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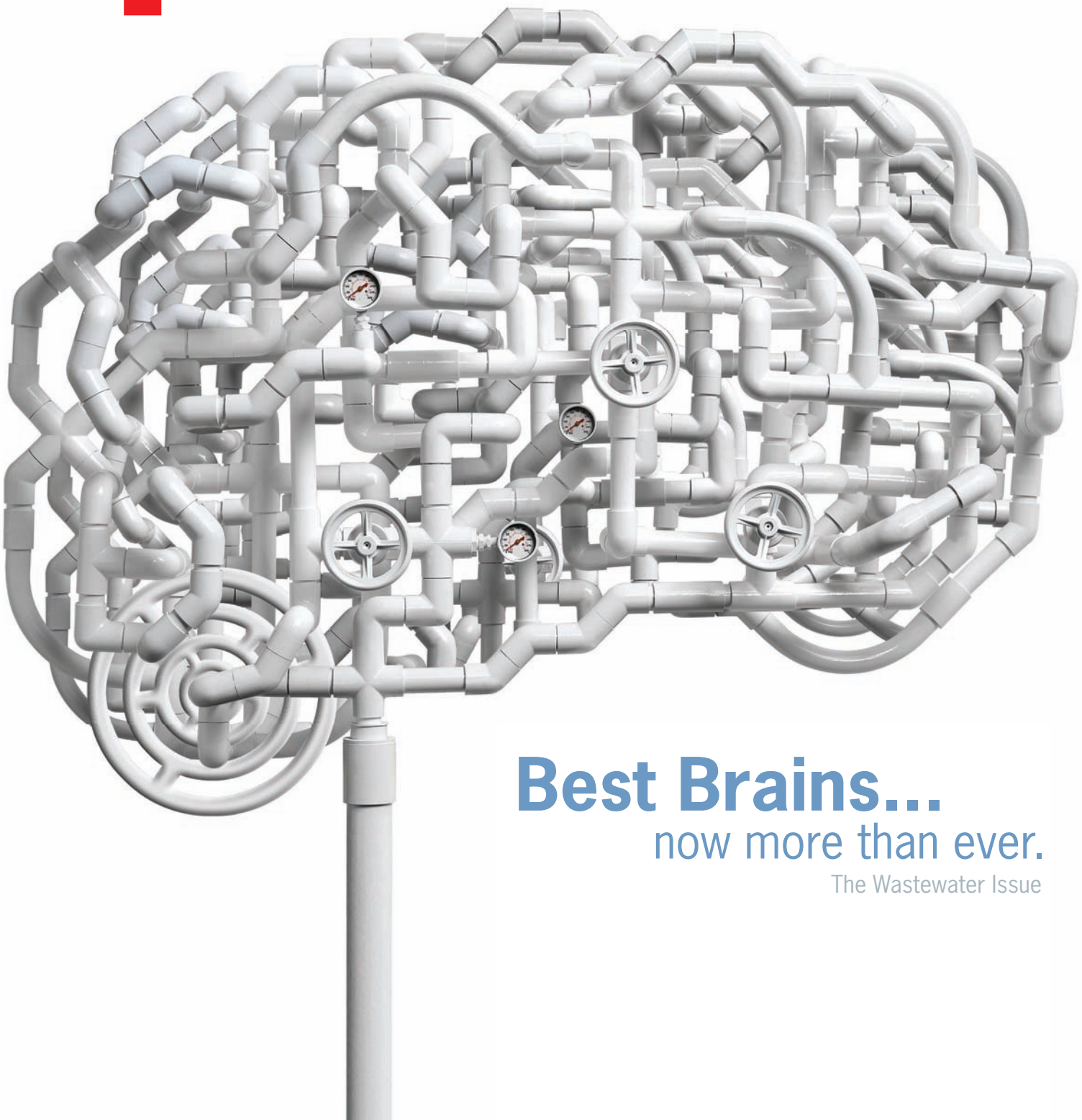

Best Brains...
now more than ever.

The Wastewater Issue

COVER PHOTO BY JEFF ALEXANDER SCULPTURE BY IVAN THELIN

QUARTERLY

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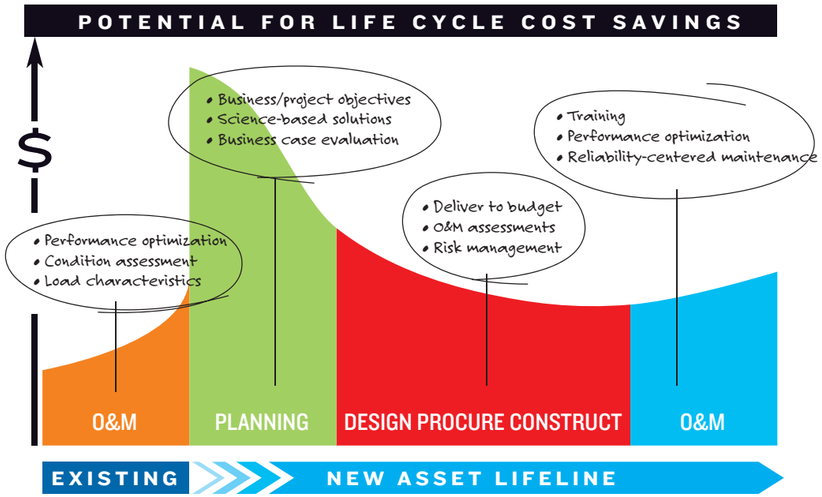
ISSUES & IDEAS

BEST BRAINS DELIVER

GET MORE FOR LESS BY FOCUSING UPFRONT ON BEST LIFE CYCLE SOLUTIONS.



Now more than ever, today's wastewater challenges demand "best brains" solutions. Utilities are under intense pressure to provide better service, throttle rates, accommodate growth with fewer staff and more stringent regulations, and provide greater accountability on all fronts. Plants must also treat flows for nearly all wet weather conditions, integrating new processes and technologies. And that's not the full story—many also have recalcitrant NIMBY communities and limited space for plant expansions.

The need for creative thinking in wastewater is as high as it's ever been, and "best brains" is Brown and Caldwell's shorthand for innovative, science-based solutions that are creative and cost-effective, yet practical. It's an open and inclusive approach to solution-making that draws in the best brain ideas from plant engineers and operators.

To be sure, innovation in the industry is highly valued; however, alternate methods of project delivery—aimed at managing risk—may be receiving greater emphasis. Solutions driven primarily by capital costs can be limiting ... and costly. A utility that's focused mostly on delivery at a project's outset may just miss its greatest opportunity to uncover life cycle savings while also meeting short-term capital cost constraints.

Smart upfront planning

While assessing current projects, client needs and industry challenges, 25 BC wastewater engineers recently concluded, once again, that their highest potential for savings, optimization and cutting-edge thinking is consistently found upfront, in the operations and planning phases, before projects enter final design, procurement and construction delivery steps.

More than ever, there is a very real benefit for thorough front-end planning. Business-case evaluation of capital projects and science-based solutions routinely uncover major opportunities for cutting not just construction costs, but the operations, maintenance and life cycle costs.

Make the business case

A clear-eyed business-case evaluation (see back cover) for a project is gaining acceptance and will soon be standard practice for most capital expenditures. Capital projects will receive more front-end scrutiny and needs validation—best brains work. The push is on to optimize overall business performance, attaining key performance goals (customer satisfaction, environmental benefit, compliance, etc.) while minimizing overall costs to ratepayers. Two essential upfront questions:

- Is this project needed? Look at the real, core issues that need to be solved. Is it capacity and/or compliance? Aesthetics, odor, noise? And what customer service levels really need to be met?
- What's the payback? With the core problem identified, institute a decision process that will lead to the solution with the lowest total life cycle costs, including capital, O&M, risk (the costs of equipment failure) and future rehab and replacement.

Science-based approach

Perhaps the low-cost answer is new treatment plant assets, but making the most of an existing facility has high payback every time. Many plants can perform at much

CONTINUED ON PAGE 21

Utilities are launching a new age of wireless, remote wastewater treatment plant automation

Mission:Control

For decades, wastewater treatment plant operators, clipboards in hand, would roam through facilities checking flows, levels and pressures and manually write down the data.

But today, in more and more plants around the country, that information is flowing automatically and remotely from communication devices imbedded in valves, flow meters, level detectors and scores of other instruments and analyzers throughout the plant.

It's a different world, and in a lab simulation for the Jupiter Wastewater Treatment Plant, BC's process control team has been exploring its possibilities. Jupiter—a fictional plant—is a test program to develop divisional control system standards for King County, Wash., using an open framework approach.

