

P R O D U C T G U I D E



JET-LUBE®

***Understanding Your
Well Problems***

**DESIGN WATER
TECHNOLOGIES**
BY JET-LUBE



Understanding Your Well Problems

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Well and System Problems, the Market

The day is quickly coming when drilling new wells will become less of an option. Regulations on drilling and the protection of ground water are becoming more stringent.

This along with the demand for greater water usage and better water quality, creates a market for a better understanding of water problems. These problems may be caused by natural water chemistry, a variety of bacteria, and physical issues in a new or existing well.

Poor water chemistry can pose problems for water treatment. It can also cause issues with mineral deposits plugging wells, piping, and systems; as well as corrosion.

Problems due to bacteria can include health concerns such as coliform bacteria, E. coli and a multitude of other pathogens or opportunistic pathogens that most labs and health agencies do not identify. Bacteria like iron bacteria, and slime formers are generally not health issues but can cause discolored water; odors, staining, and major plugging of wells, piping and systems.

Physical issues can include failed grout in a new well or corrosion in an older well allowing a continuation of problems. These can be better understood with “Timed Testing” in wells. Page 16.

This booklet is intended to give you tips for use in the field to understand what to look for; where to look, and recommend testing procedures. Each of the problems are defined by what you see in the field and will give you recommendations to understand the problem and hopefully, solve it.

Odors In a New Well

“ROTTEN EGG” ODOR - HYDROGEN SULFIDE GAS - H₂S

Odors in potable wells are most often caused by bacteria assuming there is no contamination present. The most common complaint is the “rotten egg” odor normally caused by Sulfate Reducing Bacteria (SRB). SRB are anaerobic only which means they thrive in low or non oxygen environments and require some sulfate or gypsum as a nutrient. They are naturally occurring soil organisms often found in clay or shale lenses. These lenses provide the low oxygen environment and nutrient. In new wells, if screens are placed through clay lenses or if an open hole is completed exposing open shale lenses, this odor may be noticed immediately. In the initial design, shorter lengths of screen in only clean sand/ gravel areas will minimize or eliminate the problem. If drilling in sandstone or limestone formations, set and grout casing through the deepest shale lens and drill only the clean part of the formation.

If this problem occurs, DO NOT SHOCK CHLORINATE as it is only a short term, temporary solution. Plus, large amounts of chlorine causes corrosion to any metal in the well and may even cause PVC to become brittle.

Field testing of customer complaints for a “rotten egg” odor

- Check if odors are present in hot water only. If so, take the anode rod out of the hot water heater but only remove if TDS is lower than 500 ppm.
- If present in the cold water, pour a glass of water. Let set for 10 seconds. If the odor goes away, it is a gas most probably caused by SRB. If a bladder pressure tank was installed, the bladder retains this gas so the first atmospheric condition is the faucet. That is where the odor is noticed. Install a bladderless tank, an open tank, or an air injection to iron filter. All allow oxygen contact to the water and dissipates the odor. Over time, a minor amount of sulfate powder may accumulate in the bottom of the tank.

Odors Suddenly Appear In an Older Well

If odors appear within several weeks to years of operation, suspect there may be changes in the well environment or system. “Rotten egg” odors are mostly caused by SRB (Page 4). Musty, oily, fishy, or metallic odors can be caused by other slime formers or iron bacteria. Odors may suddenly appear when,

- Slime formation in the well harbors anaerobic (odors) bacteria beneath the polysaccharide debris. Odors may vary in severity with time as debris sloughs with a flushing effect of the pumping level rising back to static. Check inside any piping for the presence of soft, sludgy debris. In domestic systems, open the “Union Joint” by the pressure tank. For larger systems, check inside gasketed water meters or check valves. See our web site under “Lab Services” for “Sludge/Debris Analysis” for directions. You can also do “Timed Tests” to determine presence of ferrous iron in the casing and aquifer. See “Timed Tests,” pages 16 and 17.
- There is a sump in a well. A sump is a pipe below the screen that allows sediment to collect but is a non-productive zone which can harbor anaerobic bacteria. This same condition occurs in the bottom of a open formation in a nonproductive zone. Review the Drillers Log for either condition. Both provide a low oxygen environment for anaerobic bacteria which can often cause odors. In some cases, you can install an airline or water flushing tube into this zone to flush this area during pumping.
- A bladderless pressure tank is changed to a bladder type pressure tank in an older system. A standard bladderless tank allows direct water to air contact which releases this gas and odors are dissipated within the tank. When a bladder tank is installed, the first atmospheric condition is now the faucet and the odor “suddenly” appears when it was not present with the old tank.

