

# Land & Water

## Conserving Natural Resources in Illinois

University of Illinois at Urbana - Champaign, College of Agriculture, Cooperative Extension Service

### Safe Drinking Water

#### Testing and Treating Home Drinking Water

##### Do You Need To Test Your Water?

The signs of drinking water contamination are not always obvious. Contaminated water does not always look, taste, or smell differently than safe drinking water. What's more, if you have a private water supply, such as a well or surface water impoundment, you are your own regulatory agency. You are responsible for the quality of water that your family drinks.

These are all good reasons why testing the water regularly is an important consideration for people who have their own water supply.

People who get their water from a public or municipal supply have more protection because these supplies are governed by federal and state standards and are tested on a routine schedule based on the population size. However, that does not mean people on

public water supplies *never* have reason to test. It is possible that corrosive water or deteriorating pipes in your home may cause certain contaminants to get into your water supply.

So how do you know whether you need to test your water or not? The following guidelines describe conditions in which you should consider testing your water. The first six points apply to people with a private *or* municipal supply. The remaining guidelines generally apply only to someone with a private water supply.

##### Private or Public Supply

1. Water has an objectionable taste or smell.
2. Your household plumbing contains lead pipes, brass fittings, or lead-solder joints.
3. You need a water softener to treat hard water.
4. You want to monitor the efficiency and performance of home water-treatment equipment.
5. The water leaves scaly residues and soap scum, or it decreases the cleaning action of soaps and detergents.
6. The pipes or plumbing show signs of corrosion.

##### Private Supply Only

7. You have recurrent incidents of gastrointestinal illness.
8. You are buying a home and wish to evaluate the safety and quality of the water supply.



**Figure 1.** When you have a private water supply, no agency will make sure it is tested regularly and is safe to drink. You are your own regulatory agency.

9. Water stains plumbing fixtures and laundry.
10. The water appears cloudy, frothy, or colored.
11. Water-supply equipment (pump, chlorinators, etc.) wears rapidly.
12. You are pregnant, are anticipating a pregnancy, or have an infant less than six months old.

If any of these conditions exist, consult with the Illinois Department of Public Health, the Illinois State Water Survey in Urbana, or a private testing lab to decide which tests should be performed on your water.

## Taking Well Location Into Consideration

The distance of the well from potential sources of contamination influences the risk of contamination. Therefore, you should also consider having your water tested if any of the following conditions exist:

1. The well does not meet existing well-construction codes.
2. The well is less than 50-feet deep.
3. Soils in the area are coarse-textured and have rapid permeability.
4. The aquifer is close to the land surface (less than 50 feet from the surface).
5. The well is in an area of intensive agricultural activity where pesticides or fertilizers may have been spilled.
6. The well is close to a retail chemical facility that mixes and handles pesticides.
7. The well is within 150 feet of a livestock confinement area.
8. The well is within 50 feet of a septic tank or 75 feet of a septic system's absorption field.
9. The well is near a gravel pit, coal mine, oil/gas-drilling operation, or other mining operation.
10. The well is located near an operational or abandoned gas station or fuel storage tanks (buried or aboveground).
11. The well is near a dump, landfill, junkyard, factory, or dry-cleaning operation.
12. The well is near a road salt storage site, or a heavily salted roadway.

## How Often Should Water Be Tested?

People with private water supplies may want to test for certain contaminants annually and other contaminants less frequently.

**Annual tests.** Test for coliform bacteria and nitrates once a year. It is a good idea to test for these contaminants during the spring or summer following a period of heavy rainfall.

Also, test for coliform bacteria whenever you repair or replace an old well or pipes and after installing a new well or pump.

**Testing before an infant is born.** If you are planning to

have a baby, it is a good idea to test your well water for nitrate and coliform bacteria before pregnancy. If you are already expecting, or if you have an infant less than six months old, have the water tested as soon as possible.

If water is high in nitrates, it should not be used to prepare infant formula or in any other way that could result in consumption by the baby. High nitrate levels in water can cause methemoglobinemia, or the “blue baby syndrome,” which can be fatal to infants under six months of age. Some believe high nitrate levels can also harm a fetus.

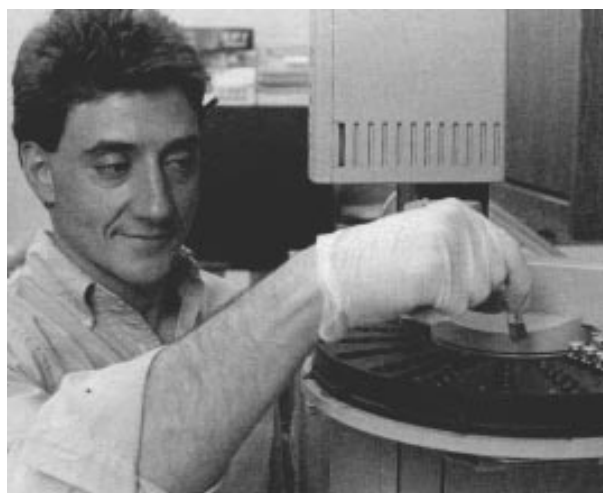
Nitrite in the blood can combine with hemoglobin to form methemoglobin, which reduces the ability of the blood to carry oxygen to all parts of an infant's body. However, because of individual differences, not all infants are affected.

If an infant is affected, his or her skin will become blue—similar to the color of the blood vessels located close to the skin. If you observe this condition, seek medical help immediately.

## Where Can You Have Water Tested?

Water can be tested by the local or regional offices of the Illinois Department of Public Health, or by private labs. Upon request, the Department of Public Health will collect the water sample; but if you prefer, you can be supplied with a bottle to take the sample yourself. A sterile bottle is needed to test water for bacteria, so contact your local or regional health department to obtain a sterile bottle.

Water can also be tested by local engineering firms, water-treatment companies and some laboratories at local universities, especially in the departments of chemistry, agronomy, toxicology, or natural resources. It is usually best to have the water tested by a public or private laboratory that does not sell water-treatment devices.



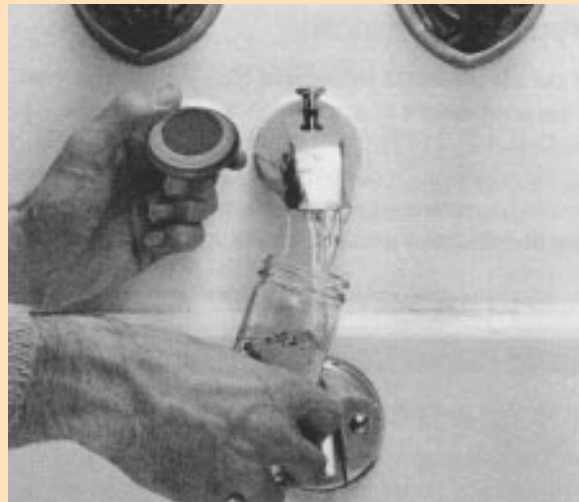
**Figure 2.** A technician prepares water samples for analysis in a gas chromatograph, a common fixture at most water-testing labs. A gas chromatograph is used to test water for pesticide residues.

## Collecting a Water Sample

Collecting a water sample is not a complicated matter. Instructions can vary from lab to lab, so be sure to follow the instructions of the lab with which you are working. To give you an idea of what is involved in collecting a water sample, the Illinois Department of Public Health makes the following recommendations:

- ✓ Collect samples on Sunday, Monday, or Tuesday, so laboratory tests can be completed during the same week.
- ✓ If possible, take samples only a short time before the mail leaves from the local post office.
- ✓ Wash hands before collecting the sample.
- ✓ Select a faucet *without* a threaded outlet, if possible. A bathtub faucet is often a good place to obtain your sample. It's better to use a faucet without threads because flakes of material can drop from the threads into the container while you are taking the sample.
- ✓ Do not take the sample from a fire or yard hydrant. Also, avoid swing faucets, faucets leaking at the handle, faucets that have attachments such as a hose or aerator, and faucets where food or beverages are dispensed or prepared.
- ✓ Allow water to flow smoothly from the pump to the faucet for at least five minutes.
- ✓ Carefully unscrew the cap of the sampling bottle. Be sure you do not touch the inside edges and threads of either the bottle or the cap.
- ✓ *Do not rinse the bottle* because a chemical preservative is intentionally added to some bottles.
- ✓ Do not lay the cap down while collecting the sample.

- ✓ Leave 3/4- to 1-inch of air space at the top of the bottle so the lab technician can adequately mix the sample.
- ✓ Find out from the post office whether sending the sample Special Delivery will get it to the lab within 48 hours. If a sample is over 48 hours old, it will not be analyzed. For best results, samples should arrive at the laboratory within 30 hours.
- ✓ The Illinois Department of Public Health will send you a water analysis report within 10 days of receiving the sample.



**Figure 3.** Collect your water sample at an unthreaded faucet, such as a bathtub faucet. Also, do not set down the lid to the glass jar, or it could pick up bacteria. For the same reason, you should never touch the inside of the lid or the sterilized jar with your fingers.

