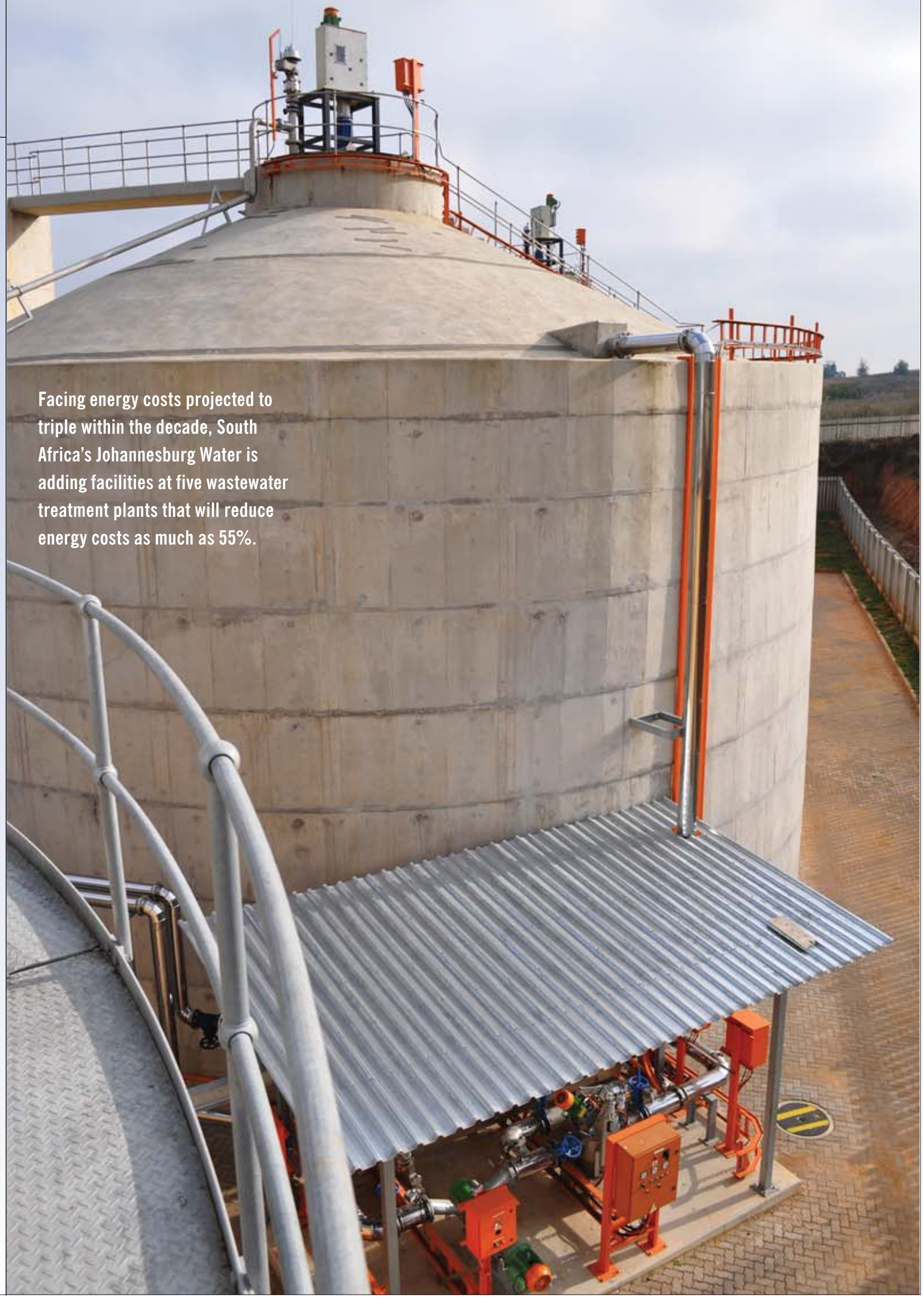
Horizons

Engineering Excellence in Meeting Water Environment Challenges

Water Environment Solutions

Summer 2011



Facing energy costs projected to triple within the decade, South Africa's Johannesburg Water is adding facilities at five wastewater treatment plants that will reduce energy costs as much as 55%.

Inside

HAZEN AND SAWYER
Environmental Engineers & Scientists

Cost-Effective Regulatory Compliance: The New Peekskill Water Treatment Plant

By Julie Herzner, P.E.

The new Peekskill Water Treatment Plant began serving customers in May 2010, utilizing a cost-effective treatment process that efficiently removes organics and produces a finished water that consistently meets Disinfection By-Product limits that had been seasonally exceeded by the old plant.

As water utilities seek to upgrade facilities to cost-effectively achieve ever-higher treatment goals and meet stricter regulations, the thoughtful selection of treatment technologies is paramount to long-term success. The American Council of Engineering Companies of New York recognized the design and construction of the City of Peekskill's new Water Treatment Plant with a 2011 Gold Award because it demonstrates the successful evaluation of alternate treatment processes, pilot-scale studies of options within the selected process, optimization of the selected treatment train, and lifecycle cost analysis.

The City of Peekskill owned and operated an aging water treatment plant that was experiencing difficulties meeting the City's treatment goals and the requirements of increasingly-stringent water quality regulations. The slow-sand filtration facility was built in 1909 and was facing operational constraints, such as capacity and hydraulic limitations. Peekskill also detected elevated disinfection by-product levels in the distribution system.

Needing to build a new treatment plant without disruption in service, the City retained Hazen and Sawyer to plan, design, and oversee construction of a new 8-mgd facility that could offer both reliable water supply and regulatory compliance long into the future.

This new plant could neither spread out (due to site area constraints) nor reach particularly deep into the ground (due to the high cost of bedrock removal). The plant is also situated in a residential neighborhood, so the City wanted to be sure the building height did not impact the neighbors. These restrictions added a layer of complexity to process selection and compelled some innovation in the design of the plant.

Several site area restrictions added a layer of complexity to process selection and compelled innovation in the plant design:

