HAZEN AND SAWYER Horizons
Engineering Excellence in Meeting Environmental Challenges
Summer 2002

UV Disinfection:
An Emerging Water Treatment Technology

Many municipalities are seeking ways to meet the impending Long Term 2 Enhanced Surface Water Treatment Rule, which will require all surface water sources to achieve at least 2-log removal/inactivation of *Cryptosporidium*. One alternative, ultraviolet light (UV) disinfection, was only recently found to be highly effective in inactivating *Cryptosporidium* in drinking water. UV disinfection can achieve greater than 3-log inactivation of *Cryptosporidium* at relatively low dosages, and is a highly effective treatment for *Giardia* and other microbes, at a lower cost than other disinfectants such as ozone.

For instance, New York City is now exploring the advantages of two types of UV systems as it prepares to treat its 2-bgd Catskill/Delaware supplies.

For further information, please contact Matthew Valade, P.E., at (212) 539-7136 or e-mail mvalade@hazenandsawyer.com.

Shopping Around

Low-pressure/high-output (LPHO) and medium-pressure (MP) reactors are the two UV systems being offered by UV equipment manufacturers, each with its strengths and weaknesses.

LPHO offers a lower operating cost through the use of more efficient lamps, but requires significantly more lamps than an equivalent MP system. MP systems may be placed more easily into existing treatment plants, since they have a smaller footprint and lower headloss constraints. However, they have higher energy requirements due to less efficient lamps.

For New York City's massive Catskill/Delaware supplies, UV disinfection has been selected as a cost-saving alternative to filtration.

The location of UV disinfection in the treatment scheme is another consideration, whether it be post-filtration, directly on the raw water, or in the distribution system storage reservoir. An assessment must be made based on existing water quality and infrastructure, available headloss, and level of treatment to be achieved.

Selection of the type of UV system, level of redundancy, and control systems (e.g., flow monitoring, UV sensors, transmittance monitors, etc.) to provide the required level of disinfection is often site-specific. This requires significant knowledge, not only of the available UV equipment, but also of the existing treatment process into which UV is to be integrated.

Validating Your Selection

Once a system has been selected, next comes testing to validate that the UV reactor will disinfect according to the manufacturer's claims. Since it may not be practicable to test large-scale (>20-mgd) UV reactors, validation may be achieved via computer modeling.

As part of our work on the conceptual design of UV disinfection of the previously mentioned Catskill/Delaware supplies, we developed computational fluid dynamic (CFD) models of full-scale UV reactors. These models have been integrated with a light-intensity distribution model, allowing us to predict the UV irradiance within a reactor.

An integrated model of this type can then be used to accurately predict the fluence (UV dose) to which a particle or microbe will be exposed as it passes through the reactor.

Further Guidance

In February 2002, AWWA and

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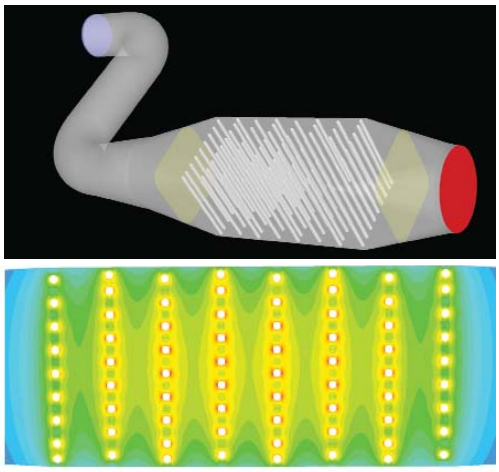
Inside



By integrating a CFD model (above) with a light-intensity distribution model (below), UV dose for a specific reactor can be predicted.

UV Disinfection *Continued*

USEPA co-sponsored a stakeholders' meeting, bringing together leading UV experts in the drinking water industry—among them, state and federal regulators, manufacturers, consultants (including Hazen and Sawyer), and academicians. The product of that meeting, soon to be published by the USEPA, will provide further guidance to utilities.

Looking Ahead

The use of UV disinfection in the drinking water industry is growing rapidly and will continue to grow as drinking water regulations evolve. It is a technology whose time has come, since its application can help utilities meet new disinfection goals, or add an additional disinfection barrier, in a cost-effective manner.