On page 4, you will find a partial listing of names and addresses of water-testing labs in Illinois. These labs have been certified by the Illinois Environmental Protection Agency and will do testing for the general public. However, the list does not include all Illinois labs, nor does it represent an endorsement by the University of Illinois.

For more information on how to locate a public or private laboratory in your area, check the Yellow Pages of your phone book or contact the local Cooperative Extension Service office.

If you receive water from a public water supply system, be aware that most systems (1) regularly test for primary contaminants, (2) monitor levels of sodium and certain unregulated chemical contaminants, and (3) look for corrosion in the water distribution system. Many public operations will provide water-quality reports upon request.

## How Are Measurements Expressed?

Water test results express the concentration of most contaminants in either “parts per million (ppm)” or “milligrams per liter (mg/l).” Although the terminology is different, 1 part per million is the equivalent of 1 milligram per liter.

Pesticide concentrations, meanwhile, are frequently reported in “parts per billion (ppb)” or “micrograms per liter ( $\mu\text{g/l}$ ).” A part per billion is 1/1000 of a part per million.

For other compounds, the results of a water analyses may be expressed in different forms of measurement. For instance, water hardness may be expressed in “grains per gallon,” while the corrosion index simply estimates whether water is corrosive or not corrosive.

## Coliform Bacteria and Nitrates

The basic test by the Illinois Department of Public Health analyzes water for the two most common contaminants—coliform bacteria and nitrates.

Coliform bacteria is an “indicator” organism; its presence may indicate the presence of other pathogenic (disease-causing) bacteria. Using an indicator organism is necessary because detecting *all* possible pathogens would be complex and costly.

If the test results for bacteria and nitrates are within allowable limits, then your water is most likely safe for drinking. But you should consult with your local health department to find out if other tests are necessary.

## Bacterial Contamination

If the test shows the presence of coliform bacteria, your water has some degree of contamination. However, the Illinois Department of Public Health cannot require you to correct the condition. It can only recommend ways to correct or prevent the problem. The Department will recommend that you disinfect your well and water-supply system and then

submit another sample for analysis.

To disinfect a well, a chemical disinfectant such as chlorine tablets or bleach is added to the well water. To do this, it will be necessary to disassemble the top of the well-casing on a drilled well. For a bored or dug well, you simply open the cover and add the bleach.

Killing pathogens in a well requires a chlorine concentration of at least 100 parts per million (ppm). The chlorine solution must remain in the well for several hours, preferably overnight, before it is pumped out. This process is called “shock chlorination.”

In addition to disinfecting the well, the plumbing system in the home must also be disinfected. This is done by turning on all water faucets after the chlorine disinfectant is added to the well. When a chlorine odor is detected in the water, the faucets are turned off and the water is not used for at least several hours—preferably overnight. After allowing water to remain in the pipes overnight, the faucets are opened and water is drained until the chlorine smell is no longer detected.

The Illinois Department of Public Health, a licensed well driller, or a pump repairman can further explain the correct techniques for disinfecting a well.

Occasionally, public water supplies become contami-

### Illinois Water-Testing Labs

The following labs are certified by the Illinois Environmental Protection Agency and will test home drinking water. This list does not include all Illinois labs, nor does it represent an endorsement by the University of Illinois.

Before submitting a water sample, find out if the laboratory will interpret the results. If it does not provide that service, you can either have the water tested at a lab that does, or you can have the results interpreted elsewhere—the local health department, for example.

#### State Services

Illinois Department of Agriculture, Animal Disease Laboratory, Shattuc Road, Centralia, IL 62801-9289, (618) 532-6701

Illinois Department of Public Health, 825 N. Rutledge, Springfield, IL 62794-9435, (217) 782-6562

Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820, (217) 333-2210

#### Northern Illinois

Allied Lab, 716 N. Iowa Ave., Villa Park, IL 60181, (708) 279-0390

Beling Consultants, Inc., Beling Building, 1001 16th St., Moline, IL 61625, (309) 757-9800

City of Chicago, Water Purification Labs, 1000 E. Ohio St., Chicago, IL 60611, (312) 744-3724

EMS, 8205 S. Cass Ave., Suite 106, Darien, IL 60559, (708) 969-9030

Enviro-Test, Inc., 319 Ogden Ave., Downers Grove, IL 60515, (708) 963-4672

Gabriel Laboratories, 1421 N. Elston, Chicago, IL 60622, (312) 486-2123

NET-Midwest, Bartlett Division, 850 W. Bartlett Rd., Bartlett, IL 60103, (708) 289-3100

NET-Midwest, Rockford Division, 3548 35th St., Rockford, IL (815) 874-2171

North Shore Sanitary District, Russell Ave., P.O. Box 750, Gurnee, IL 60031, (708) 623-6060

Scientific Control, 3158 S. Kolin Ave., Chicago, IL 60623, (312) 254-2406

York Laboratories, 126 W. Center Court, Schaumburg, IL 60195, (708) 705-0740

#### Central Illinois

Daily Analytical Laboratories, 1621 Candletree Dr., Peoria, IL 61614, (309) 692-5252

Environmental Science and Engineering, 8901 N. Industrial Rd., Peoria, IL 61615-1589, (309) 692-4422

P.D.C. Laboratory, P.O. Box 9071, Peoria, IL 61615, (309) 676-4893

#### Southern Illinois

ARDL, P.O. Box 1566, 1801 W. Forest St., Mt. Vernon, IL 62864, (618) 244-3235

ESE, Inc., 11665 Lilburn Park Rd., St. Louis, MO 63146, (314) 567-4600

Midco Industries, Inc., Analytical Laboratory, 700 S. Spring Ave., St. Louis, MO 63110, (314) 776-5600

TCT-St. Louis, 1908 Innerbelt Business Center Dr., St. Louis, MO 63114-5700, (314) 426-0880

TEKLAB, Inc., #6 Meadow Heights Professional Park, Collinsville, IL 62234, (618) 344-1004



**Table 1: Guidelines for Using Water with Known Nitrate Content**

Nitrate (NO <sub>3</sub> ) (parts per million)	Nitrate - Nitrogen (NO <sub>3</sub> -N) (parts per million)	Interpretation
0-44 ppm	0-10 ppm	Drinking water standard level. Safe for humans and livestock.
45-88 ppm	11-20 ppm	Generally safe for human adults and livestock. Water should not be consumed by pregnant women and human infants under 6 months old.
89-176 ppm	21-40 ppm	Generally acceptable for human adults and all livestock unless food or feed sources are very high in nitrates. Water should not be consumed by pregnant women and human infants under 6 months old.
177-440 ppm	41-100 ppm	Water should not be consumed by pregnant women and human infants under 6 months old. Also risky for human adults and young livestock. Probably acceptable for mature livestock if feed is low in nitrates.
Over 440 ppm	Over 100 ppm	Water should not be consumed at all.

From *Nitrates and Groundwater*, by R.E. Lamond, J.S. Hickman, and G.M. Powell, Kansas State University Cooperative Extension Service, 1987.

nated with bacteria, and the supplier issues “boil orders.” Boiling water is an effective way to kill pathogens. Two minutes of vigorous boiling will effectively kill pathogens.

### Nitrate Contamination

A water-testing lab will express nitrate concentrations in one of two ways. The lab may describe the nitrate concentration as the amount of actual “nitrate” or as the amount of “nitrate-nitrogen.” A nitrate concentration of 44 ppm is the equivalent of a nitrate-nitrogen concentration of 10 ppm.

If tests show that nitrate levels exceed the standard of 44 ppm (or 10 ppm of nitrate-nitrogen), water should not be consumed by pregnant women and infants under six months of age. Use an alternate source of water, such as bottled water, for infant formula.

For more guidelines on what concentrations are safe for children, adults, and livestock, see Table 1.

It’s important to know that boiling water *does not* eliminate nitrates. Boiling water causes some of the water to evaporate, which *increases* the concentration of nitrates in the remaining water.

You can treat water containing bacteria or nitrates by using an assortment of methods described later in this publication. But before disinfecting or treating water, try to

identify sources of contamination and correct them. It is better to correct the cause of a problem than it is to treat its results.

If you receive water from a municipal supply, keep in mind that 44 ppm of nitrate in water is an *enforceable* standard. If the nitrate level exceeds 44 ppm, the water company must notify its customers.

### Inorganic and Organic Compounds

Although nitrates and bacteria are the most common contaminants that labs test for in water, analyzing the water for other contaminants may be warranted in some instances.

Water can be analyzed for “inorganic compounds,” which are naturally occurring elements such as iron, manganese, sulfur, sodium, and chloride. It can also be analyzed for “organic compounds,” which include solvents, degreasers, pesticides, and fuel components.

To find out the maximum acceptable concentrations of the most commonly occurring inorganic and organic compounds found in water, refer to Tables 2 and 3. The tables also show the possible health effects from consuming water that contains excessive concentrations.

