STUDENT DESIGN COMPETITION 2024

weftec®
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October 5–9, 2024
New Orleans, LA

Water Environment Federation®
the water quality people®

STUDENTS & YOUNG PROFESSIONALS COMMUNITY
SYP

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Click the school's name to see their project title, abstract, team members, and more

KEY:

Wastewater Competition

Water Environment Competition

INTRODUCTION

The WEF Student Design Competition was designed to showcase top university students aspiring to become water quality professionals. It allows them to demonstrate their skills and enthusiasm while tackling real-world design challenges.

We encourage you to engage with students during breaks and at the **SYP Networking Reception on October 7 at 8 pm** (Republic NOLA, RSVP required). Also on Monday, a **Networking and Career Fair** will be held from 1-4 pm (Booth 151, Hall B1). WEF and the Students and Young Professionals Committee thank *Tetra Tech, Black and Veatch, Gannett Fleming, CDM Smith, GHD, and Arcadis* for sponsoring the SDC; the judges for their time and expertise, and the WEF Board of Trustees for supporting the Students and Young Professionals programs. Keith Hobson, 2024-2025 WEF Vice President, will announce this year's winners of the Student Design Competition. Thank you to the students and their advisors for their motivation and enthusiasm.

The Student Design Competition Sub-Committee supports design competitions at both the Member Association (MA) and national levels. MAs are encouraged to create their own prompts or allow student teams to devise their own problems. Winning teams from each MA can compete at WEFTEC and must follow the national competition guidelines. The Student Design Competition focuses on high-quality written and oral presentations, with scoring based on the design report, presentation skills, and responses during a Q&A session with judges.

We are excited to welcome 30 teams (the most ever) to this year's SDC.

Please contact the subcommittee if your MA is interested in holding a regional competition or sending a team to the SDC in the future!

FOR MORE INFORMATION, PLEASE CONTACT:

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SYP COMMITTEE

The mission of the WEF Students and Young Professionals Committee (SYPC) is to encourage and facilitate student and young professional involvement in WEF and the Member Associations through professional development and leadership opportunities. One of WEF's strategic initiatives is to encourage the involvement of students and young professionals in the organization. The following programs have been developed to provide opportunities for students and young professionals:

- Student chapters in colleges and universities
- Reduced student and YP membership rates
- Free registration for WEF Student Members attending WEFTEC, WEF conferences, and webcasts
- WEFTEC Student and Young Professionals Career Fair, Student Lounge, Students & Young Professionals Meeting, Student Design Competition, WEF Community Service Project and Water Palooza
- YP Summit, a professional development event
- Midyear Springboard Program Technical Workshop
- Development opportunities
- Stockholm Junior Water Prize
- WEF Canham Graduate Studies Scholarship

The SYPC is made up of students, young professionals, academics, and water quality professionals. We welcome your participation in the WEF SYPC and/or on a student activities or young professional committee at your local member association.

The SYPC and WEF encourage you to take advantage of WEF membership benefits. For more information contact Brad Lovett, WEF Manager, Association Engagement for Students and Young Professionals, at (703) 684-2455 or email: BLovett@wef.org.

PAST WINNERS

Year	Water Environment Competition	Wastewater Competition
2023	Georgia Institute of Technology	Texas Tech University
2022	University of Waterloo	University of Texas - Austin
2021	California State Polytechnic University, Pomona	Clemson University
2020	University of Guelph	Colorado School of Mines
2019	University of British Columbia	University of Colorado - Boulder
2018	University of British Columbia	University of Colorado - Boulder
2017	University of Guelph	University of Colorado - Boulder
2016	University of Minnesota, Twin Cities	Southern Methodist University
2015	South Dakota State University	Southern Methodist University
2014	University of British Columbia and University of North British Columbia	University of South Florida
2013	University of British Columbia	University of South Florida
2012	University of South Florida	University of Colorado - Boulder
2011	University of Florida	University of Wyoming
2010	University of Florida	Southern Methodist University
2009	University of Florida	University of Colorado - Boulder

Year	Combined Competition
2008	University of Florida
2007	University of Florida and North Dakota State University
2006	University of Florida
2005	University of South Florida
2004	University of Washington
2003	University of Central Florida
2002	University of New York at Buffalo