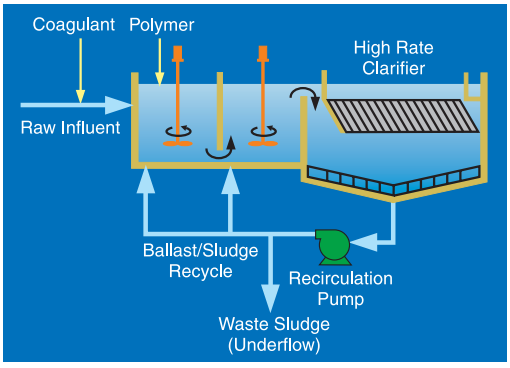
HRPCT: A Promising Wet Weather Control Method

For additional information, please contact Antoine Laurence at (212) 539-7254, or e-mail alaurence@hazenandsawyer.com.

Communities across the United States are faced with the challenge of developing solutions to control their wet weather pollution problems. With the codification of EPA's combined sewer overflow (CSO) policy in a recent amendment to the Clean Water Act and the impending release of the long anticipated sanitary sewer overflow (SSO) rule, municipalities are seeking cost-effective methods to comply with these wet weather treatment requirements.

The HRPCT Difference

One technology that is being considered by many communities is high-rate physical-chemical treatment (HRPCT). This alternative has gained acceptance in Europe, where it has been found to be highly effective in wet weather pollutant removal.



HRPCT treats CSO at overflow rates at least 50 times greater than those of conventional settling tanks, while providing much better BOD and TSS removal.

This technology is appealing for wet weather treatment because of its small footprint, highly effective pollutant removal capability, and quick startup. HRPCT treats flows at overflow rates that are at least 50 times greater than those of conventional settling tanks, with much better removals. It relies on controlled flocculation with polymer and coagulation addition, addition of a recirculated ballast (microsand or sludge) to make the floc heavier, and settling using lamellar plates or tubes. The combination of these three steps allows consistently high BOD and TSS removals with 5- to 20-minute total detention time, as opposed to several hours in a traditional process.

NYC Success Story

Seeing the potential of HRPCT to provide a space- and cost-saving solution to New York City's CSO problems, the New York City DEP undertook pilot testing at one of its 14 wastewater pollution control plants (26th Ward). Processes tested included Actiflo™ by US Filter-Krüger (Vivendi subsidiary) and Densadeg 4D™ by Ondeo Degremont (Suez-Lyonnaise des Eaux subsidiary).

The pilot test was very successful, demonstrating that HRPCT is a compact technology well-suited for the treatment of wet weather flows. Laboratory test data provided a wealth of information on the efficacy of this technology. Each unit performed well, typically removing above 80% of TSS and 55% of BOD. The test also provided important design basis-related information on hydraulic loading, chemical dosage rates, recirculation rates, ballast dosage rate, operating ranges, and sludge quality, as well as the time required to reach full performance after start-up.

Pilot testing at NYC's 26th Ward WPCP.

Based on these results, Hazen and Sawyer, in conjunction with DEP, is evaluating the design and operation of a full-scale demonstration facility.

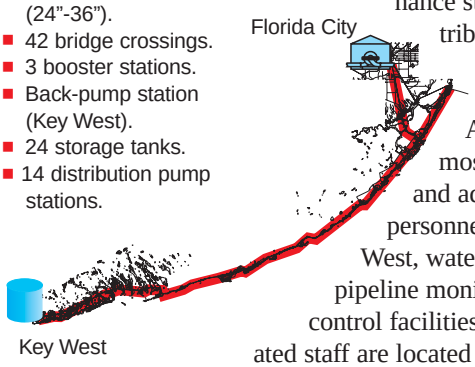
Multimedia Wide Area Network:
Economical Communications Backbone for Water Authority

The Florida Keys Aqueduct Authority (FKAA) pipes in drinking water from mainland Florida to over 160,000 residents in the Florida Keys and Key West. In the face of residential/commercial growth and tourist development, one continuing challenge is providing clear communications and coordination of personnel to operate their WTPs and 140-mile-long 250-psig transmission main system.

Typical bridge crossing between Keys.

