

Volatile Organic Compounds in Samples from Domestic and Public Wells, 1985–2002

By Barbara L. Rowe, John S. Zogorski, and Joshua F. Valder

Study basics

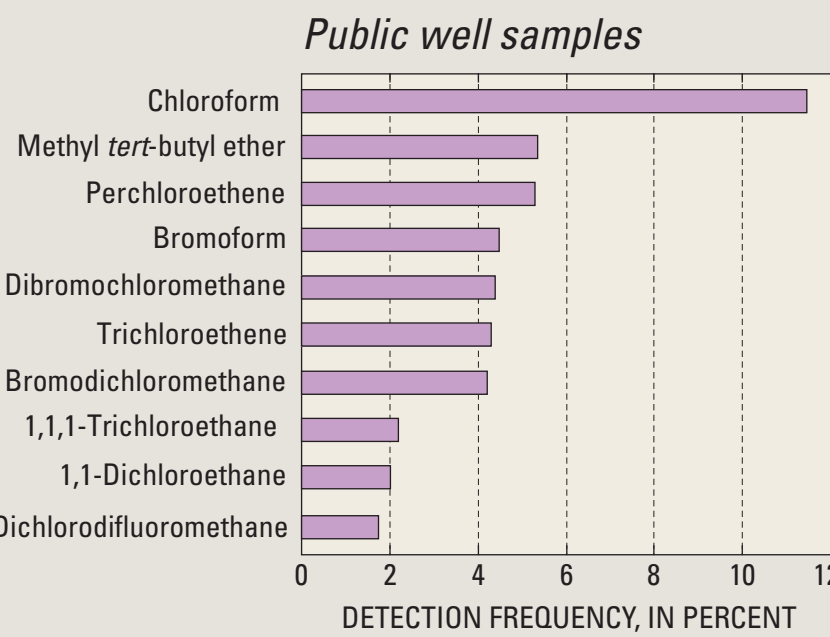
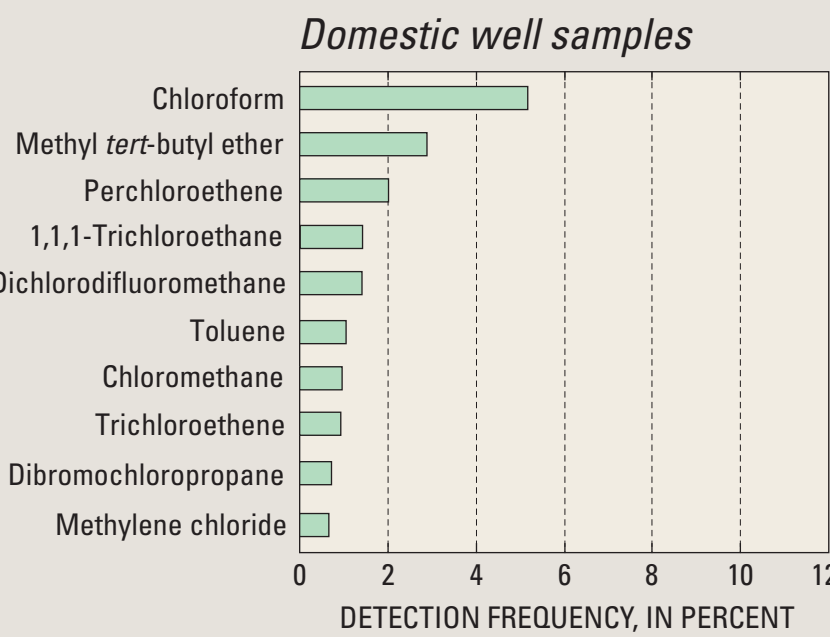
The U.S. Geological Survey's (USGS) National Water-Quality Assessment (NAWQA) Program recently completed a national study of volatile organic compounds (VOCs) in the Nation's ground water (Zogorski and others, 2006). Part of this assessment emphasizes the occurrence of 55 VOCs in samples from 2,401 domestic wells and 1,096 public wells during 1985–2002. Samples were collected prior to any treatment or blending of water.

