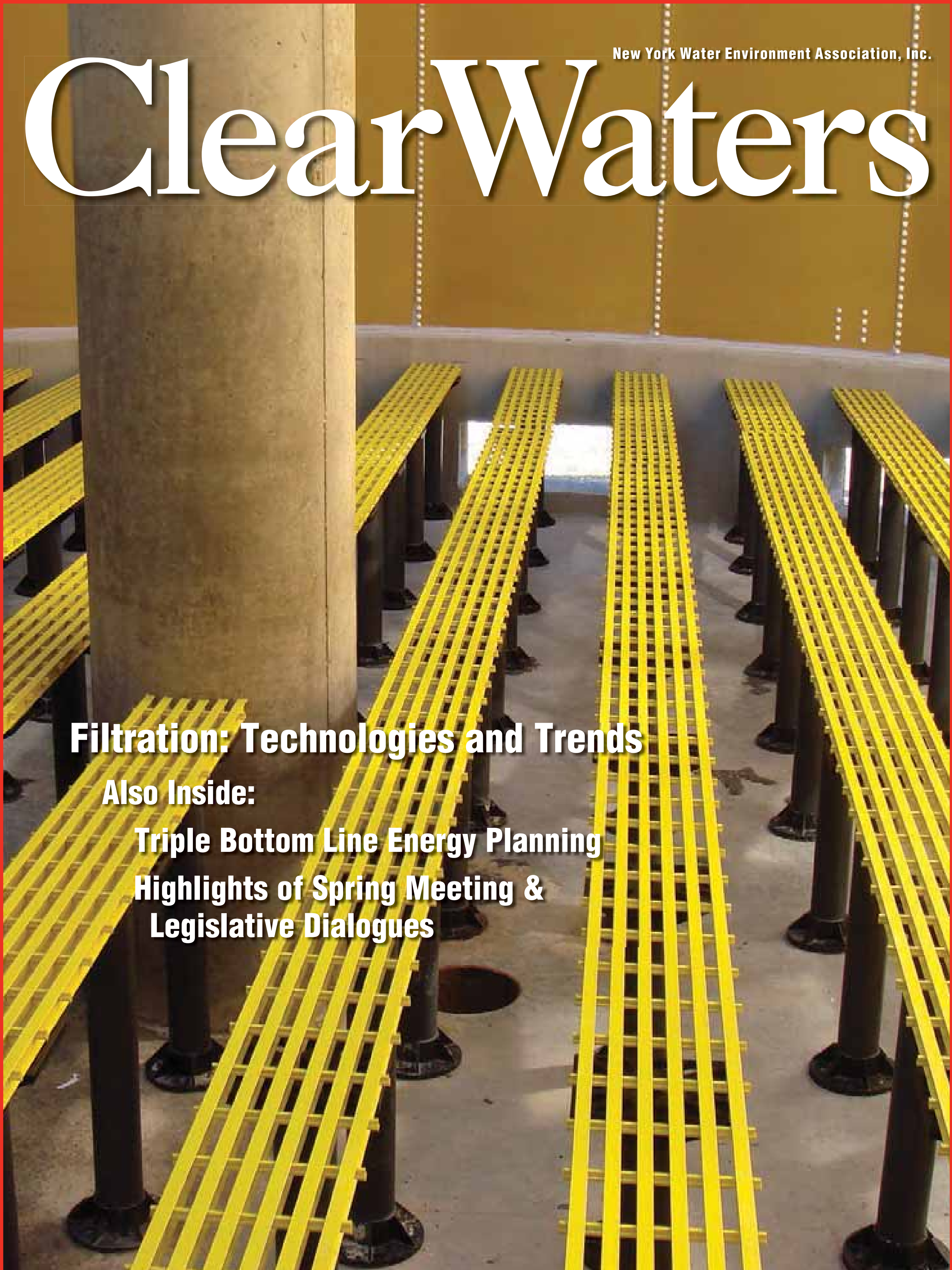
Summer 2014, Vol. 44, No. 2

New York Water Environment Association, Inc.

ClearWaters



Filtration: Technologies and Trends

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Summary 2014, Vol. 44, No. 2

Clear Waters

New York Water Environment Association, Inc.

Cover Image: A filtration alternative underdrain system of plastic stanchions and fiberglass reinforced grating *(Photo provided by Brentwood Industries)*

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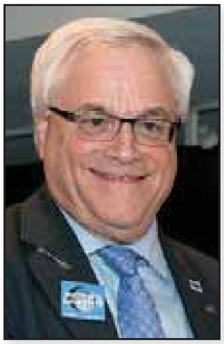
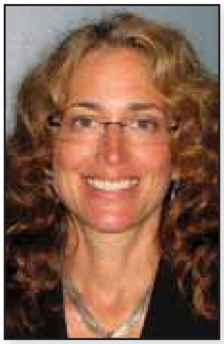
♻ **Clear Waters** ***is printed on recycled paper, using soy-based ink.***

President's Message | Spring 2014



Steven A. Fangmann

Executive Director's Message | Spring 2014



Patricia Cerro-Reehil
pcr@nywea.org

Hyatt Regency Hotel, Hauppauge, NY

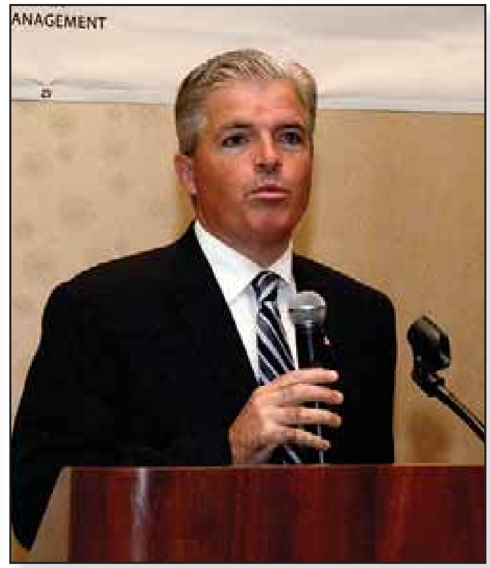
Highlights of Spring Meeting in L.I.

June 2–4, 2014

A Spring Success!

Over 200 people attended NYWEA's Spring Technical Conference and Exhibition. With 10 technical sessions around the topic of "Resilient Water Infrastructure and Facilities of the Future," attendees were able to obtain many contact hours and network with their peers. In addition to photos here, you can also find photos featured on our Facebook page.

Many thanks to the 30+ exhibitors, sponsors and advertisers who support our Spring meeting and are a large part of its success.



Suffolk County Executive Steven Bellone addresses NYWEA members during the Opening Session.

Opening Session Panel (l–r): Steven Fangmann, Joe DiMura, Shila Shah-Gavnoudias, Thomas Lauro, Timothy Burns and Stephen Vida

Claire Baldwin's workshop titled, Breaking the Paradigm: This Isn't Your Grandfather's Operations Job Anymore, was insightful and well received.

Janice and Cawsie Jijina keep warm on the boat!

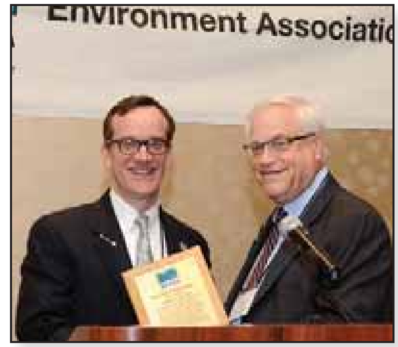
President–Elect Michael Garland and the Genesee Valley Water Recyclers: Tim Keegan, Ken Smith, Steve Reiter and Mike Burkett and Steve Peletz

Left: A grouping of Past Presidents on the boat cruise sponsored by the Long Island Chapter. (Back row, l–r): Ron Delo, Mark Koester, J. Kirk Rowland, Fotios Papamichael; (front row, l–r): Bruce Munn, Richard Lyons, Keneck Skibinski and Tom Lauro

The Long Island Boys: Tom Immerso, Mark Wagner, George Desmarais and Frank Russo

Nicholas J. Bartilucci is recognized for his over 50 years of involvement with NYWEA that culminated in a scholarship named in his honor.

NYWEA's Humanitarian Assistance Committee gave their support to America's VetDogs. A $1,000 check was presented to this organization that helps to place trained guide and service dogs with America's veterans in need.



NYWEA President Fangmann presents Michael Garland with a plaque in appreciation of his attendance and participation in the WEF Fly-In in Washington, DC.

(L–r): Al Lopez, Dana Butensky (proud mom), Reva Butensky (scholarship winner), Nicholas J. Bartilucci and NYWEA President Steven Fangmann

Left: Gilbert Anderson, left, Suffolk County DPW Commissioner participates on the panel with Joe Dimura of NYSDEC.

Right: Ken Smith of the Genesee Valley Water Recyclers works on the laboratory portion of the Operations Challenge.

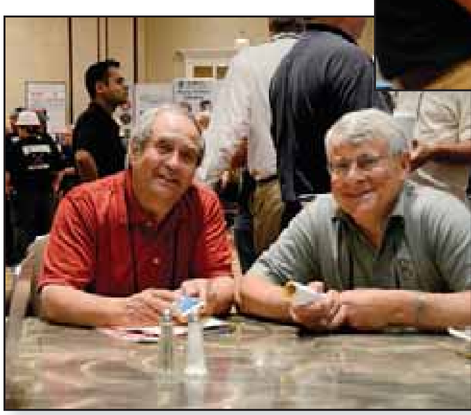
Above: Brown Tide Team members work on the Collection Systems event during the Operations Challenge.

Many thanks to the exhibitors!

Larry Brincat, left, and John Ruggiero at the Operations Challenge; J. Kirk Rowland far right background

Right: (L–r): Greg Jager of GP Jager, Janice McGovern and Mark Wagner in the Exhibit Hall

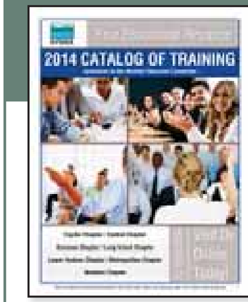
Bob Withers, far left, talks with the New Jersey Devils who came to NY to compete in the First Regional Operations Challenge. (L–r): Art Cowan, Carl Seabrook, Josh Palombo, George McCabe and Coach Tim Fisher, Sr.



Anthony Conetta and Robert Adamski

Joe Massaro and Juju Xia

Enjoying an afternoon's Victorian Tea at The Hidden Oak Cafe in Great River



Upcoming NYWEA Meetings & Chapter Training Sessions

Meetings & Chapter Training Sessions

Occupational Chemical Exposure
July 17, 2014, Lockport, NY

Sequencing Batch Reactor Design and Operations
August 14, 2014, Lyons, NY
November 20, 2014, Babylon, NY

Watershed Science and Technical Symposium
September 10, 2014, West Point, NY

DMR: Proper Completion and Electronic Reporting
September 10, 2014, Watertown, NY
October 28, 2014, Monticello, NY

NYCOM Public Works Training School
October 20–22, 2014,
Saratoga Springs, NY

Solids Handling and Dewatering
October 23, 2014, Babylon, NY
October 29, 2014, Bath, NY
November 5, 2014, Syracuse, NY

Disinfection Optimization
November 20, 2014, Albany, NY

Energy Specialty Conference
November 20, 2014, Monticello, NY

Sequencing Batch Reactor Design and Operations
November 20, 2014, Babylon, NY

NYWEA 87th Annual Meeting & Exhibition
February 2–4, 2015
NYC Marriott Marquis

Legislative & Regulatory Dialogue
May 5, 2015, Room 711 A
Legislative Office Building, Albany, NY

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LEADING THE WAY IN WATER QUALITY MANAGEMENT

Update on Sewage Pollution Right to Know Law

In the summer, New Yorkers are on and in water! Wastewater treatment plant operators have always had a key role in keeping our waters clean. Wastewater treatment has greatly improved many lakes and waterways so that people can enjoy places they probably would not have visited 40 years ago.

But there is still much work to do and still places and situations where contact with the water is not advised. Beginning in 2013 with the Sewage Pollution Right to Know (SPRTK) law, operators now have the additional role of informing the public of times and locations in which inadequately treated sewage is discharged into our waters. This notification will help the public avoid waters that may contain bacteria or pathogens that can cause illness.

The SPRTK law requires that discharges of untreated and partially treated sewage be reported by publicly owned treatment works (POTWs) and publicly owned sewer systems (POSSs) within two hours of discovery to the NYS Department of Environmental Conservation and within four hours of discovery to the public and adjoining municipalities.

Implementing the SPRTK law has involved an ongoing stakeholder process, and NYSDEC wants to make it as simple and effective as possible. It is important that the public be made aware of possible hazards while not adding an unnecessary burden to wastewater treatment operators. Since last spring, NYSDEC has made substantial progress on the reporting process and systems. It also provided additional information to the public so that New Yorkers can better understand wastewater treatment and the SPRTK law. Here is an update on activities:

- NYSDEC has been working with the State Office of Emergency Management and the Office of Information Technology Services on the use of the NY-ALERT system to report untreated discharges. The warning system is expected to be online later this year.
- NYSDEC has conducted training sessions throughout the state demonstrating how to complete and submit the Sewage Discharge Report Form to report discharges.
- NYSDEC has improved its webpages for POTWs and POSSs so that operators can readily find needed information. Improved and expanded information has been added to NYSDEC webpages for the public, including a map showing the locations of combined sewer overflows at http://www.dec.ny.gov/chemical/88736.html.
- NYSDEC has been drafting regulations to implement the SPRTK law. The department will file a Notice of Proposed Rule Making in the near future. The public will then have an opportunity to comment.

People will be out swimming, boating and fishing this summer because water quality professionals, like wastewater treatment operators, keep the water clean for them and alert them about areas to avoid. Thanks to operators throughout New York State, everyone will be able to use and enjoy its waters with increased confidence.

– James Tierney, Assistant Commissioner for Water Resources
NYS Department of Environmental Conservation

Focus on Safety | Summer 2014

Preparedness = Clean Drinking Water

In the *Clear Waters* Spring 2014 edition, I mentioned the New York State Citizen Preparedness Corps training and I had the opportunity to attend a regional training session held at SUNY Binghamton University. The session was very ably presented by members of the NYS National Guard with introductory remarks from local officials and Governor Andrew Cuomo.

The bulk of the audience appeared to be those of us in our middle years who likely have experienced several emergency situations. We all were looking for some guidance and additional information so that we would be ***ready*** – ready for a flood, snowstorm, hurricane, power outage, or any other conceivable disaster. A big emphasis was on flooding since Binghamton and its surrounding area have weathered several floods. Perhaps other sessions had a different emphasis, but one topic undoubtedly is common to all sessions across the state – be prepared to go it alone for 10 days.

I came away from the session obsessed with water – how to collect it, filter it, treat it, tote it and store it. Minimally, we were taught that a gallon of clean water per person per day for 10 days, along with a place to store it, is required. Alternatively, a way to obtain water continuously is needed. Living in a rural area where the electricity could be out for days, I may have all the water needed in a well, but no way to bring it to the faucet until a generator is installed. Would an old-fashioned hand pump work with the existing well? I had to do more research on that. I could collect creek water from my property, but then I realized it would have to be carried and then filtered because the creek winds its way through many pastures. A filtration mechanism was needed – something that would be efficient, work on hand power or gravity, and not need a filter change until after 200 gallons. The various filters could include ceramic, carbon, micro-filters, hollow tubes, reverse osmosis, sand, sphagnum moss and charcoal. Another option was to boil the water – a lot of water – but I do have acres of trees for fire fuel.

Don't become a casualty of unclean drinking water because of a waterborne bug. We should be prepared to go it alone and leave the EMS for those in greater need.

I returned home from the session knowing I had to do more research, but I felt more confident and proceeded to collect needed supplies. I am appreciative of our state's efforts to help prepare its citizens in an emergency and I encourage all *Clear Waters* readers to attend a session. The best advice may have been: "In a flood, don't stay with the house. You can't rebuild if you are dead!" The presenter, a Master Sergeant, had a way with words.

– Eileen M. Reynolds, Certified Safety Professional
Owner, Coracle Safety Management

NYWEA Stormwater Task Force Progress Update

by Gregory Liberman

Since passage of the Clean Water Act in 1972, stormwater regulations and requirements have continually changed and evolved. These changes have, and will continue to have, a direct effect on how New York State communities approach stormwater management and water resource planning. In addition to regulatory changes, physical and social changes also have a substantial impact on how municipalities engage stormwater. For instance, recent storms (i.e., Superstorm Sandy, Hurricane Irene) and subsequent flooding, shifting in funding sources (for example, the Green Innovation Grant Program), as well as advances in infrastructure technology and asset management, directly affect how stormwater is planned for and managed.

In this framework, the New York Water Environment Association Stormwater Task Force is charged with increasing awareness of these issues and how they may individually or collectively impact our communities. Our task force is focused on identifying and discussing these current issues in an integrated manner, so that all of our communities can continue to make informed decisions regarding stormwater infrastructure and water quality.

The members of the task force work across sectors, including agency staff, municipal staff and consultants. Not only do they bring a broad range of skill sets (engineering, law, landscape architecture, environmental science), they also are comprised of volunteers from across New York State. From this broad background, they have identified the following goals and objectives:

- Serve as an informational resource for members and municipalities.
- Provide clear direction and guidance with regards to regulatory changes.
- Provide guidance and training with respect to current needs.

In support of these goals, the task force has targeted issues associated with maintenance and performance of green infrastructure systems as its initial focus. As initial objectives are met, other topics are likely to emerge. For the immediate term, the task force has been focused on the following action items:

- Hosting a lunchtime work session during the 2014 NYWEA Annual Meeting in New York City. During this meeting, the task force was able to attract three new members.
- Presenting a paper titled, "NYWEA Stormwater Task Force – a Resource for the Regulated," at the Western New York Stormwater Conference in March 2014.
- Presenting a paper focused on "Green Infrastructure Maintenance" at the Greater Buffalo Environmental Conference in March 2014.

The task force will also be hosting a session focused on stormwater and green infrastructure maintenance, costs and comparison during the NYWEA Spring Meeting in June 2014. This session is intended to serve as a kick-off for a dedicated green infrastructure maintenance training series geared towards municipal staff that is scheduled to be included in the 2015 NYWEA Member Education Committee (MEC) Training Catalog. As part of this training, the task force has engaged staff from the New York State Department of Environmental Conservation, regional universities, as well as leading stormwater management maintenance experts to develop the training content. A workshop is being planned for Summer 2014 to refine the training content so that the session may be rolled out in 2015. Lastly, a regulatory update meeting focused on New York State stormwater regulations is in the works for the 2015 Annual Meeting.

Gregory Liberman, chair of the NYWEA Stormwater Task Force, is Project Manager for GHD in Cazenovia, NY and may be reached at gregory.liberman@ghd.com.

Photo courtesy of Donald Ferlow

Stormwater wetlands at the Peach Lake Environmental Center in North Salem, NY

Photo courtesy of Gregory Liberman

Reinforced turf pavement at a sanitary pump station in Chatham, MA


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Filtration: Is Anything New Under the Sun?

by Scott A. Grieco

"What has been will be again, what has been done will be done again; there is nothing new under the sun." This was a statement first posed by King Solomon 3,000 years ago. Is this statement true of filtration? Although many of us can remember life before the game changing innovations of personal computers, the internet, ipads and smart phones, filtration has a long documented history. Consider the ancient Greek and Sanskrit writings dating back to 4000 BC, which suggest that these civilizations were educated in sand, gravel and activated charcoal filtration. How about the fact that in 500 BC, Hippocrates invented the first bag filter? In the 1700s, water filters made of wool, sponge and charcoal were applied for domestic applications. Since the early 1980s, polymeric membranes have been widely applied.