Current FKAA Pipeline System

- WTP high-service pumps.
- 140-mi. steel and ductile iron pipeline (24"-36").
- 42 bridge crossings.
- 3 booster stations.
- Back-pump station (Key West).
- 24 storage tanks.
- 14 distribution pump stations.



Communications Challenge

Pipeline operation and maintenance staff are distributed throughout the Keys. Although most engineering and administrative personnel are in Key West, water production, pipeline monitoring and control facilities, and associated staff are located throughout the Keys and on the mainland. To support such a geographically widespread operation, the FKAA has installed a myriad of data communications systems over recent years, to serve various functions and purposes.

Faced with rising costs for the communications equipment and services needed to support a staff of nearly 300 employees, along with the need to further expand the communications infrastructure to provide increased system reliability, utility management capabilities, and improved customer service, FKAA retained Hazen and Sawyer to explore a variety of communications solutions, encompassing:

- Water treatment operations.
- Pipeline pressure monitoring and surge control.
- Remote monitoring and control of booster pump stations.
- Leak detection, isolation, and emergency storage/back-pumping operations.
- Local reverse-osmosis water treatment in the event of mainland supply disruption.
- Local water storage and distribution systems.
- Four maintenance yards and three customer service centers.
- Eight two-way radio towers for maintenance dispatch and local PBX system access.
- Computerized fuel management.
- E-mail, Internet access, office automation tools, etc.
- Planned video conferencing and site security.

Key West emergency operations center and reverse-osmosis facility.

Alternatives addressed ranged from further expansion of dedicated leased line telephone circuits, commercial microwave services, and Internet virtual private networks, to a private commercial data network with digital telephony.

Optimal Solution

The selected system consists of a frame-relay digital data network service from Bellsouth and a series of multimedia routers located at 13 "drops" throughout the service area. These facilities provide Ethernet TCP/IP data networking, voice-over IP communications, virtual telephone circuits, multi-drop serial data communications, and video-over IP services.

The system can best be described as a secure, digital, private commercial wide area network (WAN), furnished and managed by the local telephone service provider to integrate geographically distributed operating centers. Unlike dedicated point-to-point circuits, this system is designed as a self-healing network—such that, in the event of a path failure, digital data is automatically rerouted through another path with no impact on the end user. Likewise, in the event of a specific "drop" failure, service interruption is limited to the individual location, while the remainder of the network continues to function.

It Saves Money, Too

The cost of the installed multimedia frame relay network was $288,000, including all testing, start-up, and training services. An estimated annual cost savings of $134,000 has been achieved by eliminating existing leased line services and avoiding additional services for proposed operational improvements.

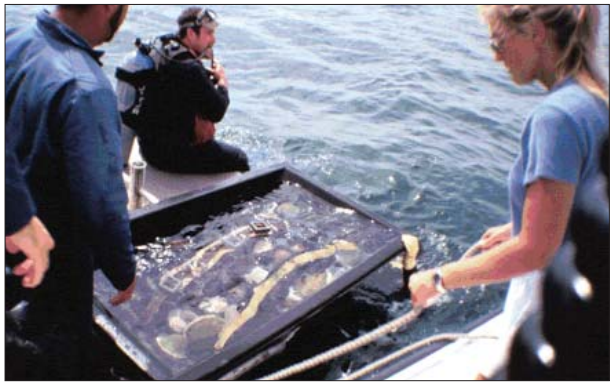
Florida City pipeline control center.

For additional information on the Florida Keys project or other projects completed by our Control and Information System Group, please contact Gary W. Bors, Director of Technology, at (561) 997-8070 or e-mail gbors@hazenandsawyer.com.

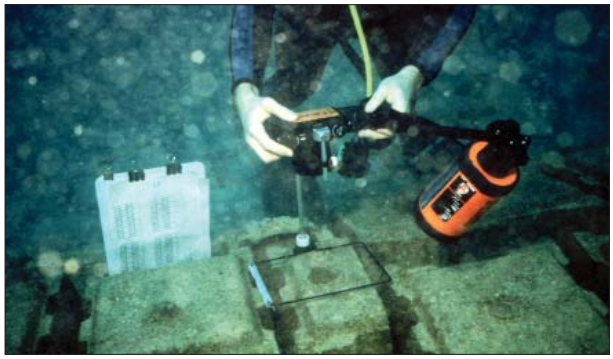
Saving the "Rainforests of the Sea"

The corals were removed with a hammer and chisel and stored in trays.

