By Pat McCool, KRWA Consultant

Water Well Problems and Evaluation

Addressing the Problem After or Before It Occurs

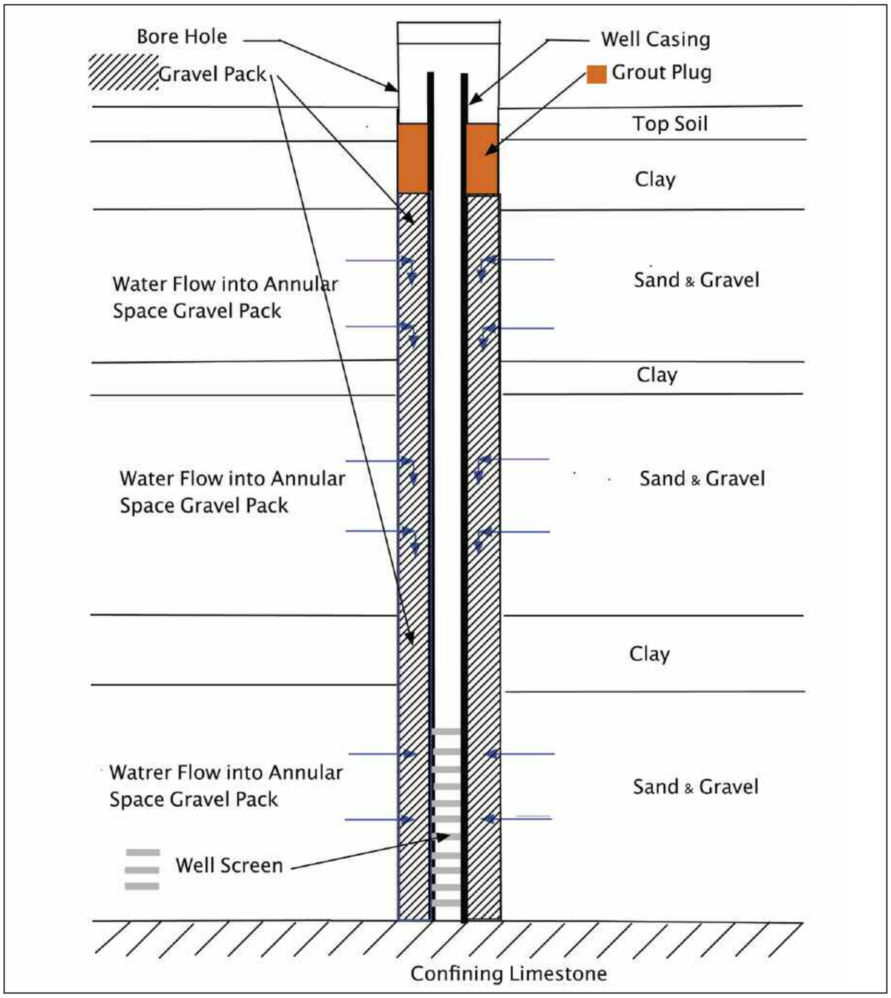
Public water wells provide drinking water for many Kansas citizens. By far, most wells have very high quality drinking water; why buy much more expensive bottle water?

However, some public water supply water wells may be increasing in certain contamination of the well water. In this article, contamination means both high levels of federally regulated compounds such as nitrate, arsenic, selenium, and radium, and of other nuisance compounds such as iron, manganese, chlorides, sulfates, and turbidity.

Some cities and RWDs have constructed expensive water treatment plants to remove the contamination from the well water without first evaluating the water well(s) construction, operating characteristics, subsurface formations and aquifer(s).

Without this evaluation a treatment plant that is constructed may not be needed because the well(s) could have been modified or chemically treated; or properly replaced so as to eliminate the contamination in the drinking water.

At right is a simplified, basic design of well construction and how contamination can occur in a water well.



This schematic shows a well that receives water from three different aquifers.