So, for those of us in the practice of specifying, designing and operating filtration systems, can we echo King Solomon's sentiments? One could argue that in the filtration market, recent technology advancements are incremental improvements on existing technology, suggesting that there is truly nothing new under the sun. However, I would suggest that this is a myopic view of the filtration market. There is something original about filtration today that is worth considering – *that seemingly incremental changes have allowed existing membrane technology to be applied to complex (previously unfeasible) applications.*

Application of filtration is primarily dependent on particle size and particle charge. In a most basic categorization, filtration can be considered "macro" or "micro." Although there is no absolute cutoff for these values, a general guidance is approximately 1 to 5 micrometers (μm). Particles larger than this range can be removed using a macro-media technology (e.g., sand, gravel, cloth); whereas, particles smaller than this range are typically removed using a micro-media technology (e.g., polymeric or ceramic membrane). As a general practice in the field, material that passes through a 0.45 μm filter is considered dissolved (0.2 μm is often used in certain laboratory applications). However, this cutoff may also still include colloidal material such as silica and clays, as well as viruses and pigments. Hence, membranes such as microfilters (>0.1 μm), ultrafilters (>0.01 μm), nanofiltration (>0.001), and reverse osmosis (>0.0001 μm) are required for many sub-micron applications.

Of the various sub-micron membranes, there is a particular example of new applications worth noting: nanofiltration (NF) and reverse osmosis (RO) for treatment of leachate.

NF/RO for Complex Leachate

Leachate from municipal waste landfill sites is considered a complex mixture of dissolved organics, nutrients and inorganic salts. Using a robust removal technology like NF or RO would be beneficial; however, drawbacks have limited the use of these technologies in large-scale applications: they are rather expensive due to pre- and post-treatment costs, and often fouling deteriorates system performance resulting in low treatability and high operating costs.

Recently, two examples of NF/RO technology have been shown capable of direct application to complex wastewaters, such as leachate.

Vibratory Shear Enhanced Processing (VSEP): The VSEP technology *(New Logic Research, Inc. – Emeryville, CA)* utilizes reverse osmosis membrane leaf elements in a stacked-disk configuration that is configured as a single vertical element ***(Figure 1)***. The disk stack is oscillated in a motion similar to the agitator of a washing machine, but at a much faster speed ***(Figure 2)***. The oscillation produces a shear at the membrane surface of about 150,000/seconds which, according to the manufacturer, is approximately 10 times the shear rate of the best conventional cross-flow systems. In a cross-flow membrane, the fluid velocity is greatest away from the membrane surface and a low shear region along the membrane surface exists. This low shear region promotes fouling and pore blockage along the membrane surface. In contrast, the shear in a VSEP system is focused at the membrane surface where it is most useful in preventing fouling, while the bulk fluid between the membrane disks moves very little.

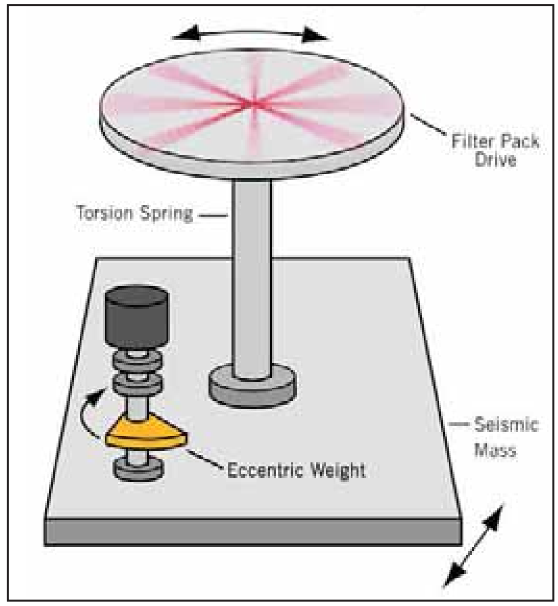


Figure 1. VSEP Stacked Disk Filter Pack Element

Source: VSEP

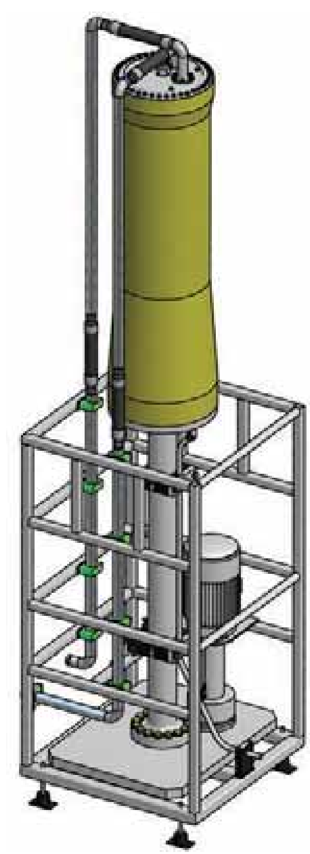


Figure 2. VSEP Disk Oscillating System

Source: VSEP

The VSEP technology using NF (50 percent sodium chloride or NaCl) and RO (99 percent NaCl rejection) was studied on landfill leachate in Greece *(Chan 2007)* and Japan *(Zouboulis 2008)*. Using the NF membrane, direct treatment of the leachate achieved 90 percent recovery at a flux rate of 24 gal/ft^2/d (gfd). Using the

continued on page 15

continued from page 13

RO membrane, treatment of the leachate adjusted to pH = 6 was evaluated at 80 percent recovery and a flux rate of 38 gfd. Results of the two membranes are shown in ***Table 1***.

Table 1. VSEP Performance of NF and RO Membranes on Landfill Leachate

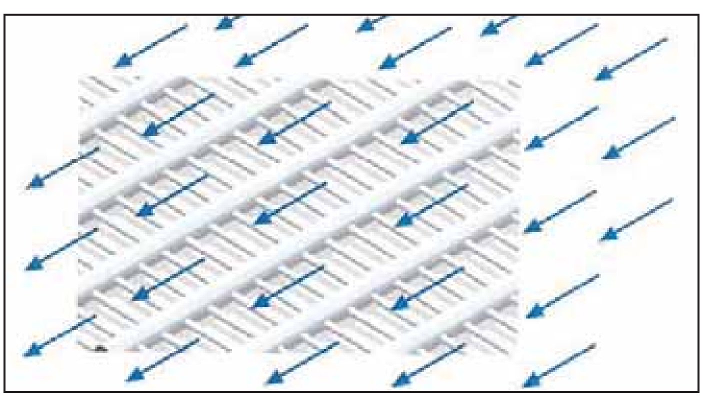
	NF Membrane		RO Membrane	
Parameter (mg/L)	**Initial Conc.**	**% Removal**	**Initial Conc.**	**% Removal**
pH (SU)	8.3	–	6.0*	–
BOD_5	NA	NA	700	93.5
COD	4100	90%	8000	97.0
NH_3-N	580	45%	2620	99.6
NO_3-N	NA	NA	290	99.8

Notes:
NA: Not Analyzed
*pH of leachate at 8.01, but adjusted to 6.0 for treatment
SU: standard units
(Chan 2007, Zouboulis 2008).

There are several VSEP leachate installations in North and South America, including an operating facility in Virginia (www.vsep.com). The system in Virginia treats 50,000 gpd at 80 percent recovery using an NF membrane. The concentrated reject is returned to the landfill. The system is designed to treat biochemical oxygen demand (BOD_5), ammonia nitrogen (NH_3-N), and arsenic. The system provides 89 percent removal of BOD_5, 64 percent removal of NH_3-N, and 94 percent removal of arsenic at initial concentrations of 1,350 mg/L, 750 mg/L, and 0.316 mg/L, respectively.

ROChem Open Channel Membrane: The ROChem Spacer Tube (ST) technology *(Ultura Water – Long Beach, California)* is a new spin on the spiral wound (SW) membrane. The ST module combines the open tube resilience with the efficiency and throughput of a conventional SW module to treat wastewater with high potential of fouling and scaling. Similar to the spiral wound module, the membrane envelopes are made of two flat membranes, between which an internal fabric collects permeate. However, the membrane envelopes are set apart by feed side spacers, creating open channels *(Li 2012)*. The feed spacers used in the ST modules consist of two types of filaments with different diameters ***(Figure 3)***. The thick filaments (parallel to the channel axis) have direct contact with the membrane. The thin filaments (perpendicular to the channel axis) are of smaller diameter and have no contact with the membrane surface, allowing small particles to pass through on either side. This allows the ST module to tolerate high dissolved solids and high turbidity, providing a greater resistance to scaling and fouling *(Li 2014)*. This system allows for direct treatment of leachate with minimal or no prefiltration.

As an example installation, raw leachate was treated using a two-stage ROChem system *(Li 2009)*. Leachate was fed from an equalization tank to a sand filter, which is used to remove suspended particles larger than 50 µm in size. Sulfuric acid was dosed to maintain a pH value between 6.0–6.5 in order to increase the solubility of the inorganic salts, as well as improve ammonia rejection. Results of the two membranes are shown in ***Table 2***.



Source: Ultura Water

Figure 3. ROChem Spacer Tube configuration.

Table 2. ROChem Example Case Study

	Stage 1		Stage 2	
Parameter (mg/L)	**Initial Conc.**	**% Removal**	**Initial Conc.**	**% Removal**
pH (SU)	6.93	–	5.13	–
Cond (µS/cm)	22800	95.6%	91.4	90.8%
COD	3400	97.6%	48	42.2%
BOD_5	900	97.1%	10	61.5%
NH_3-N	500	90.3%	8.44	82.6%
Cl-	5000	98.0%	2.5	97.5%
SO_{4}^{2-}	2000	99.5%	0.84	92.4%
PO_4	11.8	>99.6%	<0.05	–

(Li 2009)

ROChem has several leachate installations in North America and Europe, including an operating facility in Upstate New York. To provide an idea of operating pressure and flux rates, a similar system operating in a landfill leachate in New England treats approximately 130,000 gpd with average operating pressures of up to 1,100 psi and flux rates of approximately 8 gfd. The concentrated reject is returned to the landfill. The system is designed to treat residual compounds that inhibit ultraviolet (UV) transmittance at the receiving publicly owned treatment works (POTW).

Scott A. Grieco PhD, PE is Vice President and Practice Area Leader of Industrial Water and Wastewater for O'Brien & Gere in Syracuse, NY. He may be reached at scott.grieco@obg.com.

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NYWEA
LEADING THE WAY IN WATER QUALITY MANAGEMENT

Everything You Need to Know about Trickling Filters

by Jia Zhu and Bryan Rothermel

Trickling filters have been the workhorse of the wastewater treatment industry for over 100 years, and this trend will continue well into the future. These filters consist of a fixed bed media fill through which wastewater is "trickled." The term trickling filter can be a bit misleading as no physical filtration actually occurs in a trickling filter system. Rather, the filter serves as a host for microorganisms that grow on the media fill to form biofilm. It is the biofilm which biochemically extracts pollutants from wastewater: as wastewater comes into contact with the biofilm and air, pollutants are diffused to the biofilm and are converted into harmless compounds. Trickling filters drain at the bottom, and the effluent is sent to clarifiers where the solids can settle out. A modern trickling filter in operation is shown in ***Figure 1***.

Photo courtesy of Brentwood Industries

Figure 1: A modern trickling filter in operation, featuring high-performance, structured-sheet plastic media.

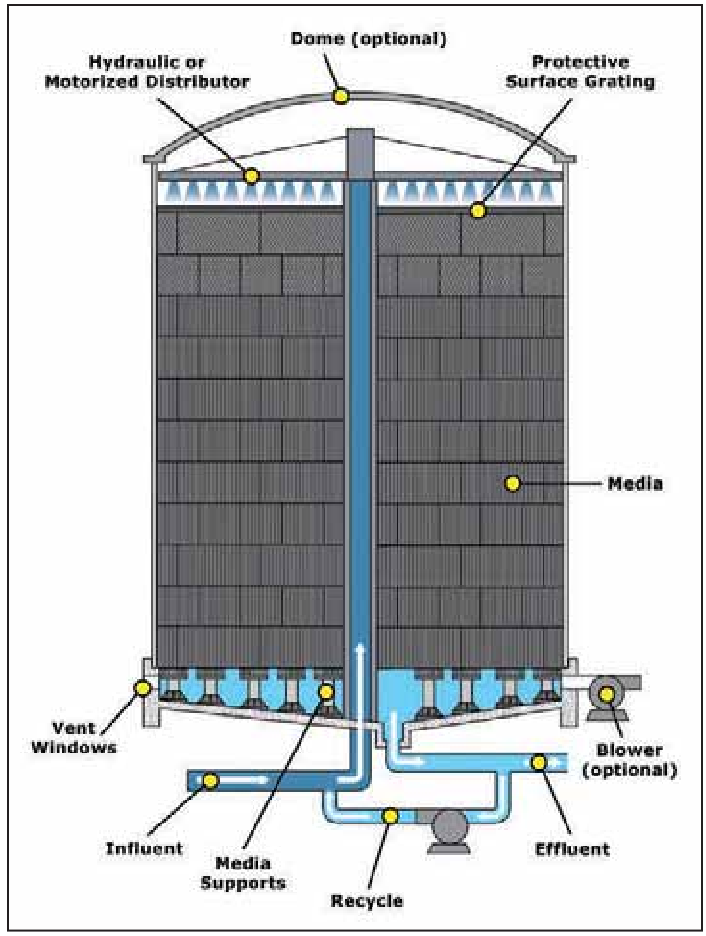

Photo courtesy of Brentwood Industries

Figure 2: The components used as part of modern trickling filter systems are seen here.

Relevancy of Trickling Filter Technology

Contemporary trickling filters can be built up to 40 feet tall and contain high-performance, structured-sheet plastic media, in combination with modern distribution and ventilation systems. The treatment capacity of these filters has been significantly increased in comparison with earlier mid-century filters. The applications of trickling filter technology have also been greatly expanded beyond early biochemical oxygen demand (BOD) roughing filters to include secondary carbon oxidizing and tertiary nitrification filters.

Trickling filter technology is both simple and reliable. With fewer moving parts than activated sludge systems or other treatment options, trickling filters require significantly less maintenance and operational oversight. Trickling filters are also known to have better resistance to shock loadings due to the nature of attached growth.

Trickling filter is a green technology that requires less energy than other treatment options. Typically only requiring power for pumping and, in some cases, fans, energy consumption for trickling filters is much less than the power hungry aeration blowers used in activated sludge systems. When installed and operated properly, trickling filters are reported to use 30–50 percent less energy than the activated sludge process.

In other words, trickling filter technology is still very relevant today.

Key Components of Trickling Filters

A typical trickling filter consists of a distribution system, filter media, an underdrain, a ventilation system, containment and, in some cases, a dome. ***Figure 2*** displays the components of a modern trickling filter.

Distribution System: This system provides for even distribution of wastewater over the media. Modern trickling filters commonly use rotary type distributors, which consist of two or more horizontal pipes suspended above the filter media. The horizontal pipes are called distributor arms and rotate a few inches above the media, distributing wastewater through the orifices in the arm. The distributor arms can be hydraulically driven using the jet-like force of the wastewater flowing out of the orifices to allow for rotation, or it can be driven by other electromechanical means.

Filter Media: Early trickling filters used rocks as fill media, but poor ventilation and limitations on filter bed height due to excessive weight limited their practical use for increasing treatment capacity and performance. In the 1950s, synthetic fills – such as PVC structured-sheet media – were introduced and have been the dominant media choice for constructing new filters or upgrading older rock filters ever since. The weight of plastic media is only from two to three percent of the rock media, and the surface area for microorganism growth is from two to four times greater. The void ratio of plastic media is also much higher, which promotes ventilation and can often provide a doubling in treatment capacity versus rock media trickling filters of the same size.

Several types of structured-sheet media have been developed for different applications. For example, vertical flow media is typically used for high strength wastewater roughing, while cross flow media is used for secondary treatment and nitrification applications. A mixed media combination of cross flow media at the top of the filter and vertical flow at the bottom can also be used for roughing applications. Media selection is driven primarily by the expected organic loading on the filter, as summarized in ***Table 1***.

Table 1. Trickling Filter Classification and Media Selection

	Organic Loading, lb/kcf/day	Removal	Media Selection
Roughing Filter	100—220	40–70% cBOD	Vertical flow or mixed media with large flutes
Carbon Oxidizing Filter	20–60	15—30 BOD_5	Cross flow media with large flutes
cBOD and Nitrification Filter	5–15	<10 mg/L BOD_5 <3 mg/L NH_3-N	Cross flow media with large or medium flutes
Nitrifying Filter	N/A	<3 mg/L NH_3-N	Cross flow media with medium or small flutes

Underdrain: Underdrain systems serve three purposes: 1) collecting treated wastewater for conveyance; 2) providing support to the media; and, 3) allowing air circulation through the media bed.

Conventional underdrains can be constructed with concrete piers or beams. An underdrain system consisting of field-adjustable plastic stanchions and fiberglass reinforced grating, as shown in ***Figure 3***, is often used as an alternative to conventional underdrains. This pre-engineered system is more economical and offers better ventilation than conventional underdrain systems. Therefore, it is gaining popularity in both new installations and retrofits.

Ventilation: The BOD removal and nitrification in a trickling filter are aerobic processes that rely on sufficient air flow for optimal performance. Older open trickling filters rely on natural draft for ventilation, using gradients in humidity and temperature between inside and outside air to drive circulation.

Domes are sometimes used in modern trickling filters to reduce temperature loss in the winter months and control odor. In domed systems, low pressure ventilation fans are used to maintain air movement.

Photo courtesy of Brentwood Industries

Figure 3: Pre-engineered underdrain system, consisting of plastic stanchions and FRP (fiber reinforced polymer) grating.

How to Maximize Trickling Filter Performance

The key to successful trickling filter operation is to produce and maintain the proper type and thickness of biofilm on the trickling filter media surface. A healthy biofilm requires the proper amount of oxygen, water and harvesting in order to produce the most efficient waste removal rates. (In trickling filter terminology, harvesting is called "sloughing".)

Recirculation of wastewater flow to the trickling filter is considered the principal process control for a trickling filter. Recirculation of effluent can increase dissolved oxygen, ensure adequate wetting of the media, and control biofilm sloughing.

The wetting rate is the overall application rate of wastewater to the trickling filter, including both forward and recycled flow. Wetting rates can be controlled by recirculation and typically range from 0.25–1.5 gpm/ft^2 depending on the treatment objectives.

Another important operational parameter is the dosing rate, or SK rate, which reflects the intensity of the wastewater application. The SK rate can be controlled by recirculation and distributor arm rotational speed. The SK rate is recorded in millimeters (mm) or inches (in.) per pass. Higher SK rates are recommended for higher organic loadings to provide the effective sloughing necessary for biofilm thickness control. For normal operations, SK rates range from 25–200 mm (or 1–8 in.) per pass. For period flushing, the SK rate increases to 10-600 mm (4–24 in.) per pass.

Macro fauna, such as snails, occur in trickling filters and may cause nuisance problems, most of which can be controlled by flushing. A proven method for snail control is raising the wastewater PH to approximately 10, which will result in free ammonia that is toxic to snails. Snail traps have also been used in some facilities to remove snails.

When Should Plastic Media be Replaced?

The service life for plastic media ranges from 20 to 30 years, although the top layer may need earlier replacement as it is subjected to UV degradation and hydraulic erosion. As a trickling filter approaches the end of intended service life, it is prudent to plan for media replacement in order to avoid poor treatment or catastrophic media structural failure. Several types of media failure are shown in ***Figures 4a–4c***.

Some good questions to ask when considering media replacement include:

- How is the trickling filter performing? Decreased performance is likely an indicator of plugged media, which results in less surface area for biofilm, decreased ventilation and decreased treatment.
- How does the trickling filter look from the top and bottom? Puddling on the top, or uneven water drainage in the underdrain area, indicate plugging of media which may cause media failure.
- What is the wastewater type? Nitrifying filters typically last longer than industrial roughing filters, which have high organic loadings and heavy biomass growth, accelerating filter aging.

With proper initial process design, sound structural design and installation of the media tower, and periodic maintenance through-

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Photo courtesy of Brentwood Industries

Figure 4a: An example of media sagging

Photo courtesy of Brentwood Industries

Figure 4b: An example of media plugging

Photo courtesy of Brentwood Industries

Figure 4c: An example of media collapse

out the service life, trickling filters can provide many years of simple, effective and low cost treatment.