Divers transported the specimens underwater from the collection site to the transplantation site.



When the sites were too far apart for easy swimming, corals were transported above water, submerged in a tub of seawater.



The specimens were macro-photographed.

Any questions? Please contact Phil Cooke, P.E., at (954) 987-0066, or e-mail pcooke@hazenandsawyer.com.

Coral reefs are called the "rainforests of the sea," because they are highly productive, contain a wealth of species, and are particularly vulnerable to future degradation, since they are often located in regions of severe poverty and high population growth. While occupying less than one quarter of one percent of the planet's oceanic ecosystem, they are home to more than a quarter of all known fish species.

The Miami-Dade Example

Almost all reefs off the Florida coast are at risk due to a variety of factors, including runoff of fertilizers and pollutants from farms and coastal development.

Hazen and Sawyer's recent work in Miami-Dade County illustrates how a practical engineering approach can help preserve fragile marine life.

The primary goals of the project were to assess the damage to an exposed outfall pipeline after many severe storms and to recommend a rehabilitation program. During our underwater survey, however, many reef-building stony corals were discovered growing on the pipe.

The recommended repair procedure for the outfall involved placing articulated concrete mats over the exposed portions of the pipe for protection and erosion control. Since this would have destroyed the opportunistic coral colonies, mitigation options were necessary. With the help of the faculty and students of Nova Southeastern University, Hazen and Sawyer planned to remove the existing corals and cement them to the articulated concrete mats.

Equal portions of Portland Type II cement and molding plaster were taken underwater in bags and mixed with seawater to create a heavy paste consistency. The coral was pressed gently into the cement at the top of the armor mat. Care was taken to use minimal cement so that it would not ooze up over the lip of the coral base and damage living tissue.

A total of 271 living corals were collected and transported from the exposed outfall pipe. After three months, 266 specimens remained in place and survived. The specimens were macro-photographed and the images digitized, so that the living tissue area could be quantified with image analysis software. Control sites on nearby reefs were also established, and a subsequent monitoring event, performed after 27 months, found that the transplants exhibited growth comparable to that of the naturally occurring corals in the control sites.

A Valuable Achievement

As a result of this project, permitting agencies in Miami-Dade and Broward Counties have approved the armor mat for coral reef and hard-bottom restoration projects. As more communities around the world learn of the success of the concrete mats as a substrate for coral transplantation, they can take advantage of this method of protecting this valuable resource.

Just How Valuable Are They?

A recent study by Hazen and Sawyer, in association with Florida State University, found that income generated from reef-related expenditures in southeast Florida ranges from $139 million to $1 billion per county, supporting from 6,300 to 36,000 jobs per county. Also, reef users are willing to pay $255 million annually to protect these reefs.

Viewpoint: SECURING THE NATION'S DRINKING WATER

William Becker, Ph.D., P.E., Vice President

After 9/11, ensuring a secure water system has taken on a new meaning for most utilities. In the past, when considering security, utilities were primarily concerned with vandals or perhaps disgruntled employees. While these are still the most likely threats, the chance of terrorists deliberately damaging a plant or contaminating a water supply or distribution system is real.

Washington's Response

Congress has enacted a number of bills to address the threat of terrorism in the US. On January 10, 2002, HR 3338, a supplemental Defense Appropriations bill, became Public Law 107-117. As part of fiscal year 2002 supplemental appropriations, the USEPA received $89 million to develop vulnerability assessments (VAs) and emergency response/operations plans (ERPs), and for planning and design of security enhancements. As a result, USEPA grants of up to $115,000 are available to large systems (those serving 100,000 or more people).

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More recently, the House and Senate almost unanimously passed the $3 billion Public Health and Bioterrorism Response Act (HR 3448), now awaiting presidential approval. Its water-related provisions include mandatory submittal of VAs and preparation or revision of ERPs for all water systems serving more than 3,300 people, setting aside $160 million in USEPA funding for utilities to conduct VAs, prepare ERPs, initiate "basic security enhancements," and respond to urgent vulnerabilities. It also establishes deadlines for completing VAs, based on population: March 31, 2003 for >100,000; December 31, 2003 for 50,000-100,000; and June 30, 2004 for 3,300-50,000. While systems with fewer than 3,300 people are not required to have VAs and ERPs, they may receive USEPA guidance and their share of the $5 million set aside for small systems.