Definitions and Notes

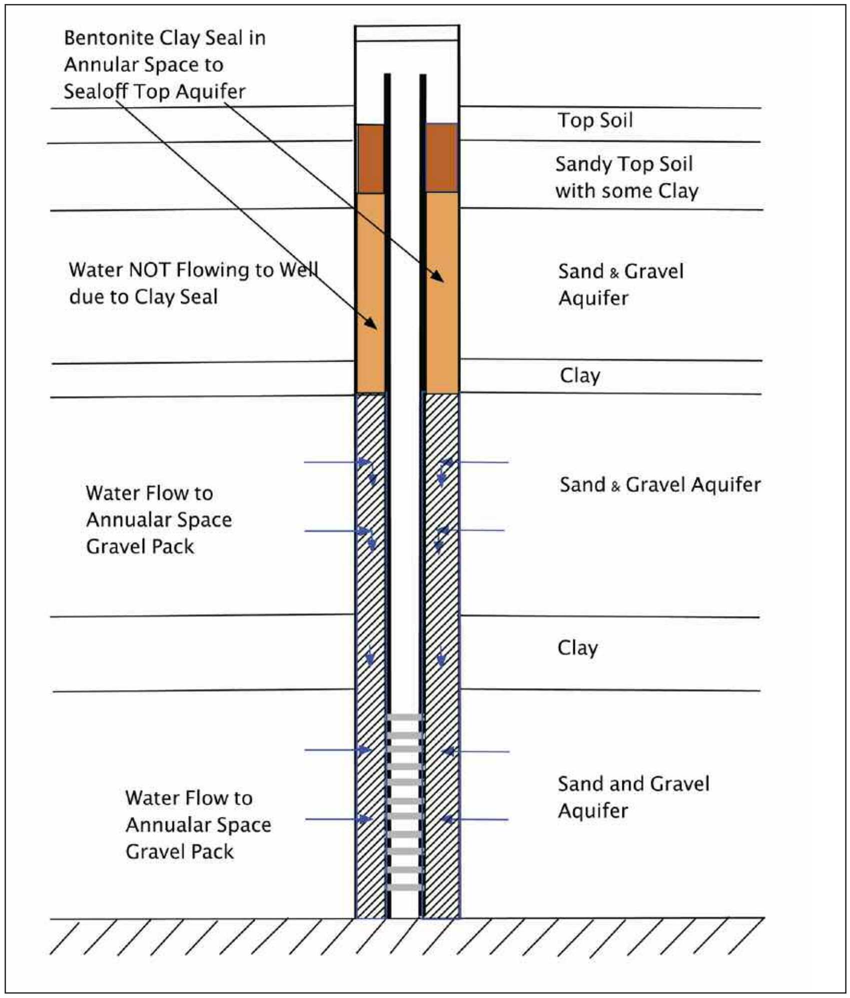
- Annular Space – the space outside the well casing and inside the bore hole. Ground-water must flow thru and down the annular space to reach the well screen.
- Clay – formation made up of very small material that swells up when in contact with water; swells up so tight that water cannot move thru the clay formation.
- Aquifer – a water-bearing formation with significant water that a water supply can be obtained.
- Bentonite Clay Seal – bentonite clay can be used to seal the annular space in a well to prevent water from entering the well bore and to prevent water from moving down the annular space to the well screen.
- Gravel Pack – the placement of gravel or synthetic material to filter out any solids flow-ing with the water to the well bore and to allow the water in the annular space to flow to the well screen. The selection / design of the gravel pack and well screen entrance slot size are very important and necessary for constructing a good well.
- Well Screen – the part attached to the well casing that allows water in the annular space to enter the inside of the casing to be pumped to the distribution system.

Contamination of well water can occur from improper well construction. That is why it is important to properly evaluate the subsurface formations and the water quality of each aquifer. This is accomplished by constructing and evaluating test hole data and water quality data from samples taken from test hole(s).

Schematic A illustrates the construction of a well that receives water from three different sand and gravel aquifers. Surface water is prevented from directly entering the well by the a 20-foot grout plug near the top. Also note that the gravel pack extends continuously from almost the top of the well to the bottom of the well.

When the well is pumping, groundwater is being drawn from each aquifer to the bore hole, through the gravel pack, and to the screen located at or near the bottom of the well. Also some compounds from the clay and/or shale may also be drawn into the well water flow.

Thus for example, if nitrate increases in the upper part of the upper aquifer from fertilizer applied to lawns, then the nitrate can enter the drinking water when the well is pumping. Nitrate can reach the upper part of the upper aquifer by percolation of nitrate-containing surface water downward from heavily fertilized lawns.



This drawing shows the same well design concept as Schematic A except the gravel pack is not continuous from near the top to the bottom of the well casing.

Some Water Quality Contaminants

- Nitrate: regulated; maximum contaminant level (MCL) of 10 mg/l
- Arsenic: regulated; MCL of 0.010 mg/l
- Selenium: regulated; MCL of 0.05 mg/l
- Radium: 226 and 228 regulated; MCL of 5 pCi/l
- Iron: nuisance; recommended 0.3 mg/l
- Manganese: nuisance; recommended 0.05 mg/l
- Chloride: nuisance; recommended 250 mg/l
- Sulfate: nuisance; recommended 250 mg/l
- Turbidity: nuisance; usually from iron, manganese, or formation particulate matter

Photo courtesy of Ned Marks, Terrane Resources, Inc., Stafford, Kan.

Manganese is being pumped from a low production well during a treatment and cleaning operation.

Schematic B shows the same construction and aquifers as Schematic A except that the gravel pack is NOT continuous from near the top to the bottom of the well casing. Note the bentonite clay seal from the cement grout plug down to the bottom of the clay layer (the top of the middle aquifer) just below the upper aquifer.

