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COOPERATIVE EXTENSION
Washington State University

CLEAN WATER FOR WASHINGTON

Protecting Groundwater from Pesticide Contamination

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Pesticides help maximize agricultural production and minimize pest populations that threaten human health and property. Pesticides can be efficient management tools against both plant and animal pests. However, they can move from the intended targets and become health hazards to nontargets, including people. The potential for pesticide movement to groundwater is a disadvantage of some pesticides. Consider possible pesticide movement while selecting a management strategy for each pest and site.

Well water from groundwater sources known as aquifers supplies drinking water for most rural Washington inhabitants. Tests have found pesticides in some Washington aquifers. Most detections have been below health concern levels, but they indicate possible future problems. Once contaminated, an aquifer can take many years to recover. Treatment is complicated, time-consuming, and expensive. Often it is not feasible.

Pesticides pose serious threats to groundwater when large amounts are released in a small area, such as spills or when pesticide solutions are backsiphoned into a water source. Other concerns include leaks from storage facilities, releases of contaminated equipment rinsewater, illegal disposal, and misapplication. Threats are greater if releases occur near a water

source. In some instances, groundwater contamination can result from normal pesticide use, at recommended rates, in agricultural and urban environments.

This fact sheet discusses:

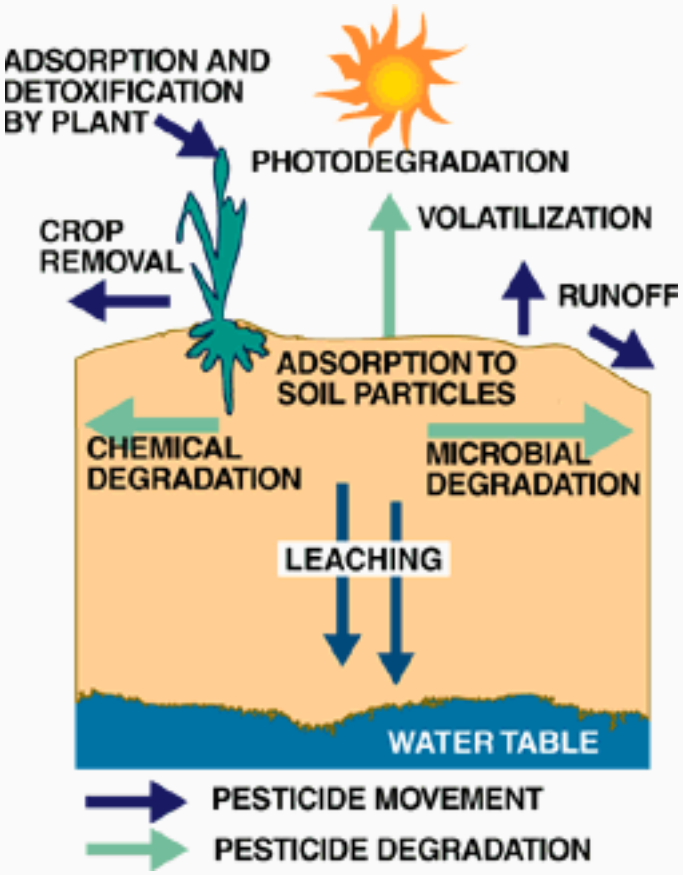
- Factors that increase pesticide movement toward groundwater, and
- Safe handling practices to PREVENT groundwater contamination.

Pesticide user responsibilities:

- Prevent contamination from the time of purchase until the chemical has degraded in the soil—during transport, storage, mixing, application, and disposal.
- Limit applications to appropriate soil types and climatic conditions.
- Read, understand, and follow label directions and precautions.

Pesticide Movement in Soils

When a pesticide reaches the soil, it may be absorbed by the plant, destroyed by degradation processes, attached (adsorbed) to soil particles, or leached down through the soil.



The pesticide's fate depends on the cumulative effects of pesticide and soil properties, application methods, and site conditions. Several factors that affect pesticide movement are discussed below. The importance of these factors to leaching varies with each situation. A single factor may be more important than another in one situation and of very little consequence in the next.

Pesticide Properties

Adsorptivity is the electrical attraction between a pesticide and soil. Pesticides strongly adsorbed to soil particles usually remain in the root zone, where they can be absorbed by plants or degrade. Weakly held pesticides move through the soil profile with rain or irrigation water. The amount of adsorption depends on the pesticide's chemical properties, its concentration in the soil water, and on the soil type and its holding potential.

Solubility is the tendency to dissolve in water. Percolating water can carry dissolved pesticides to groundwater. In general, a highly soluble pesticide is more likely to leach than a less soluble one.

