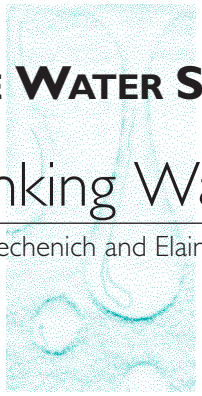
G3558-4

HOME WATER SAFETY

Interpreting Drinking Water Test Results

by Chris Mechenich and Elaine Andrews



This fact sheet is part of a series designed to help you determine the quality of your home drinking water and to show you techniques available for improving it. To make the best use of these publications, include them in a household file containing well information and water test results.

Other fact sheets in the series are:

Keeping Your Home Water Supply Safe (G3558-1)

Evaluating the Condition of Your Private Water Supply (G3558-2)

Evaluating the Condition of Your Public Water Supply (G3558-3)

Choosing a Water Treatment Device (G3558-5)

The Extension bulletin *Maintaining Your Home Well Water System* (G3399), can be used with these publications.

This series was developed by the University of Wisconsin Cooperative Extension in cooperation with the Wisconsin Department of Natural Resources and the Wisconsin Department of Commerce.

Musty odors, red-brown stains on plumbing fixtures, bathtub rings—all these are unpleasant signs of water quality problems, but usually not of harmful contaminants in the water. Contaminants that may threaten our health are usually not discernible by the senses. Drinking water can contain nitrate, bacteria, and pesticides at levels which cannot be tasted or smelled, but which can be hazardous to health.

If your drinking water comes from a private well, you should test your water once a year even if you do not observe any smells, stains or changes in water quality. Only analysis by a certified laboratory can determine if the water is free of harmful contaminants. This publication provides information about how to interpret the laboratory results for a basic set of tests conducted as part of the University of Wisconsin–Extension water testing program and that are recommended for all private wells.

The tests described in this publication are also conducted on public water supplies. If you are using water from a public water utility, consider having the water tested if your home plumbing system contains lead or copper pipes or lead solder, if you are installing a water treatment device, or if you have concerns about the water. See *Evaluating the Condition of Your Public Water Supply* (G3558-3), for more information.

The Initial Set of Water Tests

Anyone buying a home with a private well, installing a new well or simply having their well water tested for the first time should run the basic set of tests described here. These tests give a good overall picture of current water quality, indicate possible problems, and provide a "baseline" for comparing future test results. Each test is described in more detail in this publication.

Always have a certified laboratory conduct the tests. Labs certified by the Department of Natural Resources or Department of Agriculture, Trade and Consumer Protection must meet standards for accuracy. A list of certified labs is available from county Extension offices and Department of Natural Resources (DNR) regional offices.

What is a Part per Million?

Laboratory equipment can measure contaminants in water at extremely low levels, such as parts per million (ppm) or even parts per billion (ppb). For example, one part per **million** can be imagined as one red marble mixed in with 999,999 blue marbles, one inch in sixteen miles, or a minute in the space of two years. One part per **billion** is the same as two croutons in a five hundred pound salad, or eight drops of water in an Olympic-sized swimming pool.[1] Although such small numbers may seem quite insignificant, even one part per billion or less of certain chemicals has been found to cause adverse health effects.

[1]These creative part-per-million and part-per-billion examples are from the WaterTest Corporation, New London, NH.

Tests to Identify Contaminants that Harm Health

BACTERIA. Bacteria, viruses and parasites in water can cause disease. The coliform bacteria test indicates the possible presence of disease-causing bacteria from human or animal waste.

NITRATE. A form of nitrogen that can dangerously reduce the amount of oxygen in the blood of infants under six months old and may also harm the unborn. Nitrate is a common contaminant from fertilizers, septic systems and animal wastes. It often indicates the presence of other contaminants.

LEAD AND COPPER. Lead and copper can be leached into water from pipes or solder and can represent a significant health threat.

Tests to Determine Overall Water Quality

ALKALINITY. Measurement needed to determine corrosivity.

CHLORIDE. High concentrations often indicate contamination from a septic system, fertilizer, landfill or road salt.

