U.S. Department of the Interior
U.S. Geological Survey

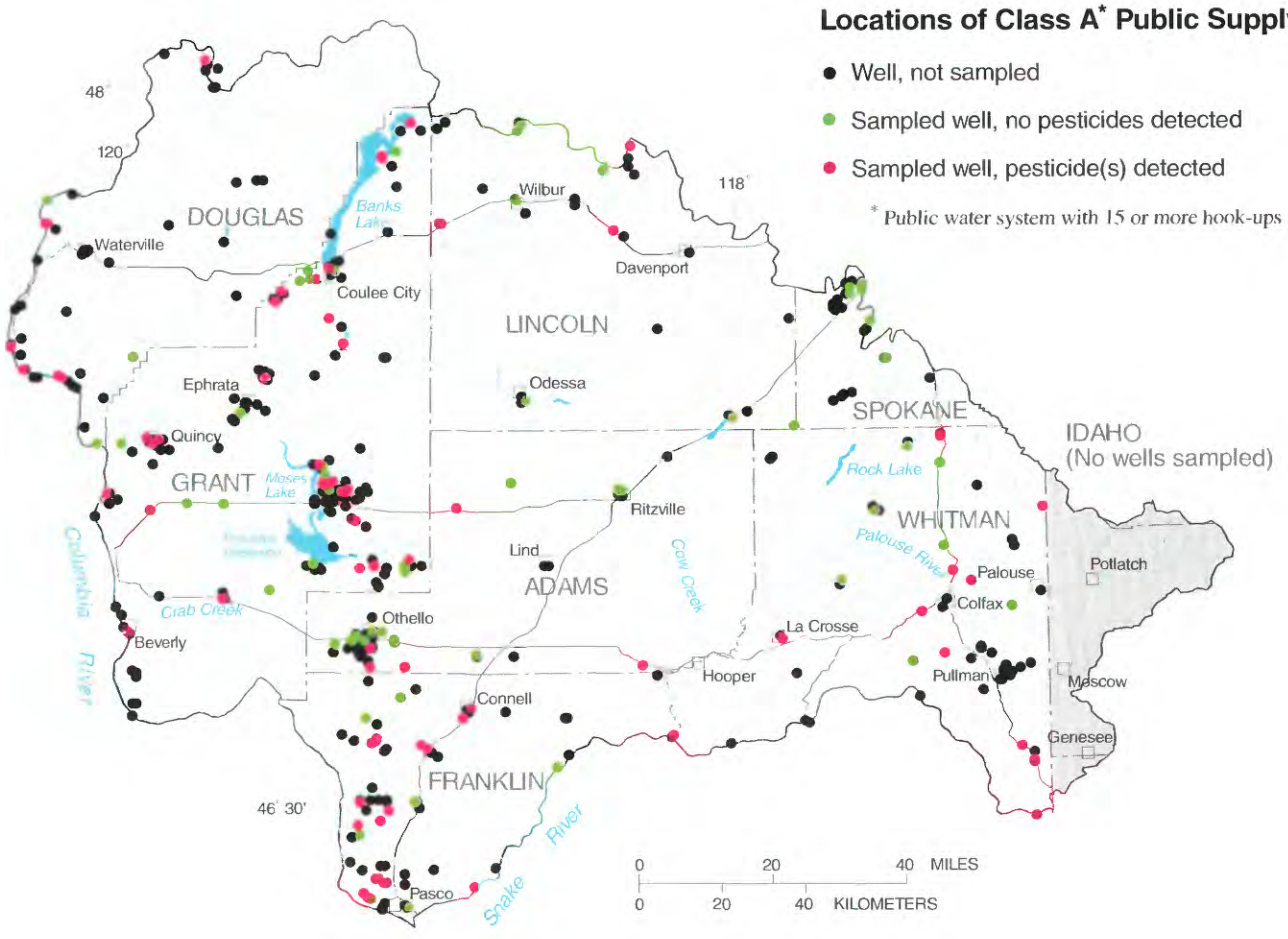
Pesticides in Public Supply Wells of the Central Columbia Plateau

USGS Fact Sheet 205-96

This fact sheet presents U.S. Geological Survey (USGS) results from sampling Central Columbia Plateau public supply wells for pesticides.