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Overview of MBR Treatment Technology

by Paul Greene

The membrane bioreactor (MBR) is a powerful technology for treating municipal and industrial wastewaters. The MBR systems offer outstanding treated water quality with cost-effective, robust performance in a compact footprint. Since first being introduced in the 1990s, the MBR is becoming increasingly accepted as mainstream technology with barriers to its acceptance continuing to drop, and membrane types and available suppliers on the increase.

How It Works

The MBR treatment process is identical to the activated sludge process from a microbiological perspective. The same suspended growth bacteria do the work of providing biochemical oxygen demand (BOD) reduction and nutrient removal. The first step in the process is generally the aeration tank where a robust mixed liquor population is maintained via proper dissolved oxygen (DO) control from diffused air, jet aeration and/or surface aeration grids. Aeration tanks can be above or below grade and made from either steel or concrete. The solids residence time is controlled by maintaining system wasting rates at specified target levels. Where MBR begins to differ from activated sludge is in the liquid/solids separation step. The MBR units deploy a physical barrier that holds onto the sludge in the system and do not rely on gravity settling of the mixed liquor solids like activated sludge systems do.

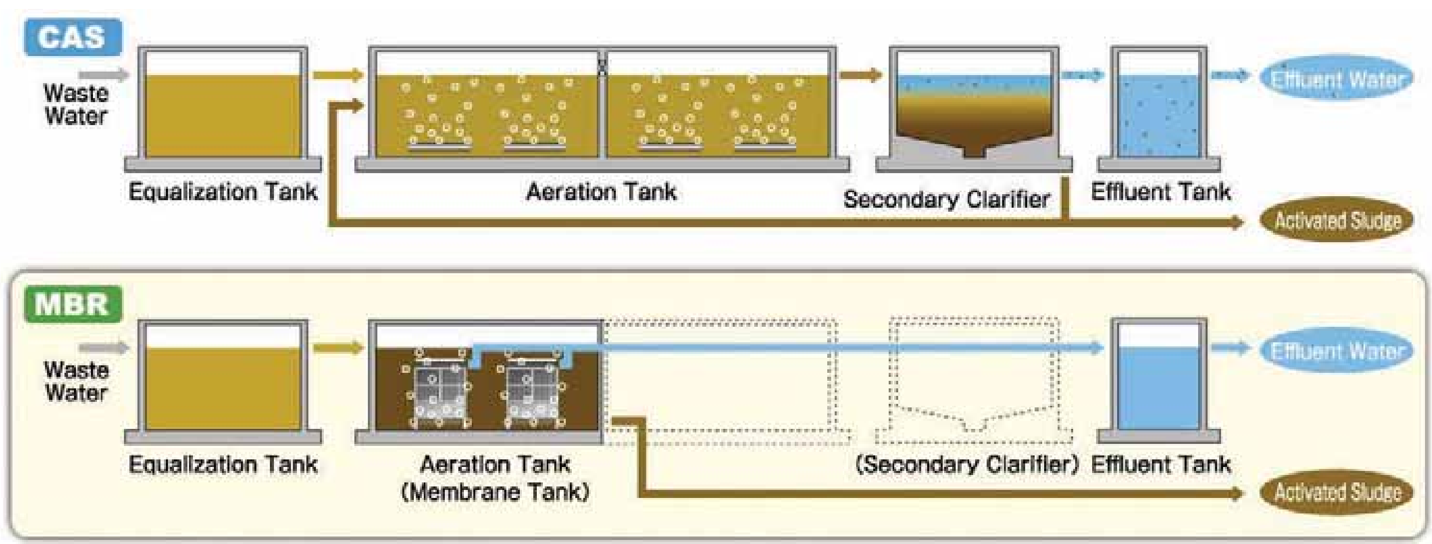
Having a membrane barrier on the mixed liquor provides several advantages over relying on gravity clarification. Unlike a gravity clarifier that, when overloaded with solids, has solids carryover in the effluent, the MBR can carry mixed liquor suspended solids (MLSS) concentrations in the aeration basin that are multiple times higher than conventional activated sludge. Whereas activated sludge units are commonly run somewhere near 2,000–3,000 mg/L MLSS, the MBR units can safely run at 10,000–20,000 mg/L. This effectively packs more biological treatment into a given unit tank volume. A comparison of how an MBR compares to activated sludge is shown in ***Figure 1***.

There are several different types of membranes that can be provided in MBR systems. The "outside/in" membranes pull treated water into the inside of the membrane by the use of a vacuum system that pulls water from mixed liquor through the fiber into an internal hollow channel. The membrane can be deployed as bundles of very thin fibers or in a flat plate sheet. Conversely, "inside/out" membranes rely on the use of a high rate cross-flow velocity of mixed liquor across the surface of a tubular membrane and treated water permeates through the membrane under pressure. This high velocity cross-flow allows for a sweeping shear action across the membrane to keep the sludge from plugging pores in the membrane.

The MBR membranes utilize pore sizes that are considered to be in the microfiltration or ultrafiltration ranges – usually between 0.02–0.5 microns. Such sized holes will create a total suspended solids (TSS) free filtrate and with very low turbidity. None of the MLSS should permeate or pass through the membrane at these pore size openings. Operators will often track treated water turbidity, so if an issue arises with one of the membranes they will see turbidity readings start to spike upwards.

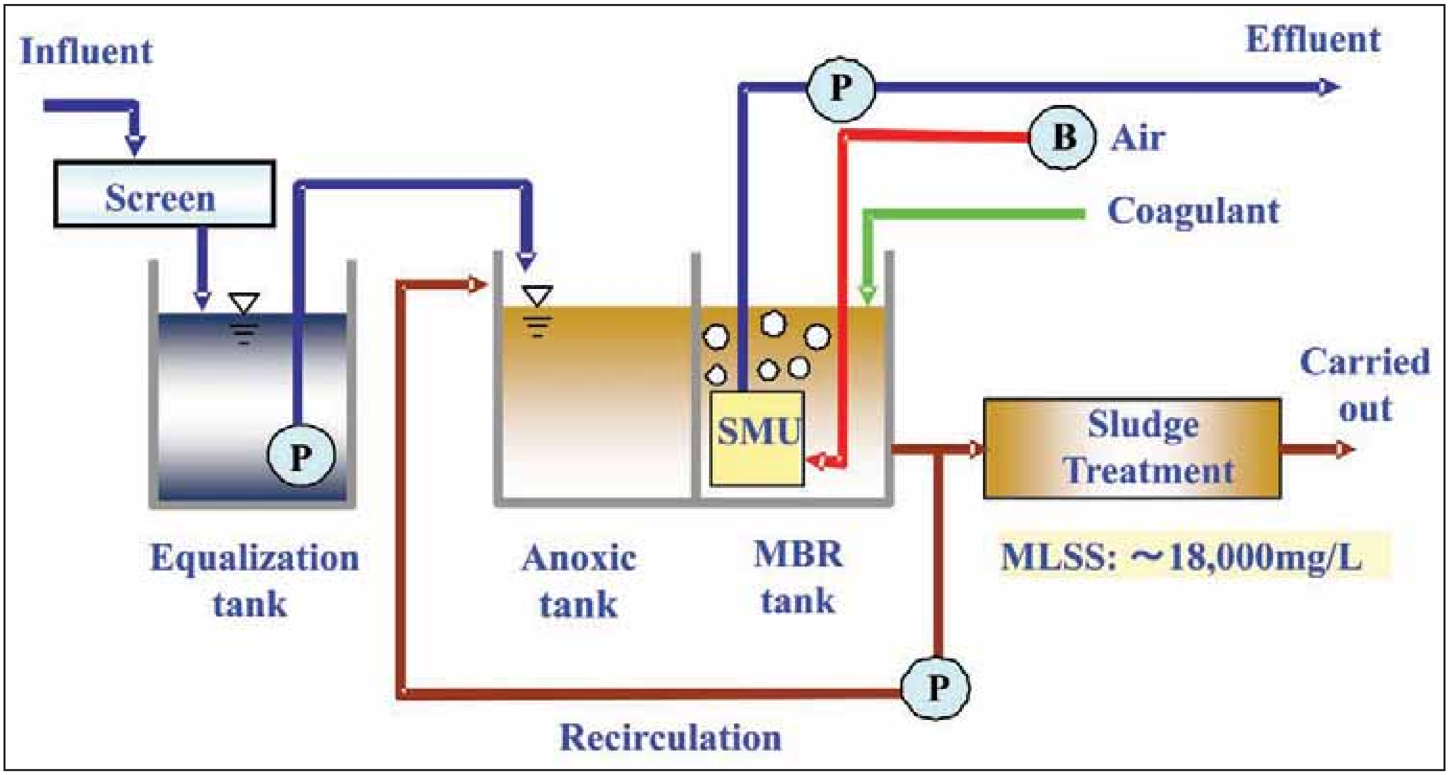
Several other design considerations factor into MBR systems. Wastewater should be screened through a fine screen, commonly 2 mm, so as to keep large contaminants from blinding or tearing the membranes. Incoming flow rate and peak flows should be carefully studied so that over designing or over spending does not occur with the overall membrane system. Upfront equalization may be deployed to dampen out-peak flows and optimize membrane cassette sizing. Incoming FOG (fats, oils and grease) level concentrations should be kept well below wastewater BOD levels to ensure the FOG is degraded and does not present undue fouling of the membranes. Most membranes are considered to be hydrophilic, which connotes surface charge properties that favor intimate contact with polar molecules - like water - and tend to repel non-polar molecules found in FOG. A common process flow diagram is illustrated by ***Figure 2***.

Membrane systems are sized based on manufacturer's recommended "flux" rates, which are the average quantity of water that passes through the membrane over time. Common flux units are expressed as gfd, or gallons per square foot of membrane surface area (flux) per day. Flux rates vary directly with wastewater temperature. Membrane manufacturers all have standard sized cartridges



Graphic courtesy of Kubota Membrane US

Figure 1. Membrane Bioreactor (MBR) vs. Conventional Activated Sludge (CAS)

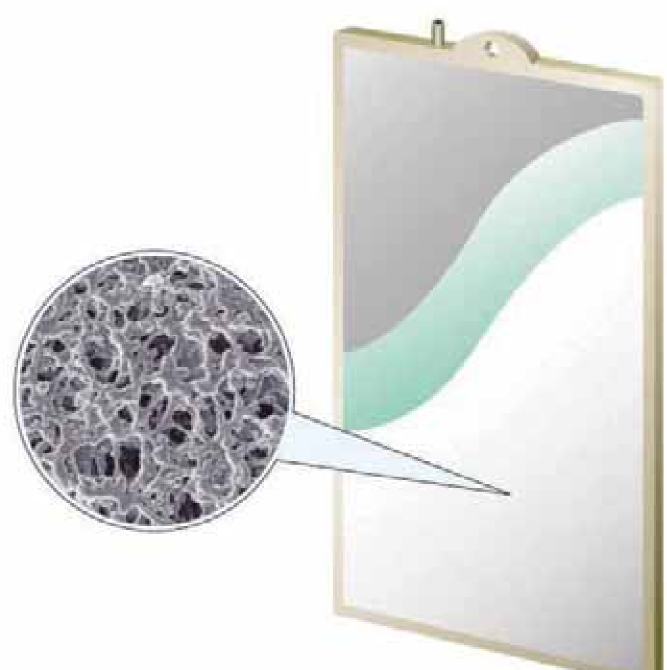


Graphic courtesy of Kubota Membrane US

Figure 2. MBR Process Flow Diagram

which are optimized for competitive manufacturing costs, ease of design, operability, installation and system cleaning.

Water passes through the membrane via a pressure change across the membrane, known as trans-membrane pressure or TMP. Most membranes deploy an air scouring system that blows air bubbles over the surface of the membrane to keep mixed liquor contents from adhering to the membrane surface and causing fouling. When TMP hits a predetermined level (i.e., 1 pound per square inch, or psi) a system cleaning is initiated. System operators will learn their best cleaning chemistry over time as they understand the nature of their particular membrane foulants. Organic fouling favors cleaning via high pH and bleach cleaning for peak efficiency. Mineral scale tends to favor cleaning with acids (i.e., oxalic acid). Membrane cassettes commonly are cleaned by a one to two hour automated cleaning cycle where the membrane units are isolated, drained and the cleaning solution is introduced in soaking and recirculated patterns. Membrane cassettes also require replacement every few years depending on specific wastewater composition, the presence of any irreversible foulants and the users' cleaning frequency.



Graphic courtesy of Kubota Membrane US

Figure 3. Layers of Flat Sheet Membrane

Nutrient Removal

The MBR systems provide robust, reliable performance, especially when end users are faced with tight effluent requirements. Systems can achieve total nitrogen (TN) performance of <20 mg/L and total phosphorus (TP) performance of <0.1 reliably. Facilities looking to achieve TN removal will commonly rely on MLSS recycle techniques sending to a first stage anoxic zone for denitrification. Stable nitrification can also be accomplished in a single aerobic stage of treatment via high MLSS concentrations. Users looking for tight phosphorous control can accomplish it by using common multi-step ENR/BNR (enhanced or biological nutrient removal) approaches for biological P control. This also can be supplemented by in-basin chemical P control through alum or iron salt addition, if needed.

Membrane Configuration: Flat Sheet

An example of a commonly deployed MBR membrane configuration is the use of a flat sheet. ***Figure 3*** shows the multi-layer construction inside a flat sheet membrane module. The nozzle shown at the top is where the vacuum draws water through the membrane sheet out of the MLSS. Systems can also be designed using gravity flow through the membrane module.

How membrane sheets are stacked is shown in ***Figure 4*** – much like a deck of cards into a cartridge assembly. The individual vacuum

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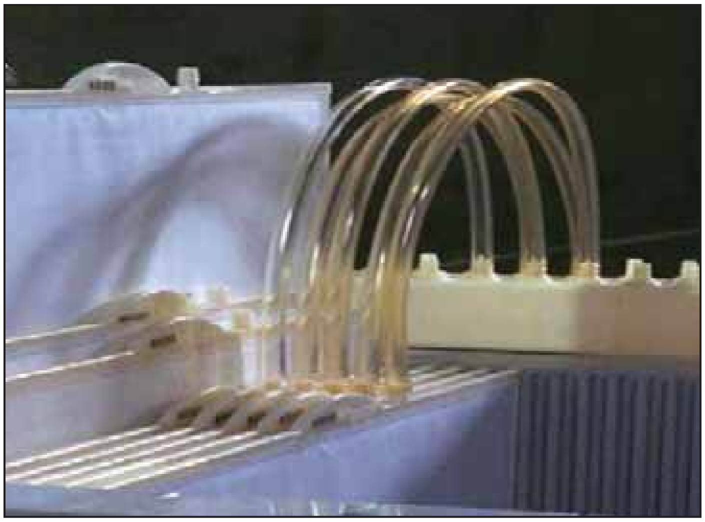
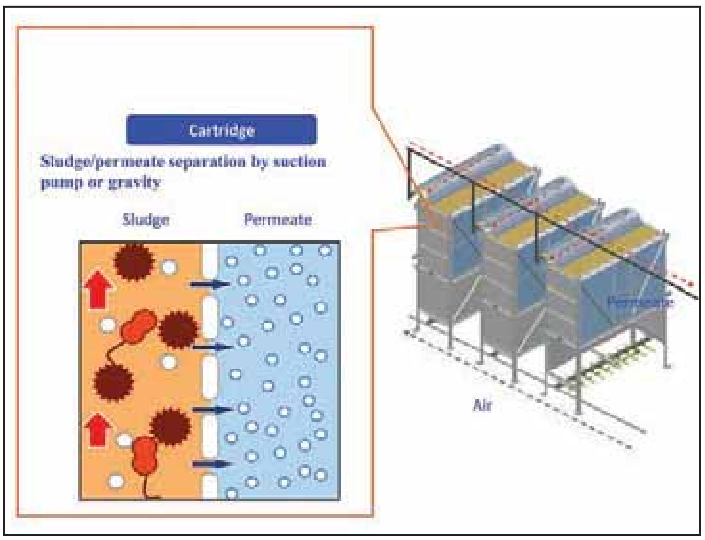


Graphic courtesy of Kubota Membrane US

Figure 4. Stacking Sheets into Cassette

Graphic courtesy of Kubota Membrane US

Figure 7. Full Scale System – Clean Water Test



Graphic courtesy of Kubota Membrane US

Figure 5. Setting Cassettes into Basin

Graphic courtesy of Kubota Membrane US

Figure 8. Operating MBR – Flat Sheet

Graphic courtesy of Kubota Membrane US

Figure 6. Stacking Cassettes

permeate tubes combine into a large permeate header that conveys treated water to discharge.

Figure 5 shows how multiple cassettes are set in basin in parallel form. Diffused air grid headers are mounted beneath the cassettes to provide the air scour by upward bubble scrubbing action. Treated water permeate headers combine to take away treated water under vacuum.

Multiple cartridges can be stacked several high in larger systems, as shown in ***Figure 6***. When operating these cartridges, they will be completely submerged under water.

Figure 7 is of a full scale operating system with all membrane racks in place while under clean water checkout. The membrane cassettes span the tank laterally. The treated water is pulled out of the tank through the clear flexible tube manifolds shown on the left side. The air scour air is provided by the pipe on the right side of the basin. ***Figure 8*** shows a full scale system under operation. Note that the turbulent operating conditions are indicative of intense air scouring of the membrane surface. This aeration air also provides some critical DO for the biological process.

Membrane Configuration: Hollow Fiber

Hollow Fiber membranes are supplied in bundles of thousands

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Figure 9. Hollow Fiber Membranes

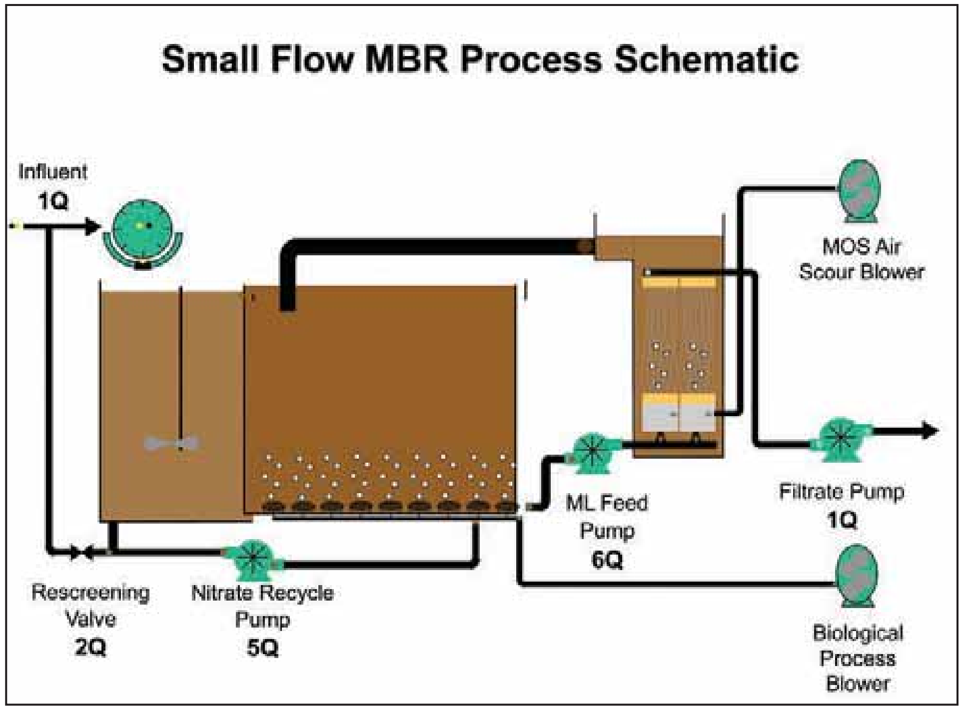

Figure 12. MBR Small Flow Process Flow Diagram

Figure 10. Setting Membranes

Figure 11. Operating MBR – Hollow Fiber

of thin, hollow fibers configured into individual modules housed in cassettes or racks. Air for air scouring of the membranes is introduced under the membrane modules and filtrate is withdrawn from the "lumen" or inside of the hollow fibers. ***Figure 9*** shows a typical hollow fiber module. At the top is an air-line entrance delivering air for membrane air scouring. The air is directed to the bottom of the module through this small drop tube. Underneath the air supply line is the filtrate suction header. Filtrate pumps create a negative pressure in the head of the membrane module pulling clean liquid through the membrane walls. Thus, under operation this top pipe contains pressurized air and the bottom pipe contains treated water under vacuum. These bundles are installed alongside each other to form a contiguous rack in full scale systems.

