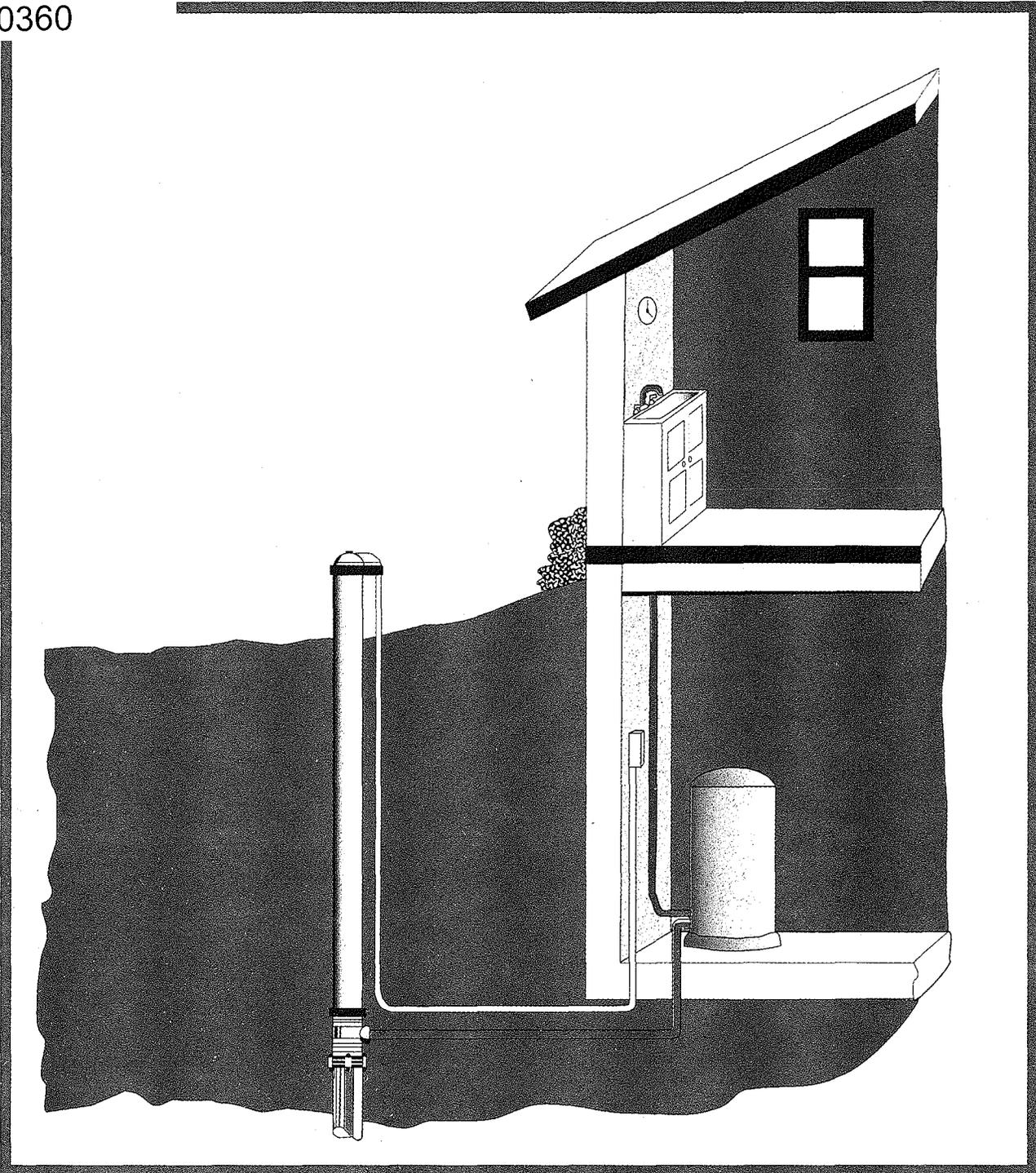




Well Owner's Handbook

A Consumer's Guide to Water Wells

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Well Management Section
Environmental Health Division
Minnesota Department of Health

Second Edition

WELL OWNER'S HANDBOOK

A Consumer's Guide to Water Wells

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Introduction

Are you thinking about having a new water well drilled? Do you have questions about an existing well?

Perhaps you are building a new home or replacing an existing water supply. Perhaps you previously have lived in a city with a public water supply system and you now have moved to a home in a rural area that uses a private well for a water supply. Whatever the case, this handbook contains important information you should know about:

- Groundwater.
- Well construction and protection.
- Well operation and maintenance.
- Well water safety and testing.
- Sealing unused wells.

What is Most Important?

- Learn about your well and the components of your water system. Wells don't last forever. If your well is old, have it inspected by a licensed well contractor (pages 6-16).
- Collect a water sample from your well on a regular basis and have it tested for total coliform bacteria and nitrate. If you are having a new well constructed, a water sample is required to be taken from a new well by the licensed well contractor (pages 18-20).
- Test your well water at least once for arsenic (page 21).
- Reduce your potential exposure to lead in drinking water by letting the faucet run for 30-60 seconds before using the water for drinking or cooking, especially after the water has not been used for more than six hours (page 23).
- Maintain your well in a sanitary condition. The well should have a waterproof cap, and the well casing should extend at least 1 foot above the surface of the ground. Keep septic systems, fertilizers, gasoline, fuel oil, and chemicals away from your well (page 30).
- Have any wells that are no longer in use permanently sealed by a licensed well contractor or a licensed well sealing contractor (page 31).

Groundwater and Wells

Our drinking water comes either from surface water (lakes, streams, or rivers) or from groundwater. Surface water is more vulnerable to contamination and requires extensive testing and treatment to assure that it is safe to drink. Groundwater obtained from a well is usually safe to drink without treatment, if the well has been properly constructed and maintained. Seventy percent of the people in Minnesota obtain their drinking water from groundwater, either from private or public wells.

Groundwater and surface water are both part of the “hydrologic cycle,” which is illustrated in Figure 1. Water rises from the earth’s surface as *evaporation* and falls to the earth as *precipitation*, in the form of snow or rain. Water that falls on the ground either moves over the ground as *runoff* or down through the soil to the saturated zone through *infiltration* — and then through an aquifer to an *area of discharge*, such as a river, lake, or pumping well.

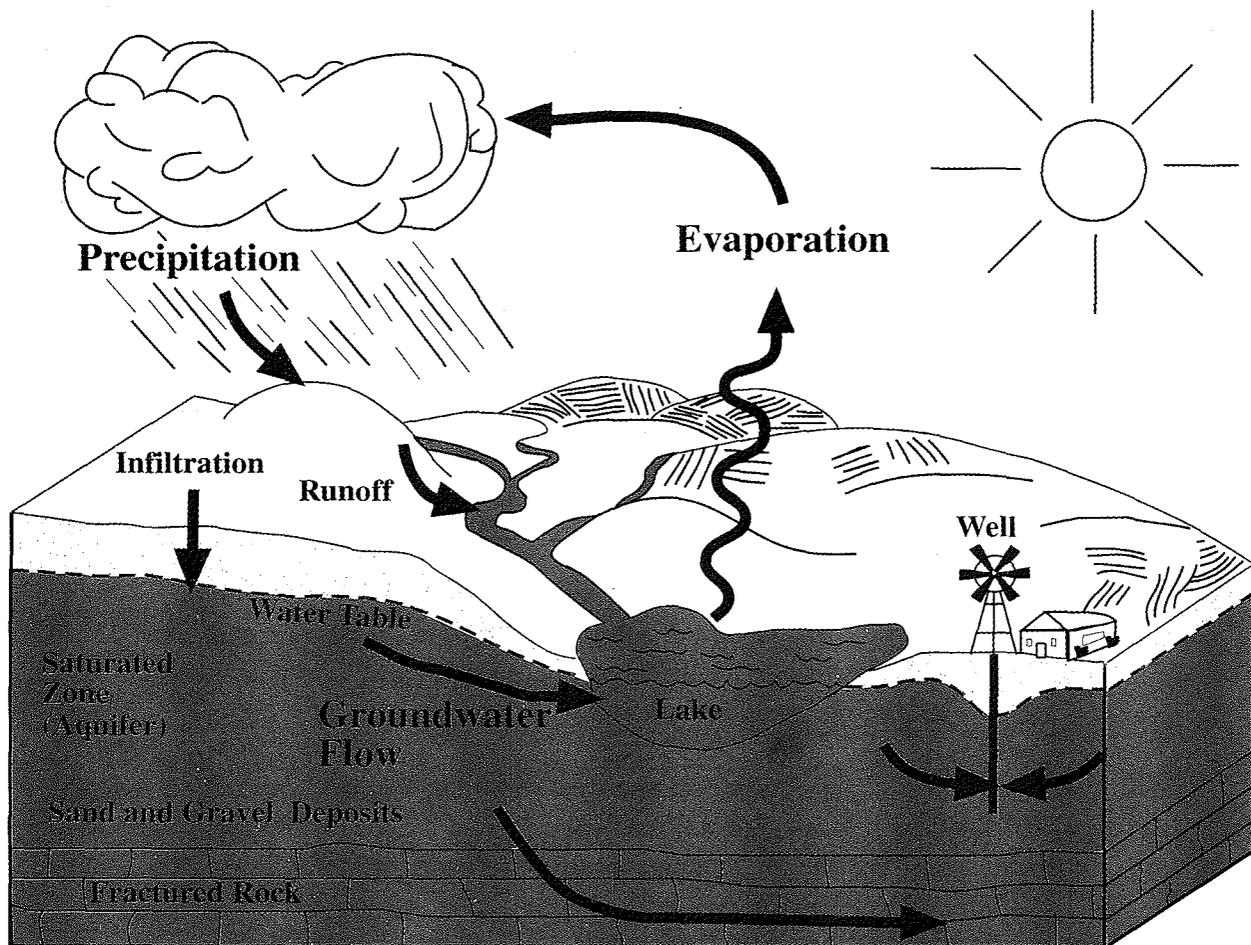


FIGURE 1 The Hydrologic Cycle.

SOURCE: Modified from *Using Ground-Water Data for Water Planning*, Educational Series-8, 1987, Minnesota Geological Survey.

As the name implies, **groundwater** is found beneath the land surface — in cracks and crevices in bedrock, or in **pore spaces**, which are the small spaces between soil or rock particles in sand and gravel deposits. Surface water becomes groundwater when it seeps downward to the **saturated zone**. The saturated zone begins at the point where the pore spaces and cracks in the soil, sediment, or rock become completely filled with water. The top of this zone is called the **water table**. An **aquifer** is a layer of sediment, such as sand or gravel, or a layer of rock, such as sandstone, that stores and transmits water to a well. A **confining layer** is a layer of sediment or rock that slows or prevents the downward movement of water — a thick layer of clay is an example of a confining layer.