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COMPETITION SCHEDULE

Start Time	Wastewater Competition Room 272	Water Environment Competition Room 276
7:30	***Teams Arrive for Check-In and Breakfast (Room 279)***	
7:50	***Opening Welcome (Room 279)***	
8:15	Utah State University	Texas Tech University
8:40	University of Colorado - Boulder	Loyola University
9:05	Universidad de Costa Rica	University of Florida
9:30	***Break***	
9:40	Washington University in St. Louis	SUNY ESF
10:05	Case Western Reserve University	Northeastern University
10:30	North Carolina State University	Illinois Institute of Technology
10:55	***Break***	
11:05	Carnegie Mellon University	Toronto Metropolitan University
11:30	University of California, Riverside	Georgia Institute of Technology
11:55	***Lunch (Room 279)***	
12:20	***Process Design Challenge (Room 279)***	
1:05	***Break***	
1:10	University of South Florida	Old Dominion University
1:35	University of Nevada, Las Vegas	University of Tennessee Knoxville
2:00	Instituto Tecnologico de Costa Rica	University of Notre Dame
2:25	Marquette University	***Break***
2:50	***Break***	**2:35** University of British Columbia
3:00	George Mason University	University of California Riverside
3:25	SUNY University at Buffalo	Johns Hopkins University
3:50	Northeastern University	***Break***
4:15	Georgia Institute of Technology	
4:45	***Networking Dessert Reception and Team Photos (Room 272)***	
5:45	***WEF Address and Awards Ceremony (Room 272)***	

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WASTEWATER

CARNEGIE MELLON UNIVERSITY

MSANK WWTP NITROGEN REMOVAL RETROFIT PROJECT

Wastewater treatment plants are significant sources of nutrient pollution, promoting eutrophication and endangering aquatic life. Unfortunately, conventional wastewater treatment is often insufficient in reducing nutrient discharge into the environment. The Municipal Sanitary Authority of the City of New Kensington (MSANK) Wastewater Treatment Plant (WWTP) is upgrading their plant to increase the flow capacity from 6 MGD to 10 MGD. As part of the upgrade, adding a nitrification process to the treatment train will be necessary to comply with new ammonia discharge requirements in the updated NPDES permit. The current plant has limited space for expansion, necessitating an efficient and innovative approach to meet these demands. Alternative solutions will be evaluated based on ammonia removal efficiency, cost, sustainability considerations (e.g. biosolid production, energy use, greenhouse gas emissions), and feasibility (e.g. physical footprint, constructability, resilience, and solids retention time required). Climate adaptation will also be considered, with estimates of future environmental conditions and an evaluation of plant resilience to extreme weather. The main objectives in developing a recommended design include optimizing the existing infrastructure, reducing costs, and minimizing environmental impact while complying with the latest discharge regulations.

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WASTEWATER

CASE WESTERN RESERVE UNIVERSITY

ENHANCING BIOSOLIDS PRODUCTION AT PQM PLANT

To convert the PQM solids handling process to produce Class A biosolids using the Lime-Heat Treatment method, strategic enhancements are needed to ensure safety compliance and maximize utility. Achieving Class A biosolids designation requires sewage sludge treatment to meet pathogen elimination and vector attraction reduction regulations. Such enhancements make biosolids suitable for broader environmental use. By examining EPA-approved alternatives approach for biosolid treatment and utilizing a decision matrix, we assessed factors like cost, implementation, and efficiency for the following alternatives: Lime Only, Heat Drying, Lime-Heat Treatment. Lime-Heat treatment was ultimately selected for its efficacy, affordability, and seamless integration potential. Using the Lime-Heat Treatment system ensures optimal treatment effectiveness while addressing concerns such as ammonia emissions and pollution using proper equipment, lime dosage adjustment and temperature control to reduce ammonia volatilization. We devised a conceptual design for the lime-heat treatment at the PQM WWTP, outlining equipment requirements, calculating lime dosages, determining mixing tank size, and assessing overall implementation and operational costs, etc. In summary, Lime-Heat Treatment is a cost-effective, rapidly implementable solution for producing high-quality biosolids, enhancing sustainability, and ensuring regulatory compliance.

