Appendix 5

BioMicrobics BioBarrier® Submission

Westport Noquochoke Village – Westport, MA

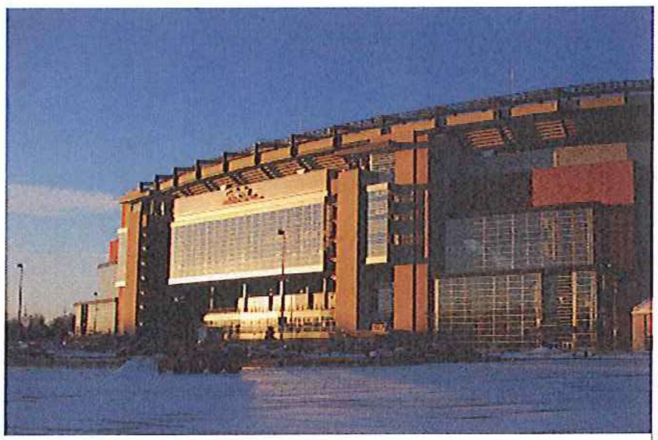
In Appendix 5 please find MBR Treatment System case studies and operational data. You will note that the MBR Technology is used for a variety of applications; and is, in many cases, the best option for an onsite treatment solution.

CASE STUDY: GILLETTE STADIUM

SYSTEM DESCRIPTION

Location: Foxborough, Massachusetts (latitude: 42° 05′ 07.72″ N; longitude: 71° 16′ 16.34″ W)

Collection: A gravity collection system brings all wastewater to several low points on the properties where pump stations transfer sewage to the treatment plant, which is located behind the stadium in a separate utility building.



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Treatment: Wastewater equalization tanks buffer wide variations in flow because of scheduled stadium events, which can change the population served by the system by more than 75,000 on a given day. The treatment plant is a membrane bioreactor that uses the Modified Ludzack-Ettinger (MLE) biological anoxic-aerobic process and ozone and ultrafiltration for polishing and disinfection. A 1900 m^3 (600, 000 gal) ground-level tank and an elevated 1900 m^3 (500, 000 gal) water storage tank provide water distribution pressure control and help mitigate the wide fluctuations in daily flow.

Product disposition: Nonpotable water is supplied to the toilet facilities for use as flush water. As flush water demand increases because of increasing use, there is an increase in wastewater flow. While processing this flow over varying flow conditions, the system first satisfies the demand for nonpotable reuse water. As the nonpotable water demand is fulfilled, excess water is recharged to groundwater via subsurface infiltration chambers located beneath the parking lots. Residuals are hauled for offsite disposal as a liquid sludge.

Flowrate: 4900 m^3/d (1.3 mgd) peak flow; design includes a 3800 m^3 (1 million gal) equalization tank to buffer wide flow variations because of stadium events.

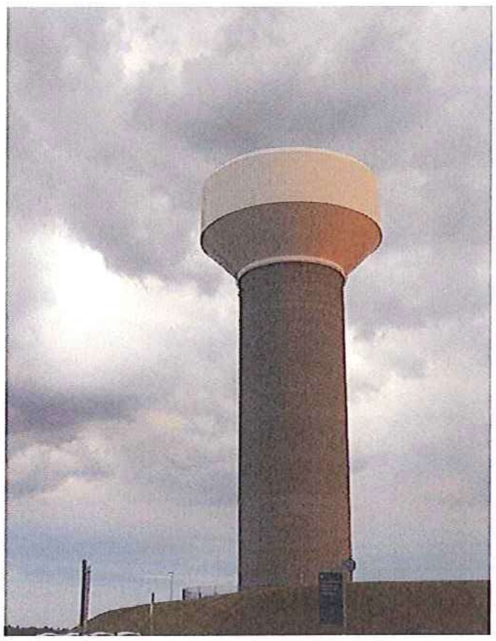
Service area: Commercial community that consists of a 68,000-seat NFL Stadium and surrounding commercial properties that consist of outlet stores, hotel, restaurants, movie theatres, and other retail.

Case study type: Development-scale cluster reuse system for commercial redevelopment and NFL stadium.

Management type: Private, with long-term O&M contract

DESCRIPTION

Gillette Stadium, located in Foxborough, Massachusetts, and the surrounding commercial development is served by a water reuse system that provides treatment of all wastewater that is produced from within its service area. The system currently has a capacity of 4900 m^3/d (1.3 mgd) peak flow and includes 3800 m^3 (1 million gal) of equalization tanks to buffer wide flow variations during stadium events. All wastewater is treated to Massachusetts' direct water reuse standards and the treated water is currently used for toilet flushing. Excess treated water is recharged to the groundwater via subsurface recharge fields located beneath the parking lots. Treated water is stored in an elevated water tank that provides storage and pressure control for the nonpotable water distribution system.



