The WaterHub at Emory University
GENERAL FAQ

What is the WaterHub?

The WaterHub is an on-site water recycling system which utilizes ecological engineering processes to clean wastewater for future non-potable uses. It is the first system of its kind to be installed in the United States. The name 'WaterHub' is reflective of the system's role as the center of sustainable water management in a given campus or community.

Emory's WaterHub is a customized system which was designed to supply nearly 40% of Emory's total campus water needs. Capable of recycling up to 400,000 gallons-per-day, wastewater circulated through the WaterHub is cleaned and used as process make-up water in Emory's steam and chiller plants and for future toilet flushing in select residence halls. The system will reduce Emory's draw of drinking quality water from Atlanta's municipal water supply by up to 146 million gallons of water annually, thus leaving more water for the community. The WaterHub includes a 50,000 gallon underground storage tank. This reserve will allow Emory's heating and cooling systems to function for an average of seven hours, depending on seasonal operating demands, in the event of any disruption in water availability.

The WaterHub was made possible by an innovative water purchase agreement between Emory University and Sustainable Water, a water reclamation technology provider. The WaterHub creates lower cost water at a long-term stable rate and is expected to save millions of dollars in water utility costs to Emory over a 20 year period. The WaterHub aligns with the University's vision for a sustainable campus and reduces the overall water demand on one of the smallest municipal watersheds in the United States.

How does the WaterHub at Emory turn wastewater into cleanwater?

The WaterHub treats wastewater (blackwater, greywater and stormwater) through biomimicry technology. Harnessing the power of biological processes found in nature, the WaterHub intensively grows beneficial bacteria and microorganisms in natural ecosystems. The ecosystems treat large quantities of water in small spaces within short periods of time.

The WaterHub uses both hydroponic technology (which contains plants and specially engineered submerged fixed film textile media) and reciprocating wetland technology (fill and drain wetlands which mimic the ebb and flow of tidal marshes) to develop large colonies of hungry microorganisms. The microorganisms consume the nutrients in the wastewater and ultimately convert it to high-quality reclaimed water. The water meets the State of Georgia as well as Emory's specific quality standards and is used as process make-up water in Emory's three central chiller plants and in the campus steam plant. Future use for reclaimed water will include toilet flushing at select residence halls.

Wastewater is first sourced from an on-campus sewer pipe and then pumped into the greenhouse portion of the WaterHub. The aesthetically pleasing, compact greenhouse contains a series of interconnected, sequentially operated, cascading hydroponic biohabitats. Water is circulated through aerobic, anoxic and anaerobic chambers which contain specially engineered free moving plastic pellets or engineered fixed-in-place textile in addition to suspended plant roots. The pellets, textile and plant roots serve as a natural

habitat for 2,000-3,000 different microorganisms and form a unique ecosystem that breaks down waste. From the greenhouse, the water travels to the outdoor hydroponic treatment tanks (located south of Peavine Creek Drive) for further processing.

Additionally, on the South site, a demonstration treatment system uses an alternative ecological treatment technology. The Demonstration Reciprocating Wetland mimics the ebb and flow of tidal marshes and creates an alternate habitat for waste-eating microorganisms. The Reciprocating Wetland technology is well suited for rural areas and the developing world-- communities which have adequate land resources, seek an ultra-energy efficient process and simplified construction.

The Reciprocating Wetland unit was purposefully created at Emory as a research opportunity for The Center for Global Safe Water (CGSW) at Rollins School of Public Health. Data from the WaterHub will be used to estimate the human health risk associated with water reuse and will help determine if similar facilities can be effectively utilized in developing countries.

After biological treatment the wastewater is filtered and disinfected with Ultraviolet (UV) light. The biological processes remove all of the solids, nutrients, and color but disinfection and filtration is required to assure all pathogens are removed as well. After treatment and disinfection, a portion of the water is stored in the Reuse Tank while the remainder is distributed to select campus locations.

What kinds of microrganisms provide the treatment?

There are 2,000-3,000 different microorganisms including bacteria, protozoa, metazoa and microcrustaceans.

What kinds of plants are used?

Low-maintenance, hardy plants which produce long, dense root systems and thrive in wastewater are an integral part of the WaterHub's design.