CONDUCTIVITY. Measures the ability of water to conduct an electrical current; can be used to signal the presence of contaminants.

CORROSIVITY INDEX. A combination of several tests that indicates the tendency for water to corrode plumbing, or for lime deposits to form in pipes.

HARDNESS. Helps determine the need for water softening; also influences corrosivity.

pH. Indicates water's acidity and helps determine if water will corrode plumbing.

After running the initial set of tests, well users should continue to test for bacteria once a year. It's also a good idea to test for nitrate annually for several years. If nitrate levels are consistently low, nitrate tests are not necessary every year. However, a nitrate test should always be conducted if an infant or pregnant woman is drinking the water.

A Note on Drinking Water Standards

Public water supplies must meet numerical water quality standards set by the United States Environmental Protection Agency and enforced by the Wisconsin DNR. Routine testing is not required for private wells. However, users of private well water should at least be aware of the broad range of contaminants that may be found in well water and that concern public health officials.

Primary standards provide health limits for 82 contaminants as of 1995.The list includes 8 inorganic compounds, such as arsenic, copper and lead; pesticides, such as aldicarb and chlordane; volatile organic chemicals such as benzene and trichloroethylene; PCBs;

microbial pathogens; and radioactive elements. Secondary standards provide aesthetic limits for 13 contaminants, such as iron, zinc, color and odor. The sources and maximum contaminant levels (MCL) for these substances are described in the publication *Private Drinking Water Supplies: Quality, Testing and Options for Problem Waters* listed in the resource section of this fact sheet.

Testing private well water supplies for all these contaminants would be expensive and is not recommended unless your well is close to a known or suspected source of contamination.

The Initial Water Tests: What the Results Mean

The initial set of water tests can provide a good overview of your well water quality if you know how to interpret the results. The information below provides a starting point for evaluating your water quality.

Note that water test results are usually presented in milligrams per liter (mg/L) or micrograms per liter (µg/L). For example, a water test might indicate that the water contains 6 mg/L nitrate, meaning that a liter of water contains an average concentration of 6 milligrams of nitrate. Note also that one mg/L is equivalent to one part per million (ppm). One µg/L equals one part per billion (ppb).

Coliform Bacteria

Coliform bacteria are microorganisms found in surface water, soil and in the feces of humans and animals. They do not usually cause disease. However, their presence indicates that fecal wastes may be contaminating the water and means that pathogenic (disease-causing) organisms could be present. If human or animal wastes are contaminating the water, gastrointestinal diseases, hepatitis or other diseases may result.

Many labs can also test for a specific fecal coliform bacteria, *E. coli*. The presence of *E. coli* in a water sample represents an even greater health risk than the presence of total coliform bacteria.

ACCEPTABLE RESULTS: 0 coliform/100 milliliters (ml) of water. If you have coliform bacteria present, you should resample. If a second test shows coliform, take corrective action.

CORRECTIVE ACTIONS: Coliform bacteria in groundwater indicate that contaminated surface water is entering groundwater without the filtering effect that soils usually provide. In areas where the bedrock is fractured and close to the surface, or in areas with coarse sand and gravel soils, contaminated surface water can naturally find its way into the groundwater. More often, detection of coliform bacteria in well water is an indication that contaminated surface water is entering a well because of defects in well construction or maintenance.

If coliform bacteria are detected in the water sample, have another sample tested. Carefully follow the sampling steps suggested by the laboratory to ensure that your sampling procedure itself is not contaminating the water. If the second test shows bacterial contamination, check the well for defects. Some defects are easily viewed; others might require excavating around the well. Follow this checklist as you look for obvious defects:

