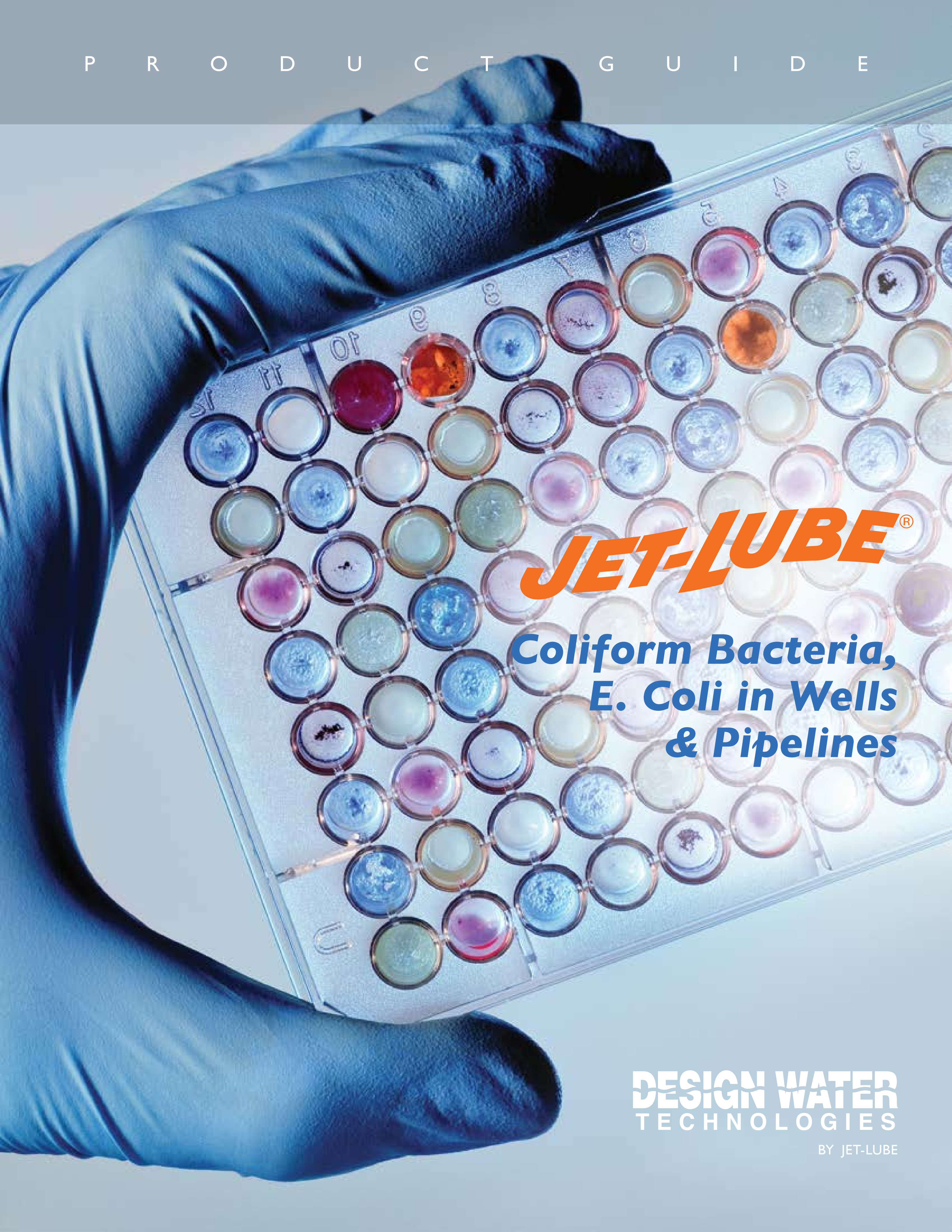
PRODUCT GUIDE

# JET-LUBE®

# Coliform Bacteria, E. Coli in Wells & Pipelines



DESIGN WATER TECHNOLOGIES

BY JET-LUBE

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# Coliform Bacteria, E. Coli in Wells & Pipelines

- 200 times more effective than standard chlorine
- Price competitive with standard chlorine
- NSF 60 Certified
- 55% available chlorine
- Granular but easy to mix, even in cold water
- No premixing to control pH
- No oxidizer label, no shipping or storage issues
- No corrosive fumes

Certified to NSF/ANSI 60

## Table of Contents

## A Quick Note

*PRODUCT USAGE*
Use STERILENE™ as you would regular chlorine, but do not pour the granules directly into a well. Mix 2 capfuls into 4-5 gal of water, then pour into the well. Recirculate with the pump, if desired. If a failure occurs, the chlorine may not have physically reached the location of bacteria toward the bottom of the well. Follow directions on the label for 2 volumes of the well.

*IRON BACTERIA*
In wells greater than 4 months old, any chlorine will not penetrate a bio-mass created by slime forming bacteria or iron bacteria. The problem will most likely return. Use UNICID™ for long term results. In new wells (less than 3-4 months old), STERILENE™ may be very effective because the bio-mass has not yet fully solidified.

*"ROTTEN EGG" OR HYDROGEN SULFIDE (H2S) ODORS IN WELLS*
In new wells, this odor is created by Sulfate Reducing Bacteria that are naturally occurring in the aquifer (shale and clay lenses). Any chlorination will only provide short term results (hours to days). In older wells where this odor suddenly appears, these same bacteria may be harboring within slime debris and again, results of shock chlorination will be short term.
Look inside of piping in the system for debris and if found, use UNICID™ chemistry, for long term results.

## Introduction to Disinfection

Chlorine has been used in the Groundwater Industry for years without really understanding the true effectiveness, or the physical process of successful chlorination in wells or pipelines. In the U.S., the industry averages a 70% successful chlorination in new wells without understanding why or even if there was a bacteria problem in the fi rst place. When failures occur, more chlorine is generally used, thinking more is better. When multiple failures occur, even more chlorine is used, often unsuccessful. When all else fails, constant chlorine injection, ultra violet light systems, or in some cases, the well is abandoned without really understanding the problem.