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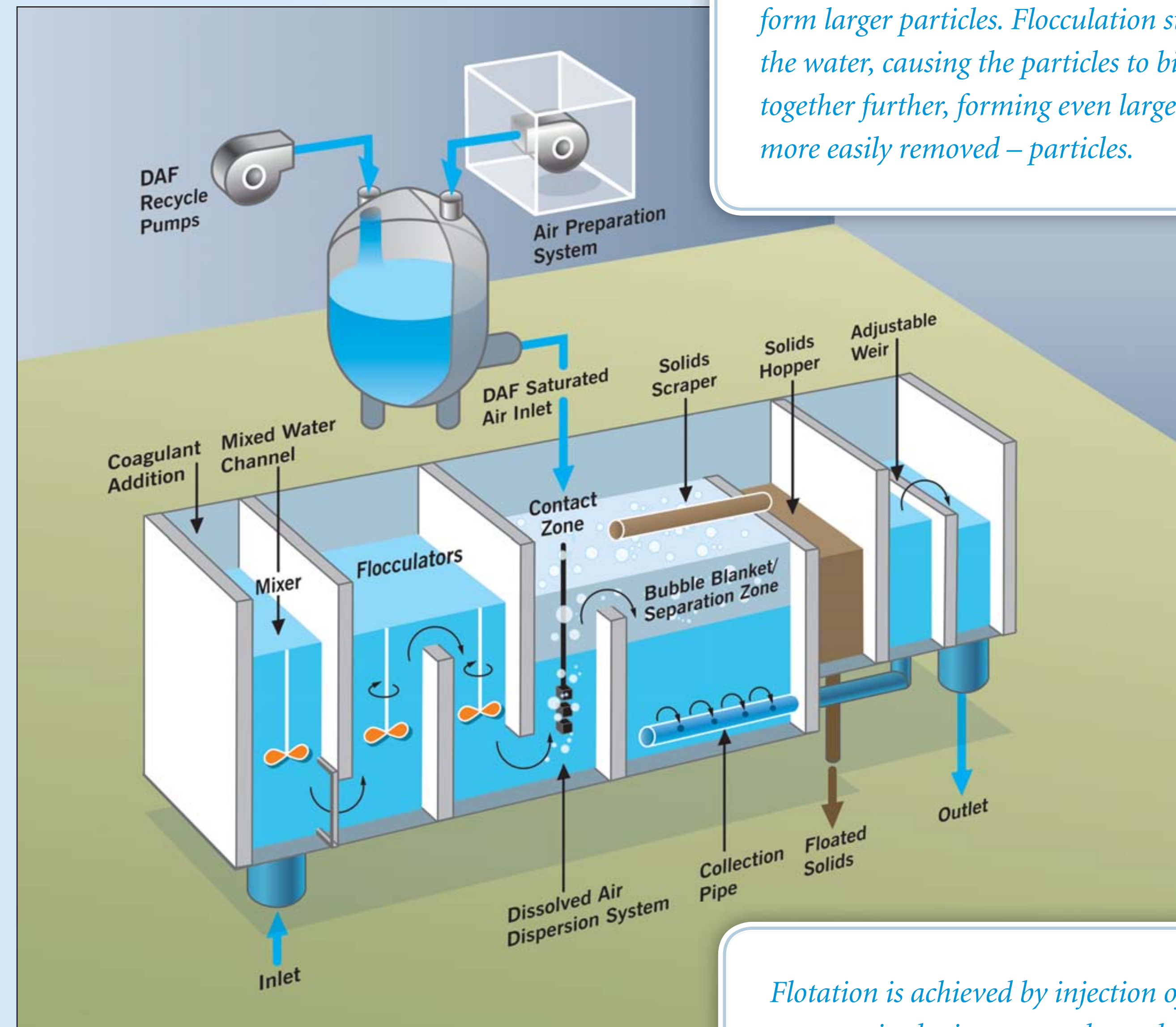
All About DAF

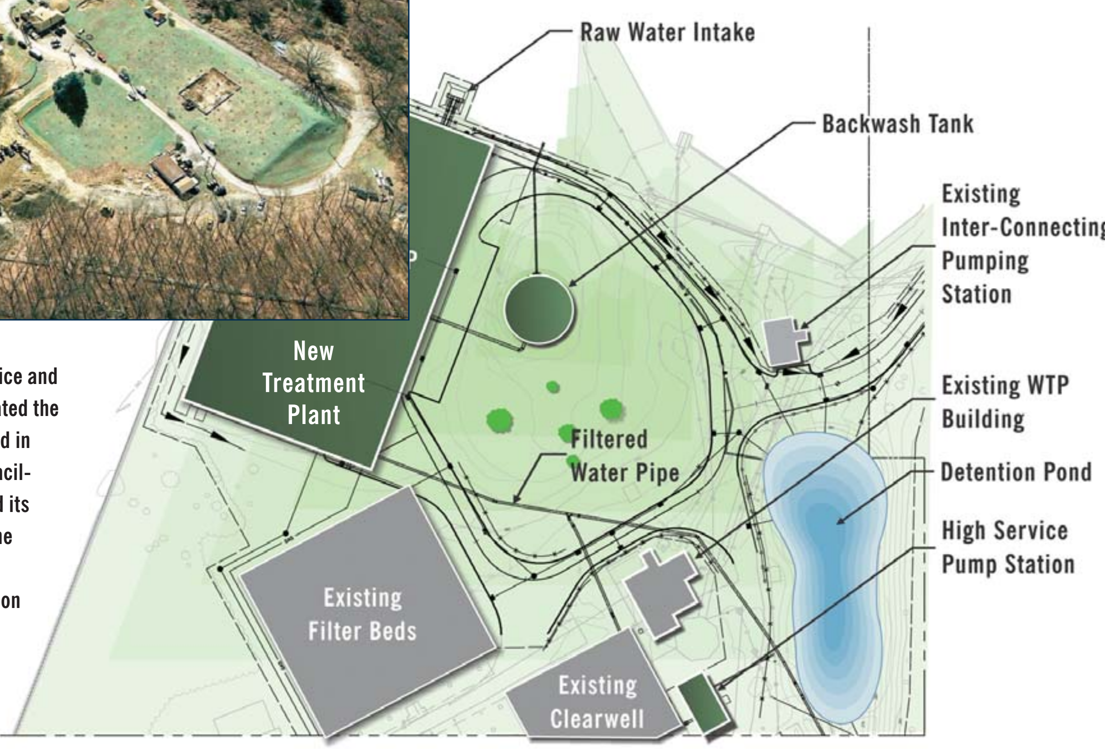
Coagulant causes small suspended particles in the water to bind together to form larger particles. Flocculation stirs the water, causing the particles to bind together further, forming even larger – more easily removed – particles.



Flotation is achieved by injection of a pressurized, air-saturated recycle stream. This recycle stream, injected into the inlet of the DAF units, results in a sudden reduction in pressure, triggering the release of air in the form of micro-bubbles that attach to flocculated particles, form a dense foam, and float them to the surface of the tank, where they are removed by a skimmer.

A proven water treatment technology, Dissolved Air Flotation (DAF) offers significantly lower capital costs than most other clarification processes. The DAF process separates flocculated particles and contaminants from water by floating them to the surface for removal.

World-renowned experts in DAF design, Hazen and Sawyer is helping to organize and host Flotation 2012, an international conference of engineers and scientists who specialize in physical and chemical treatment processes from academia, consulting engineering industry, equipment companies, government regulatory agencies, and water and wastewater utilities. Learn more at www.flotation2012.org.



The need to maintain continuous service and a number of site constraints complicated the design for the new plant. Being located in a residential community limited the facility's ability to expand and constrained its potential height; bedrock underlaid the site, constraining its potential depth. These considerations led to the decision to construct the facility at grade – minimizing costly excavation through bedrock – which required a highly space-efficient treatment process.

- The new plant was boxed into a small area by elements of the existing plant that needed to be left undisturbed so the plant could continue to deliver water during construction.
- The plant sits on bedrock – which is very costly to remove – so digging far beneath grade would quickly escalate project costs.
- The plant also sits in a residential neighborhood, so the City wanted to be sure the building height did not impact the surrounding community.

Selecting the Treatment Process

The Wiccopee Reservoir, Peekskill's supply source, is eutrophic – exhibiting seasonal algae blooms – but the supply to the treatment plant has low raw water turbidity and low-to-moderate Total Organic Carbon. A technology evaluation confirmed dissolved air flotation (DAF) as the optimum technology for treating this water supply. DAF is a robust process that accommodates variations in raw water quality and offers many advantages in treating the City of Peekskill's water supply.

In a pilot study during the fall of 2003, Hazen and Sawyer assessed two options available within the selection of the DAF processes – conventional DAF treatment and a relatively new, proprietary system that allows for a higher DAF loading rate – each followed by multi-media filtration. The proprietary process was thought to offer some important advantages, mainly a smaller footprint and lower capital cost, and the City was interested in exploring this new technology.

Pilot data confirmed that both processes would provide high-quality finished water with low turbidity and high particle removal, while maintaining filter run length goals. The pilot tests also established the process design criteria for the plant, and conceptual designs were prepared for each DAF process. Each conceptual design took into account the site, height, and rock conditions associated with construction of the new plant.