Elevated 1900 m3 (500 000 gal) water storage tank for reclaimed water at Gillette Stadium.

The wastewater treatment system consists of a membrane bioreactor with denitrification and UV disinfection. Given the commercial nature of the properties served, the water reuse system supplies approximately 75% of the total water used with the balance provided via a publicly owned potable well. The wastewater system is completely independent of any regional wastewater management infrastructure and serves as a standalone decentralized utility. The water supply is owned by the municipality and is derived from a confined aquifer with limited capacity.

The project was intended to both replace existing non-performing infrastructure and to allow for expansion to serve new economic development in the area. Wastewater at the old stadium was managed via an extended aeration plant with discharge to surface water. The property existed as an older stadium, which was demolished and rebuilt along with other commercial support services. The town of Foxborough allowed the service area to include the stadium property plus some adjoining properties along Route 1, which were zoned for commercial development. The town controls the service area, which is limited by available expansion area for the water reuse plant and at the time, the Town of Foxborough's willingness to allow the expansion.

PROJECT GOALS

The overarching system objective was to provide water and wastewater infrastructure to allow reconstruction and expansion of the stadium, while providing for economic growth in the area.

TIMELINE

Project planning, design, and permitting were conducted over a period of 18 months that ended in 1999 when construction broke ground. The facility was completed and became operational in 2000 and has operated since that time. Cooperation of the Massachusetts Department of Environmental Protection was instrumental in moving the permit process along, and a design-build-operate contracting method was used to expedite the project delivery schedule and manage costs.

DECISION MAKING

The most important factors in selecting a decentralized approach for Gillette Stadium were the inability to extend the regional infrastructure, the limited water resources, and the lack of public support at that time for a centralized system to serve a wider area of the town.

Residential development in this area is well-served by onsite septic systems and there was no public mandate for a centralized wastewater system. In addition, the centralized water supply is sourced from a limited capacity confined aquifer, thereby placing another constraint on development and economic growth. Ultimately, water reuse was the only way to viably provide the required water resource services.

Because of the high quality designation of potential receiving waters, which would have limited the potential to discharge treated wastewater effluent, water reuse and groundwater recharge were considered at a relatively early stage in the development planning and were adopted once feasibility analysis proved the site's viability. The water reuse approach was able to solve both the water supply and wastewater discharge limitations by reducing the water supply and wastewater discharge demands by 75%, making a groundwater recharge system viable. In addition to recharging the water supply aquifer, this system provides benefits associated with supplementing base flow to the local streams, supporting the natural water cycle within the service area.

Given the extensive economic investment in the stadium and surrounding commercial development and the environmentally sensitive nature of the area, the absolute highest quality performance was necessary. There was zero tolerance for any system performance failure due to the resulting loss of millions of dollars in revenue should use of the facilities be interrupted for any reason. Accordingly, membrane bioreactor technology was selected as a means of assuring high quality nonpotable water even under conditions where the flow quantity and strength would be highly variable.

The MBR technology was preferred because it provided the confidence necessary to assure safe and successful performance. The developer made the final decision about the technology to be used based on the recommendation of the design engineer, Applied Water Management, Inc. The decision to use a water reuse system with groundwater recharge backup was supported by an engineering feasibility analysis and data from the nearby Wrentham Factory Outlet Mall facility, which had been operating for several years with a similar system in place. Overall cost was an important factor, and the MBR water reuse approach emerged as the lowest cost approach that yielded the best outcome by allowing economic development while protecting delicate water resources.

Other alternatives were originally considered, including extension of regional water and wastewater lines from the Massachusetts Water Resource Authority (MWRA). This extension, however, was not desirable because it would have resulted in more sprawling development in rural areas. It also would have been very expensive and complex, involving eight different towns and multiple approvals. Construction of a Sequencing Batch Reactor (SBR) system to serve the town was also considered, but rejected, in the analysis of alternatives. Although these alternatives were politically untenable, most political forces desired to have the stadium and team remain at this location and the Town of Foxborough desired the economic growth along the Rt. 1 corridor. There was overall widespread support for the project if the negative impacts could be avoided.

