



Groundwater and Pesticides

About 50 percent of the U.S. population relies on groundwater for drinking water. Rural populations utilizing groundwater for drinking water may reach 95 percent. Groundwater feeds drinking-water wells. Because of the potential risk to human health, pesticide contamination of groundwater is a national topic.

What Is Groundwater?

Simply put, groundwater is located below the earth's surface, while surface water is found above the earth's surface. Because it is underground, groundwater is found in spaces within soil, sediment, sand, gravel, and rocks. Studies now show that the soil does not act as a barrier to prevent pesticides and other chemicals from reaching groundwater, contrary to the thinking prior to the 1970s.

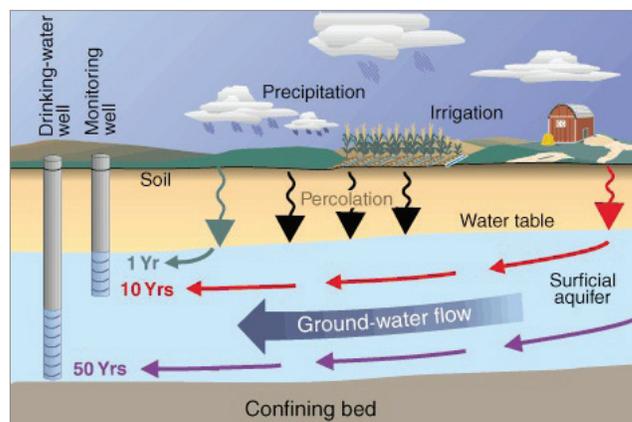
Groundwater Contamination

Aquifers are found in water-bearing beds of rock, gravel or sand and contain fresh, brackish or salty water. If the aquifer is large enough, it can feed a public water system. Groundwater can discharge from an aquifer into surface water, including rivers, lakes and wetlands. If the groundwater is contaminated, these surface water bodies can become contaminated, as well.

Contamination of groundwater by any chemical can take years even decades to develop. This delay between chemicals entering the environment and possibly polluting groundwater depends upon many factors, including the properties of the chemical, the permeability of the soil or sediment, climate conditions, management practices, and the depth of drinking-water wells.

Sources of Groundwater Contamination

Groundwater contamination can come from applications to crops, leaching from contaminated surface water, accidental spills and leaks, and improper storage and disposal. It can also occur through runoff from fields after rain, melted snow or irrigation water. Not all pesticides have been found to leach into groundwater, so it is important to understand the chemical-physical properties of a pesticide in order to predict its potential for contaminating groundwater.



U.S. Geological Survey

Pesticide Properties Related to Groundwater

Specific properties of pesticides and other chemicals that influence its ability to reach groundwater incorporate:

- **Solubility** – How dissolvable is it in water? Is it hydrophobic?
- **Soil adsorption** – How strongly does it stick to soil? How mobile is it in soil?
- **Degradation** – How quickly does it break down in the root zone?
- **Volatilization** – Does it evaporate into the atmosphere?

Here are some examples of the relevance of these properties with respect to groundwater:

- A pesticide that is not soluble in water and binds strongly to soil is basically immobile and not likely to reach groundwater. It typically remains in upper soil layers until degradation occurs.



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- A pesticide that moves freely through soil will contaminate groundwater if it is not degraded first – this consequence is especially true for water-soluble pesticides carried by water down through the soil.
- A highly volatile pesticide (exclusive of soil fumigants) is mainly lost to the atmosphere and not likely to leach into groundwater.

Factors Influencing Groundwater Contamination from Pesticides

In addition to pesticide properties, other factors affect the potential of pesticides leaching into groundwater. Soil texture, permeability, organic content and structure play a role in groundwater contamination. Coarse soil allows swifter movement of water down through the soil, potentially carrying pesticides to groundwater as the opportunity to adsorb to the soil is decreased. The same principle applies to highly permeable soil. Applying manure or plowing under cover crops increases the soil's organic content, holding water and dissolved pesticides in the root zone. Soil structure that is loosely packed or contains animal borings enhances downward movement of water and dissolved pesticides potentially contaminating groundwater.

Site conditions affect the possibility of groundwater pollution. The depth of groundwater plays a role, as some groundwater locations are only a few feet from the surface. Geologic conditions contribute to soil permeability. For example, gravel is more permeable, while clay is not. With topography, flat land with permeable soils allows water possibly carrying contaminants to gather and penetrate the ground rather than runoff. High rates of rainfall and/or heavy irrigation contribute to pesticides leaching into groundwater especially just after application and with permeable soils.

Point-Source or Non-Point-Source Contamination

Groundwater pollution can also be categorized as resulting from either point-source or non-point-source contamination. A point source comes from a specific place – a place that can be identified and pointed to. Examples of point source pollution include pesticides spilled into water from a mixing

and loading site or a direct discharge into water from an industrial or sewage treatment plant.

A non-point source of pollution can come from a broad or diffuse area where a specific source may not be identifiable. An example of this type of pollution includes contamination caused by rainfall or melted snow moving over the ground. As this runoff moves, it picks up contaminants and eventually deposits them into bodies of water including groundwater.

Another nonpoint example would involve broadcast applications of pesticides moving into water bodies. The U.S. Environmental Protection Agency (USEPA) has received reports from some states that non-point-source pollution is the main problem in water quality issues. Most of the pesticides that end up in water are from runoff from across treated surfaces or from downward leaching through the soil or sediment from the surface – this downward leaching is especially problematic for groundwater. Polluted runoff water can travel great distances through drainage ditches, streams, ponds or other surface waters.

Maximum Contaminant Limits (MCLs) for Pesticides

The USEPA has instituted MCLs for pesticides in drinking water. Drinking water wells sampled mainly in agricultural areas across the U.S. revealed that less than 2 percent of the wells sampled had concentrations that surpassed MCLs. However, not all pesticides and their metabolites have established MCLs or other water-quality criteria. Additionally, MCLs are calculated regarding individual pesticides and do not consider potential cumulative effects if more than one pesticide is present in the same well. Many pesticides and their metabolites have not been widely tested for in urban and suburban areas where pesticides are also used.

Groundwater Cleanup

Once groundwater is contaminated by pesticides, cleanup can be quite difficult and expensive. The contamination could last for years, as cold temperatures and low microbial activity in groundwater lead to slower degradation of pesticides than at the soil surface.



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Groundwater contamination effects include poor drinking water quality; loss of water supply; degraded surface water systems, including loss of wildlife habitats; high cleanup costs; high costs for alternative water supplies; and/or potential health problems. A further consequence of groundwater contamination by a pesticide is the possibility of losing the use of that pesticide through its being banned by the EPA.

Federal Regulations to Protect Groundwater Quality

The following federal regulations have been enacted to protect groundwater quality:

- **Clean Water Act (CWA)** – Regulates groundwater with a connection to surface water.
- **Safe Drinking Water Act (SDWA)** – Includes regulation that public water systems meet minimum health standards.
- **Resource Conservation and Recovery Act (RCRA)** – Regulates treatment, storage and disposal of hazardous and nonhazardous wastes.
- **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund)** – Authorizes the government to clean up contamination or sources of potential contamination from hazardous waste sites or chemical spills including those that threaten drinking water supplies.
- **Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)** – Regulates pesticide use.
- **Toxic Substances Control Act (TSCA)** – Regulates manufactured chemicals.