See related links @

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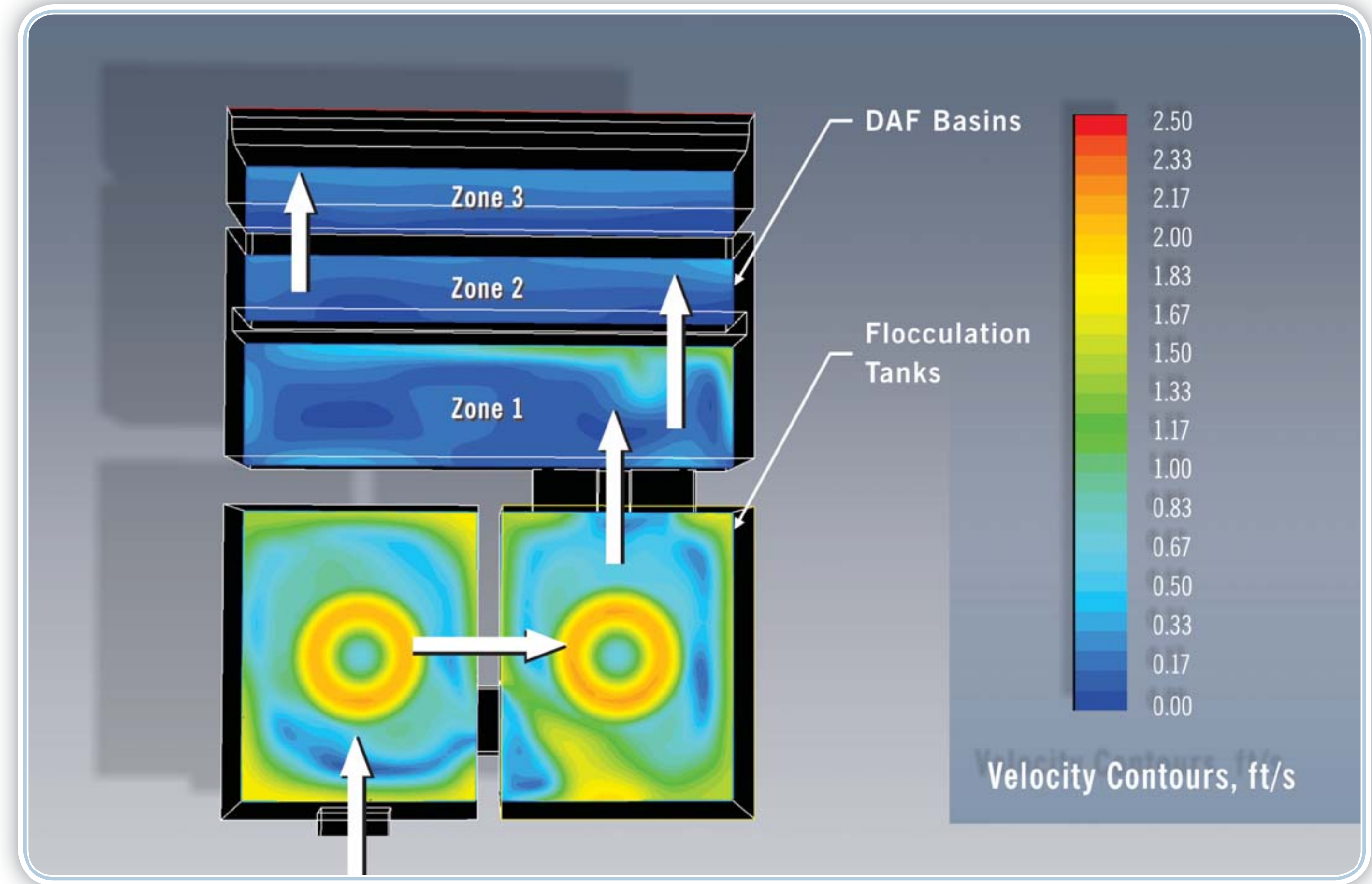
↘ A Review of the Technological Developments of Dissolved Air Flotation

↘ Selecting Treatment Processes: Comparing the Energy Consumption of 2 Plants



Computational Fluid Dynamics (CFD) modeling uses mathematical methods – and millions of calculations – to analyze systems that involve fluid flow, mass transfer, heat transfer, and their associated phenomena.

Hazen and Sawyer then prepared capital and operating-and-maintenance (O&M) cost estimates for each DAF process option developed. The results of the lifecycle (annualized capital plus annual O&M) cost evaluation indicated that – given the site constraints – the benefits associated with implementing the high-rate DAF would not be realized. Absent the lifecycle cost benefits, and with the loss of competition that comes with using a proprietary process (competition that financially benefits the City), the conventional DAF process was selected.

Detailed Design

Optimization of the selected process continued throughout the design phase with the highly innovative application of conventional DAF technology. Computational Fluid Dynamics (CFD) modeling was used to optimize facility design, minimizing both plant footprint and depth/extent of rock excavation.

As shown in the CFD image, the flocculation tanks are dedicated to their respective DAF/filtration tanks, and have matching widths. This innovative layout takes advantage of the shorter time required to form the pin-point floc removed by the DAF process, allowing for more compact design and decreased structural and excavation costs. Since flow distribution is critical, CFD modeling was used to confirm that this arrangement would not result in uneven flow distribution. CFD modeling was also used to refine the spacing of the transition baffles between the flocculation basins and the DAF tanks, resulting in a very efficient layout.

The new plant began serving customers in May 2010. The cost-effective treatment process efficiently removes organics, producing finished water that consistently meets DBP limits that had been seasonally exceeded by the old plant. This improvement in water quality from the new plant significantly improves public health for the residents of Peekskill.

The Driefontein Wastewater Treatment Plant, which was honored in 2004 as South Africa's best-operated treatment facility, is undergoing upgrades and expansion to 55 Ml/d (from 35 Ml/d).

With energy costs on the rise, the Driefontein WWTP is among five facilities adding high-performance mesophilic anaerobic digestion to their process, increasing biogas production for use in generating power and lowering energy costs.

Upgrading Anaerobic Digestion to Combat Africa's Rising Operating Costs

By Ian Seed, C.Eng.

Facing a steep increase in energy costs, Johannesburg Water is upgrading the sludge handling and digestion facilities at its five wastewater treatment plants. The new high-performance digestion facilities will significantly offset energy costs at the plants – as much as 55% at one plant.

While the cost of electricity in South Africa is among the world's lowest, the country's strong economic growth, rapid industrialization, and an effort to extend electricity to every household by 2012 led to demand for power exceeding supply by early 2008. As a result, state energy company Eskom has embarked on a massive program to upgrade and expand the country's electricity infrastructure. Plans include construction of a new generation of power stations – two new coal-fired power stations and possibly a new conventional nuclear power station – in addition to work on the country's distribution structure.

The plan also outlines the reduction of demand by pricing electricity "correctly" – meaning electrical power costs in South Africa are on the rise. The first significant increase has already taken place and substantial above-inflation rate increases are expected in the next few years. It is anticipated that power costs will double over the period 2009-2014 and triple over the period 2009-2018. This development places substantial strain on the operating budgets of Johannesburg Water's Wastewater Treatment Plants.

Biogas-to-Energy projects can reduce the operating costs at most wastewater treatment facilities. Increasing power costs only strengthen the business case, since the higher the cost of power, the shorter the pay back period on the capital invested in designing and constructing the upgrade. Biogas-to-Energy projects also demonstrate a commitment to renewable energy – fast becoming an expectation of rate-payers and municipal decision-makers alike, and an unavoidable reality in many communities around the globe.