General Corrosion

Most groundwater is not corrosive to a point of major problems. If present, there are some simple issues to look for:

WATER CHEMISTRY

Most of these tests can be done by a local laboratory, water treatment company or test kits. Check for

- Total Dissolved Solids greater than 600 ppm (see below)
- Chloride levels greater than 500 ppm.
- pH lower than 6.0.
- Carbon dioxide greater 50 ppm. Test at the well.
- Dissolved oxygen greater 2 ppm. Test at the well.
- H₂S gas (rotten egg) caused by SRB. Test at the well.
- Massive presence of iron bacteria. Pages 12 and 13.

TOTAL DISSOLVED SOLIDS > 600 PPM

Electrolysis can occur between two different metals in water that is highly conductive. When dissimilar metals are placed in highly conductive water, the lesser metal will show corrosion and the more nobler metal may show deposits.

Corrosion may be seen within the same material as simple differences can occur in the metal itself. Rolling of metals, forming/shaping, or the cutting of threads, etc. all change the structure of the metal in one area versus another.

You may find hard debris on the inside of piping or on filters. In domestic wells, look inside the "Union Joint" by a pressure tank. In large diameter systems, look under a gasketed water meter or check valve for debris. Scrape debris and dry. Crush debris into small particles and put on a piece of paper. Run a magnet under the paper to understand the percentage of particles that are magnetic. Magnetic debris is most often corrosion byproduct. Natural mineral deposits (iron, calcium, manganese, etc.) are not magnetic. Some dried bacterial debris may be magnetic caused by some iron oxidizers.

RECOMMENDATIONS FOR NORMAL CORROSION CONDITIONS

Corrosion problems can not be changed by treatment. It is best to simply move the corrosion issue to a replaceable or sacrificial metal. This will require a lesser noble metal, like magnesium and can simply be done by:

1. Strapping a magnesium cable to the pump column.
2. Burying a magnesium rod as a sacrificial anode by the metal well casing. Dig a 3-4' deep trench at the well and place this rod horizontally. Attach one end of this rod with a cable attached to the casing. Increase conductivity by adding 3-4" of bentonite chips below and above this rod and soak with water. Then simply check every 3-4 years and replace when necessary. Call oil pipeline or buried tank companies to purchase anode rods.

Massive or Early Corrosion

Severe corrosion within a short period of time (< 3 years) may be caused by more than simple chemistry. If you have reviewed water chemistry and did not find any issues, look for stray DC voltage. 1 millivolt of stray DC voltage can dissolve 12 pounds of steel per year. Symptoms may include a replacement of a pump or drop pipe in a very short period of time or large amounts of debris in filters or piping systems that is magnetic. If you see severe or early signs of corrosion in a well or piping, check hard wiring in the area for stray DC voltage with a DC volt meter. Sources of DC voltage may be phone lines, some low voltage lighting systems, electric fences, and corrosion protection for distant buried tanks or pipelines (water or oil). Stray DC voltage can travel through ground surfaces following water that is highly conductive. Clay lenses or shallow ground water containing high dissolved solids may allow conductance from miles away. You can use ground stakes in a circle around the well and measure potential between the stakes.

