

WHITE PAPER / **WATER AND WASTEWATER INFRASTRUCTURE**

# INNOVATIVE RETROFITS TO EXISTING PLANTS CAN TURN CHALLENGES INTO OPPORTUNITIES

**BY Kerrie Greenfelder, PE, DBIA**

With growing populations and increasingly rigorous regulations, owners and operators of water and wastewater treatment plants are working to keep pace. But space and budget concerns often provide significant challenges, leading to a rise in retrofitting and rehabilitation. Technology, innovative design and the right project delivery model can provide efficient solutions.



Allocating green space for new water and wastewater treatment plants can be problematic, especially in large cities. At the same time, securing funding for these projects is becoming much more difficult, forcing many cities into retrofits rather than rebuilds. But a smart, well-considered strategy — delivered by an integrated team through a collaborative model — can transform these limitations into benefits.

## REASONS TO RETROFIT

Budget and space considerations are often the most significant factors in opting for a retrofit or rehabilitation over a rebuild, but the approach also provides several other benefits:

- **Energy Efficiency:** According to the Office of Energy Efficiency and Renewable Energy, wastewater facility retrofits can yield up to 50% in energy savings and 30% on average, as many of the original treatment processes are rehabilitated as part of the project approach.
- **Improved Public Perception:** Retrofits demonstrate a strategic use of public funds. And because additional land is rarely needed, not-in-my-backyard opposition is avoided.
- **Operational and Regulatory Consistency:** Operators know the ins and outs of their plant, and can be a major asset in planning how to maintain treatment during the work. In addition, retrofitting an existing plant can minimize regulatory efforts, as which body of water the plant discharges into is already established.
- **Reliable Security:** Public infrastructure is becoming an increasing target for vandalism and/or terrorism. Working on a site that's already secured can help alleviate these concerns and preserve public safety.
- **Repurpose Capabilities:** Structural elements of a wastewater or water treatment plant are often in good condition. (A large concrete basin has a considerably long lifecycle.) Repurposing elements can offer significant cost savings.

## SCANNING AND PLANNING

Approaching a plant retrofit is akin to buying a 50-year-old house without inspection — there are no guarantees as to what's under the surface. A precise understanding of the condition and location of existing infrastructure is essential. What's underground and what shape is it in? What piping might need to be worked around? What needs to be added and what needs to be removed? What else can be improved while working in the same area?

Newer technologies, including 3D scanning, lidar, drones and wireless data acquisition, can supplement site visits and high-definition photography to provide a deep and detailed look into a plant's inner workings. By using this data to develop a 3D virtual reality design, the project team can model the current layout and test the impact of various treatment configurations.

A 3D design can help identify and resolve conflicts before demolition begins. When team members know the location of every structural beam, pipe and piece of equipment, they can confidently develop and test design solutions in a true-to-life virtual environment. These capabilities help projects achieve higher technical quality and gain greater efficiency, conserving budgets and speeding schedules.

These visualization tools can also change the way the owner, the engineer and builder approach and collaborate on water and treatment projects. When a virtual reality model brings issues and potential solutions to life, the client gains a better foundation for decision-making and the general public gains a greater understanding of the project as a whole.

## A CUSTOM, CREATIVE SOLUTION

Space concerns demand an innovative, creative approach to treating influent flow. Because each retrofit is unique, most projects present more than one treatment scenario to accommodate future increased flows and meet anticipated regulatory requirements for nutrient removal. An integrated team that can provide a number of options — as well as recommendations based on the



big picture — is a significant asset. Many of these options can be evaluated using desktop analyses and reliable, industry-accepted tools, eliminating the need for costly physical testing and thus saving those valuable funds for use in the infrastructure rehabilitation.

