By Pat McCool, KRWA Consultant

Good Well Gone Bad (Bacteria Changing Water Quality)

This is a photo of the column pipe showing corrosion inside and out along with biomass buildup.

Shown above is a column pipe joint that has been unbolted and separated. The wheel looking piece is called a spider; it has a bearing in the middle that the line shaft runs through. It minimizes the shaft wobble of the line shaft that runs from the motor on top to the pump impellers. The buildup is iron bacteria slime and biomass.

Most cities and rural water districts (RWDs) do not necessarily monitor the water quality of individual wells. The primary reason is that in the late 1970's employees of the United States Environmental Protection Agency promulgated drinking water regulations requiring the monitoring of the drinking water from samples taken at the point of entry (POE) into the distribution system.

Frequently, the POE may include a combination of wells. A POE may be for individual wells. When wells are combined in one POE, the monitoring records cannot show which well was operating at the time of sampling. Thus, the water quality of the individual well may deteriorate over time but might not be discovered until sometime later.

Change in well – change in water quality

The water quality changes in iron, manganese, selenium, and arsenic are of particular concern because there are significant problems associated with each of these elements at very low concentrations in the water.

Water wells can have very low levels of these four elements, but then an increase in one of them can become a problem. This has occurred in Kansas. Public water supplies (PWSs) are taking action to determine the cause and possible corrective actions. This is a different approach than building an expensive water treatment plant – expensive to build and expensive to operate.

Some cities and RWDs are finding significant water quality changes in individual wells. The aging of wells makes these wells more subject to change in water quality due to casing, well screen, or grouting deterioration.

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Photos are courtesy of Ned Marks, Terrane Resouces Company

Elements That Can Increase Due to Excessive Bacteria in a Well

1. Iron: Anaerobic bacteria can cause iron from minerals in the aquifer formations to enter the water and result in high levels of iron in the water and the bacteria growths. This condition can develop from the well not being disinfected correctly, such as after well maintenance or pump removal and installation. This condition can also develop from improper pump placement in the well or improper well design or construction. High iron levels in the water can cause discoloration of the water, precipitation of iron deposits in water lines, staining of water fixtures, and white laundered clothes. Iron has a rusty brown or tan appearance. Even low levels of iron can cause a slight turbidity in the water.

2. Manganese: As with iron, anaerobic bacteria can cause manganese from minerals in the aquifer formations to enter the water. An increase of manganese can be due to the same causes described for iron and can result in the same discoloration, precipitation, and staining problems as with iron. Manganese usually has a black appearance but sometimes is "masked over" or hidden by the color of a concurrent iron problem.

3. Arsenic: The maximum contaminant level (MCL) for arsenic in drinking water is 0.010 mg/l (milligrams per liter). Sometimes, this is quantified and reported as 10 µg/l (micrograms per liter) or 10 ppb (parts per billion). High levels of arsenic are associated with bacteria in the water well and aquifer creating a condition that causes the arsenic to dissociate from the minerals of the formations to enter the water. Improper water well design, improper construction, or conditions described in the previous paragraphs, can cause the arsenic level in the water to increase.

4. Selenium: The MCL for selenium in drinking water is 0.050 mg/l. The conditions described for arsenic might increase selenium levels. The significant difference between the two – and which is a problem – is likely due to the difference in the minerals in the aquifer formations.

Such deterioration also can result in catastrophic failure of water production. These problems can be discovered and possibly mitigated before becoming worse by conducting a hydrological investigation and videotaping of the well.

Also, bacterial growths in any water well can cause water quality problems. Different conditions (see nearby sidebar) or changing conditions may be the cause of the problem. A hydrogeological investigation can determine the conditions, the causes of a water quality change, and actions needed to mitigate or eliminate the cause of the adverse water quality change.