Supported by a compelling business case, Johannesburg Water has opted to implement high-performance mesophilic anaerobic digestion – including pre-thickening as well as mixed and heated anaerobic digesters with biogas collection and storage facilities – at five WWTPs. Increased biogas production is a benefit associated with the implementation of high-performance digestion facilities.

The features of the Biogas-to-Energy installations include:

- Biological sludge cell lysis (cell destruction) of the thickened waste activated sludge (WAS) streams to maximize methane production from the WAS constituent of the combined sludge.
- Cleaning of the biogas to adequately condition it to manufacturer's specifications for use in co-generation engines or turbines.
- Generation of electrical power by means of co-generation methane gas engines or turbines.

The Biogas-to-Energy installations will also provide for the recovery of heat from the coolant train of the power generating equipment. This heat will be used both for digester heating purposes and to assist in drying applications of the dewatered sludge. In collaboration with Golder Associates, Hazen and Sawyer is providing design and bidding process support for the high-performance biogas-to-energy installations.

Once complete, these upgrades will significantly reduce the operating costs at Johannesburg Water's five WWTPs and contain their vulnerability to future energy cost volatility, in addition to significantly reducing the plants' carbon emissions.

See related links @

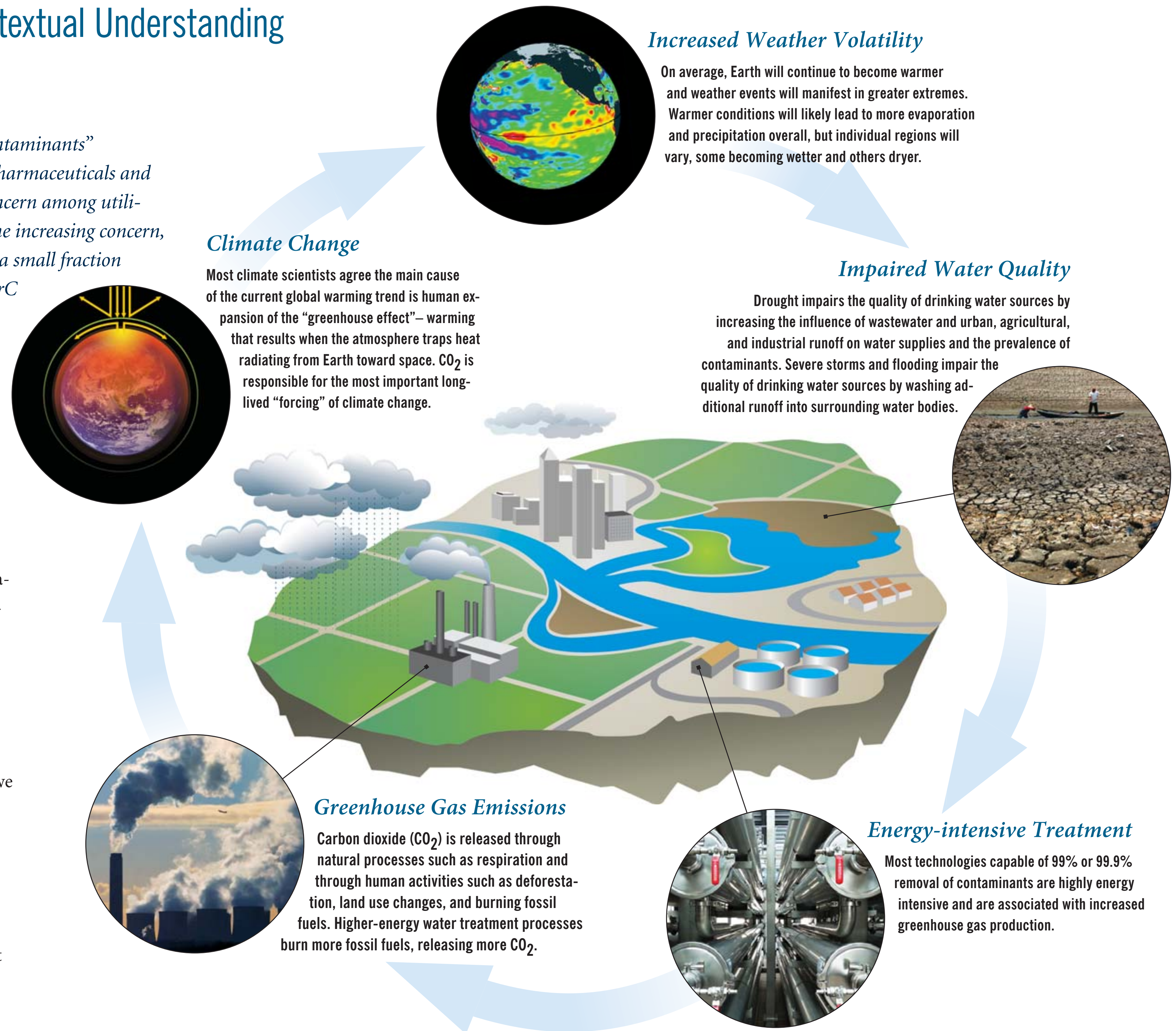
www.hazenandsawyer.com

- Seasonal and Lifecycle Cost Considerations in Evaluating Beneficial Utilization of Digester Gas
- Gwinnett County Gas-to-Energy Program to Produce Cost Savings

Trace Contaminants in Water: A Contextual Understanding

By Ben Stanford, Ph.D.

The vast amount of occurrence data regarding "emerging contaminants" or trace organic contaminants (TOrCs) in water – such as pharmaceuticals and endocrine disrupting compounds – has led to widespread concern among utilities, politicians, the media, and the general public. Despite the increasing concern, data indicate that municipal drinking water represents only a small fraction of the average person's exposure to TOrCs. Furthermore, TOrC removal from water can be very energy-intensive, raising the question of whether it actually is in the best interest of our environment and the public health.



All of the Earth's water contains measurable levels of various anthropogenic chemicals. The quantity and concentration of detectable contaminants depends on the factors influencing the water, the analytical methods applied, and the intensity of monitoring programs. The earliest published manuscripts regarding endocrine disrupting compounds (EDCs) and pharmaceuticals and personal care products (PPCPs) in North American waters date back to the 1960s and 1970s. With advances in analytical technology, the scientific community is now able to detect and quantify chemical contaminants in air and water at miniscule levels (parts per trillion and less). Though often researchers detect trace levels of organic contaminants around the world in media ranging from food to air, dust, and water, we still do not fully understand the consequences of our exposure to mixtures of these pollutants at low levels in multiple media.

One major contributor of trace organic pollutants is wastewater discharge, which introduces into surface and ground waters chemical contaminants not completely removed by current wastewater treatment processes. Indirect water reuse, whereby upstream wastewaters become part of the source water for drinking water treatment plants, is currently practiced in many areas of the country. Arguably, any water supply that is impacted by wastewater from upstream sources is practicing water reuse, regardless of whether or not this is openly acknowledged. With such water reuse/recycling systems in place, be they intentional or unintentional, the propensity of water contamination from wastewater is greatly increased.

