WELL REPLACEMENT DECISIONS

When is it time to replace a well? Part 2

By Michael Schnieders, PG, PH-GW, and Ned Marks, PG

A calibrated orifice is used to measure production capacity of an existing well as part of a preventive maintenance program.

Understanding the potential influences within the watershed and area of recharge that could impact your wellfield is vital to managing the resource.

The 1996 amendments to the Safe Drinking Water Act required states to develop and implement a source water assessment program (SWAP). Source water protection was designed as a proactive approach to protecting aquifers used as public water supplies.

Source Water Assessment

SWAP includes development and implementation of pollution prevention practices to protect water quality within a watershed or delineated wellhead protection area serving a municipality. Key parts of a source water protection plan should include:

- Identifying areas of recharge and influence
- Delineating the source water protection area
- Inventorying potential contamination sources
- Determining the aquifer's susceptibility to contamination
- Developing recommendations to protect the aquifer
- Identifying potential contaminant pathways, including the well itself.

A defined and well site-specific source water assessment program can help alleviate many regional well issues. In addition, an active program can help lessen the impact of future, unforeseen problems.

Generally, most systems relied on their respective state to develop a SWAP delineation. Therefore, most systems have a standard two-mile radius circle drawn around each well in the system. When a detailed delineation is performed, it is not uncommon to reduce the downgradient portion of the area

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of influence as well as the addition of unique surface and subsurface features to the assessment.

It cannot be stressed enough that proper decommissioning of older wells is paramount in order to minimize the cross-contamination potential for both new and existing wells. While simple enough in written form, this step often requires an understanding of the watershed—and typically a lot of legwork. Identifying historical wells, industrial wells, environmental wells, old test holes, and other similar conduits to the subsurface should be a part of any detailed, site-specific SWAP.

Assessment and Design Development

A new well is an expensive decision with far-reaching impacts. Prior to deciding if a new well is needed, it is strongly advised you first inventory and assess your current well—including out-of-service wells. As part of this assessment, you should evaluate the potential of the aquifer and contributing watershed. It is further advisable you meet with all the interested parties and assess the current water needs of the community.

Although not all communities are the same, there are some general questions you should consider as part of the decision-making process:

- Have you lost production in your current well or wells?
- Has the water level declined?
- How old are the wells? Are there any known degradation, corrosion, or damage issues?
- Are you seeing any water quality changes? Do these changes reflect contamination? Changing water quality regulations? Or will the changes drastically impact your current water treatment methods?
- Are you nearing or exceeding your use allotments per state-defined water rights?
- Are you running the wells longer than 12 hours a day and not keeping up with demand?
- Has the well or wellfield's source water protection area been delineated and are you seeing any change in activities or can you foresee potential change?
- Are there any regional changes in aquifer supply or quality occurring that will impact the current well or wells?
- Have your water needs increased or are they expected to increase due to a change in population or growth of any industry?

Once the decision process indicates a new well is needed, the next considerations should be location, location, location, and design. If a less than ideal location is the only option, then the criteria shifts to location, design, design, and design.

The most cost effective location is the one providing the best quality water with the least chance of being impacted by nearby or upgradient influences. The design of a properly sited well can maximize the benefits of a good location. If a less than desirable location is the only option, then the well's design plays an even greater role. The final design should be developed after a thorough and detailed testing program and understanding of the site.

A dielectric coupler used to insulate connection between dissimilar metals, reducing corrosion.

Many wells have been taken out of service because one of the most fundamental concepts of well design has been ignored. And what is that concept? A deep well is no safer than a shallow well if surface waters or waters from shallow zones are not properly sealed out.

Many systems installed years before the current regulations were in place and enforced are susceptible to contamination due to insufficient grout. Historically, maximum yield was expected from the well and when multiple zones contributed to the yield, they also contribute to the quality.

By going to a zone-specific design, typically better quality water is supplied to the system. A detailed evaluation of the system, aquifer parameters, and water quality needs of different users can result in better use of poor quality water.

Once the portion of the aquifer being developed is identified, the next concern needing to be addressed is overpumping. Sometimes overall water quality can be improved by targeting individual zones in a given aquifer. When specific zones are utilized in an area historically where all zones have been targeted for production, it is unreasonable to expect the same pumping rate. It is best to design the new well so as not to exceed the hydraulic conductivity of the targeted zone.

Detailed evaluation and assessment of water needs and uses coupled with design changes can result in reduced demand on potable wells. It is important to look at the total supply system to determine what infrastructure changes might be needed to better serve the customers and reduce long-term costs.

Sometimes a smaller well can be used if system storage is increased or if blending capabilities are enhanced. High capacity pumps require bigger wells, more power, and can increase maintenance demands.

