

Johnson County's Tomahawk Creek Wastewater Treatment Facility Expands Capacity to Reduce Costs

by Andy Graham, Shockey Consulting Services

One of Johnson County Government's core values is stewardship—the idea that it is building a better community today and for future generations. The county is serious about its responsibility to protect economic, environmental, and human resources. Across county government, this value comes to life in the form of initiatives and investments that make long-term operations more efficient, effective, and sustainable.

“Building a strong community requires investing for Johnson County today and Johnson County yet to come,” said Ed Eilert, the chair of Johnson County's Board of County Commissioners (BOCC) in a 2019 State of the County address.

Johnson County Wastewater (JCW) owns and operates more than 2,300 miles of sanitary sewers, 31 pump stations, and six treatment facilities that reclaim an average of 60 million gallons of wastewater per day (MGD). JCW is a massive county service provider with assets and infrastructure worth more than \$2 billion. As the system continues to age, its staff have focused investments in maintenance, repair, and rehabilitation, all aimed to keep JCW customers satisfied with their service and reduce the risk of expensive emergency repairs. The treatment process by JCW reduces pollutants and disease-causing bacteria below state limits to protect the environment for human and aquatic life.

Site overview, March 1, 2021





Team photo (left to right): Derek Cambridge, Tami Lorenzen, BJ Peterson, Susan Pekarek, Mike Kalis

In 2018, JCW began constructing a complete rebuild of its Tomahawk Creek Wastewater Treatment Facility (WWTF), representing a \$335 million investment in the county's critical infrastructure from study through construction. The biggest capital project in county history, it will modernize operations at the facility and will provide improved cost certainty for JCW customers. Prior to construction, Tomahawk's 1960s-era components were not capable of meeting the clean water standards of today.

The optimal Tomahawk Creek WWTF treatment solution involved tearing down most of the previous facility and rebuilding in the same location. When the project is complete, the facility will treat all flow in the service area, reducing operating costs by a projected \$16 million per year. The investment will also improve water quality, including environmental benefits for Indian Creek, as well as the downstream waters of the Missouri and Mississippi rivers, all the way to the Gulf of Mexico.

The Case for Tomahawk Creek Wastewater Facility Improvements

The Tomahawk Creek WWTF, located at 10701 Lee Blvd. in Leawood, Kansas, was originally constructed in 1955 and has expanded over the years to treat wastewater flows from parts of Leawood, Overland Park, Olathe, and Prairie Village, serving approximately 150,000 residents. With decades of steady population growth, the previous solution was to divert a portion of the received flow to Kansas City, Missouri, for treatment. This started in the mid-1980s and was a good economical solution to their growing needs.

By the 2010s, nearly 60% of Tomahawk's incoming flow was being directed to Kansas City, Missouri, for treatment at two to three times the cost of treating it locally. The current facility cannot process any increased flow, and many of the facility's assets are at the end of their useful life, requiring replacements and upgrades. Kansas City is also facing the need for significant improvements to their infrastructure leading to rate increases. At the same time, the Environmental



Overview of the BNR structure, March 1, 2021

Protection Agency and Kansas Department of Health and Environment are requiring stricter limits on discharge of ammonia, nitrogen, and phosphorus. These drivers led Johnson County Wastewater to act, knowing that something must be done to improve Tomahawk Creek WWTF.

“To do nothing was not an option,” said Tamara Lorenzen, assistant chief engineer for JCW and project manager for the Tomahawk facility expansion. “We could not meet or continue to meet current permitting standards.”

Seeking an effective solution to treating the area’s wastewater, JCW hired consultants to study alternatives for increasing treatment capacity and efficiently operating the treatment facility into the future. A new, expanded facility to treat all flows on the existing site was selected as the preferred solution to:

- Provide the most cost-effective, long-term solution for customers;
- Improve water quality using the latest, proven technologies;
- Protect the environment including water that flows to Indian Creek and downstream communities; and
- Preserve the high quality of life enjoyed by Johnson County residents.

“This project is the best long-term solution for treatment in the Tomahawk service area as well as the best environmental solution,” said Susan Pekarek, JCW’s general manager.

In March 2018, the Johnson County BOCC unanimously approved the construction phase of the project and the team broke ground in mid-April 2018. Major work at the treatment facility is expected to be completed by the end of 2021, with commissioning and startup planned for the fall of 2021 and into 2022. While the previous facility treated approximately 7 million gallons of wastewater per day (MGD), the expanded facility will treat 19 MGD of average annual daily flow. This will also provide capacity to treat flow from the projected ultimate build-out of the service area, meeting the future needs of the residents.

Significance of the Tomahawk Creek WWTF Project

This is the largest infrastructure project that Johnson County has undertaken to date, and it is significant for a number of reasons. First, as part of the project a new National Pollutant Discharge Elimination System (NPDES) permit was negotiated with the State of Kansas for the Tomahawk facility that included peak wet weather



BNR structure, March 1, 2021

treatment, allowing the facility to receive peak hour flows up to 172 MGD. This was the first time JCW negotiated such a provision, and it saved the county more than \$200 million in capital costs as opposed to building wet weather storage. Second, this project would not exist without the innovative and proactive problem-solving efforts of JCW staff, who worked closely together with the project team when trying to consider if there was a better way to serve customers into the future.