Domestic wells are privately owned, self-supplied sources used for drinking water and household use (Moran and others, 2002). Public wells are privately or publicly owned and supply water to public water systems (PWSs). Samples from public wells in this assessment characterize the quality of water captured by wells that supply drinking water to PWSs. These systems supply drinking water to at least 15 service connections or regularly serve at least 25 individuals daily at least 60 days a year (U.S. Environmental Protection Agency, 2005).

For a screening-level assessment, VOC concentrations were compared to human-health benchmarks. Concentrations greater than the U.S. Environmental Protection Agency's (USEPA) Maximum Contamination Levels (MCLs) (U.S. Environmental Protection Agency, 2004) or the USGS's Health-Based Screening Levels (HBSLs) (Zogorski and others, 2006) were considered of potential human-health concern. The findings from the well samples provide an important perspective on the quality of the Nation's ground water used for drinking-water supplies. More information about this national assessment of VOCs is available (http://water.usgs.gov/nawqa/vocs/national_assessment).

- One or more VOCs were detected in 14 percent of domestic well samples and 26 percent of public well samples at an assessment level of 0.2 microgram per liter.
- Chloroform, methyl *tert*-butyl ether (MTBE), and perchloroethene (PCE) were the most frequently detected VOCs in both well types; however, the overall signature of VOCs associated with domestic and public wells differed.

The 10 most frequently detected VOCs at an assessment level of 0.2 microgram per liter



- Six VOCs in about 1 percent of domestic samples and five VOCs in about 2 percent of public well samples had VOC concentrations of potential human-health concern.
- Additional VOCs had concentrations below but within a factor of 10 of USEPA MCLs.

VOCs with concentrations of potential human-health concern

Compound	VOC group	Domestic wells	Public wells
Dibromochloropropane	fumigant	X	
1,1-Dichloroethene	organic synthesis compound	X	X
1,2-Dichloropropane	fumigant	X	
Ethylene dibromide	fumigant	X	
Methylene chloride	solvent		X
Perchloroethene	solvent	X	X
Trichloroethene	solvent	X	X
Vinyl chloride	organic synthesis compound		X

Additional VOCs with concentrations below but within a factor of 10 of USEPA MCLs

Compound	VOC group	Domestic wells	Public wells
Benzene	gasoline hydrocarbon	X	X
Bromodichloromethane	trihalomethane		X
Bromoform	trihalomethane	X	X
Carbon tetrachloride	solvent	X	X
Chloroform	trihalomethane	X	X
cis-1,2-Dichloroethene	solvent		X
Dibromochloromethane	trihalomethane	X	X
1,2-Dichloroethane	solvent	X	X
1,1,1-Trichloroethane	solvent	X	

- Domestic well samples had fewer VOCs, lower detection frequencies, smaller concentrations, and fewer mixtures than public well samples.