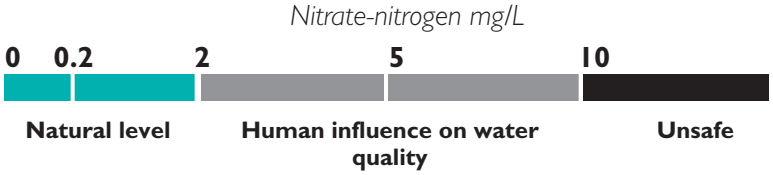
- ✓ Is the cap or seal on tightly? Is the well vented? The well cap should fit tightly to keep out surface water and vermin. On a drilled well, the screened vent that allows air to enter the well must be securely connected to the cap or seal.
- ✓ Is all wiring in conduit (tubing that connects the well with the electrical box)?
- ✓ Is the casing at least 12 inches above the ground? (The casing is the steel or plastic pipe installed in the bore hole during construction.) Also, if there are visible holes or cracks in the casing, or if you can move it, there might be a problem.
- ✓ Is the well in a pit or basement? If so, it may not meet state requirements and might be unsafe.

After correcting visible defects, disinfect the well with chlorine bleach and have another sample tested after all traces of chlorine have dissipated. Test again one month later to ensure that the contamination source has been eliminated. See the DNR publication *Bacteriological Contamination of Drinking Water* and the Extension publication *Evaluating the Condition of Your Private Water Supply* (G3558-2) for more information.

Nitrate

Nitrate nitrogen is a commonly used lawn and agricultural fertilizer. It is also a chemical formed in the decomposition of waste materials. If infants under six months of age drink water (or formula made with water) that contains more than 10 mg/L nitrate-nitrogen, they are susceptible to methemoglobinemia, a disease which interferes with oxygen transport in the blood. Pregnant women should also avoid drinking water high in nitrate. Recent studies suggest connections between high-nitrate water and birth defects or miscarriages.

High nitrate levels also suggest that other contaminants may be present. The natural level of nitrate in Wisconsin's groundwater is less than 0.2 mg/L. *Nitrite* is an unstable form of nitrogen which may be found in small amounts along with nitrate. Sometimes results of nitrate and nitrite are reported together.



ACCEPTABLE RESULTS: Labs report nitrate results either as nitrate nitrogen or as nitrate. When reported as nitrate nitrogen (NO_3^--N) or nitrate and nitrite nitrogen (NO_2^- + NO_3^--N) the acceptable level is less than 10 mg/L (less than 2 mg/L is preferred). When reported simply as nitrate (NO_3^-), the acceptable level is less than 45 mg/L.

SOURCES: Fertilizer, septic system effluent and animal wastes can all contribute to elevated nitrate levels. In most cases, elevated nitrate levels indicate general contamination of the aquifer (water-bearing formation) at the depth of the well.

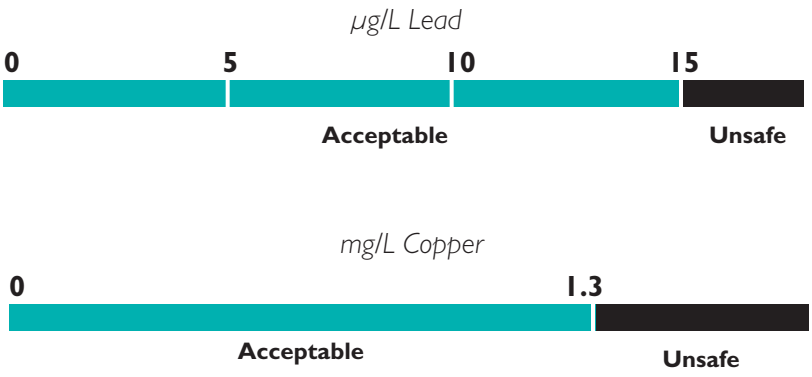
CORRECTIVE ACTIONS:

- ✓ Deepen or replace the well. Nitrate is more commonly found in shallow wells. Drilling to a deeper part of the aquifer might help reduce nitrate levels.
- ✓ Eliminate contamination sources. If the source of the nitrate can be identified (such as a nearby barnyard or septic system) the best solution might be to clean up or remove the contamination source. However, it could take years for the nitrate to return to safe levels in the well.
- ✓ Carry or buy water, especially for infants and pregnant women.
- ✓ Treat the water. Some home water treatment devices can remove nitrate from drinking water. See fact sheet *Choosing a Water Treatment Device* (G3558-5) for more information.