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WASTEWATER

GEORGE MASON UNIVERSITY

MASSAPONAX WASTEWATER TREATMENT PLANT AERATION SYSTEM EXPANSION PROJECT

The County of Spotsylvania seeks proposals from qualified consulting firms to provide professional design services for expanding and upgrading the aeration systems at the Massaponax Water Treatment Plant (MWWTP) in Fredericksburg, VA. The project involves a study and preliminary design for implementing technology upgrades and capacity expansion. The facility's existing aeration systems' capacity will increase from a rated average dry weather flow of 9.4 MGD to 13.4 MGD and peak hydraulic flow of 25.4 MGD to a peak equalized forward flow of 34.0 MGD. The improvements shall include the addition of post-anoxic tanks. The project scope consists of the selection and design of the diffuser system and blowers and the development of a control strategy for the operation of the blowers and aeration system. The MWWTP facility will undergo permit updates to reflect current Virginia Water Quality Standards and accommodate the expansion flow tiers. The proposed strategies include rendered preliminary design work, documentation to facilitate modifications, and relevant manufacturers' cost estimates. A decision matrix that focuses on safety, profit, quality, sustainability, construction cost, and operator favorability will determine the final recommendation.

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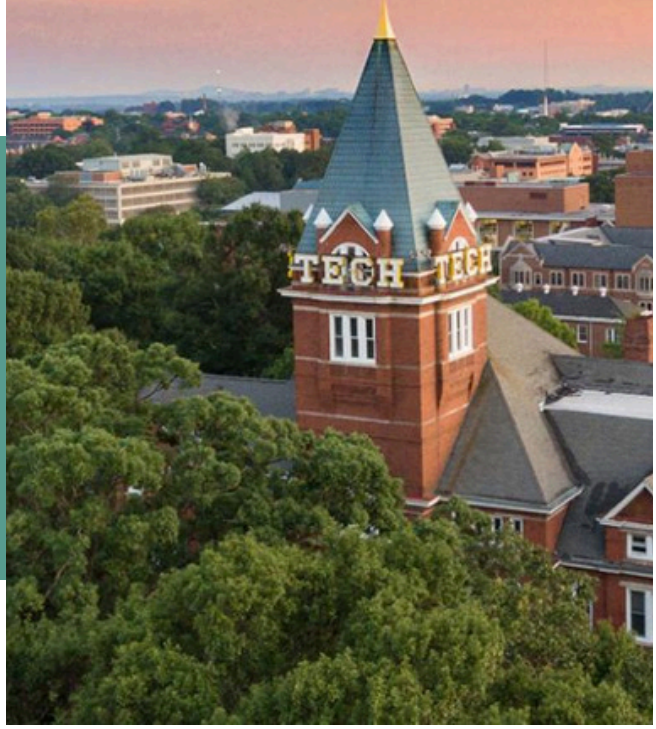
WATER ENVIRONMENT

GEORGIA INSTITUTE OF TECHNOLOGY



FINDING THE FLINT HEADWATERS NATURE PRESERVE

The Flint River begins at a spring located one mile north of the Hartsfield-Jackson Atlanta International Airport, the world's busiest airport. With development, the headwaters of the Flint River became encased in stormwater pipes. "Finding the Flint" is an initiative to improve the health of the Flint River. The project site is a 7.26-acre lot where the spring's headwaters are first daylighted. The vision is to create a nature preserve to benefit the surrounding neighborhood, improve the health of the Flint River, and manage existing stormwater flows. To model the site, the Natural Resources Conservation Service's (NRCS) web soil survey data was reviewed, NRCS TR-55 runoff calculations were prepared, and a HEC-RAS model of the site was developed. The team chose four stormwater control measures to aid in stormwater management: a pervious concrete path and parking area (22,070 ft2), a bioretention basin which doubles as a rain garden (4,500 ft2), an infiltration trench which doubles as a pollinator habitat (2,100 ft2), and a dry enhanced swale (2,025 ft2). An ADA-accessible garden path was designed, along with an unpaved nature trail. Park amenities were designed to serve the community, and educational features were included to inspire protection of local waterways.