Coliform

Tests are generally classified as “Positive” or “Present” for coliform. If multiple tests are “Present,” issues can include:

- Where the sample was taken: If you are taking a sample at a house or somewhere in the system, you must assume the problem can be from that point backward to the well. DO NOT ASSUME the well is always the problem unless you are testing at the well. If problems persist, test at the well head.
- Sampling procedures: Take the sample at the point of usage. Remove aerator from faucet. Dip the end of the faucet into alcohol. Open the faucet with a significant flow and pump for 30 minutes. Slow the flow so there is no turbulence. Open the lid of the sample bottle and hold in one hand downward while filling the sample bottle completely full with the other. Do not breathe on the lid during sampling or allow any debris or moisture to touch. Replace the lid on the bottle. Mark the bottle and send to a lab within 24 hours. If “Present,” chlorinate and resample closer to the well.
- Shelf life of liquid chlorine: Liquid chlorine, common bleach (5.25% chlorine) will lose up to 20% effectiveness each month. Industrial grade (12-15%) can be checked.
- Natural pH of water: Standard chlorine has an alkaline base. Liquid is sodium and granular/pelleted is calcium. Both cause a rise of pH resulting in an oxidative condition. This creates the odor of chlorine because of off gassing and discolored water because of oxidation of iron or manganese. Both create corrosion on metals but is not biocidal. The more chlorine you use, the higher the rise of pH, the less biocidally effective it becomes.
- Placement of chlorine: In any form, pellets, granular, or liquid, chlorine will NOT automatically mix evenly to the bottom of the well when poured from surface. If chlorine does reach the bottom of the well, it will NOT seek out bacteria into the formation.

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- Identification of bacteria: There are several bacteria that can cause false "Positive" results on enzyme test kits. Most of these are opportunistic pathogens and cause stomach cramps, diarrhea, etc. Most are often highly aerobic in nature (like areas of oxygen) and may be coming from shallow aquifer sources into a deeper well. Shallow surface water often has extremely high Heterotrophic Plate Counts (> 300 colonies/ml). Some of these bacteria will cause illness without a "Positive" or "Present" for coliform on enzyme test kits.
 - Severity of problem, not just Present/Absent: If you have had more than 2 "Present" samples, ask your lab to do, counts of coliform as MPN (Most Probable Number). Minor = 1-10 colonies/100 ml. Major = > 15 colonies/100 ml.
 - Understanding the location of coliform: If you want to separate a well problem from a potential aquifer problem, do "Timed Testing." The idea is to capture two samples, one from within the casing portion of the well and a second from the aquifer in time of pumping. Then compare the numbers (MPN) to understand if the problem is contained in the well or a continuing source of organisms. See "Timed Testing" on pages 16 and 17.
 - New well drilled with bentonite: If no or little development was done in the well, the blockage must be removed to reach the coliform. To break bentonite:
 1. Calculate the volume of the screen in gallons.
 2. Multiply that volume by 5.
 3. Have a tank at surface with that volume of water.
 4. Mix 0.03 gal of common bleach per gallon of water in the tank, creating a pH > 10 . The oxidation process will break the polymer chain of bentonite.
 5. Place equally throughout screen with a tremie pipe.
 6. Surge the well with a surge block or surface pressure.
 7. Let set overnight and airlift the well from the bottom of the well for removal. Screens longer than 10' may require surging and simultaneous airlifting or pumping to create a more localized removal of debris. Dechlorination may be required.

“TIMED TESTS” FOR COLIFORM BACTERIA.

Test at the well to remove any piping issues. If multiple coliform tests show “Present” it may be critical to understand the severity of the problem. Do “Timed Tests” with counts as “Most Probable Number” (MPN). Severe is considered above 15 colonies/100 ml and may indicate more severe conditions.

- If MPN is high in the “Casing” sample and low or zero in the “Aquifer” sample, the problem is probably contained in the well and should be treatable.
- If MPN is high in the “Casing” sample and high in the “Aquifer” sample, consider the possibility of:
 1. A continuing source of organisms due to failed grout allowing a continuous source outside the casing from an upper level source. Consider this especially if bentonite grouts were used. Dig on the outside of the well casing looking for a vertical conduit and back fill with bentonite pellets and water. Retest.
 2. A failure in the casing allowing a continuing source inside the casing. Video the well and look especially at the joint at a pitless adapter (horizontal piping), weld or glued joints in casing, leaking water, etc. Consider corrosion in metal casings of older wells. You can not get a safe sample until the physical problem is fixed.