There are many factors involved in successful chlorination of wells and pipelines:

- pH of the natural water effects the biocidal properties of standard chlorine
- Standard chlorine (an alkaline base) will drastically change pH, reducing effectiveness
- Placement of chlorine during chlorination to include the entire well column of water
- Movement of chlorine to increase contact potential
- Physical problems in new wells including grout failures, casing that is not seated properly into rock, or vertical fracture in hard rock formations, all allowing a continued source of bacteria into the well
- Physical problems in older wells, i.e., corrosion to steel casing allowing a continuous bacterial source
- Mineral or slime deposits in older wells that can harbor coliform bacteria
- Improper sampling or handling of samples, even in laboratories
- Lack of identification of bacteria that can cause false positives, but are a real health threat
- Proper development of new wells prior to chlorination to increase well efficiency and remove debris (bentonite or drill cuttings) that can actually hide coliform in the formation

*PRODUCT USAGE*
Coliform bacteria is the most common health concern in Groundwater. There are more dangerous but less frequent problems with fecal coliform, E. coli, Opportunistic Pathogens (OP), and even viruses. These require more specific identification done by a microbiologist. All issues may have to be fully understood to be successful.

*HETEROTROPHIC BACTERIA*
Heterotrophic bacteria are sometimes referred to as background, congruent, or nuisance bacteria. These are common soil organisms that are naturally occurring in the environment (soil and water). They are present in every well and are often the bacteria that present physical problems with slime formation and some odors. We can not expect Groundwater to be sterile and we should not, as these bacteria are generally benefi cial to humans. Laboratories can identify and count these organisms. The counts are called Heterotrophic Plate Counts (HPC) or Standard Plate Count. They are counted in colonies per milliliter (colonies/ml) and identified as any number of families with a variety of physical characteristics. A few of the more common families are Pseudomonas, Acinetobacter, Bacillus, and Flavobacter.
Normal aquifers will have counts in the single digit to medium double digit numbers (1-60 colonies/ml). It may be critical to understand the severity of any problem, what other factors may exist in the well, and if the problem is in fact, contained in the well to effectively provide solutions. When HPC numbers rise above 200 colonies/ml, you can expect some biological debris (slime) that may impede chlorination. This slime formation can happen within weeks of drilling a new well and can occur if the well is either stagnant or active with pumping. Elevated numbers can also indicate surface or shallow Groundwater which may indicate a continuing source of bacteria. If found in deeper aquifers, may indicate a vertical conduit (casing problems or failed grout) for a continuing source problem that may be impossible to successfully chlorinate.

*COLIFORM*
This is the most frequent health concern in groundwater, however coliform can be found naturally throughout the environment. In small numbers, they are not harmful nor do they present a health risk to humans. They have been traditionally used as "indicator bacteria" as other, more harmful bacteria may be present. In the past, testing for E. coli (fecal coliform) was expensive but coliform testing was easy, cheap, and readily available. Years ago most states allowed low numbers of coliform bacteria (< 5 colonies per 100 ml) to be present and considered safe samples as long as there was no E. coli present. Today the requirement for coliform is zero. There are simple test kits available that are very accurate and convenient. These tests show only "Present" or "Absent" for coliform. That is acceptable if the results are "Absent," but does not allow any understanding of severity if the results show "Present." Most laboratories can count coliform to understand severity. This will be very beneficial in understanding the location and severity of a problem. If counts remain high in "Timed Tests," suspect an outside contamination source. See "Timed Tests" on page 8 for more information.

*E. COLI, FECAL COLIFORM*
E. coli is NOT often found in water wells unless there is a source of contamination. These bacteria require a warm bodied source to survive. Presence in a well may indicate a contamination of the well due to inadequate surface protection, contamination during maintenance, inadequate grout or seal around a well casing, a broken well casing or pipeline, or a local source of contamination (sewer). DO NOT automatically chlorinate a well or piping system without understanding the source. If you do not understand the source and remove it, chlorination will likely fail. Physically inspect the surface area around the well head for potential sources of contamination. If nothing is evident, air lift the well from the very bottom to remove a potential source, and then chlorinate. A well video is often helpful. Wire brush older wells and airlift debris (mineral or biological) out of a well prior to a video. If problems remain, use "Timed Tests" to understand a continued presence. (Page 8).

*OPPORTUNISTIC PATHOGENS (OP)*
There are several families of bacteria that can be found in shallow ground water or contamination sources that are considered Opportunistic Pathogens. These bacteria can cause health issues in people with reduced immune deficiencies, i.e., the elderly, or infants. Some of the symptoms may include diarrhea, vomiting, etc. When found in potable wells, suspect a surface contamination or temporary flooded conditions. Most of these will cause a "Present" on coliform test kits but can actually can pose a real health threat. We recommend doing "Timed Tests" (Page 8) and actual ID to determine whether the presence of these organisms is contained within the borehole of the well or present in the aquifer as a continuing outside source. The more common families are Pseudomonas aeruginosa, Aeormonas hydrophila, and any of the Citrobacter or Enterobacter species.

# Physical Issues

*FLOODED WELLS*
Large amounts of bacteria and physical debris (silts, organic, etc.) may flow into an aquifer during flood conditions. The volume of flow will vary with Permeability of the aquifer and Static Water Level. The greater the Permeability, the greater the flow volume. The lower the static level, the greater the head pressure increasing that volume. **DO NOT immediately chlorinate the well.** Pump the well to waste 10 to 20 times the amount of time the well was flooded. Example: A well was under water for 6 hours. 6 hours multiplied by 10 equals 60 hours of continuous pumping. Test for coliform counts (not Present/Absent) and E. coli. If the counts for coliform are greater than 100 colonies/100 ml or if E. coli is present, pump an additional 5 to 10 times and retest. When coliform counts get below 20, chlorinate with 200 ppm STERILENE™ and use 3-4 times the well volume. Let set overnight. Pump a well 30 minutes past a chlorine odor or residual. Sample. Expect multiple failures for coliform and a periodic presence of E. coli. Coliform counts should decrease with time of pumping. Continue this process until success but monitor coliform counts to understand a direction.