Geologic conditions vary greatly in different parts of Minnesota. As a result, well depth, well construction, and natural water quality also vary. Most wells in Minnesota draw water from sand and gravel layers that were deposited by the melting of glaciers during past ice ages. Glacial deposits range in thickness from very thin or absent in the eastern part of the state to over 1000 feet in the west. Wells in southeastern and east central Minnesota, including the Twin Cities metropolitan area, often draw water from sandstone and limestone rock formations which underlie the glacial deposits. In northeastern Minnesota, the St. Cloud area, and the Minnesota River Valley, wells often draw water from fractured rocks such as granite. Information concerning the geology and groundwater resources in your area may be obtained from a licensed well contractor, the Minnesota Department of Health offices listed on page 35, a delegated local program listed on page 36, or the Minnesota Geological Survey at (612) 627-4784.

The quality of groundwater depends on the type of soil, sediment, or rock through which the water is moving, the length of time water is in contact with geologic materials, and whether any contaminants are present. Gases, minerals, and other chemicals may dissolve into water as it moves underground.

The quality of Minnesota groundwater as it relates to human health is generally excellent. Bacteria, viruses, and many chemical contaminants are removed or filtered from the water as it moves downward through silt, sand, and gravel deposits. Observing minimum **isolation** distances (also known as **setback** or **separation** distances) from contamination sources (Figure 2) — and well construction standards required under Minnesota Rules, Chapter 4725 (the “Well Code”) — will help ensure that the quality of the well water remains high.

Ground- water

Minnesota's geology

Water quality

Well Construction

A well is the most common way to obtain groundwater for household use. A well is basically a hole in the ground, held open by a pipe (or *casing*) that extends to an aquifer. A pump draws water from the aquifer for distribution through the plumbing system. The depth to which wells are constructed is determined by factors such as 1) depth to groundwater, 2) the groundwater quality, and 3) the geologic conditions at the well site.

Wells in Minnesota range in depth from 15 feet to over 1,000 feet. Wells that are drilled very near each other often have similar depths. However, the depth of wells in glacial deposits can vary greatly — even if they are located next door to each other.

Minnesota's rules governing well construction, which were first adopted in July 1974, are administered by the Minnesota Department of Health. The rules are based on the idea that a properly located and constructed well should provide safe drinking water and also protect the groundwater from contamination.

Types of Wells

Drilled wells

Most new wells constructed in Minnesota today are *drilled wells*. One of two methods is typically used to construct a drilled well. One method is called the *cable tool* method. A cable tool drilling machine uses a wire or "cable" to raise and lower a heavy chisel-shaped bit, which breaks up sediment and rock into small pieces called *cuttings*. The cuttings are removed from the hole with a *bailer* — a hollow tube or pipe with a valve on the bottom. Well *casing*, which is a special type of pipe, is pounded into the ground as the hole is deepened to keep the hole open.

A second method is known as the *rotary* method. A rotary drilling machine uses a rotating bit on the end of a hollow *drill rod*. Water and a special kind of clay slurry (called *drilling mud*) or foam are forced down the inside of the drill pipe as the bit rotates. The drilling mud or foam carries the cuttings, which consist of ground up rock and sediment, up and out of the space between the outside of the drill pipe and the drill hole. Well casing is then lowered into the hole. Domestic and commercial wells are usually constructed using the rotary method.

A *drive-point* well — also known as a *sand-point* or *well-point* — is an example of a *driven well*. Drive-point wells are constructed using a pointed screen on the end of a series of tightly coupled lengths of steel pipe. The well casing pipe, which is usually 1¼ inches in diameter, is driven into the ground with a heavy hammer or well driver until the point is below the water table. Water then flows into the pipe through screened openings in the well point.

A *bored well* is constructed using an earth auger, which bores a hole into the earth. The bore hole is then lined — or cased — with masonry, concrete curbing, or casing. A *dug well* is constructed by excavating or digging a hole, generally several feet in diameter, down to the water table. Rock, brick, wood, pipe, and other materials have been used in the past to line the walls of dug wells.

Dug wells, bored wells, and drive-point wells are often less than 50 feet deep, and are more likely to be contaminated by surface water, sewage from septic systems, or chemical spills. Many of the construction techniques historically used for these shallow wells are not sanitary and are no longer legal under the state rules.

Who May Construct a Well

In Minnesota, contractors who construct, repair, or permanently seal (removing a well from service and completely filling it with *grout*) water wells must be licensed by the Minnesota Department of Health (MDH). In addition to full-service well contractor licenses, the MDH also issues limited licenses to persons who perform only certain types of work, such as installing pumps or sealing wells. If you plan to have a well constructed, you should begin by getting estimates or bids from more than one licensed well contractor. As with any other construction project, it is a good idea to have a written agreement with the contractor listing in detail the materials and services to be provided.

You may **construct** your own well without a license if you own or lease the property where it will be constructed — *and* the well will be used 1) for farming or other agricultural purposes, or 2) to supply water for your personal residence. The well must be constructed in accordance with Minnesota rules (the “Well Code”) **and the proper notification must be filed**. If you are planning to construct a drive-point well, be sure to pick up a copy of the “Requirements for Construction of a Drive-Point Well,” which should be available where you purchase the drive-point well.

Driven wells

Bored wells Dug wells

Licensed well contractors

If you construct a well yourself

Minnesota Department of Health

Delegated programs

Locating your new well

“Isolation” or separation distances

Required Permit or Notification

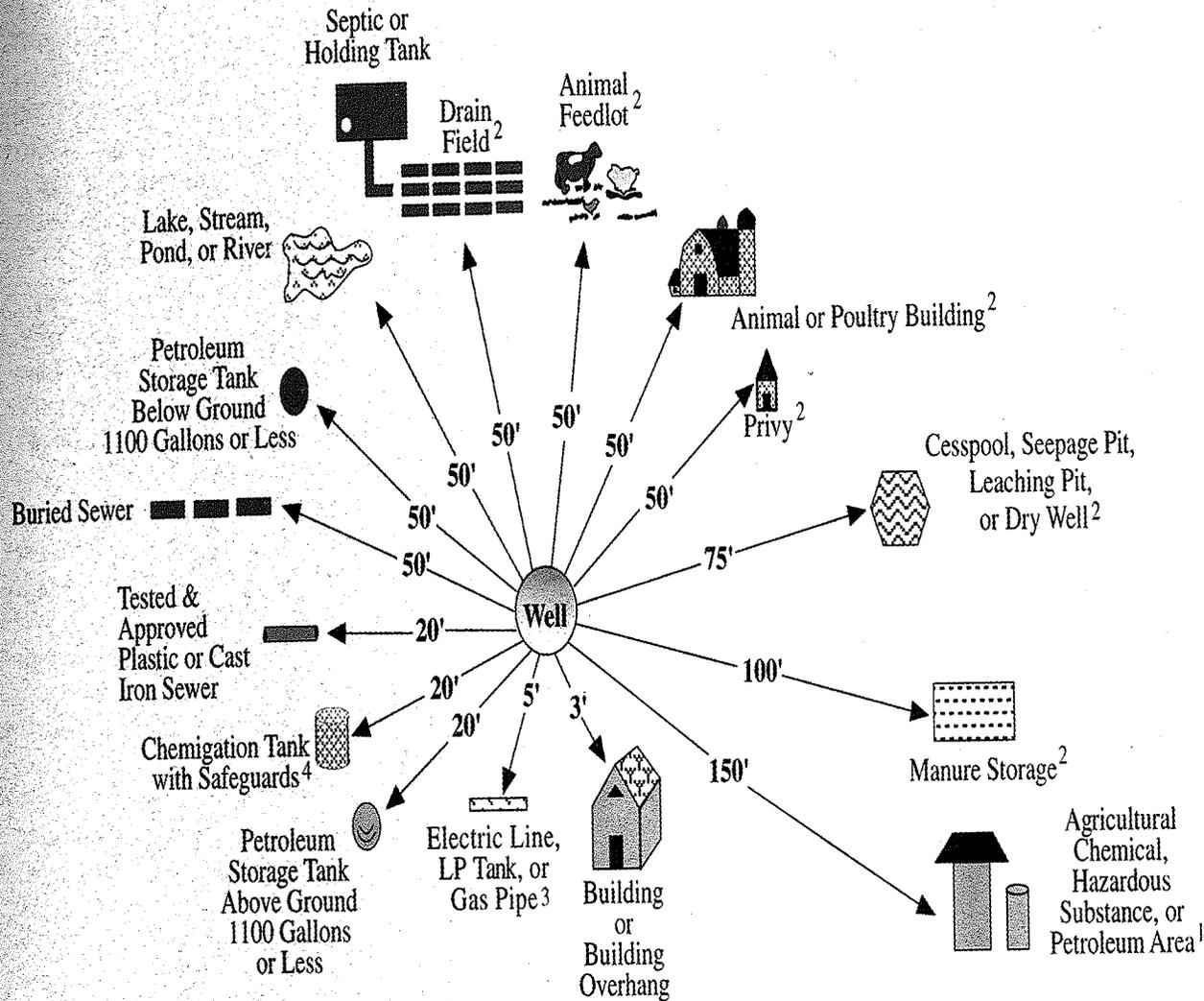
The Minnesota Department of Health (MDH) or a delegated local program* must be notified before well construction begins. The MDH notification form, which is similar to a permit, must be submitted by the well contractor or the property owner and must be accompanied by the appropriate fee. Construction may begin when the notification form and fee have been received by the MDH or a permit has been approved by a delegated program.

***NOTE:** Some counties and cities in Minnesota have assumed some of the responsibility for regulating well construction. A list of these *delegated* programs is on page 36. Delegated programs may have additional requirements beyond those spelled out in Minnesota laws and rules, and some local requirements may be stricter. A construction or sealing permit is usually required by a delegated program. If you live in a county or city with a delegated program and have questions, you should contact the delegated program representative.

Well Location

A well must be located so that it meets the minimum required isolation distances (also known as “setback” or “separation” distances) indicated in Minnesota Rules, Chapter 4725. These distances, some of which are shown on the next page, are between the well and utilities, buildings, and potential sources of contamination on your property or neighboring properties. *Before* construction begins, the *best* location on the property should be identified by considering the land elevation and the location of proposed or existing buildings, buried gas or power lines, and potential sources of contamination. Ideally, the well should be at a higher elevation than contamination sources such as septic systems or feedlots. New wells are not allowed to be constructed in basements, well pits, or in buildings other than a well house. A licensed well contractor can help you choose the best location for your new well.