Research-grant funding is also available, and ultimately billions of dollars may be offered through block grants to communities and revolving loans.

Utilities' Response

What this means for water authorities is that they have new technical and financial resources to begin preparing a security program, starting with a VA to identify and prioritize threats, identify critical infrastructure, assess the physical security system, and develop a response plan. The idea is to detect, delay, and respond to any catastrophe.

After completing a VA, the next step is to develop an ERP, specifying the actions to be taken in the event of a threat to the utility. This takes much thought and deliberation. For example, how will the utility managers respond to a called-in contamination threat? Is it better to shut down the plant, thereby causing water shortages and making it impossible to extinguish fires, or is it better to take the time to investigate, possibly causing danger to the community?

An ERP should also include provisions for engaging local government, law enforcement personnel, emergency aid professionals, and water utility staff. Another important ingredient is a communication strategy with the public, to avoid mass hysteria in an emergency situation. Utilities should establish relationships with the media and develop a plan for communicating during various threat or actual event scenarios.

Where to Go for Guidance

Utilities are in a new and challenging position. So where can they go for help?

One place to start is USEPA's Water Infrastructure Security Website (http://www.epa.gov/safewater/security/), which contains extensive information and resources and is updated frequently.

In addition, USEPA has joined forces with the American Water Works Association Research Foundation (AWWARF) and Sandia National Laboratories to develop a Risk Assessment Methodology for Water Utilities (RAM-W^{SM}). While this methodology is still being refined, a report entitled *Risk Assessment Methodology for Water Utilities* is now available from AWWARF.

Finally, utilities can retain the services of a consultant to help prepare security plans. There are many firms marketing security services, so it is important to find one with exceptional qualifications and a history of securing high-profile sites, such as nuclear power plants. At a minimum, the firm should be familiar with and use the techniques outlined in the RAM-W^{SM}.

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Hazen and Sawyer Happenings

Recent Awards

NYACE

Hazen and Sawyer received two NYACE 2002 Engineering Excellence awards: a Diamond Award (first prize) for the Mamaroneck BNR Demonstration Project and a Platinum Award (second prize) for the Black Rock Water Treatment Plant.

Above: *Receiving the Diamond Award for the Mamaroneck BNR project: Anthony Landi (Westchester County) and Alan Natter (H&S).*
Below: *Receiving the Platinum Award for the Black Rock project: David Silverman (H&S), Edward Moulton (Village of Cornwall-on-Hudson), Ralph Smith (Village of Cornwall-on-Hudson), and Gordon Starkey, (H&S).*

The Mamaroneck project, for the Westchester County Department of Environmental Facilities, NY, focused on the use of the Modified Lutzak-Ettenger process, with the addition of attached-growth media, to achieve sufficient nutrient removal via operation and process control modifications, with limited new construction and nominal cost. This process has been successfully used in warmer climates, but not in cold-weather climates, and it had never been tested in 30-foot-deep aeration tanks and stacked final clarifiers, such as those at the Mamaroneck WWTP.

The Black Rock facility, for the Village of Cornwall-on-Hudson, NY, is a new plant featuring innovative membrane treatment. Compared to a traditional water treatment plant, this facility offers a 33% savings in construction costs and a projected savings of 5-10% in consumer water costs. The membrane filters and all systems fit within a 26' x 86' building alongside the reservoir, eliminating the need to construct a larger, more expensive building above the storage reservoir. Since membrane filtration also doesn't require chemical coagulants or generate residuals, the need for solids disposal was eliminated. ◣

NYC Art Commission

Our joint-venture design of the Manhattan Pumping Station renovation for the New York City Department of Environmental Protection was among the projects selected by the New York City Art Commission for its Twentieth Annual Awards for Excellence in Design. This prestigious award was presented by Mayor Michael Bloomberg at a ceremony at the Metropolitan Museum of Art on May 30, 2002. ◣

Above: *Mike Stallone, Project Architect for the Manhattan Pumping Station, with Mayor Michael Bloomberg.*
Below: *Our inspiration for the building's design was water—NYCDEP's main focus.*

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