Lead and copper

Lead is a metal once used in solder, pipes and plumbing fixtures in many Wisconsin homes. High lead levels in the body can damage many body organs and systems. Lead can be especially dangerous to young children, infants and the unborn.

Copper is the metal commonly used to manufacture water pipes. Too much copper in drinking water may cause vomiting, stomach cramps, diarrhea and nausea. Some cases of "formula intolerance" in infants may be caused by high copper levels in water. Loss of copper from pipes into the drinking water may also eventually lead to leaks in the pipes.



ACCEPTABLE RESULTS: less than 15 µg/L (parts per billion) lead. Less than 1.3 mg/L (parts per million) copper

SOURCES: lead and copper in pipes, solder and plumbing fixtures.

CORRECTIVE ACTIONS :

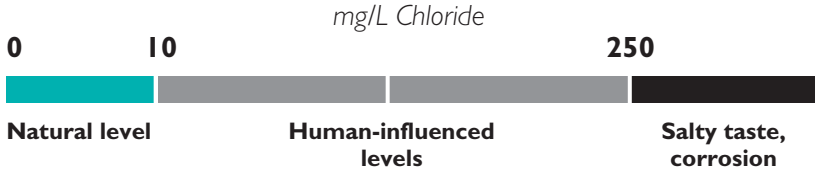
✓ Before using water for cooking or drinking, flush the cold water faucet by allowing the water to run until it is as cold as it will get (usually 2-3 minutes). Do not use water from the hot water tap for drinking or cooking because hot water dissolves metals in the plumbing system more quickly than cold water. For more information see the DNR publication *Lead in Drinking Water* and *Copper in Drinking Water*.

✓ Replace copper or lead pipes with plastic pipes.

✓ Avoid drinking water treated by a water softener. Soft water prevents a protective coating from forming on pipes and may allow metals to leach into the water. If water is naturally too soft, see "Corrective Action for Corrosivity" for steps to harden water.

Chloride

In most areas of Wisconsin, chloride in groundwater is naturally less than 10 mg/L. Some higher concentrations in limestone and sandstone aquifers in eastern Wisconsin may also be natural. Higher concentrations usually indicate contamination by septic systems, road salt, fertilizer, animal or other wastes. Chloride is not toxic, but some people can detect a salty taste at 250 mg/L. Water with high chloride may also have a high sodium content. High chloride may also speed up corrosion in plumbing (just as road salt does to your car).



ACCEPTABLE RESULTS: There is no health standard. Levels less than 10 mg/L are desirable. Levels more than 250 mg/L may cause a salty taste.

SOURCES: Septic systems, road salt, fertilizer, animal or other wastes.

CORRECTIVE ACTIONS: None required specifically for chloride. If elevated chloride levels are found in combination with high nitrate levels, take corrective actions indicated for nitrate.

Conductivity

Conductivity (specific conductance) is a measure of water's ability to conduct an electrical current. It is related to the amount of dissolved minerals in water, but it does not give an indication of which minerals are present. Conductivity (measured in µmho/cm at 25°C) is about twice the hardness (mg $CaCO_3$/L) in most uncontaminated waters in Wisconsin. If it is much greater than two times the hardness, it may indicate the presence of contaminants such as sodium, chloride, nitrate, or sulfate, which may occur naturally or be influenced by human activity. Changes in conductivity over time may indicate changing water quality.

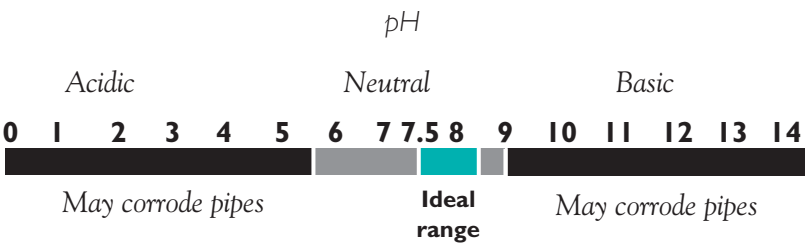
ACCEPTABLE RESULTS: There is no health standard. A normal conductivity value is roughly twice the hardness in unsoftened water.