Investigations of well construction and bacterial growth in wells have been discussed previously in *The Kansas Lifeline* magazine. Articles can be found in the July 2019 and November 2020 issues as well as online at:

- https://krwa.net/portals/krwa/lifeline/1907/WaterWellProblems.pdf
- https://krwa.net/portals/krwa/lifeline/2011/WaterQualityChangesDueToWellCondition.pdf

Recent Examples of Kansas Public Water Supplies Addressing Well Water Quality

PWS No. 1 has had increasing manganese in one of its wells. The well had no detectable manganese for decades. More recently, the manganese has increased. The PWS has undertaken a hydrogeological evaluation to determine why the manganese increased and what corrective actions are needed to once again have low manganese.

PWS No. 2 has had increases in nitrate in a well and increases in manganese and arsenic at another well. The PWS is conducting a hydrogeological evaluation to determine the causes and corrective actions. The PWS chose this option because it does not want to construct an expensive water treatment plant.

PWS No. 3 has operated two wells for approximately twenty years. Both wells were very low in iron when constructed. However, the level of iron has increased significantly in one well, causing significant iron deposition in the water line to the treatment plant and causing operational problems at the treatment plant. The reverse osmosis (RO) treatment plant was designed for softening and not specifically for iron removal. The PWS conducted a hydrogeological evaluation of the high iron well and corrective actions have been recently taken. The result of these actions appears promising.

PWS No. 4 had a well that increased in selenium. The PWS No. 4 constructed an expensive, complex water treatment plant. The treatment plant initially had good results in removing selenium, but operational problems have developed with the complex treatment plant. Consequently, the selenium levels have increased in the treated water.

Water quality change – manganese

KRWA was recently contacted about the high levels of manganese in a water well. The water supplier used that well sparingly due to the high manganese levels but needed the well for backup in emergency situations, possibly for high demand in the summer, and for the water rights associated with the well and location.

After a review of historical water quality data, two important facts were discovered. First, this particular, older well had no manganese for many years – and then low manganese for many years. However, manganese increased significantly in recent years. Secondly, the city had abandoned many wells in the past, and the manganese level and well construction deterioration probably played major parts in those decisions.

After a preliminary review of the well construction and water quality data, it was suspected that bacteria growths are adversely affecting the well. A hydrological investigation is underway to determine how best to eliminate the bacterial growths and significantly reduce the manganese level.

Water quality change – iron

Another water supplier had increasing operational problems with a treatment plant. Monitoring of the iron and manganese of the two wells showed that one well, in particular, had increased significantly in iron since its

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Conditions That Can Affect Water Quality

1. Aerobic: Aerobic condition is where the water contains dissolved oxygen. This condition occurs naturally in many Kansas aquifers. Aerobic bacteria can grow under this condition.
2. Anaerobic: Anaerobic condition is where the water does not contain oxygen. This condition provides the environment where anaerobic bacteria may form and thrive. If this condition is severe, adverse water quality will result in increases in iron and manganese in the water.
3. Facultative: Facultative condition is where the water can have oxygen sometimes and not have oxygen at other times. This condition usually occurs at the interface between an aerobic condition location and an anaerobic condition location. Problems can develop similar to that of an anaerobic condition.

construction two decades ago. Initially, both wells had very low iron and manganese when constructed.

A hydrogeological investigation was conducted. Bacteria growths were the cause of the increasing iron. A water well contractor has completed cleaning the well and eliminating the bacteria causing the high iron levels. Presently data is being obtained to determine the degree of success of the rehabilitation of the well.

Protecting the investment

Costs for new wells are expensive. The increasing price of steel and most all well components increase the cost of well construction. Thus, it is most important to periodically evaluate each well to find possible problems early and take corrective action to prolong the productive life of the well.

If you suspect or think there may be a problem with the water quality, well condition, or water rights at your system, please contact the Kansas Rural Water Association. KRWA staff are well versed in these areas and are willing to discuss these matters with you and provide recommendations. Taking action may eliminate problems early and save considerable monies. Many wells have provided water for decades. Taking action may prolong the wells for many years or even decades.

These two photos show water running clear, then not so clear – are the results of a line pigging procedure. The clear water was 12 minutes into the pigging event and the murky water was after 25 minutes. This water system routinely pigs the line from the well field to the water plant on a quarterly basis.

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