In 1994, the USGS cooperated with the Washington State Department of Health (WDOH) in the first statewide assessment of the vulnerability of Washington public supply wells to pesticides. Samples were collected from 1,326 public supply wells across Washington State. In the Central Columbia Plateau, WDOH contract laboratories analyzed samples from 302 wells, while 138 duplicate samples were analyzed by the USGS using laboratory techniques that can detect very low concentrations of pesticides. Results were used by the WDOH for a risk analysis on which to base monitoring waivers, and by the USGS to assess the quality of ground water in the Central Columbia Plateau.

- Very low concentrations of pesticides were found in 45% of 138 public supply wells sampled in the Central Columbia Plateau.
- No pesticides were detected at concentrations exceeding enforceable U.S. Environmental Protection Agency (EPA) drinking water standards. Dieldrin exceeded an EPA health guideline in one well.
- 66% of wells with detections had more than one pesticide detected.
- Shallow wells with elevated concentrations of nitrate had the highest rate of pesticide detection.



The map shows 500 Class A public supply wells, including two groups of wells sampled by the USGS.

- 120 wells were randomly selected, so as to be representative of the study area's water quality.
- 18 additional wells were selected as a high-risk group, on the basis of elevated nitrate concentration (greater than 2-3 mg/L) and shallow well depth.

Pesticide detections in randomly selected wells and high-risk wells

What pesticides were detected?

The combined table and graph below show concentrations of 14 pesticides detected in 138 public supply wells in the Central Columbia Plateau. This study analyzed primarily agricultural pesticides, as 61% of the Central Columbia Plateau is agricultural land. For a complete list of pesticides (insecticides and herbicides) analyzed and their detection limits, see Wagner and others, 1996.

Pesticide or degradate[1]		Concentration, in micrograms per liter (µg/L)	Rate of detection
Insecticide	**Trade name(s)[2]**	0.001 0.01 0.1 1 10 100 1,000	
p,p'- DDE	DDT (degradate)	◆ 5 detections	4%
Carbaryl	Sevin		1%
Dieldrin	Panoram D-31		1%
Herbicide		0.001 0.01 0.1 1 10 100 1,000	
Atrazine	AAtrex		34%
Desethylatrazine[3]	Atrazine (degradate)		31%
Simazine	Aquazine, Princep		14%
Prometon	Pramitol		5%
Bromacil[4]	Hyvar, Urox B	◆ 2 detections	5%
Metribuzin	Lexone, Sencor		2%
Bentazon[4]	Basagran		2%
EPTC	Eptam, Sonalan		1%
Metolachlor	Dual		1%
Tebuthiuron	Spike		1%
Terbacil[3]	Sinbar		1%

Detections in this range are below the method detection limit (MDL)[5] — MDL — Pesticide detection — Drinking water standard or guideline[6] — Detections in this range exceed a standard or guideline

EXPLANATION

What pesticides were not detected? [4]

Insecticide	Trade name(s)[2]
Azinphos-methyl	Guthion
Carbofuran[3]	Furadan
Chlorpyrifos	Genpest, Lorsban
Diazinon	several
Disulfoton	Di-Syston
Ethoprop	Mocap
Fonofos	Dyfonate
alpha-HCH	Lindane (impurity)
gamma-HCH	Lindane
Malathion	several
Methyl parathion	Penncap-M
Parathion	several
cis-Permethrin	Ambush, Pounce
Phorate	Thimet, Rampart
Propargite	Comite, Omite
Terbufos	Counter

Herbicide	Trade name(s)[2]
2,6-Diethylanaline	Alachlor (degradate)
Alachlor	Lasso
Benfluralin	Balan, Benefin
Butylate	Sutan +, Genate Plus
Cyanazine	Bladex
DCPA	Dacthal
Ethalfluralin	Sonalan, Curbit EC
Linuron	Lorox, Linex
Molinate	Ordram
Napropamide	Devrinol
Pebulate	Tillam
Pendimethalin	Prowl, Stomp
Pronamide	Kerb
Propachlor	Ramrod
Propanil	Stampede
Thiobencarb	Bolero
Triallate	Far-Go
Trifluralin	Treflan, Trilin

[1] Break-down product. This study and others (Kolpin and others, 1996) found that degradates of some common herbicides are detected at least as frequently as the parent pesticide.