The expense to test water for some of these compounds can be considerable, so ask about the cost before you send a



**Table 2: Inorganics**

Material	Maximum Acceptable Level		Possible Effects of Higher Levels
	(parts per million)	(parts per billion)	
Arsenic (As)	0.05 ppm	50 ppb	Lung cancer, kidney damage
Barium (Ba)	1.0	1,000	Heart damage
Cadmium (Cd)	0.01	10	Kidney damage
Chromium (Cr)	0.05	50	Liver, kidney damage
Lead (Pb)	0.05	50	Brain damage
Mercury (Hg)	0.002	2	Brain damage, birth defects
Nitrate (NO <sub>3</sub> )	44.0	—	Possibly fatal to infants
Nitrate as Nitrogen	10.0	—	Possibly fatal to infants
Selenium (Se)	0.01	10	Growth inhibition
Silver (Ag)	0.05	50	Skin discoloration
Flouride (F)	1.4-2.4	—	Pitting of teeth
Manganese (Mn)	0.05	50	Bitter taste, black stains on fixtures
Iron (Fe)	0.3	300	Metallic taste, orange stains on fixtures
Copper (Cu)	1.0	1,000	Metallic taste, blue-green stains on fixtures
Chloride (Cl)	250.0	—	Salty taste, corroded pipes
Sulfate (SO <sub>4</sub> )	250.0	—	Medicinal taste, laxative effects
Total Dissolved Solids (TDS)	500.0	—	Salty taste, hardness, cloudy water
Total Alkalinity	400.0	—	"Soda" taste
Zinc (Zn)	5.0	—	Metallic taste



**Table 3: Organics**

Material	Maximum Acceptable Level	
	(parts per million)	(parts per billion)
Trichloroethylene	0.005 ppm	5 ppb
Carbon Tetrachloride	0.005	5
Vinyl Chloride	0.002	2
Benzene	0.005	5
Styrene	0.14	140
Toluene	2.0	2,000

sample to a lab. Also, water-testing labs have different procedures for collecting and handling the samples for different analyses, so follow the laboratory instructions exactly. Not following the correct sampling procedure can make the lab analyses inaccurate.

### Water Hardness

Water hardness is caused by dissolved minerals such as calcium and magnesium. Although there is little health risk associated with hard water, it can cause soap and scale deposits in plumbing fixtures and appliances. Hard water can also decrease the cleaning performance of soaps and detergents.

Water hardness is a common water-quality problem, and it is often necessary to test for water hardness if you intend to evaluate and treat other problems.

Table 4 shows the different levels of hardness and indicates when water should be treated. The levels relate to the concentration of dissolved minerals, which can be expressed in either grains of calcium and magnesium per gallon of water, parts per million, or milligrams per liter.

### Pesticides and Health Advisories

If you have questions about the effect of specific pesticides in drinking water, you can obtain health advisories from the regional offices of the Illinois Department of Public

Health and most county Cooperative Extension Service offices. For more details on health advisory summaries, refer to Table 5.

### Other Problems

Labs can also test water for a wide range of other physical and chemical problems. As Table 6 indicates, labs can measure color, corrosiveness, odor, and pH, and they can test for the presence of detergents and other contaminants.



**Color.** A visible tint in the water can be caused by iron, copper, manganese, organic chemicals, and organic matter.

**Corrosiveness.** Your water may be corrosive if the pipes are pitted, the water has a metallic taste, or the fixtures are stained.

**Detergents/foaming agents.** Household and industrial wastes can give the water a frothy, cloudy appearance, a soapy taste, and an unpleasant odor.

**Odor.** A rotten-egg, septic, musty, or chemical smell can have a variety of causes, such as dissolved gases, minerals, and chemicals; leaking underground storage tanks; landfill or septic runoff; or bacteria, algae, and organic matter.

**pH.** pH refers to the acidity or alkalinity of water. Acidic and alkaline water can corrode pipes and affect taste.

	Table 4: Water Hardness		
	Concentration of Hardness Minerals grains per gallon (gpg)	Level of Hardness	
	parts per million (ppm) or milligrams per liter (mg/l)		
	Below 1.0	Below 17.1	Soft
	1.0 to 3.5	17.1 to 60	Slightly hard
	3.5 to 7.5	60 to 120	Moderately hard
	7.5 to 10.5	120 to 180	Hard
	10.5 and above	180 and above	Very hard
	 Within shaded level, consider softening water		
	Based on a table in <i>Water Testing and Interpretation: The Secondary Drinking Water Standards</i> by Judith C. Stewart, Ann T. Lemley, Sharon I. Hogan, and Richard A. Weismiller, Cornell University and the University of Maryland, 1988.		



**Table 5: U.S. EPA Health Advisories for Pesticides in Drinking Water**

Chemical	Use	Trade Name or Common Name	Lifetime Non-Cancer Health Advisory* parts per billion**	Carcinogenicity Group	Cancer Health Advisory parts per billion
Acifluorfen	H	Blazer	—	Probable	1
Alachlor	H	Lasso	—	Probable	0.4
Aldicarb	I,N	Temik	1***	Inadequate data	—
Ametryn	H	Evik	60	Inadequate data	—
Atrazine	H	Atrazine, AAtrex	3	Possible	—
Bentazon	H	Basagran	20	Inadequate data	—
Bromacil	H	Hyvar	90	Possible	—
Butylate	H	Sutan+	350	Inadequate data	—
Carbaryl	I	Sevin	700	Inadequate data	—
Carbofuran	I,N	Furadan	40	Not a carcinogen	—
Carboxin	F	Vitavax	700	Inadequate data	—
Chloramben	H	Amiben	100	Inadequate data	—
Chlordane	I	Several names	—	Probable	0.03
Chlorothalonil	F	Bravo, Daconil	—	Probable	2
Cyanazine	H	Bladex	10	Inadequate data	—
Dalapon	H	Dowpon	200	Inadequate data	—
Diazinon	I	Diazinon	0.6	Not a carcinogen	—
Dicamba	H	Banvel	200	Inadequate data	—
DBCP	N	Nemafume	—	Probable	0.03
DCP	N	Telone	—	Probable	0.2
DCPA	H	Dacthal	4000	Inadequate data	—
2,4-D	H	Several names	70	Inadequate data	—
Dieldrin	I	Several names	—	Probable	0.002
Dinoseb	H	Dinitro	7	Inadequate data	—
Diphenamid	H	Enide	200	Inadequate data	—
Disulfoton	I	Disyston	0.3	Not a carcinogen	—
Diuron	H	Karmex	10	Inadequate data	—
Endrin	I	—	2	Inadequate data	—
Ethylene Dibromide	FUM	EDB	—	Probable	0.0004
Ethylene Thiourea	F	Several names	—	Probable	0.2
(breakdown of EBDC pesticides)					
Fenamiphos	N	Nemacur	2	Inadequate data	—
Fluometuron	H	Cotoron	90	Inadequate data	—
Heptachlor	I	Several names	—	Probable	0.008
Heptachlor Epoxide	I	—	—	Probable	0.004
Hexachloro-benzene	F	HCB	—	Probable	0.02
Hexazinone	H	Velpar	200	Inadequate data	—
Lindane	I	Several names	0.2	Possible	—
Methomyl	I	Nudrin, Lannate	200	Inadequate data	—
Methoxychlor	I	Several names	400	Inadequate data	—
Metolachlor	H	Dual	100	Possible	—
Metribuzin	H	Lexone, Sencor	200	Inadequate data	—
Oxamyl	I	Vydate	200	Not a carcinogen	—

H—Herbicide  
I—Insecticide  
N—Nematicide  
F—Fungicide  
FUM—Fumigant  
WP—Wood Preservative

	Chemical	Use	Trade Name	Lifetime Non-Cancer Health Advisory* parts per billion**	Carcinogenicity	Cancer Health Advisory parts per billion
	Pentachloro-phenol	WP	PCP	—	Probable	0.1
	Picloram	H	Tordon	500	Inadequate data	—
	Prometon	H	Pramitol	100	Inadequate data	—
	Pronamide	H	Kerb	50	Possible	—
	Propachlor	H	Ramrod	90	Inadequate data	—
	Propazine	H	Milogard	10	Possible	—
	Propham	H	IPC, Beet-Kleen	100	Inadequate data	—
	Propoxur	I	Baygon	3	Possible	—
	Silvex	H	Many names	50	Inadequate data	—
	Simazine	H	Princep, Aquazine	1	Possible	—
	Tebuthiuron	H	Spike	500	Inadequate data	—
H—Herbicide	Terbacil	H	Sinbar	90	Not a carcinogen	—
I—Insecticide	Terbufos	I	Counter	0.9	Not a carcinogen	—
N—Nematicide	2,4,5-T	H	Several names	70	Inadequate data	—
F—Fungicide	Trifluralin	H	Treflan	5	Possible	—
FUM—Fumigant	*A Lifetime Health Advisory is calculated for a 154-pound adult who consumes 2 quarts of water per day.					
WP—Wood Preservative	**The measurement, parts per billion, is the equivalent of micrograms per liter.					
	***The Lifetime Health Advisory level for the combination of adicarb sulfone and either adicarb or adicarb sulfoxide in water is 1 microgram per liter.					

## Health Advisories

The U.S. Environmental Protection Agency (U.S. EPA) has established health advisories for various pesticides in drinking water.

Health advisory levels are *not* legally enforceable standards. They serve as guidelines, and they contain a margin of safety. The advisory levels are typically 100 to 1,000 times lower than a concentration that causes no adverse health effects in the most sensitive laboratory animal test.

