NebGuide

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Drinking Water Treatment: Emergency Procedures

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Emergency or short-term treatment of drinking water may be required when the water supply to your home is interrupted due to natural disasters, accidents, or other causes. Campers and hikers also may use short-term drinking water treatment methods. This guide discusses situations requiring an emergency or short-term drinking water supply and methods that can be used to treat limited amounts of water for human consumption.

What alternative water sources can I use in different emergency situations?

There are numerous situations in which a water supply may be temporarily interrupted due to natural or human causes. Because water is the most important nutrient for the human body, availability of adequate drinkable water is critical. The amount of water needed is different for each person and depends on factors such as age, health, activity, and climate. If your water supply runs low, do not ration drinking water. Drink the amount you need today and try to find additional sources for tomorrow.

Options for alternative water sources in an emergency include a stored emergency water supply that has been prepared ahead of time, bottled water, "hidden" sources of water within the home (i.e., ice, hot water tank), and outside water sources. For information on preparing and storing an emergency water supply ahead of time, see NebGuide G1499 *Drinking Water: Storing an Emergency Supply*. In certain situations, such as a large scale disaster, availability of bottled water may be limited. Information on bottled water as a short-term water supply can be found in NebGuide G1448 *Drinking Water: Bottled or Tap?* NebGuides and NebFacts are available online or may be obtained from your local or state University of Nebraska–Lincoln Extension office. If an interruption occurs in a private water supply, the nearest public water supply is also an alternative water source.

The emergency procedure methods discussed in this guide are for temporary drinking water needs. Long-term drinking water treatment methods are discussed in other guides listed at the end of this publication.

Most water supply interruptions can be categorized into one of four main types:

1. Loss of water pressure can occur due to incidents such as damage to the water distribution system (e.g., water main break) or electrical failure. When this occurs water is unavailable at the tap. Alternative water sources may include:

   Most desirable
   - Stored emergency supply (See NebGuide G1499)
   - Bottled water (See NebGuide G1448)

   Less desirable
   - Hidden sources in the home (See further discussion in this guide)

   Least desirable
   - Outside sources (See further discussion in this guide)

2. Known pathogen (disease-causing organism) contamination of a water supply can occur after floods, earthquakes, or other natural disasters, or any time there is human or animal waste contamination of the water. Pathogen contamination may be suspected in surface water sources such as lakes, ponds and streams. Campers and hikers using surface water supplies should suspect human or animal impact on the water source and may treat the water as described later in this guide.

   Public water utilities occasionally issue "boil water advisories" when known pathogen contamination of a water supply occurs. Boiling water or emergency treatment by chemical disinfection should be continued until the boil advisory is lifted by the public water system. Guidelines for treating contaminated water by boiling as well as chemical disinfection are discussed subsequently.

   If bacterial contamination of a private well occurs, shock chlorination of the well and waterline is recommended. See NebGuide G1255 *Shock Chlorination of Domestic Water Supplies.* Treatment of the water contaminated by a known pathogen is discussed in NebGuide G989 *Drinking Water: Bacteria.* Alternative temporary water sources may include:

   Most desirable
   - Stored emergency supply (See NebGuide G1499)
   - Bottled water (See NebGuide G1448)

   Less desirable
   - Contaminated water from the home that has been appropriately treated by emergency treatment methods (See further discussion in this guide)

Least desirable
- Outside sources (See further discussion in this guide)

3. Short-term accidental contamination of a private water supply with known chemical agents can occur from chemical spills during tank filling or back-siphoning during filling of tanks, or when any private well is contaminated from spills during chemical use. Alternative temporary water sources may include:
   Most desirable
   - Stored emergency supply (See NebGuide G1499)
   - Bottled water (See NebGuide G1448)

   Less desirable
   - Contaminated water from the home that has been appropriately treated. These treatment options are different from those for pathogenic contamination of water. An example would be when it is known that atrazine contamination has occurred; activated carbon filtration could be used to treat the drinking water. See Extension Circular EC703 *Drinking Water Treatment: An Overview* for appropriate treatment options.

