

# Knowing the Problem Down Below

*Knowledge will help you devise methods for proper disinfection*

*John H. Schnieders, PhD  
Water Systems Engineering\**

*Water Well Journal is always looking for ways to make you a better professional. That's why we are excited to bring you a new column, "Well Science" by former McEllhiney Lecturer John Schnieders, Ph.D., CPC. The column will focus on the chemistry and biology found in wells. A better understanding of these important aspects will lead to better well operation. Schnieders, a principal chemist for Water Systems Engineering, Inc., will use his more than 40 years of experience studying water systems to offer insight that will certainly benefit you.*

Welcome to a new byline in *Water Well Journal*. My column will deal with the sciences of water well operation (particularly those of chemistry and biology) because that is what I do.

I will try to investigate for you the reasons why certain practices have and have not worked or what will be successful in the overall operation of water wells. In my short period of time in water wells (about 20 years), I have learned the strength of field application. So even though I will be relating a lot of "facts" from

the laboratory, I hope to prove all of them by relating some field applications, too.

I will depend on my own experiences and the experiences of those of you who choose to write, e-mail, or call with tales from the field. The breadth of experience of us all boiled down into a common denominator is usually the best answer.

This column starts a short series on the subject of good well disinfection. I know a lot has been written on it, but let's look at the problem closer. By some logic and knowledge of what is happening downhole, we can learn to devise, adapt, or change our own methods to do a better job at properly disinfecting the well.

Although I have been working on well disinfection for the last eight years (my first article on the subject appeared in a 1997 *Water Well Journal*), the true essence of the problem came to me only recently when NGWA executive director Kevin McCray sent an e-mail request for a method to be used for well disinfection in the tsunami-stricken area in Asia.

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His exact words were:

NGWA proposes developing simple, step-by-step guides on well disinfection. There at least are two problems with this: One is drafting something simple enough that someone with little or no knowledge about wells (and sparse resources) could use it, and, two developing guides that take into account different types of wells, which may require different disinfection techniques (i.e., dug, driven, drilled). When I say guides, I am talking about one-pagers in the most simple language practicable. Also, there may be additional issues with the nature of the flooding, since it was salt water.

Now you might not think this is enlightening, but you have to admit it challenges you to do “something that we have all struggled with” when you have little or nothing in the way of equipment and resources. Let’s take this time to review the thinking of what went into the “method or procedure” that was sent. This may clarify some of our own techniques that we use every day and what may be the missing key to some of our disinfection problems.

Some key points of well disinfection are:

**Clean or clear the well.** The stricken wells have been flooded with ocean water and all the accompanying debris and sediment.

**Proper placement of the disinfectant.** In an emergency zone it’s easy to just pour hypochlorite into the well and expect it to disperse throughout the well environment.

**Provide some mechanical activity.** In an emergency zone we may not have a rig to apply a swab or surge block.

**Contact time and pump-out.** A contact time of six hours or more is necessary to provide an adequate kill rate against the bacteria present.

## Clean or Clear the Well

In a Third World environment, many of the wells have been in use for 10 to 100 years without any cleaning or proper maintenance. At the very least, they are incrustated with biological growth and the accompanying slime (the greatest impediment to good disinfection). The flooding debris has only added to it. Here in the United States, we would pull the pump and evacuate out all the debris. But in the Third World

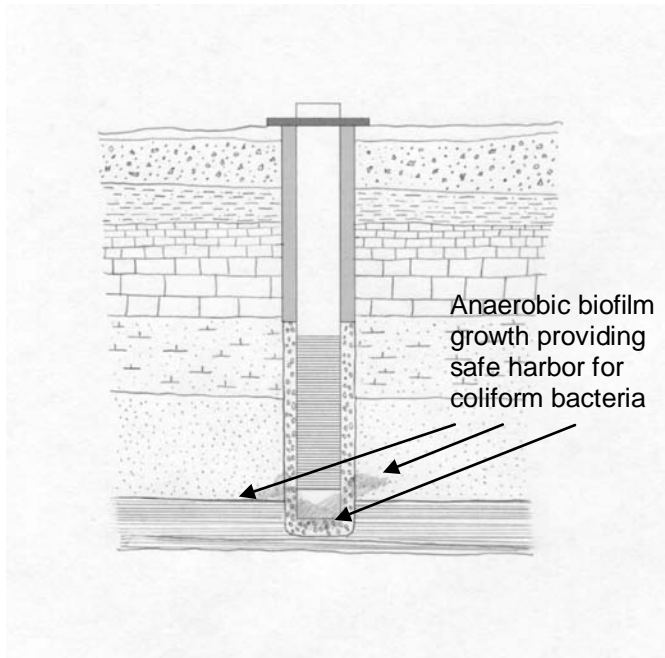
emergency, we have to rely on pump-out only, hoping the influx of salt water has loosened the biological growth and that extended pumping will remove much of the biology as well as the sediment. The old adage that you can’t disinfect a “dirty” surface will always be true.

