Disinfecting Wells and Springs

Purpose and Scope

NRCS staff is occasionally asked to provide technical water quality information about developing, operating, and maintaining water supplies in association with use of water well or spring development conservation practices. Given the recent interest in animal and human health security and the heightened awareness of the problem of bacterial contamination of water supplies, the question gets asked more commonly than one might think. This technical note is intended to provide guidance for NRCS staff to assist land managers and domestic water system operators using NRCS technical assistance. All newly constructed water wells in Montana must be sterilized by the well's driller or owner following completion (ARM 36.21.662). See http://www.dnrc.mt.gov/wrd/water_op/bwwc/default.asp. Springs and distribution pipelines are less commonly treated by the installer, but the practice should be considered more frequently, particularly where the presence of iron or sulphate-reducing bacteria is common.

Well or spring decontamination is typically prescribed when a water sample analysis indicates the presence of a group of bacteria called coliform bacteria. These bacteria are found in the intestinal tract of warm-blooded organisms (new research is also showing some cold-blooded organisms or ecotherms host coliform bacteria), including humans, as well as in soil. Presence of coliform bacteria indicates that contamination may be present. As such, the water is not considered safe for human consumption until further testing shows no presence of these indicator bacteria. Montana's water quality standard for bacteria in drinking water has been updated to a numeric E. coli bacteria count per unit volume of water (less than 1 per 100 ml). Contamination by E. coli is a much more direct indicator of the true human health hazard than either fecal coliform or total coliform bacteria, but most testing guidance still suggests starting with coliform. Public water supplies are required to routinely test for bacteria. Homeowners should be encouraged to test private wells for bacterial contamination at least once a year. Well owners can also be advised to use properly trained well service providers to accomplish the disinfection work if they are not willing or able to do it themselves.

If the testing is done as part of a regular well maintenance program, consider also sampling and testing for pH, total dissolved solids (TDS) or electrical conductivity/salinity (EC), and nitrate plus nitrite Nitrogen (NO^3 + NO^2 N). If the lab results indicate continued bacterial contamination and the problem persists, a continuous treatment system may be required. A professional well service provider should be consulted in this case.

It is important to note that the standard tests for coliform or other bacteria do not detect giardia, cryptosporidium and other micro-organisms. Specific tests should be conducted if these organisms are suspected as a source of illness.

Most public water supplies utilize a continuous drip or application of chlorine combined with other means to disinfect against bacteria and other contaminants when needed. With much smaller domestic water systems in place, private well owners typically use the more simple solution of shock chlorination.

Shock chlorination relies on using chlorine (most commonly standard household, unscented, laundry bleach). The required concentration is a minimum of 200 parts per million (ppm) chlorine. Other sources of chlorine that can be used are swimming pool disinfectant or concentrated bleach (12 to 17 percent chlorine) or calcium hypochlorite tablets or dry powder (65 to 75 percent chlorine).

Shock chlorination should be used:

- Following construction or repair,
- Following opening of any part of the system,
- After a flood or anytime water may have entered the system,
- Whenever water has a bad taste or smell,
- When a water test is positive for bacteria,
- When a lab test indicates high nitrate levels and human or animal waste is suspected, and
- At least once a year as part of annual maintenance.

Wells

The table below shows the amount of chlorine to use for disinfecting various well supplied systems. The initial step, in any case, should be to do a general review of the integrity of the system. If a well system doesn't meet current construction standards for wells (see NRCS Conservation Practice Standard, Water Well, Code 642), shock chlorination will only have very temporary benefits. Make repairs as needed before proceeding. The steps to follow are:

1. **Calculate.** Determine the size of the well casing and depth of water in the well (or spring system) and the relative amount of chlorine needed from Table 1. Add in the volume of water in pipelines if significant and calculate added chlorine needed (see Tables 2 and 3). Dilute at the rate of 12 parts water with 1 part chlorine before adding to the well.

2. **Preparation.** Assemble all the dosing materials and tools needed including a clean 5 gallon bucket to hold the removed well cover seal.