Final infrastructure decisions were made by the developers of the Gillette Stadium property together with the municipal officials of the Town of Foxborough. However, the project went through a public review for land development which involved actions by the Foxborough Board of Water and Sewer, the Planning Board and Board of Selectmen. Public hearings were conducted on the proposed development and on the water reuse system service area. The Town of Foxborough is governed by the traditional Open Town Meeting form of government that is typical for New England and tends to provide direct public input to key decisions. A Town Meeting vote was held to approve this project which included some broader municipal improvements including the construction of elevated water supply tanks. Economic growth was important to the town and the vote passed.

The Massachusetts Department of Environmental Protection administers the Pollution Discharge Elimination Permitting program and the Massachusetts Office of Energy and Environmental Affairs administers the Massachusetts Environmental Policy Act (MEPA), which is the process for environmental assessment and review for new developments. Both the MADEP permits and the MEPA review process were favorable to the project and supported the water reuse concept.

CHALLENGES

This project serves as a good example of how innovative solutions can move ahead when all parties work together in identifying constraints and concerns and to work out appropriate mitigating measures.

Strong cooperation from the regulatory agencies involved allowed the system to readily be constructed as envisioned. However, subsequently, MADEP developed water reuse standards to provide clear guidelines for future water reuse infrastructure. It was also important to have the cooperation of the regulatory authorities who allowed performance standards implemented at an earlier and smaller facility (Wrentham Outlet Mall) to apply to a much larger and more significant project.

FINANCING

The project was funded by the developer and the town. Through public finance bonds, the town provided funding for portions of the system that provided direct benefits beyond Gillette Stadium. The town's portion included a new potable water storage tank and other associated appurtenances. The Kraft Group, developers of the stadium, privately financed the water reuse plant and associated distribution piping and recharge fields.

Other funding alternatives were not considered because the project was complex and had to be approved in a timely manner. Other sources of funding were not readily available and would have possibly caused delays.

In many senses, the overall project was a public-private partnership where the developer and municipality worked cooperatively with regards to funding aspects of the project, but the developer provided the bulk of the financing and all of the project design and construction management.

MANAGEMENT

The treatment facility and water reuse pipingis owned by the developerwhile the Town owns the water reuse tank and all water supply infrastructure. Operating and management risks were shared with the designer-builder, Applied Water Management, under a 20-year performance contract. The town owns the potable water system. Applied Water Management provided the feasibility analysis, design, and construction and operates the system. Operating and maintenance costs are covered under a 20-year operating agreement.

The Town of Foxborough preferred that the developer take responsibility for system construction and operation, but reserved capacity in the system for expansion as other commercial development occurs. The initial system was constructed for the stadium only and had an average flow capacity of 946 m^3/d (250,000 gpd). Subsequently, the system has been expanded to the current 4900 m^3/d (1.3 mgd) capacity to serve additional commercial development by adding treatment trains as planned in the design.

All operating costs are paid for by the stadium complex owners who assess property tenants accordingly. Applied Water Management is fully responsible for the system operation.

PERMITS

The system was permitted through the MADEP under the State Pollution Discharge Elimination System program. It is administered and enforced by the MADEP, which requires monthly monitoring, and the completion of Discharge Monitoring Reports.

Permitting the complete system required integration of groundwater discharge permits together with water reuse requirements. Water reuse provisions were not formally defined at the time of this project, but precedent had been established through the implementation of several previous water reuse projects. Overall support for the project helped the regulators feel comfortable moving forward with the required permits. Subsequent adoption of statewide water reuse standards should facilitate the implementation of future decentralized water reuse projects in Massachusetts.

PERFORMANCE

The project is in compliance with all permits and is meeting water quality objectives. The system has produced reclaimed water of the quality required, and the stadium and surrounding commercial development have been successful in providing a solid economic base for the Town of Foxborough.

LINKS

www.amwater.com/products-and-services/about-us/applied-water-management-group.html

www.thekraftgroup.com/environment/#gilletteStadium

Better Water. Better World.

FOR IMMEDIATE RELEASE

CASE STUDY

Title: Onsite Residential Membrane Systems, *Possible?*

Homeowners test the latest advancements for their wastewater treatment

BioBarrier® System installed by Alternative Wastewater Systems, LLC. in Idaho.

Situation

Since early 2001, Alternative Wastewater Systems (AWS) of Idaho has distributed Bio-Microbics products. Very familiar with the MicroFAST® and other FAST® systems, they wanted to try out the new BioBarrier® Membrane Bioreactor (MBR) unit, also from Bio-Microbics.

Ryan Spiers of Spiers Construction identified a family needing a MicroFAST® 0.5 and asked them if they would be willing to upgrade at no additional cost to a BioBarrier® MBR system. With all of the benefits that this system promises, they agreed.