SOURCES: Natural and human-made dissolved substances in the water.

CORRECTIVE ACTIONS: None specifically required for conductivity.

pH

The measure of the hydrogen ion (acid) concentration in water is called pH. A pH of 7 is neutral. Values above 7 are alkaline or basic; those below 7 are acidic. A change of 1 pH unit is a tenfold change in acid level. Acidic water is often corrosive (see Corrosivity Index). Iron may also be found at problem levels in acid water. Laboratory pH values are often slightly higher than would be found in a fresh water sample from your well.



ACCEPTABLE RESULTS: There is no health standard. Values from 6.5 to 8.5 pH units occur in most natural waters. Ideal values range from 7.5 to 8.3. The lower the pH, the more corrosive the water will be.

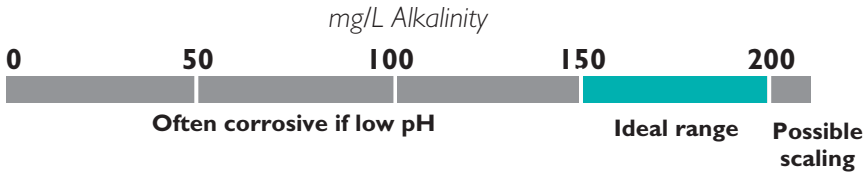
SOURCES: Low values are most often caused by lack of carbonate minerals, such as calcium and magnesium found in limestone and dolomite rocks. Water leaking from a landfill may also lower pH.

CORRECTIVE ACTIONS: See Corrosivity Index.

Alkalinity

Alkalinity is a measure of water's ability to neutralize acids, and so is related to pH. It results primarily from carbonate minerals, such as those found in limestone, dissolving in the aquifer. Alkalinity and total hardness are usually nearly equal in concentration when both are reported in mg/L $CaCO_3$ (calcium carbonate), because they come from the same minerals. If alkalinity is much higher than total hardness in an unsoftened sample, consider testing for sodium.If alkalinity is much lower than total hardness, test for chloride, nitrate and sulfate.

The lower the alkalinity, the more likely water is to be corrosive. Water with high alkalinity (greater than 150 mg/L) may contribute to scale (lime) buildup in plumbing.



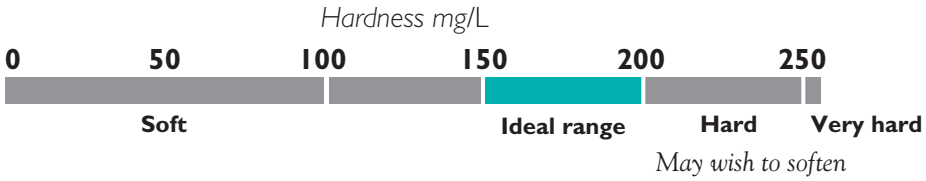
ACCEPTABLE RESULTS: There is no health standard. Values near 150 are considered ideal if the corrosivity index is satisfactory. When expressed as mg/L $CaCO_3$, the value should be near that of hardness (from 75 to 100 percent of the hardness value).

SOURCES: Primarily dissolved minerals from soil and limestone and dolomite rocks (carbonates and bicarbonates).

CORRECTIVE ACTIONS: See Corrosivity Index.

Hardness

Hardness in water is caused mostly by dissolved calcium and magnesium, primarily the end product of dissolving limestone and dolomite from soil and rock materials. Hard water is beneficial to health. However, high hardness can cause lime buildup (scaling) in pipes and water heaters. It also reacts with soap to form a "scum" which decreases soap's cleaning ability, increases bathtub ring and turns white laundry grey. Water that is naturally too soft may be corrosive. The water softening industry measures hardness in grains per gallon. One grain/gallon=17.1 mg/L $CaCO_3$.



ACCEPTABLE RESULTS: Hard water is beneficial to health. However, values near 150 mg/L are ideal from an aesthetic viewpoint, if the corrosivity index is satisfactory.