## Proper Placement of the Disinfectant

While removing the blockage is necessary to be able to disinfect, getting the chlorine to the proper location is also important. What is the proper location, and why is it so necessary? First, look at how a well becomes contaminated, particularly with bacteria but also with minerals and other solid contaminants. Ideally, water enters the well in the mid to lower half. The pump is also usually placed in this location. Picture water entering the well and being pumped off to distribution. The area in the lowest section becomes stagnant; that is to say, there is less water movement in this area, and gravity pulls sediments and other entities downward. Thus, the lower section becomes a collecting zone. Here, food accumulates in the form of organic debris and the lack of oxygen promotes anaerobic bacterial growth. Most of the would-be contaminating bacteria, the coliforms, and the pathogens are at home in this environment. The presence of a heavy organic slimy material is not only resistant to oxidation by chlorine solutions but physically blocks penetration of the disinfectant. Chlorine solutions placed at the static water level usually never reach the area in sufficient concentration to disinfect the area. Any attempt at disinfection must incorporate placement of the chlorine solution at or as near the well bottom as possible.

## Provide Some Mechanical Activity

The diagram shows a congested well bottom that is very protective of a “contaminant” lurking there. The walls and the well intake areas may also have a deposit of bacterial slime and minerals such as iron oxides and carbonates or sulfates, all of which are potential hiding areas for coliforms or other contaminating bacteria. To be able to disinfect these surfaces, we need to get under or through the depositing material. Of course, here in the United States we can pull the pump and swab or use a wire brush to clean up the surfaces of the well before disinfection. In the emergency situation, we are limited and will have to depend on the excess pumping to remove the sea water as our mechanical action on the many surfaces. We will also depend on the extended pumping for removal of some of the bottom debris.



### Contact Time and Pump-Out

We wouldn't need to worry if contact time was just the time it took for the chlorine ion to kill the bacterium. Unfortunately, it must also incorporate getting the chlorine to the area to be disinfected and getting it through the blockage to the bacterium. We complete some experiments this past year to determine how fast a typical dosage of sodium hypochlorite will disperse throughout the well environment. Not counting for penetration of any slime layers or sediments, it took approximately three hours to travel from the static water level to the well bottom. This varied a little depending on the ratio of well diameter to water depth, but was amazingly consistent and sufficiently close to use as a standard. It then took almost three more hours to saturate the gravel pack or to penetrate out into the formation of open bore wells. Allowing for differences in chemical concentrations (our work was performed at 200 mg/L in what would have equated to a 50-gallon mix) and the geology of certain open borehole wells, the six-hour requirement appears absolutely necessary for proper chlorination. This does not take into consideration penetration of slime and sediment and probably explains why those of us who use overnight chlorination are more successful.

Pump-out is also a part of the chlorination process. Sure, you have to remove the high level of chlorine before the well can be put back into service, but the pumping out of the well can be used to remove the high level of chlorine before the well can be put back into service, but the pumping out of the well can be

used to remove some of the oxidized and loosened debris and some of the large "chunks" of bacterial biofilm. Some mechanical activity, even as simple as bumping the pump several times after the contact period and before regular pumping begins, will help remove debris.

If you have weathered this article, I'm sure you're curious as to what we sent to those aiding in tsunami-stricken area. You can view the guide at [www.ngwa.org/pdf/welldisinfection.pdf](http://www.ngwa.org/pdf/welldisinfection.pdf).

But I also hope you take the time to review your own disinfection process. Are you addressing all the facts? Is the well clean? You can't disinfect a dirty well! What about dosage? Are you using too much chlorine? Studies show that levels above 500 mg/L are detrimental to good disinfection. A high level can cause oxidation and solidifying of the slime layer, and prevents penetration so that the chlorine never reaches the bacteria.

In the recommendation for emergency disinfection, we relied on excess pumping for cleaning and bumping the pump for mechanical agitation to enhance the chlorine activity. These are poor excuses for genuine cleaning of the well. Some good old fashioned swabbing and surging during the chlorine application helps to provide more adequate disinfection.

And last but not least, don't forget the contact time. If we need six hours to disperse throughout the well environment, how much time should we give to penetrating the slime and deposit layer especially in the formation or gravel pack areas where we can't swab? Overnight may be the best, no matter what size well we are chlorinating.

In future columns, I will cover the best treatment levels, some good application techniques, and why cleaning is so important for maintenance and disinfection of water wells.

In the meantime, please send in any questions or comments. *WWJ*

### Water Systems Engineering, Inc.

3201 Labette Terrace  
 Ottawa, KS 66067  
 Phone 785.242.6166 · Fax 785.242.9411  
[Http://www.h2osystems.com](http://www.h2osystems.com)