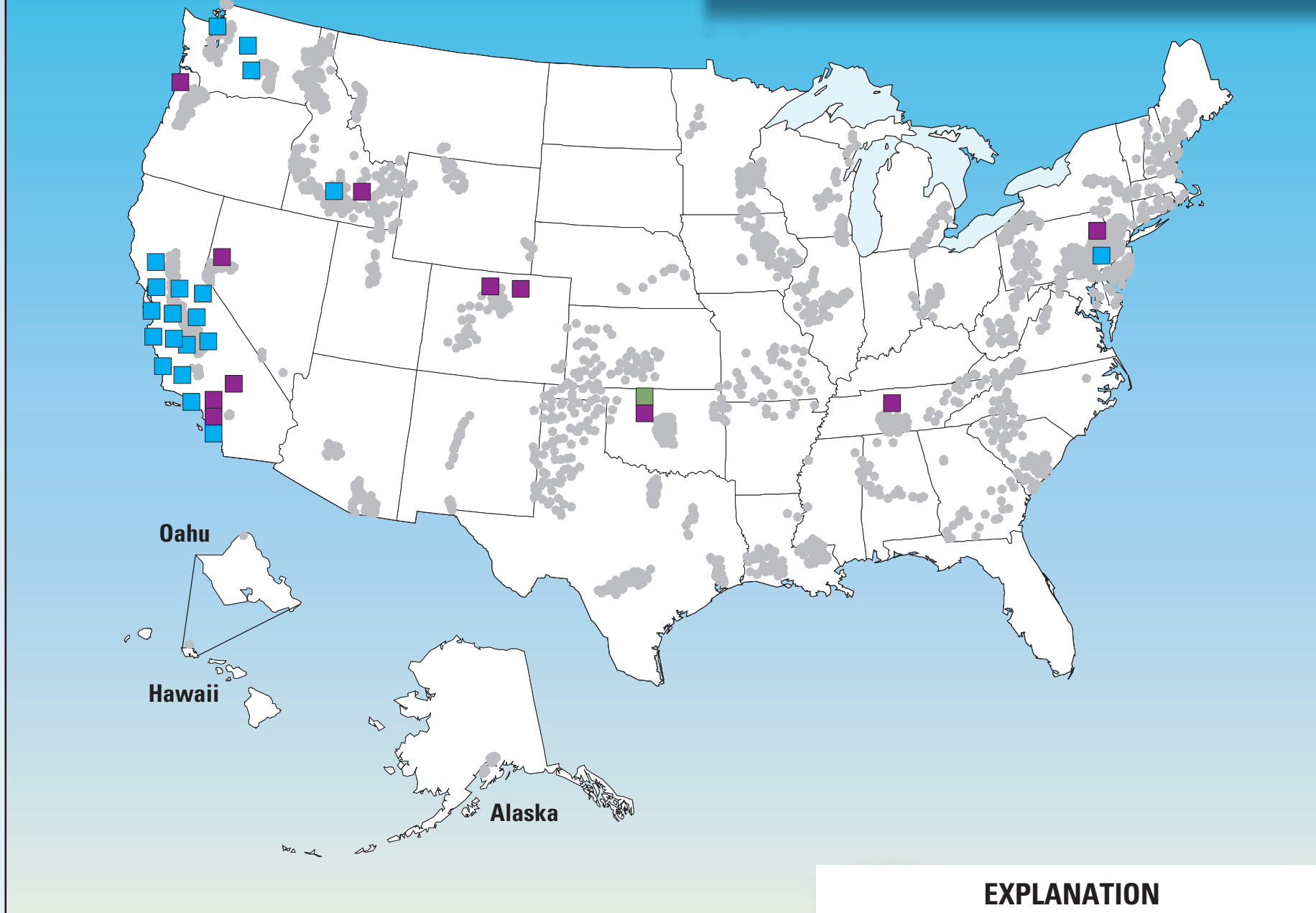
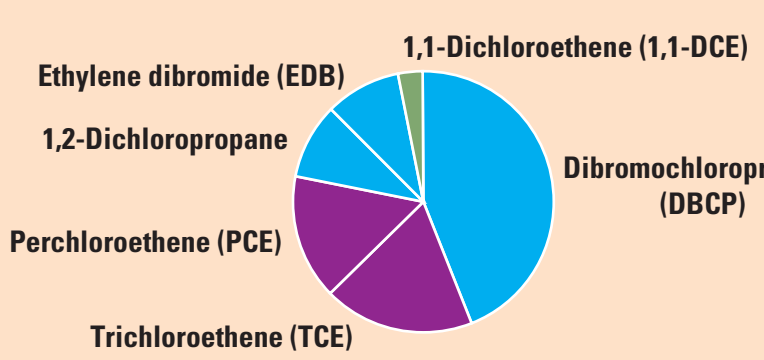
Statistics for VOC occurrence in samples from domestic and public wells at an assessment level of 0.2 microgram per liter (µg/L)