The isolation distances are based on the ability of soil and bedrock to remove certain types of contaminants from the groundwater before they reach the well. A well may be more susceptible to contamination if its watertight casing extends less than 50 feet below the soil surface — or if it passes through less than 10 feet of a *confining layer* (see page 5). These more vulnerable wells must be located at least twice as far as other wells from sources of contamination that leach contaminants to the soil, such as septic system drainfields (Figure 2).



¹If safeguards are provided this minimum distance may be shortened. Consult Minnesota Rules, Chapter 4725.

²A water-supply well which has less than 50 feet of watertight casing or which is not cased through a confining layer, such as a clay layer, at least 10 feet thick, must be located at least twice the indicated distance from the potential contaminant source.

³A well between 5 and 10 feet of an electric transmission line, gas pipe, or LP tank must be placarded and work must not be performed on the well unless the line is deenergized and grounded or shielded, and the gas pipe or LP tank does not contain flammable gas.

⁴The 20-foot distance applies to only irrigation wells and chemigation tanks protected with safeguards meeting the requirements of the Minnesota Department of Agriculture.

FIGURE 2 Selected "Isolation" or Separation Distances.
 SOURCE: Complete listing may be found in Minnesota Rules, Chapter 4725.

How a Well is Constructed

Well Casing

Well casing

Most new household wells are lined with steel or plastic pipe known as *well casing*, which is illustrated in Figure 3 and 4. The casing is typically 4 to 6 inches in diameter and extends from above the ground surface into the *aquifer*. The casing provides a connection to the groundwater and a pathway for bringing the water to the surface. The casing also prevents loose soil, sediment, rock, and contaminants from entering the well. The casing may also house and protect the pump and related equipment. In order to prevent contaminants from entering the well, the well casing must be properly vented and have a cap that is weatherproof and insect-proof.

Steel vs. plastic casing

The type of casing chosen depends on the drilling method, local geological conditions, and natural groundwater quality. Steel casing is installed when the cable tool method is used to construct the well, or when high strength is needed. Plastic casing is lighter in weight and resistant to the corrosive effects of some groundwater, as well as the effects of chemicals that may be used to treat the system. Whichever type of casing is installed, it must be watertight, extend at least 15 feet below the surface, and meet the minimum standards specified in Minnesota Rules, Chapter 4725.

Well Screen

Well screen

If a well pumps water from a sand or gravel aquifer, a *well screen* is usually attached to the bottom of the casing (Figure 3). The screen is a sieve or strainer-like cylinder that extends into the aquifer and allows water to move through it, while preventing sand and gravel from entering the well. The screen openings — or *slot size* — are selected by determining the size of the sand or gravel particles comprising the aquifer. A well screen is generally not necessary if the bottom of the well has been drilled into solid bedrock — such as sandstone, limestone, or granite — that can remain open on its own. The screen is typically made of stainless steel, carbon steel, plastic, or brass. Stainless steel or plastic screens are most often used if the groundwater is corrosive. The screen is typically 3 to 5 feet in length for residential wells but may be tens of feet long for municipal, industrial, or irrigation wells. It is usually slightly smaller than the diameter of the well casing. It may be

threaded or welded to the casing. It may also be *telescoped* — that is, inserted inside the well casing and sealed to the casing with a neoprene *packer*. An envelope of sand or gravel — called a *gravel pack* or a *filter pack* — may be placed outside the well screen, between the screen and the bore hole wall. The filter pack keeps fine sediment from entering the screen and also promotes the movement of water into the well.

Grouting

The rotary drilling method produces a bore hole which is larger in diameter than the casing. The space between the outside of the well casing and the bore hole wall is called the *annular space*. After the well casing has been placed in the bore hole, it is necessary to fill the annular space to keep surface water and other contaminants from entering the well. The material used to fill this annular space is called *grout*, which consists of a mixture of water and either cement or a special type of clay called *bentonite*.

According to Minnesota law, the grout must be pumped in from the bottom of the well upward, to assure a complete seal around the casing. The usual method is to insert a $\frac{3}{4}$ - to 1 $\frac{1}{4}$ -inch diameter pipe (known as a *grout pipe* or *tremie pipe*) down to the bottom of the space between the well casing and the bore hole. The grout is then pumped in until it comes to the ground surface. **The grout must not be poured from the surface.** All rotary-drilled wells must be grouted from a required minimum depth to the surface or to the base of the pitless adapter or unit, which is illustrated in Figure 3. There are additional grouting requirements for some other types of wells, such as flowing wells, and wells drilled in certain kinds of rock.

Developing a Well

After a well is drilled, it is necessary to remove drilling mud, cuttings, and loose sediment from the bottom of the well and from around the screen. This process, which promotes the movement of water into the well, is called *development*. A number of techniques can be used to develop a well. Air or water can be injected into the well, or water can be pumped out of the well at higher than normal rates. A properly constructed and developed well should not normally produce sand. If you notice sand in your water, you should call your well contractor. The sand can damage or plug up your well pump, water softeners, plumbing, faucets, and many household appliances, such as dishwashers.

Gravel
pack

Grout

Sand in
your water

The Water System The Three P's

A *water system* is needed to pump the water out of the well to the surface and deliver it under pressure to the place where you will be using it. A typical home water system, as indicated in Figure 3, consists of a *pump*, a *pitless adapter or unit*, and a *pressure storage tank* and *control devices* that allow the system to operate automatically.

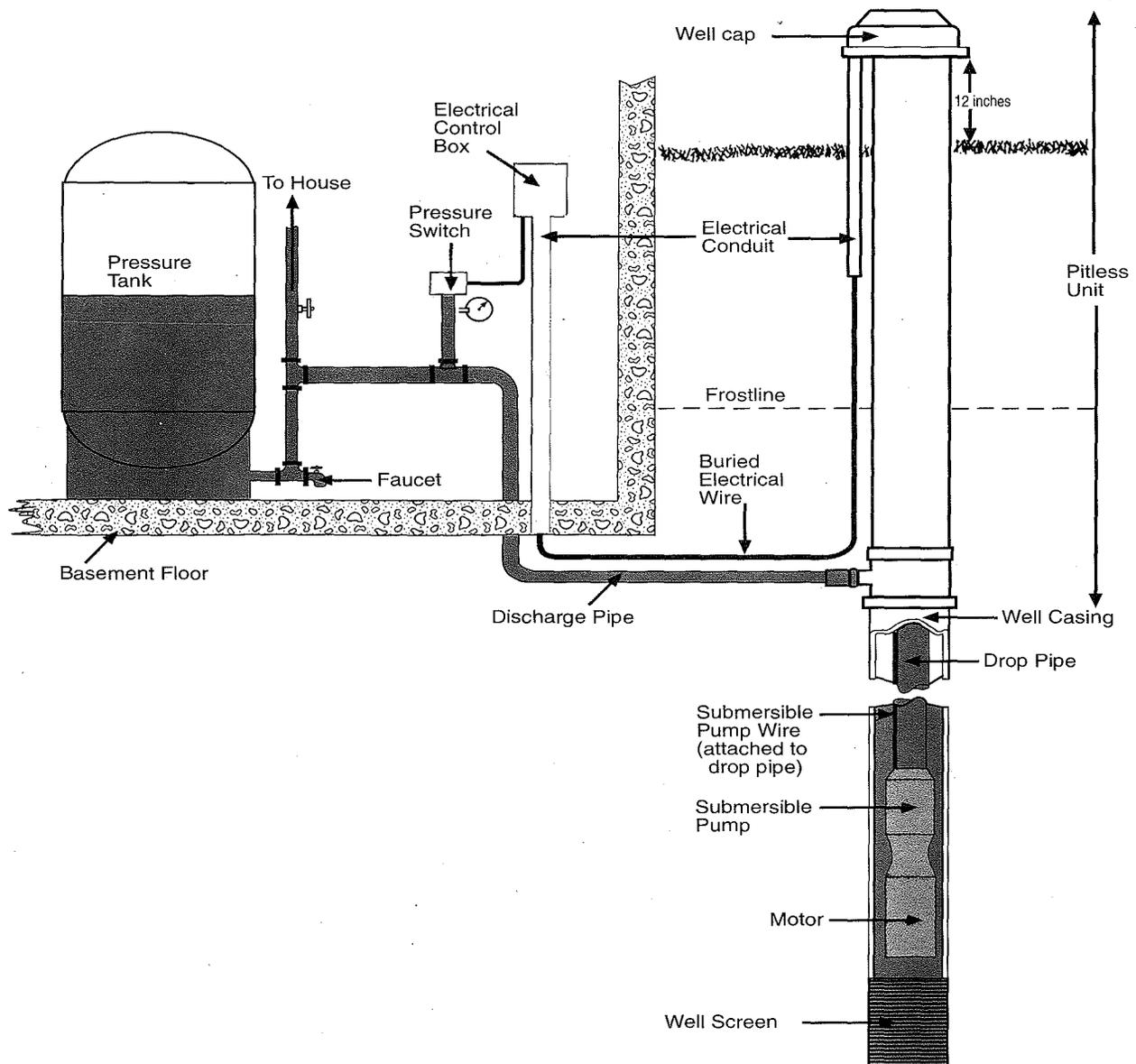


FIGURE 3 Well and Water System.

Pumps

Unless the well is a flowing well, a pump is needed to push or lift water from the well so it will flow through your household plumbing. The correct size pump and pump motor depends on the well diameter, the water level in the well, the number of plumbing fixtures, the amount of water use, and the peak water *demand*. Peak demand usually occurs during the morning and evening hours. Pumps are rated in *gallons per minute* (gpm) or *gallons per hour* (gph), and pump motors are rated in *horsepower* (hp). A typical pump for domestic use might have a 10 gpm pump with a ½ or ¾ hp motor.

Special water needs — such as for irrigation, heat pumps, or livestock — can increase peak demand and require a pump capable of producing more water. If the required rate of flow to meet the peak demand exceeds the maximum rate at which water can be pumped from the well, the difference can often be made up by increasing the storage capacity of the pressure tank. In some locations, a larger diameter well which is capable of handling a larger pump can provide more water.