Solution

First of its kind in Idaho, to evaluate membrane treatment for the single family home, the NSF®/ANSI STD 40/245 certified system was installed and has been tested every other month to show the effluent being treated to direct discharge characteristics, i.e. effluent quality of BOD <2 mg/L, TSS <2, Ammonia <1 and reduces Fecal Coliform and E. Coli to less than 10 cfu.

With these advanced, biological nutrient removal capabilities, the BioBarrier® is engineered in a small footprint and immersed directly in the aeration process in the tank. Utilizing flat sheet membranes for a versatile design and robust process, the BioBarrier® has a high surface area of membrane material in a double plate configuration. The membranes and processes used in this advanced system act as a physical barrier for nearly all common pollutants found in wastewater. The treated water moves through the pores to the space between the films. A pump then extracts the clean water to discharge in to the environment. Using a completely automated control strategy, the unique operation sequence of the BioBarrier® system requires no complicated backwash.

BioBarrier® drops down into tank with floats and air tube (one unit per 500 GPD).

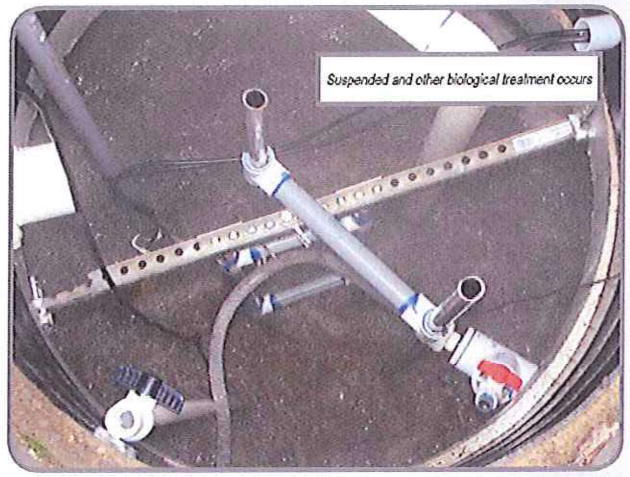
8450 Cole Pkwy, Shawnee, KS 66227 • 1.800.753.FAST (3278) • ph 913.422.0707 • sales@biomicrobics.com • www.biomicrobics.com

Results

The BioBarrier® MBR system, which received the 2009 Technology Award presented by the Environmental Business Journal (EBJ), provides new opportunities for wastewater recycling. After more than 8 months in operation, the test results have proven the system is capable for direct discharge.

"I really am amazed at what this little unit does, California standards on what class A effluent is can be easily attained by this unit all by itself. We've been testing the coliforms and I believe there is no need for further disinfection. The effluent is at acceptable levels for direct discharge to any where you would want to put it," says Mr. Spiers.

The BioBarrier® MBRs and HSMBR® systems are one of first MBR systems specifically designed for the onsite market. More than ever, onsite professionals and end users choose Bio-Microbics for their wastewater treatment requirements to help conserve natural resources, protect ground and surface waters, and overcome land constraints.


Suspended and other biological treatment occurs


Small footprint and landscape friendly design.

About Bio-Microbics, Inc.

With a worldwide emphasis on environmental concerns and improving water quality, Bio-Microbics manufactures proven wastewater and storm water treatment systems for decentralized communities and commercial properties. Ideal for concrete, fiberglass, steel, or plastic tanks, the simple, pre-engineered, modular design of our FAST® [including the popular MicroFAST®] wastewater treatment systems deliver consistent high performance. Successfully used for over 35 years in municipal, industrial, marine, commercial and residential properties located around the globe, the advanced FAST® (Fixed Activated Sludge Treatment) technology is easy to install and maintain. Our advanced wastewater and stormwater treatment products help treat the world's water better.

Bio-Microbics...Better Water. Better World.®

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Design Considerations for the Complex Waste Streams of Wineries

WINERY WASTEWATER TREATMENT | By Sheldon Sapoznik, REHS

Complexity is a term often used in tasting rooms to describe a fine wine, although little thought and understanding is given to the complexity of treating winery wastewater. It is vital to understand not only the nature of winery wastewater, but the by-products produced during the wine making process, such as juice acidity, lees, and cleaning agents that dictate the various constituents and concentrations encountered. Beyond the romanticized season of harvest and the demands created by crush, other activities that generate wastewater throughout the year include barrel washing, fermentation tank washing, and equipment cleaning from racking and bottling operations.