Wastewater is certainly not the only source of TOrCs to the environment, however. Industrial discharges, urban runoff, farming operations, septic systems, and other non-point source pollutions add to the overall burden of contaminants in our source waters. So while it is easy to point at wastewater treatment plants as a source of many EDCs and PPCPs, some of the TOrCs of greater environmental concern (e.g., steroid hormones, pesticides, dioxins, PCBs) are present in greater concentration in runoff from farms, urban areas, and industrial sources than wastewater treatment plant effluents. Thus, one must examine the issue from a watershed level perspective, and consider both the environmental impacts as well as the human health impacts of the presence of various TOrCs.

That said, the public health impacts of low levels of EDCs and/or PPCPs has yet to be determined. Researchers generally agree that the long-term risk to humans from any single compound at sub-µg/L levels in water is negligible. However, these compounds are detected as complex mixtures, and it is not clear what toxicological implications chronic exposure to suites of trace contaminants may pose.

The impact of EDCs and wastewater contaminants on aquatic species is irrefutable. Many studies have identified impacts on wildlife species from short- and long-term exposure to sewage effluents and/or compounds present in sewage effluents including steroid hormones, nonylphenols, plasticizers, and other TOrCs. Similarly, compounds found in agricultural runoff, urban runoff, and industrial discharges have been shown to have impacts on aquatic species. Whereas wildlife may be directly exposed to water or contaminated soils and sediments at or near point and non-point sources of pollution, direct human contact with surface water is likely to be minimal, with the exception of potential infrequent contact or incidental ingestion during swimming or other recreational activities.

It would thus appear that drinking water represents the most direct vector for human exposure to wastewater derived contaminants. In fact, there is a growing literature on the occurrence of PPCPs and EDCs in municipal drinking water, and there is no doubt that humans are exposed to a myriad of such compounds through water.

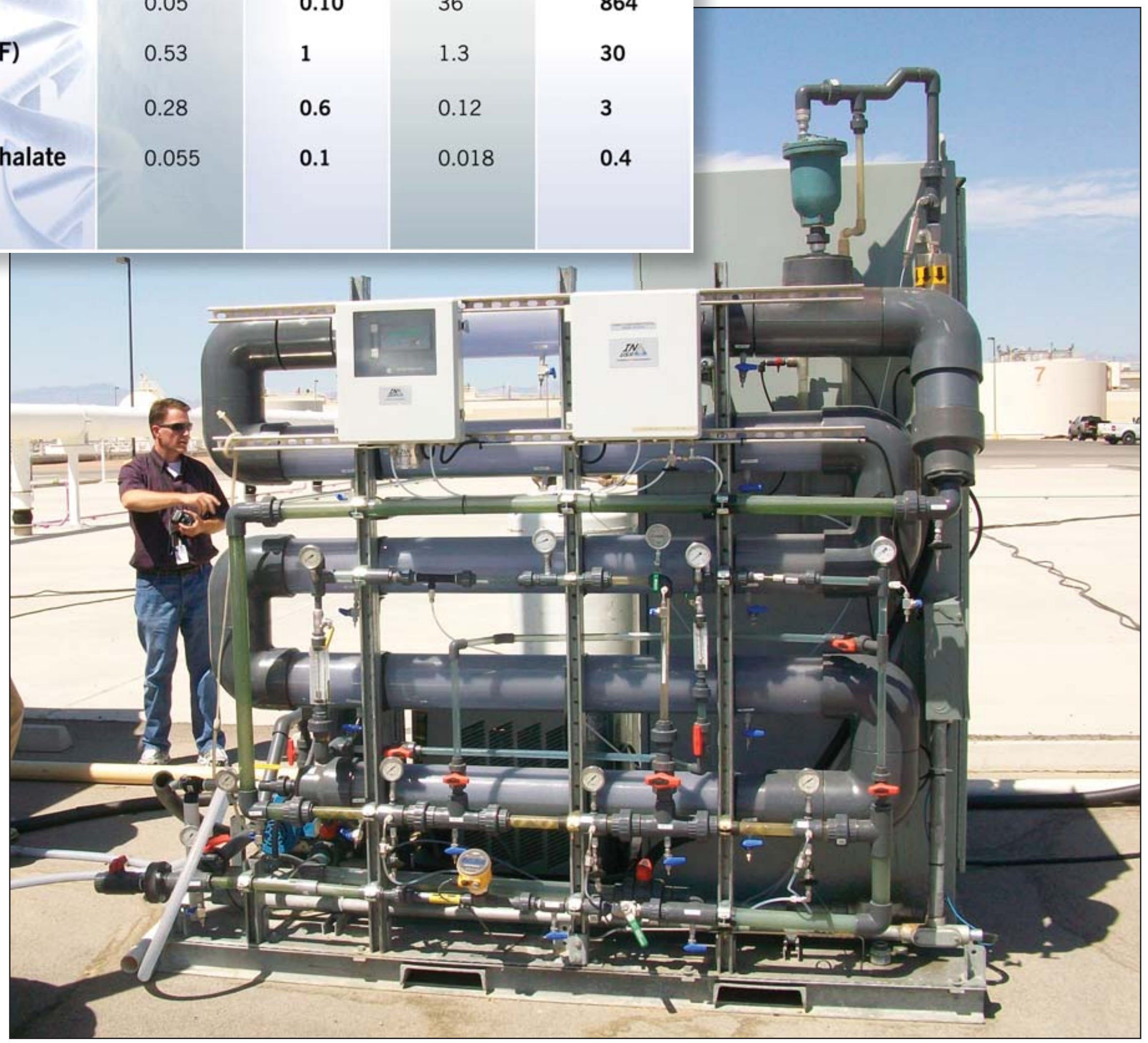
However, water is far from the only exposure route: air, food, and beverage items also contain measurable levels of EDCs and PPCPs. In fact, based on average daily intake (e.g., 2 liters of water per person per day vs. 24,000 liters of air per person per day), air and dietary routes may account for thousands of times greater exposure to EDCs, PPCPs, carcinogens, and other contaminants.

At present, providing a drinking water that is 100% free of EDCs and PPCPs is impossible to achieve, since no technology can completely remove all contaminants. It would also likely provide little benefit, since the concentrations present in drinking water pale in comparison to food and airborne exposure routes. Furthermore, most technologies capable of 99% or 99.9% removal of contaminants are highly energy intensive and are associated with increased greenhouse gas production. Given the link between greenhouse gas production, climate change, drought, wastewater flows, contamination of drinking water, and the use of energy-intensive treatment technologies to remove TOrCs, we must consider seriously the risks and benefits of improved drinking water treatment. These risks must be weighed concurrently with dietary and air exposure scenarios to gain a holistic picture of the public health risks. Furthermore, when improved treatment technology is warranted, it should be focused on the wastewater side and/or on watershed protection, to reduce the impacts on wildlife species and to provide the greatest benefit to downstream drinking water treatment plants.