"Open framework means that any manufacturer's instrument or control system can connect to and openly communicate with other manufacturer's devices or systems," explains Kevin Stively, leader of the instrumentation and control (I&C) project for BC's fast-growing process control team in Seattle.

The test lab was developed to support control system design strategies for the county's major new 130 mgd greenfield facility, in which all plant operations will be fully automated. In the lab simulation, 10 computers, four programmable logic controllers (PLCs) and one human operator can remotely control every single operation in the plant.

"With the Jupiter pilot, we've successfully demonstrated wireless, automated and remote control for a major facility,"

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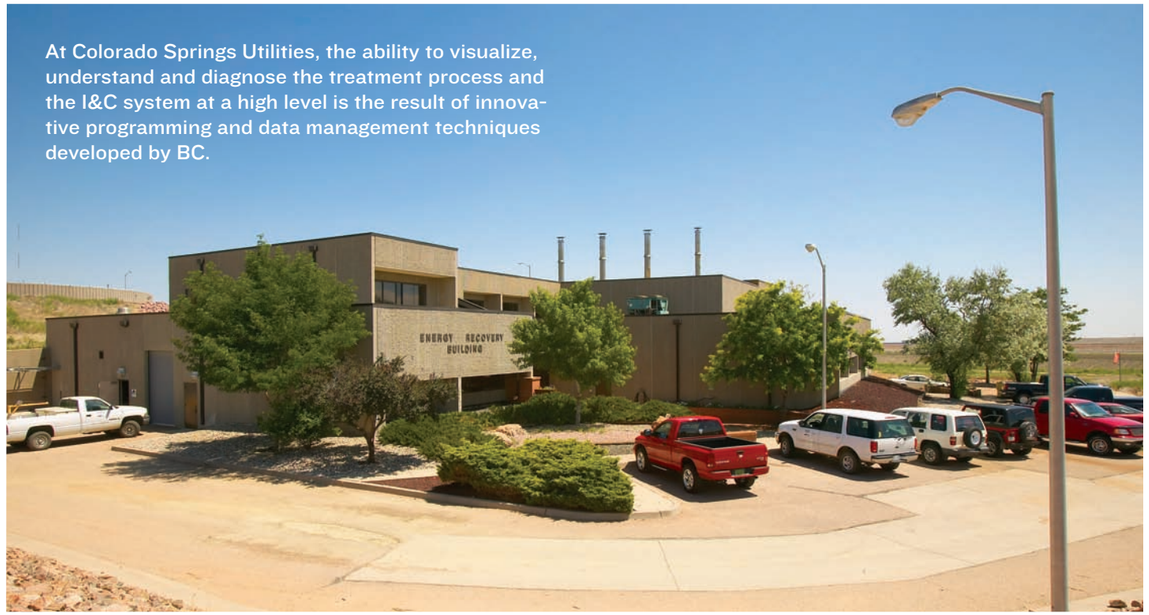

At Colorado Springs Utilities, the ability to visualize, understand and diagnose the treatment process and the I&C system at a high level is the result of innovative programming and data management techniques developed by BC.

PHOTO BY EDWARD L. EWERT

Stively states. "Without a doubt, these sophisticated control and data systems are changing the face of the wastewater treatment process."

Moving the bar

They're already transforming it in places like Colorado Springs. When the local utility there recently expanded its Clear Springs Ranch Solids Handling and Disposal Facility, the agency replaced outdated PLCs, upgraded the plant's data visualization system and installed a state-of-the-art control room—all while the plant was in full operation. With the new instrumentation and control system, the facility only requires on-site staff 40 hours a week; the rest of the time, a single operator runs it remotely.

The ability to visualize, understand and diagnose not only the treatment process but also the control and instrumentation system itself at a high level of detail is the result of innovative programming and data management techniques developed by BC Engineer Fred Wilson.

"Clear Springs Ranch has moved the bar in terms of what a process control system can do," says BC Engineering Manager Dennis McQuillan, who oversees all electrical controls, design and programming as manager of Brown and Caldwell's seven-person electrical, instrumentation and control staff in Denver

"This technology is really new—we've never had this level of automation and connectivity before," notes Colorado Springs Utility's Team Leader Jay Hardison. "It's definitely decreased our costs, since staffing can be as much as 30 percent of a plant's budget. It also gives us much better, more consistent and more accessible data."

The new process control system works so well that the utility is installing a more advanced version in a second plant—the 20 mgd greenfield North Water Reclamation Facility, now in construction. The plant will be unmanned and operated from a remote monitoring location.

"The North Water facility will essentially run by itself," Hardison says. "When events do occur that need attention, the process-control system will automatically page on-call operators. They'll then be able to use laptops and Internet connections right at home to patch into the control system and do everything that they formerly would have done on-site."

Rich data

This kind of sophisticated automation depends on a continuous feed of rich, real-time data from the instrument level on up.

"With our new field networks, we can access vast amounts of information about each individual intelligent instrument and device," explains Gary Wyse, SCADA Systems administrator for the Littleton/Englewood Wastewater Treatment Plant near Denver. As part of a $110 million expansion of the plant, the City of Littleton converted all of its PLCs from traditional copper wire inputs and outputs to advanced network data communications.

Now, operators can remotely perform instrument calibrations, control processes with fewer staff, free existing operators to improve performance and reduce the overall cost of operating the plants and treating wastewater.

"With Brown and Caldwell," Wyse adds, "we were also able to create a superb human-machine interface that could set a new standard for the industry. The depth of information we can get is unbelievable—with a design standard that requires no more than five clicks, operators can access any piece of data or diagnostic immediately. Working with Brown and Caldwell also allowed a synergistic informal sharing of SCADA standards that benefited both utilities."

O&M savings

These sophisticated data capture, organization and management techniques, Stively says, can also lead to big savings on operations and maintenance. The wealth of field-device information, combined with advanced diagnostics programs, enables utilities to perform maintenance when it's really needed—just in time—instead of according to a traditional fixed schedule.

"Utilities everywhere," he notes, "face shrinking budgets for maintaining their processes and equipment. Increased automation saves money by allowing them to monitor processes and respond as needed to actual changes in conditions.

"They can also use historical instrument and control data to predict their equipment replacement needs, based on actual running conditions instead of on the manufacturer's expectations."

Maintenance costs can drop significantly, Hardison agrees, thanks to online diagnostics. "When the system detects that some piece of equipment needs attention," he says, "the operator is often notified before the point of failure. We are moving toward having the control system automatically issue and schedule a work order, saving the operator the task of doing that manually."

Today, maintenance staffing requirements have been reduced by as much as 40 percent.

Utilities, Stively adds, can also use the wealth of historical field data to create standard operating procedures that are documented, reproducible and defensible.

"As long-time operators retire," he explains, "these systems can supply critical field knowledge and go far to help ease the brain-drain problem."

Smart upgrades

Putting these advanced electronic systems in place is a lot less expensive than in the past.

"There have always been electronic controls," notes Hugh Pace, who leads BC's 20-person electrical and control team in Phoenix. "But typically, they've been patched together piecemeal over the years, and there was no easy way to tie them together."

Now, however, technology has advanced so that utilities can connect all these disparate programs in a central system without having to redo them.

"Compatibility's not an issue anymore," he states. "New technology gives you a seamless framework for all your activities."

As systems age, he points out, many utilities are realizing that it's a good time to take a look at upgrading and networking their operations.

"The initial upfront costs are small," he says, "in comparison to the long-term manpower savings you achieve when plants are automated."

For more information, contact Kevin Stively at 206.749.2262, kstively@brwncald.com; Dennis McQuillan at 303.239.5481, dmcquillan@brwncald.com; or Hugh Pace at 602.567.3873, hpace@brwncald.com.

Putting these advanced electronic systems in place is a lot less expensive than in the past.

Membrane bioreactor technology—paired with top-quality process design—is the cutting edge in wastewater treatment

When a small coastal community began planning a new wastewater treatment plant, it faced some big challenges. The narrow site was near an environmentally sensitive shellfishery and next to a marina and waterfront park filled with boaters and picnickers.

To meet these space, water quality and aesthetic challenges, utility managers turned to membrane bioreactor technology, known as MBR—three letters that are fast revolutionizing wastewater treatment across the country.

Taking the industry by storm

MBR facilities use space-efficient microfiltration or ultrafiltration membranes, instead of secondary clarifiers, to separate activated sludge from treated effluent. With proven technology and fast-dropping costs, MBRs are now taking the wastewater industry by storm.