[2] Use of trade names is for descriptive purposes and does not imply endorsement by the U.S. Geological Survey. Parent compound names are included for degradates.

[3] Concentrations for these compounds are qualitatively identified and reported as estimated values because of problems with gas chromatography or extraction (Zaugg and others, 1995).

[4] A subset of the samples (43/138) was analyzed for 41 additional pesticides. Of these, only bromacil and bentazon were detected. Due to the smaller sample size, the 39 undetected pesticides are not listed.

[5] The MDL is the smallest concentration of a compound that the laboratory can detect with 99% confidence. Detections below the MDL are identified and reported as approximate concentrations.

[6] For atrazine and simazine, standards are EPA maximum contaminant levels (MCLs). For *p,p'*-DDE and dieldrin, guidelines are risk-specific doses (RSDs), concentrations corresponding to a 1 in one million increased chance of developing cancer. Guidelines for other pesticides are concentrations considered safe for a 70-kilogram adult in 70 years of exposure (Nowell and Resek, 1994; U.S. Environmental Protection Agency, 1996).

What factors influence pesticide concentration and detection?

Concentrations of agricultural pesticides in ground water are influenced by a number of interrelated factors:

- The amount of each pesticide used, the timing and method of application, and other farming practices
- Characteristics of the pesticide, such as solubility, volatility, degradation rate, and adsorption to soil particles
- Soil and aquifer characteristics, and recharge rates from precipitation and irrigation. Recharge rates affect how quickly a pesticide is transported from the land surface to well water.

An analysis of public supply wells from across Washington State (summarized by Ryker and Williamson, 1996) found that three factors correlated with pesticide detection:

- **Land use** predominantly agricultural or urban
- **Well depth** less than 125 feet
- **Nitrate concentration** greater than 2.7 mg/L

(Steve Swope, Pacific Groundwater Group, written commun., 1994)

In Central Columbia Plateau public supply wells, the two factors most clearly related to pesticide detection are the concentration of nitrate detected in the well and the well depth (see bar graphs below). Agricultural land use is an important factor in the Central Columbia Plateau; however, to correlate specific types of agriculture with pesticide detection would require more current and detailed land-use data than are currently available.

Is my drinking water vulnerable?

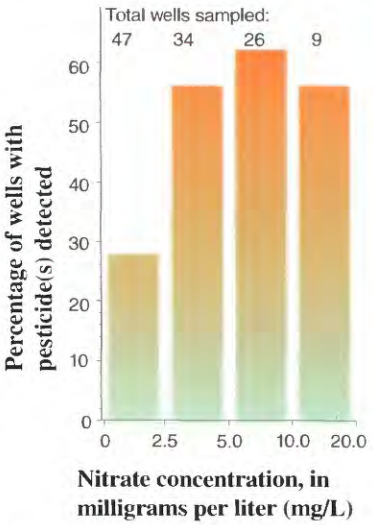
All of the above factors, and also site-specific factors such as well construction, affect whether pesticides get into well water.

- To assess the vulnerability of domestic (private) water wells, Cooperative Extension agents in most counties can provide a self-assessment tool called Home-A-Syst.
- For information on the water quality of your public supply system, contact your water utility or county health agency, or the Washington State Department of Health: 1 (800) 521-0323. These agencies can also provide health information.

Nitrate concentration

Agricultural fertilizers are the primary source of nitrate in ground water. Nitrate concentrations greater than 2-3 mg/L in well water indicate that chemicals applied to the land surface are reaching the ground water system, so detection of pesticides in these wells may be more likely.