Note, if you are testing in the piping system and continue to get “Positive” or “Present” for coliform in the “timed tests,” you may have a leak in horizontal piping. Install a pressure gauge on the well side of the pressure tank (domestic wells) or in sections of piping (large diameter). Allow the pump to build to say, 50 psi, shut off and monitor pressure. If there is a leak, pressure will drop drastically within a few seconds. Lift the submersible pump discharge to make sure the check valve in the submersible pump is holding. If the check valve is holding, the leak is in the buried line and needs to be replaced.

E. Coli or Fecal Coliform

E. coli (fecal coliform) can be a serious health issue and are not often found in wells as they require an actual source of contaminant to survive. This source can include fecal contamination from septic systems, animals or insects that get into wells, contaminants leaking into a well or pipeline problems. Test at the well to remove any pipeline issues. Symptoms can include severe, bloody diarrhea and abdominal cramps but can be as simple as a slight fever. See a Doctor.

If found in a well or potable water pipeline, DO NOT AUTOMATICALLY CHLORINATE! Chlorination will probably not remove the source. Test at the well. If positive at the well, consider pulling the pump and airlifting the well from the very bottom to remove the source. Chlorinate and retest. If still present, suspect contamination from: 1. an upper level formation into a shallow well via a contamination source as a septic system. 2. outside the well casing through failed grout. 3. inside the well casing through failed fittings, split well casing, or corrosion in an older wells with metal casing.

When multiple samples show the presence of E. coli:

1. Test at the well head to remove any issues with piping.
2. Do a "Timed Tests" to determine the potential for a continued source of organisms. Page 16.

If E. coli is present in both the "Casing" and "Aquifer" samples, there is probably a continuing source problem. Look for any physical possibilities for a source. Consider a vertical contamination either inside the well casing or outside. Video the well casing and look especially at the upper level areas near a pitless adapter connection to horizontal piping. Look for any water running down above static or sudden discoloration below static. If nothing is obvious, consider digging outside the well casing down some 7-10' looking for a conduit outside the well casing. Back fill any vertical holes with bentonite pellets and water. Retest. Potentially, this well may be a vertical source for a new well.

Debris on Filters, Plugged Pipelines, Discolored Water on Startup, Fluctuating Iron or Manganese Levels, Debris Present on Pumps When Pulled

Debris on filters or in pipes and discoloration especially upon startup of the pump may be caused by a mineral buildup, slime created by bacteria, corrosive water in steel casing, or silts/fine sand. First, inspect piping. For domestic systems, look inside the "Union Joint" by the pressure tank. In large diameter wells, look inside gasketed water meters or check valves. Any debris found may originate in the well and proper diagnosis is critical to success. A "Sludge/Debris" analysis can be done. Check the ID of piping or lift the pump at the well to assure problem is originating there.

MINERAL DEPOSITS

- Debris in piping or on pump is hard. Debris will be stable as chunks/plates and will NOT be easily crushed.
- Coloration of hard debris may be red/brown (iron), black and brittle (manganese), light tan/brown (calcium) or green (sulfate).
- Video of well will show flakes that will float but sink to bottom with camera movement. The flakes or chunks will NOT be fluffy or show a cloudy discoloration.
- Debris will be more noticeable in the screen area or open.
- Check water chemistry, pH will be generally be > 7.0, iron, > 1.0-1.5 ppm, manganese > .02 ppm, sulfate > 40 ppm, hardness > 200 ppm.
- Water chemistry should be consistent over long periods of time. Compare iron and manganese with past samples. If there are major increases, see below.

IRON BACTERIA, SLIME BACTERIA

- Debris found may be slimy, soft, granular, sludgy, etc.
- When this debris dries it may break apart easily to a dust because of high oxygen produced by bacteria.
- Color of debris may be brown, red, black, green or in some cases, clear.
- Odors may be noticeable within debris but not always.
- When pulling the pump, notice any soft buildup on the inside or outside of the pipe or pump.
- Sudden odors may appear in the system and may be identified as rotten egg, fishy, oily, metallic or musty.
- Notice increasing or fluctuating levels of iron or manganese. Use "Timed Testing" Page 16.