In the greenhouse, lush tropical plantings are utilized including: Angel Trumpet, Ginger, Scarlet Rosemallow, Giant Calla Lilly, Native Water Canna, Longwood, Taro, Umbrella Palm, Mexican Papyrus and Elephant Ear, among others.

The outdoor treatment area features some of the same plants in the greenhouse and also includes: Mexican Petunia, Common Rush, Arrow Arum, Lords and Ladies, Duck Potato, Pickerel Weed, Mallow, Water Willow, Golden Club, Acanthus and Iris.

How are the plants selected?

Sustainable Water worked closely with Emory University to select a low-maintenance plant palette that perfectly suits the university's environment, aesthetic standards and educational needs while performing their critical role as habitat for the microorganisms that treat wastewater.

What function do the plants serve?

Dense root mass provides large surface area and habitat for waste-treating microorganisms to thrive. Plants are supported by fixed horizontal racks in both the indoor and outdoor treatment areas, and provide year-round aesthetic enhancement and student learning opportunities.

While plants do remove the basic plant nutrients of phosphorus (P) and nitrogen (N), the plant's contribution to P and N uptake is incidental. It is the plant roots which serve the primary processes in the WaterHub.

How is the WaterHub different from traditional wastewater treatment solutions?

The WaterHub minimizes the overall resources needed to treat wastewater in terms of energy, land and chemical use.

Unlike traditional systems which utilize enormous pumps to move water through progressive treatment areas, the WaterHub's ecological treatment processes contains simpler mechanical components and relies on gravity to move water from one level of treatment to another. Additionally, with its close proximity to the source of the wastewater, the WaterHub requires minimal energy to transport waste for processing. In contrast, centralized municipal treatment systems require miles of infrastructure and multiple pumping stations to move wastewater long distances for treatment and then for redistribution.

Ultra-efficient, and compact, the WaterHub is much smaller than municipal systems and require significantly less land. Designed to be aesthetically pleasing with lush plantings, no wastewater is exposed in the treatment process, creating an odor-free experience. The WaterHub's odor-free, natural aesthetic allows it to be located in densely populated urban areas. Traditional wastewater treatment systems are typically large open basins with exposed wastewater typically located on outlying, low-value land.

The WaterHub uses adaptive ecological approaches for wastewater treatment which mimic natural methods of water treatment found wetlands, tidal marshes and rivers. Traditional wastewater systems often rely on more mechanical and chemical approaches. Further, the WaterHub's ecological treatment system breaks down organic materials in water more completely than traditional activated sludge treatment systems.

Where is the WaterHub located on Emory's Campus?

The greenhouse structure is in Campus Services' Facilities parking lot. The Demonstration Reciprocating Wetland area is on a parcel behind Chappell Park.

Why is water reclamation and reuse important for the Atlanta region?

Metropolitan Atlanta has become emblematic of 21st century water issues, with its 20-year legal battle between Georgia, Florida and Alabama over its drinking water source (known as the "Tri-state Water Wars"), $4 billion consent decrees with EPA mandating improvements to Atlanta's over-burdened and aging sewer lines, continued problems with drought, low reservoir levels, lack of space for additional reservoirs, and small watershed area. Water reclamation and reuse will help minimize potable water consumption, reduce strain on sewer lines, reduce wastewater discharge, and demonstrate energy savings associated with decentralized reuse. Additionally, this project provides valuable cost savings and risk minimization by limiting exposure to drought.

Are there any foul odors associated with the WaterHub?

No. All treatment in the WaterHub is carried out below the surface. By design, every system mitigates odors by covering and sealing tanks with vapor barriers, aggregate and natural vegetation. This layering effect acts as a natural filter against odors originating from the tanks. In addition, special care is taken to seal all pipes and connections to ensure no odors are created from mining or pumping wastewater. To provide additional community confidence, an activated carbon filtration system was built into the system.

Is reclaimed water safe?

Yes. State health departments mandate strict water quality requirements for reclaimed water. The reclaimed water from the WaterHub will go directly into campus steam and chiller plants and in the future into select residence halls for toilet flushing. It will never be used for drinking or other potable uses.

How does the WaterHub alleviate water scarcity?