Figure 10 shows the installation of a membrane rack into a membrane tank containing a multiple number of similar racks. The number of racks needed is based on flow.

Figure 11 shows a typical membrane installation in operation. Air scour lines entering each membrane rack are shown in the foreground and filtrate discharge piping runs behind the air lines.

Hollow Fiber MBR systems are suitable and widely used in both small scale development and recreational types of applications as well as large scale municipal and industrial facilities. ***Figure 12*** illustrates a small flow system flow schematic, and ***Figure 13*** is of a typical small flow, packaged MBR system which incorporates an inlet screen, anoxic and aerobic biological zones, a two-cell membrane system, and a mechanical equipment skid. ***Figure 14*** is a skid-mounted, stand-alone, membrane operating system that can be coupled with a variety of intermediate flow capacity biological systems. ***Figure 15*** shows an arrangement for a typical larger scale municipal or industrial application that includes multiple membrane operating tanks running parallel to each other. A large hollow fiber MBR system, shown in ***Figure 16***, is under operation with both air being fed into the system and treated water being pulled out of the system through the blue painted piping.

A common thread between each of these hollow fiber and flat

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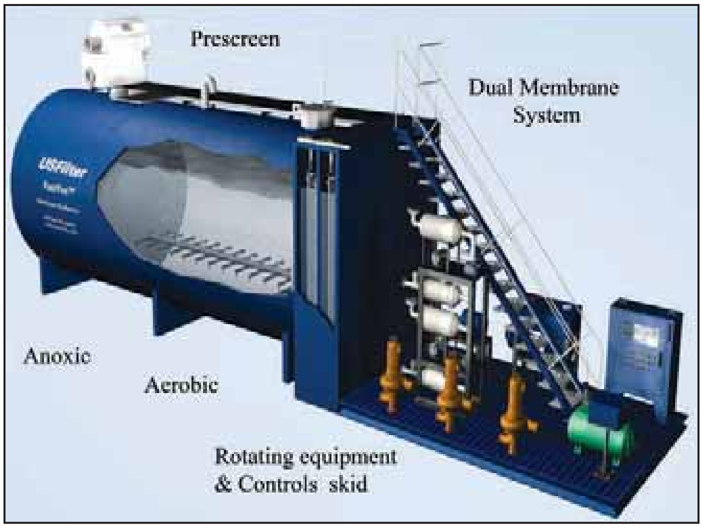

Figure 13. MBR Package Plant

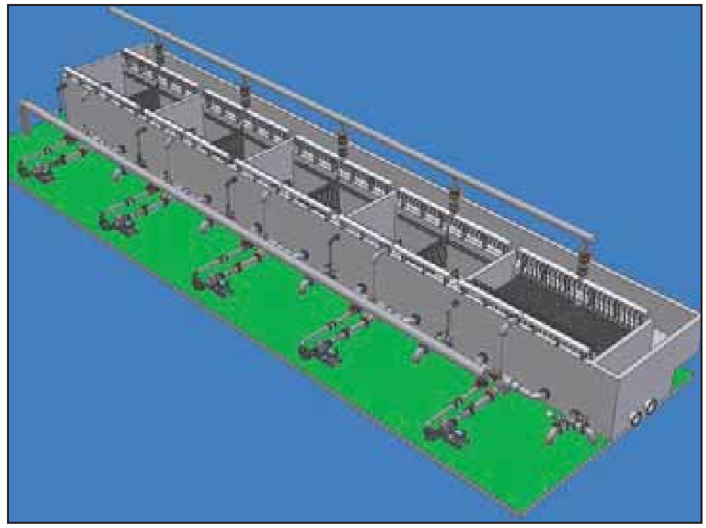

Figure 15. Membrane Operating System – Multiple

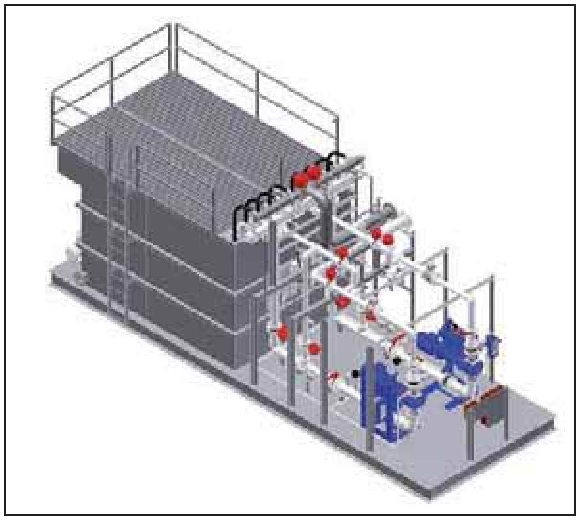

Figure 14. Membrane Operating System – Single

sheet membrane configurations is that air is pushed in and clean water is pulled out of the system based on pressures.

In summary, MBR technology, when properly deployed, can provide end users with numerous advantages including:

- Outstanding water quality
- Compact footprint
- Years of consistent service from a set of membranes
- Ease of existing facility capacity expansion without adding additional aeration tanks or clarifiers
- Ease of operation through system automation

The MBR systems are increasingly gaining in market share and can provide years of reliable service to both industrial and municipal clients.

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Figure 16. Large Full Scale MBR System

Biological Filtration to Meet Nitrogen Goals at New Rochelle WWTP

by Frederick Kincheloe, Timothy Cheatham and Thomas Lauro

The New Rochelle Wastewater Treatment Plant (NRWWTP), located in New Rochelle, NY, is undergoing a $250 million upgrade, the largest ever performed in the history of Westchester County. The NRWWTP was originally constructed in the 1950s and was facing several challenges:

- The facility was operating beyond its 13.6 mgd permitted capacity and needed to be upgraded to 20.6 mgd to accommodate existing and future development.
- New York State Department of Environmental Conservation (NYSDEC) proposed changes to the State Pollution Discharge Elimination System (SPDES) permit for total suspended solids, carbonaceous biochemical oxygen demand, nitrogen, and total residual chlorine, which required significant changes to the treatment process.
- The equipment is near the end of its useful life and in need of replacement.
- The site is constrained by the Long Island Sound and neighboring properties with little to no room for expansion.

To address those challenges, ***biological filtration*** was identified as the optimum solution and the project team developed a programmatic implementation approach that ensured compliance within a challenging timeframe.

New Rochelle Wastewater Treatment Plant

The NRWWTP is located on a peninsula in Long Island Sound and has a service area of approximately nine square miles that includes most of the City of New Rochelle, the eastern portion of the Village of Pelham Manor, the Village of Larchmont, and a small portion of the Town of Mamaroneck. The NRWWTP was originally constructed in 1955 as a primary treatment facility and was upgraded to secondary treatment in 1979 using a pure oxygen activated sludge process. Several plant improvement contracts followed in the 1980s and 1990s to maintain the facility in a good state of repair.

Prior to the upgrade, the NRWWTP treatment processes included pumping, screening, primary treatment, pure oxygen activated sludge process tanks, secondary settling, and disinfection. Under high flows, disinfected effluent is directed to an effluent pumping station to overcome the head loss in the discharge outfall. Primary and secondary sludge are combined with sludge pumped from the Mamaroneck wastewater treatment plant and thickened in gravity thickeners. Thickened sludge is dewatered in belt presses and trucked off site. Thickener overflow is directed to the secondary influent channel.

New Rochelle Receives Revised Permit Limits

In 2005, NYSDEC modified the SPDES permit for the NRWWTP to include new discharge limits on nitrogen and other pollutants. Given the scope and magnitude of the permit change on the NRWWTP, Westchester County and NYSDEC subsequently negotiated an Order-on-Consent to establish the timelines and deliverables for Westchester County to meet the revised permit requirements.

Westchester County, New York owns and operates four wastewater treatment plants (Blind Brook, Mamaroneck, New Rochelle and Port Chester) that discharge to the Long Island Sound (LIS). In the revised SPDES permits, the four LIS WWTPs were given an aggregate total nitrogen (TN) discharge limit of 1,768 pounds per day as a 12-month rolling average. Based on the combined capacity for all four LIS WWTPs of 53.6 mgd, an average TN discharge of 4.0 mg/L from each facility is required to meet the aggregate discharge limit. In addition to the SPDES permit modification for TN removal, the permit for the NRWWTP was also modified to include an increase in permitted capacity from 13.2 mgd to 20.6 mgd, a reduction in total residual chlorine (TRC) from 2.0 to 0.5 mg/L, and changes to the TSS and CBOD discharge limits to bring them in line with current standards.

A detailed process and engineering evaluation involving dozens of wastewater technologies for nitrogen removal was performed. Using a value-based evaluation matrix that was developed to standardize the cost estimating and technological differences of numerous design alternatives, each alternative was ranked based on weighted monetary and non-monetary factors including performance history, compatibility with existing conditions, automation potential, flexibility, complexity, operating costs and capital costs. Biological filtration (***Figure 1***) appeared to be the best approach for the NRWWTP.

Biological Filtration

The filtration process is conventionally used to remove particulate matter from the wastewater stream. There are several types of filtration with the most common being sand media filtration. Filtration is designed as a physical barrier to remove particulates. As particulates are removed, they fill the void spaces between the media and continue to increase the head loss through the filter cell until it is cleaned through backwashing. The media size, shape and material determine the size of the particulates that can be filtered out and the frequency at which the filter cell requires backwashing. Multiple filter cells are typically specified with each cell being backwashed independently to allow the system to continuously treat the water.

When considering fixed film biological treatment processes, filtration media can be an excellent ballast for growing bacteria. Compared to other media, such as rotating biological contactors and moving bed bioreactors, filtration media have a very high ratio

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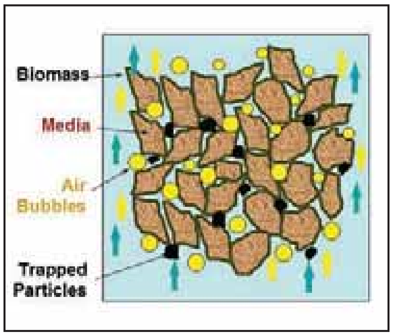
New Rochelle Wastewater Treatment Plant prior to construction upgrade.



Courtesy of Infilco Degremont

Figure 1. Schematic of a biofilter

of surface area per unit volume. This high surface area means that more fixed film bacteria can grow per unit volume and therefore biological pollutant removal rates can be relatively higher. When using aeration for biological activity, the circuitous pathway of the air through the filter allows coarse bubble diffuser efficiencies to achieve efficiencies similar to fine pore diffusers in activated sludge. The physical barrier of the filter media means there is no need for clarification and lower effluent solids can be achieved. Overall the process provides efficient treatment in a very compact space.

However, this efficiency does come at a price. To meet the head loss requirements of the filtration process, the wastewater must be pumped. To support the high biological uptake rates, the bulk oxygen concentration must be high requiring significant air. In addition, the backwashing of the filter cells to remove captured particulates and excess biological growth results in a significant recycle that must be accounted for in both the wet stream processes and the solids handling processes. Unlike the backwashing of conventional filters, care must be taken with biological filters not to over backwash, reducing the biological growth available for treatment.

During the planning stages of the project, there were very few biological filtration facilities in operation in the United States. The data from several independent facilities could be pieced together to develop a treatment approach that would meet the target nitrogen limits, but the process as proposed had never been done before. To confirm that the process objectives could be met and to quantify the above advantages and disadvantages, a year-long pilot study was performed.

Pilot Testing

The pilot study was carried out at the NRWWTP (for a full description see Kincheloe, et al., "Westchester County's Success Story using Biofiltration" *Clear Waters* magazine, Fall 2007). The pilot facility consisted of three staged biological filter units that were operated in secondary treatment, nitrification, pre-denitrification or post-denitrification modes. Primary effluent and secondary effluent were both tested as feed sources. Feed piping between each cell was altered allowing for several different process configurations to be tested. Limiting hydraulic and pollutant loading rates were identified, chemical usage determined, backwash frequencies tracked, and an accounting of operational issues was evaluated for each configuration. Project costs for the alternatives were updated by sizing facilities using the pilot results and a final process configuration was selected. The selected process was a two stage nitrification-denitrification biological filtration process treating final effluent from the existing pure oxygen activated sludge process.

Courtesy of Savin Engineers, PC

Three stage biological filter pilot facility at the NRWWTP tested alternate process configurations to remove nitrogen from the waste stream.

Procurement

There are currently two vendors in the market that have the experience and capability to supply the equipment (Kruger's BioStyr and Infilco Degremont's BioFor) for the chosen process configuration and meet the low levels of nitrogen required by the project. Each vendor is unique in the process flow profile, hydraulics, media type, structural requirements, electrical infrastructure, screening requirements, aeration needs, chemical usage and backwashing approach. One system utilizes an upflow filter containing buoyant media which is backwashed by gravity using a countercurrent flow to expand the media bed. The other system utilizes an upflow filter containing non-buoyant media, which is backwashed using pumped concurrent flow to expand the media bed. In order to ensure the county received the best value for the project, the project team developed a pre-purchase agreement that would allow the vendors to competitively bid the project based on lifecycle costs. Potential bidders were given the hydraulic characteristics of the NRWWTP, the anticipated wastewater constituents, the footprint available for their process, general equipment requirements, and other constraints and pertinent technical details from which to develop a proposal to meet the stated effluent requirements. Performance-based specifications were included in the bid documents and the bidders provided the following as part of their bid:

- Biological filtration equipment cost and a treatment performance guarantee
- Guaranteed chemical addition rates (caustic soda for nitrification and methanol for denitrification)
- Guaranteed aeration rates for nitrification
- Guaranteed sludge production

These performance guarantees were compiled with the construction costs to determine an overall lifecycle cost. Kruger's BioStyr process was selected and the design was developed around the unique requirements of the process.

Design Process

A key factor to the success of the project was the inclusion of Kruger in the design process. Kruger's technical personnel have the most experience in the design, construction, and start-up of the system. The pre-purchase agreement included requirements for Kruger to actively participate in the design process. This included the development of shop drawings and participation in a specified number of design workshops. This provision allowed the facility's team to incorporate its local knowledge of the NRWWTP with Kruger's unique knowledge of its technology as well as the lessons learned during construction.

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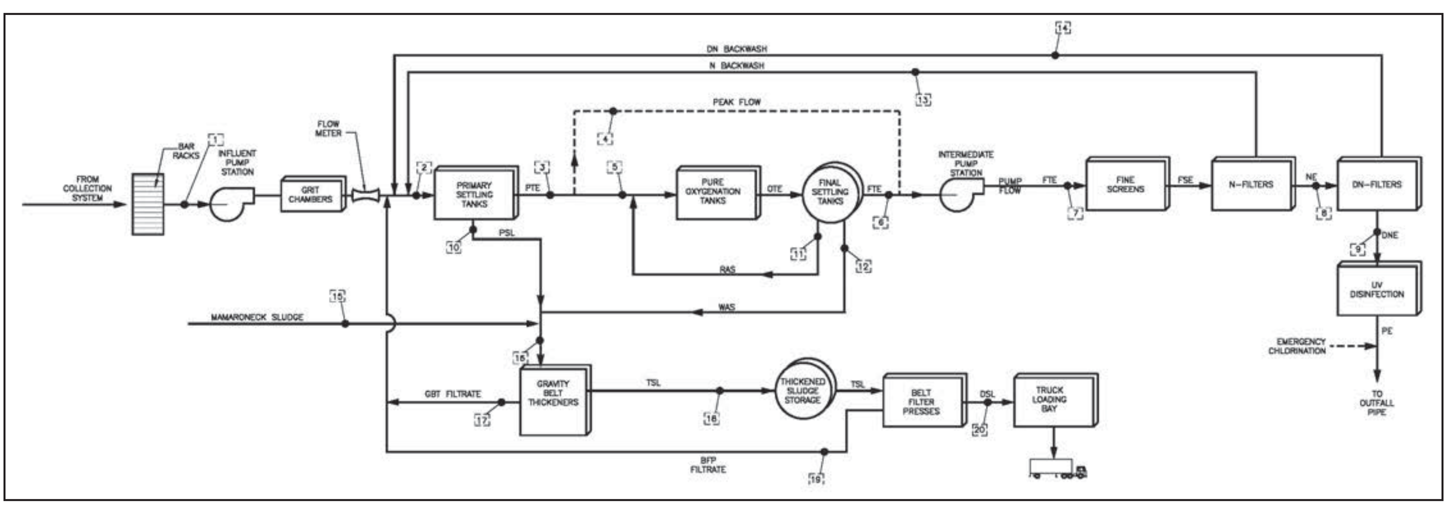
The New Rochelle Wastewater Treatment Plant is seen under construction for the largest upgrade in its history.

The selected process provided by Kruger is being integrated with the existing treatment facilities to address all the revised permit requirements. The headworks is being expanded to accommodate higher flows and include new pumping, screening and grit removal. The primary settling tanks are being upgraded to include new sludge collection equipment and odor control. The pure oxygen activated sludge process tanks are being expanded and the final settling tanks upgraded with new sludge collection mechanisms. The effluent pump station is being converted to an intermediate pump station to convey the entire plant flow to the fine screens located in the new BNR (biological nutrient removal) Building. The wastewater will flow by gravity to the nitrification and denitrification filters and then to a new ultraviolet (UV) disinfection building before being discharged to the outfall chamber.

Nitrification and denitrification filter backwash waste will be returned to the primary settling tank influent channel. Primary and secondary sludge will be combined again with the Mamaroneck sludge and thickened using new gravity belt thickeners and then dewatered in belt presses prior to hauling off site ***(Figure 2)***.

A number of the unique design features of the biological filtration process are discussed below.

Fine Screening Facility: One of the critical design issues that the project team addressed was the fine screening facility. As with any filtration technology, the filters provide a positive barrier between the influent and effluent and large debris, grease, or other material can cause a complete failure of the system. A review of other installations revealed that good protection of the biofilters would result in significant operational benefits in both manpower and performance. Given the quality of the effluent coming out of the secondary clarifiers, continuous screening may not be required, but due to the



Courtesy of Savin Engineers, PC

Figure 2. Process Flow Diagram

Courtesy of Savin Engineers, PC

Fine band-type screens prior to installation

Courtesy of Savin Engineers, PC

Installation of distribution piping

hydraulic limitations of the clarifiers, primary effluent above 30 mgd will be sent directly to the biological filters which can be a significant operational risk. The project team selected automated band-type screens that include a continuously cleaned perforated plate screening mechanism.

Biological Filter: With 12 nitrification units and 10 denitrification filters, the system requires a significant amount of flow distribution throughout. To complicate the hydraulics of the system, each filter is backwashed one after the other and will be in a different stage of filtration at any given time. This means that the head loss through each filter cell will be different and, in order to equally distribute flow, control valves are required to regulate the flow. The capability to manually operate the filters was also considered. Special attention was made to the location of all of the valves to ensure that operators can access them if necessary.

Chemical Addition: To achieve total nitrogen removal, supplemental alkalinity (caustic) and carbon (methanol) addition is necessary to support the nitrification and denitrification processes, respectively. As nutrient removal technologies are advancing, alternate chemicals are being considered to reduce operation costs and enhance process performance. However, the application of these chemicals remain unproven for biological filtration. As part of the design process the capability to test new supplemental carbon in dedicated filter cells was provided.

A major concern of supplemental carbon addition to meet low levels of nitrogen removal is the over dosing of the carbon source. Overdosing can lead to CBOD bleed through, and the subsequent violation of the SPDES permit. As part of the process, Kruger provided an aeration system within the bed of the denitrification filter to oxidize any bleed through.