"Membrane bioreactors have exploded on the scene over the last few years," says Brown and Caldwell Vice President Eric Wahlberg. "It's probably the most significant breakthrough the wastewater industry has seen in decades."

A big advantage, he explains, is that MBR plants can be constructed in small spaces. In Snohomish County, Wash., for example, the Alderwood Water and Wastewater District is doubling the capacity of its 3 mgd wastewater treatment plant on a site with approximately 4 acres of space.

"Even with this limited footprint, MBR technology is enabling the district to serve its fast-growing population," says BC Project Manager Art Molseed, who is spearheading the project's membrane procurement and solids handling design.

The small footprint of membrane bioreactors also makes it possible to design aesthetic exteriors that disguise the true

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PHOTO BY **XENON**

MBRs can substantially reduce a treatment plant's footprint, making it possible to design aesthetic exteriors that blend in with their surroundings. These three images, although not all BC designs, demonstrate this feature: **1**) An artist's rendering to the BC-designed LOTT Hawks Prairie Satellite Reclamation Plant (hollow fiber); **2**) the Wessex Water treatment plant in Swanage, England (flat-sheet); and **3**) the Cauley Creek Water Reclamation Facility in Fulton County, Ga. (hollow fiber).

purpose of the facilities. In England, for example, a 3.5 mgd MBR plant was built in the middle of a small, fishing community that's a popular tourist destination, concealed in a stone structure designed to look like a traditional boatyard.

"MBRs are so small and easy to hide that they can even be built in affluent residential neighborhoods," notes BC Senior Process Specialist John Bratby. They can work as standalone treatment facilities serving 20 to 50 homes as well as satellite or end-of-line plants in larger, more populous communities.

High-quality water

Another advantage is that they produce extremely high-quality effluent. "The discharge is largely bacteria-free," explains BC Wastewater Treatment Specialist Henryk Melcer, "and to a limited extent, it also removes viruses." As a result, MBR effluent meets the most rigorous water quality standards—a key consideration in areas where discharge is reused or could adversely impact marine and shoreline environments.

In Washington state, for example, a partnership of Lacey, Olympia, Tumwater and Thurston counties (the LOTT alliance) is building the first of three satellite MBR wastewater treatment plants that will produce Class A reclaimed water for irrigation and recharging a potable water aquifer.

"As the area's population grows," says BC's Project Manager Bill McCarthy, "LOTT will be able to expand the capacity of its satellite plants in small increments, up to 5 mgd each, to meet its goal of cleaning, restoring and reusing wastewater and ultimately returning it to the environment."

Good process design

Given these advantages, it's no wonder that many communities are interested in constructing MBR plants. "Especially as effluent discharge standards become more stringent and supplies of fresh water dwindle," Wahlberg explains, "there's increasing interest in wastewater treatment technologies that can produce high-quality effluent for reuse."

But utilities considering MBRs need to understand that good process design is crucial to the successful operation of these plants.

"MBR isn't a turnkey, plug-and-play technology," Wahlberg cautions. To begin with, the available technologies vary widely. One manufacturer may use hollow-fiber membranes, arranged horizontally or vertically in rows, while another vendor may use membranes shaped like flat plates that are stacked in layers.

"Brown and Caldwell," McCarthy notes, "has worked with all the major membrane manufacturers on MBR projects," and each one features a different cleaning frequency, complexity and ease of access. Different manufacturers also have different engineering requirements and limitations, depending on the flow and composition of the wastewater.

MBR is not a turnkey, plug-and-play technology. One size doesn't fit all.

"One size doesn't fit all," Bratby cautions, "and it's always essential to have careful process design."

Skipping that step can be costly, as a community in the Southwest discovered. "The local utility rented a crane, brought in MBR modules and fired them up without adequate design and planning. That plant," Wahlberg says, "has since gone though three expansions because it didn't have enough membranes to treat peak wastewater flows."

MBR challenges

Average-to-peak wastewater flows, points out BC Process Engineer Rion Merlo, are an important factor for MBRs.

"In a membrane bioreactor plant," he explains, "every single drop of wastewater has to pass through tiny holes or pores in the membrane, and there's a limit to how much you can push through those little holes. There's no way to avoid that filtering step during peak flows, so utilities need to install enough membranes to handle that extra volume, build equalization basins or handle peak flows separately."

Screening and cleaning, Bratby adds, are also important for the successful long-term operation of MBRs. "The membranes have a propensity to foul," he says, "and anything you can do to reduce fouling will increase their longevity and reduce long-term operating costs."

Utilities, moreover, need to pay attention to the mixed-liquor suspended solids concentration in MBR aeration tanks. "When utilities shrink the size of reactors to rein in costs," Melcer explains, "they increase the mixed-liquor suspended solids concentration, which, in turn, lowers oxygen transfer and increases the potential for membrane fouling."

In addition, the sludge produced by MBRs is not always as readily dewatered as that produced by conventional wastewater treatment facilities. All of these variables—including wastewater flow, screening and aeration—are crucial considerations for MBR design engineers.

"MBRs, however, may not be the best approach in all cases," Bratby notes. "Other technologies might also achieve given treatment objectives and in some cases may be more appropriate."

"By looking carefully and thoroughly at all these factors," Wahlberg asserts, "utilities can realize the full potential of MBRs, in the right circumstances, with optimal, intelligent process designs."

For more information, contact Eric Wahlberg at 714.689.4803, ewahlberg@brwncald,com; Henryk Melcer at 206.749.2219. hmelcer@brwncald.com; John Bratby at 303.239.5452, jbratby@brwncald.com; or Art Molseed at 206.749.2225, amolseed@brwncald.com.

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ILLUSTRATION BY IVAN THELIN

Plant Influent
MBRs are being used to treat municipal and industrial wastewater. Because MBRs are limited by how much flow can pass through the membrane, peak flow events must be accounted for using equalization or more membranes. Lower temperatures will affect flow through the membrane and must be considered.

Grit Removal
Grit removal protects the downstream equipment and the membranes.

Screening
With openings between 1 and 3 mm, screening preserves the integrity of the membranes by removing debris, making it the most important preliminary treatment step.

Return Activated Sludge (RAS)
The RAS line moves concentrated mixed liquor from the membrane tank back to the start of the process.

MBR Membranes
Membranes are submerged in the mixed liquor and can be either flat sheet or hollow fiber configurations. Membrane fouling is controlled using a coarse bubble aeration. The fluid motion moves solids away from the membrane surface. Both types of membranes can be relaxed intermittently; hollow fiber membranes can also be backwashed. Chemical cleanings are also performed to restore membrane permeability.

Primary Clarifier
Although not required, primary clarification can serve as an additional pretreatment step to prevent membrane damage and can also reduce reactor sizes by removing BOD.

MBR Effluent
MBR effluent will be virtually free of suspended solids and will have turbidity values of less than 0.2 NTU.

Anoxic Zone
Anoxic zones can be used where nitrogen removal is necessary and to recover alkalinity that has been consumed by nitrification.

Permeate Pump
Permeate pumps draw water through the membrane. A siphon approach, which eliminates the need for pumps, can be taken where adequate change in surface elevation exists.

Aeration Basin
MBRs are typically designed for nitrification. Aeration basins must be designed for adequate oxygen transfer for both carbon removal and nitrification.

Aeration Blower
MBR mixed liquor suspended solids concentrations are higher than activated sludge processes, so oxygen transfer efficiency will be lower. As a result, blowers must be sized accordingly.

Treated Effluent
The high-quality effluent can be used for reclaimed water applications, where stringent discharge requirements exist, or for industrial applications such as boiler feed water. MBR effluent is also a suitable feed water for reverse osmosis membranes.

Membrane Tank
By placing membranes in separate tanks, units can be taken out of service for cleaning in place.

Waste Activated Sludge (WAS)
The SRT of the MBR is controlled by the waste sludge flow rate. WAS from the MBR process has different properties than standard activated sludge processes and the solids processing strategy must be designed accordingly.

Disinfection
MBR effluent requires disinfection in many instances and can be performed using chlorination or UV. MBR effluent will have higher transmittance than traditional tertiary effluent and can reduce lamp requirements.

Putting a MBR to Work

A significant breakthrough in wastewater treatment, membrane bioreactors (MBRs) use space-efficient membranes instead of secondary clarifiers, which enables them to be constructed in small spaces. Often touted as a cure-all for problems in conventional activated sludge treatment, the technology is evolving at a dizzying pace. But MBRs can't compensate for poor process engineering and close attention must be paid to the detailed design in order for them to perform, both technically and financially.