Two-page health advisory summaries, which are available from the U.S. EPA, describe both the non-cancer risk and the cancer risk from pesticides and other chemicals. When the U.S. EPA has collected enough data, it places chemicals in one of several categories:

- (1) Not a carcinogen (cancer-causing agent)
- (2) A possible carcinogen

(3) A probable carcinogen. If the chemical is classed as a probable carcinogen, the health advisory summary provides a cancer advisory level.

The U.S. EPA states that when the level of a pesticide in drinking water is below or at the *non-cancer* advisory level, you can consume the water every day for an entire lifetime without increasing your health risks. If you drink water containing pesticide levels equal to the *cancer* advisory level over an entire lifetime, you increase the risk of cancer by one in a million.

The accompanying table provides some of the information available in U.S. EPA health advisory summaries. The

summaries also explain how a chemical is used, what specific health effects can occur, and what actions you should take if the chemical shows up in your water supply.

You can obtain health advisory summaries from the EPA by contacting the Safe Drinking Water Hotline, Monday through Friday, 7:30 a.m. to 3:30 p.m., Central Time. The number is 800-426-4791. The hotline can also provide details on drinking water quality and water-treatment methods.

If pesticides show up in your drinking water, you can contact a toxicologist with the Illinois Department of Public Health or other state and county experts. You can also call the National Pesticide Telecommunications Network at a toll-free number, 800-858-7378. The network operates 24 hours a day, every day of the year.

**Safe Drinking Water Hotline**  
**800-426-4791**  
**Monday through Friday**  
**7:30 a.m. to 3:30 p.m., Central Time**

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**National Pesticide Telecommunications Network**  
**800-858-7378**  
**24 hours a day; Every day of the year**



**Table 6: Other Problems**

Undesirable Characteristics	Source	Symptoms	Test	Secondary Maximum Contaminant Levels
Color	Iron, copper, manganese, organic chemicals, organic matter	Visible tint	Color	15 color units
Corrosivity	Depends on temperature, acidity, hardness, and oxygen content of water.	Pitted or leaking pipes; metallic taste; staining due to lead, copper, iron or zinc dissolved from plumbing.	Corrosion index	Noncorrosive
Detergents/ Foaming Agents	Household and industrial wastes.	Frothy, cloudy appearance; soapy taste and unpleasant odor.	Methylene blue test	0.5 milligrams per liter
Odor	Dissolved gases, minerals, chemicals; leaking underground storage tanks; landfill or septic runoff; organic matter.	"Rotten egg," septic, musty or chemical smell.	Odor	3 Threshold Odor Number
pH	Dissolved acid and alkaline materials.	Pitting of pipes and fixtures, bitter or metallic taste (low pH); slippery feel, soda taste, scaly deposits (high pH).	pH	6.5 to 8.5 on pH scale

From *Water Testing and Interpretation: The Secondary Drinking Water Standards*, by Judith C. Stewart, Ann T. Lemley, Sharon I. Hogan, and Richard A. Weismiller, Cornell University and the University of Maryland, 1988.

**Table 6.** Listed above are miscellaneous water contamination problems, their sources and symptoms, methods to test for them and listings of Secondary Maximum Contaminant Levels. Secondary Maximum Contaminant Levels are only recommendations. They are not required. Under the pH category, keep in mind that the pH scale runs from 0 to 14, with 7 being neutral. pH values less than 7 indicate that the water is acidic, while pH values greater than 7 indicate that the water is alkaline (low acidity). The ideal range for drinking water is 6.5 to 8.5.

### Buyer Beware

The water-treatment field, like other consumer areas, attracts its share of questionable claims. For instance, some people sell non-chemical treatment devices that use magnetic fields, electrostatic fields or other physical forces to treat water.

Backers of these devices claim that the equipment will eliminate corrosion, scale, bacteria, algae and other assorted problems. However, independent studies have found most of these devices to be ineffective and without scientific basis.

When confronted with a suspicious device, consult the local offices of the Illinois Department of Public Health or Cooperative Extension Service.

### Turning to Treatment

If you find that your drinking water supply contains unacceptable levels of some compounds, take corrective action, if possible, to stop further contamination before considering a treatment device. When you are ready to consider treatment, you can find local sales representatives for treatment devices in the Yellow Pages of the phone book.

Because water treatment can be costly, find out about costs and frequency of service and maintenance, as well as the cost per gallon to treat water. A trade association, such as the Water Quality Association, may also be able to recommend companies that sell treatment equipment. You can reach the Water Quality Association at 4151 Naperville Rd., Lisle, IL 60532. The phone number is (708) 505-0160.

A description of common treatment devices follows.

## Activated Carbon Filters

**Contaminants effectively removed by activated carbon filters:** Some volatile organic chemicals, some pesticides, radon gas, chlorine, and mercury. Activated carbon filters also treat odors, as well as off-color and off-taste problems.

**How activated carbon filters work.** An activated carbon filter consists of a container filled with carbon-containing material, such as bituminous coal, coconut shells, lignite, peat, or wood. These materials have been “activated”—treated with steam in the absence of oxygen. This process fragments the materials and creates exposed pores on their surface.

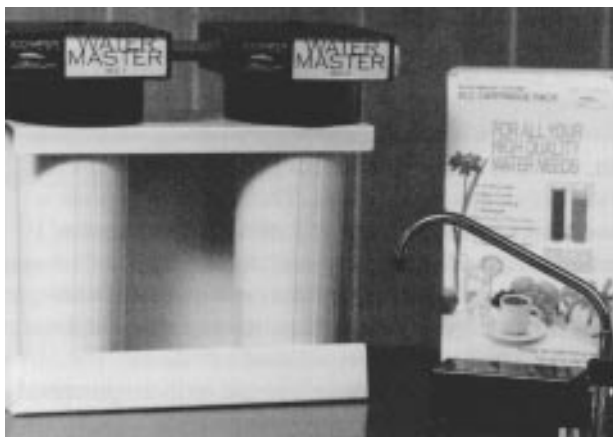
When water passes through the material, certain contaminants in the water chemically attach to the surface of the material’s many pores and are removed from the water. (See Figures 4 through 6.)

**Limitations.** As contaminants build up on a carbon filter, the filter will eventually lose its ability to remove contaminants and must be replaced. If the filter is not replaced, there is the risk that contaminants on the filter will re-enter the water. If this happens, the contaminants may re-enter the water in amounts that are even *more* concentrated than they were originally.

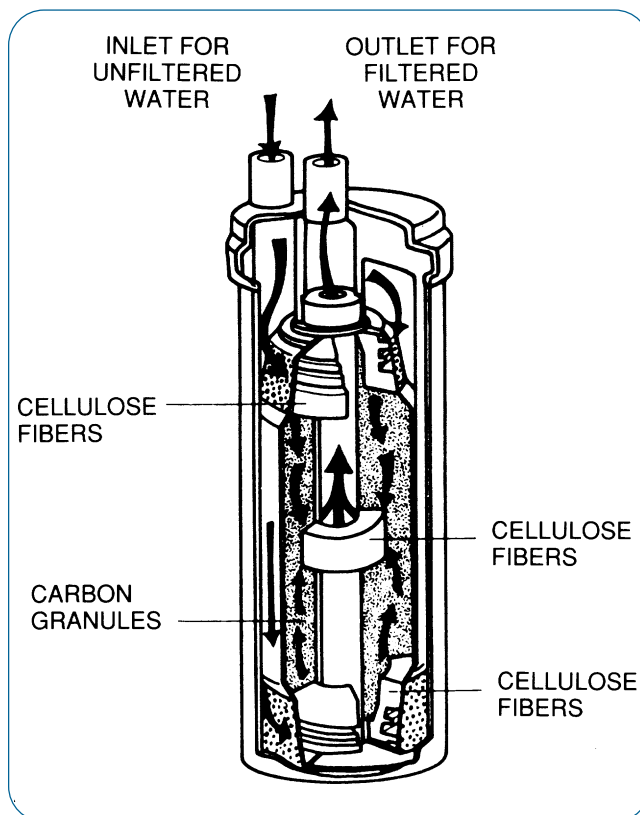
**Maintenance.** Most manufacturers suggest that you replace the filter after it has treated a certain volume of water. But using the volume of water as a guide is not necessarily accurate because a filter’s life can be shorter or longer, depending on the concentration of contaminants in the water.

Another common rule of thumb is to replace the carbon filter every four to six weeks. This is necessary because of bacterial growth on the filter.

Other manufacturers point out that a filter probably needs to be replaced if a poor taste or odor returns to the



**Figure 4.** *Activated Carbon Filter.* Activated carbon filters can have one or two filter cartridges. The carbon filter inside of each cartridge *must* be periodically replaced if treatment is to be effective. Figure 5 shows the interior of an activated carbon filter cartridge.