Types of Pumps

A **submersible pump**, which is the type most often used in drilled wells, consists of a pump and motor unit, typically 3½ inches in diameter and 2 to 3 feet long. The pump is placed directly into the well, below the water level, as indicated in Figure 3. Most submersible pumps are used in wells 4 inches or more in diameter, but some pumps are available for wells that are 3 inches in diameter.

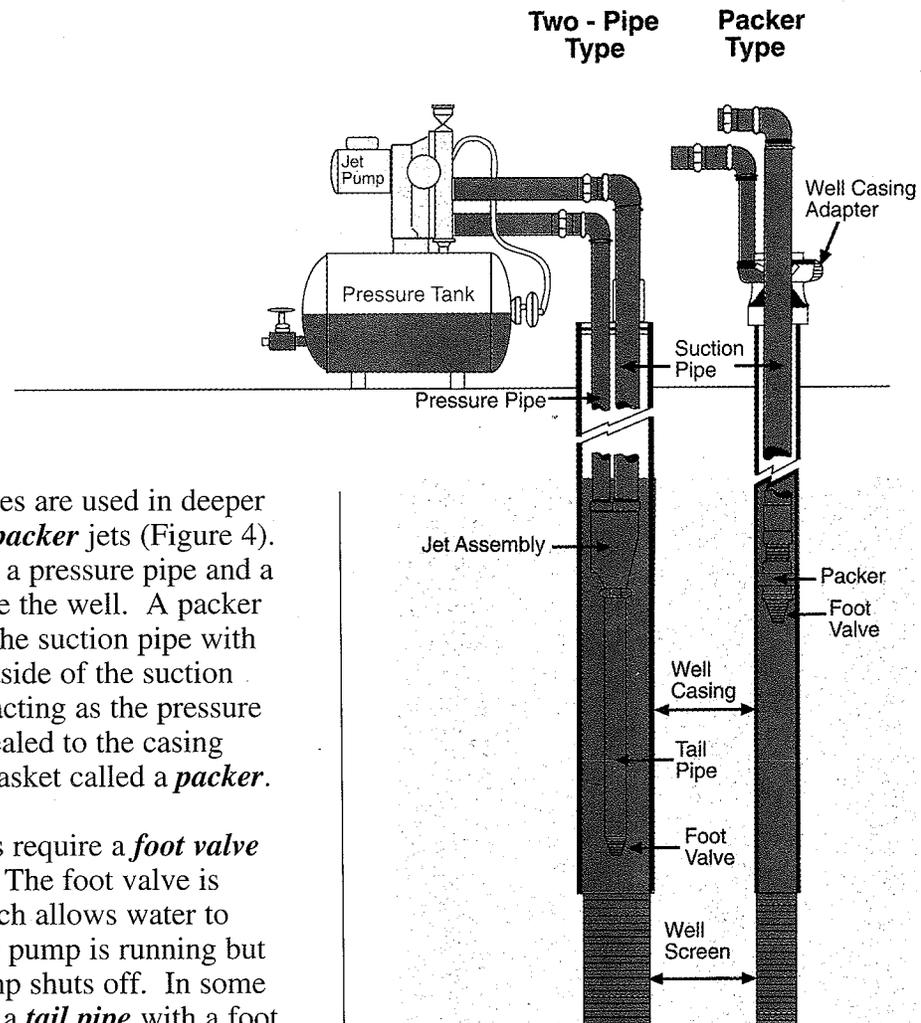
Jet pumps are most often used on wells that are 3 inches or less in diameter, such as drive-point or other shallow wells. The pump may be located on top of the well — or it may be offset from the well in a pump house, and connected to the well with piping. Jet pumps typically have a lower operating pressure and a lower water yield than submersible pumps. Jet pumps operate by forcing water through a jet or *venturi* — a narrow, cone-shaped device which creates a partial vacuum (suction) and draws water from the well into the pumping system. **Shallow well** jet pumps — which are used where the water is less than 25 feet below the surface — have the jet located in the pump itself. For deeper wells, the jet is located inside the well below the water level.

Pump size

Special water needs

Submersible pumps

Jet pumps



Two types of jet assemblies are used in deeper wells: *two-pipe* jets and *packer* jets (Figure 4). The two-pipe jet has both a pressure pipe and a suction pipe located inside the well. A packer jet uses a single pipe for the suction pipe with the space between the outside of the suction pipe and the well casing acting as the pressure pipe. The inner pipe is sealed to the casing with a rubber or leather gasket called a *packer*.

Deep well jet installations require a *foot valve* below the jet in the well. The foot valve is simply a check valve which allows water to flow into the jet when the pump is running but closes tight when the pump shuts off. In some two-pipe jet installations, a *tail pipe* with a foot valve is added to the bottom of the jet assembly. The purpose of the tail pipe is to prevent the risk of overpumping, which would allow air to enter the system. Deep well jet pumps are usually installed on wells with water levels less than 200 feet deep.

All jet pump systems have some portions of the piping that operate under suction. In systems where the pump is located some distance away from the well, the suction pipe is usually buried. If a buried section of suction pipe between the well and the pump developed a leak, contaminants could be drawn into the water supply system. For that reason, Minnesota law specifies that *concentric pipe* must be used for buried sections of suction pipe. Concentric piping consists of a suction pipe, which is contained inside an outer, pressurized pipe.

FIGURE 4 Deep Well Jet Installations.
SOURCE: Modified from *Water Systems Handbook*, 10th ed., Water Systems Council, 1993.

Turbine pumps are typically used for municipal, industrial, or irrigation wells, which produce a large volume of water. They have a motor which is placed on top of the well and a turbine shaft extending below the water level. The bottom of the shaft is connected to impellers which push water to the discharge pipe at the top of the well.

Cylinder pumps, which are used in windmills and hand pumps, have largely been replaced by jet pumps or submersible pumps. They consist of a cylinder on a pump rod, which moves up and down and forces water to the surface.

Pitless Adapters and Pitless Units

Years ago, wells were completed in pits, below ground level, so the pump and water pipes would not freeze in cold weather. Well pits, however, represent a serious health hazard, because contaminated flood water and runoff can easily flow into a well pit and get into the well itself. Well pits are also a safety hazard. Children and animals may fall into the pit due to missing or deteriorated pit covers. Farming equipment may fall into a pit when driving over it. Toxic gases can also build up inside a well pit, making it a dangerous place to enter and work.

Current well construction rules prohibit the construction of well pits. If you have an older well located in a well pit, the Minnesota Department of Health recommends that you upgrade your well installation. Have a licensed well contractor extend the casing above the ground level, and install a pitless unit or pitless adapter. For safety reasons, the pit should then be filled in with clean earth.

The invention of the **pitless adapter** and **pitless unit** have made well pits unnecessary. Pitless adapters and pitless units are special fittings that allow the casing to be extended above ground, while providing safe access for maintenance and repair. The water service pipes are attached to the fittings on the well underground — below the frost line, typically 6 or 7 feet below the surface, so they will not freeze during cold weather. A water service pipe connects the well to the house or to other water piping. The pipe is usually 1 to 1½ inches in diameter, and made of copper, iron, or plastic. Most new installations use polyvinyl chloride (PVC) pipe. Pitless adapters are small fittings that can be inserted through a hole in the well casing. Pitless units are more complex assemblies, which completely replace the well casing between the frost line and the ground surface (Figure 3).

Turbine pumps

Cylinder pumps

Well pits

Pitless adapter

Pitless unit

Pressure tanks

Pressure Tanks

Most water systems include a water storage container called a *pressure tank* or *hydropneumatic tank* (Figures 3 and 4). The pressure tank is usually located in the basement or a utility room, although some types of tanks may be buried underground. It is a good idea to have a faucet placed near the pressure tank for flushing the tank and collecting water samples for testing. The pressure tank has three purposes:

- To store water and provide water under pressure when the pump is not running.
- To build up a reserve supply of water each time the pump runs, so the pump has to start and stop less often. This serves to prolong the life of the pump.
- To provide a reserve supply of water for use during times of high demand.

As the name implies, a *pressure tank* contains water under pressure. As water is pumped into the tank, it compresses the air in the tank until the pressure reaches a preset level — typically from 40 to 60 pounds per square inch (psi) — which automatically shuts off the pump. When a faucet is opened, the air pressure in the tank forces water through the pipes until the pressure drops to another preset level — usually from 20 to 40 psi — which starts the pump again. A *pressure switch* starts and stops the pump at the preset pressure levels, and allows the system to work automatically (Figure 3).

Drawdown

The size of the tank usually depends on the amount of water produced by the pump in 1 to 2 minutes. The amount of water delivered by the pressure tank between the time the pump shuts down and the time it starts up again is called the *drawdown*. The drawdown is typically much smaller than the overall size of the tank. Common pressure tank sizes range from 10 gallons to over 200 gallons. Tanks holding 20 to 44 gallons, which have a drawdown of 5 to 16 gallons, are the most frequently used. Larger tanks, or more than one tank, may be needed for low-yield wells or systems with high water demands. The most common type of pressure tank design has a diaphragm or bladder, which provides a permanent separation between the air and the water in the tank. If the air and water are not separated, the water can eventually absorb all the air in the tank, a condition called waterlogging. The pump will then rapidly turn on and off, which is called “cycling.”

A Safe Well

Sometimes water can become polluted with potentially hazardous contaminants such as nitrate, lead, or disease-causing microorganisms. Many contaminants are tasteless, odorless, and colorless. Water which looks and tastes good may still be unsafe. Most naturally occurring substances in well water — such as iron and manganese, or the minerals that cause “hard water” — may be objectionable but are usually not a threat to health. Some dissolved substances, including some types of minerals and gases, help to give water its characteristic taste. Distilled water, with the minerals and gases removed, has little taste and is not particularly pleasant to drink. Proper well construction, disinfection, regular water testing, and water system maintenance help assure a safe water supply.

Well Disinfection

Harmful bacteria or viruses can enter a well through holes or other defects in the casing. Bacteria can also enter a well when it is first constructed, or later when it is repaired or serviced. **Every new well must be disinfected after it is drilled and before the water is used for drinking or cooking.** A well must also be disinfected whenever it is opened for repairs. If a well is flooded, you should assume that it has become contaminated. Both the well and the plumbing system need to be thoroughly disinfected. Disinfection should eliminate potentially harmful bacteria and viruses from the water. Disinfection should be repeated if water testing reveals that indicator bacteria are still present. If these organisms are still present after several attempts to disinfect the well, the source of the contamination in the well or water system should be located and removed, and the well should be checked for any defects.