Control of Recycles: Each of the biofilters requires regular backwashing to clean accumulated solids and biological growth from the filter media. Due to the hydraulic flow rates required to expand the media bed and clean the filter, backwashing generates a large volume of backwash wastewater that must be evacuated from the filter cell within a short period of time. This rush of backwash would create unstable process conditions for the primary settling tanks. The design includes a backwash waste tank to control the backwash flow rate to the head of the tanks, minimizing process issues for the remainder of the plant.

Automation: The biological filtration process is a highly integrated system of controls, valves and sensors requiring a level of automation not normally seen at many municipal WWTPs. Each of the filter cells operates somewhat independently and with different operational characteristics than the other filters in its stage. Individual filters are placed online/offline according to the flows and pollutant loads of the influent wastewater. Aeration blower operation is keyed to the operational characteristics of individual filter cells. Backwash cycles are started automatically and consist of a complex operation of valves, blowers and other equipment to progress through each of the steps in the backwash process. A significant amount of operator training must be included in the startup of the process to provide the operators with the information needed to operate, maintain and troubleshoot the various biological filtration systems.

Construction: Construction of the biological filtration facilities commenced in July 2011 and will be substantially complete in summer 2014. The construction management team, Kruger staff, the contractor, and Westchester County engineering and operations staff worked together to meet the consent order deadlines and maintain process performance during construction. The extensive design coordination and partnering with Kruger during the production of the construction documents were significant in streamlining the construction process by reducing the potential for conflicts and revisions to the documents based on the equipment proposed by the contractor. Process performance testing is ongoing at the time of this publication and the NRWWTP staff is looking forward to successful results.

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Grit Particle Settling – Refining the Approach

by Patrick Herrick, Adam Neumayer and Kwabena Osei

Overview

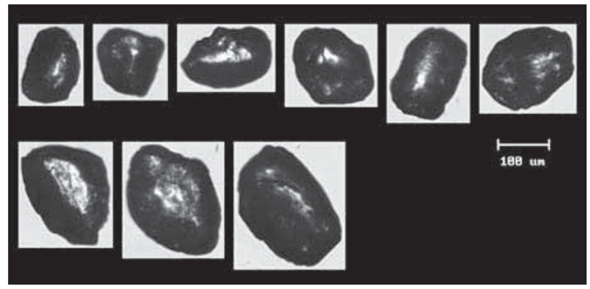
Grit system design is heavily influenced by factors affecting the settling behavior of the targeted grit particle.[1] As such, the classic correlations of sedimentation for discrete solids, Stokes' or Newton's Law, are commonly used to guide design. To simplify the design process, it has been common to assume that grit is spherical with the density of silica sand. Unfortunately, grit particles are rarely ideal spheres with the assumed textbook density of 2.65 for silica sand. Less than ideal characteristics are frequently measured or observed.[1,2] By utilizing well established sedimentation theory corrections from other fields of engineering, these correlations can be refined to provide a useful tool to improve grit system design.

Grit particle settling is principally determined by size, density, homogeneity and shape with some industry accepted assumptions regarding the characteristics of the fluid. This can be seen in the particle settling velocity equation below as determined by Newton's Law.[3]

$$V_p = g(\rho_p - \rho_w)d_p^2 \;/\; 18\mu = g(sg_p - 1)d_p^2 \;/\; 18\nu$$

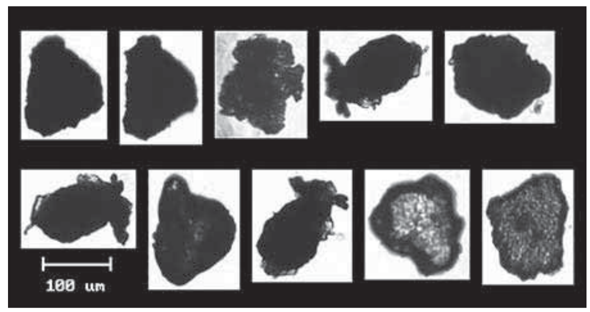
Size is most typically measured in terms of the mean diameter. In the last few years, density and shape implications are also being considered as a key aspect of grit behavior.[2] It has been observed that particle density and shape do not align with traditional assumptions which necessitates the refinement of sedimentation calculations. Further, grit can be affected by attached materials such as fats, oils, and grease which impact the settling velocity.[4] ***Figure 1*** shows pictures of individual clean silica sand grains; and, similar sized grit particles are shown in ***Figure 2***. It can be seen that the clean sand particles have a more rounded shape while the grit particles are more heterogeneous, angular shaped and appear to have other materials attached to them.

The net effect of the various deviations from "idealized" characteristics can be accounted for by measuring the true settling velocity of the grit particles. ***Figure 3*** shows the nominal physical size versus the equivalent settling velocity of grit particles. This is often referred to as the sand equivalent size (SES). The SES is described as the equivalent sand particle having the same settling velocity as the slower settling endemic or native grit particle. The SES concept is discussed in more detail elsewhere.[5] The diagonal black line in ***Figure 3*** indicates the expected settling velocity based on conventional ideal assumptions. It can be seen that as the particle diameter gets larger than 100 micron, the settling velocity appears to be impacted more significantly by the deviations from the ideal characteristics. It is expected that this effect will diminish as the ratio of surface area to volume decreases with increasing particle diameters further to the right of the chart.



Courtesy of Hydro International

Figure 1. Clean silica sand as shown through digital imaging



Courtesy of Hydro International

Figure 2. Wastewater grit as shown through digital imaging particle analysis. Samples were obtained at Muddy Creek WWTP, Cincinnati, OH.

Stokes' Law

Stokes' Law ***(Tables 1 & 2)*** is a common tool for estimating the settling velocity of grit particles, based on the assumption of laminar flow. It has been found to be accurate where Reynolds numbers are less than 1.[2] A review of the Reynolds number for grit particles in the

Table 1. Reynolds Number vs. Diameter

	Laminar										*Transitional*											
d_p (μm)	50	60	70	80	90	100	*105*	110	120	130	140	*150*	160	*175*	190	*212*	*250*	*300*	350	*400*	450	*500*
N_R final [-]	0.1	0.2	0.3	0.4	0.6	0.8	*0.9*	1	1.3	1.7	2	*2.5*	2.9	*3.7*	4.6	*5.3*	*9.3*	*14*	21	*28*	36	*45*

Table 2. Calculated Particle Settling Velocity

	Settling Velocity (cm/s)				
	Stokes' Law	**Newton's Law**	**Shape Factor = 2.0**	**Specific Gravity (SG) = 2.0**	**Shape Factor = 2.0 & Specific Gravity = 2.0**
50 mesh (300 micron)	8.08	4.81	2.74	3.21	1.79
70 mesh (212 micron)	3.59	2.64	1.44	1.7	0.91
100 mesh (150 micron)	2.05	1.64	0.87	1.04	0.55
140 mesh (106 micron)	0.99	0.87	0.45	0.54	0.28
212 mesh (75 micron)	0.50	0.47	0.24	0.29	0.15

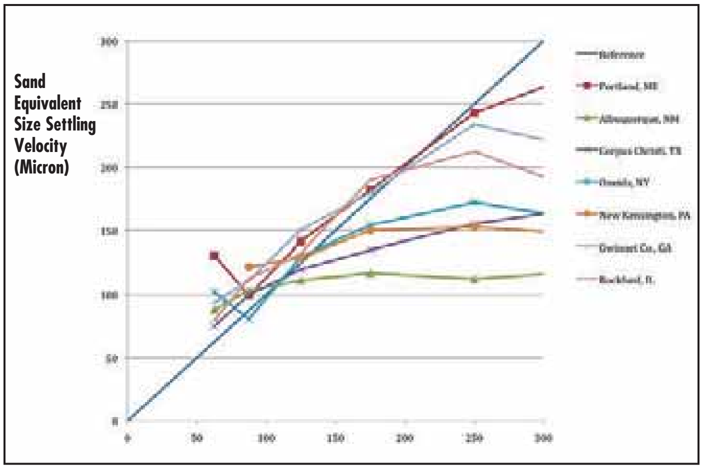


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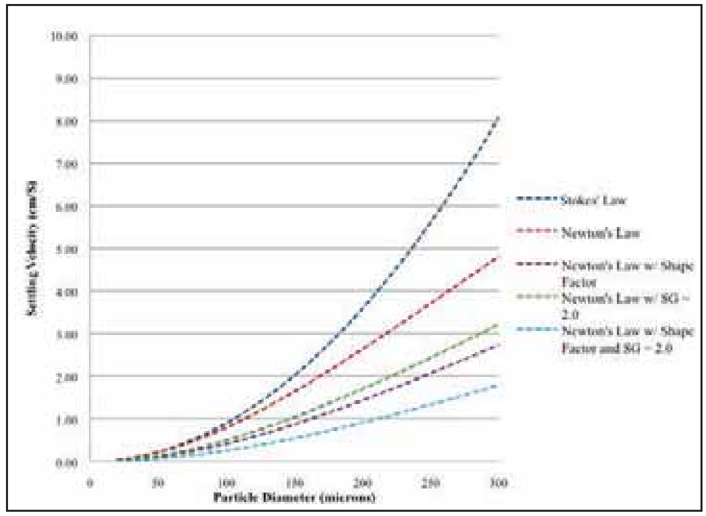
Figure 3. Physical Size of Grit Particles vs. Sand Equivalent Size (SES) Settling Velocity. The Oneida, NY plant (medium blue line) was included among the sampling sites.



Courtesy of Hydro International

Figure 4. Settling Velocity Refinements–settling velocity vs. particle diameter

typical design range of 50-500 micron for wastewater grit removal systems, shows that the impact of transitional flow begins to affect particle settling above the 100 micron range resulting in a departure in predicted accuracy using Stokes' Law.

Recommended Corrections

While a force balance requires an iterative process to determine settling velocity, it can be an irreplaceable tool by virtue of the physical characteristic corrections that can be layered in to refine the results towards real world measurements. ***Figure 4*** illustrates the impact of eliminating common assumptions aimed at simplifying the calculation; and adding in refinements to align theory with field measurements. First, the settling velocity of a range of particle diameters is calculated using a laminar assumption (Stokes' Law).[2] Then the laminar assumption is removed resulting in a force balance (Newton's Law).[2] Subsequently, the assumption that grit/sand is a perfect sphere is eliminated and the equation is corrected for the angularity of the particles (Newton's Law with Shape Factor).[6,7,8] Then, an adjustment is made for the density of the particle based on field observations.[9] Finally, all refinements are combined and plotted.

Overall, ***Figure 4*** shows that the commonly used Stokes' Law may not be the best approach to ensure an appropriate design to capture grit particles larger than 150 micron. Focusing on Newton's Law, it can be seen that simply eliminating the laminar flow assumption in and of itself will result in a more conservative design in the critical 50–300 micron range. With each successive refinement, a level of realism is incorporated.

Figure 5 plots the physical size distribution of grit at a typical wastewater treatment plant as well as the sand equivalent size based on the settling velocity. It can be seen that nearly ~70 percent of the grit entering the plant is larger than 212 micron (75 mesh) based on physical size, yet only ~30 percent of the incoming grit settles as though it is larger than 212 micron. The 212 micron particle has a Reynolds number of 5.3, therefore, Stokes' is not an accurate equation for settling velocity of this and larger particle sizes. Based on Newton's Law, these 212 micron grit particles are expected to settle at a rate of 2.64 cm/sec. However, when adjusted for shape and SG, the calculated settling velocity is lowered to 0.91 cm/sec or roughly the equivalent of a 106 micron particle. Therefore, in order

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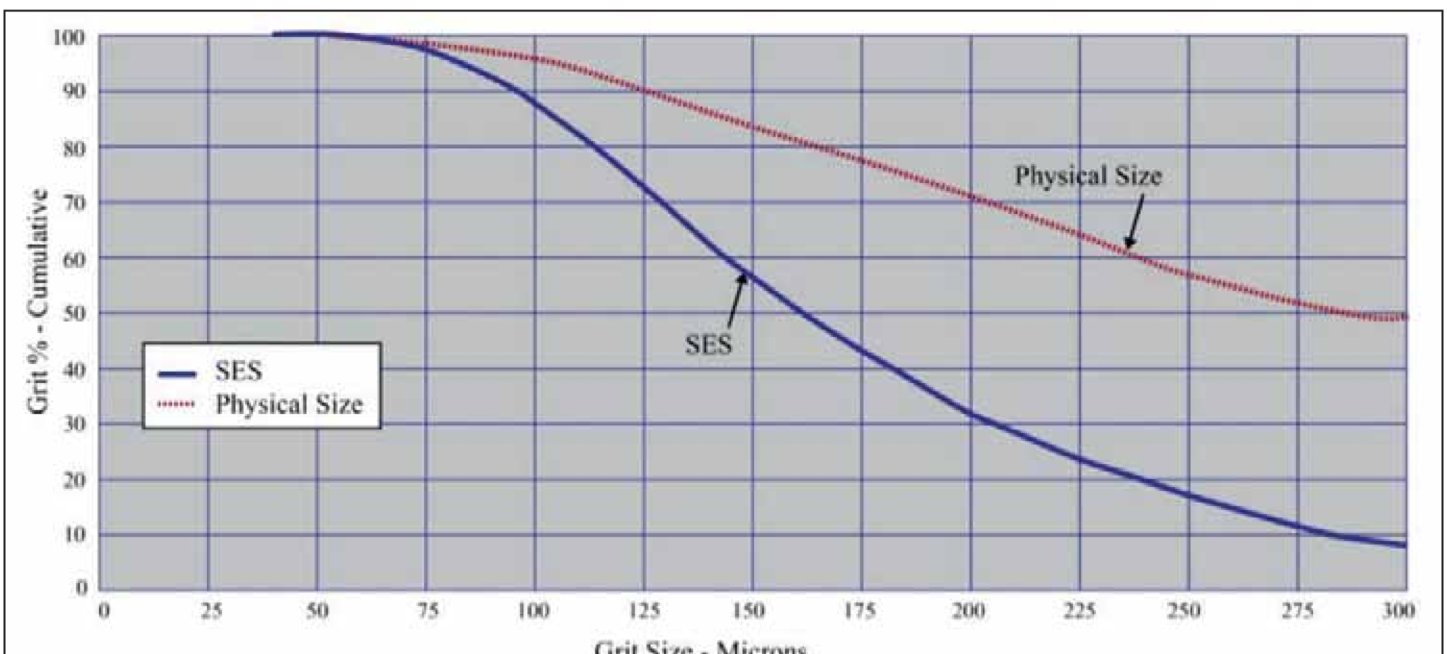

Courtesy of Hydro International

Figure 5. Measured Physical Size vs. Settling Velocity Equivalent Size (SES) at the East Regional WWTP Montgomery County, OH

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to remove 70 – 90 percent of the incoming grit load the system must be designed for 106 micron removal.

In a very qualitative manner, we can layer measured settling velocity of grit particles on the calculated settling velocity chart to provide some sense of the validity of the refinements. This is shown in ***Figure 6***.

What can be taken from ***Figure 6*** is that field measurements reinforce the idea that refinements to Newton's law to account for shape and density narrow the gap between ideal theory and real world behavior. Accurately sizing a grit system can be a challenge given several variables that are often difficult to measure. Nevertheless, using widely available data on shape and density will certainly provide an increased level of reliability that a grit system will perform as anticipated.

Conclusions

- Grit settling velocity is significantly impacted by variability in size, density and shape. The conventional assumption of spheres with a specific gravity of 2.65 is inadequate.
- Grit particles larger than 110 micron have a Reynolds number >1, therefore, Stokes' Law should not be used in grit removal system design for particles larger than 100 microns.
- Targeting 75-150 micron particle size for grit removal system design minimizes the impact of non-idealities.
- Characterizing native grit physical particle size and settling velocity is the best means to determine grit removal system design requirements.
- In the absence of site specific characterization, regional grit gradation and settling velocity data should be used for system design.

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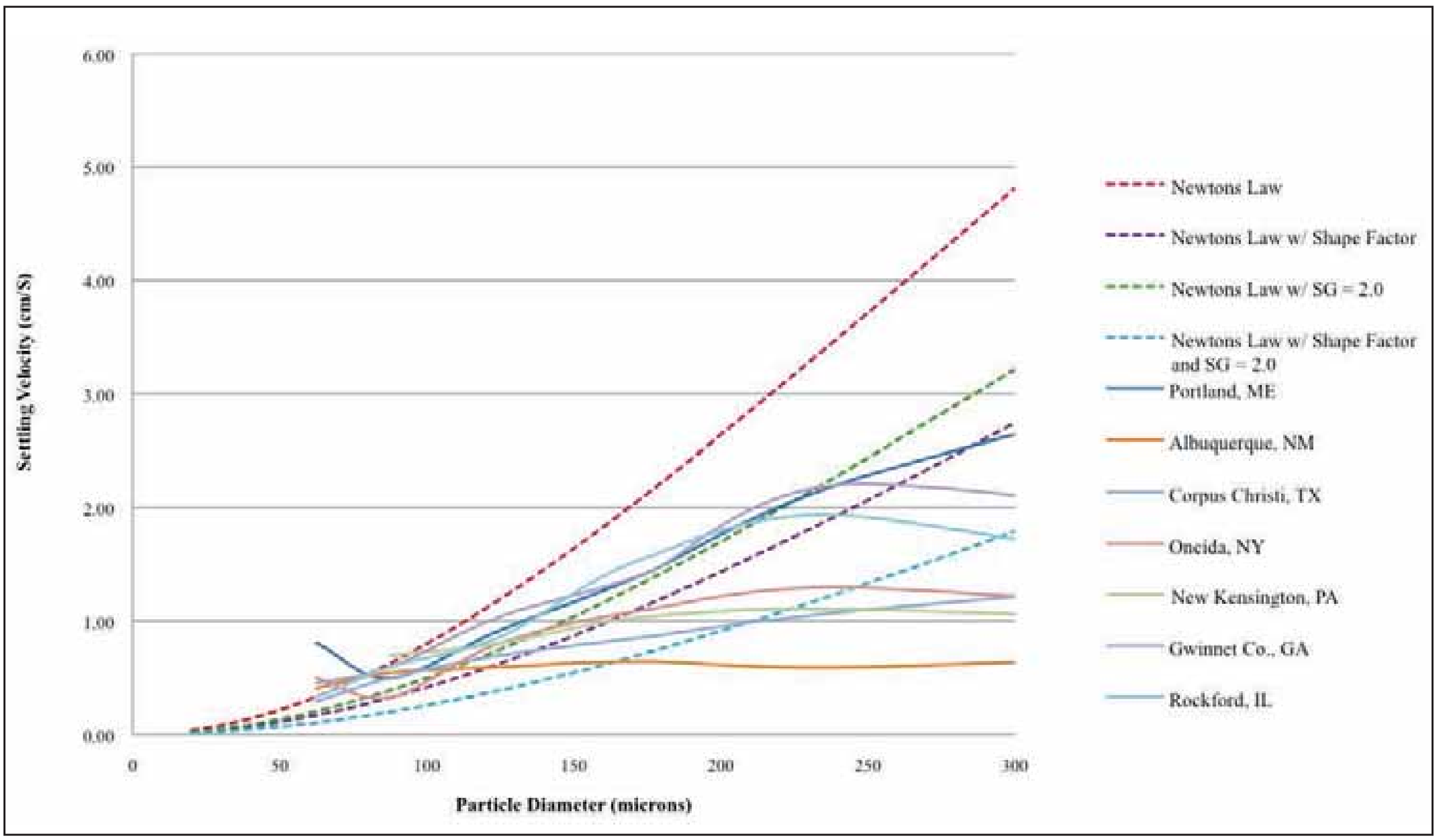

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Figure 6. Measured Settling Velocity vs. Calculated Settling Velocity. Oneida, NY (red line) is among the sampling sites.