QUARTER NOTES

Easterly Upgrade

Historic Ohio wastewater treatment plant enters the new millennium

The intended renovation will result in a state-of-the-art facility designed to offer the flexibility needed to target changing demand over the next 30 to 50 years.

Brown and Caldwell was recently selected by the Northeast Ohio Regional Sewer District to lead a comprehensive facilities plan for its historic Easterly Wastewater Treatment Plant. The Easterly plant is one of three the district owns and operates to meet the water and wastewater treatment needs of the greater Cleveland metropolitan area.

Not just any old WWTP, Easterly was initially constructed in the 1930s as a Federal Works Project Administration project, and parts of the plant actually have been in service since the 1920s. The plant was one of the first in the United States to run the activated sludge process, which was a relatively new biological treatment process at the time. At present, the plant treats an average of 115 mgd and can receive up to 1,480 mgd during wet weather events.

Easterly has been modified over the past 70 years to meet increasingly stringent discharge limits, but the intended renovations will result in a state-of-the-art facility designed to offer the flexibility needed to target changing demand over the next 30 to 50 years. The updated plant will continue to reliably meet effluent discharge limits and remain simple to operate and maintain.

The Brown and Caldwell project kickoff took place in mid-July, and the team is in the process of assessing the conditions and performance of the existing facilities in order to recommend necessary modifications or replacements. The project is expected to be completed within two years.

The district is also starting a 30-year capital projects program designed to control combined sewer overflows (CSOs). The project includes a wet-weather flow management strategy. Peak combined flows will be captured and stored within a deep tunnel system and pumped to the Easterly plant for treatment. This project will ensure that the plant has adequate capacity to reliably meet effluent discharge limits once the upstream CSO control projects are completed.

For more information, contact Mike Macaulay at 651.468.2030, mmacaulay@brwncald.com; or Ron Appleton at 925.210.2294, rappleton@brwncald.com.

Pushing the Envelope

North Carolina wastewater utility extracts big performance out of a small treatment plant

Near Chapel Hill, N.C., the Orange Water and Sewer Authority (OWASA) needed to increase the capacity and performance of a small, 24-acre treatment plant bordered by the state botanical garden and a university golf course. Even with no room to expand, however, the utility was able to boost capacity from 12 mgd to 14.5 mgd, more cost-effectively treat peak wet-weather flows, reduce the level of nutrient discharge and improve reliability and flexibility.

The innovative $50 million upgrade and expansion plan maximized the use of existing tanks and equipment, explains Brown and Caldwell's Peter Schuler, who headed the design engineering team. The utility also added a new 135-foot-diameter secondary clarifier, denitrifying filter complex, headworks and pump station, as well as new influent sewers and chemical storage facilities. OWASA also expanded its existing secondary process and multistage aeration blower systems and improved its solids handling capabilities.

"This was a real success story," Schuler says. "All the project stakeholders worked together to meet the OWASA's objectives, and it should be able to meet the utility's needs for a long time."

Initial construction should be complete by December; the project should be operational by July 2007.

For more information, contact Peter Schuler at 704.373.7111 or pschuler@brwncald.com.

Huddle on the Hudson

Brown and Caldwell heads group tasked with improving the New York river's water quality

A century ago, millions of people used to swim in New York's Hudson River every summer. But worsening water quality, stricter public health codes, liability issues and increasing costs for operating beaches caused many of these facilities to close.

Now, thanks to a $2 million grant attached to New York Gov. George Pataki's Beaches Initiative, the state aims to make the entire Hudson River clean enough to swim in by 2009.

Controlling CSOs

Receiving water improvements are the cornerstone of the initiative. Studies show that the leading source of water quality impairments in receiving waters across the United States is combined sewer overflows (CSO) from urban areas, and the Hudson River Estuary is no exception.

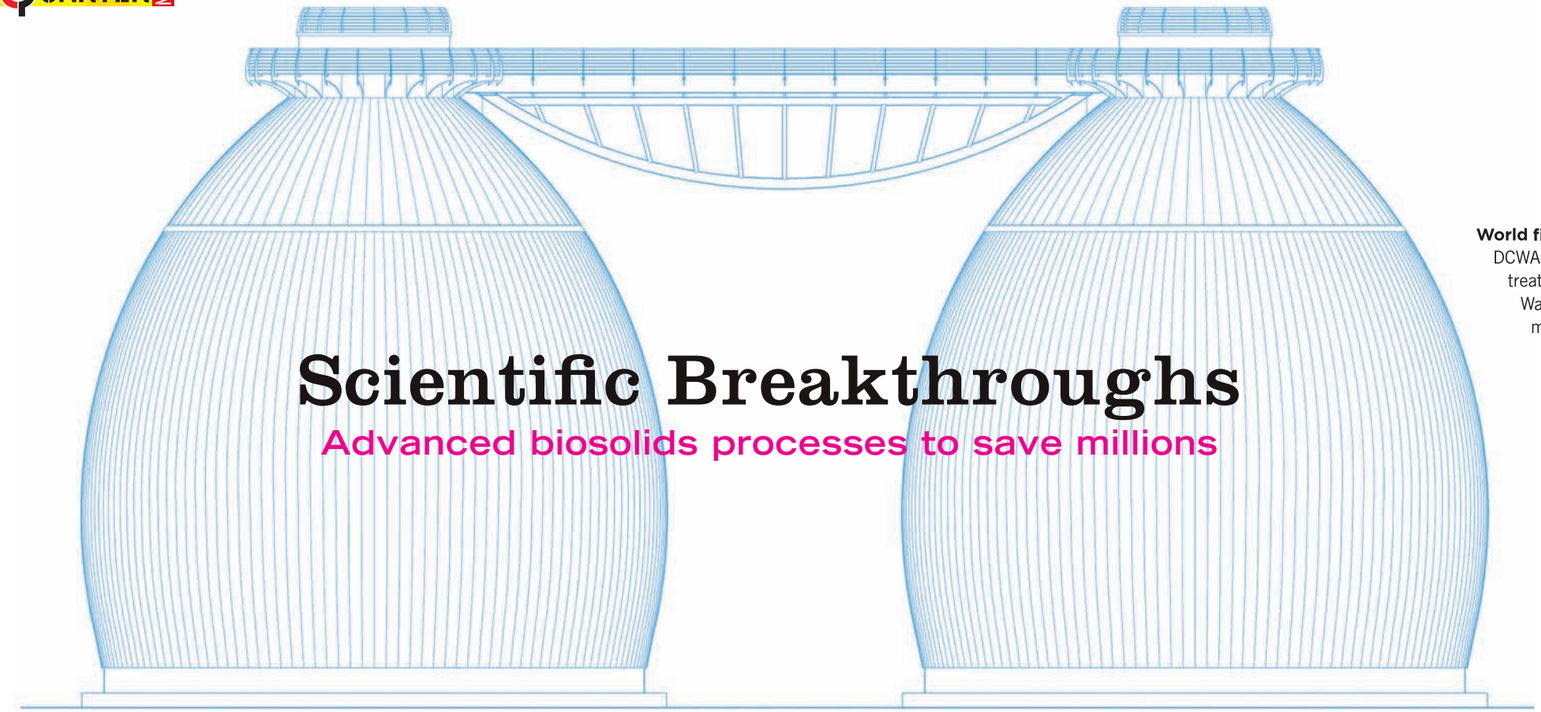
Most communities in the area are older and have combined sewers. As such, they are not subject, in New York State, to the U.S. Environmental Protection Agency's recent decision against blending discharges with pollutants in stormwater runoff from impervious surfaces like compacted lawns, parking lots, roofs and driveways.

Nevertheless, many Hudson River communities in upstate New York—including the cities of Albany, Troy, Rensfelaer, Cohoes, Watervliet and the Village of Green Island—are tackling combined CSOs to help solve the river's water quality problem. These six independent communities are working together to develop a regional CSO abatement plan. Brown and Caldwell is the lead technical firm for the project team, which includes Black & Veatch, CDM, LMS, Malcom Pirnie and other local firms.

The first step, explains BC's CSO Technical Director Peter Moffa, P.E., is to build consensus among the Hudson River communities. "Then, by implementing a long-term plan for CSOs," he adds, "we can work to improve the water quality and swimmability of the Hudson River."