   Least desirable
   - Outside sources (See further discussion in this guide)

4. Possible contamination with unknown chemical or biological agents may occur from intentional tampering with the water distribution system or source. In this situation, the contaminant and when it was introduced are unknown. Emergency treatments described in this guide may or may not be effective for treating the affected water source. An unaffected water source should be used. The disinfection methods described in this guide will effectively treat water for most microorganisms commonly found in drinking water but may not necessarily remove certain biological agents, chemicals, heavy metals or salts. It is important to seek professional guidance to determine what contaminants may be present in the water.

   If you suspect intentional tampering with a public water system, contact your public water supply utility. If you are unable to contact the utility or if you suspect intentional tampering with a private water system, contact the Nebraska Department of Health and Human Services at (402) 471-2541.

   In case of contamination with unknown chemical or biological agents, temporary water sources include:
   Most desirable
   - Stored emergency supply (See NebGuide G1499)
   - Bottled water (See NebGuide G1448)

   Least desirable
   - Outside sources (See further discussion in this guide)

What hidden sources of water in the home are available?

If you experience an interruption in your drinking water supply and do not have an emergency stored water, you might turn to a number of sources of water in your home. In most situations, water from these sources should be treated by methods described later in this guide. If the interruption in water supply is due to power failure and only a short time has passed since interruption, water from the hot water tank or household pipes as described below could be used without treatment; water such as this in the plumbing system is safe for only a few days and then must be treated before use.If there has been a major disaster, prevent contamination of the water in the house plumbing by shutting off the water valve that leads from the water main into the house.

Water drained from the hot water tank

Some emergency water can be obtained from a hot water heater. If the water heater is old or the quality of the water in it is questionable (e.g., high sediment content), drain a few gallons of water every six months, allowing water to drain until it flows clean. This process will ensure that the tank and water remain free of mineral and rust deposits.

To obtain water from the hot water tank, follow these instructions.
- Turn off the gas or electric supply to the tank.
- Close the water intake valve into the tank by closing the shut off valve at the top of the tank.
- Open the drain faucet briefly to rinse the interior surfaces and then catch water in a container. Never turn the gas or electricity back on until the water supply is restored and the tank is full of water.
- Use caution when emptying the tank; water will typically be 120-140°F.

Water remaining in pipes

You can drain the existing water in the pipes by gravity flow. Follow these instructions.
- Locate and open the faucet with the highest elevation in your house. This allows air into the plumbing when water is drained out of a lower faucet (see below). **Note:** To obtain water from both the cold and hot water pipes, turn on both the cold and hot taps or select the warm water mix on single-lever faucets.
- Obtain water from the lowest faucet in the house, which may be an external faucet.

Water dipped from the flush tank (not bowl) of the toilet

- Dip water out of the toilet flush tank with a ladle, cup, or pan, being careful to use a clean dipper.
- Follow the instructions given later in this guide for disinfection using chlorine bleach.
- Do not use flush tank water that has been treated with drop-in tablets or other chemicals.

Ice makers or other appliances

Appliances such as ice makers in refrigerators may be another source of emergency drinking water. If the ice was made before contamination occurred, it is an acceptable source of drinking water. Ice made from contaminated water should be melted and treated using an appropriate method for the contaminant in the ice, following one of the emergency treatment procedures given later in this guide.

Outside sources of water

In certain situations water may be obtained from outside sources such as swimming pools, ponds or streams. Outside sources of water will need to be treated prior to consumption following one of the emergency treatment procedures described later in this guide. Try to avoid choosing water from an area where human or animal waste may have contaminated the water. Also, try to obtain water from a clear water source. The nature of contaminants present in an outside water source is unknown, whereas contaminating agents in household waterlines are often known. Therefore it is generally preferable to treat contaminated household water in a short-term situation and reserve treating outside sources as a last resort.

Emergency treatment principles and processes

Inspect the water before treatment. Microorganisms may be attached to or embedded in soil or other organic particles suspended in the water. The water to be treated should be allowed to stand so suspended material settles to the bottom of the container. Coarse materials like sand will settle more quickly than finer materials suspended in the water. During and after settling, care should be taken not to agitate the water. Water from the top of the container can be gently poured or drawn off into a second clean container. A second option for removing suspended particles is to strain the water through a clean cloth, layers of paper towels or paper coffee filter; do not use a commercially available portable water filter (see discussion on filters in this guide) for this step as the suspended material may rapidly clog such filters.