Assuming a city is using 3 to 5 million gallons a year for parks and green area irrigation, the demand on the potable well system can be reduced by installing use-specific wells. Reducing the demand on the potable supply wells can result in lower operational costs, more efficient pumping systems,

An isolation tool used as a double disk surge block to aid development efforts. The tool allows for a combination of air lifting and swabbing while pumping or injecting chemicals.

and lower replacement well costs. It can also serve to aid in conservation efforts during drought conditions.

Balancing water needs with the resources available will be an important part of water management as we move into the future. There are systems today that have been successfully redesigned so that wells producing water with lower nitrate concentrations deliver to the potable system, while wells with higher nitrate levels are directed to nearby parks and green areas that historically used potable water.

In time, with monitoring and nutrient management, fertilizer and application costs may be reduced significantly, while some of the contaminants are utilized and removed from the aquifer. This usage may still have to be accounted for in most states to satisfy water rights requirements, but the municipality is better served when multiple uses are evaluated.

A number of maintenance and water quality issues experienced by well owners can be traced back to poor well design. Oftentimes decisions implemented to save money initially can result in increased costs of operation, maintenance, and water treatment over the life of the well.

Examples of these decisions include the use of low-carbon steel in moderately aggressive water, resulting in:

- The need for iron treatment at the surface and periodic patching of the well
- Foregoing the use of screen and gravel pack in favor of open borehole construction resulting in repeated pump replacement and premature failure of pipe systems
- Failure to isolate zones of questionable water quality impacting produced water quality with changing regulations.

Many design issues can be avoided by evaluating the treatment history of the current wells and reviewing emerging trends. All too often, mistakes of the past are repeated by simply failing to learn from them.

Aside from the misuse of dissimilar metals downhole, one of the main problems faced with fouled wells is poor initial well development. Development, situated at the end of well construction, is often overlooked and misunderstood.

Poor or incomplete well development can impact well efficiency, water quality, maintenance efforts, and severely affect the operation lifespan of the well. Additionally, improper placement or configuration of the pump assembly can magnify poor development practices.

It is strongly recommended development be discussed as part of the well design and bid process. Key issues include:

- Clear expectations and goals of the work
- Outline of approved methods (multiple recommended)
- Minimum time and per hour cost
- Achievable benchmarks defined by a stepped rate test prior to turnover.

Understanding monitoring of well conditions should go beyond state and federal testing and that routine maintenance is necessary are two important realizations that should go into new well design. Through evaluation of test well data, aquifer conditions, and regional water quality, a short list of parameters should be developed to aid in tracking water quality.

When included with pump efficiency and performance testing, and produced water quality treatment observations, this information can help identify fouling conditions early when maintenance efforts are often cheaper and more effective.

We recommend each well be inspected annually for signs of damage, impact, material degradation, and fouling. As part of the evaluation, the well should be tested for basic water quality parameters as well as certain key tests unique to the well and aquifer, such as carbonate hardness in hard water areas.

In addition, the evaluations should include well pump testing to observe, record, and calculate operational parameters for comparison with original design information and previous test data.

In addition to static/pumping water levels, you should measure flow, pressure, electrical connection, and discharge water quality (turbidity, sediment, etc.).

Assigning a realistic expected lifespan of the well is also an important decision. Far too often we are faced with addressing issues on wells designed with a 25-year active service life that have continued regular use for decades longer.

Increased demand, tightening regulations, declining water tables, and material degradation are all realistic issues that impact the well. Accepting the well will be needed beyond its initial targeted life cycle should become a part of well design.

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Satellite image of the Konza Prairie in north central Kansas. Images such as these can be used to help identify watershed boundaries and assist with delineation of the source water protection area for a well and its area of recharge.

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As such, certain considerations should be included in design decisions to reduce the impact they will have on the well in the future. At a minimum these should include the use of stronger, less reactive materials; provisions for a declining water level; access and accommodations for maintenance; and greater (and verifiable) surface seals and grout.

Summary

The changing weather patterns and evolving role of water in our society have changed the way a lot of people look at groundwater. As such, wells represent a valuable resource to our communities.

With rising costs of materials, equipment, and labor, the price of a new well continues to climb, while at the same time the ability to drill when and where you want is changing rapidly. Deciding whether to replace an existing well is a major decision for many—and as such, should not be taken lightly.

Decisions avoided or not given sufficient consideration can change the costs and lifespan of a well system. Fully understanding your wells, aquifer, system, and needs is key to making the best decision. The goal should be to provide the client with the best available data allowing them to make informed decisions. WWJ

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