The simplest and most effective product for disinfecting all parts of your water system is a chlorine solution. *Unscented* laundry bleach is a readily available source of chlorine. Whenever the pump is primed, chlorinated water should be used. With proper precautions, chlorine solutions are safe and easy to use. After disinfection, the chlorinated water should be flushed from your well and plumbing system. **The chlorinated water should not be discharged directly into your septic system. An outside faucet and hose should be used to discharge the chlorine solution to a location away from lawns and gardens.** After the chlorine has been flushed from the well, the relatively small amount of chlorine solution still in the plumbing can be drained directly into the septic system. Licensed well contractors are familiar with proper disinfection procedures.

Minnesota law requires that a licensed well contractor must disinfect a well after construction or repairs.

If you are planning to disinfect a well yourself, please first read the instruction sheet on well disinfection that is available from the Minnesota Department of Health.

Water Testing

Drinking water should be free of disease-causing organisms, and should not contain harmful levels of chemicals. Two standard tests — for *coliform bacteria* and *nitrate* — should be performed regularly on every well. Testing for other contaminants may also be advisable (page 21).

When is a water test required?

When a new well is constructed, Minnesota law requires that the water be tested for coliform bacteria and nitrate. The person who constructs the well is responsible for obtaining a sample and having it tested by a certified laboratory.

How often should a well be tested?

A water test tells you only about the water quality at the time the sample was taken. Groundwater pumped from some wells, in particular shallow or old wells, may vary in quality during the year, especially after heavy rainfall or melting of snow. More frequent testing of old wells or wells less than 50 feet deep is recommended. **At a minimum, private wells should be tested for coliform bacteria once a year and for nitrate every two or three years.** If nitrate is detected, the well should be tested for nitrate every year. Anytime that you notice a change in the quality of the water or after work is done on the well, you should have the well tested for coliform bacteria and nitrate. Before collecting a water sample for testing, you should contact the certified laboratory for instructions.

Certified testing laboratories

Water testing services are available from both county health agencies and private laboratories. A list of Minnesota certified laboratories can be found on the Minnesota Department of Health, Well Management web site (www.health.state.mn.us/divs/eh/wells) and click on "[Testing Labs](#)." Many private water testing laboratories are listed in the Yellow Pages under "Laboratories-Testing." You can also contact your local health department or the Minnesota Department of Health for a list of state-certified laboratories and to answer questions concerning test results.

The Total Coliform Bacteria Test

Waterborne diseases

Waterborne diseases can be spread by drinking water that has been contaminated with infected fecal wastes from humans or animals. Examples of these diseases include salmonellosis, dysentery, and hepatitis. It may take only a small number of disease organisms to make someone sick. The symptoms of these diseases often include diarrhea, nausea, vomiting, and sometimes fever. It is not unusual for people to mistake a case of water-related disease for "food poisoning" or a "24-hour flu bug."

It is not practical to test water for every possible disease-causing organism. Instead, water is usually tested for one particular group of bacteria known as the *total coliform group*. These organisms serve as *indicator* bacteria — they indicate how sanitary your water system is.

Coliform bacteria can be found everywhere on the land surface but are usually not found more than a few feet below the soil surface. Coliform bacteria are also found in the intestinal tract (and fecal wastes) of all warm-blooded animals. Most coliform bacteria do not usually cause disease, but if they show up in a water test, they indicate that surface contamination has somehow entered the water and *disease-causing organisms may also be present*. Remember that waterborne infectious disease is caused by fecal contamination, which is usually found only on the surface (in the case of animal waste) or near the surface (in the case of contamination from sewers or septic systems).

Coliform bacteria are also good indicators of the sanitary quality of your water because they are killed in the same way that most disease-causing organisms are killed. With few exceptions, if a well is disinfected with a strong solution of chlorine, and the coliform bacteria disappear, disease-causing organisms in the well have also been killed.

Several different methods can be used to test for total coliform bacteria. Some methods report results as the actual number of coliform organisms detected in a specific volume of water. Other test methods report results not as a number, but only indicate the “presence” or “absence” of coliform organisms. The absence of coliform organisms indicates satisfactory sanitary water quality. If any coliform bacteria are detected, the well should be disinfected and sampled again.

A second more specific bacterial test for either “fecal coliform bacteria” or “E. coli,” may also be performed. If either of these tests is found to be positive, the water is contaminated with fecal matter, and should never be consumed without vigorously boiling for at least one minute.

Disinfection with a chlorine solution will usually eliminate bacteria and viruses if they entered the well during construction or repair of the well — when a new pump is installed, for example. **Disinfection or treatment will not provide a permanent solution if the contamination is caused by faulty well construction, a failing septic system, surface water contamination, or some other ongoing problem.** In that case, it will be necessary to repair the well, construct a new well, or remove the source of contamination. More information about disinfecting your well and plumbing system is on page 17.

**Coliform
bacteria**

**Indicator
bacteria**

**Tests for
coliform
bacteria**

Disinfection

The Nitrate Test

Nitrate

Nitrate (NO_3), a chemical containing nitrogen and oxygen, moves easily through the soil to the groundwater. Some nitrate occurs naturally in groundwater that is near the surface, but the levels are usually low, less than 1 milligram per liter (mg/L).* Nitrate levels of 1 mg/L or greater in groundwater usually indicate contamination from fertilizers, animal wastes, or on-site sewage systems. In some wells, particularly drive-point wells or other shallow wells, nitrate may only be present during the spring, or after a heavy rainfall when rapid infiltration of surface water occurs. Because nitrate can move rapidly down through the soil into the groundwater, the presence of nitrate may provide an early warning of possible problems and can sometimes indicate the presence of other contaminants.

Blue baby syndrome

Nitrate levels above 10 mg/L (reported as nitrogen) can cause a condition known as infantile methemoglobinemia, or "blue baby syndrome," in infants less than six months old. This condition occurs when nitrate is ingested and then converted to nitrite (NO_2) by stomach bacteria. The nitrite then reacts with hemoglobin in the blood to form methemoglobin. The build up of methemoglobin reduces the ability of the blood to carry oxygen. If the level of methemoglobin becomes high enough, the baby's skin will turn a bluish color and suffocation can occur. Untreated methemoglobinemia can be fatal, but it is reversible *with prompt medical attention*. After six months of age, the conversion of nitrate to nitrite in the stomach no longer occurs. **Water containing more than 10 mg/L nitrate-nitrogen should *not* be given to infants less than six months of age either directly or in formula. Blue baby syndrome has been known to occur after just one day of exposure to high nitrate water.**

If nitrate is detected in your water

If your well water contains nitrate-nitrogen levels between 1 and 10 mg/L, you should test the well at least annually. If the level is above 10 mg/L, the well should be inspected to find out if it is properly constructed or if it is too close to a potential source of contamination, such as a septic system or feedlot. If possible, have the well repaired. If necessary, drill a new well. **Boiling the water will not remove the nitrate. It will actually increase the concentration of nitrate in your water.** Also it is not recommended to rely on a home water treatment device to remove nitrate from water fed to infants, because there is usually no way to immediately tell if a treatment device has malfunctioned. For infant feeding, use water from a source that is known to have low nitrate.

Tests for Other Contaminants

Even if testing detects no nitrate or coliform bacteria, well water could contain other contaminants such as arsenic, lead, pesticides, or "volatile organic chemicals" (from petroleum products or solvents). There is no single test that covers all possible contaminants. To determine whether you should consider testing for other contaminants in your water supply, contact one of the Minnesota Department of Health (MDH) offices listed on page 35 or a delegated well program listed on page 36. Information on testing services is presented on page 18.

Some of the more common substances that can be found in some wells are discussed below. The MDH has brochures available on water quality and treatment techniques. They are free of charge and listed on the last page of this handbook.

Arsenic occurs naturally in the groundwater in many parts of Minnesota, and about 15 percent of wells produce water which exceeds 10 micrograms per liter ($\mu\text{g/l}$),* the federal drinking water standard. Arsenic is more prevalent in western Minnesota, but can occur almost anywhere in the state (see Figure 5, the map on arsenic occurrence on page 22). Long-term consumption of arsenic above the drinking water standard may increase the risk of health problems of the skin, circulatory system, or the nervous system, including some cancers. Every private well should be tested at least once or twice to determine if arsenic is present in the water, and at what levels. Arsenic levels in groundwater will not usually change much over time. Long-term consumption of well water with arsenic levels above 10 micrograms per liter should be avoided.

Boron is naturally present in groundwater in some areas, especially in the volcanic rocks of northeastern and in sedimentary rocks in southwestern Minnesota. Boron can also leach from coal (and coal ash) and some fertilizers. The MDH has established a Health Risk Limit (HRL) of 600 $\mu\text{g/l}$ because of potential to cause toxic effects on the male reproductive system or birth defects. The HRL assumes a lifelong (70 year) exposure. You should consider testing your well water for boron if your well is completed in the rock units noted above. The water should not be used for drinking or cooking if the boron level exceeds 600 $\mu\text{g/l}$. The water can still be used for other household uses, such as bathing and washing. Reverse osmosis and distillation are the most common in-home treatment of water to reduce boron.

* Some laboratories may report the results in parts per million (ppm) or parts per billion (ppb). A concentration of 1 milligram per liter (mg/L) is approximately equivalent to 1 ppm; 1 microgram per liter ($\mu\text{g/L}$) is approximately equivalent to 1 ppb.