Occurrence information	Well type	
	Domestic	Public
Detections		
Number of VOCs detected	37	41
Frequency of one or more VOCs, in percent	14.0	26.2
Concentrations		
Total VOC concentrations less than 1 µg/L, in percent	62.2	49.8
Total VOC concentrations greater than 10 µg/L, in percent	6.6	8.4
Detections and concentrations of potential human-health concern		
Number of VOCs with concentrations greater than their MCL	6	5
Frequency of concentrations greater than their MCL, in percent	1.2	1.5
Frequency of concentrations greater than their HBSL, in percent	0	0
Total number of VOCs with concentrations of potential human-health concern	6	5
Multiple VOCs		
Total number of VOCs that occurred in mixtures	38	40
Number of VOCs occurring only in mixtures	16	18
Frequency of mixtures in all well samples, in percent	3.9	13.4
Frequency of mixtures in well samples with VOC detections, in percent	27.7	51.2

Domestic well samples

- VOCs with concentrations of potential human-health concern in samples were predominantly fumigants and solvents; DBCP accounted for about 50 percent of these concentrations.

Proportions of VOC concentrations of potential human-health concern in domestic well samples



EXPLANATION

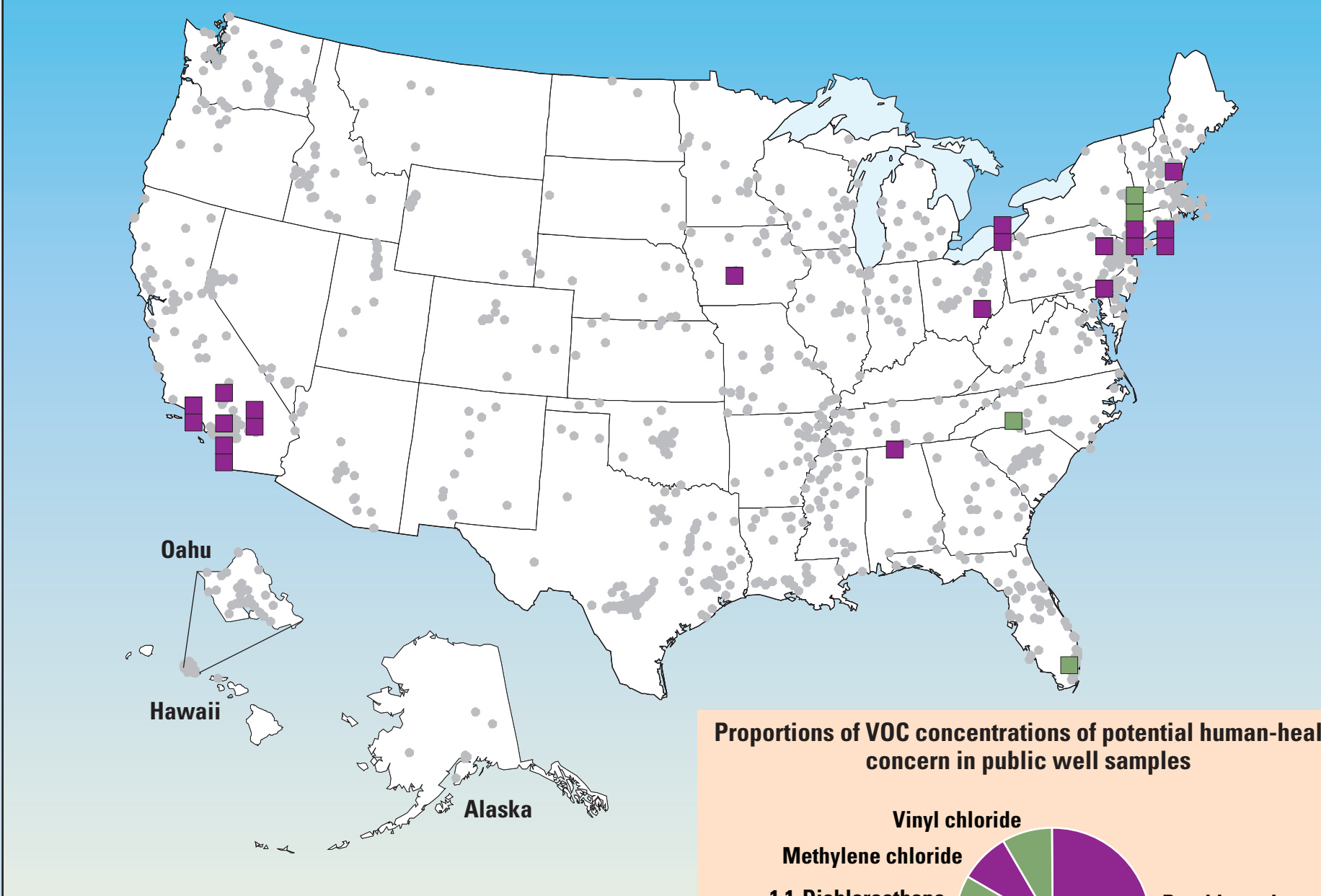
Domestic and public well samples

- Contained no VOCs with concentrations of potential human-health concern
 - Contained one or more VOCs with concentrations of potential human-health concern¹
- Fumigant
■ Organic synthesis compound
■ Solvent

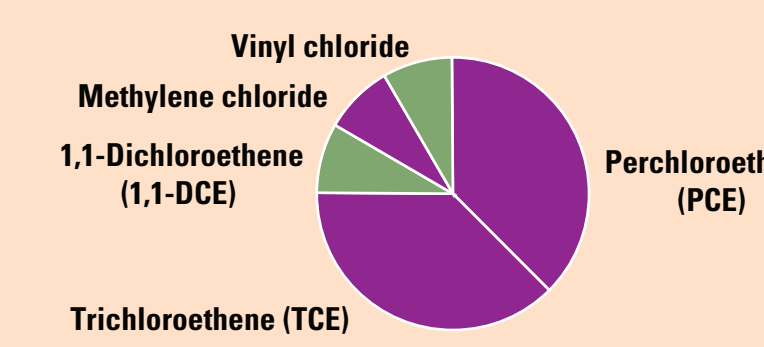
¹ Stacked box symbols indicate that the sample contained more than one VOC of potential human-health concern. Some box symbol locations have been slightly shifted to reduce overlaps.

Public well samples

- VOCs with concentrations of potential human-health concern in samples were predominantly solvents and organic synthesis compounds; solvents accounted for about 85 percent of these concentrations.

