



ADVANTAGES

OF REAL-TIME

**WATER
MANAGEMENT**

IN THE OIL FIELD USING

**REMOTE MONITORING
TECHNOLOGIES**



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Integrating technology and operational knowledge creates opportunities for substantial improvements in water management these systems by allowing operators to have real time visibility of water assets while reducing labor, storage and drive time. Automation & tracking also provides users the ability to more closely control water quality and can result in meaningful operational cost savings and reduced management overhead.

According to a nationwide study released in June 2015 by the United State Geological Survey and the American Geophysical Union, the amount of water used to complete a well has been steadily increasing. The latest data shows that the median horizontal well completed in the major shale plays uses between 63,000 barrels and 230,000 barrels of water per well. Added to this increase in water demand is the commonality of multi-well pad locations, which directs this high water volume into one specific location over a series of wells. In an article published in 2014, DrillingInfo reported that 58% of the unconventional wells drilled in the United States were associated with multi-well pad locations. These realities have evolved as a result of operators constantly pushing to make drilling and completion programs more efficient.

The added wells per pad and the increased water demand dictate a comprehensive water management plan for both drilling and completions, with the bulk of water being provided over the completions process. A series of integrated technology and operational knowledge has created opportunities for substantial improvements in water management. One such improvement is the use of AquaView®, a product suite developed by Select Energy Services (“Select”) that allows for operators to have real-time visibility of water assets. This automated system allows for the remote monitoring of specific water management parameters including water level, volume, recharge, discharge, and quality. This system reduces labor costs, increases safety, sharpens storage demand, and reduces the overall management overhead.



Measuring Water Assets

Within the completion program of an E&P operator, the procedural water demand required often calls for significant infrastructure. The aforementioned volumes of water per completion often necessitate a network of water wells, frac pits, aboveground storage tanks (“ASTs”), pumps, and transfer pipe, which can be spread over large geographies, multiple leases, varying water sources, and require teams of management personnel.

One such example of this complicated network comes from a major operator in Pennsylvania. After acquiring third party assets and acreage, this operator found themselves with over 20 frac pits, ranging in size from 50,000 barrels to over 150,000 barrels, spread out over an expansive leasehold. The issues this operator ran into were the engineered design had been altered over the years, the pits had unknown volumes of water still in storage from previous activity, and the water itself varied in levels of quality and clarity. Utilizing the Hydrographic Mapping Vessel (“HMV”; figure 1) and the Remote Pit Monitoring (“RPM”) components of AquaView®, Select was able to create hydrographic maps of each frac pit to determine the existing and potential volumes. The HMV is equipped with a combination of sonar and global positioning

technologies to accurately measure the capacity of the pits and provide data for the RPM units. The HMV is a highly accurate, repeatable, self-contained, and remotely operated device, leading to safe and efficient operations.

The results of the HMV data gathering are a three-dimensional model of the impoundment, which is then used to calculate the static volume of the water. The associated data from this model can also be used to gain information on the potential capacity limits of the storage being mapped.

The RPM units allow users to continuously track water volumes and conductivity measurements in real-time, in addition to receiving alerts if either parameter crossed user-defined thresholds. RPM units are installed after the mapping process and utilize a vented pressure transducer and telemetry system that delivers data from the sensor, via satellite, to Select servers for display on the user’s report page. Based on the customer need, data can be reported with variability between 30 minutes and 2 hours, plus various triggers can be set to send alerts via e-mail and/or SMS text messages. These alerts allow for the efficient management of multiple water infrastructure networks from a remote location.





Figure 1: Hydrographic mapping vessels are equipped with sonar, GNSS and compass technology to deliver a complete view of water assets. It's also strong and nimble enough to navigate environments ranging from flowback pits to tight tree-filled water sources.

By combining these AquaView® components, Select and the operator determined that the frac pits in question held significantly less volume than the engineered designs outlined.



With AquaView, Select discovered there was a 35% difference in full-capacity engineered volume and the mapped volume at full capacity (figures 2 & 3). In some cases, Select has identified variances in excess of 50%. The operator's water supervisor, now armed with an accurate water inventory and real-time data monitoring, is able to communicate to personnel within the organization and to the necessary water transfer operators the exact volumes of water in storage prior to, throughout, and after the well completion.

This inexpensive system provided the information needed for the operator and water transfer companies to easily stay within strict guidelines of maximum and minimum allowable pit volumes.