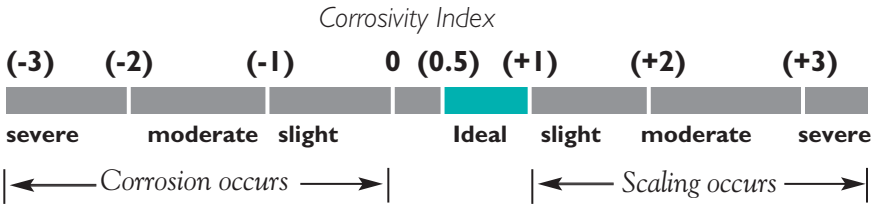
SOURCES: Primarily dissolved limestone minerals from soil, limestone and dolomite rocks (calcium and magnesium).

CORRECTIVE ACTIONS: See Corrosivity Index.

Corrosivity Index (also called Saturation Index, Stability Index, Langelier Index)

Corrosivity index is a measure of the tendency for lime (calcium carbonate) to precipitate (form a solid and settle out) from water. It is calculated from pH, alkalinity, calcium hardness and conductivity data.

Water is a good solvent, and will attack unprotected metal plumbing. Lead, copper and zinc from pipes and solder joints may then leach (dissolve) into drinking water. Symptoms of corrosive water include pinhole leaks in copper pipes or green stains on plumbing fixtures. Lime precipitate (scale) from hard water is a natural protection against corrosion. Too much scale, however, will partially plug pipes and water heaters, decreasing their efficiency. Water softeners prevent scale buildup, but also decrease any protection from corrosion the water may have provided.



ACCEPTABLE RESULTS: There is no health standard. Values between 0.5 and 1 units are considered the most desirable for a corrosivity index. However, the relationship between the corrosivity index and leaching of metals is imperfect. You may still need to test your water for lead and copper, or run the water until cold before drinking it, if your plumbing contains these metals.

Should I Worry About Changes in My Water?

Sudden changes in water quality may be a sign of serious contamination problems which may harm health. If there is a problem with the construction of your private well, you are especially likely to observe sudden changes in taste, odor or clarity in the spring or after heavy rain. Such changes should be investigated immediately with laboratory testing for coliform bacteria and nitrate. The water may be used for washing and bathing but should not be consumed until the laboratory results show that your water is safe.

You may find that some changes you observe are natural. If your water quality changes routinely at a certain time of year, you may want to make that the time at which you do your routine annual testing. Ultimately, sampling frequency is a personal decision which should be based on your own judgment, level of concern, and previous contamination levels.

SOURCES: Low values may be caused by natural lack of carbonate minerals in the aquifer and/or high nitrate levels. High values normally relate to high water hardness and alkalinity.

CORRECTIVE ACTIONS FOR CORROSIVITY, HARDNESS, ALKALINITY OR pH: If values are **too low**, indicating a corrosion problem, you should consider:

- ✓ Deepening the well.
- ✓ Increasing the hardness and/or alkalinity of the water with a water treatment device (see the Extension publication *Choosing a Water Treatment Device* (G3558-5)).
- ✓ Running water for several minutes before using it for drinking or cooking if the plumbing includes copper pipes, lead pipes or lead solder. Replacing all plumbing with plastic would be also be a solution.

If hardness or corrosivity values are **too high**, indicating a scaling problem:

- ✓ Soften water (except a cold water tap for drinking water). Softened water prevents protective scale formation and also contains sodium.

If alkalinity or pH values are too high, contact a water test interpretation specialist (see page 12).

When You Should Consider Additional Tests

In addition to the initial set of tests and once-a-year checks for bacteria and nitrate, you should consider additional testing of your private water supply in the following circumstances:

If you are installing a water treatment device
TEST FOR: Any contaminants you are concerned about removing. You will need to know the levels of contaminants present to choose the best treatment device.

If you have copper pipes soldered with lead solder or lead pipes
TEST FOR: Lead and copper.

If there is an infant or pregnant woman in the home
TEST FOR: Nitrate, copper, lead and coliform bacteria before the infant begins drinking the water.

If there is a family illness that could be related to drinking water (such as gastrointestinal illness)
TEST FOR: Coliform bacteria and copper. (Consult a physician for medical advice.)