Relative Exposure Scenarios for Drinking Water and Air

CONTAMINANT	DRINKING WATER		INDOOR AIR	
	Conc. (μg/L)	Exposure (2 L/day) (μg)	Conc. (μg/m^3)	Exposure (24 m^3/day) (μg)
BHT	0.05	**0.10**	36	**864**
TCPP (Fyrol PCF)	0.53	**1**	1.3	**30**
Galaxolide	0.28	**0.6**	0.12	**3**
Butylbenzyl phthalate	0.055	**0.1**	0.018	**0.4**

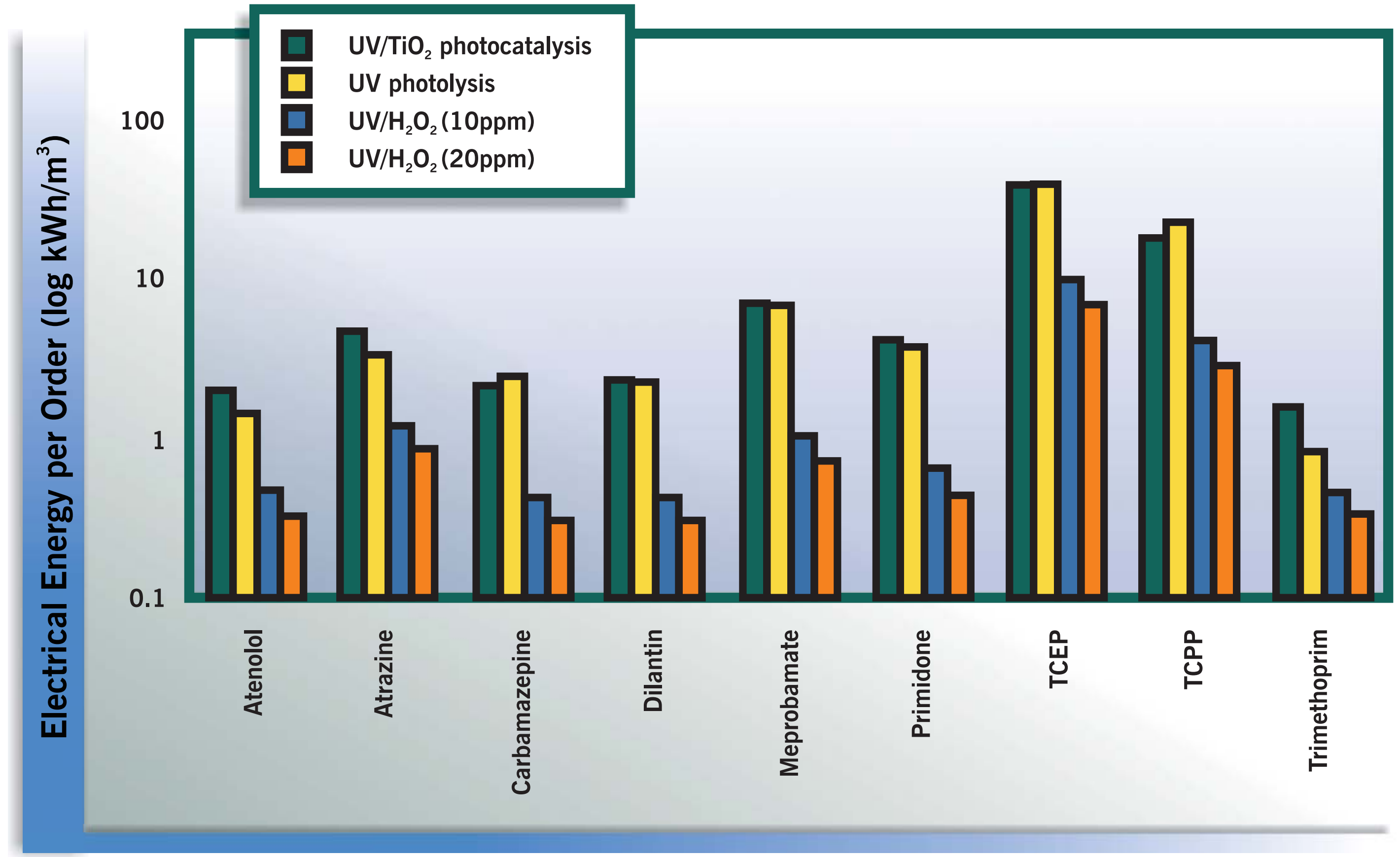
The author installing a HiPOx® reactor in Las Vegas, NV to evaluate the oxidation of contaminants in water and wastewater, using ozone or ozone/peroxide.



Where We Ingest TOrCs

A recent study led by Hazen and Sawyer demonstrated the relative exposure to estrogenic activity and other trace contaminants in drinking water compared with food, bevberage, and air exposure. Drinking water for nearly 28 million people in 17 US cities – along with 40 food and beverage items – was screened for 51 trace contaminants, including suspected endocrine distrupting chemicals, pharmaceuticals, personal care products, pesticides, phytoestrogens, and total in vitro estrogenic activity. Only three drinking water samples exhibited measurable estrogenic activity, whereas 34 of the 40 food and beverage items had measurable estrogenic activity, a fact almost entirely attributable to the presence of phytoestrogens, a beneficial component of many plant-based products. Thus, estrogenic activity does not provide an adequate prediction of risk. However, on an adult, per-serving-basis, food and beverage intake of specific trace contaminants resulted in hundreds to thousands times greater exposure than from drinking water. Of the literature studies available, air exposure for six suspected EDCs analyzed in this study resulted in at least 30-36,000 times the exposure from drinking water.

Amount of energy required to achieve 90% reduction in contaminant by process



Comparison of energy required to decrease contaminant concentration by 90% for various advanced oxidation and photolysis pilot systems: UV + titanium dioxide photocatalytic membrane reactor, UV photolysis with TiO2 removed from rector, and UV peroxide at two doses (10 mg/L and 20 mg/L peroxide) in the reactor. As a point of reference, the use of reverse osmosis membranes in surface water treatment and water reuse applications typically requires 0.5 to 1.5 kWh/m3, including pretreatment, and provides >95% removal of most TOrCs though the waste brine stream. However, RO brine will still contain those contaminants and require special handling and disposal; oxidation technologies chemically transform the contaminants into byproducts. Thus, in choosing which technology to use, one must consider the difference between compartmentalizing and disposing of contaminants versus oxidizing contaminants while considering the formation of oxidation byproducts.

Removing TOrCs

Two on-going studies sponsored by the WateReuse Research Foundation (WateReuse-08-05, "Use of Ozone in Water Reclamation for Contaminant Oxidation", and WateReuse-08-08 "Pilot-Scale Oxidative Technologies for Reducing Fouling Potential in Water Reuse and Drinking Water Treatment Membrane Systems") have been evaluating the efficacy and energy requirements of ozone for the removal of trace organic contaminants in wastewaters. Initial results from these studies indicate that both ozone and ozone peroxide provide excellent removal of many EDCs/PPCPs of concern and at lower energy costs than UV/peroxide systems.

Further, due to the complex nature of wastewater organic matter, ozone can produce its own advanced oxidation process without the use of peroxide. Both ozone and ozone/peroxide systems will become increasingly important technologies for advanced wastewater treatment and water reuse, as they provide many benefits, including disinfection, oxidation of trace organic contaminants, minimization of membrane fouling, and (when used in combination with biological filtration) enhanced removal of oxidation byproducts.

See related links @

www.hazenandsawyer.com

- Estrogenic Activity in U.S. Drinking Waters: A Relative Exposure Comparison
- Researching Safer, More Cost-Effective AOPs

Construction of the replacement in-line storage interceptor is nearing completion. This project is projected to result in a reduction of 56 million gallons of CSO annually, and will significantly reduce solids and floatables discharges to the Ohio River during very large storms.

Improving Water Quality in Northern Kentucky

By Sean Fitzgerald, P.E.

The integration of gray and green stormwater solutions has already begun to reduce Combined Sewer Overflows and eliminate Sanitary Sewer Overflows across a three-county watershed in Northern Kentucky. Planning included the examination of a wide range of alternatives to determine the most cost-effective way to achieve the desired water quality benefits.

Sanitation District No. 1 of Northern Kentucky entered into an innovative Consent Decree with the State of Kentucky and USEPA Region 4 in April 2007, the first in the nation to address wet weather issues using a watershed management approach. The Consent Decree is aimed at achieving water quality improvements more quickly and cost-effectively by specifically allowing the District to consider all sources of water quality impairment when developing long-term plans to address wet weather water quality impacts. The current approach is to implement the watershed-level green solutions and inflow and infiltration removal activities first, monitor effectiveness, and then build additional gray controls to reach the target level of control.