The WaterHub enables Emory to maintain current campus water usage levels yet use nearly 40% less drinking-quality water. By offsetting drinking-quality water with non-potable water in campus heating, cooling and toilet flushing functions, more drinking-quality water is available to a thirsty community.

How does the WaterHub help the environment?

The WaterHub, and water reclamation in general, is one of the most sustainable water management practices available. Every gallon reused is a gallon that is not withdrawn from aquifers or sensitive eco-systems. Every gallon reused is also a gallon of wastewater – potentially containing a variety of organic and inorganic pollutants – that is not discharged back to the environment.

By reducing load on municipal systems, water reclamation reduces the potential for over-capacity combined-sewer overflows. It also helps expand the life of existing municipal water and sewer infrastructure by reducing the amount of waste being handled. Further, because wastewater is treated closer to the source, water reclamation reduces the carbon footprint associated with the treatment and distribution of water.

As the first ecological water reclamation treatment facility of its kind in the United States, the WaterHub is a case study in progressive, resourceful and sustainable water management practices. It will influence and inspire generations of the academic and broader community to utilize adaptive technology to meet the demand of our water needs.

(For more information see the EPA's *Water Recycling and Reuse: The Environmental Benefits* site.)

How does the WaterHub make Emory more resilient to drought and water service disruptions?

The WaterHub has a 50,000 gallon underground storage tank which provides a backup supply of non-potable water. This resource will help Emory maintain heating and cooling functions in the event of water service disruption caused by municipal water main breaks, drought, or other water stresses.

What is the general governmental policy toward water reclamation & reuse?

The federal government, along with most state governments, recognizes water reclamation and reuse as an impactful water management strategy with numerous community benefits. As a result, the U.S. Environmental Protection Agency releases Guidelines for Water Reuse to help incentivize and promote the implementation of water reclamation projects across the county. Federal and State governments even offer funding incentives for reclaimed water projects through revolving funds or grants.

Are there permitting requirements for water reclamation / reuse facilities?

Most states regulate minimum design and construction standards, along with operational requirements, for water reclamation plants to ensure public health and safety. Additionally, local municipal agencies may require permits for construction, wastewater pretreatment, or discharge. The WaterHub is designed in compliance with all state and local permitting requirements. Sustainable Water, the provider of the technology, in conjunction with Commercial Contractor Reeves Young, provides turn-key project support, supporting all engineering, permitting, construction, commissioning (start-up services), and operational services.

How long does the treatment process take?

The treatment process (hydraulic retention time) takes approximately 18 hours. Overall, treatment time depends on a number of factors including: influent quality, effluent requirements, and the specific technologies utilized.

Where does the wastewater come from?

Wastewater can come from the sewer or directly from a building, series of buildings or industrial process.

At Emory, the wastewater is collected from the northernmost of the University's three sewer lines. In addition, stormwater run-off from the WaterHub greenhouse is captured and directed to the chambers for processing.

As installed, the municipal line would carry the wastewater offsite to Atlanta's R.M. Clayton Water Reclamation Center. This includes sewer coming from the Health Sciences Research Building, most of the new freshman residence halls, and the Health Sciences quad across the railroad tracks.

How have Emory students participated in the WaterHub?

The WaterHub will serve as a laboratory for research and teaching from environmental, legal, ethical, human health, and other perspectives, and will strengthen and support research on the applicability and functionality of water reclamation beyond Emory's campus.

The Center for Global Safe Water (CGSW) at Rollins School of Public Health at Emory has already conducted applied research, training, and evaluation in water, sanitation, hygiene and health implications. Students seeped in theory and program administration have gained practical exposure and real-world experience in sampling and analysis methods.

Going forward, CGSW researchers will utilize the WaterHub as a field learning resource and will monitor the removal of enteric microbes and pathogens by testing the influent and effluent for fecal coliforms, E. coli, coliphage, and selected enteric pathogens (norovirus, adenovirus, enterovirus). CGSW will also monitor the parameters required by the State of Georgia for reclaimed water. The sampling data will provide information on overall treatment efficacy and microbiological quality of the reclaimed water. The data on the pathogens will be used to estimate the human health risk associated with reuse and help determine if similar facilities can be effectively utilized in developing countries.