As one of the largest purely water focused, onshore service companies in the United States, Select delivers innovative and efficient end-to-end water solutions to oilfield operators. Select is dedicated to providing customers with an arsenal of efficient and environmentally conscious water solutions to service the full life cycle of the well. Select

accomplishes this through the unique capabilities of its Water Solutions business unit, which involves products and services like AquaView®.

Select's nationwide footprint, and growing inventory of water monitoring equipment, allows for the easy deployment of AquaView® systems by utilizing experienced, in-house technicians.

The full suite of products ranges from the RPM and HMV units, as mentioned and among other services includes flowmeter monitoring with satellite telemetry, electrochemical and volumetric monitoring, and multi-zonal leak detection systems (figure 4) for various containment options. The proprietary user interface and database architecture of the AquaView® system was developed internally, is customizable to specific needs, and is hosted by redundant servers in multiple locations to ensure reliability. The following example demonstrates the scale and the detail to which AquaView® technology can be utilized and integrated into a complex water management system.



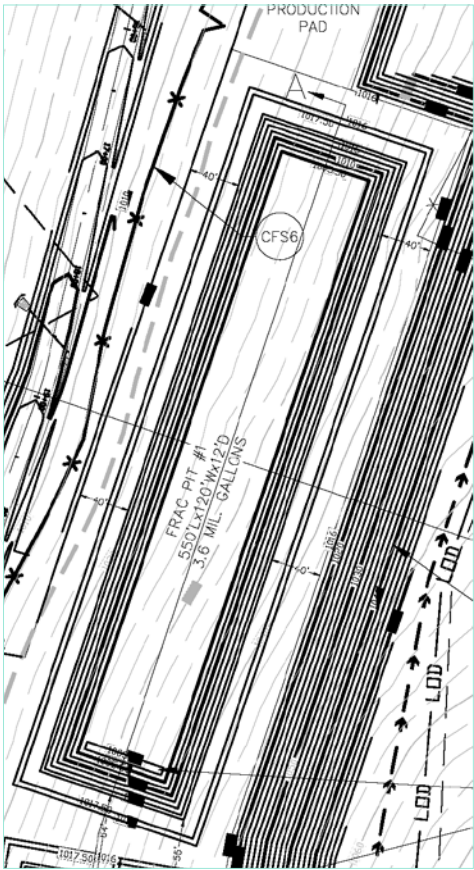


Figure 2. The outside contractor's engineered drawings reflect an as-built maximum capacity of 85,714 barrels.

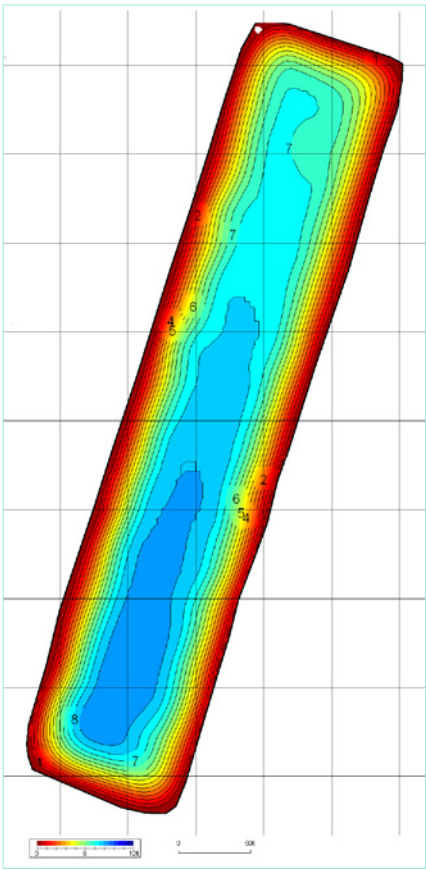


Figure 3. AquaView® 's HMTV created a bathymetric map of the water asset, which determined that the actual maximum pit capacity was only 59,414 barrels. This 31 percent reduction in capacity could have resulted in significant operational issues.



Figure 4: Leak detection units add an extra layer of security to tank monitors. Each section of an aboveground storage tank corresponds to a blue light on the leak detection unit, allowing operators to pinpoint the exact location of a leak. The unit is capable of alerting employees on-site with alarms and lights as well as sending remote alerts to employees via text message or email.