For emergency or short-term situations, water can be treated by using heat, chemical treatments, or filtration. Each method has certain advantages and disadvantages that must be considered. In some situations, a combination of these methods may be preferred (e.g., filtration and chemical treatment). Contaminants in water which may cause illness or disease include bacteria, such as *E. coli*, protozoan cysts such as giardia or cryptosporidium, and viruses such as Hepatitis A. Giardia or cryptosporidium are not likely to be present in Nebraska groundwaters but may be encountered in contaminated surface waters. Viruses should be suspected in any water that may be contaminated with human waste.

Heat treatment

Heat kills microorganisms and is the oldest effective means of disinfecting drinking water. The process of bringing water to a boil will kill virtually any disease-causing organism including bacteria, cysts such as giardia and cryptospyridium, and viruses. Heat the water to a vigorous boil and then let it cool. There is some variation in recommendations regarding boiling time required for disinfection. It is important to realize that bringing water to a vigorous boil will adequately disinfect it. If fuel is not limited, however, additional boiling for one minute or keeping the water covered and hot for several minutes can provide an additional margin of safety. Since water boils at a lower temperature as elevation increases, the Centers for Disease Control and Prevention (CDC) recommends boiling for 3 minutes at altitudes above 6562 feet (2000 meters) in order to be certain that viruses are killed.

Though boiling effectively disinfects water for drinking, it does not provide a residual (or long-term disinfection). Therefore, care must be taken not to re-contaminate the water Boiled water may taste flat; the taste can be improved by pouring it back and forth between two clean containers to re-oxygenate it or by adding a pinch of salt to each quart after it has cooled.

Chemical treatments

Chlorine and iodine are the most commonly used chemicals for emergency disinfection of water. The killing effectiveness of the chemical depends on the concentration of the chemical in the water, the amount of time the available chemical is in contact with the water prior to use (contact time), the water temperature and the characteristics of the water supply. A decreased concentration of the disinfectant or a lower temperature will require a longer contact time for adequate disinfection. If the water temperature is less than 41°F (or 5°C), it should be allowed to warm prior to disinfection or the chemical dose should be doubled. If the water is cloudy, it is recommended to strain it through a coffee filter before treatment.

A common objection to chemical disinfection is the flavor it gives to the treated water. If flavorings of any kind are added to the water to improve taste it should be done after the recommended contact time for disinfection. Flavorings added before adequate contact time has been achieved will "tie up" some of the chemical available for disinfection. Adding about 50 mg of vitamin C (ascorbic acid) per liter or quart of water after the contact time can improve the taste. Vitamin C is often avail-able in 250 and 500 mg tablets where vitamin supplements are sold. Tablets should be pulverized and divided before adding to the water. In addition, freshness preservatives containing vitamin C are often available where canning supplies are sold.

Bacteria are very sensitive to chemical disinfectants such as chlorine and iodine. Viruses, cryptosporidium, and giardia require very high dosages of disinfectant or longer contact times with the disinfectant than the standard recommendations. Heat treatment is recommended if these pathogens are suspected in the water.

Chlorine

Regular household chlorine bleach that contains 5% to 6% sodium hypochlorite as the only active ingredient can be used for disinfection. Standard household bleaches are 5.25% sodium hypochlorite; those labeled "Ultra" are generally 6% sodium hypochlorite. Bleaches with labels such as "Fresh Wildflowers," "Rain Clean," "Advantage," or labeled as scented may contain fragrances, soaps, surfactants, or other additives and should be avoided for drinking water disinfection. Using a medicine dropper, add 16 drops per gallon (4 drops per quart). Stir the water and let it stand covered for 30 minutes. For adequate disinfection, the water should have a slight chlorine odor to it after the 30 minute waiting period. If this odor is not present after the 30 minutes, repeat the dose and let it stand covered another 15 minutes. If this odor is not present, the bleach may have lost its effectiveness due to age of the product or exposure to light or heat.

Use the freshest chlorine bleach available. If the chlorine taste is too strong in the treated water, taste can be improved by pouring the water from one clean container to another several times.

Halazone® tablets are another form of chlorine for drinking water disinfection. The tablets are convenient and inexpensive but may require high doses and longer contact times. Follow manufacturer directions for use. Chemical treatment with chlorine provides some protection against recontamination since some available chemical remains in the water.