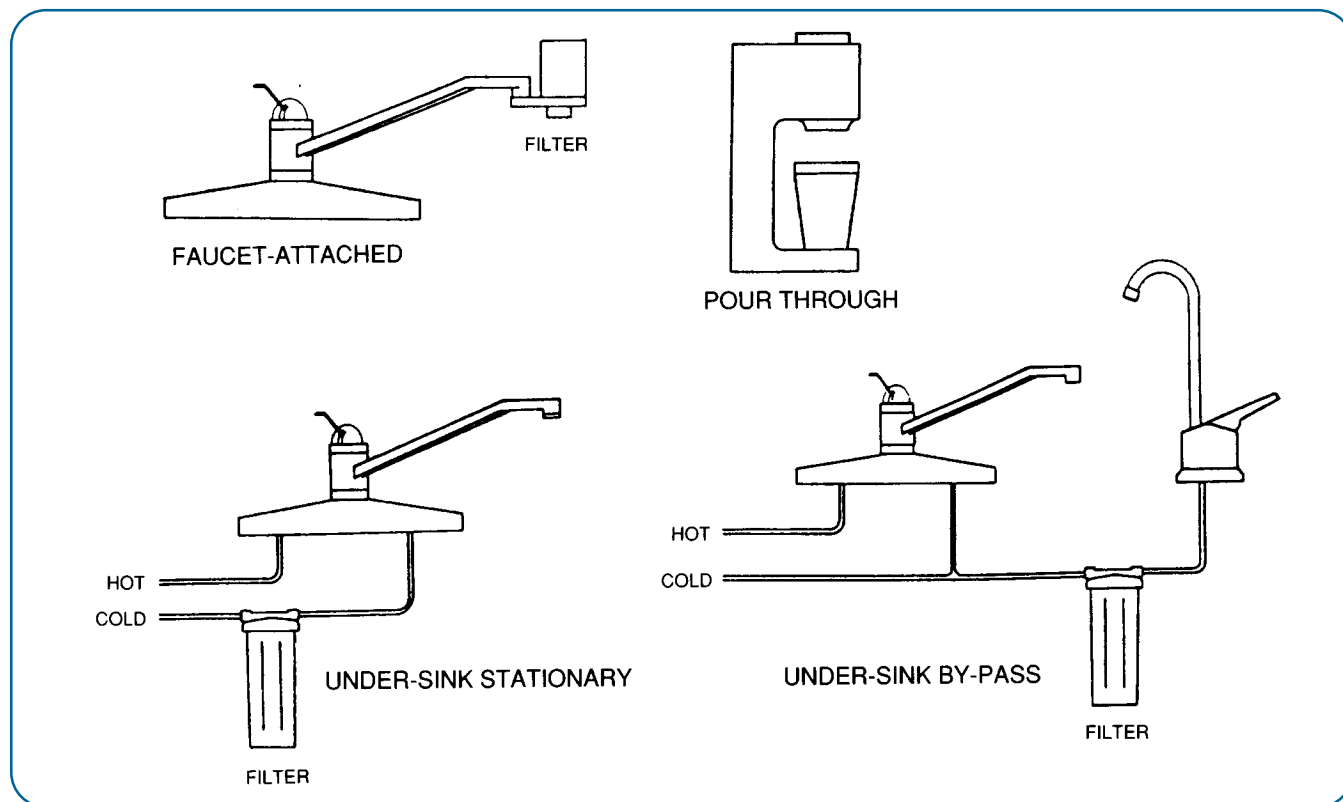
**Figure 5.** *Activated Carbon Filter.* Water enters through the top of the cartridge, then filters through carbon granules. As water passes through pores in the carbon material, certain contaminants attach to the surface of the material and are removed from the water. The water then moves up through cellulose filters to the outlet.

water, if there is a color change in the filter material, or if there is a reduced flow through the filter. These guidelines may be suitable if the contaminant is only an annoyance; but they may not be appropriate if the contaminant is a health hazard. Many hazardous contaminants do not cause off-tastes, odors, or changes in color. The only way to determine if a filter is successfully removing contaminants is by repeated testing of treated water.

When using activated carbon filters to remove health-related contaminants, it is preferable to install two units, one after the other. Also, installing a sampling tap between the two filters will make it possible to collect water samples and determine which unit needs replacement.

**Additional information.** Some activated carbon filters contain silver, which manufacturers claim will kill bacteria. These units are registered with the U.S. Environmental Protection Agency (U.S. EPA) as bacteria-killing units. But the registration does not mean the U.S. EPA certifies that the carbon filter actually kills bacteria. The registration simply indicates that silver, a possible contaminant, is not being leached from the unit into the water supply.

If a manufacturer produces activated carbon filters that contain a chemical disinfectant, they *are* required to prove that the device kills microbiological contaminants. The U.S. EPA requires these units to go through another registration process.



**Figure 6. Activated Carbon Filter.** Activated carbon filters come in a variety of styles. You can attach some carbon filters directly to the water faucet, while some sit on the counter top. You pour water through a counter-top unit, and the water passes through the filter into a container. Under-the-sink stationary filters and under-the-sink bypass filters are similar. However, stationary filters treat *all* of the water coming to the faucet; a bypass unit treats only the water flowing through an alternate faucet. Treated water in the alternate faucet is used for cooking and drinking, while untreated water in the main faucet can be used for cleaning. Carbon filters also can be used to treat water for appliances such as ice makers and water coolers.

## Distillation

### Contaminants effectively removed by distillation:

Microbiological contaminants, trace elements of heavy metals, some inorganic chemicals (nitrates, for instance), some volatile organic chemicals, salt, and dissolved iron and manganese. Distillation is the only water-purification process that removes microorganisms, such as bacteria and viruses, with absolute certainty.

**How distillation works.** Water is heated until some of it turns to steam. Contaminants remain behind in the unevaporated water, while the steam moves past either a condensing coil or a fan. The fan, or circulating water in the coil, cools the steam, causing it to condense into distilled, or purified, water. (See Figure 7.)

**Limitations.** Because distilled water is essentially free of minerals, and because it adsorbs carbon dioxide from the

air, it is acidic and can corrode materials with which it comes into contact—materials such as iron and copper.

Also, distilled water has been described as tasteless and flat, so it may not be ideal drinking water. Sample distilled water before purchasing a unit. The distillation process is slow—although it is somewhat more rapid than reverse osmosis—and energy costs (electricity) are high.

Another problem with distillation is that some units allow certain organic contaminants to evaporate with the water, which means they are released into the air. The contaminants then re-condense and end up in the processed water. This can happen with organic contaminants that have a lower boiling point than water (some pesticides, for instance). A type of unit called a “fractional distiller” avoids this problem, but not all distillers are of this type.

Finally, if water is used as the coolant in the distillation

process, this treatment method can consume large amounts of water—even more than with the reverse osmosis process.

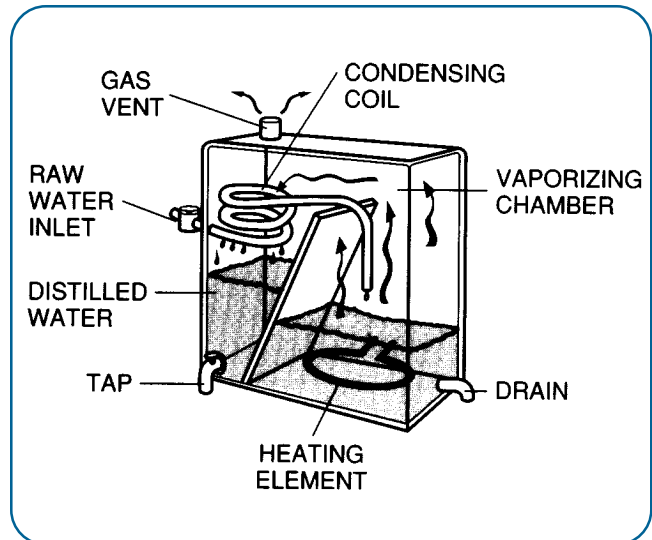
**Maintenance.** Maintaining distillation units can be a problem, depending on their design. The minerals and other contaminants, left behind in the boiling chamber during the process, can build up and interfere with the unit's operation. In addition, hard water can quickly clog a distiller.

Some units are easy to clean by hand, but others are difficult or require strong acid. You can clean some units by leaving white vinegar in the boiling tank overnight, or you can use a special cleaner made by the appliance manufacturer.

The frequency of cleaning varies with the quantity of impurities in the water. Some manufacturers recommend cleaning after every third distillation.

**Additional Information.** Certain distillation models have reset switches and timers, which make automatic operation possible. This feature may be desirable when distilled water is continuously used.

All distillers should be listed with Underwriters Laboratory (UL). Look for the UL symbol.



**Figure 7.** Rectangular cart distiller. Water enters on the left side of the distiller, moving through a condensing coil to the right side. A heating element on the right side of the distiller heats the water, causing some of the water to turn to steam. Impurities remain behind in the unevaporated water as the steam moves to the left side of the unit. There, the condensing coil cools the steam, transforming it back into water—distilled water.

## Air Stripping

### Contaminants effectively removed by air stripping:

Some volatile organic chemicals, radon, dissolved iron and manganese (with filtration), and gases such as hydrogen sulfide and methane. In addition, air stripping helps treat odor and taste problems.