*NEW WELLS*
Drilling a new well may cause plugging in an aquifer. Direct rotary, reverse rotary, and air rotary methods of drilling can deposit debris which blocks the flow of water and requires development to remove this blockage. Drilling damage in the direct rotary method can include bentonite which is used to control the loss of fl uid in an unconsolidated aquifer (sand, gravel, and some sandstone) so the formation stands open during drilling. In some cases, this bentonite is not fully removed during development and can hide coliform bacteria.

A continuing source (coliform counts, E. coli, OPs, etc.) can be caused by failed or lack of grout (neat cement or bentonite grout) in the annulus area between the original bore hole and the well casing. Casing that has not been properly seated into hard rock can allow potential contamination on the outside of the casing into the aquifer. See "Timed Testing" on page 8 of this brochure for further information on testing.

*OLD WELLS*
Well casing, screens, and even open rock formations (fractured rock, limestone, sandstone, etc.) can have a buildup of mineral deposits or slime over time. Coliform can hide within this debris. When a pump is pulled it can scrape this debris exposing coliform resulting in a test that is "Present" for coliform. Standard chlorine oxidizes this debris but will not remove it which results in a continued coliform problem. Look inside water pipes as close to the well as possible for a physical presence of any debris. In municipal systems, check inside the water meter or check valve. In domestic systems, check filters in line or open the "Union Joint" generally by the pressure tank. Make sure the tank is drained and the pump is shut off. If there is debris present in the piping system, the well and piping system will require cleaning to fully remove. Do not check the toilet tank for debris because it is an oxygen rich environment and a great place for aerobic, slime forming bacteria to grow. If you have continued failures, review "Timed Tests" (Page 8).

*CHLORINE PLACEMENT*
Chlorine is often just dumped into the well from the surface. This causes severe corrosion of metal parts using regular chlorine. You can create a recirculation of chlorinated water from the pump to the surface and return to the well. This practice assumes, 1. the location of any bacterial issues are between the static level and the pump. 2. that chlorine mixes evenly throughout the water column in the well and sinks to the bottom. When using standard chlorine, tremendous issues such as off gassing, corrosion, extremely high pH will occur at the static level that make successful chlorination improbable. UNICID™ GRANULAR or liquid chlorine will only reach 30-40' below static level before becoming totally dissipated. Pellets may reach the bottom of the well, but will never go into solution as there is little water movement. Chlorine will never automatically seek out bacteria that may be outside the screen or in the borehole. In order for chlorine to be effective, it must come in contact with the bacteria. For a more effective direction, see "Placement of Product," (Page 13).

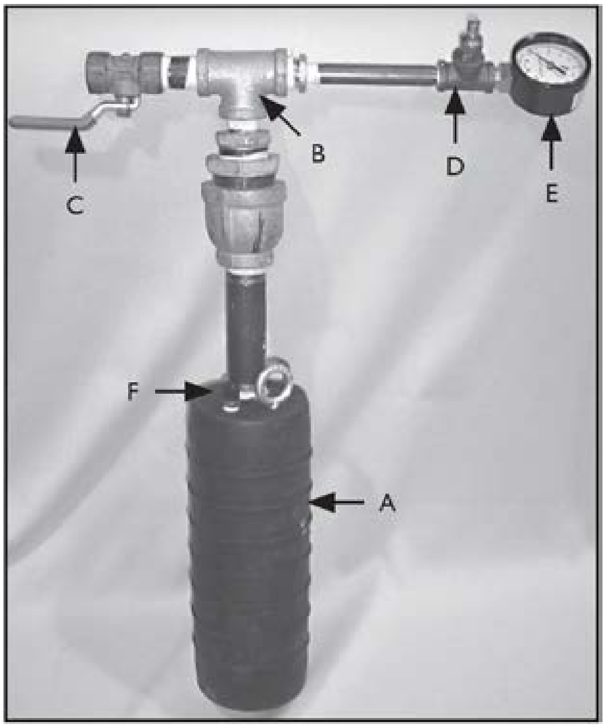


Figure 3

Any movement during treatment is designed to push chemistry into the aquifer to increase contact potential. Contractors can create movement, 1. with a surge block (plunger-like device) operating vertically in the casing, screen, or open borehole. This type of movement creates a two directional flow into and out of formation. 2. with an airlift method using an airline in the well which when pressurized, will lift chemistry in the well and the release of air allows chemistry to fall. Do not allow chemistry to overfl ow the surface. Install a quick release gate valve on the airline to release pressure more quickly.
3. This same two directional surging effect can be obtained by a surface packer that you can make. It is simply a "Muni-Ball Plug®" (a) with a "pipe Tee" (b), a gate valve (c) an air pressure valve (d) and pressure gauge (e). Set the packer (a) inside the well casing at the top of the well and pressurize, with the air valve (f) to seal against the well casing. Close the gate valve (c) and pressurize the unit (d) to 12-15 psi ONLY. This will push chemistry out into the formation which may gain greater success in treatment. This can often be done in many domestic wells with a submersible pump in place. Figure 3. The "Muni-Ball Plug®" is a registered Trademark of Cherne Industries of Edina, MN. 4. Pumping chemistry from the well into the piping system will even create some movement using our recommendations for two well volumes. 5. Pumping chemistry from the well into the system and then back down the well may be beneficial, especially if the recommendations for two well volumes of chemistry is followed. 6. In larger diameter wells with a turbine pump, remove the non-reverse ratchet, pump the well until there is a discharge at the surface and stop the pump to allow fl ow back into the well. This is a common practice called, "Rawhiding."