Additional information

Arsenic

Boron

***What is a mg/L or a $\mu\text{g/L}$?**

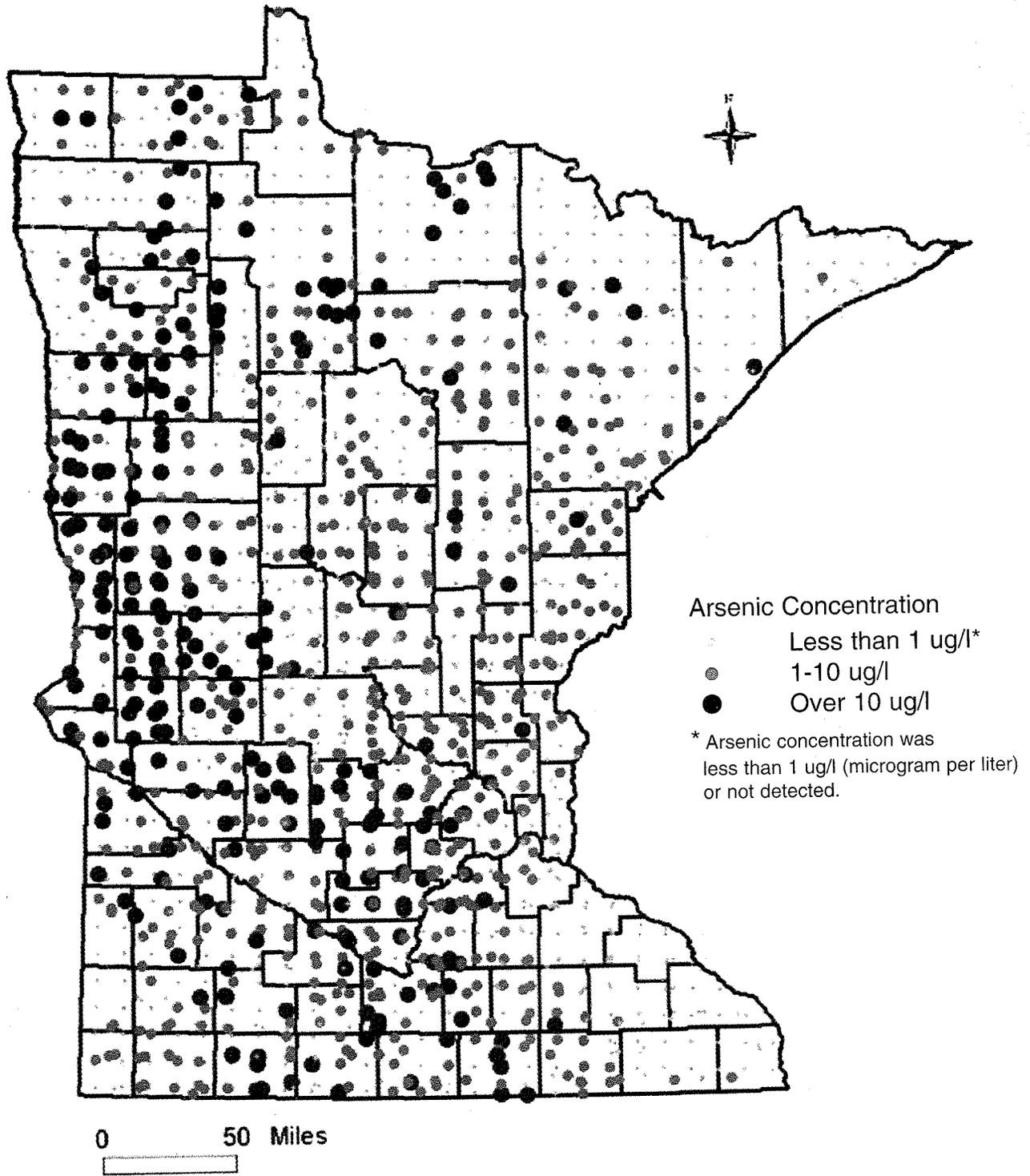


FIGURE 5 Arsenic concentration reported for selected wells in Minnesota.
SOURCE: Minnesota Pollution Control Agency and Minnesota Department of Health.

Fluoride is naturally present in the groundwater in some areas, but usually in low concentrations, less than 1 milligram per liter (mg/L). Fluoride concentrations of approximately 1.5 mg/L can be beneficial in forming human teeth and helping to prevent cavities. Discoloration or damage of teeth can occur if the concentration of fluoride in the water is too high. A small number of wells in Minnesota, primarily in northeastern Minnesota, do exceed the health limit for fluoride. A test for natural fluoride will give your dentist useful information about whether children or adolescents should be using fluoride supplements.

Hardness is caused primarily by calcium and magnesium ions, but also by iron and manganese ions present in the water. The higher the concentration of these minerals, the greater amount of soap that is required to produce suds. The soap that is combined with the minerals leaves an insoluble scum, which causes laundry and staining problems. Hardness is reported by some laboratories and water conditioning companies as "grains per gallon." One grain per gallon equals 17.1 mg/L. Water that has a hardness of more than 50 mg/L or 3 grains per gallon is considered hard. Testing for hardness can help you develop an effective water treatment program. Hardness in water does not cause detrimental health effects.

Iron is naturally present in some groundwater. It is typically not a health concern, but concentrations above 0.3 mg/L cause an objectionable metallic taste. It can also cause reddish brown stains on plumbing fixtures and clothes during laundering, encrust well screens, and clog pipes. Water softeners can typically remove up to about 3 mg/L of iron. Manganese greensand iron filters, which are regenerated with potassium permanganate, can remove higher concentrations of iron.

Water that exhibits "swampy" or "oily" tastes or smells, or red, slimy growths in toilet tanks may indicate that you have **iron bacteria** in your well and water system. These bacteria do not cause disease. Iron bacteria can be treated using techniques, including physical removal, pasteurization, and chemical treatment, such as shock chlorination. Some laboratories can analyze water samples for iron or iron bacteria.

Most groundwater does not contain detectable levels of **lead**, but water can dissolve lead from lead pipes, lead-soldered copper pipes, or brass plumbing components when the water stands in the plumbing system for more than a few hours at a time. Infants, children, and pregnant women are especially vulnerable to the potential health effects of lead. Too much lead can damage the nervous system, red blood cells, and kidneys. The MDH recommends that the intake of lead be as low as possible. For community drinking water systems, the U.S. Environmental Protection Agency (EPA) and the MDH require that action be taken to reduce the level of lead in water if it is at or exceeds 15 micrograms per liter. **You can minimize your exposure to lead**

Fluoride

"Hard water minerals"

Iron

Iron bacteria

Lead

in your drinking water by letting the water run until you feel the water getting colder (at least 30-60 seconds) before using it for drinking or cooking. Avoid using water from the hot water tap for drinking or cooking, because hot water dissolves lead more quickly. If you have the water tested for lead, the sample(s) should be taken from a regularly used faucet after the water has been standing in the plumbing for at least six hours.

Manganese

Manganese is naturally present in some groundwater. It is typically not a health concern, but concentrations above 0.05 mg/L cause an objectionable metallic taste. It can also cause brownish-black stains on plumbing fixtures, and clothes during laundering, encrust well screens, and clog pipes. Treatment techniques for manganese are similar to those for removal of iron.

Pesticides

When **Pesticides** are found in Minnesota wells, the levels are usually low. But there are exceptions. Wells most at risk of pesticide contamination are shallow or old, located close to areas of pesticide use or storage, and located in geologically sensitive areas such as sand plains or "karst" (weathered limestone) bedrock areas. Wells that have high levels of nitrate are also more likely to have detectable levels of pesticides. If you have an old or shallow well and you live in an agricultural area, or if your well has a high level of nitrate, consider testing your well water for one or more of the pesticides used most frequently in your area.

Radon

Radon is a naturally occurring radioactive element that exists as a gas dissolved in some groundwater. It can be released to the air when you run water inside your home, but well water usually contributes only a small fraction of the total amount of radon in indoor air. Exposure to radon increases your risk of developing lung cancer. Simple, low-cost detectors for radon gas are available. If the air in your home has annual radon concentrations at or above 4 picocuries per liter (pCi/l), steps should be taken to reduce the radon level.

Sulfate

Sulfate is a naturally occurring ion present in groundwater particularly in the southwestern part of Minnesota. Sulfate concentrations above 250 mg/L can act as a laxative. Most people become acclimated to sulfate after a couple days and the symptoms disappear. **Infants should not be given water with a sulfate concentration above 400 mg/L.**

Sulfur bacteria

A "rotten egg" smell in well water may indicate the presence of **hydrogen sulfide** gas, which can be produced by **sulfur bacteria**. They often occur together with iron bacteria. Treatment techniques for sulfur bacteria are similar to those for removal of iron bacteria.

Volatile Organic Chemicals, or "VOCs" are common components of gasoline and other fuels, as well as products such as solvents, paints, cleaners, and degreasers. It is estimated that about one private well in 50 has detectable levels of one or more VOCs. Long-term exposure to VOCs above state health limits may damage the central nervous system, liver or kidneys, and some VOCs are known to cause cancer. If you live near a commercial or industrial area, a gas station, or a landfill, and especially if your well is old or shallow, you should consider having your water tested for VOCs.

Water Treatment

In most of Minnesota, it is possible to construct a well that will provide an adequate supply of drinking water that is both naturally safe and aesthetically acceptable. Some well water will contain "aesthetic contaminants," substances that can cause hardness, objectionable tastes or odors, staining, or other nonhealth effects. Water treatment can often reduce or remove these contaminants.

Some well water can also contain contaminants that can adversely affect health. These can occur naturally, as in the case of arsenic, or as the result of human activities such as chemical spills, improper waste disposal, or failing septic systems. Wells that are old, shallow, in disrepair, or are not properly located and constructed are more likely to have unsafe water. It is always preferable to have naturally safe well water, rather than relying on treatment. Drilling a well deeper often gives additional protection from surface contaminants such as nitrate and spilled chemicals.

Treating Private Well Water for Safety

As discussed in the previous section on Water Testing, there are a number of drinking water contaminants that can adversely affect the health of you and your family. The most common include bacteria, viruses, nitrate, arsenic, lead, and synthetic chemicals such as fuels, solvents, and pesticides. Because many common health-related contaminants have no taste or odor, it is important to have water testing performed by a certified laboratory.

If testing does indicate the presence of a health-related contaminant, treatment should be considered only if no other options are possible.

Options may include a new well, repair of the existing well, or removal of the source of contamination. For example, the presence of **coliform bacteria** in the water often does not indicate that the groundwater is contaminated, but that there is a problem with well construction, operation, or maintenance, allowing surface water or contaminants to enter the well. If multiple thorough well disinfections do not solve the problem, the well probably needs to be repaired, upgraded, or replaced.

**Volatile
organic
chemicals**

**When
treatment is
needed**

**Health
related
contaminants**

**Coliform
bacteria**

Nitrate

If your well has **nitrate** contamination, a deeper well can often solve the problem. Treatment by reverse osmosis, ion exchange, or distillation, can remove nitrate. However, a treatment system should not be trusted to remove nitrate from water given to an infant or other vulnerable person, because systems can fail without warning, and high nitrate water can affect infants in a matter of hours or days. If your well has high nitrate, give your baby water from a known safe source, or use bottled water. Also, the presence of nitrate may indicate the presence of other contaminants.

Lead

If your water has **lead**, it is most likely coming from the plumbing system itself, not from the groundwater. Lead may be dissolved from metal water pipes and plumbing fixtures as the water sits idle in the pipes. Flushing the system in the morning, or after other periods of nonuse, can significantly reduce lead levels. Reverse osmosis or distillation can remove lead.