“JCW Chief Engineer Aaron Witt and I have been studying this facility and working to find the best solution for well over a decade,” Pekarek said. “This project represents the best long-term solution for serving our rate payers for the next several generations.”

The entire team evaluated several alternatives and determined that building an expanded facility with capacity to treat all of the area’s wastewater was a lower cost, longer-term solution than continuing to treat only a portion of the flow. Once the project is complete, JCW will have greater control over managing the cost of treatment and therefore the sewer rates charged to customers. It was estimated that over a 35-year period, the cost to upgrade and operate a 10 MGD facility would cost \$785 million more than expanding the facility to 19 MGD and treating all the flow on-site. It’s anticipated that by the end of 2021 all flow will be treated at the new facility.

“This is one of the largest wastewater projects we’ve worked on. There have been dozens, but this is the largest in Kansas or Missouri,” said Michael Kalis, vice president and water section manager for HDR, a key engineering partner on the Tomahawk Creek WWTF expansion.

The 19 MGD option was chosen for its capacity to handle full build-out of the entire Tomahawk Creek service area, so no future expansions are anticipated. The life expectancy of the new facility is comparable to any mechanical facility, with major mechanical components anticipated to last approximately 20 years before requiring replacement.

“For me, the biggest takeaway from working on this project is you shouldn’t be afraid to think outside the box,” Lorenzen said. “It would have been easier to stay with the status quo.”

A Fresh Approach to Project Management and Collaboration

The Tomahawk Creek WWTF is a joint project of JCW, engineering firms Black & Veatch and HDR, construction lead McCarthy Building Companies, and Shockey Consulting overseeing community engagement. McCarthy serves as the Construction Manager at Risk (CMAR), a role that represents a progressive approach to keeping complex, high-risk projects such as this one on-schedule and on-budget. The benefits of this model include a shorter feedback loop, greater collaboration between all parties, earlier true cost awareness, and significant pre-design work.

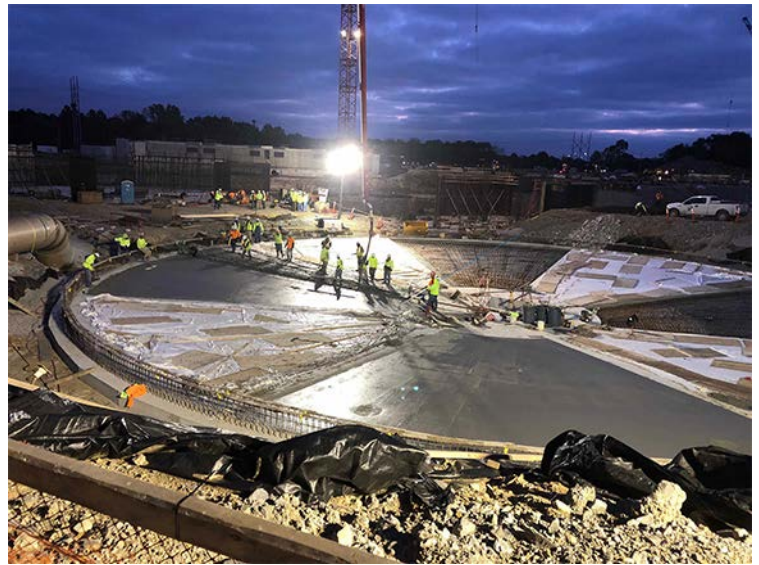
“Of the best practices used during this project, most notable would be the CMAR delivery process that was selected to help JCW track project costs earlier in the schedule, provide schedule certainty, and use a collaborative approach in the design process,” said Derek Cambridge, Black & Veatch’s associate vice president, water. “One of the great successes of this process was how the value engineering efforts saved approximately \$44 million (during design).”

Close collaboration with JCW operations staff ensured all permit and environmental regulations were followed, a crucial component of moving the project forward. Despite the COVID-19 pandemic, the project team stayed in close touch, leveraging drone video, aerial photos, and 360-degree photo technology to communicate progress and coordinate virtually as a team. The team also created a frequently updated project website to help communicate construction progress, engage the public, and explain how treatment processes work.

“Seeing the team continue to come together and find solutions to meet challenges and keep the project moving



Piping, August 20, 2019



Pouring clarifier slab, October 16, 2019



Final clarifiers, March 17, 2020



Final clarifiers, March 1, 2021



Final clarifiers at ground level, March 4, 2021



Digesters, March 1, 2021

forward on schedule and budget has been exciting,” Cambridge said. “It’s been a rewarding project to be a part of with a great team mentality for working together. By the end of the year the new facilities will be operating and allow the county to reduce their operating costs.”