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WASTEWATER

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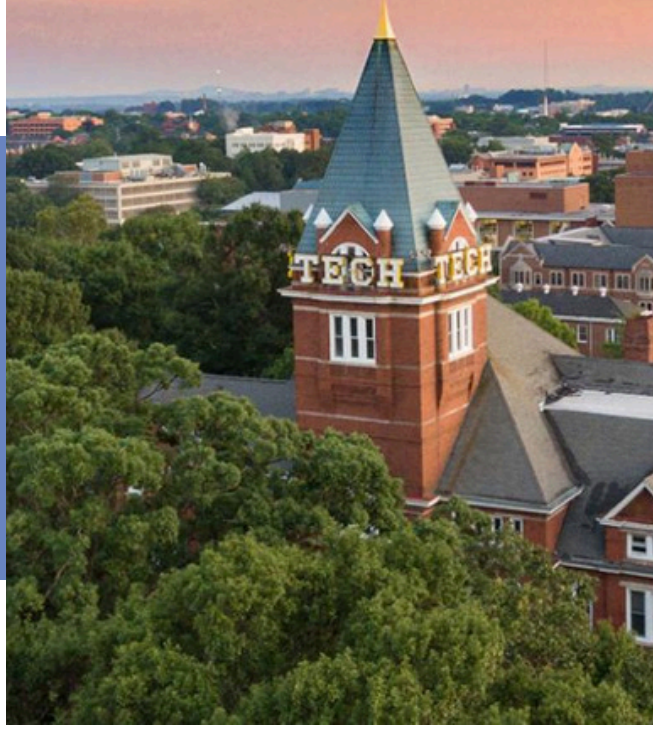

MISSISSIPPI PHOSPHATES SUPERFUND LEACHATE TREATMENT

The Mississippi Phosphates Corporation site operated from 1958 until bankruptcy in 2015, manufacturing fertilizer by combining phosphoric acid and ammonia. The site was designated as a Superfund site and placed under EPA control in 2017. The EPA is completing a multi-year capping of remnant phosphogypsum stacks which currently produce 730,000 gal/day of acidic, high phosphorus content leachate. Contaminated runoff and leachate are treated on-site before discharge to the Gulf of Mexico. The site's existing wastewater treatment plant (WWTP) is decades old and planned for demolition due to property sale; therefore, a new plant is needed by 2027. The team conducted a site visit, compiled 2.5 years of handwritten log forms, prepared site schematics, and used the EPA Hydrologic Evaluation of Landfill Performance (HELP) model to predict changes in leachate flow as capping proceeds at the site. Modeling, weather, and site data were used to predict future flows and estimates were validated. A two-stage lime precipitation plant was designed to provide necessary hydraulic retention times and maximize plant longevity. The design includes sludge dewatering through a plate-and-frame filter press, to replace on-site disposal to allow full site closure. The modeling, predictions, detailed design, and cost estimates will be discussed.

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WATER ENVIRONMENT

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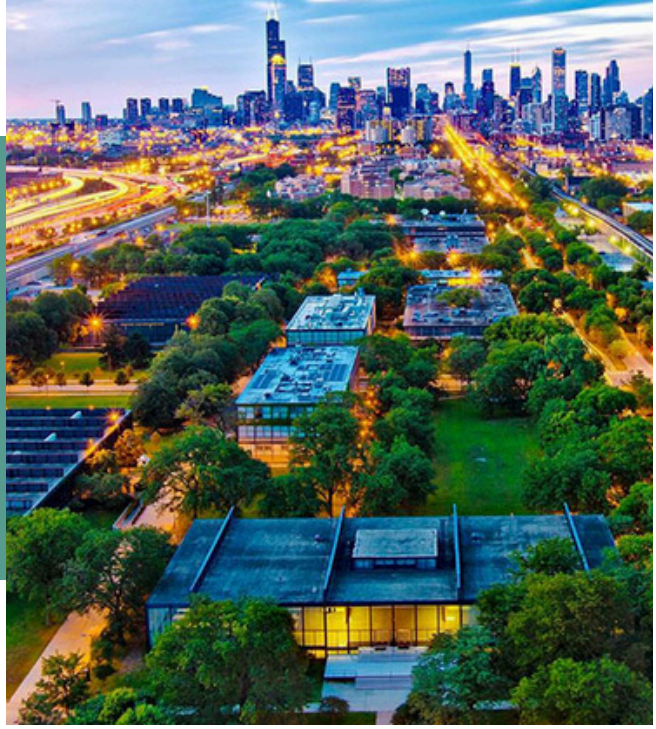