Arsenic

If your water contains **arsenic**, it may be possible in some cases to drill a deeper, or shallower, well that will solve the problem. If low arsenic water cannot be obtained, arsenic can be removed by reverse osmosis with preoxidation, distillation, anion exchange with pretreatment, or with one of the newer "adsorption media" systems, currently under development by several companies.

**VOCs
Pesticides**

If your water contains **Volatile Organic Chemicals (VOCs)** or **pesticides**, a deeper well may reduce or eliminate the problem. These contaminants can often be removed from the water by granular activated carbon.

It is important to repeat that obtaining a naturally safe water supply, without the need for treatment for health-related chemicals, should be the goal. If treatment is used, it is critical to install the correct treatment device, do proper maintenance, and test the water on a regular basis to make sure that the treatment system is still functioning properly.

Treating Private Well Water for Aesthetic Contaminants**"Aesthetic
contaminants"**

"Aesthetic contaminants" cause tastes, odors, scaling, or staining, but do not typically cause adverse health effects. Common aesthetic contaminants include calcium and magnesium, which cause hardness; iron, which causes staining; and hydrogen sulfide, which causes the "rotten egg" odor. The previous section on tests for other contaminants provides more information on specific aesthetic contaminants. Water treatment systems can reduce the levels of these contaminants and can often improve the taste and odor of your water.

Choosing the Correct Type of Treatment

There are a number of types of water treatment systems that can remove health-related and aesthetic contaminants from drinking water. The table at the end of this section lists the types of water treatment systems that are suitable for removing each contaminant. Treatment may be provided at either the "point of use" (POU) or "point of entry" (POE) of the water supply. POU treatment units are designed to treat small amounts of water, usually for drinking or other consumption. They are typically located on the counter, attached to the faucet, or installed under the sink. POE treatment units are designed to treat all of the household water and are installed at the location where the water enters a home. Contact a reputable water treatment dealer in your area for information about water treatment systems.

It is very important to choose a unit which will remove the specific contaminants of concern. Proper installation by a qualified plumber or water conditioning contractor is also important. It is recommended that treatment units meet the standards of NSF International and the American National Standards Institute (ANSI). These organizations establish independent standards of quality and performance for treatment units and other equipment.

Note: Manufacturer's recommendations must be followed in order for a treatment unit to work properly. If the unit is not properly maintained, it will not be effective in removing contaminants and may actually make a problem worse. The treated water from any unit should be tested periodically to make sure the unit is still working properly.

Some common treatment techniques are described in the following paragraphs. For more information, the MDH has brochures available on water quality and treatment techniques. They are free of charge and listed on the last page of this handbook. Water treatment companies can also provide you with more information. Check the water treatment table on page 29 to find out the appropriate unit for a particular contaminant.

Activated Carbon Filters contain a type of "adsorption" media consisting of material such as coal, charcoal or carbonized wood to "adsorb," or remove, many organic contaminants, including organic contaminants that cause offensive tastes and odors. These types of units are less expensive to purchase than many other types of treatment units and do not waste water. However, some filters can stimulate bacterial growth, so regular maintenance and replacement of the filter cartridge is necessary. Depending on the concentration of the contaminants, some large carbon filters have been known to last for years, while some small filters may last for only weeks or even days. They can be either POU or POE units.

**POU and
POE**

**Standards for
treatment
units**

**Importance
of proper
maintenance**

**Activated
Carbon
Filters**

Specialty Adsorption Media

Specialty Adsorption Media products are being developed specifically for the removal of arsenic. They may use activated alumina, ferric hydroxide, or sulfur modified iron. Some have been tested to verify compliance with NSF/ANSI standards. They can be either POU or POE units.

Reverse Osmosis

Reverse Osmosis (RO) is a water treatment process that removes most dissolved, inorganic contaminants from water by forcing the water through a cellophane-like plastic sheet known as a "semipermeable membrane." A small counter top RO unit will produce about 3 gallons per day. Slightly larger units that are usually installed under the sink will produce 5 to 20 gallons per day. RO units typically produce only 1 gallon of water from every 4 to 10 gallons of water treated. The remaining water goes to waste. The reverse osmosis unit should be checked regularly because the membrane can deteriorate over time. This is a POU unit.

Distillation

Distillation is a water treatment process that boils water, then cools the steam until it condenses into a separate container. The dissolved contaminants are left behind in the boiling pot. Distillation units require about four hours to produce 1 gallon of water, so this type of treatment uses a considerable amount of energy in its operation. Distillation is not effective for removal of some organic contaminants, and may actually concentrate them. This is a POU unit.

Ion Exchange

Ion Exchange (including Water Softening) is a process where one or more chemical ions is switched or "exchanged" for others. One type of process exchanges "cations," which are positively charged ions. An example of this type of unit is a standard water softener. Water softening works by passing "hard" water - water with calcium and magnesium - through a tank filled with a special resin saturated with sodium or potassium ions. The hardness minerals exchange with the sodium or potassium in the resin bed. Water softeners can often remove a small amount of iron. Another type of ion exchange process is "anion" exchange. It replaces anions, which are negatively charged ions, such as sulfate or arsenic, with chloride ions. Anion exchange uses different types of resins. When the resin in an ion exchange process is full to capacity, it must be "regenerated" with a salt solution. **Note: If not regenerated at the proper frequency, these devices can discharge contaminants into the drinking water at concentrations greatly exceeding the untreated water concentrations.** This is a POE unit.

Oxidizing Filters

Oxidizing Filters consist of media beds that change dissolved contaminants to solid particles that can be filtered out of the water. Oxidizing filters are commonly used to remove hydrogen sulfide or iron. The media must be periodically regenerated before the capacity is exhausted. One type of media consists of sand coated with manganese dioxide. Another type is manganese

greensand, which consists of a natural mineral glauconite or a synthetic material. Potassium permanganate is used to regenerate a manganese greensand media. This is a POE unit.

Oxidizing-Filtration Systems typically utilize a feed pump to inject an oxidizer, such as chlorine or air, into the water-supply line prior to a storage or mixing tank. When sufficient contact time is allowed, the oxidizer changes the hydrogen sulfide to sulfur, or oxidizes the iron to a form that can be removed by a particulate filter. These types of systems are commonly used for well water that contains high amounts of hydrogen sulfide, arsenic, or iron. Excess chlorine can be removed by activated carbon filtration. This is a POE system.

Oxidizing-Filtration Systems

TABLE 1. Water Treatment for Specific Contaminants.

Contaminant or Substance	Water Treatment Unit or System						
	Adsorption Media		Reverse Osmosis (RO)	Distillation	Ion Exchange	Oxidizing Filter	Oxidation-Filtration System
	Activated Carbon Filter	Specialty Adsorption Media					
Arsenic ^{1,3}		X	X	X	X (Anion) ⁴	X	X
Boron ¹			X	X			
Fluoride ¹			X	X			
Hard Water Minerals ²				X	X (Cation)		
Hydrogen Sulfide ¹	X					X	X
Iron/Manganese ²				X	X (Cation)	X	X
Lead ¹			X	X			
Nitrate ¹			X	X	X (Anion) ⁵		
Radon ¹	X						
Sulfate ¹			X	X	X (Anion)		
VOCs ¹	X						

¹ Health related contaminant - use treatment only when other options not possible.

² Aesthetic contaminant.

³ Pretreatments, such as oxidation, may be necessary. The best option may depend on the other contaminants present.

⁴ Use strong base sulfate selective resin.

⁵ Use nitrate selective resin.

Well Maintenance

Modern wells require remarkably little routine maintenance, but there are several steps that you can take to protect your well:

- When constructing new additions to your home, adding new buildings, or altering waste systems or chemical storage facilities, be sure to maintain the separation distances shown in Figure 2 (page 9). Minnesota law requires that separation distances be maintained. Constructing any type of building or structure, such as a deck, other than a special well house over a well is prohibited.
- When landscaping your yard, keep the top of the well at least 1 foot above the soil surface. This will help keep insects, dirt, and other contaminants from entering your well. If you must grade within 1 foot of the top of the well, you should arrange with a licensed well contractor to extend the well casing. Do not pile snow, leaves, or other materials around the well. Slope the soil away from the well casing to promote proper drainage. Minnesota law does not allow a well to be buried. Be careful when working around your well. Avoid damaging the well casing, which could jeopardize the sanitary condition of your well.
- Have any defective well parts repaired by a licensed well contractor or pump installer. Be sure the well cover or well cap on top of the casing is properly attached and in good repair. Any connections to the cap also should be watertight. Provide flood protection if the well is in an area subject to flooding.
- When working with hazardous chemicals like paint, fertilizer, pesticides, and motor oil, keep them away from your well.
- Take steps to prevent *back-siphonage*, which occurs when a drop in water pressure causes potentially hazardous substances to be sucked back through your plumbing system — and into your well. When connecting a hose to a faucet, do not submerge the hose end in a laundry tub, chemical tank, container, or sprayer — or leave it lying on the basement floor. When filling pesticide tanks or containers with water, avoid placing the hose inside the tank or container. The nozzle of the fill hose should be secured at a distance above the container or tank opening, which maintains an air gap. The distance should be equivalent to at least twice the diameter of the delivery pipe.
- Be aware of changes in your well, the water from your well, and the area around the well. Changes in how often your pump runs, or in the smell or color of the water, can tip you off to potential problems. If necessary, seek the advice of an expert, such as a licensed well contractor or a well specialist from the Minnesota Department of Health. Have your well inspected at the first indication of trouble.
- Have the water tested regularly for coliform bacteria and nitrate.

Sealing Unused Wells

Unused or abandoned wells that have not been properly sealed can provide a direct pathway for contaminants to enter the groundwater. Contaminants from surface water, runoff, or sources, such as leaking sewers or septic system drainfields, can enter the well through casings that have deteriorated. An unused, unsealed well can potentially threaten water quality for new wells. Unused wells also pose a safety hazard, especially for children, pets, and livestock. It is illegal to dispose of wastes in an unused well, and it will result in additional costs to clean the well and possibly the groundwater before the well is sealed.