This relationship between nitrate concentration and pesticide detection may help identify wells at risk for contamination by pesticides. Laboratory analysis of nitrate is simpler and less costly than analysis of pesticides. Consequently, many more Central Columbia Plateau wells have been sampled for nitrate (see Ryker and Jones, 1995).



Nitrate data are from routine monitoring by WDOH (Washington State Department of Health, written commun., November 1995). Nitrate data were not available for 22 wells.

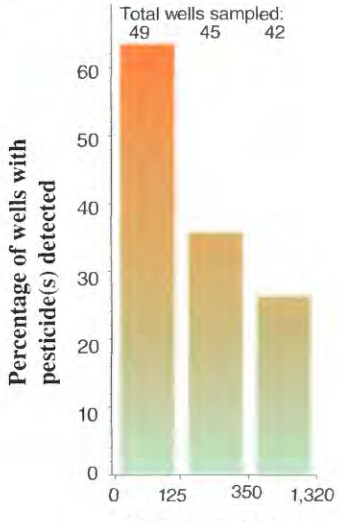
The graph at left shows that, in general, Central Columbia Plateau wells with lower nitrate concentrations have a lower rate of pesticide detection.

- Pesticides were detected in 58% of wells with nitrate concentrations greater than 2.5 mg/L.
- Pesticides were detected in only 28% of wells with nitrate concentrations less than 2.5 mg/L.

Well depth

As pesticides travel from the land surface down through the ground-water system, they may degrade. Many modern pesticides are designed to degrade rapidly, to reduce contamination of ground water. However, shallow wells can take in water containing pesticides that have not yet degraded. Shallow wells therefore tend to have a higher rate of pesticide detection.

However, even water from deep public supply wells can contain pesticides. This could be due to poor well construction, high pumpage rates (drawing more ground water into the well), or local ground-water pathways that allow water to move quickly to greater depths.



Depth data are from WDOH (Washington State Department of Health, written commun., November 1995), supplemented with data from the USGS National Water Information System. Depth data were not available for 2 wells.

The graph at left shows that, in general, deeper wells in the Central Columbia Plateau have a lower rate of pesticide detection.

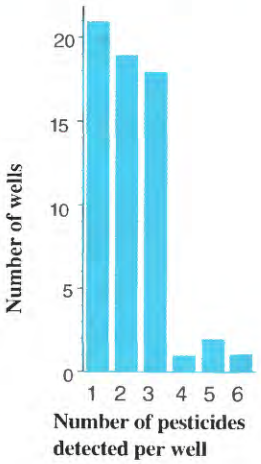
- Pesticides were detected in 63% of wells less than 125 feet deep.
- Pesticides were detected in only 31% of wells more than 125 feet deep.

Combinations of pesticides

Multiple pesticides were detected in 66% of the 62 wells with pesticide detections. No well had more than 6 pesticides detected.

Health effects of combinations of pesticides in drinking water are not well understood. However, just as the effectiveness of pesticides may increase ***or*** decrease when mixed together for agricultural use, the toxic effect on humans may change when combinations of pesticides are present in drinking water. Currently, health standards are set only for individual compounds.

The EPA is considering establishing health standards for combinations of triazine pesticides, and for their individual degradation products (U.S. Environmental Protection Agency, 1994).



In this study, three of the five most frequently detected pesticides in public supply wells were members of the triazine family:

- atrazine and its degradation product desethylatrazine
- simazine
- prometon

Triazine pesticides were also the compounds most commonly detected ***together*** in Central Columbia Plateau public supply wells.

In contrast, *p,p'*-DDE, the fifth most detected compound in this study, was never detected in combination with other pesticides. *p,p'*-DDE is a degradation product of DDT, which was discontinued for use in the United States in 1973. Wells where only *p,p'*-DDE is detected, and not the more modern pesticides, may be taking in older water that predates use of triazine pesticides. This scenario assumes that the more recently applied pesticides have not yet moved deep enough to be taken in by these wells.

Are these findings representative of ground-water quality in the Central Columbia Plateau?

YES . . .