Volatility measures how quickly a pesticide evaporates in air. Highly volatile pesticides vaporize into the atmosphere, thus reducing the leaching potential. However, placing or sealing a pesticide in the soil reduces volatilization and increases leaching potential.

Degradation rate is the time required to break down a pesticide into other chemicals. Pesticides degrade by hydrolysis (reaction with water), photolysis (breakdown by sunlight), and by soil bacteria and fungi. Most degradation occurs due to sunlight and soil microorganisms. Most degradation occurs at the soil surface or within the root zone. Rapid degradation reduces leaching potential. Long-lived pesticides are more apt to leach. When a pesticide leaches below the root zone, conditions reduce degradation and increase groundwater contamination potential.

Soil Properties

Soil texture and *organic matter* largely control pesticide movement in soil. Because sandy soils are coarse and porous, they permit relatively rapid water movement. Also, they bind little pesticide due to their small surface area. Finer-textured clay soils have much more surface area, and more adsorptivity. They limit pesticide and water movement better than sandy soils do. Organic matter has the most pesticide adsorption and water holding potential. Higher percentages of organic matter greatly lower the risk of contamination. Depth of soil to groundwater affects the amount of filtration and degradation that can occur.

Site Conditions

Geologic layers between the soil and groundwater influence pesticide movement. They vary from very permeable gravel and fractured basalt that permit rapid drainage to caliche (a cemented hardpan material), which is virtually impermeable.

Weather, climate, and irrigation practices affect leaching and degradation. Heavy rainfall or irrigation can saturate soil. Water moves faster through saturated soil. Saturation reduces degradation potential and increases contamination risk. Generally, warmer soil temperatures speed degradation while cool temperatures retard breakdown.

Using Pesticides Safely

Select a pest management strategy to prevent groundwater contamination.

Seriously consider the environmental impacts for all potential pest control practices. Select one or more methods that will produce adequate control with the least impact on the environment. Use alternative control methods where feasible.

Where contamination is a concern and chemicals are needed, select pesticides with low-leaching potential.

To prevent groundwater contamination, handle pesticides carefully to avoid unwanted releases into the environment, most notably spills. Select pesticides based on their properties, site conditions, pest complex, and severity of the infestation. Proper application rates are critical in prevention of soil overloading. Handle pesticides safely from initial purchase through ultimate use or disposal.

Well Location

Direct contamination through a wellhead or other water source is a great threat to groundwater. Wells are the most common source of present day contamination. **Do not handle, store, or use chemicals where pesticides can enter a well or any water.** Maintain a buffer zone around all water sources.

Transportation.

An accident while transporting a product can spill a large amount of concentrated pesticides over a small area and can cause a substantial threat of leaching to groundwater.

- Inspect containers for tightly closed caps and plugs.
- Make sure labels are legible.
- Handle containers carefully to avoid rips or punctures.
- Carry concentrated pesticides on a steel truck bed with solid side walls and endgate.
- Firmly secure containers against movement during transit.
- Equip truck with spill cleanup materials: personal protective clothing, shovel, plastic, absorbent material, and empty containers larger than the pesticide packaging.
- ***In case of a spill:*** Use personal protective equipment. Act immediately. Three C's for spill cleanup.
- Control the spill: Place torn or punctured containers into larger empty ones. Stand overturned containers upright.

	Contain (confine) the spill: limit chemical spread by using a dike or dam. Seal off all entry points into water or sewers, no matter how small the spill. Add an absorbent (dirt, sawdust, cat litter) to liquids.
	Clean up the spill, including any contaminated absorbent material. Quick cleanup minimizes entry into surface or sewer water and leaching to groundwater.
	Excavate as much soil as necessary.
	Decontaminate or neutralize the contaminated area.
	Clean equipment.
	If possible, apply spilled material and contaminated soil to a labeled site or crop, at or below the recommended application rate.
	If the spill is a hazard to people, or to the environment, or if it may enter water, call:
1	the regional office of the Department of Ecology,
2	the local emergency service number or Washington Department of Emergency Management (1-800-265-5990).

Contributors to Greater Vulnerability

The More of These Conditions Present, The Greater the Vulnerability

Chemical	Soil	Site	Practices

	Low Soil Adsorption		Sandy or Gravelly		Shallow Groundwater		Spills
	Soil Degradation		Little Organic Matter		Permeable Geology		Incorporation, Injection
	High Solubility		Water Saturated Soil		Sinkholes, Abandoned Wells Nearby		Improper Storage, Use, Handling, Disposal
			High Rainfall or Irrigation				

Storage.