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- Change in requirement for chlorine or phosphate injection rates in a municipal piping system.
 - Video may show stringy debris, fluffy debris, gelatinous masses, puffiness may occur with camera movement. Debris loosened by camera movement will most often float, be fluffy, or create cloudiness in water.
 - In video, debris may be noticeable from static to pumping level, at the intake area of pump, and throughout screen or open bore hole crevasses.
 - In a water sample, Heterotrophic Plate Count in the "Casing" sample will often be > 200 colonies/ml. The "Aquifer" sample counts should be < 60 colonies/ml.

Note: Slimy growths in toilet tanks. Slime forming bacteria are naturally occurring soil organisms and will be present in every well in normal numbers as Heterotrophic Plate Count (< 60 colonies/ml). These bacteria are mostly aerobic in nature meaning they prefer areas of high oxygen. What a great place for natural bacteria to grow with the flushing action in a toilet tank.

RECOMMENDATIONS/ANALYSIS

1. DOMESTIC WELLS. Most systems have a "Union Joint" at the "Tee" by the pressure tank. Drain the pressure tank and shut off the pump. Open the "Union Joint" and look inside piping for the presence of debris there.
2. LARGE DIAMETER WELLS. Check for gasketed check valves or water meters at the well head. Remove the gasket and inspect inside piping for debris.
3. If debris is found in a piping system, it is often assumed the problem is the well. Always check piping at the well for the presence of this same debris.
4. "Sludge/Analysis" analysis can be done.

Air In Pipes or Faucets, Low or Changing Yields In Wells

Air can appear in the system when well screens or fractures zone in an open rock well plug due to mineral, biological deposits, or fill in the well which will not allow normal flow of water to the pump.

This will require more drawdown to attempt to pump water. The pump may operate effectively for a short period of time until the water level in the well is drawn down to the intake of the pump. Then air appears in the system. When a pump shuts off, water in the well will recover to the static level and the pump will operate successfully again, for a short period of time. **DO NOT OPERATE THE PUMP in this condition long term.**

The only measurement of well production is Specific Capacity (SC). To measure SC, allow the well to set for several hours and measure the static level. Start the pump and measure the pumping level at say, 30 minutes of pumping (domestic well) and at least 60 minutes of pumping (large diameter wells). Record the average pumping rate as gallons per minute (GPM). Subtract the static level from the pumping level for what is called drawdown (d.d.). Divide GPM by drawdown for gallons per minute per foot of d.d. or SC. Example. Static level is 30'. The well is pumping an average of 25 GPM with a 98' pumping level at 60 minutes of pumping. $98' - 30' = 68'$ of d.d. $25 \text{ GPM} \div 68' \text{ d.d.} = 0.37$ gallons per minute per foot of d.d.

It is critical to understand SC of present well conditions and compare with original data. If the original SC is 0.80 and is now 0.37 gpm/ft of d.d., the yield has declined 50% and the well needs attention. If pump yield (GPM) is lower but the SC is higher, the pump needs repair.

In domestic wells, SC is not often calculated but the information may be available. In most large diameter wells, the information should be available and comparisons can be easily calculated.

If a well is plugging, SC will decline. Severity of plugging is determined by percentage of decline of SC. If GPM is declining but SC is higher, the pump needs repair.

A reduction of yield in a well can be caused by either:

- Mineral deposits: Mineral deposits often precipitate continually outward into the aquifer blocking flow. If SC declines by over 40%, it becomes very difficult to fully rehab the well to the original SC. You can not control acidic chemistry direction beyond 6-8" from the screen surface. Page 12. Treat the screen or open bore hole only with UNICID™ GRANULAR acid.
- Slime or iron bacterial deposits: These deposits have a tendency to stay close to the bore hole plugging flow so even if SC has declined to almost zero, the well can be treated successfully. Page 12. Use UNICID™ GRANULAR and UNICID™ CATALYST to dissolve deposits and remove all live and decaying debris.
- Fine sand filling in a screen or caving formation into an open bore hole: Always measure the bottom of well when pulling any pump. Fill in the screen or open bore hole may effect yield. Bail this fill out and test the well for yield and sand content. You may see sediment in pipelines. Check the "Union Joint" at the pressure tank in domestic wells and gasketed check valves or water meters in large diameter wells for sand.
- Silts infiltrating toward the well: This is a very difficult to diagnose as there may be little or no physical debris or symptoms available. You may or may not see silts in pipelines or on videos of wells. Polyphosphates, as it promotes bacterial growths.
- Changes in the static level: In a Water Table Aquifer, a decline in the static reduces the thickness of the aquifer and pumping capability of the aquifer. A drastic decline in static levels in an Artesian aquifer will not necessarily reduce the SC but will reduce the available drawdown (distance from the static to the top of screen) and therefore total yield.
- Changes in flow conditions in the aquifer: Other wells pumping in the area may reduce flow. Seismic activity can also change or restrict flow to a well.