## Sampling for Coliform Bacteria

Some tips for taking samples: Get a locally approved sample bottle from the health department, a local approved laboratory, or a professional well/pump contractor. Take a sample at a major point of usage which assures safety to that point. That may be a faucet at a high usage area. Remove the aerator from any faucet. Clean off the end of the faucet with alcohol or dip the end of the faucet to help sanitize it. Dipping a faucet in straight chlorine can cause corrosion if done multiple times. Open the faucet with a significant flow of water and fl ush for at least 30 minutes prior to taking a sample. Slow the flow so it is not turbulent. Open the lid on the sample bottle and hold in one hand downward, while filling the sample bottle with the other. Do not touch the inside of the lid or sample bottle. Do not breathe on the cover or the open bottle. Fill the bottle and carefully replace the lid. Mark the bottle and get it to the laboratory within 24 hours. Most laboratories will test with a simple "Present/Absent" test kit. If the results are "Absent," there is nothing else to be done. If the results are "Present," there is coliform at the point of sampling, but no indication of severity. The problem may not always be in the well, but in buried piping from the well or piping within the building. You may want to test closer to the well or at the well head to better understand the source of the problem. If multiple failures occur, consider coliform counts or "Timed" tests discussed on (Pages 8-9).

## Coliform Problems

*NEW WELL-NEW PIPING*

While sampling from a point some distance from the well, you have to assume that any bacterial problem is from that point backwards to, and possibly including the well. The assumption is often made that the problem is in the well but the system is forgotten. Many states now require a sample tap on piping just inside a building. If the sample passes there, the problem is in the internal piping system. If the sample fails, install a pressure gauge on the well side of the pressure tank, if there is a check valve on the pump. Turn on the pump and allow the system to build to shut off pressure (say 50 psi). Do not use any water from the pressure tank. Monitor the pressure gauge for any loss of pressure. If there is a pressure loss within seconds, there is either a leak in the buried line, or the check valve at the pump. Lift the drop pipe of a submersible pump to surface and check the water level inside the pipe. If the water level is stable there, any leak that occurred is due to a failure in the buried piping. Take a sample to make sure the well is not the problem. Replace the buried piping.

*NEW WELL-OLD PIPING*

If there are repeated tests with "Present" for coliform in the system, test at the well head. If the test is "Absent" for coliform, there may be debris present in the piping system that may have to be more fully cleaned. Inspect the piping in the system for any debris. Chlorination, even shock chlorination will not remove debris (mineral or bacterial).

## Multiple Failures with Samples That Show "Present" for Coliform

If you have multiple failures that show "Present" for coliform, more information may be needed to make better decisions about a treatment direction or if the problem is due to physical issues in the well (lack of grout in the annulus outside the well casing or source contamination in the aquifer). Check with a local laboratory to see if they can do the following lab tests. If a local laboratory cannot do these tests, see "Lab Services" on our web site.

A. **MPN** (Most Probable Number) of coliform. This gives a count of coliform per 100 milliliters of water and provides some idea of the severity. If the count is in the single digits per 100 ml, the problem may be fairly minor. If the count is greater than 15 colonies/100 ml, the problem may be more serious. Test for the presence/absence for E. coli, as well.

B. **"Heterotrophic Plate Count"** (HPC) or Standard Plate Count." Bacteria can be grown on a nutrient plate in an incubator, identifi ed, and counted in colonies per milliliter. Most of these bacteria are naturally occurring organisms and in most cases, are not a health concern. Normal aquifers will have HPC counts ranging from 1 to 60 colonies/ml of water. When the count rises over 200-250 colonies/ml, there is a potential for continuing contamination from shal low/surface water or slime formation in the well which can hide and in fact, protect coliform bacteria.
Premature slim formation can happen within a couple of weeks of drilling a well. It does not matter if the well has been pumped or not. Chlorine can not cure a continuing source of bacteria ("Timed Tests" on page 8) and will not penetrate slime deposits.

C. **Identity of bacteria** on the Plate (HPC). There are many bacteria that may indicate "Present" for coliform on test kits that can include Opportunistic Pathogens. Page 4. In some cases, the identity of these bacteria may assist in understanding the reasoning for the "Positive" test or the source of bacteria if they have tendencies to be surface water related.

# “Timed Tests” in Wells

If coliform or E. coli problems continue, consider taking two samples at different times of pumping. Test for MPN, HPC, and Identity as described on page 5. The idea is to determine if bacterial issues are contained in the well only, or coming from a continuing source (faulty grout, faulty well casing, improperly seated casing in hard rock formations, or the aquifer itself). Let the well set for at least 8 hours with no pumping. When the pump is started, the upward water velocity will scour newly attached biological debris from inside the well casing which may lead to high HPC or coliform counts. Once the water has run for a significant time (30-50 volumes of the well), this loosely bound debris will be stripped from the casing and the sample will be more consistent with the natural aquifer. If there are continuing issues in the aquifer with high numbers of coliform, E. coli, OP, assume there are physical problems in the well. Page 9. Timed tests can help determine the location of problems and the likelihood of success for any treatment. If comparative levels are high in “Casing” and low in the “Aquifer” sample, the problem is treatable. If levels are similar and both elevated, the problem may be the aquifer or a physical problem in the well allowing a continuing source. Use this type of test to understand other well problems such as arsenic and nitrate levels.