Unlike residential wastewater, winery wastewater usually does not contain pathogenic bacteria in the waste stream; however, Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) are found in significantly higher concentrations. In fact, BOD and TSS concentrations can be forty times as high as household wastewater with 12,000 mg/L BOD and 6,000 mg/L TSS typical during harvest activities. At other times of the year, the various winemaking activities create fluctuating flows, which create system over-capacity concerns. The need for versatility in design and operation is key in selecting a winery wastewater treatment system.

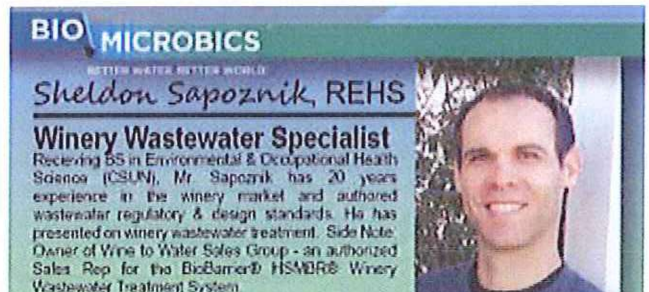
There are several factors to consider in all winery wastewater treatment system projects. Determining the actual wastewater flows during crush (the highest wastewater generating operation at a winery) can be challenging. These flows are based on industry experience, regulatory agency calculations, as well as input and data from the winery itself. Misjudging the maximum design flow and pollutant concentrations can be devastating to a winery treatment system. However, oversizing a system can equally create functional problems and add unnecessary cost. A winery wastewater treatment system should have the flexibility to handle the high and low flows and loads. Most successful winery wastewater treatment systems include proper primary screening, a robust active aeration system followed by a clarifier, or membrane barrier to separate the treated effluent from the biological process. Additional key considerations include proper sizing and material selection of the treatment tanks to provide required biological retention time, surge capacity and sludge storage capability.

The Bio-Microbics BioBarrier® HSMBR® winery wastewater treatment system takes the complexity out of treating winery wastewater with its simple, award-winning design and fully certified treatment process.

Utilizing superior aeration capabilities in conjunction with durable flat sheet membrane technology, the modular and scalable design provides flexibility to wineries, ensuring optimum treatment throughout the year and lower operating costs. These proprietary units assure all effluent passes through the membrane making it virtually impossible to bypass the treatment process along with providing microfiltration and ultrafiltration resulting in consistent high quality effluent ready for water reuse.

Introduced to the Northern California wine region of Napa/Sonoma County in 2013, the BioBarrier HSMBR winery wastewater treatment system's recent installations have generated tremendous optimism and interest due to its treatment capabilities, ease of installation, and low operating costs. As the Pacific Northwest Wine Region continues to address winery wastewater concerns, the BioBarrier HSMBR system will surely be a solution to provide vital water reuse opportunities such as quality irrigation water for vineyards, recycled water for dust control, processing area wash-down water, or just highly treated effluent for disposal where untreated or poorly treated winery wastewater threatens vital habitats or groundwater resources.

Author Bio: Sheldon Sapoznik, REHS is the Owner of Wine to Water Sales Group. With his 20 years' experience in winery wastewater treatment as a Registered Environmental Health Specialist for Napa County, California, Mr. Sapoznik left the public section to help promote and expand the use of Membrane BioReactor technology for winery wastewater filtration.



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WASTEWATER TREATMENT SYSTEM

Southborough, Massachusetts

Client **Fay School**

Description

The Fay School is a private day and boarding school for elementary and middle school students in Southborough, Massachusetts. Construction of a 26,500 gallon per day membrane bioreactor wastewater treatment facility was completed in 2009. A portion of the treated effluent is reused for toilet flushing in five new dormitory facilities and a new maintenance building. Wastewater is treated by fine screens, a membrane bioreactor and ultraviolet disinfection. As a school facility, The Fay School experiences significant fluctuations in wastewater flow rate over the course of a day and throughout the year. Careful planning was required to ensure that adequate pre-treatment and post-treatment storage capacity was provided and that the treatment capabilities of the equipment would be able to handle such fluctuations.

Tighe & Bond designed the treatment facility and assisted the School with the permit application process, which included working closely with the Massachusetts Department of Environmental Protection on the water reuse system permitting, effluent testing and quality requirements. This project was part of a campus expansion that included LEED certification of buildings and use of "green" technologies and construction practices.