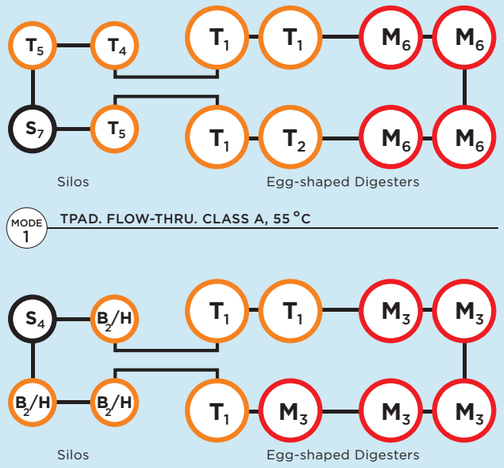
For more information, contact Peter Moffa at 315.449.3010 or pmoffa@brwncald.com.

Many Hudson River communities are tackling combined sewer overflows to help solve the river's water quality problem.



Scientific Breakthroughs

Advanced biosolids processes to save millions



With a first-of-its-kind innovation, Brown and Caldwell planned DCWASA's sludge processing facility to operate in several different Class A and Class B digestion modes. The figure at left shows the project's tankage layout and the two primary Class A operating modes (secondary Class A operating modes not shown). The alpha-numeric (T1, M6, etc.) identifies Thermophilic/Mesophilic and the order of the stages in each mode. The various Class A operating modes have distinct advantages, and which mode to use at startup will depend on regulatory and other factors over the next several years.

Brown and Caldwell is providing solutions by bringing leading-edge technology to the forefront in biosolids processing work.

Two utilities in the East—Washington, D.C.'s, Water and Sewer Authority and Georgia's Columbus Water Works—have broken from the norm with major sludge processing advancements. Both are implementing unique anaerobic digestion processes to get to the same end point—biosolids that meet the Class A pathogen standard in the EPA's Part 503 rules.

Anaerobic digestion is the most common sludge treatment process used in the United States, but most facilities only meet a Class B pathogen standard.

"Both of these utilities are looking to the future to do a better job when it comes to addressing the public's concern over pathogens," says Brown and Caldwell Vice President Perry Schafer. "These facilities are going the extra mile to meet the Class A standard."

World firsts

DCWASA operates the world's largest advanced treatment facility, the Blue Plains Advanced Wastewater Treatment Plant, which services more than 2 million people.

In 2002, the authority and BC began designing a new anaerobic digestion facility that will include the world's largest egg-shaped digesters. Standing 10 stories and holding up to 4.5 million gallons, the eight behemoth digesters will process more than 600 dry tons (from raw sludge to Class A) per day. The facility, which also includes four silo-shaped digesters, will sit on a mere six-acre parcel.

In another first-of-its-kind innovation, the facility will be operable in several different Class A and Class B digestion modes. BC's design provided this flexibility with a unique plumbing/heating/cooling arrangement in the central tunnel/gallery.

The new facility also will cut the dewatered solids production by half, reducing biosolids trucking and handling costs by several million dollars per year, while at the same time producing an end product that is more readily acceptable to the public.

Construction is expected to begin in mid-2006 and be completed by 2011.

Technological first

Farther south, Columbus Water Works (CWW), which provides safe drinking water and treats wastewater for more than 200,000 residents, is implementing the Columbus Biosolids Flow-Through Thermophilic Treatment process (CBFT^3), a breakthrough technology developed by BC.

CBFT^3 reduces required batch processing times from 24 hours to 30 minutes, saving CWW approximately $3 million in capital costs. The innovative approach won top honors at the American Council of Engineering Companies Engineering Excellence Awards earlier this year, and recently received a patent from the U.S. Patent Office.

The CWW project also could break new ground as the first thermophilic digestion facility in the country heated solely by burning digester gas for electric power. The design also calls for more efficient engines that use digester gas as a fuel. These advanced reciprocating engine systems (termed ARES by the U.S. Department of Energy) promise to produce 15 percent to 20 percent more power from the same fuel as lean burn engines.

Columbus recently completed and tested a full-scale, plug-flow prototype that is designed to accomplish the equivalent of a batch operation in a flow-through tank.

For more information, contact Perry Schafer at 916.853.5329, pschafer@brwncald.com; or John Willis at 770.673.3643, jwillis@brwncald.com.

Brain Trust

Florida utility convenes a panel of wastewater experts

To reduce the nutrient levels in its discharge into the St. Johns River, Florida's Jacksonville Electric Authority (JEA) voluntarily sought to cut effluent nitrogen levels in half several years ahead of implementation of Total Maximum Daily Load (TMDL) regulations. Conventional solutions, however, would cost the utility about $120 million, so JEA decided to take a different approach, convening a panel of wastewater experts to come up with alternatives.

The utility brought together five national wastewater engineering firms, including Brown and Caldwell, as part of its innovative Biological Nutrient Removal (BNR) initiative. The panel identified approximately $25 million in improvements to JEA's four wastewater treatment plants, which range in size from 7.5 mgd to 52.5 mgd. The upgrades—including hydraulics, primary clarifier process tankage and process tank equipment modifications—will save JEA nearly $100 million compared to its original BNR estimate.

"With this panel, JEA was able to target technical issues and get value-added, innovative results," says BC's Hal Schmidt Jr., who served on the BNR panel.

"It was a tremendous savings," adds JEA's Director of Water and Wastewater Scott Kelly. "We were able to squeeze out all the capacity available at the lowest cost."

First upgrades

JEA, Kelly adds, also selected BC to make improvements at the Mandarin Wastewater Treatment Plant, the first of its four facilities to be redesigned. After evaluating six different scenarios for the plant using kinetic modeling software, BC recommended deferring installation of a third clarifier, saving JEA $2 million on initial construction.

The design also converted the existing Simultaneous Nitrification Denitrification process to a Modified Ludzack-Ettinger process to further remove nitrogen in the effluent. Other improvements included the addition of mixers in the anoxic basins, aeration system modifications and internal recycle modifications. Most importantly, BC also managed to unlock the plant's capacity, increasing its rating it from 7.5 mgd to 10 mgd.

Thanks to aggressive scheduling, the project team, headed by BC's Ted Hortenstine, will complete several of the improvements in just eight months. The plant rerating and modifications will help JEA achieve its goal of reducing the total nitrogen load discharged into the St. Johns River by more than 50 percent.

For more information, contact Hal Schmidt Jr. at 407.661.9537 or hschmidt@brwncald.com.

More municipalities are reaping the benefits of heat-drying biosolids.

Cut and Dried

Utilities save money by baking biosolids

For years, many small and medium wastewater treatment plants in North America have been cashing in on the advantages of heat-drying biosolids.

Now, the economic, environmental and social benefits are making the process difficult for municipalities to pass up.

Lower disposal costs, safer Class A byproducts, reduced air emissions and resale revenue streams are just a few of the benefits that heat-drying offers, according to Brown and Caldwell's Philip Wolstenholme.

Still, he says, use of heat-drying should be analyzed on a case-by-case, life cycle basis. Safety issues, for one thing, are a consideration. Combustion and explosions can occur in the dryer, on dried product conveyors, in product storage facilities and in dust collection systems, although increased awareness has led to better safety measures and fewer incidents.

And while initial capital costs account for only about 10 percent to 20 percent of total expenditures, the operating costs can prove daunting.

"But there are solutions," Wolhstenholme says. "For instance, reusing digester gas, supplemented at times with natural gas, to heat biosolids can be quite effective in reducing operating costs."

In Washington State, for example, King County's Lakehaven Utility District will save more than $120,000 a year by using digester and natural gas to dry cake from the district's two plants in a process designed by Brown and Caldwell. A life cycle analysis showed that drying biosolids from both facilities at a single location was more cost-effective than the district's existing biosolids cake disposal methods.

And because it meets Class A standards, the dry product can be used on district property, given away or even sold as fertilizer, potentially generating revenue for the utility. Other uses for the product include agriculture, silviculture, land reclamation and landfill cover.

BC, Wolhstenholme adds, has also designed biosolids drying facilities for Chambers Creek Wastewater Treatment Plant in Pierce County, Wash., the Myrtle Creek Wastewater Treatment Plant in Myrtle Creek, Ore., and the Friday Harbor Treatment Plant on Washington's San Juan Island.

For more information, contact Phillip Wolstenholme at 206.749.2234 or pwolstenholme@brwncald.com.

SUPER-SIZED Centrifuges

State-of-the-art solids thickening saves city millions

Here's a challenge: Solids processing at your wastewater treatment plant is spread across 480 acres, future demand projections show your solids processing capabilities will need to expand and optimizing space is proving a challenge. What do you do?