*CALCULATION OF SAMPLE TIMES*

“Casing” Sample

Let the well set for at least 8 hours with no pumping. This time will allow the attachment and growth of any slime forming or iron bacteria. The idea is to capture a sample just out of the pump but still within the casing portion of the well. **Domestic wells:** Test on the well side of the pressure tank. Calculate the volume of water in piping from the sample point to the well and in the drop pipe of the pump. Divide this volume by GPM rate. Add 15-20 seconds for the sample time. Example: 1.25” buried piping, 50’ long. Add for a 200’ setting depth for a submersible pump, and a pumping rate of 15 GPM. 1.25” pipe has 0.08 gallons per foot multiplied by 250’ (50’ + 200’) equals 20 gallons. 20 gal divided by 15 GPM is 1.33 minutes (1 minute 20 seconds) plus 15 seconds equals 1 minute 35 seconds for “Casing” Sample. **Large diameter wells:** Test at the well head to minimize piping calculations. Calculate volume of water in pump column. Divide by GPM rate. Add 2 minutes for sample time. Example: 6” column pipe with a check valve set to 210’, pumping 400 GPM. 6” pipe has 1.5 gallons per foot multiplied by 210’ equals 315 gallons. Divide 315 by 400 GPM equals 0.78 minutes (47 seconds) plus 2 minutes equals 2 minutes 47 seconds for “Casing” Sample. Note, if no pump check valve (Vertical Turbine), subtract the static level in the well from the pump setting depth for water column. Figure 4. NOTE: Take the sample even if the water is discolored.

“Aquifer” Sample for either Domestic or Large diameter wells

Calculate the volume of water per foot in the well casing. Figure 4. Subtract the static level from total depth which equals the total footage of water in the well. Multiply the gallons per foot of water from the chart on Figure 4 by the total footage of water. Multiply that volume by 30 times in wells < than 300’ and 50 times for a well depth > 300’. Divide that volume by the pumping rate in GPM for minutes to the sample time. As water is continuously pumped over this time, up hole velocity will scour the inside of the casing. The number of bacteria or symptoms should subside if the problem is contained in the well. If the problem is in the aquifer or a continuing source issue due to physical problems, you will see similar or elevating numbers.

| *PIPE AND WELL CASING VOLUMES* | | | |
|---|---|---|---|
| ***Diameter*** | ***Gallons/foot*** | ***Diameter*** | ***Gallons/foot*** |
| 3/4” | 0.035 gal/ft | 8” | 2.6 gal/ft |
| 1” | 0.041 | 10” | 4.2 |
| 1 1/4” | 0.08 | 12” | 5.9 |
| 2” | 0.17 | 14” | 7.2 |
| 3” | 0.37 | 16” | 9.5 |
| 4” | 0.67 | 18” | 12.0 |
| 5” | 1.04 | 20” | 15.0 |
| 6” | 1.50 | 24” | 23.5 |

*Figure 4*

| INTERPRETING "TIMED TESTS" FOR WELLS | | |
|---|---|---|
| ***STERILENE™ will work if...*** | ***"Casing Sample" Test*** | ***"Aquifer Sample" Test*** |
| MPN (coliform number/100 ml) | < 100 counts/100 ml | zero count |
| HPC (Heterotrophic Plate count/ml) | < 60 colonies/ml | < 60 colonies/ml |
| Fecal coliform/E. coli | Negative | Negative |
| *Coliform problem is probably contained in the well. Use STERILENE™.* | | |
| ***STERILENE™ may NOT work if...*** | ***"Casing Sample" Test*** | ***"Aquifer Sample" Test*** |
| MPN (coliform number/100 ml) | > 15 counts/ml | counts similar to "Casing" |
| HPC (Heterotrophic Plate count/ml) | > 60 colonies/ml | > 60 colonies/ml |
| Fecal coliform/E. coli | Positive or Negative | Positive or Negative |
| *Problem may be due to physical well issues or contaminant in aquifer may show a continuing source of bacteria. See Page 7 for analysis of physical problems.* | | |
| ***STERILENE™ may NOT work if...*** | ***"Casing Sample" Test*** | ***"Aquifer Sample" Test*** |
| MPN (coliform number/100 ml) | > 250 colonies/ml | < 60 colonies/ml |
| HPC (Heterotrophic Plate count/ml) | >1 colony/100 ml | < 1 colony/100 ml |
| Fecal coliform/E. coli | Negative | Negative |
| *There may be premature slime growths in the well, hiding coliform."* | | |

*NOTE < = less than & > = more than*

*Figure 5*

## Physical Problems that May Cause a Continuing Source of Bacteria

Repeated samples with a "Present" for coliform/E. coli, or excessive HPC bacteria may be caused by physical issues that chemistry can not cure. When any problem (coliform, E. coli, discoloration, odors, slime, etc.) exists at a sampling point, we too often assume the problem starts in the well. If you have a problem at a sampling point within a house or building (Item 1. in Figure 6), test closer to the well or at the well itself, to determine the location. Some states require a sampling port just inside the building (Item 2, Figure 6). This offers a point to sample the buried piping and the well, which removes any issues in the internal piping. We recommend contractors install this sampling port, even if local regulations do not require it, as a precaution to compare any differences between the well verses internal piping.

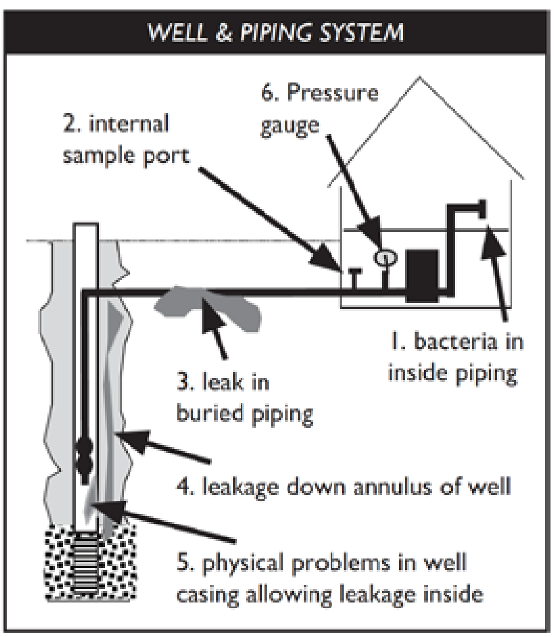


*Figure 6*

*CHECKING FOR PHYSICAL PROBLEMS IN PIPING SYSTEM*

To test the system, turn on the water until the pump starts. The pump will build pressure in the system until the high pressure point is obtained. Shut off all water usage in the system and monitor the pressure gauge (Item 6, Figure 6) on the well side of pressure tank a few seconds to see if the pressure declines. You may have to install a pressure gauge for this purpose.