This Consent Decree is unique in that new Watershed Plans will be developed every five years, providing more flexibility to try innovative approaches to reduce the impacts of wet weather across the region. Each plan includes a detailed five-year Improvement Program along with a conceptual Long Term Plan to

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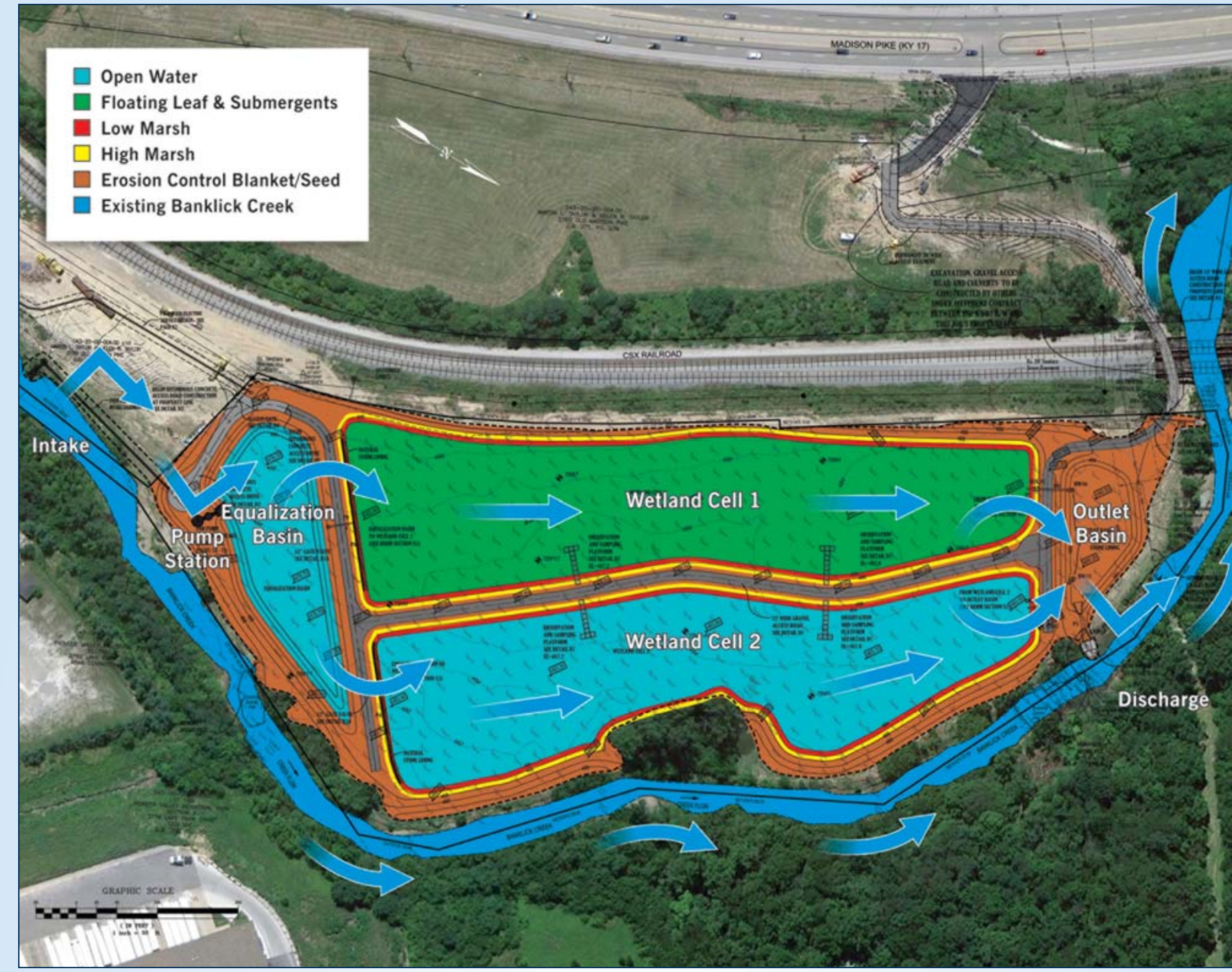


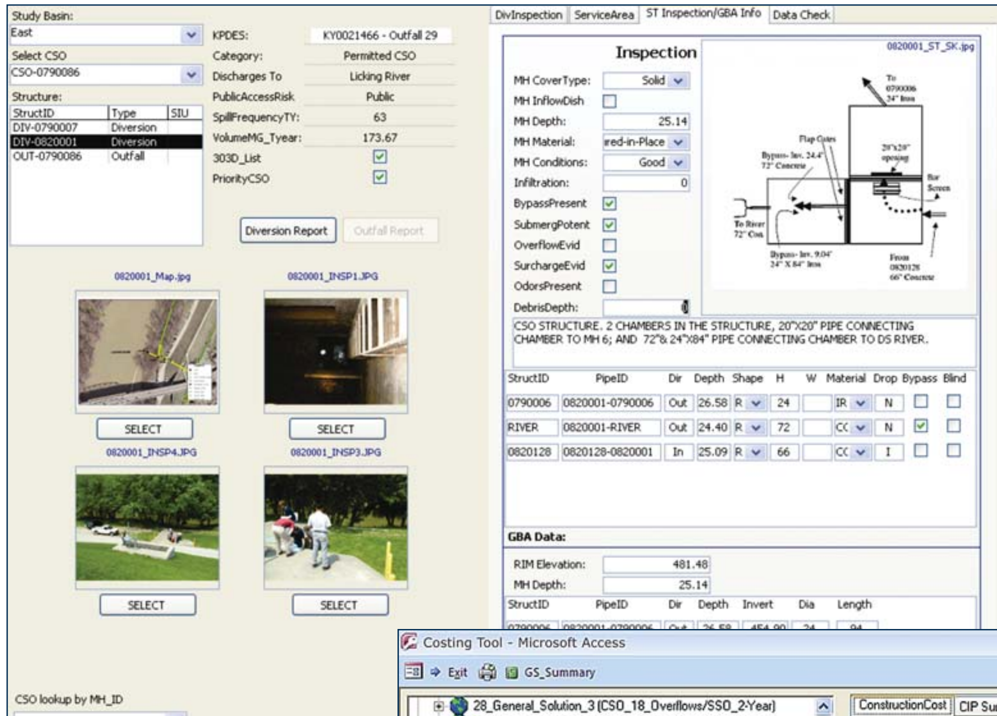
Banklick Creek Wetlands Project

High bacteria concentrations impair Banklick Creek during dry weather, limiting the number of days during the recreational season that the Creek meets the state bacteria standard for primary contact recreation. The Banklick Wetlands Project will divert a portion of the flow from Banklick Creek and convey it through a six-acre constructed wetland, improving water quality in the Creek.