Proper storage protects chemical life, people, and the environment.

Provide a secure location, out of reach of children, pets, livestock, and irresponsible people.
Lock Category I pesticides (Danger, Danger/Poison) in a posted enclosure, such as a separate building or storeroom.
Locate storage facility at least 100 feet from, and if possible, down slope from any water source (well, ditch, stream, etc.) to keep spilled material from the water source.
Construct a well ventilated, cool, and fire resistant facility.
Install a concrete floor and concrete curbing around the perimeter. Slope the floor toward a liquid-proof sump where any pesticide spill or leak can easily be cleaned up.
Include an adjacent mix/load/rinse containment area (if feasible).

- Consider building a dike around the storage and mixing center, especially in areas that might flood.
- Equip the facility with cleanup materials.
- Inventory and monitor pesticide stocks regularly to discover and clean up spills and leaks.

Before Applying Pesticides.

Evaluate your soil and site conditions based on information from your local Cooperative Extension agent or USDA-Soil Conservation Service.

- Choose application methods that are least likely to contaminate groundwater. Generally, avoid soil injection and soil incorporation.
- Make the fewest applications at the lowest rate that will achieve acceptable pest control.
- Maintain application equipment in good condition. Repair leaks. Replace or recondition worn parts, especially those that affect pesticide delivery: hoses, valves, gauges, spray nozzles, pumps, screens, etc.
- **Calibrating equipment and calculating how much pesticide to apply are two of the most important tasks for minimizing environmental harm.** Inaccurate calibration or calculations, and excessive application overlap cause overapplication.

	Degradation, plant absorption, and soil adsorption may not keep excess pesticide in the root zone, thus increasing contamination risk. Overapplication increases costs as well.
	Check operating manuals for proper calibration methods.
	Re-calibrate equipment before each season and with each change in delivery rate or formulation.
	When calibrating, check your boom height and pattern overlap to avoid over- or underapplication.
	Check spray pattern and nozzle flow each day.

Mixing and Loading.

Read the label thoroughly before mixing. Handle pesticide concentrates carefully to avoid accidental spills and personal harm. **A major source of groundwater contamination is mixing and loading near the primary water source—a well.** Keep pesticides from reaching the soil, well, or any water source when mixing and loading.

	Mix in the field to be treated to avoid concentrating all spilled material from mixing and to avoid the chance for accidents on the way to the site. (Portable mixing/containment facilities are available.)

If you must mix and load pesticides near a water source, or if you regularly mix at the same site, build a liquid-tight, curbed concrete mixing/containment pad.

Measure accurately for proper concentration.

Mix only the amount needed.

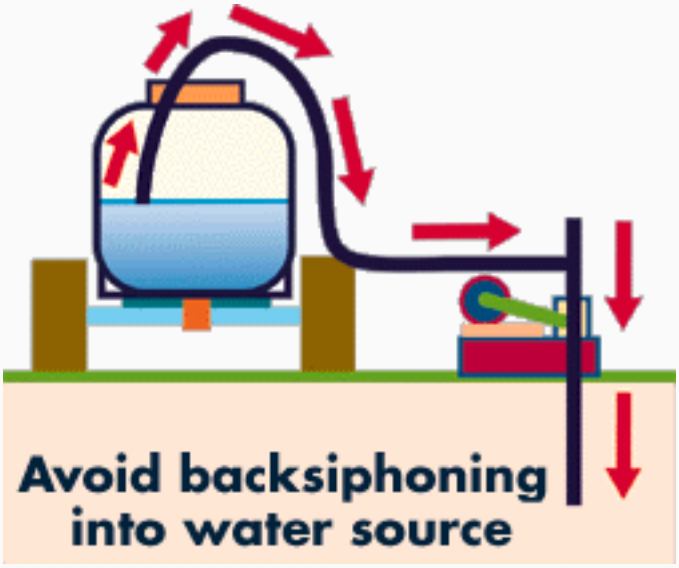
Never exceed label application rates.