CASM (CHATHAM AREA STORMWATER MANAGMENT)

Urbanization in the United States, particularly in areas like Chicago, has led to significant challenges in managing stormwater runoff. Impervious surfaces such as roads, sidewalks, and buildings, combined with outdated sewer infrastructure, place neighborhoods like Chatham at high risk of flooding. Chatham experiences severe basement flooding annually due to sewer system overflows and backups. Increasing rainfall, driven by climate change, exacerbates this problem, overwhelming current infrastructure. This project aims to mitigate basement flooding in Chatham through a combination of green and gray infrastructure. Implementing these solutions is projected to reduce peak stormwater runoff by at least 25% during a 10-year storm event. Alternative 1 proposes a stormwater storage tunnel as a relief system for the overflowing intercepting sewer in Chatham. Drop shafts connected to both the sewer and the storage tunnel would divert overflow water during storm events, which would then be pumped back once the event passes. Alternative 2 suggests a stormwater diversion tunnel linking Chatham's main sewer outlets at Indiana Ave and Dobson Ave to MWRD's Deep Tunnel system, using gravity to redirect overflow water without requiring pumps. Alternative 3 focuses on green infrastructure, converting open areas into bioswales and permeable pavement to facilitate ground infiltration of runoff.

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WASTEWATER

INSTITUTO TECNOLÓGICO DE COSTA RICA

DESIGN OF THE CENTRALIZED WASTEWATER COLLECTION SYSTEM AND WRRF FOR THE COMMUNITY OF HORQUETAS IN SARAPIQUÍ, COSTA RICA

The community of Horquetas in Costa Rica lacks a centralized system for the comprehensive treatment of wastewater, with septic tanks being the most common form of treatment used in the area. This situation hinders the traceability of wastewater and prevents adequate monitoring of the physicochemical and microbiological conditions under which septic tank effluent is discharged into various bodies of water in the community. Due to this issue, and being mindful of population projections and tourist growth, a centralized system for wastewater treatment and the by-products generated in the process is required, in accordance with the abundant regulations in Costa Rica. Therefore, the main objective is to design a sanitary sewer system that will collect and subsequently convey wastewater to a centralized Water Resource Recovery Facility (WRRF). The recommended design is based on an anaerobic-facultative lagoon arrangement and was compared against two alternative preliminary designs. Final recommendation was made using a decision matrix based on the Analytic Hierarchy Process (AHP) by Thomas Saaty, incorporating five criteria: economic impact, social repercussions, plant autonomy, technical requirements, and environmental sustainability; ensuring that the selected proposal meets the demands and possibilities of the community.

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WATER ENVIRONMENT

JOHNS HOPKINS UNIVERSITY

SHELLFISH FOR NUTRIENT MITIGATION NEAR BALTIMORE'S WASTEWATER TREATMENT PLANTS

The Back River and Patapsco Wastewater Treatment Plants, located in Baltimore, MD, release phosphorus and nitrogen, leading to water quality degradation in the Chesapeake Bay and potentially contributing to eutrophication and dead zones. There has also been a historic decline in shellfish populations, which are essential for nutrient removal. To address these issues, this project recommends deploying oysters near the Patapsco Wastewater Treatment Plant (PWWTP) and mussels near the Back River Wastewater Treatment Plant (BRWWTP). Oysters and mussels filter nutrients like nitrogen and phosphorus, providing a natural solution to water quality problems. The deployment solution consists of oysters being grown in cages suspended from a dock at PWWTP and then transferred to the Fort Carroll oyster reef, while mussels at BRWWTP will use a rope-based cultivation design. Preliminary cost estimates are $39,300 for Patapsco and $92,500 for Back River, with annual maintenance costs of $600 and $2,600, respectively. Community involvement is vital. Partnering with the Chesapeake Bay Foundation (CBF) and offering volunteer opportunities enhances engagement and support. Utilizing land owned by the WWTPs and eco-friendly materials further supports the project. Collaborations with organizations like CBF can improve outreach and education, ensuring widespread support for the program's objectives.