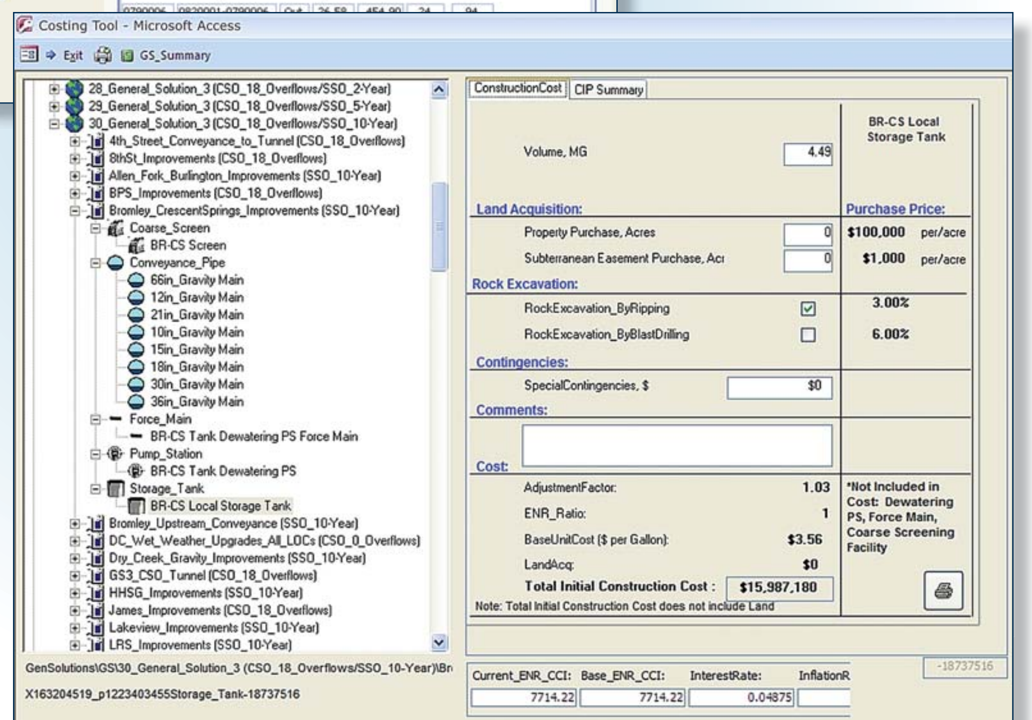
The project is being funded through the American Recovery and Reinvestment Act, and had to be under construction by February 2010. The initial team found that gravity flow to the wetland would not be possible as originally envisioned and contracted Hazen and Sawyer to design a high-flow, low-head pump station to lift water to the wetland. Given the "shovel ready" deadline, Hazen and Sawyer had only two months to design the pump station.

The 5.6-mgd submersible pump station was designed with one constant speed and two variable speed pumps, to maintain the minimum base flow in the Creek while pumping all remaining flow up to the capacity of the pump station through the wetland. Water quality modeling indicates that the pump station design and operational protocol we developed will lead to a 50% increase in the number of recreation days that the Creek attains the water quality standard as compared to a conventional pumping arrangement without variable speed pumps.

When completed, the wetland will primarily function to reduce bacteria concentrations during the contact recreation season, but will also provide other water quality benefits such as nutrient and sediment removal throughout the year.



◀ To facilitate overall infrastructure characterization, and as part of Nine Minimum Controls compliance, we created a database for each CSO diversion and outfall based on existing data and field inspections. Key attribute data and photographs were captured during inspection, housed in the database, and linked to GIS.



An important aspect of the full-system solution concept to address CSOs and SSOs has been a Microsoft Access-based costing tool we created for developing capital, present worth, and CIP cost. Used in combination with the updated Infoworks model – which projects water quality benefits – this tool enables quick and reliable cost/benefit analysis of potential green and gray stormwater control solutions. ▶

meet the final requirements of the Consent Decree. The District's Five-Year Improvement Program addresses the highest priority overflows and includes a combination of gray and green solutions to significantly reduce overflows and address significant dry weather water quality problems along Banklick Creek. Hazen and Sawyer recently assisted with the design of one of these early projects, called the Banklick Wetlands Project. This wetland will divert a portion of the flow from Banklick Creek and convey it through a constructed wetland that will significantly increase the number of days that the Creek is in attainment with water quality standards. The Wetlands Project is currently under construction.

Another key project for the Five-Year Improvement Program was the River's Edge In-line Storage project. This project was an opportunity to significantly reduce local overflows in an area with planned development. The developer planned to install an additional 35 feet of fill over a crumbling interceptor that had to be replaced. This provided an opportunity to install a larger pipe to provide near-term and long-term in-line storage, as well as potential use as conveyance to a regional CSO solution in the future. The project included the installation of more than 8,000 LF of 84" and 120" diameter pipe, which provides 2.2 MG of storage. The project also included the design and construction

Also, as part of this effort, we evaluated the District's Dry Creek WWTP to determine the required wet weather upgrades. Numerous early action projects have already been completed, including new solids handling facilities and rehabilitation of the secondary clarifiers. These and other identified upgrades will increase plant capacity from 75 mgd maximum capacity to 160 mgd firm capacity, thus maximizing treatment during wet weather.

of two solids and floatables control chambers, which also divert flow to the new in-line storage interceptor. This improvement is expected to reduce two local overflows by 68%. The construction of these improvements is complete.

For the development of the Integrated Long Term Plan, Hazen and Sawyer helped develop and implement a continuous model simulation methodology within the Infoworks model to simulate the reduction in runoff from system-wide green infrastructure projects. Our approach was aided by the use of the groundwater infiltration module and evapotranspiration parameters that allowed the model to account for seasonal and antecedent moisture conditions in a single simulation. Simulations of a typical year and a typical five-year period are used to project water quality improvements. The post-green-implementation results were then used to size various alternatives to meet the target level of control. ◣

See related links @

www.hazenandsawyer.com

- Skimming the Surface: Options for Solids and Floatables Control
- Innovative Blue Roof/Green Roof Design Wins DEP Grant

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- Abstracts from ACE, WEFTEC, and other conferences from coast-to-coast.
- Articles reprinted from industry-leading publications WE&T, the AWWA Journal, and many more.
- Write-ups of our award-winning work.

The Threat From Hydrofracking

Drilling for natural gas using high-volume hydraulic fracturing, or hydrofracking, is all over the news in New York these days. Hardly a day goes by when there isn't an article in the paper, a rally in Albany, or the announcement of a public information session from one point of view or another. Politicians are fully engaged on the issue and legislation is pending in both houses at the state level as well as in Congress. State and local jurisdictions are revising environmental reviews, updating regulations, and conducting studies. In just more than two years, hydrofracking has gone from obscure oil industry jargon to perhaps the greatest threat the New York City water supply faces today.

New York City's water supply provides high-quality drinking water to nearly half the population of New York state—more than 8 million people in New York City and another million people in upstate counties. The New York City Department of Environmental Protection (DEP) is the city agency with primary responsibility for overseeing the operation, maintenance, and management of the water supply infrastructure and the protection of the 1,969-square-mile watershed. The Marcellus Shale, currently a prime target for natural gas drilling, underlies the entire portion of the New York City water supply located west of Hudson, N.Y. This west-of-Hudson area typically supplies 90% of the city's drinking water and is of such high quality that the water does not require filtration.

NATURAL GAS DEVELOPMENT SPARKS CONTROVERSY IN 2008

In early 2008, the city first learned of natural gas leases within the watershed and that the state was considering modifying regulations governing natural gas exploration and development that would facilitate the use of hydrofracking. The issue became quickly polarized, with some groups perceiving this as the most serious threat to the environment in a generation and others viewing it as a much-needed boost for the local economy. The city quickly determined there was a need for a balanced, objective assessment that carefully evaluated realistic impacts on the water supply with a focus on water quality, water quantity, and the water supply infrastructure. Thus, a one-year study was commissioned and conducted through a joint venture of Hazen & Sawyer and Leggett, Brashears & Graham. This assessment was completed in December 2009 and has been used to evaluate the supplemental environ-

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