The USGS National Water-Quality Assessment (NAWQA) program is designed to assess the status of, and trends in, the Nation's water resources. The NAWQA design includes a Study-Unit Survey intended to characterize the quality of the ground-water resources used in the study area. Wells are randomly selected to ensure a representative sample population.

This study's random sampling of public supply wells fulfills the NAWQA Study-Unit Survey for the Central Columbia Plateau. The sampling results appear to be representative of the area's ground-water quality: similar pesticides and concentrations have been detected in shallow domestic wells, monitoring wells, and-surface waters sampled by other components of NAWQA (Roberts and Jones, 1996a and b; Wagner and others, 1995).

. . . BUT INCOMPLETE.

The pesticides reported here are not the only contaminants in the ground water of the Central Columbia Plateau. The WDOH contract laboratories analyzed for, and detected, a slightly different group of pesticides (Washington State Department of Health, 1995). WDOH sampling results are not reported here because the contract laboratories were unable to detect concentrations as low as many of the USGS pesticide detections. WDOH sampling results were otherwise very similar to the USGS sampling results (Ryker and Williamson, 1996).

The NAWQA study also has detected additional pesticides, volatile organic compounds, and several other types of contaminants in Central Columbia Plateau public supply wells, domestic wells, and monitoring wells (Roberts and Jones, 1996a and b).

Kolpin, D.W., and others, 1996, Occurrence of selected pesticides and their metabolites in near-surface aquifers of the midwestern United States: Environmental Science and Technology, v.30, no.1, p. 335-340.

Nowell, L.H. and Resek, E.A., 1994, Summary of national standards and guidelines for pesticides in water, bed sediment, and aquatic organisms and their application to water-quality assessments: U.S. Geological Survey Open-File Report 94-44, 115 p.

Roberts, L.M. and Jones, J.L., 1996a, Agricultural pesticides found in ground water of the Quincy and Pasco Basins: U.S. Geological Survey Fact Sheet 240-95, 2 p.

Roberts, L.M. and Jones, J.L., 1996b, Pesticides found in ground water below orchards in the Quincy and Pasco Basins: U.S. Geological Survey Fact Sheet 171-96, 4 p.

Ryker, S.J. and Jones, J.L., 1995, Nitrate concentrations in ground water of the Central Columbia Plateau: U.S. Geological Survey Open-File Report 95-445, 4 p.

Ryker, S.J. and Williamson, A.K., 1996, Pesticides in public supply wells of Washington State: U.S. Geological Survey Fact Sheet 122-96. 2 p.

U.S. Environmental Protection Agency, November 1994, Atrazine, simazine, cyanazine; notice of initiation of special review: Federal Register, v.59, p. 60412-60443.

U.S. Environmental Protection Agency, February 1996, Drinking water regulations and health advisories: Washington, D.C., Office of Water, U.S. Environmental Protection Agency, EPA 822-R-96-001, 16 p.

Wagner, R.J., and others, 1996, Agricultural pesticide applications and observed concentrations in surface waters from four drainage basins in the Central Columbia Plateau, Washington and Idaho, 1993-94: U.S. Geological Survey Water-Resources Investigations Report 95-4285, 50 p.

Washington State Department of Health, Spring 1995, Preliminary Results of the Areawide Groundwater Monitoring Project: Washington State Department of Health, 9 p.

Zaugg, S.D., and others, 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory--determination of pesticides in water by C-18 solid-phase extraction and capillary-column gas chromatography/mass spectrometry with selected-ion monitoring: U.S. Geological Survey Open-File Report 95-181, 49 p.

USGS Fact Sheet 205-96 by Sarah J. Ryker and Alex K. Williamson

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
National Water-Quality Assessment Program

For further technical information contact:

Project Chief
Central Columbia Plateau NAWQA
1201 Pacific Avenue - Suite 600
Tacoma, WA 98402

Phone: (206) 593-6530 x235 Email: nawqa_ccpt_wa@usgs.gov
World-Wide Web: http://wwwdwatcm.wr.usgs.gov/ccpt/