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Comparison of Performance of Grit Removal Technologies

by Marcia Sherony

A comparative study of the efficiency of wastewater grit removal technologies was conducted using identical and consistent sampling analysis methodology. The processes tested were Aerated Grit Basins (AGB), Detritus Sedimentation Tanks (DST) and several vortex-based technologies: mechanically induced vortex (MIV), stacked tray and structured flow vortex systems.

Removal of grit from incoming raw water flow is increasingly seen as a key stage in modern wastewater treatment. Effective removal technology offers essential protection to downstream processes and mechanical equipment. The benefits in improved treatment process efficiency and reducing costs of maintenance and plant replacement can quickly pay back the investment.

Despite significant advances in understanding grit behavior, selecting grit removal technologies can be a challenge for owners and engineers due to the lack of comparative data available, together with often conflicting performance claims from manufacturers. There has also been no accepted, peer-reviewed test standard for grit sampling and analysis.

Grit Comparison Sampling Methodologies

Settling velocity is important, as most grit separation and removal technologies such as sedimentation basins and forced vortex technologies rely on gravity as the predominant force field. Particle settling velocity influences sedimentation basin sizing and is influenced by particle size, shape and density. While very important in system design, settling velocity is considered extensively in other papers (e.g. see www.AdvancedGritManagement.com); this paper is looking specifically at particle removal efficiency based on physical size distribution.

To ensure accurate, consistent, repeatable and reproducible results, a sampling technique widely used by engineers and sewage plant operators was used. This is the Vertical Slot Sampler (VSS) which is designed to draw off a known vertical slice of the influent and/or effluent water column to provide an accurate sample of solids.

The VSS results corroborate with the operating performance at those plants with respect to grit removal. The methodology can be used to compare the grit removal efficiency of various technologies and VSS data has been widely used in other published papers and articles.

Removal Technology Comparisons

To compare the effectiveness of different technologies, the Hampton Roads Sanitation District (HRSD) in Virginia, USA, performed comprehensive testing at five of its wastewater treatment plants using the VSS sampling method. The equipment tested included three different mechanically-induced vortex systems (MIV), a detritus sedimentation tank (DST) system and an aerated grit system (AGB). During the same period, HRSD conducted a side-by-side pilot test comparing the stacked tray Eutek HeadCell® and the structured flow vortex Grit King®.

As the period under study coincided with extended dry weather, the AGB data collected at the HRSD plant was inconclusive because the flows were insufficient to re-suspend grits and sediment in the collection system and transport it to the treatment plant. As this was unrepresentative of performance under normal operation, the HRSD AGB data was excluded and replaced by AGB data from Columbus, Georgia, providing a meaningful performance comparison for the AGB technology using the same testing methods.

MECHANICALLY-INDUCED VORTEX

Plant 1

Chesapeake-Elizabeth Treatment Plant is a 91 minimum level per day (ML/d) capacity plant operating with an average flow of approximately 72 ML/d (19 mgd). Grit removal equipment consists of two 7.3 m (24 ft) diameter MIV units (One unit was in operation during the study).

Design Grit Removal Target: The design removal parameter for each unit is 95 percent removal of 150 µm particles, 2.65 SG, at 114 ML/d (30 mgd), and 95 percent removal of 270 µm particles, 2.65 SG, at 265 ML/d (70 mgd). Average flow during testing was 71.1 ML/d (18.79 mgd), which is well below the rated capacity of the grit unit.

Results: The observed removal efficiency was **48–52 percent** of all grit 150 µm and larger and **45–50 percent** of all grit 106 µm and larger. Removal efficiency of particles > 297 µm, a slightly larger particle than the performance claim, was **72–78 percent** or roughly 20 percent less than the claimed removal.

Plant 2

Virginia Initiative Plant is a 151 ML/d (40 mgd) capacity plant with an average flow of approximately 110 ML/d (29 mgd). The plant employs three 6.1 m (20 ft) diameter MIV units. (One unit was in operation during the study.)

Design Grit Removal Target: The manufacturer states each unit will remove 65 percent of 150 µm grit, 2.0 SG, at 101 ML/d (26.7 mgd). Average flow during three days of testing was 99.2 ML/d (26.23 mgd), very near the rated capacity of the grit units.

Results: The observed removal efficiency was **43–45 percent** of all grit 150 µm and larger, 20 percent below the claimed efficiency, and **43–44 percent** of all grit 106 µm and larger.

Observations: Testing results for the mechanically-induced vortex technology were considerably below the manufacturer's claimed removal efficiency even when running well below design flows. The highest observed removal efficiencies was for large grit particles, approximately 60 percent removal of particles larger than 297 µm and very low performance removing smaller particles, with less than 30 percent removal of particles 210 µm and smaller.

At Chesapeake-Elizabeth, the observed removal efficiency of grit particles 150 µm and larger was more than 40 percent less than the stated claim. Based on the Surface Loading Rate (SLR), the MIV technology would, in theory, be expected to retain a large percentage of particles approximately 165 µm and larger. The observed removal efficiency for much larger particles, 297 µm and larger, was only 72–78 percent. The low removal efficiency suggests the importance of considering the likely effects of grit settling velocity and other criteria.

DETRITUS SEDIMENTATION TANK SYSTEM

Plant 3

James River Treatment Plant is a 76 ML/d (20 mgd) capacity plant with an average flow of approximately 49 ML/d (13 mgd). Four DST units, each 8.5m (28 ft) in diameter have a design capacity of 24.6 ML/d (6.5 mgd).

Design Grit Removal Target: Each unit is designed to remove grit particles 150 µm and larger, with 2.65 SG. The average flow during three days of testing was 48.75 ML/d (12.88 mgd) with one

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of the DST units out of service. Therefore, each unit was processing approximately 16.27 ML/d (4.3 mgd) or roughly 33 percent below their rated capacity.

Results: The observed removal efficiency was **66–73 percent** of all grit 150 µm and larger and **57–68 percent** of all grit 106 µm and larger.

Observations: While test data indicates the DST system achieves higher removal efficiency than the MIV technology, the DST also fell short of design removal efficiency while operating at 66 percent of design flow. Test data shows relatively high removal efficiencies of large grit particles, as would be expected, but reduced capability of removing smaller particles.

Although an older style technology, sampling and analysis for the detritus tank displayed some of the higher removal efficiencies of the technologies tested. Removal efficiency would be expected to decline at peak design flow.

AERATED GRIT BASINS

Plant 4

City of Columbus, GA, South Water Reclamation Facility operates four AGB units with a combined average flow of 106 ML/d (28.0 mgd). The plant has two AGBs that are 5.18 m x 11.89 m (17 ft x 39 ft) and two basins 3.96 m x 10.97 m (13 ft x 36 ft).

Design Grit Removal Target: No design data was available. However, based on the calculated SLR of 0.35 m^3/min./m^2 (8.6 gpm/ft^2) the AGBs would be expected to remove a significant percentage of fine particles, 106 µm and below. Once the flow reaches 132.5 ML/d (35 mgd) the SLR increases to 0.435 m^3/min./m^2 (10.7 gpm/ft^2) and removal efficiency decreases. Based on SLR alone, the basin would still be expected to retain a percentage of fine particles at 132.5 ML/d (35 mgd) with particle size retained increasing, and overall capture efficiency decreasing, as flow continues to rise.

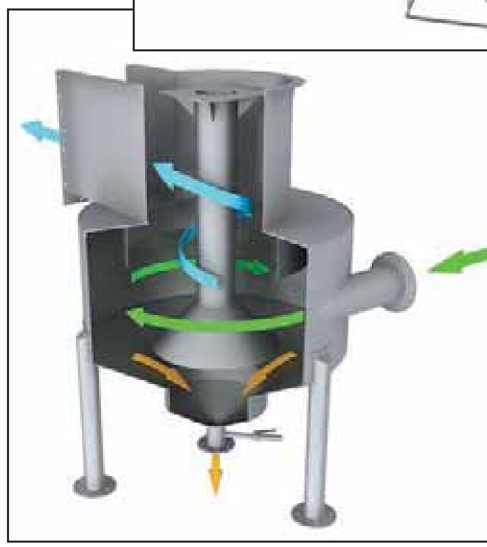
Results: A rain event occurred on one of the three days of testing. When the flow to the grit chamber increased during wet weather the removal efficiency decreased, as would be expected. The observed removal efficiency was **35–70 percent** of all grit 150 µm and larger and **32–67 percent** of all grit 106 µm and larger when the wet weather data was included. Removal efficiency improves to **58–70 percent** of all grit 150 µm and larger and **53–67 percent** of all grit 106 µm and larger during average flow of 106 ML/d (28.0 mgd). While excluding the performance during the wet weather event indicates improved performance, removal efficiency is well below what would be expected based solely on SLR.

Observations: The AGB results were comparable to those for the DST system during the plant average flow. However, during wet weather the removal efficiency was reduced to 32.5 percent. Even considering the small increase in flow during the rain event, which was in the region of 135–175 percent of average, the quantity of grit increased substantially from 3.36 g/m^3 (28.1 lbs/MG) to 8.89 g/m^3 (74.2 lbs/MG). The fraction of grit smaller than 297 µm also increased significantly. A reduction in removal efficiency at higher flows is expected. However, during the elevated flow influent grit concentration also increased by a factor of more than 2.5 times the dry weather influent levels. A removal efficiency of 32–35 percent of the heavier grit load will obviously not be adequate to protect the plant from deposition and abrasive wear.

Plant 5

The HRSD piloted two new grit removal systems side by side for their Army Base Treatment Plant using the same sampling and testing methodology. The stacked tray Eutek HeadCell® and a Grit King® structured flow system.

Above: Eutek HeadCell® stacked tray system



Left: Grit King® structured flow system

STACKED TRAY SYSTEM

Design Grit Removal Target: The stacked tray HeadCell® unit was fed at 38.6-38.8 m^3/hr. (170-171 gpm). At that flow rate it was designed to remove 95 percent of all grit 75 µm and larger, with 2.65 SG.

Results: The observed removal efficiency was **92–93 percent** of all grit 150 µm and larger and **89–90 percent** of all grit 106 µm and larger.

STRUCTURED FLOW SYSTEM

During the side-by-side testing, the 1.2 m (4 ft) diameter structured flow Grit King® pilot unit was fed at a rate of 38.8 m3/hr (170 gpm) on the first day and 25.4 m3/hr (112 gpm) on the second day.

Design Grit Removal Target: The design removal parameter at the higher flow is about 95 percent of all grit 106 µm and larger, 2.65 SG. At the lower flow of 25.4 m^3/hr. (112 gpm) the removal would be expected to be 95 percent of all grit 75 µm and larger, 2.65 SG.

Results: The observed removal efficiency was **90–95 percent** of all grit 150 µm and larger and **87–93 percent** of all grit 106 µm and larger.

Observations: Both technologies displayed the highest removal efficiency; in all cases >87.5 percent of all influent grit 106 µm and larger was captured. While a pilot study, the results are consistent with full scale performance tests using the identical test method at other facilities. Measured removal efficiency for both technologies was slightly below that claimed by the manufacturer, but within +/– 8 percent. This small deviation is very near the margin of error in testing. Comparatively, these two technologies provide very high removal efficiencies of large grit particles, approximately 93 percent removal of particles larger than 300 µm. The observed removal efficiency of particles between 150–210 µm was only slightly less and ranged from 78–90 percent.

Overall Conclusions and Implications

Grit sampling using the VSS method produces results that are repeatable, accurate and effective. The results corroborate with grit system performance and plant operating history, therefore providing insights into what most operators experience. Using this common testing method allows comparison of performance of various grit removal technologies and can assist in improving grit system design and justifying advanced processes.

Table 7. Relative Performance of Grit Removal Devices

Technology	% of Design Flow	Design Removal Efficiency at 100% Flow	Total % Removal 150 µm and up	Total % Removal 106 µm and up
Detritus Tank	66	150 µm and larger, 2.65 SG	66–71	57–68
AGB	66–100	N/A	35–70	32–67
MIV	27–90	95% removal of 270 µm, 2.65 SG 65% removal of 150 µm, 2.0 SG	43–52	43–50
Stacked Tray	100	95% removal of 75 µm, 2.65 SG	91–92.5	89–90
Structured Flow Vortex	66–100	95% removal of 75 µm, 2.65 SG	90–95	87–93

Least and Most Effective Grit Removal: Based on the reported and referenced testing, the technologies that displayed the lowest removal efficiencies were the AGB and the MIV systems. The observed removal efficiency for both technologies was well below claimed removal at peak flows.

The structured flow vortex and stacked tray vortex units had very high removal rates, none lower than 87.5 percent of incoming grit 106 µm and larger. These results are significantly (20 percent to 55 percent) higher than any of the other technologies tested. Over the life of the facility, the difference in captured grit is substantial. Also of note, is the fact that high removal results were achieved with the equipment running at peak design flow.

None of the technologies tested met their performance claim exactly, although the technologies that targeted the finest particles displayed the best results and came closest to achieving their performance claim. Systems designed for high removal efficiency of small particles, 106 µm and finer, should remove 85 percent or more of grit entering the plant.

Flow Performance Variation: The observed decrease in performance with increased flows provides strong evidence that the tested technologies are strongly influenced by loading rate and gravity to capture and retain grit. A better understanding of *in situ* grit settling velocity will allow for more efficient design which would afford the plant increased protection from abrasive wear and deposition.

Wet weather is an important consideration in grit system design. The impact of wet weather flows was documented during testing of the AGB in Columbus, GA. One would expect the greatest increase would be of coarse grit particles, but the overall gradation was finer. Overall, a 60 percent increase in flow resulted in a 48 percent decrease in performance.

Significant increase in grit volumes during wet weather events is a common phenomenon and indicates the need to design the grit system for effective removal at peak hydraulic loadings. The AGB and MIV performed poorly at peak design flow and, based on the data, the DST would be expected to perform similarly to the AGB. Observed removal efficiencies were less than what would be expected based on SLR alone indicating process inefficiencies or grit settling velocity implications.

Designing the grit removal system for high removal efficiency at peak hydraulic loading will protect the plant from the negative impacts of grit. Advanced, compact, high-efficiency grit removal processes are, therefore, the more appropriate proven choice to protect plants from deposition, abrasive wear and associated costs from this nuisance material.

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McNamara, B., M. Sherony, and P. Herrick, Relative Performance of Grit Removal Systems (2012). McNamara, Hampton Roads Sanitation District, 401 Lagoon Road, Norfolk, VA 12505, USA. Sherony and Herrick, Hydro International, 2925 NW Aloclek Drive #140, Hillsboro, OR 97124, USA.

April 7–9, 2014

WEF, WERF and NACWA Fly-In to Washington, DC

The NYWEA delegation again traveled to the nation's capital to assist with advocacy for pending environmental legislation of national importance. The New York Water Environment Association (NYWEA) has taken part in the annual "fly-in" in Washington, DC since 2011, an event sponsored by the Water Environment Federation, Water Environment Research Foundation and the National Association of Clean Water Agencies.

This year, the key proposed legislation being tracked is the Water Resources Development Act (WRDA). Although this bill usually covers only US Army Corps of Engineers' projects, being considered this year are provisions for both a two-year Clean Water and Drinking Water State Revolving Fund (SRF) as well as a Water Infrastructure Finance and Innovation Act (WIFIA). The WRDA bill is in conference committee, which means that both the Senate and House have passed legislation on it and a final joint bill is being worked out. If all goes well, the SRF will be funded at a higher level than anticipated and the WIFIA provision, if added, will allow loans and loan guarantees for larger projects that exceed $20 million (and which the existing SRF does not fund). The bill allows for a number of pilot projects under the WIFIA provision as a trial for this method of financing.

Other legislation ranges from Integrated Planning, a Clean Water Trust Fund, and Water Resources Utility of the Future initiatives. The NYWEA contingent completed nine appointments on its itinerary with congressional offices that included both New York senators and/or staff members involved with the legislation. Our contingent met with Congressman Tim Bishop of Long Island who is a key ranking member on the subcommittee which is writing the WRDA legislation. The group also awarded NYWEA's Rockefeller Award to US Senator Charles E. Schumer who graciously accepted.

Delegation members offered effective advocacy on behalf of NYWEA, and they included: Michael Garland, Drew Smith, Matt Millea, Robert Kukenberger, Steven Fangmann and Patricia Cerro-Reehil.

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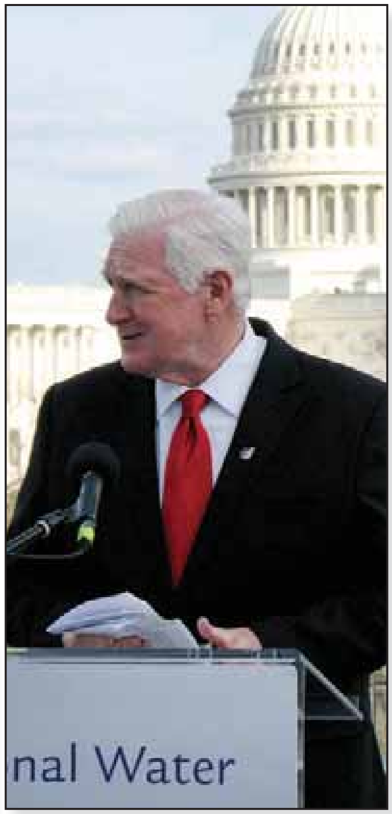
NYWEA President Fangmann introduced Congressman Timothy Bishop during the WEF, WERF and NACWA Fly-In.

(L–r): Robert Kukenberger, Michael Garland, President Steven Fangmann, XXXXX XXXXXXXXX, Drew Smith

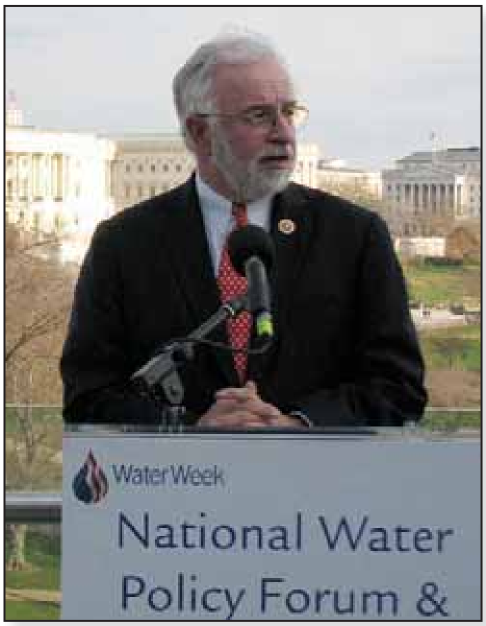
(L–r): Steve Dye, Robert Kukenberger, Matt Millea, Michael Plochocki, Patricia Cerro-Reehil and Tim Williams

Representative Donna Edwards (D-MD), (left), receives an Honorary Membership from WEF for her support for green infrastructure and innovative stormwater management approaches.



Rep. James Moran (D-VA), ranking member of the House Interior and Environment Appropriations Subcommittee

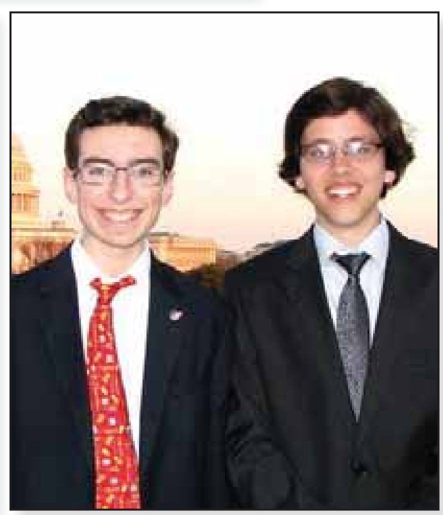
Above: Michael Garland, Robert Kukenberger, Drew Smith and President Steven Fangmann on the Hill



Congressman Timothy Bishop (2011 Rockefeller Award recipient) speaks to the attendees about the importance of infrastructure funding.