The location of the bentonite clay seal in the annular space prevents the aforementioned, possible nitrate water in the upper aquifer, from entering the annular space and from flowing downward to the well screen. Thus the nitrate water contamination is sealed off from the well screen and the resultant water production from the two lower aquifers of the well will be low in nitrate.

The construction of a new water well, and specifically the proper placement of gravel pack and bentonite clay seals, is important to having a water well with good water quality. Thus it is important to complete an evaluation of subsurface formations and the water quality of all aquifers if a well is to provide the best water quality.

Also, evaluating the construction of an existing water well can be used in determining possible reasons for water quality changes such as increasing amounts of regulated compounds or of nuisance compounds.

Bacteria in wells

Bacteria can contaminate a well. Bacteria can first enter the well when the well is constructed or when well pump and piping are placed in the well. The well should be disinfected with chlorine after construction. At all times the pump and piping should be kept as clean as possible when above ground and should be disinfected before placing in a well.

If the population of bacteria grows in a well and becomes high enough, the bacteria will change the conditions in the well. Bacterial growths can also start clogging well screens. This can

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cause a decrease in well efficiency and in water production. If not removed the well efficiency will decrease, well production will decrease, and complete well failure can occur.

Well corrosion

Contamination of well water can occur after many years of the water production not previously containing the contamination. This can result from deterioration of the well construction such as corrosion of screen and casing.

Bacteria growths can change the chemical quality of the water in the well so as to accelerate corrosion of the well casing and screen. This corrosion can develop over several decades until a well has a catastrophic failure resulting in the inability to produce any or sufficient water.

If your system has a well or wells more than 30 to 40 years old, then you should consider having the well casing and well screen video recorded with a down-hole camera the next time the pump/motor is pulled for maintenance or replacement. Also, if you have or suspect a well problem, then a video recording should be considered. A video recording properly done and competently evaluated can tell a lot about the condition of the well and its ability to produce water in the future.

A good video recording can show the amount of corrosion of the well casing and screen, and any leaks and holes in the casing and screen. Any of these conditions might forecast an upcoming catastrophic well failure if the matter is not addressed. Sometimes rehabbing or providing preventative maintenance on an existing well is much less expensive than constructing a replacement well.

Photo courtesy of Ned Marks, Terrane Resources, Inc., Stafford, Kan.

Well rehabilitation resulted in vastly improved water quality for this Kansas water system.

Recent examples of Public Water Supplies (PWS) Addressing Water Supply Wells

- One PWS had nitrate increasing in its two wells. The PWS had an hydrological evaluation of the wells, possible contamination sources in the recharge area, and of new test hole data. The PWS took action including more frequent nitrate monitoring and eliminating possible nitrate sources. The nitrate in the wells has been going down slowly and the PWS is also planning another well for water production.
- One PWS had nitrate contamination of a city well from a nearby agricultural chemical facility. The PWS had an hydrological evaluation of the well and contamination. The PWS took action to eliminate the upper aquifer (it was a multiple aquifer well such as in schematic A) for the lower aquifers. The well in that location of the contamination is not producing water low in nitrate.
- One PWS has had a significant increase of arsenic in one well. The PWS has initiated an hydrological evaluation. Preliminary information indicates that structural, corrosion damage to the well casing may be contributing to or be the cause of the higher arsenic.
- One PWS has two well fields with two wells in one field. One of those two wells had a catastrophic failure resulting in no water production. The cause of the failure is corrosion of the casing. The well had a casing collapse and so it must be rehabbed or a new well constructed. It is important in this situation to have two wells in each well field.
- One PWS had a well that increased in iron and manganese. The city is undertaking a hydrological evaluation. Preliminary information indicates the source may be certain aquifers may be higher in these nuisance elements or that bacteria is causing the increase.

Chemical quality change

Bacteria growths can change the chemical quality of the water in the well so as to precipitate solids on the well screen or in the gravel pack; or increase, for example, the amount of the elements of iron, manganese, arsenic or selenium in the drinking water.

These precipitates and the increase of these elements are the result of a bacterial growths changing the pH of the water to more solubilized minerals containing these elements, and/or the bacteria using these elements as an energy source.

Again, video recording, water quality sampling, well construction evaluation, and test hole data can determine how the problems have developed and what action is necessary to mitigate or eliminate the cause and improve water quality.

Water wells

As a knowledgeable person on water wells once stated something like, "... you would not responsibly drive a car from many years and 150,000 miles without maintenance and oil changes. So why would anyone think that a well can necessarily continue to produce water for many years from now after 30 years already without an informed evaluation?".

Owners and operators of public water supply system wells should plan to ensure a long-term, economic water supply for their customers. The evaluation of water supply wells should be part of that planning.

Should you want further information or wish to discuss your specific present water supply, please contact KRWA.

Pat McCool has worked as a consultant to KRWA since January 2004. He previously worked for KDHE for 30 years. Pat has a bachelor degree in Chemical Engineering and a masters degree in Environmental Engineering from the University of Kansas.