**If pressure declines** without any water usage, 1. There may be a leak in the buried piping (Item 3, Figure 6). When high pressure is reached in a system and the pump shuts off, water in a pipeline could leak at a point of corrosion, loose fittings, and a split in the pipe, etc. Water will leak around the pipe and into the soil, potentially causing all kinds of problems including coliform, E. coli, slime/iron bacteria, odors, discoloration of water, debris, etc. The leak causes a drop in pressure. When the system calls for water, velocity through the pipe may create a effect pulling bacteria or debris into the system.

## Physical Problems that May Cause a Continuing Source of Bacteria

2. In submersible applications, the check valve may fail so lift the drop discharge to the surface and monitor water level inside the drop pipe. If the water level does not drop, the check valve is holding and the loss of pressure from your test is due to a leak in the buried pipeline. In line shaft turbines, check the line check valve for leakage at the well head.

**If the pressure holds** in the line during this pressure test and problems continue to exist in the "Aquifer" Sample, the piping system is secure and the submersible check valve (if present) is holding. Suspect continuous source, either. 1. inside the well casing caused by faulty casing, corrosion, faulty weld joints/threaded couplings, physical wear from the pump operating on the well casing, or improper casing seat in hard rock, etc. Page 9, Item 5, Figure 6. 2. outside the well casing, potentially in failed grout, no grout, open annulus area, lack of casing seal in hard rock formations, etc. See Item 4 in Figure 6. This grout failure can occur with cement grout due to shrinkage of the grout and corrosion or high velocity aquifer gradients. It can also occur with bentonite grouts due to erosion of high velocity gradients in an aquifer, lack of hydration above the static level, or settling of grout with development in the fi lter pack.

## Traditional Chlorine Chemistry

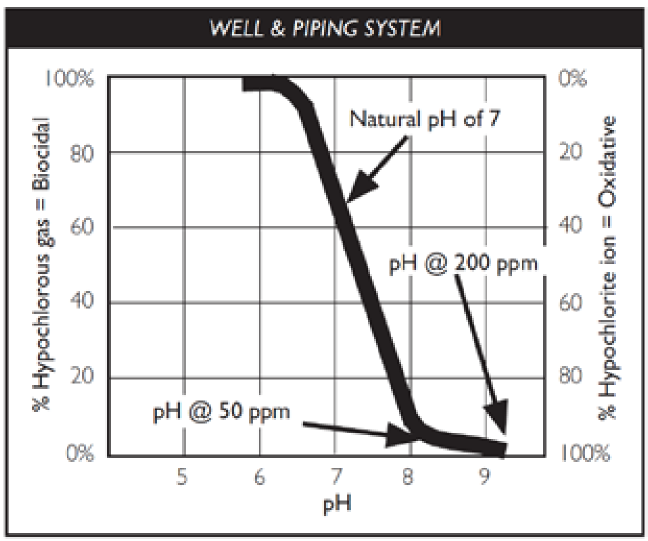


*Figure 7*

Chlorine has been used for years assuming that it was highly effective. The biocidal effectiveness of chlorine is based upon the production of hypochlorous gas and is 100% effective only between a pH of 5.5 to 6.0. Traditional chlorine has an alkaline base (sodium in liquid and calcium in granular/pelleted chlorine). When added to water, pH will rise 1 to 3.5 points depending upon concentration. This produces a much higher percentage of the hypochlorite ion which creates an oxidative state. In this state chlorine, 1. oxidizes minerals in solution (iron = yellow, manganese = gray, etc.) causing discoloration, 2. creates corrosion on metals (stainless, mild steel, etc.), as well as any mineral deposits precipitated in the well (scale). 3. produces a chlorine gas (odor) which can be dangerous. 4. requires a much greater contact time to kill bacteria, 5. can even fracture PVC pipe in large concentrations, and 6. can deteriorate bladders in domestic pressure tanks. In fact, the more chlorine that is used, the higher the rise of pH, the lower the production of hypochlorous gas and the lower the effectiveness. Figure 7.

Groundwater often has a pH > 7. If just 50 ppm chlorine is added to water, pH will rise 1 point if the chlorine is good (sodium) or mixed well (calcium). Page 9. If the initial pH is 7, the production of hypochlorous gas (biocidal effectiveness) is now 8% while the production of the hypochlorite ion is 92% (oxidative). When larger amounts of chlorine are used (200 ppm), pH will rise 2-2.5 points. Now the production of hypochlorous gas (biocidal) is less than 2%. Figure 7. When pH of natural groundwater is higher than 7.5, successful disinfection becomes very difficult. When failures occur at lower concentrations, more chlorine is often used but does not mean automatic success.

# Traditional Chlorine Chemistry

*SHOCK CHLORINATION*

This is a term familiar to many and is often tied to multiple failures with coliform issues or iron bacteria/slime bacteria. More is not better. In fact more chlorine causes huge issues with corrosion, off gassing, and even plugging wells with redeposited calcium using granular chlorine. Shock chlorination has never been effective at penetrating and removing iron bacteria. After shock chlorination, the problem will return since, 1. chlorine will not kill all of the bacteria because it can not penetrate the polysaccharide mass, 2. chlorine will not fully dissolve the decaying debris which leaves a nutrient base, and 3. most slime formers are naturally occurring bacteria so when pulled to the well during pumping, there remains a large nutrient base for future growth. The problem will always return and the frequency of treatment gets shorter and shorter as more of this decaying debris remains.