(L–r): Matt Marko, Drew Smith, Michael Plochocki and Michael Garland

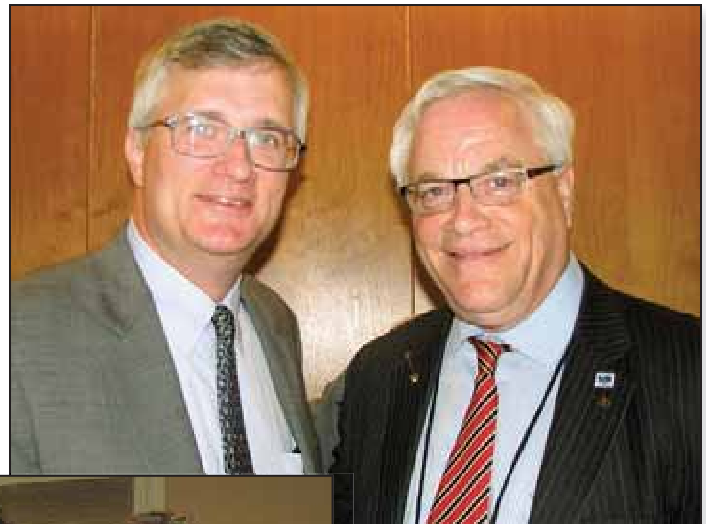
NYWEA members present Senator Schumer with the Nelson A. Rockefeller Award. (L–r): Matt Millea, Michael Garland, Patricia Cerro-Reehil, Steven Fangmann, Senator "Chuck" Schumer, Drew Smith and Robert Kukenberger



Above: WEF Stockholm Jr. Water Prize winners, Jack Lohmann (left) and XXXX XXXXXXX AND THEIR STATES??

Legislative & Regulatory Dialogue Highlights

NYWEA's Annual Legislative & Regulatory Dialogue was held on May 13 in the Legislative Office Building in Albany, NY. The event was attended by four elected officials: Senator Mark Grisanti, Assemblymen Robert Sweeney, Brian Kavanaugh and Joseph Saladino. Staff from the ?? office were also present. Some of the topics discussed included: NYS leadership in water and wastewater infrastructure funding, nutrients management and integrated planning. The 2015 Legislative Dialogue is scheduled for Tuesday, May 5.



Above: Chair of the newly formed Environmental Caucus, Brian Kavanaugh, left, and NYWEA President Steven Fangmann

Above: Assemblyman Robert Sweeney, left, and Senator Mark Grisanti share a moment during the Legislative Dialogue.

Above: Jeff Gratz, left, shares a laugh with Jeff Myers of NYSDEC who gave a talk to members about nutrients and water quality.

Phillip Musegaas of the Hudson Riverkeeper addresses the members.

Catherine Young of Binghamton/Johnson City shares her experiences during the last few years of flooding and major issues at their wastewater treatment plant.

Boris Rukovets, Chair of NYWEA's Government Affairs Committee

Left: Dave Comerford of Buffalo Sewer Authority addresses NYWEA members.

William McMillin gave a presentation on nutrients.

NYWEA President–Elect Joe Fiegl shares his experience with Erie County DEP.

Mike Miller talks about his experience with the Albany Pool.

Using the Triple Bottom Line Approach to Identify Energy Neutral Biosolids Management Options

by Michael Elenbaas, Ned Beecher, Andrew Carpenter and Steve Tarallo

Many wastewater treatment facilities striving to become "Utilities of the Future" are using triple bottom line (TBL) assessments to help make decisions about opportunities for long term sustainability. Using TBL they can evaluate common wastewater solids management technologies and processes amenable for energy recovery based on social and environmental impacts, as well as financial metrics. Management of wastewater solids can be viewed from many perspectives, focusing explicitly on thickening, treatment, dewatering, and final use or disposal processes; or within the larger context of green infrastructure. The point of view ultimately helps to shape the criteria that will be used to define "sustainability" for a particular application.

Researchers funded through a collaborative effort of the New York State Energy Research and Development Authority (NYSERDA) and the Water Environment Research Foundation (WERF) used a TBL approach to evaluate common wastewater solids management technologies and processes relative to their potential for long term sustainability including energy neutrality. The TBL assessment began at the point where solids are removed from wastewater (in primary and secondary clarifiers) and ended with final use, or disposal, of the final product(s). It included anaerobic digester side-stream treatment processes to the extent practicable. This approach is consistent with other studies, such as the BEAModel *(Brown et al., 2010)*.

Initially, criteria and weightings were developed so that the TBL sustainability scores of six solids disposal options could be assessed. ***Table 1*** lists these options. The researchers selected TBL criteria that fell under one of the three major categories (i.e., economic, environmental, social as shown in ***Figure 1***) and are widely considered the most significant for differentiating between management options. Each major criterion was weighted equally at 33 percent; however, individual sub-criteria were given a different weight based upon feedback from a panel of expert advisors. ***Figure 2*** shows the criteria used in the analysis as well as the weightings.

Figure 3 shows the overall results from the TBL analysis. Anaerobic digestion of biosolids combined with co-digestion, combined heat and power (CHP) and land application of biosolids (configuration 2X) received the best overall TBL result. Incineration with landfill disposal (configuration 3Y) had a similar economic score, which was offset by lower scores for the environmental (green) and social (blue) criteria. From the perspective of a research-based TBL analysis, anaerobic digestion of biosolids combined with co-digestion, CHP and land application of biosolids is the most sustainable option for processing solids; though these results cannot specifically be applied to a particular wastewater treatment facility.

Conservation of Resources was a criterion under the Environmental category. Energy Recovery Potential was one component of this criterion. Energy Recovery Potential was calculated as the net value of energy recovered from the inherent energy in the solids (or water) treated at a wastewater treatment facility, measured in megajoules per day (MJ/day). The results of the calculations are shown in ***Figure 4***.

In the four anaerobic digestion based configurations, significant net energy was derived from the biosolids through conversion of volatile solids to biogas, and subsequently using the biogas to generate both usable electricity and heat in a combined heat and power system. Energy balances developed for each of the anaerobic digestion configurations took parasitic heat and electricity (i.e., digester heat [1X, 1Y, 2X, 2Y], thermal hydrolysis [1X, 1Y]) into account; parasitic energy was subtracted from the overall balance for these configurations. The anaerobic digestion configurations

Figure 1: Sustainability and the Triple Bottom Line

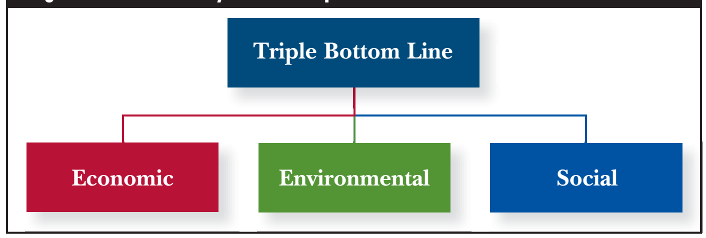
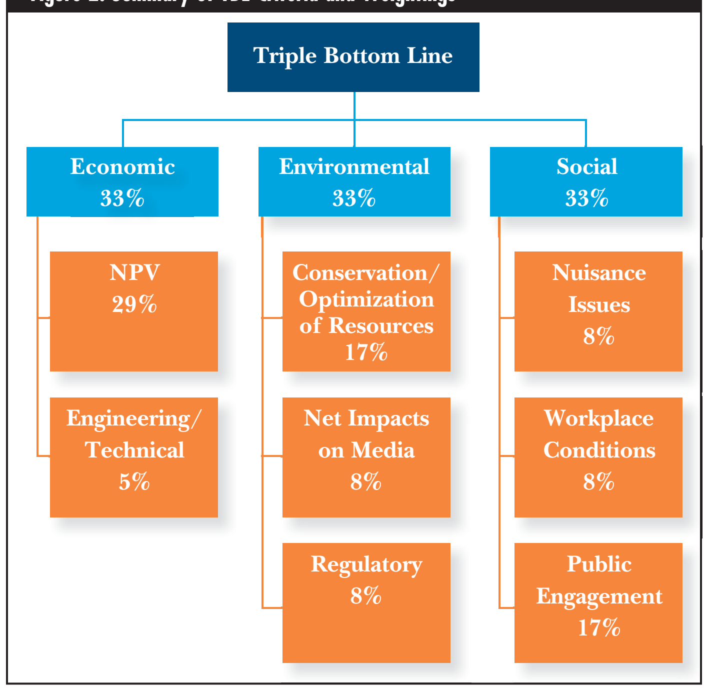


Table 1: Solids Disposal Options for TBL Analysis

- 1X = AD, solids pretreatment, CHP, land application
- 1Y = AD, solids pretreatment, CHP, landfill disposal
- 2X = AD, co-digestion, CHP, land application
- 2Y = AD, co-digestion, CHP, landfill disposal
- 3Y = Incineration with ash landfill disposal
- 4Y = Gasification with ash landfill disposal

AD = Anaerobic Digestion
CHP = Combined Heat and Power

Figure 2: Summary of TBL Criteria and Weightings

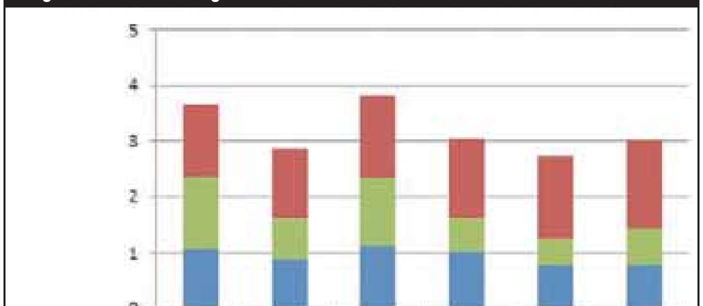


produced roughly equivalent amounts of net energy from the biosolids – 24,094 MJ/day (for configurations 1X and 1Y) and 22,662 MJ/day (for configurations 2X and 2Y).

In the fluidized bed incineration configuration (configuration 3Y), approximately 24 percent of the heat generated during the incineration process was directed to a waste-heat boiler that in turn drove a steam turbine to generate electricity. The amount of electricity generated (2,300 kilowatt-hours per day [kWh/day]) is greater than the 1,400 kWh/day used in the incineration process; however, approximately 67,300 MJ/day of natural gas was needed for the process and subsequently the final net-energy balance was negative (-63,829 MJ/day).

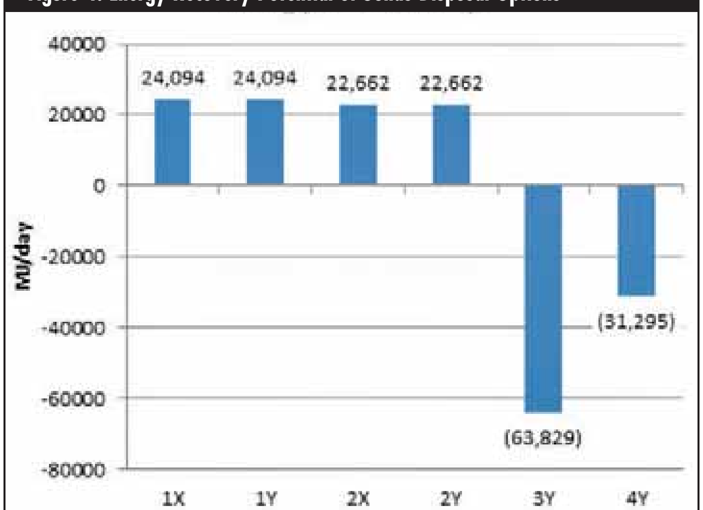
In the gasification configuration (configuration 4Y), syngas generated during the gasification process was used to dry biosolids in a thermal dryer as a pretreatment step for subsequent gasification. However, insufficient quantities of syngas were produced, and approximately 25,000 MJ/day of natural gas was required as a supplement to the syngas. The net result for energy recovery in this configuration was also negative (-31,295 MJ/day).

Figure 3: Overall Weighted TBL Results



	1X	1Y	2X	2Y	3Y	4Y
Economic	1.3	1.2	1.5	1.4	1.5	1.6
Environmental	1.3	0.7	1.2	0.6	0.5	0.7
Social	1.1	0.9	1.1	1.0	0.8	0.8

Figure 4: Energy Recovery Potential of Solids Disposal Options



1X = AD, solids pretreatment, CHP, land application
1Y = AD, solids pretreatment, CHP, landfill disposal
2X = AD, co-digestion, CHP, land application
2Y = AD, co-digestion, CHP, landfill disposal
3Y = Incineration with ash landfill disposal
4Y = Gasification with ash landfill disposal

The TBL approach is currently being used by many wastewater treatment facilities to assess their solids management strategies; particularly by those facilities looking to become energy neutral Utilities of the Future. While these results were based on modeled energy balances and specific TBL criteria weightings, the outcome of the study strongly suggests that anaerobic digestion with CHP should be considered part of a wastewater treatment facility's solids management strategy if the facility is looking for long-term sustainability that includes energy neutrality.

Michael Elenbaas (elenbaasm@bv.com) is Principal Consultant of the Management Consultant Division of Black and Veatch. Stephen Tarallo (tarallos@bv.com) is Business Leader of Sustainable Water and Energy Solutions of Black and Veatch. Ned Beecher is Executive Director of the North East Biosolids and Residuals Association (ned.beecher@nebiosolids.org) based in Tamworth, New Hampshire; and Andrew Carpenter is President of Northern Tilth (soils@northerntilth.com), located in Belfast, Maine.

Total Systems Approach to Wastewater Treatment

Making All the Pieces of the Puzzle Fit for Industrial Clients

by Chandler Johnson

The total systems approach (TSA) to wastewater treatment is focused on offering industrial clients a fully integrated wastewater solution – one that includes all pieces of the puzzle, rather than simply a set of uncoordinated components and systems. The approach includes a collaborative evaluation process to understand a particular facility's requirements, use of proven designs and materials, and selection of innovative products that have the best life cycle cost while achieving the best water quality.

What is a total systems approach and why is it better than the alternative? A true TSA begins with an evaluation that identifies options to help achieve a company's production goals. After identifying and evaluating any issues, the next step is the development of a detailed engineering design in collaboration with facility engineers. Components and equipment are selected with an eye on durability and design optimization and the overall system fitted together is focused on long-term reliability and consistent performance. Efficient installation, startup, and training are other important pieces of the TSA. Compliance is ensured with the use of binding performance guarantees. Extended service plans can make the provider almost an adjunct to the company's process engineering team. The final piece of the TSA is the availability of a complete system warrantee.

Courtesy of World Water Works

An operating MBBR (moving bed biofilm reactor) with a covered EQ (equalization) tank in the background

Courtesy of World Water Works

MBBR aeration grid shown inside the tank

Components included in a TSA vary depending upon the application. The two main categories include primary and secondary liquid/solid separation to remove particulates and organics and biological treatment of soluble biochemical oxygen demand (BOD) and ammonia. Related equipment may include pump stations, screening devices, sludge tanks, and a range of other ancillary equipment to handle any byproducts created.

TSA in Action

The total systems approach is a customized approach in which solutions are specifically tailored to each industrial customer's wastewater treatment requirements. In the three examples given next, the TSA fits the puzzle pieces differently, but in each case an in-depth evaluation sets the stage for a truly integrated and trouble-free solution.

Dairy Plant to Handle Wastewater from Facility Expansion

An interesting example of the TSA in action is the upgrading of Dannon's Utah yogurt manufacturing facility's wastewater treatment system. Just two years prior, the company had installed a circular Dissolved Air Flotation (DAF) pretreatment system but had found that it was not well designed, with high operational costs from chemical consumption, and poor performance.

Dannon recognized that the existing plant would not be able to handle additional wastewater expected from a planned facility expansion and decided to construct a new wastewater treatment system. After evaluating several possible technologies, including both anaerobic and aerobic solutions, the company selected a system that uses two rectangular high-rate DAF units, one for separation of suspended solids and fats, oils and greases, and one for separation of biological solids. The DAF selected has the added benefit of handling pH swings without corrosion.

In addition, they selected the moving bed biofilm reactor (MBBR) technology for degradation of soluble organics. The MBBR is a biological process used for BOD removal, nitrification and /or denitrification. The system provides significant advantages over other biological processes and has been successfully implemented at several dairies, which have widely variable wastewater loads. Aside from the core DAF and MBBR technologies, the total system also includes rotary screening to remove debris and equalization to normalize the flow and load.

To implement the turnkey project, Dannon selected a partnership employing MWH Engineering and manufacturer World Water Works (WWW). MWH Engineering provided the complete total systems approach for the turnkey solution, while World Water Works provided design, engineering, manufacturing, and supply of the primary Ideal DAF™ and the Ideal MBBR-DAF™, the slot injector system for the EQ (equalization) tank, as well as associated chemical feed equipment, start up, and commissioning and performance guarantee. The new DAF-MBBR-DAF process is shown in ***Figure 1***.

The plant began treatment and within a few weeks the DAF

Courtesy of World Water Works

Figure 1. Total Systems Approach at Dairy Facility

Courtesy of World Water Works

A sidehill screen with hopper for solids being captured used at KanPak

Courtesy of World Water Works

DAF (dissolved air floatation) effluent weirs, showing effluent from the DAF system

units were operating at a fraction of the costs of the previous unit, according to Dannon. The system has been designed so it can be expanded easily to meet further production needs. It is a flagship site for Dannon, and the plant has won awards at environmental conferences in the food industry.

Aseptic Packager Upgrades Overloaded Pretreatment System

Using a TSA approach can frequently reduce land, labor, and operational costs compared to such traditional conventional wastewater approaches as activated sludge. In addition, using the TSA approach ensures that the system will actually meet permit effluent requirements.

Take the example of KanPak® LLC, a family-owned company based in Arkansas City, KS, that develops aseptic packaging for beverages and desserts, including smoothies, coffee drinks, creamers, frozen desserts, and more. The company is known for advanced aseptic processing and packaging, including stringent quality control measures throughout each step of the production process.

To meet discharge and pretreatment requirements at one of its manufacturing facilities, KanPak had installed a traditional biological wastewater treatment system, including a biological process and a secondary DAF. The system included an interceptor/pump station; EQ tanks; aerobic fixed film bio treatment; secondary solids separation; DAF with flocculation tank; compressor/pressure tank; sludge dewatering; vertical rotary screw press; and a final effluent flow/pH monitoring.

Within a week of startup, the treatment process had failed; solids would not flocculate and effluent was out of compliance. The plant had been quickly overwhelmed by production discharge, as well as hot water (steam), sanitation products, floor foams, clean-in-place chemicals, and sterilants. The design load was 2,800 pounds/day of BOD_5 but the actual load was 5,600-14,000 pounds/day.

To solve the wastewater challenges, KanPak decided to embark on a TSA, using a partnership between an engineering consultant (Fuss & O'Neil), and WWW. The work began with an evaluation of the treatment systems, which determined that the wastewater equalization tank was not designed properly for dairy wastewater. Dairy wastewater can go septic within hours if not properly handled, and the resultant odors and low pH were affecting downstream processes. The partners also noted that combined sanitary wastewater was a safety issue for operators, as well as a solids issue. The system was not properly dewatering, which was causing poor sludge quality. Finally, the treatment system lacked primary treatment – the high concentration of milk fat requires long hydraulic retention time for hydrolysis by bacteria, and interferes with oxygen transfer.

The evaluation also considered a major in-plant source reduction initiative undertaken by KanPak, which used an internal audit to identify excessive water usage and the potential for reduction. The audit resulted in recommendations for batching system modifications, directing boiler blow-down to the publically owned treatment works (POTW) instead of the pretreatment system, closed loop recirculation, conversion from retort to aseptic bottle line, and directing sanitary wastewater to the POTW. As a result, the hydraulics to the pretreatment system were reduced from 400,000 gallons per day (gpd) to 100,000 gpd.

Based on the evaluation and source reduction initiatives, WWW developed a TSA for KanPak, with improvements installed in phases over several years. The first phase resulted in odor elimination, reduced sludge production through better dewatering characteristics of the solids and savings on chemicals, as well as better TSS and organics removal. The second phase involved a pilot treatment study, followed by treatment plant design. The new system improved the EQ basin to prevent anaerobic conditions, installed a second

continued on page 53

continued from page 51

Courtesy of World Water Works

A side-mounted mixer in an EQ tank

DAF, replaced nitric acid for pH control with CO^2, and upgraded the biological treatment with a new aeration system. The third phase improved dewatering (going from 4 percent to 18 percent solids) and significantly reduced sludge disposal costs.

