, septic systems rely on biological organisms and gravity flow to treat the wastewater. These systems are commonly used for domestic management of sewage and liquid household wastes.

A variety of waste fluids are disposed of in septic systems and, as a consequence, the potential for ground water contamination is high. Ground water may be contaminated when the septic systems are poorly designed or constructed and/or improperly used, located, maintained, or abandoned. Private wells located near septic systems and leachfields are at a higher risk of becoming contaminated.

Typical contaminants from household septic systems include bacteria, nitrates, and viruses from human wastes; phosphates from detergents; and other chemicals that might originate from household cleaners. Contaminants from commercial and industrial facilities may include metals and organic chemicals.

Most municipal, commercial, and industrial facilities that provide a service or manufacture a product generate process wastes. Sometimes the wastes end up in shallow disposal systems, particularly in unsewered areas. Examples of other shallow disposal systems include: industrial waste disposal wells, motor vehicle waste disposal wells, cesspools, dry wells, improved sink holes, and agriculture and storm water drainage wells. EPA is proposing to add requirements to its existing Underground Injection Control program to ensure that high risk shallow injection wells do not endanger underground sources of drinking water. This step-wise approach consists of (1) a proposed rule creating additional requirements for three types of high-risk shallow injection wells in ground water-based source water protection areas: industrial waste disposal wells, motor vehicle waste disposal wells, and large-capacity cesspools; and (2) further study of other types of shallow injection wells not covered in the proposed rule to provide the factual basis for further regulatory action, as necessary. However, the problem is too vast to be effectively managed solely by the traditional State and Federal regulatory approach. Thus, most solutions will continue to be implemented at the local government level.

What is the Cost of Ground Water Contamination?

As more and more areas of ground water contamination are discovered, Americans are becoming increasingly aware that contaminated ground water is both difficult and expensive to clean up. There are both direct and indirect costs associated with contaminated ground water. Direct costs usually result from cleanups and associated activities and are usually more quantifiable. Indirect costs, related to the effects of contaminated ground water on the public, are less tangible and may be more difficult to determine and quantify.

Direct costs (e.g., legal fees for cleanup, investigative, engineering, and operational activities) can be estimated and have proven to be very high. Treatment to remove contaminants from ground water has cost individual businesses thousands, and sometimes millions, of dollars every year. Despite the staggering monetary direct costs, indirect costs may be of even greater concern. Indirect costs include the potential for increased health risks, increased public concern, and decreased availability of fresh water and may prove to be more costly than the direct costs.

When both direct and indirect costs are considered, it becomes evident how expensive it is to clean up ground water resources that have been contaminated by human activities. Efforts to compare the costs of post-contamination cleanup to the costs of preventive ground water protection have found that there are real cost advantages to promoting protection of this resource.

What Is Being Done to Prevent Ground Water Contamination?

Because it is expensive and technologically complex to clean up contaminated ground water resources, ground water protection has become the focus of numerous State and Federal programs. Some of these programs are regulatory in nature and restrict or control specific activities from introducing contaminants *onto* the land surface, *below* the land surface, or *into* ground water resources. Two of the most important Federal programs addressing ground water protection are authorized by the Clean Water Act and the Safe Drinking Water Act.

Under the Clean Water Act, EPA has provided funding to the States for over 13 years to develop and implement ground water strategies and programs. Every State in the Nation has developed ground water strategies and has implemented them in many creative ways. Based on an EPA-wide initiative in the early 1990s, nine States to date have achieved EPA endorsement of a basic comprehensive ground water program, and seven other States are in the process of developing one. These programs have increased the coordination among State agencies and increased the consistency in the way State programs focus on priority ground waters. EPA programs, in turn, have been seeking to align program priorities with these State ground water priorities.

Under the Safe Drinking Water Act, EPA is authorized to ensure that water is safe for human consumption. One of the most fundamental ways to ensure consistently safe drinking water is to protect the source of that water. This law, re-authorized in 1996, requires all States to assess all source waters for the benefit and protection of all public water systems. By 2003, States will complete assessments for the 170,000 public water systems, which for many such systems, will lead to protection programs. States will delineate drinking water source protection areas around public water systems (whether based on ground water, surface water, or both); inventory all significant potential sources of contamination; and determine the susceptibility of public water systems to the contamination sources. States have many options to develop and implement Statewide and local protection programs. The options will address the inventoried contamination sources identified as threatening public water systems through non-regulatory or regulatory measures.

What Actions Are Needed to Complete a Local Drinking Water Source Assessment?

Delineation

Delineate a source water protection area

Establish Delineation Areas with Best Available Data

Inventory

Identify significant potential sources of contamination

- Identify contaminants
- Inventory sources of those contaminants
- Map significant potential sources

Establish Inventory

Susceptibility Determinations

Study the hydrology and geology of the source water protection area

- Consider well or intake integrity
- Look at contaminant source characteristics

Determine Susceptibility of PWS to Inventoried Sources of Contamination

States, in cooperation with EPA, also implement Wellhead Protection Programs, Sole Source Aquifer Programs, and Underground Injection Control Programs. Wellhead Protection Programs will likely be operating in all States by the year 2000, with the goal of protecting all public water systems based on ground water. Over the last five years, EPA has been assisting the States, in part, by sponsoring local ground water protection pilot projects in all 50 States through various stakeholders. EPA has designated 63 sole source aquifers nationwide and the Regions reviewed close to 200 federally-funded projects in 1997 for these aquifers. The Underground Injection Control Program protects ground water from all injection wells and has been focusing in the late 1990s on addressing injections wells in shallow aquifers.

EPA's programs offer assistance and guidance to States for the implementation of ground water protection efforts, but, ultimately, the key to protecting this resource is for individuals to become knowledgeable about the ways this resource becomes contaminated and learn how each of us can protect it.

Where Do You Go For More Information?

For more information about ground water protection, contact your local water supplier, environmental protection or health department, or the state office responsible for protecting your water supply. For more information about the *National Water Quality Inventory: 1996 Report to Congress*, contact:

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800-426-4791

or visit the Internet sites
http://www.epa.gov/safewater
http://www.epa.gov/305b