3. **Treatment.** Remove the wellhead seal and pour the proper amount of diluted chlorine into the well bore. Move the stream around when pouring so that it runs down the complete interior perimeter of the well. Also, dose the wires and internal pipes(s) taking care to avoid electrical shock if the wiring is substandard or otherwise exposed. Correct the hazardous conditions before proceeding.

4. **Attach hose**. Attach a clean hose to the nearest hydrant or faucet, open and circulate water back into the well, using the hose to wash down and disinfect the casing until the smell of chlorine is detected. Also, use the hose to wash down the well cover in the 5-gallon bucket. Keep the hose running into Step 5.

5. **Distribute solution.** Open one faucet at a time in the house or on the system (all faucets including outdoor faucets and hose bibs connected to the system) until you detect the smell of chlorine in the water at that tap. Close each tap once the smell of chlorine is detected. If you can't smell chlorine after running a faucet for a few minutes, add more chlorine to the well. Water treatment equipment such as softeners, reverse osmosis devices and most chemical or activated charcoal filters can be damaged by this level of chlorine concentration so they should

be disconnected or bypassed. Residual levels of chlorine should provide adequate treatment when initially returned to service.

6. **Solution contact.** Let the system sit without running for 12 to 24 hours to allow adequate time for the chlorine solution to do its work. Be sure to post signs on each faucet to alert potential users that the system has been treated, paying special attention to protect any children or the elderly in the household. Livestock may refuse to drink heavily chlorinated water so arrange for an alternate supply as needed.

7. **Flush system.** Flush all the lines and storage tanks by letting each tap run until the smell of chlorine is gone. If the system being tested has a septic wastewater treatment system, open outside faucets first to reduce the discharge to the septic system as you don't want to impair the bacteria in the septic tank and leach field. Take care not to mix the chlorine-loaded solution with ammonia or other cleaners as toxic gases can be produced.

8. **Test the water.** Wait one to two weeks and then test the water, checking first that no chlorine is present. Follow all lab instructions for sample collection and shipment. Tests for total and fecal coliform should be conducted within 24 hours following sample collection. See Environment Tech Note MT-1 for a list of approved labs in Montana.

Springs

Spring developments, by nature, are more susceptible to contamination from surface runoff since they generally tap shallow aquifers with relatively short resident times. Springs may also be susceptible at inadequately completed collection lines and spring boxes. Properly completed spring developments successfully divert surface flow and exclude use by people, wildlife and livestock away from the collection area and springbox. Following are the steps that should be followed when disinfecting new or contaminated spring-fed water systems with chlorine.

1. **Preparation.** Flush and drain the spring box (if present) and remove debris and sediment from the spring box and system. Scrub the interior of the spring box with a strong chlorine solution (1/2 cup of plain, unscented, liquid laundry bleach mixed in 5 gallons of water. Wear gloves, appropriate protective clothing and eyewear).

2. **Calculate and treat.** Allow the spring box to fill with fresh water. Add enough chlorine to achieve the 200 ppm concentration (see Tables 1-3). Keep the overflow outlet open.

3. **Disinfect.** Disinfect the water distribution system including pipelines, storage tanks, valves and faucets by pumping or flowing chlorinated water through the system until a strong chlorine odor is detected at each device.

4. **Solution contact**. Allow to sit for 12 hours. If the flow rate is too high to retain the chlorine solution for the required time, use a tank to feed the chlorine solution into the springbox continuously for at least 12 hours.

5. **Flush system.** Open valves and faucets to allow fresh spring water to flow until no chlorine taste or odor can be detected.

6. **Test the water.** Wait one or two weeks and test the system again. Continuous chlorination may be necessary if bacterial contamination continues after repeated shock chlorination attempts. Contact time for continuous chlorination is one to five minutes. A chlorine residual of 3 to 5 ppm should remain. Typical feed rates are about 1 cup of 5 percent common, unscented, liquid laundry bleach per 300 gallons of water. The rate depends on water temperature, pH and flow rate. An inexpensive chlorine residual kit (available from pool and hot tub suppliers) should be used to determine if the feed rate needs to be altered to obtain the proper chlorine residual.