The end result of the TSA was improved sanitation with a marked reduction in water consumption, resulting in savings of more than $100,000 a year, a $4.5 million per year savings in sludge disposal and chemical costs, and a $1 million per year savings in compliance costs.

Turkey Processor Takes Pressure Off Municipal Wastewater Treatment

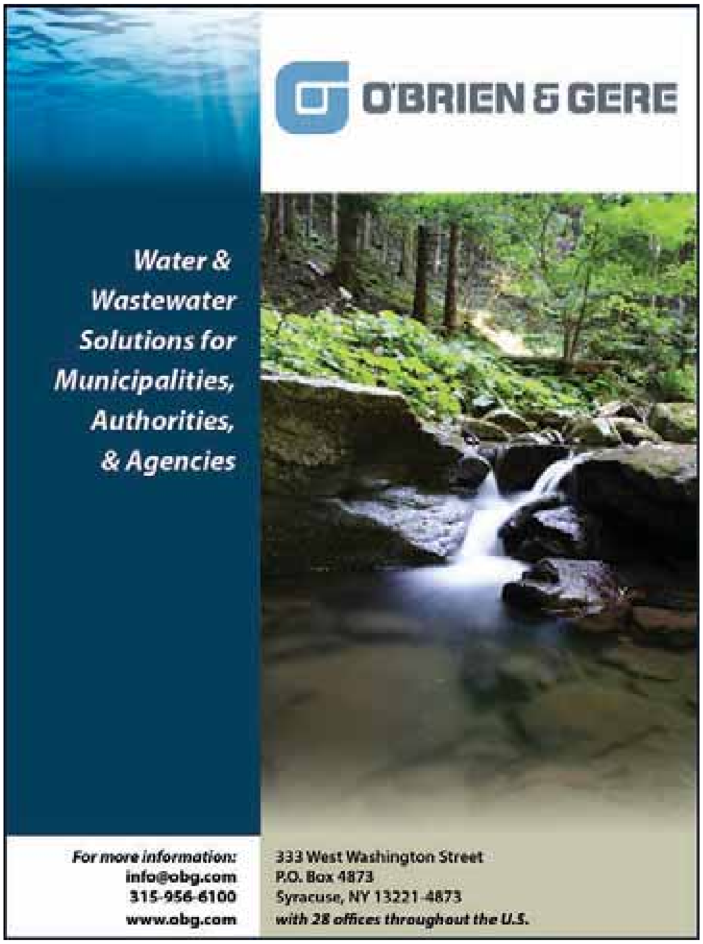
A final example of the benefit of a TSA is for Sarah Lee/Hillshire Farms, which needed expanded wastewater facilities for its Iowa turkey processing plant.

After conducting an evaluation of the plant's requirements, WWW suggested beginning with a EQ-DAF-DAF system and then conducting a further evaluation to determine if biological treatment was needed at all. The evaluation step gave the company time to review the impacts from the initial system and ask questions about what could be achieved with the effluent if additional treatment was added. The evaluation took place over the course of about nine months.

The company decided to add an MBBR to the treatment line, which reduced its BOD and TSS to single digits. The load reduction means the municipality now has significant additional capacity and will not have to expand its facilities to build any needed capacity.

Focusing on the total system as a whole is important because zoning in on only one specific component may result in missing the bigger part of the picture. Even if a company needs to replace only one piece of its system or add a new component, the project should still include the same elements, with a focus on complete problem evaluation and provision of a solution tailored to the company's individual needs.

Chandler Johnson is Chief Technology Officer for World Water Works and focuses on building the company's biological division, including biological nutrient removal technologies. Chandler led a project that recently received the AAEES Honor Award for Environmental Sustainability. He holds an MS in environmental engineering from RPI. Inquiries may be sent to info@worldwaterworks.com.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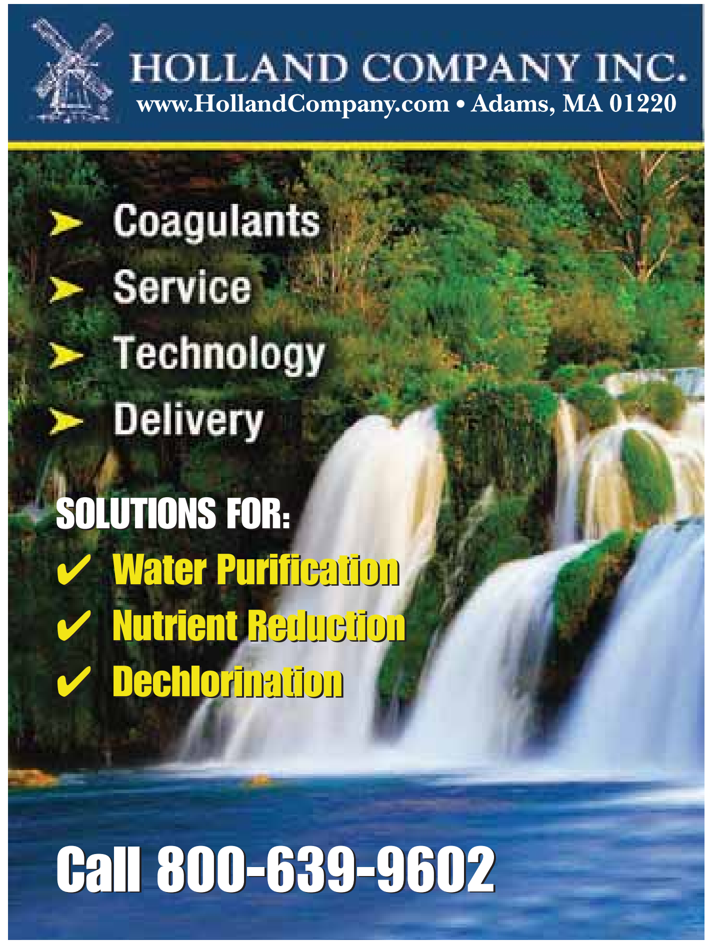
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Operator Quiz

Test No. 104 – Anaerobic Digestion

The following questions are designed for trainees as they prepare to take the ABC wastewater operator test. This quiz is also designed for existing operators to test their knowledge. Each issue of *Clear Waters* will have more questions from a different section of wastewater treatment. Good luck!

1. What is the typical operating temperature of a Mesophilic anaerobic digester that is producing biogas at a higher rate?
   a. 75 to 85 degrees F
   b. 85 to 90 degrees F
   c. 90 to 95 degrees F
   d. 100 to 105 degrees F

2. What are the main byproducts produced by the acid forming bacteria during the initial digestion phase?
   a. Water and methane
   b. Carbon dioxide and organic acids
   c. Struvite and hydrogen sulfide
   d. Water and completely digested sludge

3. What best describes methane forming bacteria in an anaerobic digester?
   a. Sensitive to environment and environmental changes
   b. Fast growing organisms
   c. Produce biogas at very low pH
   d. They work best in the presence of oxygen

4. What is the best way to "feed" an anaerobic digester?
   a. Once per day, all feeding within a one hour time span
   b. Twice per day
   c. High feed flow rate
   d. Small, frequent feed, near continuous feed rate

5. What statement is most true about anaerobic digester mixing?
   a. Need to bring food (VS) into contact with bacteria
   b. Provide infrequent mixing
   c. If the mixing system isn't working, increase feed rate
   d. Proper mixing is not that important to efficient digester operation

6. What is a typical operating range for volatile acids in a moderately loaded anaerobic digester that is only treating primary and waste activated sludge?
   a. 750 to 1,000 mg/L
   b. 25 to 75 mg/L
   c. 500 to 750 mg/L
   d. 50 to 300 mg/L

7. What is the daily recommended maximum temperature change that should occur in an anaerobic digester?
   a. 0.1 degrees F
   b. 0.3 degrees F
   c. 1.0 degrees F
   d. 3.0 degrees F

8. Which one of the following will change first if you have an upset of your anaerobic digester?
   a. Alkalinity
   b. Methane production
   c. pH
   d. Volatile acids

9. What is the purpose of a vacuum relief valve on your anaerobic digester?
   a. To add air to the digester
   b. To remove excess air
   c. To decrease the pressure
   d. To prevent liquid from leaving the digester

10. Your digester has a liquid level of 30 feet. What is the pressure at the bottom most point of the digester in pounds per square inch (psi)?
    a. 3.0 psi
    b. 13.0 psi
    c. 22.0 psi
    d. 69.0 psi

11. An anaerobic digester has a diameter of 60 feet and a sludge depth of 20 feet. Calculate the volatile solids loading if 9,500 pounds of sludge with a 70 percent volatility are pumped to the tank daily?
    a. 0.12 lbs/day/cu ft
    b. 0.17 lbs/day/cu ft
    c. 0.31 lbs/day/cu ft
    d. 0.38 lbs/day/cu ft

12. Listed below are the sludge lab results. The primary and secondary sludges are pumped to the thickener: Primary sludge – 7% solids at 69% volatile; Secondary sludge – 1.5% solids at 75% volatile; Thickened sludge – 4% solids at 72% volatile; and Digested sludge effluent – 3.0% solids with 63% volatile. Calculate the volatile solids reduction through the digestion process.
    a. 12%
    b. 18%
    c. 34%
    d. 38%

Answers on page 61.

For those who have questions concerning operator certification requirements and scheduling, please contact Tanya May Jennings at 315-422-7811 ext. 4, tmj@nywea.org, or visit www.nywea.org/OpCert.

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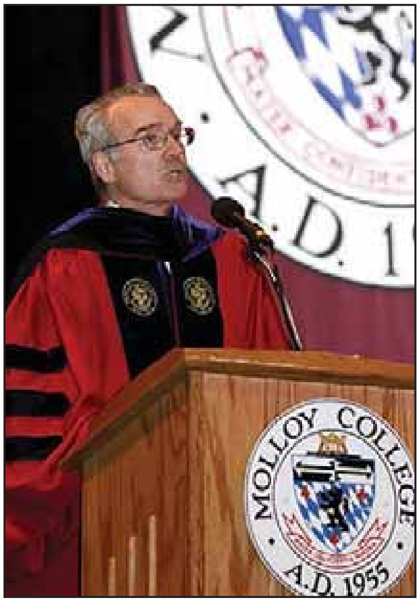
NYWEA Members in Action

John Cameron College Commencement Speaker

John D. Cameron, Jr., PE, was the speaker at the Molloy College 2014 Commencement Ceremony held at the Nassau Veterans Memorial Coliseum before a crowd of over 5,000. Cameron was also conferred with an honorary Doctor of Laws degree during the ceremony. Chairman of the Long Island Regional Planning Council, Cameron told students the world is a competitive place – hard work and perseverance will be key.



John Cameron speaking at Molloy College graduation

"Be a beacon of light in a world that too often appears dark. It will not be easy; it will often be unpopular. But it will be right."

A past NYWEA president, Cameron is very involved in his profession, community and church and has received many career recognitions, including being inducted in the NYWEA Hall of Fame. He is the founder and managing partner of Cameron Engineering & Associates, LLP. With offices in Woodbury, NY, White Plains and New York City, the multi-disciplined consulting planning and engineering firm serves government and the private sector in the New York metropolitan area and beyond.

A Lake in Need

For **Aimee Clinkhammer**, a new New England Interstate Water Pollution Control Commission (NEIWPCC) environmental analyst, the task of cleaning up Onondaga Lake is a challenge she has fully embraced. Since joining the NEIWPCC team in August 2013 as Onondaga Lake watershed coordinator, Clinkhammer has worked with community groups, businesses, and local government agencies in a unified effort to accelerate the progress made in restoring this Central New York lake with a long toxic history.

For centuries, Onondaga Lake has been considered sacred by the Onondagas and other Native American tribes, but industrialization severely tarnished its waters. In recent years, water quality has improved, thanks to the combined efforts of key stakeholders as well as the unique collaboration between federal, state, and local entities including the Onondaga Nation under the Onondaga Lake Watershed Partnership (OWLP).

Clinkhammer is now building on that hard work. Based out of NYSDEC's Region 7 office, she is helping to develop a shared


Photo courtesy of NEIWPCC

NEIWPCC's Aimee Clinkhammer on the shores of Onondaga Lake, the focus of her restoration efforts. Far in the background is one of the hydraulic dredges being used to remove contaminated sediments from the lake bottom.

community vision for the restoration of the lake's watershed and its physical, chemical, and biological integrity. Her initial efforts have focused on assisting with the development of a principles document and planning community events that inform the public about the restoration process and the history of the lake. And momentum is building. Case in point: experts from EPA, NYSDEC, the New York State Attorney General's Office, Onondaga County, City of Syracuse, Onondaga Nation, and the US Geological Survey are convening a panel to develop a strategy to reduce sediment loading, with a particular focus on managing the proliferation of sediment-producing mudboils in Onondaga County's Tully Valley. Clinkhammer's many other activities have included developing a communications plan for the OLWP that has already resulted in her launch of a website (www.olwp.org) and a communications group to assist with OWLP outreach activities. It's all a lot of work done in a short bit of time, but then, there's a lot at stake. Onondaga Lake means a great deal to a great many people. It's only right that we do all we can to make it beautiful again.

– Aimee Clinkhammer is a member of the NYWEA Central Chapter Board of Directors

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Monitoring the Gains

The national goals of the Clean Water Act are to achieve, wherever attainable, water quality that provides for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water. Considerable progress has been made to achieve these goals in water bodies in and around New York City, but one problem that remains is combined sewer overflows – that is, discharges of untreated sewage that occur when a sewage system that carries

NYWEA Members in Action, *continued*

both wastewater and stormwater is overwhelmed by flow. While CSOs have impacted many of the city's waters, such as Flushing Bay, Bronx River, Hutchinson River, and Newtown Creek, the good news is something's being done about it. Actually, a lot of things.

To date, New York City has implemented numerous projects to reduce CSOs, including construction of overflow storage tanks at Paerdegat Basin, Flushing Creek, Spring Creek and Alley Creek. The projects are being implemented under the auspices of a CSO consent order between New York City and New York State, and it's the job of two NEIWPCC staff members based in New York – Linda Allen and Paul Kenline – to monitor efforts to comply with the consent order. Over the past five years, Allen and Kenline have seen tangible improvements in water quality directly related to consent order-driven projects.

In addition to the CSO abatement, New York City is working to reduce nitrogen discharges to large open water bodies – discharges that can cause algae blooms and hypoxic conditions. Under a consent judgment with New York State, the city is upgrading wastewater treatment plants to implement biological nutrient removal technology to reduce nitrogen loadings to Long Island Sound and Jamaica Bay. The progress on these upgrades and compliance with the consent judgment is monitored by **Lindsey Walaski**, a NEIWPCC staff member based in Albany. Walaski reports that the city has completed the first phase of the work, and in 2013, finished a major upgrade at the Wards Island WWTP. The result: a significant reduction in nitrogen loadings.


Photo courtesy of NEIWPCC

NEIWPCC's independent environmental monitors (l-r), Paul Kenline, Lindsey Walaski and Linda Allen

– Lindsey Walaski is a member of the NYWEA Capital Chapter and coordinates the chapter's Young Professionals activities. She left NEIWPCC at the end of June to enter a master's program in sustainable engineering at Villanova University.

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***Clear Waters* Note:** Make sure to read the Fall edition of *Clear Waters* focused on Nutrient Removal with a planned article on upgrades made to the NYCDEP Wards Island WWTP.


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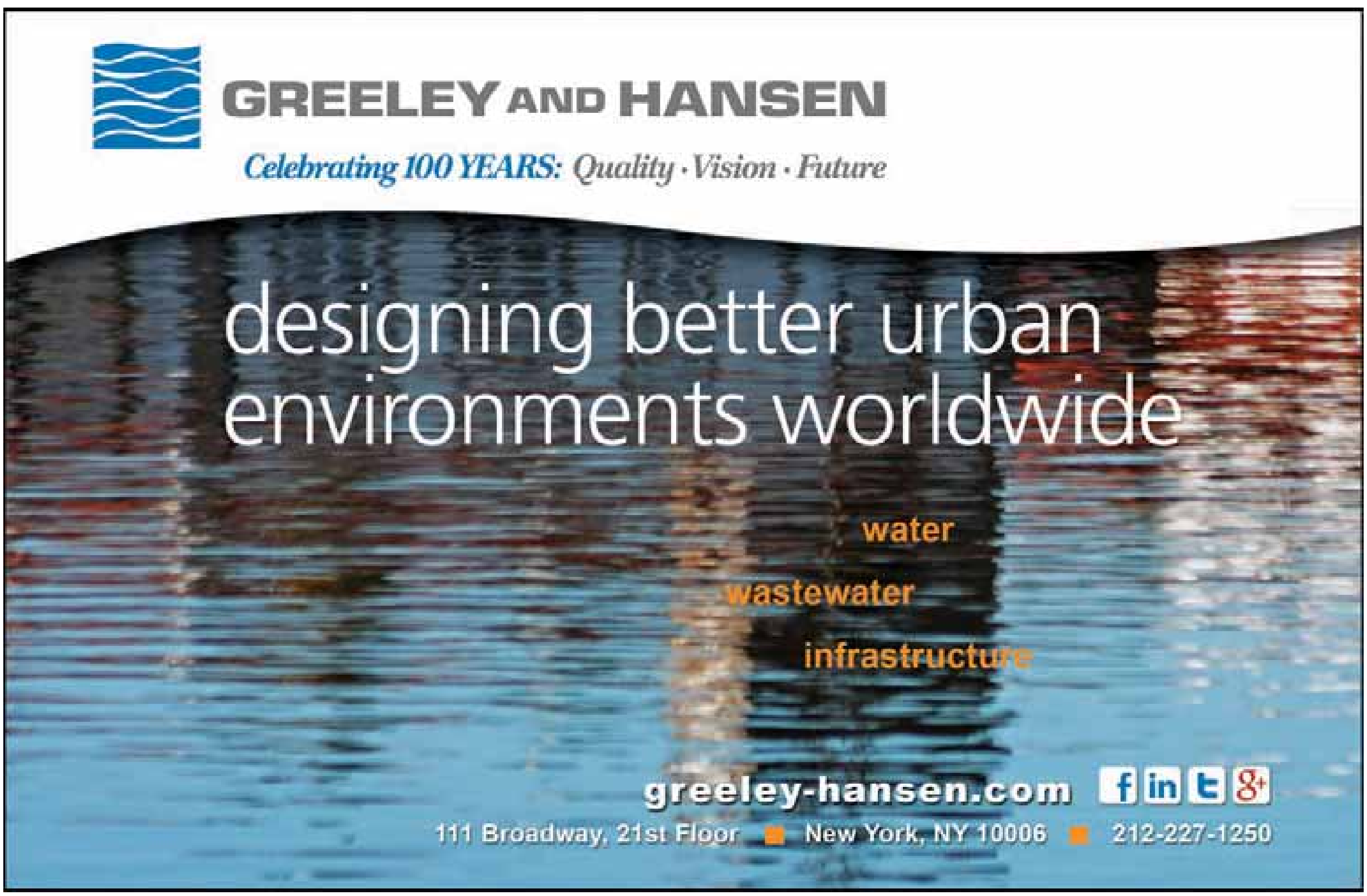
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Answers from page 55: 1C, 2B, 3A, 4D, 5A, 6D, 7C, 8D, 9A, 10B, 11A, 12C

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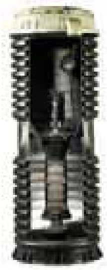

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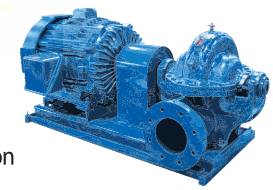

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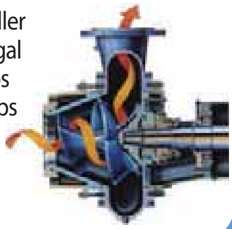

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