Integrating with Complex Water Management Systems

In the West Texas play in the Permian Basin, there has been a recent push to complete wells with non-potable water sources. Many companies are looking to utilize their own produced or flowback water, or looking towards groundwater resources of lower quality. While this practice reduces the industry's impact on water sources viable for agriculture and human consumption and reduces the cost of disposal, it is not without its challenges. In many instances, these alternative frac water sources will require some level of treatment prior to being sent downhole. When a mid-sized E&P elected to begin reusing its impaired water, it faced several challenges. In analyzing this project, the operator sought to reduce the high storage, treatment, and transportation costs associated with the water needed for its drilling and completion program. Water resource managers at the operator reached out to Select to discuss a semi-permanent and low-cost, water collection, treatment, and storage facility.

The issue with storage was addressed by deploying four ASTs to contain its water. The first two ASTs

directly received raw water via a manifold system and were equipped with oil skimming equipment and the other two tanks were split, one dedicated to hold skim oil and the other one to hold treated water (Figure 5). All tanks were in operation 24/7, so the installation of a monitoring system was deemed beneficial; a programmable logic controller ("PLC") with a customized touch screen interface was installed that allows users to view levels in the tanks on-site at any time. For containment of produced or flowback water, such as these, a density compensated pressure transducer can be deployed for accurate readings, despite the high levels of total dissolved solids. The monitoring system reported real-time data to a web portal where all the associated AquaView® components send data. This portal allows viewers to monitor water levels and volumes in the tanks. One addition to this RPM unit are the safety measures installed in the system. The PLC utilizes a two-stage, on-site audio and visual alert system. When the water level in the tanks reach pre-defined levels, which in this case is 24" of remaining freeboard, then an audible, 30 second alarm will sound and a yellow indicator



light will flash. As a secondary safety measure, if the water level reaches 12" from the top, a second audible alarm will sound for 10 minutes and a red indicator light will flash.

This simple system notified users that thresholds had been exceeded prompting them to make the necessary pumping adjustments to ensure that the tanks do not overflow.

The alarms and display helped ensure that third-party trucking companies were always aware of containment capacity.

Though large amounts of suspended solids were settled out into the containment battery and oil successfully skimmed, significant treatment was still needed. To accomplish this, a trailer mounted mobile water treatment plant using chlorine dioxide was deployed on-site by one of Select's strategic treatment partners. This cost-effective system is a highly automated processing mobile plant with close to 1,500 real-time monitoring points. Between fall 2014 and spring 2015, the entire facility, transferred, stored, monitored, and treated 2.2 million barrels of

impaired water, of which 70% was flowback water from the operator's nearby leases. While every program is different and every situation warrants analysis, the advanced technologies implemented on this program and the partnerships between the E&P, Select, and the treatment group, kept the all-in, average price per barrel of treated water around \$0.92.



Figure 5: Select installed a network of aboveground storage tanks in close proximity to the Permian operations. The remote tank monitor units allowed the E&P company to monitor fluid levels, volume, and quality and efficiently schedule recharge, discharge, and clarification operations.



Managing Variable Costs with Accuracy

The AquaView® system is a technology and service platform that improves communication between water resource teams and the completion program. With declining rig counts and low priced oil, E&P companies are looking for opportunities to extract the most value from every capital dollar.

These case studies show the scope of technologies available and how they assist in the complex process of managing water assets. With variable expenses, such as raw water costs, water transfer rates, loss of water from evaporation and damage from overflowing pits, it is crucial to have accurate water volumes prior to the completion. In some areas, regulations stipulate that overfilling containment is considered a spill. In this case, not only will operators invest in an asset they will not utilize, but costs will increase significantly.

Conversely, under-filling prior to a frac will add considerable expense due to service company downtime until sufficient water is procured.

There are many challenges in obtaining, managing, and transferring large quantities of water for frac completions. AquaView® technologies are a cost-effective and efficient system that can be an important tool for the required planning and attention in water resource management.

Accuracy is absolutely key to this technology, and while there may be cheaper alternatives, those systems lack the precision, efficiency, safety, and the ability to be customized like AquaView®.

Most importantly, the overall price for AquaView® is considerably lower compared to the expenses of mismanaged or underutilized assets.



AquaView® has been proven in every major shale play in the United States with over 200 monitoring system installations and more than 2,700 hydrographic mapping missions.

Strategically deploying a state-of-the-art, remote monitoring system that takes advantage of the latest ruggedized electronics and industry best practices can reduce costs, improve efficiencies, support necessary reporting, and improve overall safety surrounding water management.

Figure 6: Remote units safely and remotely monitor water assets with a small on-site footprint. Each unit uses satellite connectivity to deliver information to operators as often as every 30 minutes.