**How air stripping works.** Until recently, this method had been limited to large operations at water-treatment plants, but a few manufacturers have developed devices for the home. With air stripping, water flows *down* through a tube while air is pumped *up* the tube by a mechanical blower. During this process, volatile organic compounds are transferred from the water to the air and then vented outside.

The rate at which volatile organic compounds are removed from the water depends on several factors: water flow rate, air/water ratio, the type of packing material in the glass tube, and the type and amount of volatile organic compounds.

**Limitations.** Once water passes through the column, it is necessary to store and re-pump it throughout the home. Take into consideration the energy costs of pumping the water to and from the column, as well as running the blower.

Also, it is possible for bacterial growth to occur in the system's holding tank. Therefore, you may need to chlorinate water in the tank.

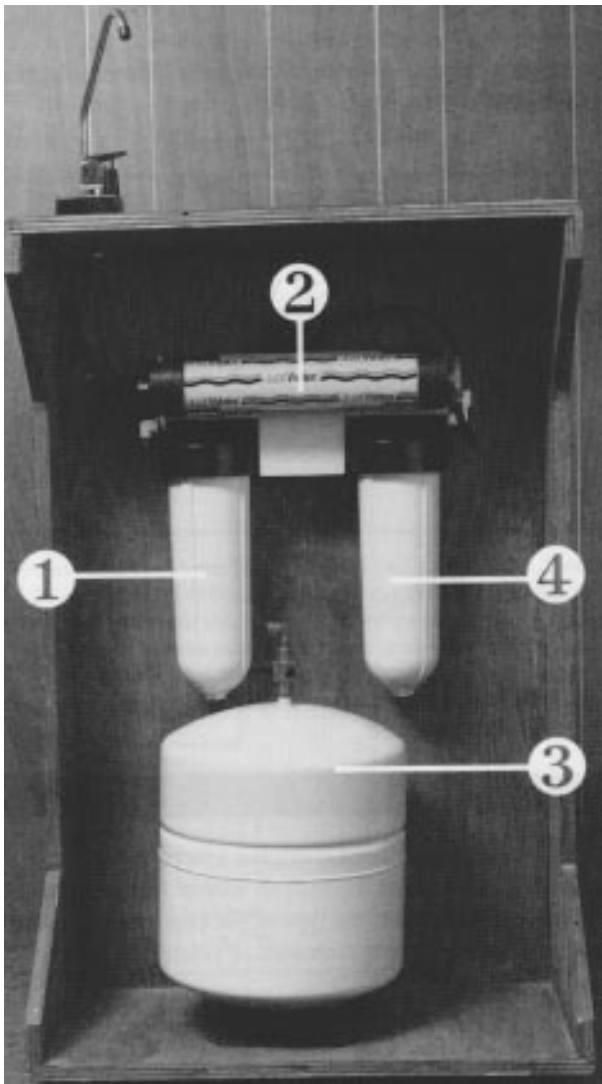
## Reverse Osmosis

**Contaminants effectively removed by reverse osmosis:** Bacteria, radium, heavy metals, and inorganic compounds such as sulfate, calcium, magnesium, potassium, nitrate, fluoride, boron, and orthophosphate (phosphorus). Reverse osmosis (RO) also successfully treats water with high salt content. It is even effective with certain detergents, volatile organic contaminants, pesticides, and taste-, color-, and odor-producing chemicals.

**How reverse osmosis works.** With an RO unit, a membrane filters out dissolved impurities as water passes

through it at normal tap pressure. (See Figure 8.) Reverse osmosis will remove 90 to 95 percent of the dissolved contaminants. What's more, a very dense membrane will even remove many types of bacteria.

RO units contain either a cellulosic or polyamide membrane. Cellulosic membranes are not harmed by chlorine in municipal water systems. But chlorine *can* degrade a polyamide membrane. Therefore, if you plan to treat water from a municipal supply, a polyamide membrane should be preceded by an activated carbon filter. The activated carbon filter will remove the chlorine present in municipal water.



**Figure 8 (above).** *Reverse Osmosis.* Water passes through a sediment filter (1), which removes coarse particles that could clog the reverse-osmosis membrane. After water moves through the reverse-osmosis membrane (2), contaminated water drains away and treated water moves to the holding tank (3). When water is withdrawn, it moves from the holding tank, through an activated carbon filter (4), to the faucet.

Some systems do not include an activated carbon filter at all. In addition, some systems have an activated carbon filter placed *before* the reverse-osmosis membrane. This is necessary when the reverse osmosis unit contains a polyamide membrane. Water that contains chlorine can damage a polyamide membrane; therefore, the carbon filter is used to remove the chlorine before water reaches the membrane.

**Figure 9 (right).** *Reverse Osmosis.* Water that passes through the membrane of a reverse osmosis unit is called “permeate,” or treated water. Water that *doesn't* pass through the membrane is called “concentrate” or “reject” water. As you can see, a reverse osmosis unit treats only a portion of the water passing through it. With smaller devices, about 5 to 15 percent of the water is treated. With larger units, about 25 to 35 percent of the water is treated. The rest is reject water.

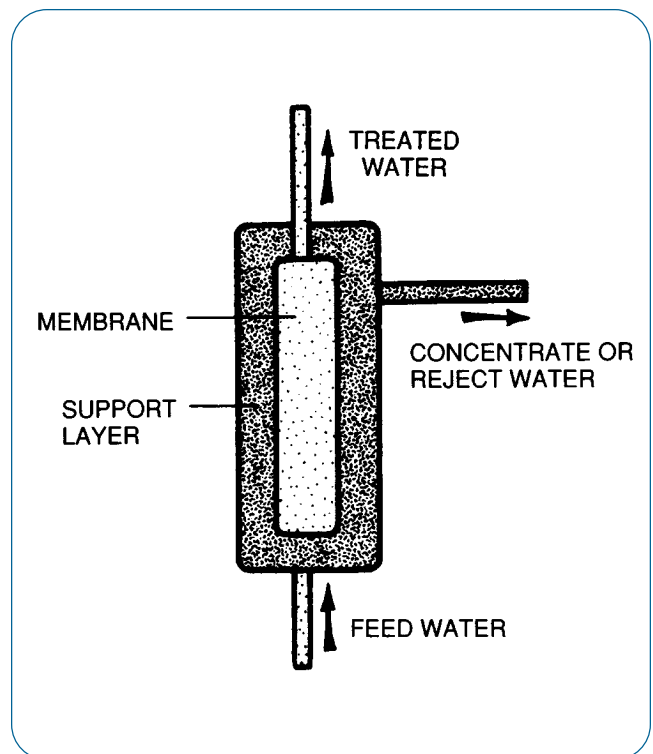
An RO unit can be installed either on the counter top or under the sink.

**Limitations.** Reverse osmosis under-the-sink installations are costly and require space that is not ordinarily available in small kitchens. The usual installation requires three separate cartridges—one to remove particulates, one for the activated carbon filter, and one for the reverse osmosis membrane. The useful life of the cartridges varies and their replacement can be costly.

Whether the unit is installed on the counter top or under the sink, reverse osmosis is slow and wasteful of water. (See Figure 9.) For every gallon of drinkable water that the unit provides, four to six gallons of water will go down the drain. It also takes up to 33 hours of intermittent operation to produce the first five gallons of filtered water; however, drinking water should be available on demand once the tank is filled.

**Additional information.** Reverse osmosis has been used by industry for many years, but its introduction to the home market is fairly recent. Manufacturers continue to increase the life of the membranes and the water-recovery rates.

Before using reverse osmosis, be sure the water-quality problem you are treating warrants an expensive treatment method that uses large amounts of water. If you have an on-site septic system, make sure the system is able to dispose of the additional wastewater load produced by the RO unit.



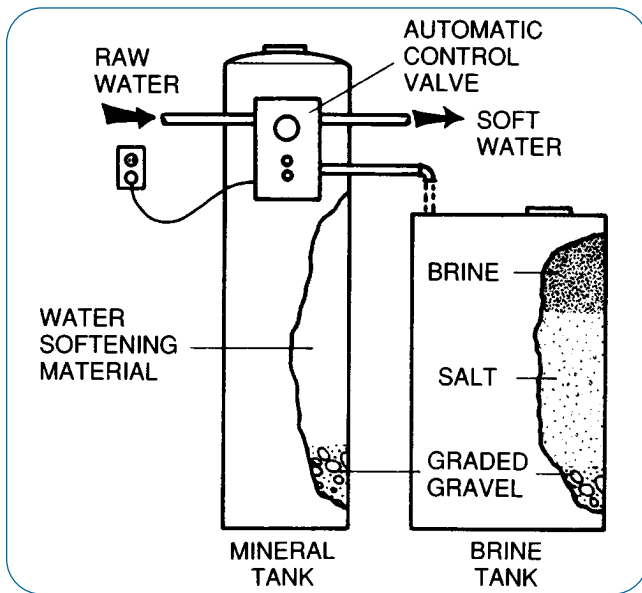
## Ion Exchange (Water Softener)

**Contaminants effectively removed by ion exchange units:** Calcium, barium, radium, and taste-, odor-, and color-producing chemicals. This process, commonly referred to as water softening, can also remove dissolved iron and manganese when they are present in low concentrations.