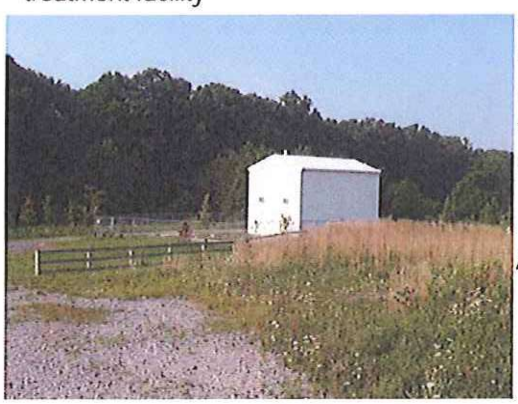
Environmental Operating Solutions

MicroC™ Performance Example

Brass Castle Estates

Satellite image of property

Typical home served by wastewater treatment facility



Wastewater treatment plant building

Facility Name: Brass Castle Estates

Facility Location: Pittstown, New Jersey

Facility Description: Subdivision of residential properties

Flow: Average flow* = 12,963 GPD. Design flow = 22,000 GPD

Denitrification technology: Zenon Zeeweed® 500 Membrane Bioreactor (MBR) with anoxic compartment for denitrification

Previous carbon source: Sucrose solution**

Date MicroC™ started: December 11, 2004

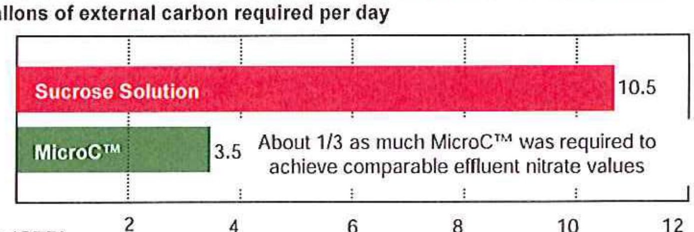
Operations & Maintenance firm: Applied Water Management
Operator – Roger Parr

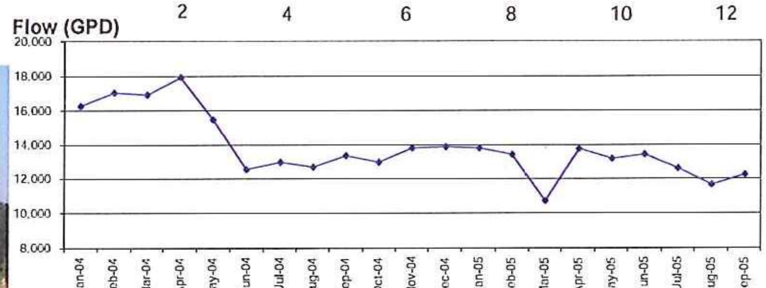
Discharge permit : NJ DEP Permit Number NJ0068829

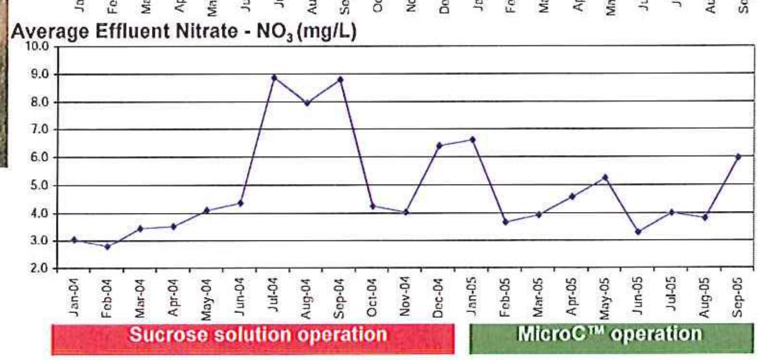
Permit limits : Flow – 22,000 GPD, pH - report
Total Nitrogen – 10mg/L, Volatile Organics – report
Fecal Coliform – 200 col/100ml

MicroC™ performance narrative: Plant switched from sucrose solution to MicroC™ in December of 2004 and demonstrated consistent performance in terms of nitrate removal vs. prior carbon source. About one third of the volume of MicroC™ was required to achieve comparable effluent nitrate concentrations.

Gallons of external carbon required per day







* Average GPD from Oct. '04 to Sept. '05

** Mixture of four pounds of table sugar per gallon of water

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MicroC™ Performance Example (continued)