Calcium Hypochlorite (granular/pellets)

- Available as 65-70% available chlorine.
- The base is 30-35% calcium. Most groundwater has a calcium hardness greater than 60 ppm (3.5 grains hard). At that point, calcium is already at the maximum saturation point and any calcium in granular/pelleted chlorine will not easily go into solution. That can cause:
  1. A calcium paste which can actually plug wells when used in high concentrations or multiple chlorinations. This paste is very difficult to remove when lodged in the aquifer.
  2. Pellets can remain in the bottom of a well for years since there is generally no water movement at that point in the well.
  3. Pumps can be cemented in place when constant feed pellet applicators are used. This buildup will often cause severe corrosion on metal casing.
  4. Calcium is an alkaline and causes a tremendous rise in pH (Figure 7). Control of pH is required during chlorination to maintain a high percentage of effectiveness.
- Storage of containers next to metal will cause severe corrosion from off gassing.
- Does not mix well in cold water.

Sodium Hypochlorite (liquids)

- Available as common household bleach with approximately 5.2% available chlorine and industrial grade with up to 15% available chlorine.
- Liquids easily mix with water with no saturation issues.
- Base is sodium which is alkaline and just as calcium hypochlorite, causes a dramatic rise in pH (Figure 7). Control of pH during chlorination is recommended to maintain effectiveness.

  As Bleach
  1. Is most commonly used because of availability. Do not use the scented brands because they can leave a residual or thickened blends (silica base) which can cause plugging.
  2. Potency of household bleach declines approximately 20-25% every month. How old is it?

as Industrial grade

1. More consistent and most chemical companies will guarantee a potency but has similar shelf life issues.

DO NOT DUMP REGULAR CHLORINE DIRECTLY INTO A WELL FROM SURFACE

- It causes excessive corrosion on pitless adapters
- Causes off gassing and corrosion on steel casing at the static level
- Does not reach the bottom of the well
- Does not automatically go out and seek out bacteria in the aquifer – chlorine must physically come in contact to remove bacteria

# STERILENE™ Field Usage

### 8 OZ. RETAIL TUB, DOMESTIC (SMALL DIAMETER) WELLS

8 oz (1/2 lb) Retail Tubs for domestic wells are available from your local well contractor, pump installer, or on line. If your contractor is not yet aware of this product, have them contact their local distributor or go to our web site under "Master Distributors." See Chlorination of Domestic Wells in the Literature section for an "Easy Method" or a more enhanced method of placement of the product. Follow these instructions.

### CONTRACTOR USAGE WITH 8.5 LB AND 50 LB CONTAINERS

Contractors often mix chlorine into a 4-5 gallons of water in a bucket and pour into the well. Some will follow that with more water and recirculate with the pump back into the well in an attempt to distribute the chlorine. That will certainly work better with STERILENE™ than regular chlorine. If a "Present" for coliform occurs after 1 or 2 chlorinations, we highly suggest to follow our standard instructions on the product label. This two times the well volume recommendation, 1. will allow chemistry to flow into the formation where bacteria can hide. 2. allows a more even concentration of chemistry to reach all areas of the well. The chart (Figure 9) doubles the volume of the well for greater contact area with a larger volume. Multiply the gallons of water per foot times the footage of water in the well. Have a single tank or multiple tanks capable of holding this amount of water. Multiply the total amount of water in gallons times the pounds per gallon of STERILENE™ for the total amount of product required. (Figure 8).

| *Dosage of STERILENE™* | *Dosage per gallon* |
|---|---|
| For 50 ppm | 0.0008 lbs/gallon |
| 100 ppm* | 0.0015 lbs/gallon |
| 200 ppm | 0.003 lbs/gallon |
| * recommended dosage | |

**Concentrations of STERILENE™ greater than 100-200 ppm are not necessary. The volume of chemistry is more critical to reach bacteria than concentration.**

Example: For a 6" diameter well, 210' total depth with a 25' static level. 210' minus 25' = 185' of water column multiplied by 3.0 gal/ft = 555 gallons. Use a single tank or multiple tanks with that amount of water. For 100 ppm solution, use 0.0015 lbs/ gallon of STERILENE™ multiplied by 555 gallons equals 0.83 lbs.

The cap from the 8.5 lb container can be used as a measuring cap. One heaping capful of STERILENE™ equals 100 ppm solution in 100 gallons of water. Using the above example for 555 gallons of water, that would be 5.6 capfuls of the product to equal 100 ppm. The 50 lb container has a measuring scoop for 100 and 200 ppm per 100 gallons of water. Recirculate water in the tank and pour the required STERILENE™ into the intake of the pump to mix. In smaller containers, you might stir with a paddle to mix as long as all granules are in solution. Pump or pour directly into the well. The first volume displaces water in the well and the second pushes chemistry into the formation to reach bacteria in the bore hole. In domestic applications where piping systems are greater than 100', consider adding the amount of water in the system piping (Figure 4) to the original amount of water calculated for the well (Figure 9). Mix the chemistry for the total volume. In large diameter applications and piping systems, it is always a good practice to add the volume of piping (Figure 4) to the well volume (Figure 9) into a surface tank, and mix.

| *DOUBLE VOLUME OF WELL* | |
|---|---|
| ***Casing Diameter*** | ***Volume of Water in Casing x2*** |
| 4" | 1.3 gal/ft |
| 5" | 2.1 gal/ft |
| 6" | 3.0 gal/ft |
| 8" | 5.2 gal/ft |
| 10" | 8.6 gal/ft |
| 12" | 11.8 gal/ft |
| 14" | 14.4 gal/ft |
| 16" | 19.0 gal/ft |
| 18" | 24.2 gal/ft |
| 20" | 30.0 gal/ft |
| 24" | 47.0 gal/ft |
| 30" | 73.4 gal/ft |