The right treatment scenario is driven by a wide variety of information, including:

- Analysis of influent flow and loading data using monthly operating data and discharge monitoring reports.
- Forecasted flowrates based on census data, population growth predictions and hydraulic modeling based on metering data.
- Both conceptual and detailed modeling of the treatment system to predict plant performance for a variety of process configurations.
- Hydraulic modeling of each service area to predict future flowrates.
- Physical evaluations of facilities, evaluating treatment processes and associated equipment from growth, regulatory and capacity standpoints.
- Regulatory reviews based on national, state and local nutrient water quality criteria.

With that data, the project team can recommend several treatment scenarios, encompassing headworks, biological treatment, clarification, disinfection, solids handling and ancillary facilities. A number of emerging techniques and technologies — such as integrated fixed film activated sludge (IFAS), granular activated sludge (GAS) and membrane bioreactor (MBR)/aerated biofill — can be viable options, particularly for biological nutrient removal (BNR) of nitrogen and phosphorus.

The project team and plant operators will also collaborate to reduce disruptions to operations. After all, city officials can't ask citizens to stop taking showers, flushing their toilets or washing their laundry and dishes for the duration of the project. Proper phasing and strategic scheduling allows the plant to maintain treatment throughout the retrofit.



## INNOVATIVE SOLUTIONS LEAD TO COST-EFFECTIVE RESULTS

More stringent treatment requirements and the need for additional capacity drove improvements at an aging wastewater treatment plant in Emporia, Kansas — but the budget to rebuild wasn't there. A design-build delivery approach and alternative technology enabled the repurposing of existing infrastructure, saving the city \$1 million. As a team, Burns & McDonnell and our construction partner worked collaboratively to meet impending discharge permit requirements, using an innovative technology based on an IFAS process. The approach eased installation in the existing aeration basin, effectively eliminating the need to build separate anaerobic/anoxic basins for nutrient reduction.

## COLLABORATIVE DELIVERY FOR OPTIMAL RESULTS

Ideas rely on implementation to make an impact — and efficiency is essential for complicated retrofit projects. An integrated design-build approach offers a single point of accountability, enhanced collaboration and reduced project cost and delivery time.

With this approach, designers, engineers and builders work together as a single united team. For example, Burns & McDonnell and one of our trusted construction partners have collaborated as a team on more than 30 water and wastewater treatment projects, all delivered with no change orders, no safety incidents, no cost overruns and no schedule delays.

Enhanced collaboration and communication is especially important on plant retrofit projects, where creative solutions are prized but must be constructable to be viable. With design-build, constructability is considered throughout design, so by the time the solution hits the field, and often before it's even on paper, it's tested and vetted to work.

Constant communication and cohesion between engineer, owner and builder bring out the best in each discipline for the project's benefit. Engineers are challenged to develop buildable solutions that can be implemented affordably; contractors are challenged to offer buildability advice for the implementation of certain technologies. And it's rare to find anyone that knows the existing facility better than the owner, whose valuable input guides the project.

Design-build creates an underlying foundation of predictability that positively affects safety, constructability, quality, budget and timeline. It's also optimal for procuring, scheduling and testing — and creates the potential for flexibility that a retrofit often demands.

## THE RETROFIT REVOLUTION

For water and wastewater plants, new construction is typically the most expensive option — and space concerns add another complication. So, it's no surprise retrofits and rehabs are an increasingly popular solution. Especially when delivered using a design-build approach, retrofitting a plant delivers a host of benefits: consistency in operations, a reduced regulatory burden, potentially shortened schedules, improved public perception, energy efficiency and — most importantly — cost savings.

## BIOGRAPHY

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**KERRIE GREENFELDER, PE, DBIA**, a municipal water department manager at Burns & McDonnell, has more than two decades of experience in design-build for water/wastewater treatment, as well as landfill design and construction. She's been involved in providing design and management for design-build projects for a variety of municipal, public, industrial and federal clients. She is an active leader with the Water Environment Federation (WEF), Society of Women Engineers (SWE), and the Kansas Society of Professional Engineers (KSPE).