**How ion exchange works.** Ion exchange is a process in which ions (positively or negatively charged elements) are transferred from the water to a solid material. The solid material is known as an exchange resin.

As water passes through the resin, ions in the water are exchanged with sodium ions in the resin. For example, calcium and magnesium ions (which cause water hardness) attach to the resin and are removed from the water. They trade places with sodium ions, which are added to the water. As a result, the water is softened. (See Figure 10.)

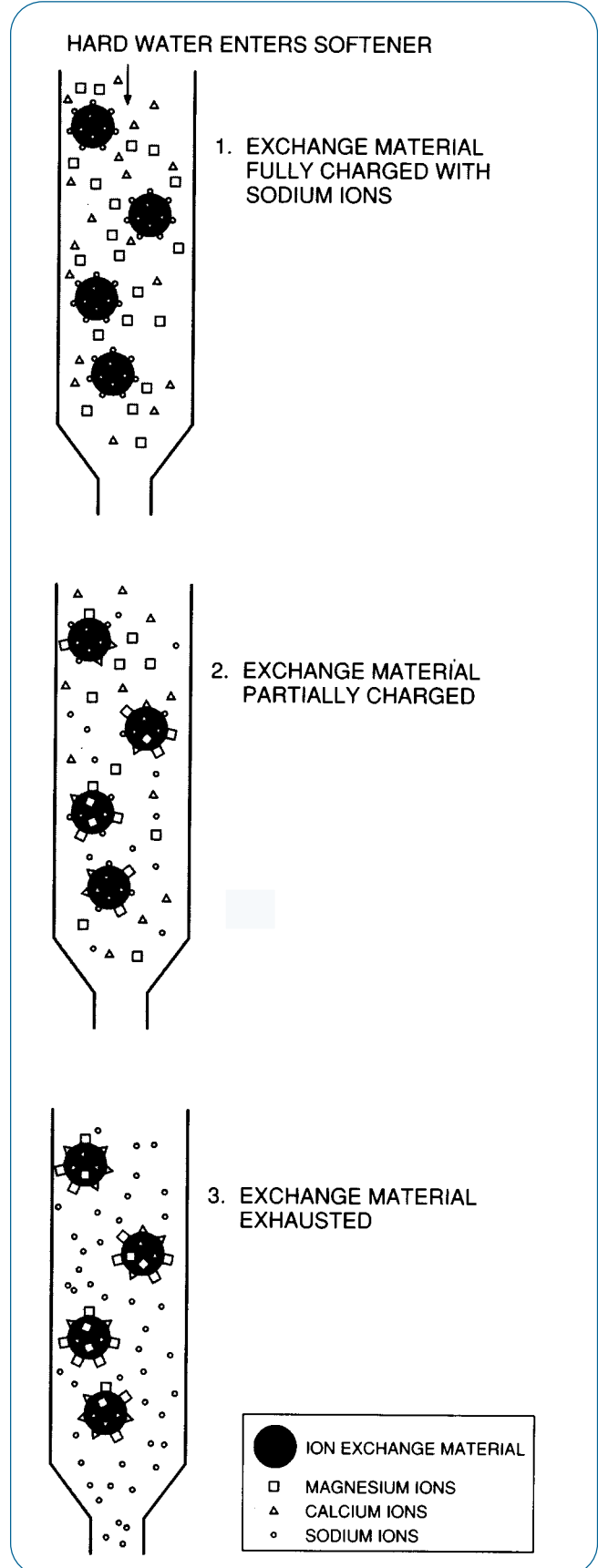
Before purchasing an ion exchange device, analyze your water. Hard water, which contains dissolved minerals such as



**Figure 10. (above) Ion Exchange/Water Softener.** Hard water enters the mineral tank, which is filled with water-softening material—synthetic resin beads. The ion exchange process, depicted in Figure 11, takes place inside the mineral tank. Salt water in the brine tank recharges the synthetic resin beads.

**Figure 11. (right) Ion Exchange/Water Softener.** When hard water passes through the ion exchange column, magnesium and calcium ions in the water exchange places with the sodium ions on the resin beads. As a result, the water is softened.

As the resin beads lose sodium ions, however, they eventually become exhausted. To recharge them, salt water from the accompanying tank—the brine tank—flows through the resin material. Sodium ions in the salt water exchange places with the calcium and magnesium ions on the resin. As a result, the resin is recharged with sodium ions. The brine water, now containing the magnesium and calcium ions, drains away.



calcium, magnesium, or iron, is not harmful. But the minerals make water less useful for washing and cleaning. The selection of a water-softening unit depends on the hardness of the raw water and the amount of water that needs to be softened.

**Maintenance.** There eventually comes a point in which the resin material can remove no more calcium or magnesium ions. The resin is considered “exhausted” and cannot be used effectively to soften water until it is recharged. (See Figure 11.) To recharge, sodium is added to the water softener.

Your involvement in recharging the resin depends on whether you have a manual, semiautomatic, or fully automatic unit. The newest available equipment has digital controls and many programmable options.

**Limitations.** People with hypertension or high blood pressure should consult their doctor about possible health risks associated with drinking softened water. The additional sodium in softened water could cause health problems for these people.

**Additional information.** If an ion exchange unit is used to treat water in the entire house, some people use a bypass for large tasks, such as filling a pool or watering a yard. Water for the yard or pool does not have to be softened, so the bypass does just what it says. It bypasses the ion exchange unit, allowing you to use untreated water for the pool or yard.

## Mechanical Filtration

**Contaminants effectively removed by mechanical filtration:** Dirt, sediment, loose scale, and insoluble iron and manganese. Insoluble iron and manganese are in the form of flakes, which have not dissolved.

**How mechanical filtration works.** Mechanical filtration is often referred to as “particulate” or “turbidity” filtration. This method uses sand, filter paper, compressed glass wool, or other straining material. (See Figure 12.) It acts as a fine sieve, clearing the water of dirt, sediment, and coarse and fine particulates, including rust particles. The result is water that is physically cleaner, clearer, and aesthetically more pleasing.

**Limitations.** Mechanical filtration does not do much to remove harmful, dissolved organic or inorganic chemicals. For instance, these filters will not remove nitrates, heavy metals, pesticides, or trihalomethanes.



**Figure 12. Mechanical Filtration.** Mechanical filtration units and their filters come in a variety of sizes. The filters act as sieves, clearing the water of dirt, sediment, and particulate matter of varying size.

## Chlorination

**Contaminants effectively treated by chlorinators:** Bacteria, other microbiological contamination, and taste-, odor-, and color-producing chemicals. Chlorinators also remove dissolved iron and manganese when followed by mechanical filtration or an activated carbon filter.

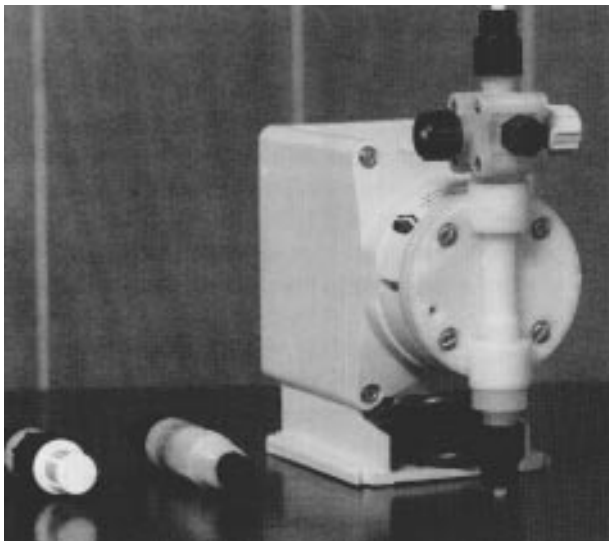
**How chlorination works.** Chlorination of an individual water system should be considered a last resort because it can be expensive and chlorine is toxic. Before purchasing chlorination equipment, try disinfecting the water with “shock chlorination.”

As a general practice, shock-chlorinate a new well before putting it in use, and again whenever it is opened to pull the pump or to remove sand and sediment from the bottom of the hole. Shock chlorination is briefly described earlier in this publication under the section, “Bacterial Contamination.” For

more information on shock chlorination, contact the local office of the Illinois Department of Public Health.

If contamination persists after shock chlorination, consider obtaining chlorination equipment. The “positive-displacement” chlorinator is the most reliable type of device. It consists of a small, electrical, chemical-feed pump, which feeds chlorine into the water supply. (See Figure 13.) You can increase or decrease the amount of chlorine by simply adjusting the control knob. Operation of the pump can be synchronized with the well pump so they both start and stop at the same time.

For more accuracy in the chlorine dosage, consider a “flow-actuated positive-displacement hypochlorinator.” This type of unit, which only operates when water is flowing in the pipe, dispenses chlorine in direct proportion to the actual rate of water flowing through the system. As a result, the dosage



**Figure 13. Chemical Feed Pump.** Pumps such as this can be used to dispense liquid chlorine into the water supply. A chemical feed pump can be synchronized with the well pump so they both start and stop at the same time. It can also be used with an in-line flow sensor. The sensor makes it possible for the chemical feed pump to dispense chlorine in direct proportion to the rate of water flowing through the system. As a result, the dosage of chlorine needed to disinfect the water is more accurate than with a unit that turns on and off with the water pump.

of chlorine is more accurate than with a unit that simply turns on and off with the water pump.