Table 1. Amount of chlorine needed for shock chlorination for treatment of bacterial contamination (approximately 200 ppm chlorine concentration). Increase concentration for unusual conditions such as excessive sediment or algal growth, especially iron- or sulfate-reducing bacteria.

Using plain liquid laundry bleach (about 5.25 percent Hypochlorite)

Depth of water in well	Casing Diameter				
	4-inch	**6-inch**	**8-inch**	**10-inch**	**12-inch**
10 feet	½ cup	1 cup	1 ½ cups	1 pint	2 pints
25	1 cup	1 pint	2 pints	3 pints	4-½ pints
50	1 pint	1 quart	2 quarts	3 quarts	1 gallon
100	1 quart	2 quarts	1 gallon	1-½ gallons	2 gallons
150	3 pints	3 quarts	1-½ gallons	2 gallons	3 gallons

Using concentrated Hypochlorite (HTH 65 – 75 percent Hypochlorite dry wt.)

Depth of water in well	Casing Diameter				
	4-inch	**6-inch**	**8-inch**	**10-inch**	**12-inch**
10 feet	-	-	-	-	-
25	-	-	-	¼ pound	½ pound
50	-	-	⅓ pound	½ pound	¾ pound
100	-	⅓ pound	¾ pound	1 pound	1-½ pounds
150	¼ pound	½ pound	1 pound	1-½ pounds	4 pounds

Source: http://ohioline.osu.edu/aex-fact/0318.html

Table 2. Volume of water in small diameter pipes

Inside Pipe Diameter (inches)	Volume (Gallons of water per 100 linear feet)
0.75	2.29
1.0	4.08
1.25	6.38
1.50	9.18
2.0	16.3
3.0	36.7

Note: Above 3 inches use Table 1.

Table 3. Computing Disinfectant for Total Volume of Water in Pipelines (approx. 200 ppm chlorine concentration)

Total Volume of Water in Pipelines (gallons)	Amount of Product Needed to Disinfect	
	Liquid Chlorine (5.25 percent)	Dry Hypochlorite (65-75 percent)
25	1 pint	1 ounce
50	2 pints	2 ounces
100	4 pints	4 ounces
200	1 gallon	8 ounces
300	1-½ gallons	¾ pound
400	2 gallons	1 pound
500	2-½ gallons	1-¼ pound

Source: Adapted from Kansas State Water Quality, Shock Chlorination for Private Water Systems MF-911, revised. July 2005.

Unit Conversions: Liquid Measure

1 cup equals 8 ounces
1 pint equals 16 ounces
1 quart equals 32 ounces
1 gallon equal 128 ounces

Unit Conversions: Dry Measure

1 pound equals 16 ounces

Example

To calculate the volume of plain, liquid laundry bleach needed to decontaminate a well and distribution system with the following sizes: 8-inch diameter well; standing water column in well from 150 feet to 50 feet depth. 2,600 linear feet of 2-inch inside diameter pipeline.

From Table 1. 8-inch well casing with water depth = (150 feet) minus (50 feet) = 100 feet = 1 gallon bleach.

From Table 2. 2,600 linear feet of 2-inch inside diameter pipeline = 16.3 gallons per 100 linear feet x 26 = 424 gallons

From Table 3. 400 gallons = 2 gallons plus / 1 pint for 25 gallons.

Total volume of plain laundry bleach to use = 3 gallons and 1 pint. Dilute bleach in 24 gallons water (1:12 ratio) and add to the well casing or springbox as per the instructions above.

References

Administrative Rules of Montana, Board of Water Well Contractors, Title 36, Chapter 21, Subchaper 6 (36.21.662) Construction Standards. Online at: http://www.dnrc.mt.gov/wrd/water_op/bwwc/default.asp

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