The City of Phoenix developed a gigantic solution for just such a scenario at its 179.25 million gallon per day 91st Avenue Wastewater Treatment Plant. By using centrifuges with four to five times the normal capacity and combining all thickening facilities in one location, the city was able to satisfy tight site constraints, keep the plant on track to meet future demand and save nearly $9.1 million in capital costs—meaning savings for ratepayers in Phoenix, Glendale, Mesa, Scottsdale and Tempe.

Award-winning design

The new design, developed by Brown and Caldwell, is on the cutting edge of wastewater technology; only one other centrifuge of this size in the world is in municipal operation.

The 91st Avenue Solids Thickening Project was honored with a Grand Award by the American Consulting Engineers Council of Arizona.

"It was impressive how quickly the completed facility was commissioned and began meeting the desired performance parameters," says Gary Newman, BC's engineering project manager during construction. "This was a great example of effective teamwork between engineers, city staff, contractors and equipment suppliers."

For more information, contact Gary Newman at 602.567.3867 or gnewman@brwncald.com.

Blending Alternatives

With federal policy out, agencies look for other capacity solutions during wet weather

The EPA's decision May 19 to evaluate options other than blending to address pollutant discharges during wet weather has forced the industry to float other ideas and solutions.

Without the federal blending policy, municipalities may face regulatory actions that cause them to eliminate blending altogether and provide "full" secondary treatment during peak flows. Expanding WWTPs to handle these flows is expensive and usually not an option for most municipalities.

According to the CRS Report for Congress, although the EPA has not estimated the national cost of providing sufficient treatment to preclude blending, it has estimated the cost of correcting sanitary sewer overflows nationwide is $88.5 billion. Groups representing municipalities believe the cost is likely higher, perhaps from $200 billion to $300 billion.

"Muncipalities nationwide have said that without the blending policy, they would have to spend more than $100 billion to upgrade their plants," said Brown and Caldwell's Denny S. Parker, Ph.D., P.E. "A program for rerating, optimizing and debottlenecking wastewater treatment plants will pay big dividends for our industry. For instance, the potential cost savings (in avoided costs) for rerating secondary clarifiers and other process improvements is at least $10 billion nationally over the next 20 years, with the right technology."

Brown and Caldwell has been at the forefront of process optimization, developing protocols for rerating and debottlenecking for the Water Environment Research Foundation, as well as applying the newest technologies for these purposes.

Debottlenecking secondary clarifiers

Anywhere from 10 percent to 40 percent of WWTP capacity typically goes untapped because of unquantified safety factors or inefficient designs. But these days, methods are available to rerate or identify bottlenecks in secondary clarifiers—fixes more cost-effective than building new units. For instance, increasing sludge removal conveyance to optimize peak hydraulic capacity is easier and less costly than investing in new tankage.

Optimization and rerating also have allowed several agencies to redesign clarifiers, improving hydraulics and extending the flow and solids loading range to maximize efficiency. Rerating also only involves a reassessment of a unit's capacity, says Parker.

Biological contact treatment

The biological contact process is an innovative, cost-effective treatment technology that addresses suspended solids and five-day biochemical oxygen-demand removal by bioflocculation and oxidation during high-flow, wet weather events. Often, it can be implemented in existing WWTPs with few modifications, Parker says, and unlike physical/chemical treatment alternatives, it can achieve secondary treatment requirements for BOD^5 and suspended solids.

How it works? Mixed liquor or return activated sludge (RAS) is directed from a mainstream activated sludge plant to a small contact chamber, with short hydraulic detention time, where it meets wet-weather flows and passes to a set of secondary clarifiers for final solids-liquid separation. The process produces effluent that meets secondary treatment requirements.

The biological contact process "borrows" its mixed liquor from the mainstream activated sludge process, allowing a quick startup during wet weather. No chemical addition is required.

"During peak flows, retention time is usually 30 minutes or less," said Jose Jiminez, Ph.D., who developed the kinetic expressions used to size the process. "To obtain the highest throughput rates through secondary clarifiers, mixed liquor levels are reduced, but the impact is only a modest increase in the size of the biological contact tank, typically sized for a residence of less than 30 minutes."

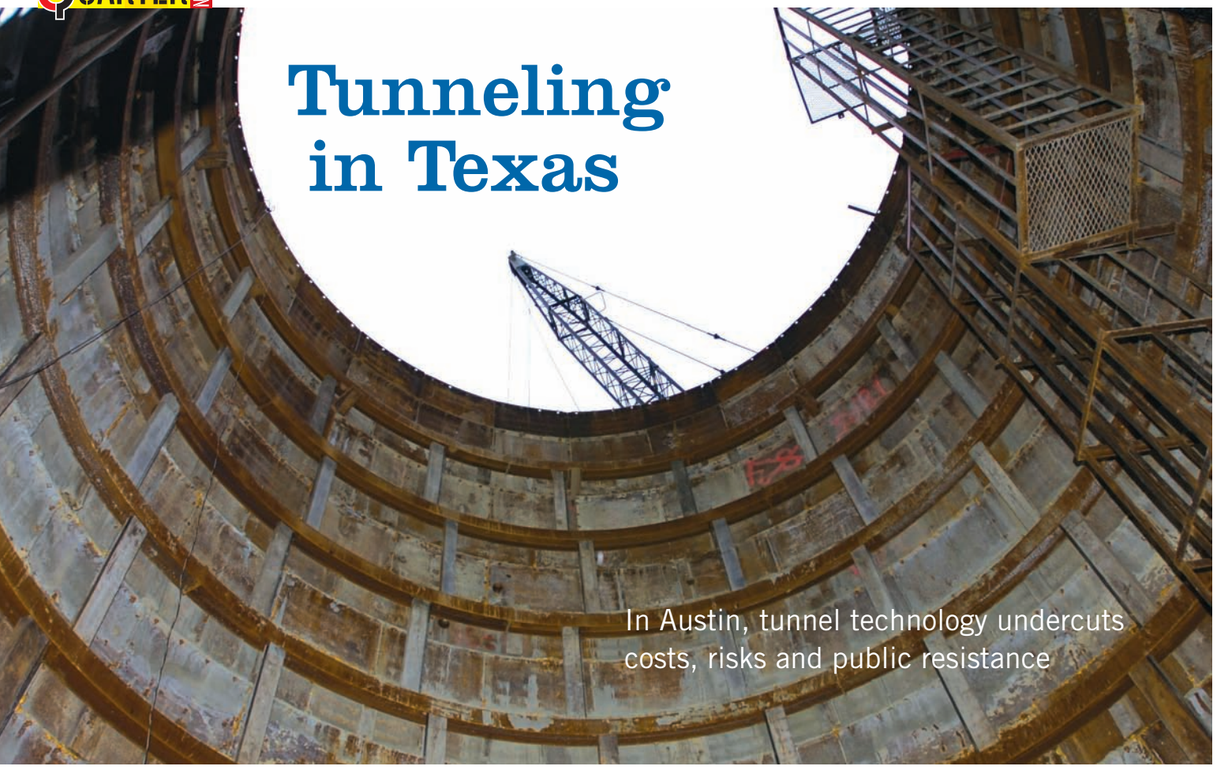
Advanced CEPT

Chemically Enhanced Primary Treatment (CEPT) using primary clarifiers was not initially considered a means for increasing the surface overflow rates. But using modern chemical mixtures and proper chemical dosing protocols, BC's Steve Krugel, P.E., says this process makes sense for intermittent use during high-flow events.

"CEPT has been previously applied in the Great Lakes region for nutrient control and on the West Coast for enhanced chemical primary treatment," said Krugel. "The process is promising because facilities can apply it to existing primary clarifiers to promote and maintain flocculation and increase surface overflow rates as much as 100 percent."

Regardless of when or if the EPA revisits its blending policy, municipalities have some clear alternatives—and exciting opportunities—to optimize during all kinds of weather.

For more information, contact Denny Parker at 925.210.2274, dparker@brwncald.com; or Steve Krugel at 206.749.2214, skrugel@brwncald.com.



Tunneling in Texas

In Austin, tunnel technology undercuts costs, risks and public resistance

When the Environmental Protection Agency's Region 6 came knocking on the Austin Water Utility's door, it didn't come empty-handed. The regulatory agency brought an Administrative Order (AO) requiring the central Texas utility to eliminate sanitary sewer overflows by December 2007.

Austin was under the gun: It needed to quickly implement land acquisition, permitting, design and construction of a large number of projects across its five-plant, 2,316-mile collection system. The city put together a rotation list of engineering firms to work on several fast-track collection system projects, one of the most challenging and critical of which was the Little Walnut Creek Tunnel Interceptor Project.