Timed Tests in Wells

Timed tests can help determine the location of problems and the likelihood of success for treatment. If comparative levels are high in “Casing” and low in the “Aquifer” sample, the problem may be treatable. If levels are similar, the problem is in the aquifer. Use to even understand arsenic and nitrate.

CALCULATION OF SAMPLE TIMES - “CASING” SAMPLE.

Allow the well to set for 12 to 24 hours with no pumping. If there are bacterial issues in the well, this time will allow attachment and growth. The idea is to capture a sample out of the pump but still within the casing portion of the well.

- Domestic well: Calculate the volume of water in the drop pipe. Page 18. Divide this volume by GPM rate. Add one minute for the sample time. Example: 1.25” submersible drop pipe with a 200’ setting depth and a pumping rate of 15 GPM. 1.25” pipe has 0.08 gallons per foot multiplied by 200’ = 16 gallons. $16 \text{ gal} \div 15 \text{ GPM} = 1.06 \text{ minutes}$ plus 1 minute = 2 minutes for “Casing” Sample time.
- Large Diameter: Calculate volume of water in pump column. Divide volume by GPM rate. Add 3 to 5 minutes for sample time. Example: 6” column pipe set to 210’ deep, pumping 400 GPM. 6” pipe has 1.5 gallons per foot multiplied by 210’ setting = 315 gallons in pump. $315 \text{ gal} \div 400 \text{ GPM} = .78 \text{ minutes}$ + 3 minutes = 3.78 minutes or 3 minutes 45 seconds for “Casing” Sample time.

“AQUIFER” SAMPLE FOR EITHER DOMESTIC OR LARGE DIAMETER WELL

As water is continuously pumped, velocity will scour and clean the inside of the casing with time. 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. Calculate the volume of water in the well. Subtract the static level from total depth of well equals the total footage of water in the well. Multiply the gallons per foot of water from the chart on page 18 by the total footage of water. Multiply that volume by 30 times. Divide that volume by the pumping rate in GPM for the minimum sample time. Compare the numbers and severity.

PROBLEM	“CASING SAMPLE”	“AQUIFER SAMPLE”
Coliform	< 10 MPN count/100 ml	1 or zero MPN
	Use STERILENE™ for chlorination	
	> 10 MPN count/100 ml	> 10 MPN
	Continuing source problem. Physical problem in well. Video well or dig outside of well casing.	
	HPC > 300 counts/ml	HPC > 300 count
	Continuing source problem. Physical problem in well. Video well or dig outside of well casing.	
Slime or Iron Bacteria	HPC > 300 count/ml	HPC < 60 count
	Treat with UNICID™ GRANULAR and UNICID™ CATALYST	
Iron or Manganese	Excessive in ppm	Much lower/normal
	Excess due to slime forming bacteria. Treat with UNICID™ GRANULAR and UNICID™ CATALYST.	
	Same or similar reading in both sample times.	
	Water treatment to remove iron or manganese.	
Discoloration	Present	Absent
	May indicate slime formation. See iron above. May indicate corrosion. Pages 6 and 7.	
H₂S Odor “Rotten Egg”	H ₂ S gas Present - high	H ₂ S Absent - low
	May indicate slime forming bacteria. Do “Sludge/Debris analysis. Treat with UNICID™	
	Present	Similar or present
	Treatable with aeration only.	

PIPE AND WELL CASING VOLUMES

<i>Diameter</i>	<i>Gallons/foot</i>	<i>Diameter</i>	<i>Gallons/foot</i>
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



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