A big part of the project was developing and nurturing relationships with community partners and nearby neighborhoods. Shockey Consulting led outreach efforts to make sure residents in the area have been kept up-to-speed on progress at the facility. A project website (<https://www.jcwtomahawk.com>) was developed to provide more information, updates, and live streaming video of the project. This project is good for the local community as it allows JCW to better serve ratepayers with the latest technology for more efficient operations, a higher quality water product that is better for the environment, provides improved odor and noise control, and keeps rates affordable while treating all the flow onsite.

“It’s been good to work with the community and have productive community conversations,” Pekarek said. “At the county, we are a high performing organization, which means we want to leave the county and community better than we found it. This project represents that philosophy.”

Environmental Benefits

The new facility will provide multiple environmental benefits to the area, including how it will improve Tomahawk Creek's and Indian Creek's stream health. It will feature dual purpose filters to provide enhanced nutrient removal for phosphorus and nitrogen, as well as treating peak flows during wet weather events. These nutrients promote algae growth, which can impair the stream. By enhancing the stream, JCW not only protects aquatic life, but it is also good for the community. Improved nutrient removal provides near and far field stream benefits and addresses nutrient impairments in Indian Creek and beyond. The increased effluent flows

Filter and disinfection complex, March 1, 2021



will mitigate some of the seasonal low dissolved oxygen concerns experienced in Indian Creek due to low summer creek velocities. Beneficial biosolids will be reused on crop land, and sidestream treatment using annamox, a new energy-saving technology that will pay for itself in five to seven years.

“The team completed a dynamic model of Indian Creek and confirmed the additional base flow in the creek created by discharging treated water from Tomahawk will benefit the water quality in the downstream section of the creek,” Cambridge said. “It will provide better dissolved oxygen and less algae growth. Water quality downstream will be improved by removing higher levels of nitrogen and phosphorus.”

Navigating Project Challenges

Among numerous project challenges such as the arrival of the COVID-19 pandemic and working within a tight construction footprint, the Tomahawk Creek WWTF project kicked-off during the wettest 365-day period in the Kansas City region (64.25 inches of total rainfall between Oct. 1, 2018, and Sept. 30, 2019). Since the site was almost entirely in the 100-year flood plain, the wet weather made construction much more complicated. The site was raised using fill excavated from the site, plus imported material. A large overflow channel was constructed to serve as a relief point for Indian Creek floodwaters, eliminating the potential for additional upstream community flooding. Flood water could flow through the channel, essentially bisecting the site in two, which requires a bridge to maintain access to the site once the site is fully operational. Ultimately the site will be raised to the 500-year flood elevation to allow for continuous access to the site during wet weather conditions.

Other obstacles included a project footprint that is 30% greater than that of previous facilities. At one point in construction, there were more than 400 craft employees working on site, supported by three tower cranes and three rough terrain cranes. The team also encountered varying rock elevations in the old sludge lagoon area,

and an old, buried stream channel running through the site that required additional time and efforts to address. These factors, in addition to the unusually wet weather, pandemic, characteristics of underground rocks in the area, and maintaining crane access, made the job very complex.

“Moving equipment, material, and craft workers on a tight site requires the entire team to work closely on a daily basis to optimize site logistics and keep everyone safe,” said B.J. Peterson, vice president at McCarthy Building Companies. “Despite wet weather, different underground conditions and a pandemic, we’ve worked together to keep the project on schedule.”

State-of-the-Art Technology and Key Innovations

A project with so many moving parts and unique challenges required next-level innovations and technology for success and to achieve the desired outcome. These include a unique influent pumping scheme that lets JCW handle flows ranging from 7 MGD (diurnal nighttime low flow) to 172 MGD (peak hour wet weather flow).

The nutrient removal facilities use a Sidestream Enhanced Biological Phosphorus Removal process (S2EBPR), which protects biological processes, specifically conditioning phosphorus accumulating organisms from adverse effects during wet weather. Coupled with the S2EBPR is the fermentation process applied to primary sludge that uses the energy in wastewater to reduce the need for chemical supplementation. Another innovation is sidestream treatment using annamox bacteria to remove ammonia—a more efficient process than sizing the main liquid process. A more detailed look at each process at the Tomahawk Creek WWTF can be found by visiting the “How it Works” page on the project website, <https://www.jcwtomahawk.com>.

Looking Ahead

As Johnson County Wastewater continues to meet the challenges of aging infrastructure and higher



Headworks and primary clarifiers, March 1, 2021

effluent quality standards, successful projects such as the Tomahawk Creek Wastewater Treatment Facility expansion prove that innovations, creativity, and a solid team mentality can achieve great savings for the public and improved services. As JCW embarks on other large-scale, complex projects to maintain and improve the county's wastewater system, lessons learned from this experience are sure to benefit residents, in many ways, for generations to come.

“This is a great project team that shared a common vision, values, and purpose, which is resulting in a high-quality project from cost, schedule, and construction—all of which I expect will translate to ease of operations,” Pekarek said. 💧