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Water Stewardship Information Series

When Standard Water Well Chlorination Procedures are Ineffective

Fact Sheet developed for Well Drillers, Health Authority Staff and others involved in well recovery efforts after a flood

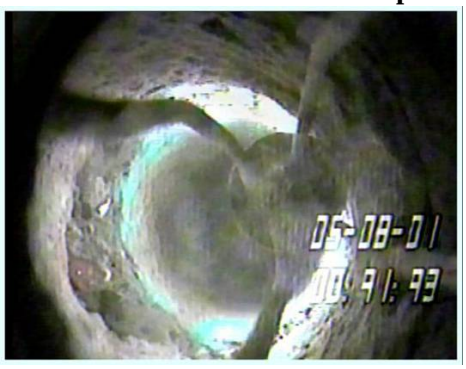
Experience has shown that standard chlorination procedures are not always effective in disinfecting water wells, and well owners can continue to experience unsatisfactory coliform test results following chlorination. There can be several reasons for this:

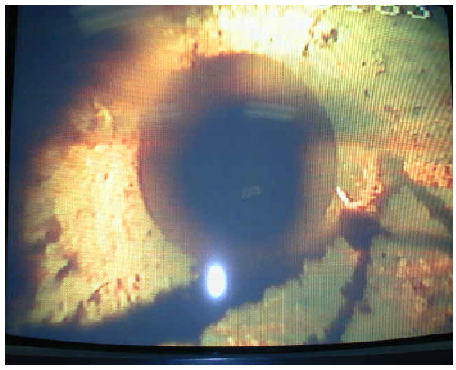
- The groundwater may still be contaminated with flood water or there may be a source of continuing contamination.
- The well was infrequently (or never) cleaned prior to the flood, and over time large quantities of mineral scale and biofilm have accumulated in the well. This material can greatly impair attempts to disinfect a well.

If a well owner finds that, following chlorination, they continue to get unsatisfactory coliform test results, they may need to bring in a registered water well driller or registered pump installer to carry out more aggressive cleaning and disinfection of their water well.

It is recommended that a registered water well contractor and/or a registered pump installer be used to carry out the work described in this fact sheet.

Biofilm and mineral deposits accumulate inside a water well over time





To disinfect a water well that has not received regular preventative treatments, it is recommended that the well be thoroughly cleaned using mechanical and chemical procedures and then disinfected using a pH adjusted chlorine solution.

Why use a pH adjusted chlorine solution when disinfecting a water well?

Adding a pH adjusted chlorine solution to the well is recommended to increase the biocidal effectiveness of the disinfectant. Liquid chlorine or granular chlorine is extremely alkaline, resulting in an increase in pH when mixed with water. As more chlorine is added, the pH rises and the chlorine becomes more oxidative in nature. In a high oxidative state, chlorine can corrode metals, produce chlorine gas, and is slow to kill bacteria. ***For optimum disinfection it is important to keep the concentration of chlorine below 200 ppm and maintain a fairly neutral pH.***

Factors to be incorporated when disinfecting a well that has not received ongoing preventative treatments:

- **Build-up of mineral and biological deposits:** Any mineral or biological accumulation must be removed by cleaning the interior of the well with a wire brush and/or mechanical agitation with a surge block or jetting tool; the loosened deposits can be removed by air-lift pumping. If water analysis and losses in well production indicate potential mineral buildup or biological fouling then the well may need to be cleaned initially with an acid and dispersant.

- **Distribution of Chlorine Solution into the Surrounding Aquifer:** A pH adjusted chlorine solution of up to four to five times the volume of water in the well is used to penetrate into the surrounding aquifer; a surge block or jetting tool can be used for improved distribution into the surrounding aquifer material.

- **Redevelopment and Pumping after Chlorination:** After the chlorine treatment, aggressive redevelopment with a surge block or jetting tool is conducted along with air-lift pumping to remove the chlorine solution and any loosened debris.

References:

Water Wells that last for Generations. Alberta Agriculture, Food and Rural Development; Alberta Environment; Prairie Farm Rehabilitation Administration of Agriculture and Agri-Food Canada

Water Well Management Level 2 Training Module. Prairie Farm Rehabilitation Administration of Agriculture and Agri-Food Canada, Alberta Environment, Alberta Water Well Drilling Association and Alberta Agriculture, Food and Rural Development

Chemical Cleaning, Disinfection and Decontamination of Water Wells. John Schnieders. Published by Johnson Screens Inc. St. Paul, MN

Procedures for disinfecting a small diameter (4 to 8 inch) drilled well using a pH adjusted chlorine solution

If this procedure is being used to disinfect a well containing coliform bacteria it is recommended that a water sample be taken a few days following chlorination and another at least one week after constant use to verify that the water is free of coliforms. Until water testing indicates that the water is safe for use, find another source of water, or boil the water for one minute, at a rolling boil, before consuming.

Preparations for Well Cleaning and Disinfection

Before you start the well disinfection procedure it is recommended you do the following:

1. Remove any sources of contamination near the well and repair any cracks or broken seals.
2. Check the condition of the pump and plumbing system including leaking pipes, pressure tank and the possibility of cross connections and repair any problems that could lead to contamination.
3. Store sufficient water for family and livestock needs for at least 24 hours or utilize another water source temporarily. Drain as much water from the water system as possible including the pressure and hot water tanks so that chlorinated water can be circulated through the entire water system.
4. **Do not** chlorinate activated carbon filters since these filters will remove the chlorine until they become overloaded. Activated carbon filters should be bypassed until chlorine has been flushed from the system. Consult your water treatment equipment supplier to ensure the appropriate steps are taken to protect the equipment during chlorination.
5. Follow the safety practices for handling chlorine and acid cleaners. **Remember that chlorine is very volatile so it is dangerous to work with in confined areas.** Prepare the chlorine solution outside in a well ventilated area and wear appropriate safety clothing and equipment.
6. Caution: even before treatment, dangerous vapors can accumulate in confined spaces such as well houses, pits and crawl spaces.