If the dose of chlorine is *not* properly synchronized with the water flow rate, water may move through the system too quickly. This means chlorine may not have enough “contact time” to treat the water.

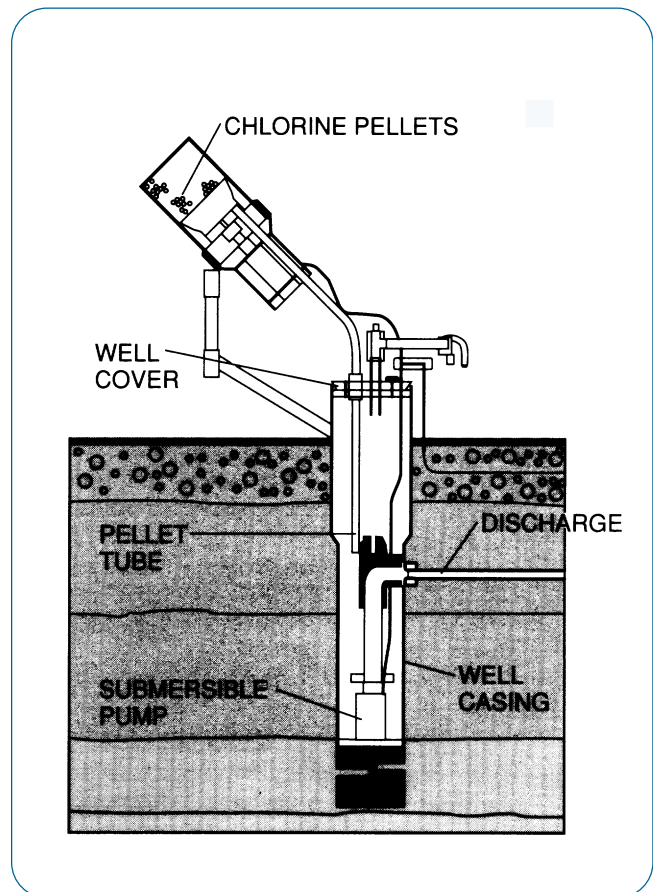
Aspirators or suction-type chlorinators are generally *not* reliable because the chlorine dose is not tied to the rate of water flowing through the system. Also, minerals in the water and chlorine solution will clog the small jets in the aspirator, preventing chlorine from being drawn into the system. Inspect the chlorine solution storage tank frequently to be sure that the chlorine solution is always available and the equipment is working properly.

You can mix a chlorine solution by using calcium hypochlorite in either powder or tablet form. To obtain the proper concentration of chlorine in the mixture, mix according to directions on the label. After mixing, use only the clear solution and discard the bottom sediment. The sediment could clog the hypochlorinator.

**Additional information.** If bacteria and other microorganisms repeatedly contaminate your water, check whether the well has a water-tight seal. Also, have your septic system inspected to find out if it is the source of contamination. A leaking septic tank or improperly functioning septic field may be the source of contamination. Make sure the septic tank is at least 50 feet from the well and the absorption field is at least 75 feet from the well.

If your well is improperly constructed, do not use chlorination or other disinfection processes to treat the water. The treatment will mask the problem and the contaminants will continue to build up. Eventually, contaminants will become so concentrated that the chlorine will not kill all harmful bacteria. The result will be illness.

Also, keep in mind that effective chlorination depends on the water’s proper pH. Consult your local health department for further information.



**Figure 14. Chlorine Injection.** Chlorine pellets, an alternative to liquid chlorine, are dispensed directly into the well by injection equipment. Like a chemical feed pump, chlorine injection equipment should be synchronized with the water pump so they both start and stop at the same time.



Table 7: Treatment Methods

Contaminants	Treatment methods								
	Activated carbon filters	Air stripping	Chlorination	Distillation	Ion exchange/water softener	Mechanical filtration	Reverse osmosis	Ultra violet radiation	
Chlorine	X								
Coliform bacteria, other microorganisms			X	X			X	X	
Color (black sediment, reddish-brown)	X		X		X		X		
Inorganics, minerals, and heavy metals (lead, mercury, arsenic, cadmium, barium)	X <sup>1</sup>			X	X <sup>2</sup>		X		
Iron/manganese—dissolved		X <sup>3</sup>	X <sup>4</sup>	X	X <sup>5</sup>				
Iron/manganese—insoluble						X			
Nitrates				X	X <sup>6</sup>		X		
Odor and off-taste	X	X	X		X		X		
Some pesticides <sup>7</sup>	X						X		
Radium					X		X		
Radon gas	X	X							
Salt				X			X		
Sand, silt, clay (turbidity)						X			
Volatile organic chemicals	X	X		X <sup>8</sup>			X		
Water hardness					X				

1. Mercury only.
2. Barium only.
3. When followed by mechanical filtration.
4. When followed by mechanical filtration or an activated carbon filter.
5. When present in low concentrations.
6. Anion exchange units will remove nitrates. But cation exchange units will *not*.
7. For information on ways to treat water for *specific* pesticides, obtain pesticide health advisory summaries. See the section on health advisories on pages 8-9.
8. Works for volatile organic chemicals with high boiling points.

## Ultraviolet Radiation

**Contaminants effectively treated by ultraviolet radiation:** Bacteria and other microbiological contaminants.

**How ultraviolet radiation operates.** Ultraviolet (UV) radiation devices use a special light bulb that produces ultraviolet light. As water passes through the device, ultraviolet light kills bacteria and other microbiological contaminants.

When operating properly, UV systems can produce bacteria-free and virus-free water. Most claim a 99.9 percent killing rate. The process also leaves no residue, taste, or odor.

Some systems include a meter, which measures the UV radiation being transmitted through the water. If insufficient radiation is present, the device may either turn off the water pump or activate an alarm.

**Limitations.** To effectively purify water, a minimum dose of UV radiation must pass through every molecule of water. In clear water, this is not difficult to achieve. But in turbid, or cloudy water, disease-causing organisms can “hide behind” sediment, shielding themselves from the killing radiation. For that reason, it may be necessary to clean the water before it reaches the UV unit.

One feature of the UV system—its ability to treat water without leaving a residue, taste, or odor—can also be a drawback. With other devices, a change in residue, taste, or

odor can sometimes tell you whether the equipment is operating properly or not.

You can overcome this limitation if the UV system is equipped with a meter like the one described earlier—a meter that measures the ultraviolet light being emitted. If your device doesn’t have this meter, there is no way to find out if it is operating properly unless you test the bacteria level.

Another limitation is that a UV unit does not have a “residual” effect. This means it will not kill bacteria that contaminates the water *after* the water has already passed through the UV unit. With chlorination, on the other hand, a residual amount of chlorine remains in the water. Residual chlorine can kill any bacterial contamination that occurs after the water has already passed through the chlorinator.

One final point: Like chlorination, UV systems must be synchronized to the flow of water. As the water flow increases, the effectiveness of a UV system may decrease.

**Maintenance.** A major problem with most UV systems is the collection of sediment and the growth of algae inside the “irradiation chamber”—the chamber containing the UV light bulb. New designs may eliminate this problem. With one new UV system, for instance, water flows through Teflon tubes that are surrounded by UV lights. This prevents the UV light bulbs from being fouled, and it appears to be an effective and relatively maintenance-free method.

## Bottled Water

When a private well is contaminated, bottled water may be a good alternative. If you have an infant, for instance, bottled water could replace household water that has high nitrate levels. (High-nitrate water can be fatal to infants.)

The bottled water industry adheres to a plant inspection program established by the American Sanitation Institute. According to the International Bottled Water Association, bottled water comes from protected sources and is bottled in facilities that are regulated in the same way as a food processing or preparation plant.

The United States Food and Drug Administration (FDA) regulates bottled water on a national level, but some states have their own standards. The FDA has established quality standards for bottled water, although mineral waters are exempt. Mineral waters are *supposed* to contain high levels of minerals, so by their very nature they exceed limits in the Bottled Drinking Water Standard.

The FDA also has established Good Manufacturing and Practice Regulations for processing and bottling water. These regulations outline, in detail, the sanitary conditions under which water is to be obtained, processed, bottled, and tested. For instance, the FDA requires that water be obtained from sources free of pollution and that it be “of good sanitary

quality.” Water bottlers must list the addition of salt and carbon dioxide on their labels, and they are prohibited from making “objectionable therapeutic claims.”

But are bottled waters safer than public water supplies? To answer this question, you must investigate your water supply to be sure it is as “safe” and risk-free as you want it to be. If you obtain water from a public water system, find out where your water comes from, what contaminants it is tested for and whether any are present in quantities that pose a health risk.

If you decide that bottled water is for you, investigate the bottled water you select. There is no need to spend a lot of money on bottled water if it is no better than your tap water.

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### Land and Water Number 17

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