*Figure 9*

# STERILENE™ Field Usage

*PLACEMENT OF PRODUCT USING TWO VOLUMES OF THE WELL*

- **If less than 200' of water in the well,** simply pump or pour chemistry into the well.
- **If more than 200' of water in the well,** it may be beneficial to displace chemistry through a tremie equally in 40' sections from the bottom of well upwards. For example, 12" diameter, 500' total depth with 160' static equals 340' of water column. Use 11.8 gal/ft (Figure 9) multiplied by 340' of water equals 4,012 total gallons. 340' of water divided by 40' equals 8.5 (8) increments. 4,000 gallons divided by 8 sections equals 500 gallons per 40' section starting 40' off the bottom of the well.

*DEVELOPMENT WITH CHEMISTRY*

It may be beneficial to move the chemistry in the well to enhance contact to bacteria. See chemical contact and development on page 4.

*MONITORING OF CHEMISTRY AFTER TREATMENT*

It is important to have a chlorine residual upon startup of the well. This indicates there is still chlorine available and is not totally used up affecting bacteria. Upon startup of the pump, 1. measure chlorine residual with the chlorine strips, or 2. notice a chlorine odor. STERILENE™ will have a chlorine odor but will not be as obtrusive as regular chlorine.

If there is a chlorine residual upon startup, pump until there is no chlorine residual or odor. Pump an additional 15-20 minutes for domestic wells and 30-45 minutes for municipal wells. In all likelihood, the sample will pass with an "Absent" for coliform. If the sample shows "Present" for coliform, retreat. DO NOT re-chlorinate more than 3 times with STERILENE™, as likely is a physical issue in the well. Follow our guidelines for "Timed Testing" (Pages 8-9) to determine if there is a continuing source or call our Technical Service for assistance. This can happen in a new well with failed grout, failed fittings in the well casing, etc. In older wells, corrosion may be an issue. If testing in the piping system, test at the well to remove any issues with the pipeline.

If there is no chlorine residual or odor upon start up, pump for an additional 15 minutes (domestic wells) and 30 minutes (large diameter wells). A chlorine residual may suddenly appear which indicates the aquifer gradient may have carried the chlorine solution downstream of the borehole. Pump past the chlorine odor and take the sample. The lack of a chlorine residual during initial pumping may indicate chemistry is used up and there is a higher chance your sample may fail. Repeat the treatment and resample. DO NOT re-chlorinate more than 3 times with STERILENE™, as likely is a physical issue in the well. Do the "Timed Tests" to understand the potential for a continuing source or call our Technical Service for assistance.

*MEASURING CHLORINE RESIDUAL*

Distributors have bottles of 50 chlorine test strips that measure Free Chlorine from zero to 120 ppm. The kit includes monitoring instructions.

# Treatment of Filter Pack Material with STERILENE™

STERILENE™ can be used during installation of filter packs in new wells using the measuring cap for dosage.
Develop the well as you would normally and a chlorine odor or chlorine residual will be present.

*SMALL DIAMETER WELLS*

Most bags of fi lter pack are either 50 lbs (1/2 cubic foot) or 100 lbs (1 cubic foot).

**100 lb bags:** Use 1/2 capful of STERILENE™ from the 8.5 lb container per every 2 bags.

**50 lb bags:** Use 1/2 capful for every 3-4 bags. Place with pack as evenly as possible.

*LARGE DIAMETER WELLS*

Use 3 capfuls per 1,000 lbs of Filter Pack. Simply pour chemistry as evenly as possible during placement of the pack material.

# Chlorinating Pipelines

*NEW PIPING*

Use STERILENE™ as you would regular chlorine. Flush piping with plain water until all physical debris is removed. Slug chlorination may be used by mixing STERILENE™ into a tank of water (say 1000 gallons) at 100 or 200 ppm. Pump through the piping system. If failure occurs repeat with a larger volume but ask your lab to do coliform counts, not "Present/Absent" tests. **Suggestions:**

1. If multiple failures occur in a system, sample at the well to eliminate it as a source. Do "Timed" Testing if present at the well and follow lab testing procedures on pages 8-9 to better understand severity, the identity of bacteria over time of pumping, and the potential of a continuing source.

2. If the well tests show no issues with bacteria, pressure test the piping. Splits in piping, loose joints, or weld failures may allow leakage of water outside the pipe under pressure. When the system calls for water, velocity can create a venturi effect dragging this water with potentially coliform, E. coli, iron bacteria, OPs, discolored water, odors, silts, sand, etc. into the system at this point of leakage. Isolate areas of a pipeline to understand variances to locate the problem. Repair or replace the piping. 3. If there are "dead head" areas in piping, fully drain out all the water. Calculate the amount of water in the entire pipeline. Use a mix tank on one end of the piping system with that volume of water and mix the STERILENE™. Pump chemistry into the piping system and monitor at the other end. Shut off the pump when a chlorine odor is noted and allow to set for 4-5 hours or overnight. It may help to pressurize the piping system to force chemistry into physical pipe joints and connections. Flush the pipeline with plain water until there is no chlorine residual or odor. Pump for an additional 15 minutes and test.

*OLD PIPING*

Debris (mineral or biological) may be present inside a pipeline which can harbor coliform bacteria. Obtain a sample of debris by physically checking the ID of the pipe. See our "Analysis of Sludge/Debris" on our web site under Lab Services. If there is physical debris present, a more thorough chemical cleaning may be required for removal of debris. Physical "pigging" may remove most of this debris but not all of it and should be followed by a chemical treatment.

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