With approval and collaboration with Emory's Facilities Management, professors are invited and encouraged to incorporate the WaterHub in their curriculum. The facility will provide research and teaching opportunities for those in Environmental Sciences, Chemistry, Biology, etc. Undergraduate students pursuing a minor in Sustainability will explore and research the environmental, social, and economic aspects of the WaterHub. In particular, these opportunities will provide students with a

unique option for their required Capstone Project that integrates classroom work with experiential learning through research, internship, or sustainability-related activity.

In addition, students will have the opportunity to hone public-speaking skills by becoming trained tour docents for a wide range of facility visitors.

What areas of curriculum does the WaterHub involve?

The WaterHub touches many areas of student learning, including:

- Core coursework
- Student labs
- Internships
- Immersive learning
- Comparative studies

Specific curricular tracks include:

- Performance Landscaping
- Urban Planning
- Water Quality
- Health implications
- Sanitary Standards
- Environmental Justice
- Social Equity
- Environmental Sciences
- Biology
- Health Sciences
- Contaminant Removal (hormone interceptors, xenobiotics)
- Microbial Ecology

How can I use the WaterHub for field learning?

If you are interested in conducting future research using the WaterHub, contact the Office of Sustainability Initiatives (OSI) at emorysustainability@emory.edu. OSI will coordinate access with the plant operator.

Will the facility be open to the public for tours?

To highlight this facility as an innovative model of sustainability, Emory will coordinate facility tours for the public at pre-determined times during the month.

For more information, contact Brent Zern in Campus Services, brent.zern@emory.edu. Brent will request completion of a tour questionnaire which will provide basic information about the tour's goals and participants.

What happens to the WaterHub in the winter?

All WaterHub structures and plantings are designed according to specific environmental conditions, enabling it to remain fully operational year-round.

The WaterHub™ at Emory University

DESIGN AND CONSTRUCTION FAQ

DESIGN

Utilizing a small footprint of undeveloped land on the densely developed Emory campus, the WaterHub is a custom-designed ecological water reclamation facility which features an elegant greenhouse design and lush outdoor planting areas.

The project was designed by Sustainable Water, a Virginia-based firm that supplies the WaterHub's pivotal biomimetic technology and is a leading provider of water reclamation and reuse solutions.

CONSTRUCTION

Reeves Young, an Atlanta-based commercial contractor with over sixty years of expertise in technically challenging, urban utility installation, served as General Contractor for the WaterHub.

The WaterHub's revolutionary technology is housed in two sites adjacent to Peavine Creek Drive. To the north, and built on a section of former Campus Services parking lot, is the WaterHub's glasshouse, a nearly 2,000 square foot poured concrete and glass structure which resembles a botanic greenhouse. To the south is a series of largely underground concrete processing tanks whose upper few feet are visible above ground. To the human eye, the above-ground portion looks like ornamental landscaping; in reality the seven tanks are up to 25' deep.

The first phase of the project required installing purple reclaimed water distribution piping throughout a highly developed, urban campus. Piping was installed through a spaghetti-like assortment of electrical, telephone, cable, storm water, domestic water and sewer lines. The 8" and 6"pipe was installed throughout the campus, and into operational buildings.

The next phase was the simultaneous construction of the two building sites. Construction and material delivery required close coordination in order to not impact the functions of the University.

In addition to conventional construction on a small footprint, building the WaterHub required coordinating technology which had never been assembled together before and integrating the WaterHub's control system within Emory's facilities management monitoring system.

The project was completed on time.

The WaterHub™ at Emory University

GLOSSARY/TECHNICAL FAQ

What is blackwater?

Blackwater is sanitary wastewater.

What is greywater?

Greywater is the wastewater from non-sanitary sources, such as showers, sinks and washing machines.

What is stormwater?

Stormwater is water from precipitation events, such as rain or snow. This water may be collected and cleaned for reuse.

What is recycled/ reused/ reclaimed water?

Reclaimed water is wastewater that is treated and recycled to be reused again for non-potable purposes.

What is non-potable demand?

Non-potable demand is the need for water which is not necessarily of drinking water quality. Rather than use highly-treated potable water for heating and cooling, for example, this demand could be met by reclaimed water.

What is purple pipe?

Pipes which carry reclaimed water are always purple—this differentiates them from wastewater and drinking water.

