Well maintenance has historically been ignored until wells experience a significant amount of deposition and plugging of the pore volume in and around the well. One of the most significant problems with delaying well cleaning is the mineralization process leading to more difficult mineral scale removal. When wells experience loss capacity and water quality changes, it is often necessary to pull pumping equipment in order to perform more aggressive rehabilitation treatments to clean the water well and pore volume of deposited material.

Effective Well Maintenance

The most effective method of getting cleaning energy into the well and the surrounding aquifer is with the use of gaseous and liquid carbon dioxide. If the well is cleaned at an early stage of deposit formation, the effective energy injected into the well allows the surfaces within the water well environment or well screen, well components and gravel pack to be effectively cleaned without the need to pull the pump.

A group of wells have been effectively maintained without pulling pumping equipment from the well since the first pilot installation on Sept. 11, 2001. These wells were experiencing iron bacterial growth so rapidly that they required rehabilitation on a monthly basis and the facility required five micron prefiltration to be changed twice a day at a considerable expense. With the installation of the Aqua Gard well maintenance system, the specific capacity could easily and cost effectively be maintained and the water quality improved.

This article is the first of a three-part series that will discuss well maintenance, well performance and capacity, and finally, preventative maintenance systems that were effective against bacterial growth in a pilot installation.

Maintenance & Rehabilitation

More than 50% of raw water supplies in the U.S. are obtained from groundwater wells. The installation costs of wells and the cost of pumping water are ever increasing, resulting in the increased importance of maintaining maximum efficiency of wells and pumps. In many cases, the cost of well rehabilitation and maintenance over the lifecycle of a well can be many multiples of the original installation cost. Reduction of maintenance costs associated with well operation can significantly reduce the total cost of water delivered.

Many wells experience loss of production and water quality problems as a normal process of aging. The causes of these problems are categorized as physical, mineral and biological.

Often the cause of problems in wells is a combination of bacteria growing in biofilms and filtering minerals from the water as it passes over the surface. Within this biologically accumulated material, fines from the formation (clay, silt and fine sand) can also become trapped. This trapped, filtered and accumulated material increases costs by reducing the efficiency of the hydraulic connection of the well with the aquifer.

If allowed to proceed, well plugging can result in the total loss of the well. Power use is not the only cost increase; the rehabilitation costs more and takes longer if deposits are allowed to accumulate and harden.

Maintenance problems are one of the most significant costs of operating water supply systems. Much of the cost is associated with downtime leading to the need for additional wells and also the inability to achieve a design extraction rate and maintain capture in environmental sites.

The most extreme costs come with complete loss of a capital asset and the returns that asset would have provided. There is natural variability in water chemistry and aquifer composition, requiring specialized materials and construction techniques to install wells that perform as expected.

The subsurface environment is not aseptic as was once thought, and there are abundant microorganisms in subsurface environments. Because of the concentration of flow near the well, microorganisms receive a better food supply than elsewhere in the aquifer and thrive. That same concentration of flow serves to mobilize the finest particles of the aquifer, transporting them to the interface between the well and the aquifer and reducing open space or pore volume. Any reduction of open space in the aquifer will eventually impede flow to the well once the pore volume is reduced enough, resulting in turbulent flow losses in the near well environment.

There can often be too much focus on the bacteria in subsurface
environments. The dissolved minerals in the water are a more significant cause to accelerated lost capacity than the accelerated growth rate of bacteria. Deposits in wells and aquifers responsible for plugging the pore volume are normally composed of both mineral and biological components. The mineral content of the deposit is normally the higher percentage of the deposit (80% on average) and the organic component normally is the smaller percentage of the deposit (20% on average).

In the well water industry, rehabilitation is a term used to reflect many different repairs performed on wells, some of which have no effect on regaining well efficiency. Rehabilitation is the term generally used when the well repair does not involve pulling the pump, an often lengthy and expensive process. For clarity, we define rehabilitation to be a well cleaning process designed to restore lost production capacity or solve quality problems that require the pump to be pulled.

The rehabilitation process will generally involve the use of chemical, physical or thermal treatment, singly or in a combination that is designed to loosen or dislodge fouling, often referred to as deposition. This step can be combined with physical surging, scrubbing and development to move the dislodged material into the well where it can be removed. Preventative maintenance consists of a program of well cleaning with the pump in place that is conducted at a frequency and level of effectiveness sufficient to greatly reduce, or eliminate, the need for rehabilitation.

Routine Procedure Problems
The routine operational procedures regarding well fouling and plugging is to wait until the well has experienced a significant problem before performing some type of rehabilitation or maintenance treatment. Often, the amount of deposited material can be extensive and complete removal of the deposits can be difficult. Under these conditions, it is difficult to achieve the same pore volume that existed when the well was new.

Maintenance is often performed when rehabilitation is required to reduce costs. Cleaning a well with the pump in place creates a significant limitation for removing material from the bottom part of the well and the surrounding aquifer. Consequently, the bottom parts of many wells are not effectively cleaned due to the lack of velocity to get deposits detached from surfaces and effectively flush them from the well.

Traditional chemical treatments are often not capable of delivering the necessary energy to remove the deposited material and return to the original surfaces of the well screen and aquifer materials. Chemical treatments aggressive enough to clean the well screen and pore volume can be too aggressive for pumps. This causes less pore volume to be recovered each time a maintenance treatment is performed and the time frame between treatments becomes shorter.

This historical limitation to maintenance efforts lies in the inability to deliver sufficient force and chemistry into the well and the surrounding aquifer to clean the well and remove the deposits with the pump in place. We report on an effective CO2-based preventative maintenance system that delivers the required force and chemistry to maintain original well capacity, improve water quality, reduce downtime and costs far less than a rehabilitation or conventional maintenance program.

Another common problem facing water utilities in the past few decades is failure of the bacterial test for water quality. The issue of unsafe bacterial samples due to coliform and high bacterial counts has become a more critical issue in recent years, partially due to changes in regulations.

The reason that the bacteria could be present at one point in time and absent at another is because of attachment and detachment. Understanding the attachment of bacteria to surfaces and the occasional detachment is paramount to understanding many of the water quality problems experienced in water systems. One of the benefits of maintaining wells on a frequent basis is more consistent water quality.