Infiltration and inflow had been a problem on the Little Walnut Creek interceptor, with residents and neighbors complaining about wastewater discharges for more than 15 years. The existing 42-inch pipeline runs beneath a streambed, with manholes rising out of the water at 100-yard intervals. During wet weather events, wastewater overflows into the creek.

But in the late 1980s when the city originally floated the idea to replace the interceptor, residents blocked the project, concerned that the proposed open-cut construction would disrupt nearby neighborhoods and harm the environmental integrity of the creek. The city went back to the drawing board and redesigned the improvement project, only to have it blocked again by dissatisfied neighbors.

Fast-forward to July 2005: Under the City of Austin's Clean Water Program, this third—and current—design is being led by Brown and Caldwell. To gain public buy-in, BC produced a design that uses Tunnel Boring Machine (TBM) technology to construct a new 10,000-linear-foot, 96-inch-diameter tunnel in one continuous run with no intermediate shafts.

The $12.7 million project design also calls for a 60-inch fiberglass carrier pipe, which will significantly increase the pipeline's useful life over more traditional reinforced concrete pipe.

Mining crews are currently 140 feet below the Austin hill country, pushing a 300-foot-long TBM along the pipeline route. The best part? The tunnel is bounded within right-of-way limits of existing surface streets, minimizing land acquisitions and ensuring zero impact to the neighborhood, traffic or the creek. Also, construction shafts at each end of the tunnel are on undeveloped property, further keeping the project out of the public eye.

"Things aren't always as they seem from the surface," says Brown and Caldwell Project Manager Susan Kelly. "Following the surface streets is not only economical, but also less risky."

The project also includes open-cut construction of 3,700 linear feet of 60-inch wastewater interceptor, allowing AWU to abandon a similar length of deteriorated pipeline and lay the groundwork for a city park near one of the construction shafts.

"We listened to the community and decided to invest in the more expensive tunnel design," says Reynaldo Cantu, AWU assistant director. "The design successfully addresses residents' concerns regarding the impact of construction activities on the neighborhood, traffic and the creek, thereby preserving their quality of life."

The design phase, including field investigations, was performed within six months and completed $100,000 under budget. The tunnel construction is well on its way to meet the EPA's AO deadline.

For more information, contact Susan Kelly at 512.652.1143 or skelly@brwncald.com.

Treatability Testing

Process, strategy are key to keeping wastewater flowing smoothly

Wastewater utilities and industries certainly have financial—as well as health, safety and environmental—incentives for reducing wastes and emissions, but sometimes tapping the best cost-saving approach isn't easy. The key is selecting the right process and right operating strategy.

But understanding how to select the right approach in wastewater treatment can be as murky as the water being treated. Choose the right process and right operating strategy and everything else flows smoothly.

Treatability testing

Case in point: A Brown and Caldwell landfill client in Tennessee asked for a detailed design of a pretreatment system to reduce ammonia-nitrogen concentrations in leachate—from 650 mg/L to less than 30 mg/L—before discharging to a publicly owned treatment works.

Using treatability testing, BC developed conceptual designs and cost estimates for biological nitrification, breakpoint chlorination, ion exchange, alkaline air stripping and selective membrane treatment. During this process, BC discovered the leachate was strongly inhibitory to biological nitrification and that breakpoint chlorination was the most cost-effective solution.

"But the client was planning on a more conventional approach," Brown and Caldwell's Houston Flippin, P.E., DEE, remembers. "Specifically, they were listening to a turnkey vendor-provider who was recommending biological nitrification—with a performance guarantee. This 'guarantee' had several loopholes, though."

Fortunately, the client took BC's advice and installed breakpoint chlorination. Two years later, the treatment system has been operating efficiently, allowing the Tennessee client more flexibility in receiving wastes without the added worry of onsite biological treatment of leachate.

Recipe for savings

Treatability testing also defines site-specific performance factors, an ingredient that saved a BC food industry client and the City of Murray, Ky., more than $5 million.

In designing a pretreatment facility, Flippin says, "we had to overcome the misperception that the industrially dominated POTW was greatly overloaded and that it was necessary for the industry to greatly reduce its load to the plant."

After BC conducted treatability tests, thoroughly characterized POTW performance and applied the Biowin and Eckenfelder Activated Sludge models, city and state regulators agreed that plant capacity could be increased by 80 percent with only modest improvements. The cost? Less than $1 million compared to the $5 million in upgrades proposed by the city's own consultant.

Regulators also agreed that the facility could provide much less pretreatment than originally proposed, and still protect the POTW. The resulting pretreatment system cost of $1.8 million was significantly less than the $3 million price tag attached to the city's originally requested pretreatment system.

For more information, contact Houston Flippin at 615.250.1220, or hflippin@brwncald.com.

PHOTO BY SCOTT WALL

MASTER OF WATER AND WINE

ERIC WAHLBERG, A BC VICE PRESIDENT IN CHARGE OF PROCESS OPTIMIZATION, GETS A KICK OUT OF LIQUID TRANSFORMATIONS

Wastewater treatment has a lot in common with winemaking, says Eric Wahlberg—but that's not a fact he's likely to feature on the label of the red and white wines he crafts on a rural ridge in Boonville, Calif.

It could be, though, what led him to his off-hours passion for growing vines, crushing grapes and turning their juices into fine, medal-winning vintages. To Wahlberg, liquid transformations are amazing, whether it's grape juice to wine or sewage to clean water, the latter something he knows lots about after 28 years in the wastewater treatment industry.

From the ground up

Wahlberg learned the wastewater business from the ground up, literally, starting right out of college as a janitor in a small treatment facility in Colorado. Armed with his bachelor's degree in public health, he worked his way up through various jobs in small plants that had him do everything from electrical work to microbiology, snow plowing and process control, eventually becoming chief of operations for a sanitation district in the Rocky Mountains.

After seven years as an operator, Wahlberg received his master's and doctoral degrees in environmental systems engineering, then joined Brown and Caldwell in 1994, where he's a vice president in charge of process optimization. For his work on activated sludge process control and primary and secondary clarifier design and operation, the Water Environment Foundation awarded him the 1995 Harrison Prescott Eddy Medal for exceptional research, as well as the 1997 George Bradley Gascoigne Medal for excellence in operations.

Even after all these years, "it still absolutely amazes me," he says, "to look at what comes into a wastewater treatment plant and compare it to the sparkling water that comes out."

He says he's equally amazed when people taste the wine he's barreled, bottled and aged "and don't spit it out." His wine, in fact, has won fans as well as medals at the Orange County Fair, the largest home winemaker competition in the country. He's now setting up a "subscription" winery that will produce small bottlings of Zinfandel, which he grows, as well as Pinot Noir and Chardonnay under the Arlanda label.

A knack for winemaking

Wahlberg, people tell him, has a knack for winemaking—maybe because it involves the same processes and transformations he knows so well, involving microorganisms, growth kinetics, substrate availability, nutrient concentrations, solids separation and environmental control. It also involves lots of hands-on work, something he's always been passionate about in the wastewater industry.

"I love the operations side of things," he says, "and the sense of accomplishment you get when you see results from day to day."

Wahlberg's enthusiasm for the practical side of his profession—bridging the gap between science and operations—is, perhaps, best seen in the "Math for Operators" workshop that he teaches at the annual Tri State (California, Arizona and Nevada) operations conference. Once moribund and poorly attended, he volunteered to take it on in 1999 and has since turned it into an annual event that draws near-standing-room crowds and invitations from other operator conferences across the country.

As a winemaker, though, Wahlberg admits he's had his own lessons to learn. His 1999 vintage, he recalls, was a "complete disaster"—he over-cropped his vines, leaving too much fruit hanging for the amount of foliage available to ripen the grapes. Then birds ate most of his 2000 vintage, leaving him with just three paltry gallons of wine.

Living his dream

Still, with Arlanda—now in the planning stages—Wahlberg will be living his dream. When he was growing up, he says, his dad, who was of Swedish descent, formed a land development business named "Arlanda," which he thought was Swedish for "our land."

"Spelling, in English or Swedish, was never my father's strong suit," Wahlberg acknowledges, and it turns out that Arlanda has no meaning in Swedish. Still, in honor of his father's wordsmithing, Wahlberg named his winery Arlanda —"which means to me 'to reach one's dreamland.'"