How does the WaterHub use biomimicry?

The WaterHub technology is modeled on biological processes, taking the best of the natural world and creating highly efficient engineered solutions to mimic them. These ecological processes leverage beneficial organisms, such as those found on plant roots in natural ecosystems, and provide them with highly efficient engineered growth media, enabling these organisms to treat large quantities of water in small spaces within short periods of time. The systems increase the surface area upon which beneficial organisms grow and increase oxygenation to promote treatment.

What are the different technologies used within the WaterHub and how are they different than traditional wastewater treatment technologies?

The WaterHub's biologically-based technologies include Moving Bed BioReactors, Hydroponic systems with submerged fixed film media and Reciprocating Wetlands, as well as filtration and disinfection technologies.

The WaterHub uses natural processes and improves upon them, while traditional wastewater treatment facilities rely heavily on energy intensive mechanical processes and chemicals.

What is a reciprocating wetland?

Pioneered by the Tennessee Valley Authority (TVA), Reciprocating Wetlands consist of pairs of adjacent bio-cells that contain plants and rock media. Utilizing anaerobic, anoxic and aerobic environments—adjacent cells are alternately drained and filled with wastewater on a recurrent basis to mimic a tidal process. This fill-and-drain sequence facilitates control of microbial processes, such as nitrification and denitrification. By mimicking natural biological degradation, these systems treat water to reuse standards under a very low energy footprint relative to traditional biological treatment systems.

What are the advantages of adaptive ecological systems?

These systems are low-energy, highly efficient and require little to no chemicals.

Is the technology suitable for retrofitting existing treatment plants?

The WaterHub is easily retrofitted into existing facilities.

Can it be used to treat industrial wastewater?

The WaterHub can handle most types of wastewater, including industrial streams.

What industries currently reclaim water?

Reclaimed water is currently being used in most industrial sectors, including food and beverage, the power industry, hotels, airports, higher education and wherever non-potable water is used.

What does the Environmental Protection Agency (EPA) think about this?

The EPA provides specific guidelines for water reuse, stating that 'Water reclamation and reuse offer an effective means of conserving our limited high-quality freshwater supplies while helping to meet the ever-growing demands for water.' – EPA Water Reuse Guidelines
http://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf

What does the Department of Energy think about this?

In the US, power producers have consistently utilized reclaimed water since the 1950s. As part of its effort to define challenges and opportunities surrounding the water-energy nexus (or the unavoidable link between water and energy creation), the Department of Energy stated a need to, 'Increase safe and productive use of nontraditional water sources,' which includes reclaimed water. For more information on the Department of Energy's viewpoints, refer to The Water-Energy Nexus report:
http://energy.gov/sites/prod/files/2014/07/f17/Water%20Energy%20Nexus%20Full%20Report%20July%202014.pdf

Who is responsible for operations and maintenance?

Treatment plant operations are regulated by the State with defined protocols, testing requirements and reporting. A certified operator is required for system oversight, along with performing various mechanical and maintenance functions. Sustainable Water, who developed the WaterHub, also provides the services required to produce a clean, safe and reliable source of reclaimed water.

What is a biofilm?

A biofilm is a layer of complex, adaptive ecosystems, which break down organic waste in water.

What is fixed-film and moving media?

Fixed media, typically found in hydroponic systems, is a specially engineered fabric, fixed-in-place, which is designed to mimic natural media that support biofilm growth. Because root systems only extend a few feet into hydroponic reactors, fixed-media textile such as BioWeb™ significantly increase the surface area for biofilm growth. Moving media, such as Bioportz™, are freely circulating plastic pellets that provide surface area for biofilm growth within the moving-bed bioreactors. Each engineered medium is designed to provide habitat for biofilm microorganisms that help break down wastewater. Each is ideally suited for different stages in the treatment process.

What is a hydroponic treatment system?

Hydroponic treatment systems are made-up of a series of inter-connected reactors that have an array of plant life growing above them. Plant root systems grow into the reactors and provide a natural habitat for fixed-in-place and suspended micro-organisms that break down pollutants in water. The hydroponic systems at Emory include artificial media to support further biofilm growth. Deep reactor vessels with high levels of biodiversity enable the treatment of larger volumes of wastewater under lower energy and physical footprint requirements.