Brass Castle Estates

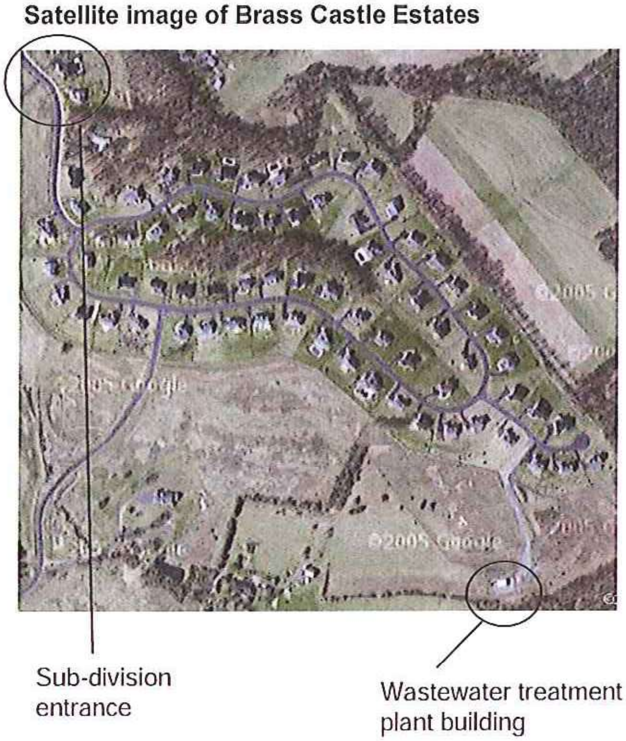
Brass Castle Estates

	Flow GPD	Carbon Source	Carbon GPD	Avg. Effluent NO3 (mg/L)	Avg. Effluent NH4 (mg/L)	Max. Effluent NO3+NH4 (mg/L)
Jan-04	16,285	Sucrose	10.2	3.0	0.1	3.3
Feb-04	17,042	Sucrose	10.9	2.8	0.1	3.6
Mar-04	16,933	Sucrose	10.2	3.4	0.1	3.2
Apr-04	17,934	Sucrose	10.1	3.5	0.2	4.3
May-04	15,506	Sucrose	9.5	4.1	0.2	6.7
Jun-04	12,578	Sucrose	6.0	4.3	0.2	6.9
Jul-04	12,961	Sucrose	5.3	8.9	0.2	9.0
Aug-04	12,702	Sucrose	3.9	7.9	0.3	0.7
Sep-04	13,363	Sucrose	4.3	8.8	0.3	7.8
Oct-04	12,973	Sucrose	9.6	4.2	0.2	2.0
Nov-04	13,823	Sucrose	10.4	4.0	0.3	6.9
Dec-04	13,887	Transition	3.5	6.4	0.3	5.3
Jan-05	13,791	MicroC™	3.5	6.6	0.3	3.4
Feb-05	13,393	MicroC™	3.6	3.7	0.3	9.3
Mar-05	10,756	MicroC™	3.4	3.9	0.3	4.7
Apr-05	13,746	MicroC™	3.5	4.6	0.2	5.3
May-05	13,203	MicroC™	3.4	5.2	0.1	5.8
Jun-05	13,401	MicroC™	3.5	3.3	0.2	7.2
Jul-05	12,656	MicroC™	3.4	4.0	0.2	6.8
Aug-05	11,677	MicroC™	3.4	3.8	0.2	5.6
Sep-05	12,247	MicroC™	3.5	6.0	0.2	5.4

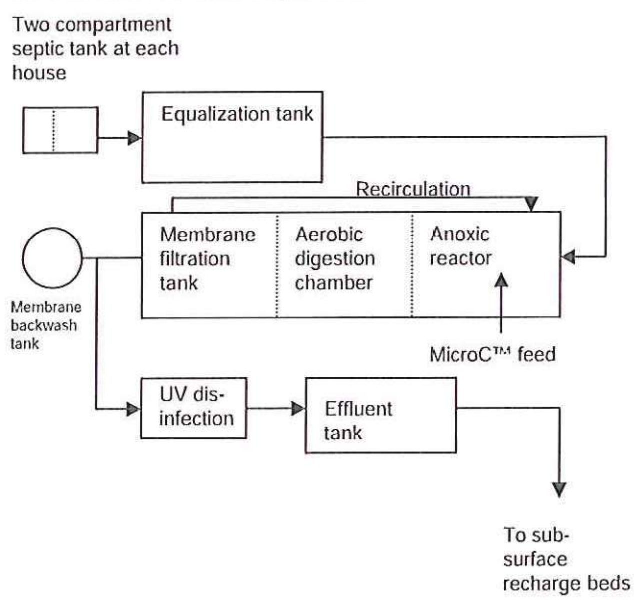
May-Sept. '04 Sucrose usage low due to air-bound pump/sucrose fermentation. PHS* used, but usage data not available.