Materials required:

- Clean tank with a holding capacity of 500 gallons (2300 liters)
- Tremie line with sufficient length to reach the well screen
- Injection pump with hoses and fittings that can be connected to the tremie line (i.e. pipe) placed down the well.
- Appropriate volume of chlorine or bleach
- Appropriate volume of acid (vinegar-5% acetic acid-can be used on small wells)

Table 1: Amount of Chlorine Required to Obtain a Chlorine Concentration of 200 PPM
(Reference - this table has been modified from the *Canada-Alberta Water Wells that Last for Generations* publication)

Casing Diameter		Volume of Water Needed (the following calculations represent 2X the volume of water in the well casing)		5.25% Domestic Chlorine Bleach	12% Industrial Sodium Hypochlorite
		Water needed per 1 ft. (30 cm) of water in the casing		L needed per 1 ft. (30 cm) of water	L needed per 1 ft. (30 cm) of water
(in)	(mm)	(gal.)	(L)	(L)	(L)
4	(100)	1.1	5.0	.019 (19 ml)	.008 (8 ml)
6	(150)	2.4	10.9	.042 (42 ml)	.018 (18 ml)
8	(200)	4.2	19.1	.072 (72 ml)	.032 (32 ml)

Step 1 Determine the feet of water in the well using a drillers report, or water level measurement device (i.e. sounder). Measure the well depth and measure the static or resting water level from the top of the well casing. Calculate the feet of water in the well by using the following formula.

Feet of Water in the Well = Total well depth – Static water level

Using table 1 determine the amount of clean water required for the chlorine solution and pump the water into the mixing tank. The table is based on using 2 times the volume of water in the casing to treat the well. Two batches of chlorine solution (4 times the volume of water in the well casing) are recommended to penetrate into the surrounding aquifer

Step 2 Lower the pH of the water in the mixing tank to a pH of 4.5 before adding the chlorine; a weak acid like vinegar (i.e. 5% acetic acid) can be used for small well applications since it is readily available and fairly safe to use (20 L of 5% acetic acid may be required for every 1000 L of water added to the well). To lower the pH in the mixing tank, slowly add the acid to the water while checking the pH level with pH test strips. Agitate the water to ensure uniform distribution of the acid. *(Note: if the source water contains hydrogen sulfide (H_2S) allow the water to aerate so the H_2S dissipates, otherwise the acid will cause an immediate release of H_2S gas from the water, which poses a serious health risk).*

Step 3 Using Table 1, calculate the amount of chlorine required for treating the well.
Example: 10 feet of water in a 6 inch diameter well would require 109 L of water and 420 ml of 5.25% chlorine.
Add the chlorine to the mixing tank; sodium hypochlorite is generally recommended (i.e. common household bleach) ***Always prepare the chlorine solution outside in a well-ventilated area and stand up-wind when adding the chlorine to the acid solution** *(at a pH of 4.5 some chlorine gas will form; however, the addition of the chlorine will start to raise the pH to a safer level).*

Step 4 Measure the pH of the chlorine solution. The final pH of the chlorine solution should be between 6 and 7 for the best biocidal effect.

Step 5 Remove the well cap and introduce the chlorine solution into the well using a tremie line to carefully place the chlorine solution throughout the entire length of the well intake area - from the bottom to the top.

Step 6 Circulate the chlorine solution through the lines and then recirculate into the top of well for better mixing and contact.

Step 7 To disinfect the distribution system open household taps and run water to ensure a chlorine smell is present, then close taps. Activated carbon filters should be bypassed until the chlorine has been flushed from the system. Be careful not to over pump the well. For low yielding wells slowly run the water from the taps (i.e. a well that yields only 1 gal per minute should only be pumped at 1 gal per minute)

Step 8 Ensure contact time of 6 to 12 hours or longer, if possible.

Step 9 After the contact period, flush the system and pump the chlorine solution to waste. Flushing should continue for at least an hour after the chlorine smell is no longer detected. Make sure to direct the water away from sensitive plants and grass. Do not run this solution into the septic system, storm drains or any stream or ditch that connects to a fish bearing water body. *Caution: If your well is low yielding or tends to pump any silt or sand, you must be very careful using the following procedure because overpumping may damage the well. For low yielding wells slowly flush the well.*

Note: Turbidity in the water can result from the disinfection process, due to the flushing action and the effect of the chlorine on iron that may be present in the water. Usually extended continuous pumping will clear the water of turbidity, unless the turbidity is the result of a defect with the well casing or screen.

Step 10 Place the well and treatment system back into operation.

Step 11 After the well has been in operation for several days collect a sample from the well for bacteriological analysis. To determine if the well has been adequately disinfected it is important to collect a sample from a hydrant or outside tap before the sample has gone through the household treatment system. However, pipes can also become contaminated therefore it is also important to collect a sample from the kitchen tap and have it tested to ensure that it is safe to drink.

There is no guarantee that, even if you follow these procedures you will not continue to have problems with your well water quality. **ALWAYS sample and test your well water before using it for domestic water supply.** You may want to boil your drinking water until you are sure it is safe for consumption. Contact the local Health Authority if you continue to have water quality problems after disinfecting your well.

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