Iodine

Two forms of iodine commonly sold for chemical disinfection of drinking water are tincture of iodine (2%) and tetraglycine hydroperiodide tablets (Globaline®, Coghlan's® and Potable-Aqua® are examples). Iodine was once widely used, but is no longer recommended because health research has shown that as many as 8% of people have hidden or chronic thyroid, liver, or kidney disease which iodine can make worse. Iodine should not be ingested by children younger than age 14. Do not use iodine-containing products unless you have discussed the risks with your physician.

Filtration

Commercially available portable filters provide widely varying degrees of protection against disease-causing contaminants. The better filters provide adequate protection but

less sophisticated filters on the market (often lower cost) may not provide protection. The more sophisticated filters typically operate by a hand pump which draws water into the filter through an intake hose or by slow gravity flow through a filter or series of filters. The filtration process works by physically removing the contaminants from the water and retaining them within the filter medium. The size of contaminants retained depends on the pore size or the space between media fibers or granules. Most filters list an average pore size and are rated by the manufacturer according to the smallest particle they can trap. For example, a one micron (one thousandth of a millimeter) filter traps contaminants one micron in diameter or larger. The removal percentage of contaminants is affected by the amount of time the water is in contact with the filter media; shorter contact time with filter media generally results in less contaminant removal. Some filters have a chemical treatment component such as activated carbon, or iodine-impregnated resins which are effective against bacteria and some viruses. The contact time with the iodine in the filter may be too short to kill protozoan cysts, however.

Portable filters do provide immediate access to drinking water without adding unpleasant tastes or odors. However, as with boiling, the water can become re-contaminated after filtration. Also, portable filters sold for field use with pore sizes of 0.1 to 0.3 microns may be acceptable for cysts and bacteria but do not have small enough pore sizes to reliably remove viruses. While the filters may be reliable in remote areas where human waste contamination is unlikely, in populated areas filtration should be followed by either chemical disinfection with chlorine or boiling as described previously.

Proper selection, operation, care and maintenance of portable water filters is essential for producing safe drinking water in emergency or short-term situations. When considering the purchase of a filter, be aware of the filter's rating for pore size, output, pump strokes per liter, and pump force (how much effort is required to operate the pump). If size and speed are not critical factors, a gravity-fed drip filter that lets water slowly drip from a reservoir down through a filter may be a good option. Be aware that membranes in some filters can be damaged by chlorine in the water. Also, cloudy or turbid water can quickly clog a filter and shorten the life of the unit. When using a portable water filter, always follow the manufacturer's instructions for use, care, and replacement.

Summary

Emergency or short-term treatment of drinking water may be necessary due to natural disasters, accidents or other situations caused by humans. Alternative drinking water sources for emergency situations and short-term use may include a stored emergency water supply that has been prepared ahead of time, bottled water, hidden sources of water within the home, and outside water sources. When a stored water supply or bottled water supply are unavailable, alternative water sources may be made acceptable for drinking by use of heat, chemical disinfection, filtration or an appropriate combination of these methods. Each method has advantages and disadvantages which should be considered for individual situations.

If local public health department (or water utility) information differs from the recommendations in this guide, the local information should be followed. Local officials will be familiar with site- and event-specific conditions.

Related Drinking Water Treatment Publications

EC703 Drinking Water Treatment: An Overview
G1489 Drinking Water Treatment: Activated Carbon Filtration
G1255 Shock Chlorination of Domestic Water Supplies

Related Drinking Water Contaminant Publications

G907 Testing for Drinking Water Quality
G989 Drinking Water: Bacteria
G1279 Drinking Water: Nitrate-Nitrogen
G1280 Drinking Water: Iron and Manganese
G1282 Drinking Water: Man-made Chemicals
G1369 Drinking Water: Nitrate and Methemoglobinemia
G1448 Drinking Water: Bottled or Tap?
G1499 Drinking Water: Storing an Emergency Supply

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Views expressed in this publication are those of the authors and do not necessarily reflect the views of either the technical reviewers or the agencies they represent. Mention of trade names is for clarity only and is not intended as an endorsement by the University of Nebraska.

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