Source data from New Jersey Department of Environmental Protection DMR data and Applied Water Management.
* PHS is a peat humic substance made from highly humified peat

Satellite image of Brass Castle Estates



Wastewater treatment process schematic



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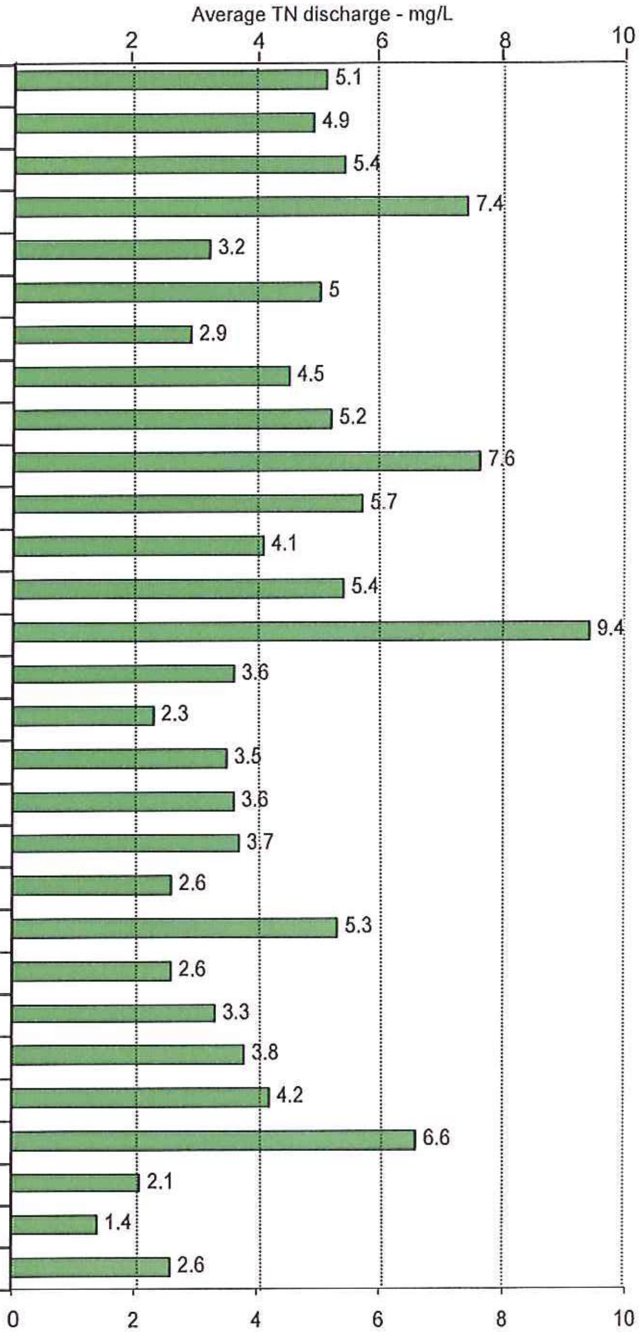
Environmental Operating Solutions

MicroC™ and MicroC G™ Case Study

New Jersey Decentralized MicroC™/MicroC G™ Performance History

MicroC™ and MicroC G™ have been used extensively in the New Jersey decentralized wastewater treatment market since 2004. The figure below provides information for several plants on average Total Nitrogen (TN) and flow through August 2007 obtained from the NJPDES online database. The "months" column refers to the number of months that the plant has been using EOS products. MicroC™ and MicroC G™ are ideal carbon sources for decentralized facilities due to safety, handling and cost concerns. Plants are able to achieve their TN goals with EOS products.

Plant ID	Technology	Months	Average Flow - GPD
Small Municipality A	SBR	30	16,860
School A	MBR	26	54
School B	MBR	26	1,307
School C	MBR	29	4,327
School D	MBR	29	1,221
School E	Wetlands	29	528
Housing Development A	MBR	27	33,539
Housing Development B	MBR	32	11,005
Housing Development C	MBR	27	1,197
Housing Development D	Sand Filter	32	50,469
Housing Development E	MBR	29	4,932
Housing Development F	MBR	29	5,952
Housing Development G	Aquionics	30	13,962
Housing Development H	Aquionics	31	1,967
Housing Development I	MBR	17	7,195
Golf Course A	MBR	26	11,579
Golf Course B	MBR	5	380
Golf Course C	MBR	29	510
Sports/Recreation Complex A	MBR	29	497
Sports/Recreation Complex B	MBR	29	1,815
Sports/Recreation Complex C	MBR	26	768
Sports/Recreation Complex D	MBR	29	341
Office Building A	MBR	26	20,403
Office Building B	MBR	27	47,545
Office Building C	MBR	29	19,662
Office Building D	MBR	29	Reuse
Office Building E	MBR	26	1,330
Shopping Complex A	SBR	29	2,144
Shopping Complex B	MBR	29	2,855



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