According to Minnesota law, a well *must* be **sealed** in any of the following situations:

1) the well is contaminated and cannot be corrected; 2) the well has been improperly sealed in the past; 3) the well poses a threat to the health or safety of the public or to groundwater quality; or 4) the well is not in use and does not have a maintenance permit. A water well is properly **sealed** when it is removed from service and is completely filled with *grout*, which is cement or another approved material. Although you may construct your own well (page 7), you may not seal your own well. **Only a licensed well contractor or a licensed well sealing contractor may seal a well. The contractor must seal the well in accordance with Minnesota law.**

There are three main steps that are followed when a well is sealed:

- Before a well can be sealed, any obstructions in the well — an old pump, drop pipe, and any debris — must be removed. In some situations, the well casing will have to be *perforated* — meaning that holes will have to be punched through the casing. This helps ensure that both the inside and the outside of the casing will be completely sealed when grout is pumped into the well.
- The well is sealed by completely filling it with *grout*, which is a special type of cement, concrete, or a clay known as *bentonite*. Filling the well casing with grout *seals* the well and helps protect aquifers from contamination. To ensure a complete and effective seal, free of voids, Minnesota regulations require that the grout be pumped into the well from the bottom upward. The licensed well contractor inserts a *grout pipe* (or *tremie pipe*) all the way down to the bottom of the well, and then pumps in the grout until it comes out the top. **Dumping grout from the surface into the well is not allowed except under special circumstances.**
- After the well has been sealed, the licensed well contractor must send a **Well and Boring Sealing Record** to the property owner and to the Minnesota Department of Health (MDH). The property owner should keep this document with other important papers relating to the property.

**Removing
obstructions**

**Sealing
with
grout**

**Well and
Boring
Sealing
Record**

**Water Well
Maintenance
Permit**

According to Minnesota law, the well owner must apply for a **Water Well Maintenance Permit** if an unused well is not sealed or is not placed back in service. This document can be issued by the MDH, or by a delegated city or county water well program. The permit is not transferable, and an annual fee is required. In most cases, unless you are planning to put the well back into use at a later time, it will save you money in the long run to get the well sealed as soon as possible rather than applying for a maintenance permit.

A maintenance permit cannot be issued if the well is contaminated, if it has been improperly sealed, or if it poses a health or safety hazard because of improper construction or maintenance. The maintenance permit application must be reviewed and approved before the permit is granted. If you would like to apply for a maintenance permit, please contact the MDH or the delegated city or county water well program.

Record Keeping

It is a good idea to keep *all* information and documents relating to your well in one place. Ideally, your water well file should include:

- Your written **contract** with the contractor who constructed your well.
- A copy of the well report or the MDH **Well and Boring Record** that was filled out by the licensed contractor who constructed your well.
- Records of **all water test results** for your well.
- Your copy of the **Well Owner's Handbook**.
- **Maintenance records**, warranties, and other papers for any work performed on your well, including the pump and water system.
- A copy of the MDH **Well and Boring Sealing Record** for any previously sealed well on your property.
- A copy of your MDH **Well Disclosure Certificate** (see the next page), *if* you purchased your property after October 31, 1990.

Well Disclosure Upon Sale of Property

If you sell your property, Minnesota law requires that you provide information to the buyer regarding the location and status of any wells on the property. The disclosure process includes two steps.

Step 1 — the seller provides a written *Well Disclosure Statement* to the buyer *before the purchase agreement is signed*. This statement must include the legal description of the property, a map showing the location of each well on the property, and a listing of each well and its current status (*in use, not in use, or sealed by licensed well contractor*). A well is *in use*, if the well is functioning for some purpose. A well is *not in use* if the well is not functioning or is not capable of functioning, such as when the well pump is disconnected or when the well is no longer connected to a power supply. A well is *sealed* if the well has been filled with an approved sealing material by a licensed well contractor and the Minnesota Department of Health (MDH) has received a Well and Boring Sealing Record.

Step 2 — the seller provides a *Well Disclosure Certificate at the time of closing of the sale*. If the information is not provided by the seller, the buyer can prepare the certificate. This certificate contains the same information as the statement in addition to the name and address of the buyer. You can obtain blank copies of this form from the county recorder's office, your Realtor, or the MDH. The Well Disclosure Certificate is filed with the county recorder — and a fee is paid — when the deed is recorded. The county recorder then forwards the Well Disclosure Certificate to the MDH.

If a Well Disclosure Certificate has been filed previously and there has not been a change in the number and status of the wells, it is not necessary to file another certificate when the property changes ownership. However, the deed must include the following statement:

I am familiar with the property described in this instrument and I certify that the status and number of wells on the described real property have not changed since the last previously filed well disclosure certificate.

This statement is followed by the signature of the seller or buyer, or a person authorized to act on behalf of the seller or buyer.

If a new well has been drilled, or there has been a change in the status and number of wells on the property, a new Well Disclosure Certificate must be filed when the property is sold and recorded.

**Well
Disclosure
Statement**

**Well
Disclosure
Certificate**

**More
information
about this
process is
available
in the
MDH
brochure
on "Well
Disclosure."**

Troubleshooting

If you are having problems with your pump or water quality, refer to the table below to determine the possible cause. If you would like more information, you can call a licensed well contractor, the Minnesota Department of Health at one of the offices listed on page 35, or a delegated well program listed on page 36.

Problem	Possible Cause	Refer to Page
Sand in the water	Improperly constructed well or hole in the screen or well	11
Pump turns rapidly on and off (cycling)	Waterlogging in pressure tank	16
White/gray scale in cooking pots when water is boiled	Water Hardness	23
Red staining on plumbing fixtures, clothes during laundering	High iron concentration in water	23
Oily sheen on water in containers; slime in toilet tanks	Iron bacteria	23
Rotten egg smell in water	Sulfur bacteria and/or hydrogen sulfide gas	24
Change in color, taste, or odor of the water	Possible contamination of the water	18-29
Well damaged (cracked casing, loose or missing cap, or exposed wires)	Well struck by plows, snowmobiles, vehicles, or other heavy equipment	30

Additional Information

The Minnesota Department of Health (MDH) has brochures, pamphlets, and fact sheets regarding wells and water systems available at no charge. An order form is provided for your convenience on the last page. You can also order by phone by calling (651) 215-0811 or toll-free at 1-800-383-9808. When you call, the MDH can provide you with a current list of brochures, pamphlets, and fact sheets.

If you have questions about water quality, well construction, well sealing, or licensing of well contractors, please contact the MDH, Well Management Section at the following locations or the delegated well programs listed on page 36.

Central Office and Metro District Office
Metro Square Building, Suite 220
P.O. Box 64975
St. Paul, Minnesota 55164-0975
(651) 215-0811

Northwestern District Office
1705 Anne Street, Suite 3
Bemidji, Minnesota 56601
(218) 755-3820

Northeastern District Office
320 West Second Street, Room 703
Duluth, Minnesota 55802
(218) 723-4642

West Central District Office
Building 4A, East Drive
Fergus Falls, Minnesota 56537
(218) 739-7585

Central District Office
3400 First Street North
St. Cloud, Minnesota 56303
(320) 255-4216

Southwestern District Office
1400 East Lyon Street
Marshall, Minnesota 56258
(507) 537-7151

Southeastern District Office
18 Woodlake Drive Southeast
Rochester, Minnesota 55904
(507) 285-7289

Delegated Well Programs

Some counties and cities in Minnesota have assumed some of the responsibility for regulating well construction through a delegation agreement with the Minnesota Department of Health. Here is a list of the current delegated programs:*

City of Bloomington

Bloomington Environmental Services
1800 West Old Shakopee Road
Bloomington, Minnesota 55431
(952) 563-8934 Fax: (952) 563-8949

City of Minneapolis

Minneapolis Environmental Management
250 South Fourth Street, Room 414
Minneapolis, Minnesota 55415
(612) 673-5897 Fax: (612) 673-2635

Blue Earth County

Blue Earth County Government Center
410 South 5th Street, 3rd Floor
P.O. Box 3566
Mankato, Minnesota 56002-3566
(507) 389-8381 Fax: (507) 389-8431

Dakota County

Dakota County Environmental Services
14955 Galaxie Avenue West
Apple Valley, Minnesota 55124
(952) 891-7011 Fax: (952) 891-7588

Goodhue County

Goodhue County Environmental Health Department
509 West Fifth Street
P.O. Box 408
Red Wing, Minnesota 55066
(651) 385-6130 Fax: (651) 385-6472

LeSeuer County

LeSeuer-Waseca Community Health Services
88 South Park Street
LeCenter, Minnesota 56057
(507) 357-2251 Fax: (507) 357-8541

Mower County

Mower County Environmental Health
1105 1/2 - Eighth Avenue Northeast
Austin, Minnesota 55912
(507) 437-9527 Fax: (507) 437-9582

Olmsted County

Rochester-Olmsted Consolidated Planning
2122 Campus Drive Southeast
Rochester, Minnesota 55904
(507) 285-8213 Fax: (507) 287-2275

Wabasha County

Wabasha County Public Health Services
Wabasha County Courthouse
107 East Third Street
Wabasha, Minnesota 55981
(651) 565-5200 Fax: (651) 565-2637

Waseca County

LeSueur-Waseca Community
Health Services
900 Third Street Northeast
Waseca, Minnesota 56093
(507) 835-0651 Fax: (507) 835-0687

Winona County

Winona County Environmental Health
Winona County Courthouse
225 West Second Street
Winona, Minnesota 55987
(507) 457-6405 Fax: (507) 457-6465

*as of March 2004

To request this document in another format, call (651) 215-0700, T.D. (651) 215-0707, or for greater Minnesota through the Minnesota Relay Service at 1-800-627-3529 and ask for (651) 215-0700.

The Minnesota Department of Health has brochures, pamphlets, and fact sheets pertaining to wells and water systems available at no charge. To order, please check the items you are interested in receiving, tear off this sheet, fold it as indicated on the back side, and mail to the Minnesota Department of Health. You can also order by phone by calling (651) 215-0811 or toll-free at 1-800-383-9808.

Water Quality

- Arsenic in Drinking Water
- Bacterial Safety of Well Water
- Boron in Drinking Water
- Commonly asked Questions about Springs
- Copper in Drinking Water: Health Effects and How to Reduce Exposure
- Iron Bacteria in Well Water
- Iron in Well Water
- Lead in Well Water Systems
- Let It Run...And Get the Lead Out!
- Nitrate in Well Water
- Sulfate in Well Water
- Volatile Organic Chemicals in Drinking Water
- Why Does My Water Smell Like Rotten Eggs?
Hydrogen Sulfide and Sulfur Bacteria in Well Water

Water Treatment

- Home Water Treatment Units: Point-of-Use Devices

Wells

- Protecting Your Well
- Requirements for Construction of a Drive-Point Well
- Building, Remodeling, Demolition, and Wells
- Rules Relating to Wells and Borings
- Sealing Unused Wells
- Finding Lost Wells
- Well Disclosure
- Well Disinfection
- Flooded Wells

Name

Street Address or P.O. Box

City, State, ZIP Code

Telephone Number (including area code)