If there are noticeable changes in livestock or poultry performance
TEST FOR: Compounds measured in the initial water test.

If your neighbors find one or more contaminants when they test their well
TEST FOR: The same contaminants found in the neighbors' well.

If agricultural chemicals or petroleum products have been spilled near your well, or you suspect an accident might have back-siphoned these products into the well
TEST FOR: The suspected volatile organic chemicals (VOCs) or pesticides.

If pesticides or fertilizers are applied to fields within 100 feet of your well
TEST FOR: Nitrate and pesticides with a scan that includes the pesticides used on the fields. If corn is grown, consider screening for atrazine, a common corn herbicide.

If there is an old underground fuel storage tank nearby
TEST FOR: Oil, gasoline and volatile organic chemicals.

If indoor air testing reveals radon concentrations higher than 4 picocuries/liter in kitchen and bathroom areas (Radon is a naturally occurring radioactive substance in geological materials in some areas; in well water, radon can contribute to elevated indoor air radon levels.)
TEST FOR: Radon. Contact the DNR water systems specialist for help.

If you notice rust stains on bathroom or kitchen fixtures, laundered clothes, cooking utensils
TEST FOR: Iron.

If you live near an active or abandoned solid waste landfill
TEST FOR: Volatile organic chemicals, chloride, and chemical oxygen demand.

Sources of Information

Publications

University of Wisconsin-Extension:

Do Deeper Wells Mean Better Water? (G3652)

Improving Your Drinking Water Quality (G3378)

Maintaining Your Home Well Water System (G3399)

Available from: Extension county offices or from Extension Publications, Rm. 170, 630 W. Mifflin St., Madison, WI 53715 608/262-3346; fax 608/265-8052

DNR:

Bacterial Contamination of Drinking Water PUBL-WS-003 97 REV

Copper in Drinking Water PUBL-WS-027 92

Iron Bacteria Problems in Wells PUBL-WS-004 89 REV

Lead in Drinking Water PUBL-WS-015 94 REV.

Nitrate in Drinking Water PUBL-WS-001 95 REV.

Pesticides in Drinking Water PUBL-WS-007 93 REV.

Private Well Construction in Granite Formations PUBL-WS-017 91 REV.

Radium in Drinking Water PUBL-WS-008 90 REV.

Sulfur Bacteria Problems in Wells PUBL-WS-005 95 REV

You and Your Well PUBL-WS-002 95 REV.

Available from: DNR, 101 S. Webster St., Madison, WI 53707 or DNR regional offices.

Northeast Regional Agricultural Engineering Service:

Private Drinking Water Supplies: Quality, Testing, and Options for Problem Waters NRAES-47

Available from: Northeast Regional Agricultural Engineering Service, 152 Riley-Robb Hall, Cooperative Extension, Ithaca, NY 14853-5701

Sources of Assistance

Water testing: A list of certified laboratories is available from county Extension offices and DNR regional offices. The Wisconsin State Laboratory of Hygiene provides inexpensive nitrate and bacteria testing. For information, contact the State Laboratory, 465 Henry Mall, Madison, WI 53706, 608/262-6303. In addition, the lab provides an inexpensive scan for atrazine (a common agricultural herbicide). For information call 1/800/334-1641.

Water test interpretation: County Extension offices, DNR regional offices, county health departments.

Well constructors report: Available from the Wisconsin Geological and Natural History Survey (WGNHS), 608/262-7430 and from DNR regional offices.

Well inspection: Licensed well drillers and pump installers.

Well compensation fund: In some circumstances the state will help pay for the cost of installing a new well or reconstructing an existing well. Contact DNR regional offices for more information.

Toxicity of water contaminants: Wisconsin Department of Health and Family Services: 608/266-0923 or 608/266-7480.

EPA Safe Drinking Water hotline: 1/800-426-4791

DNR regional drinking water offices

Northeast Region 414/492-5800

Northern Region—Rhinelander 715/365-8900

Northern Region—Spooner 715/635-2101

South Central Region 608/275-3266

Southeast Region 414/263-8500

West Central Region 715/839-3700

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