ISSUES & IDEAS CONTINUED FROM PAGE 1

higher capabilities than originally thought, or be retrofitted with newer and better technology.

In St. Paul, Minn., the regional wastewater utility expanded the capacity of an existing treatment plant simply by changing the technology to incorporate biological phosphorous removal—a move that saved $100 million in construction costs for new facilities.

A detailed, science-based assessment of wastewater flows and plant performance—including process monitoring, stress testing and modeling—might similarly show that you can get 50 percent more out of an existing plant instead of investing millions of dollars in new construction.

Optimization is never achieved with a cookie cutter. It requires operator trust, thorough data gathering, new and creative approaches, "big picture" thinking and confident engineering skills. This goes way beyond standard rule-of-thumb factors and textbook boundary conditions—it's where our best brains approach excels and delivers value.

A good example is the use of membrane bioreactors (MBRs) in wastewater treatment. While membranes expand treatment options, they are not a plug-and-play, one-size-fits-all technology (see "The MBR Revolution," page 5). Purchasing an off-the-shelf module and fast-forwarding through process engineering by relying solely on the manufacturer for design is an invitation for disaster.

Whether you're looking at conventional or more advanced technologies—from wet-weather solutions to sustainable biosolids options—science-based process engineering is critical (see our piece on high rate treatment on page 11 and advancing biosolids processes on page 12). A primary sedimentation tank project, for example, shouldn't be considered in isolation; one must look at how it fits with and impacts the whole plant.

The best solution to a digester problem may be major renovations to the plant's headworks and preliminary treatment. And staffing shortages might best be solved with new instrument and control technologies that automate plant operations (see "Mission: Control," page 2).

Bring everyone to the table

Generate the best ideas and strategies by putting your best brains to work. Bring everyone to the table during planning, including engineers, financial managers and O&M personnel. Pulling together collective experience/expertise with a facilitated approach that enables people to build on each other's ideas and brainstorm solutions can be powerful. At the end of the day, it's often difficult to identify the source of the best ideas, because they are ultimately a synthesis of the team and process that was used to define them.

Getting it right takes discipline

It's an old, but accurate adage: There's nothing more expensive than cheap (or rushed) engineering. By taking advantage of the project planning phase—making a strong business case, exploring a variety of options and incorporating thorough, science-based engineering—utility managers can discover cost-saving approaches they might never have found if they'd pushed the project headlong into delivery phase.

Taking the time to ask and answer the right questions, then having the team carry forward the money-saving concepts through project delivery and operations, agencies will get more value and performance out of every project.

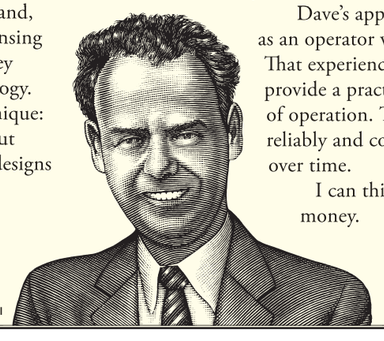
Matt Davis, P.E., Boston
Phil Heck, Ph.D., P.E., Salt Lake City
Woody Muirhead, Class IV Operator, Honolulu
Denny S. Parker, Ph.D., P.E., Walnut Creek
Hal Schmidt Jr., P.E., DEE, Orlando
Tracy Stigers, P.E., Walnut Creek

As Complexity Increases, Practical Solutions Prevail

Garr Jones, a 46-year Brown and Caldwell veteran, reflects on the company founder's lasting qualities now captured in our best brains approach

Technology has always been Brown and Caldwell's strong suit. Dave Caldwell made a practice of keeping abreast of developments in the technical areas that affect our business. His interest transcended treatment technology to embrace advances in mechanical equipment and systems, instrumentation, electrical equipment and myriad other disciplines that affect the way water and wastewater projects are conceived, developed, constructed and, finally, operated. This was long before state licensing agencies required registrants to demonstrate they were continuing to stay up on evolving technology.

Dave's focus on the approach made him unique: practical solutions that use the best available, but technically sound, treatment technology. And designs with the operator in mind, such that operation and maintenance costs are kept to a minimum, thereby delivering the best value to the owner over the long term.



Dave Caldwell

His eagerness to adopt new developments was tempered by an equally strong education in basic engineering principals that caused him to assess each development by picking it apart, literally piece by piece, to make certain it made sense. Working with him made us all better engineers by teaching a discipline that remains at the core of BC's culture: Make certain it is right before you commit.

Dave's approach was also rooted in his background as an operator while in school and his military service. That experience served to temper his approach and provide a practical consideration of the effort and cost of operation. The result: sound technology that delivers reliably and consistently at reasonable cost of operation over time.

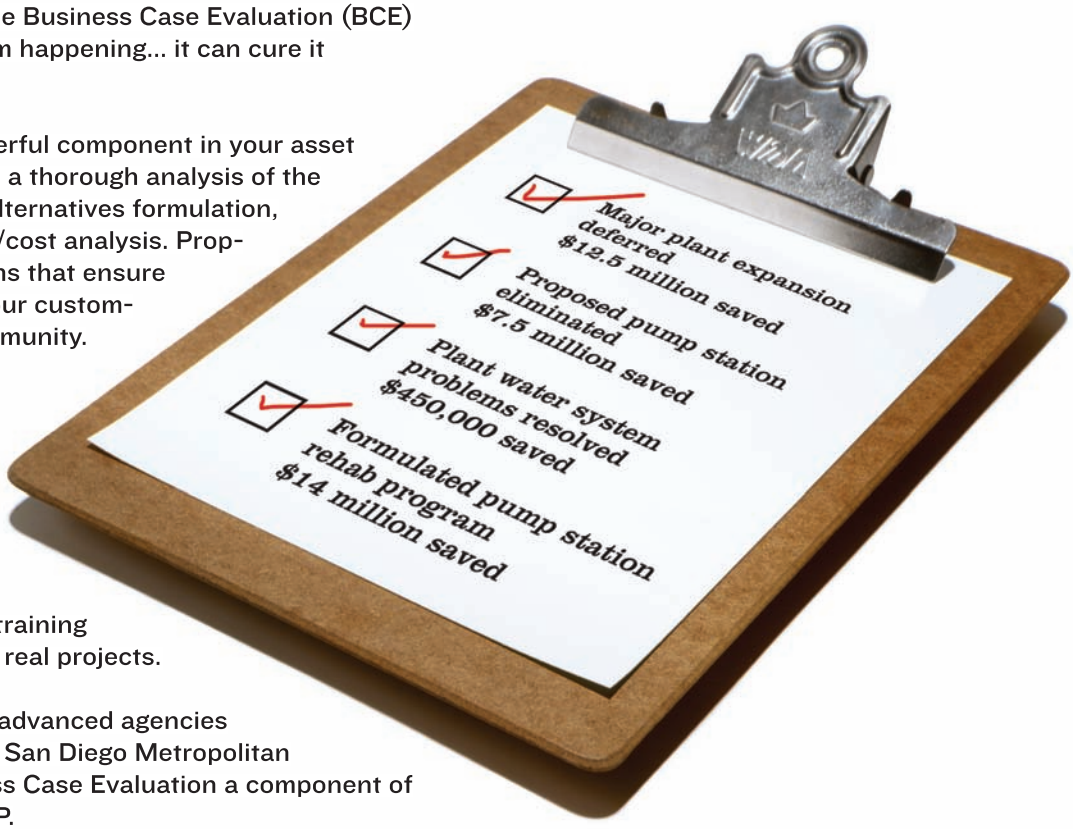
I can think of no better way to spend the public's money.

Garr Jones, P.E.
Senior Vice President

The Business Case Evaluation

A powerful process for making just-in-time CIP decisions.

Some projects take on lives of their own. Others get grounded for the wrong reasons. The Business Case Evaluation (BCE) not only prevents that from happening... it can cure it when it does.



The BCE is probably the most powerful component in your asset management tool set. Starting with a thorough analysis of the project's drivers, it steps through alternatives formulation, risk analysis and economic benefit/cost analysis. Properly done, it yields recommendations that ensure your CIP is the best it can be for your customers, the environment and your community.

Brown and Caldwell has more experience performing BCEs for water and wastewater projects than any firm in North America. What's more, we don't just perform BCEs, we can teach your staff to do them. Your cross-functional team starts out with a short training course, moving into the analysis of real projects.

Find out why a growing number of advanced agencies such as Seattle Public Utilities and San Diego Metropolitan Wastewater now make the Business Case Evaluation a component of every significant project in their CIP.

Contact Ken Harlow,
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