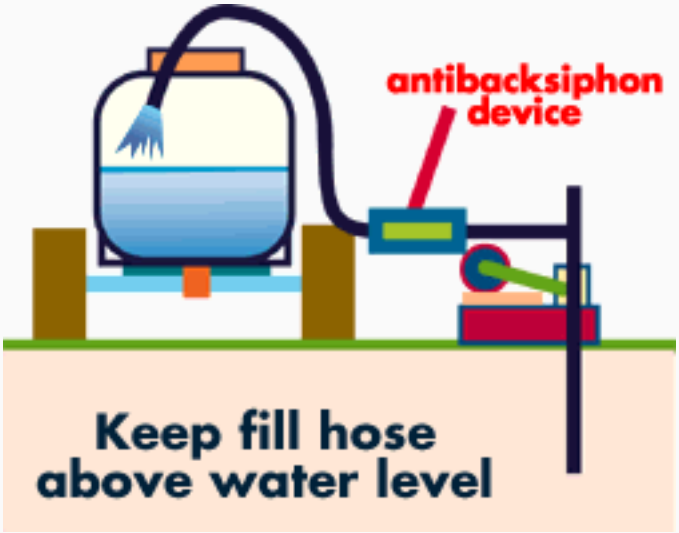
Avoid backsiphoning. For example, if the well pump stops, the filler hose can suck the tank mixture back into the well.

- Attend your sprayer during the entire filling operation.
- Keep the fill hose above the liquid level in the tank.
- If possible, fill the tank with water before adding pesticides.
- Install and maintain antibacksiphoning valves on all pumps and water valves, including residential sill-cocks and chemigation equipment. The valves prevent liquids from moving backwards through water lines.

If possible, use a "closed" application system to reduce spill potential when mixing.

Triple rinse containers immediately upon emptying.





Application

Delay an application to avoid periods of heavy rain or irrigation.

Leave no-spray buffer strips at least 100 feet wide along surface waters and at least 50 feet wide near abandoned wells and irrigation ditches.

Pay close attention to soil and environmental conditions when introducing pesticides into the soil with soil injection or incorporation. These methods reduce soil surface degradation processes, and increase contamination risk.

- Be prepared for spills. Have cleanup materials available.
- Control application overlap with swath markers, such as dyes or foam generators.

Cleaning Equipment.

Equipment cleaning can concentrate chemicals in a small area, and can heavily contaminate soil and, potentially, groundwater.

- Carry a nurse or saddle tank of clean water for an initial equipment rinse in the field; spray the rinsate on the site. After this rinse, little residue is brought to the mix/load/rinse site.
- Unless you will use the same chemical for the next application, rinse and clean the sprayer after each use.
- Follow label instructions for cleaning if listed.
- Wash the entire sprayer system, inside and outside.
- Do not wash equipment near wellheads, ditches, streams, or other water sources.
- Construct a site for regular equipment cleaning that can virtually eliminate generating hazardous waste materials.
  - Build a combination mixing/loading/washing containment pad.

Install a liquid-tight, sloped concrete floor with concrete curbing around the perimeter.

Slope the floor toward a liquid-proof sump with a pump.

Install a dike around the pad. Include your pesticide storage facility if it is adjacent. Make the dike high enough to keep out all surface and possible flood water.

Pump liquids from the sump to one or more labelled holding tanks. Use collected liquids as diluent for later spray batches. Re-use of rinsewater usually requires a separate holding tank for each group of pesticides.

Disposal.

Dispose of chemicals safely. Careless disposal can concentrate materials in the soil, potentially leaching to groundwater.

You can dispose of triple rinsed containers at designated landfills. Check with landfill for disposal acceptance and procedures.

Most excess pesticides and nonrinsed containers must be transported to a hazardous waste facility by a licensed hazardous waste transporter. Minimize generating hazardous waste.

Find someone who can legally use your excesses to avoid generating waste.

Do not purchase more than you need.

Chemigation.

Heavy irrigation increases pesticide movement through the soil toward groundwater.

- Chemigate using only those pesticides with labels clearly approving the method.
- Use only enough water to activate the pesticide.
- Use anti-backsiphon devices.
- Continuously monitor chemigation practices.

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Your Care Can Protect Groundwater

- Select a pest management strategy carefully; consider environmental impact.
- Be especially careful around wellheads and water sources.
- Understand site vulnerability: soil type, geology, climate.
- Understand pesticide vulnerability: select pesticides carefully.
- Be prepared for spills and leaks with clean-up equipment and personal protective equipment: while transporting, at the storage area, while mixing and loading, and while applying.
- Follow label directions and precautions.
- Calculate and measure accurately. Calibrate accurately and often. Check equipment operation and spray patterns at least daily.
- Monitor weather and irrigation schedules carefully.
- Store pesticides safely, away from water sources.
- Triple rinse pesticide containers. Crush, then dispose of containers and unused pesticides legally.

- Do not use pesticides if conditions exist for potential groundwater contamination.

For further information about pesticides and their safe use, consult the manual Washington Pesticide Laws and Safety. MISC0056. Cooperative Extension, Washington State University.

For further information about pesticide movement in soil, consult Pesticide Movement in Soil—Groundwater Protection. EB1543. Cooperative Extension, Washington State University.

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