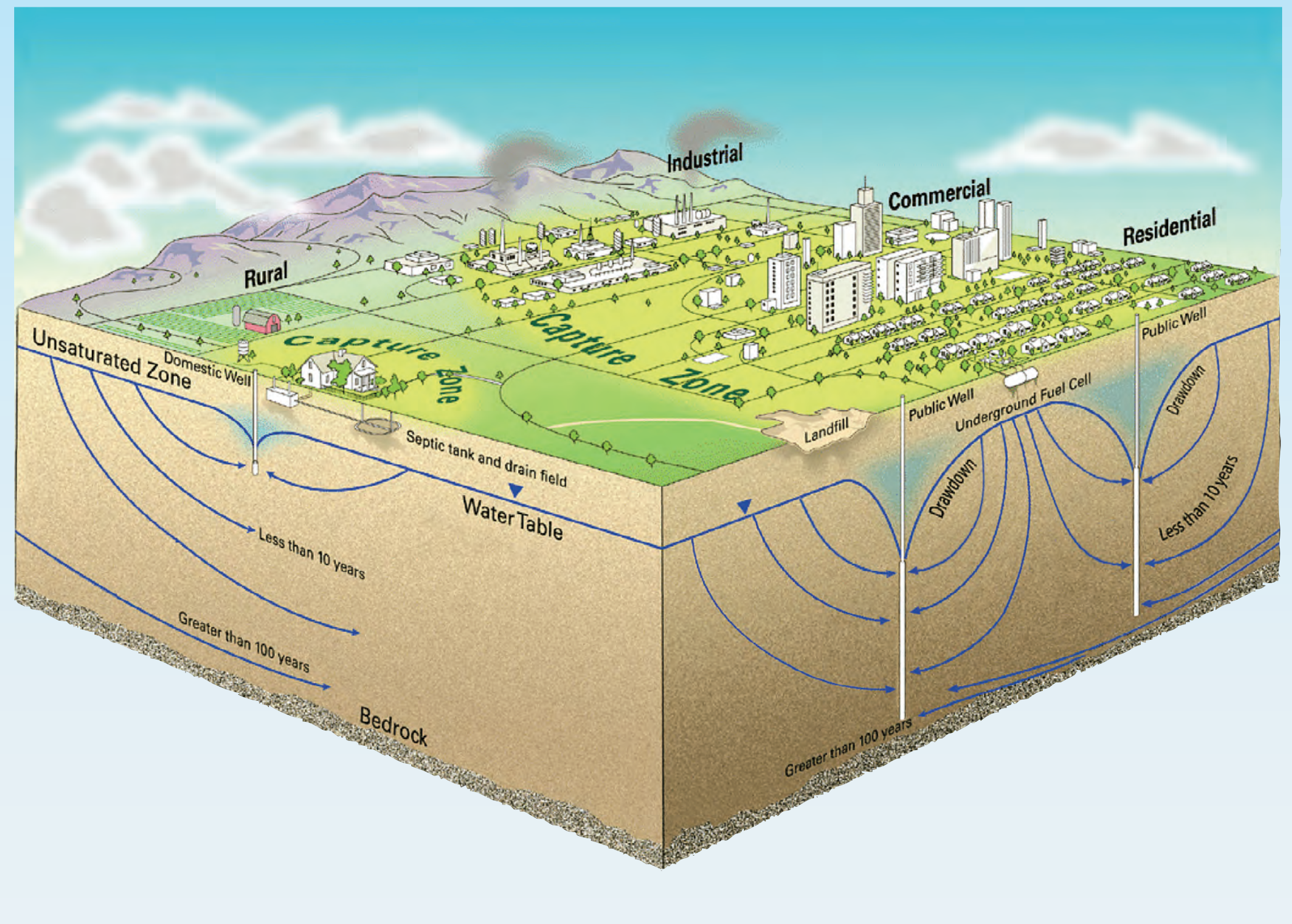


Proportions of VOC concentrations of potential human-health concern in public well samples



Vulnerability to VOC contamination is greater for public wells than domestic wells due to:

- Proximity to developed areas.
- High volume pumping systems.
- Large contributing areas, capture zones, withdrawal rates, and drawdown.
- Interception of water from recharge areas with multiple land uses and point sources.



Implications

- Future studies of VOC contamination in domestic and public wells can focus on relatively few compounds.
- Most VOC concentrations in domestic and public well samples in this screening-level assessment were less than MCLs and HBSLs, and therefore are unlikely to result in adverse human-health effects.
- Eight VOCs with concentrations of potential human-health concern merit additional study to understand contaminant sources and VOC concentrations in drinking-water supplies.
- Seventeen VOCs may warrant inclusion in low-concentration, trends-monitoring programs.
- Due to the relatively large number of concentrations near to or greater than their MCLs, the solvents PCE and TCE warrant special emphasis to understanding the sources and capture of these contaminants by domestic and public wells.
- Detection of VOCs in public well samples and the vulnerability of public wells to VOCs indicate the importance of effective well head protection programs and the need to identify and control VOC sources.

References

Moran, M.J., Lapham, W.W., Rowe, B.L., and Zogorski, J.S., 2002, Occurrence and status of volatile organic compounds in ground water from rural, untreated, self-supplied domestic wells in the United States, 1986–99: U.S. Geological Survey Water-Resources Investigations Report 02–4085, 51 p.

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Zogorski, J.S., Carter, J.M., Ivahnenko, Tamara, Lapham, W.W., Moran, M.J., Rowe, B.L., Squillace, P.J., and Toccalino, P.L., 2006, The quality of our Nation's waters—Volatile organic compounds in the Nation's ground water and drinking-water supply wells: U.S. Geological Survey Circular 1292, 101 p.