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WATER ENVIRONMENT

LOYOLA UNIVERSITY

CONSERVATION LEADERSHIP CENTER RAINWATER CAPTURE AND REUSE

Brookfield Zoo Chicago is advancing its sustainability practices by limiting its reliance on municipal water for outdoor turtle habitats. Rainwater runoff from a nearby building's roof must be collected, then filtered of heavy metal contaminants and disinfected before it can be reused for habitat irrigation. An innovative aspect of this design is the recirculation system that pumps water from the 200-gallon cistern through a granular activated carbon filter and UV sterilizer before reintroducing it to the cistern. This subsystem operates at intervals to conserve energy while still agitating the cistern's water enough to prevent bacteria accumulation and mosquito reproduction. An automation system utilizes sensor data to control valves that direct water in different directions depending on system conditions. A display of sensor data is used to aid in water quality monitoring. The design abstains from using chemicals in water treatment to prioritize turtle health and reduce maintenance costs. The main objective of this design is to collect, recover, and store rainwater at a quality sustainable to ambient freshwater aquatic life – a collection of standards approved by Brookfield Zoo Chicago. The Zoo aspires for this project to bolster its sustainability initiatives and inspire community members to consider implementing similar systems.

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WASTEWATER

MARQUETTE UNIVERSITY

NOVEL PYROLYSIS OF MUNICIPAL WASTEWATER SOLIDS FOR ENERGY AND BIOCHAR

The Milwaukee Metropolitan Sewerage District (MMSD) currently repurposes some of their wastewater biosolids as a fertilizer branded as “Milorganite”. However, land-application of biosolids has recently come under scrutiny for perpetuating the presence of unregulated Contaminants of Emerging Concern (CECs), such as per- and polyfluoroalkyl substances (PFAS), in various agricultural and environmental contexts. A novel treatment process called “pyrolysis” has gained traction within the scientific community for its ability to remove/destroy CECs such as PFAS, which it achieves by heating biosolids in the absence of oxygen to 400˚ C - 900˚ C. This process creates a substance known as “biochar” as well as renewable energy, which makes it an attractive methodology for the handling of biosolids. This project seeks to incorporate pyrolysis into an existing water reclamation facility’s wastewater treatment train to improve the decontamination of biosolids while producing valuable by-products and increasing capacity of the water reclamation facility. In addition to the design of a treatment train to meet the project scope, the project also includes the structural design of a facility to house the pyrolysis process equipment, an updated transportation plan surrounding the proposed facility, and a construction schedule and cost estimation for the execution of the proposed project.

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WASTEWATER

NORTH CAROLINA STATE UNIVERSITY

REHABILITATION AND UPGRADES OF THE TRIANGLE WASTEWATER TREATMENT PLANT

Rehabilitation and upgrades of the Triangle Wastewater Treatment Plant (TWWTP), owned and operated by Durham County, will improve the efficiency and longevity of the plant to effectively serve customers. Multiple assets are at the end of their life (EOL), or not operational. Additionally, the plant has received five permit violations for excess effluent BOD in recent years. Replacement of EOL assets will improve the consistency of TWWTP BOD removal. The team met with TWWTP staff and toured other local treatment plants to aid in prioritization of equipment rehabilitation and evaluation of replacements. The team found that the screens, compactors and conveyors, odor control system, grit chambers and classifier, filters, and UV system needed to be replaced or rehabilitated. An additional UV train is also needed for redundancy. To enhance BOD removal, an inline equalization basin will be utilized for improved consistency of flow and BOD loading, in combination with fine-bubble diffuse aeration in the 5-stage Biological Nutrient Removal. These upgrades will extend the life span of the plant and allow for consistent BOD removal to best serve the residents of Durham County while protecting the environment.

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WASTEWATER

NORTHEASTERN UNIVERSITY

BIOSOLIDS PROCESSING UPGRADES AT EAST END FACILITY IN PORTLAND, MAINE

Due to recent legislation in Maine restricting the land application of biosolids, wastewater treatment plants are currently facing rising disposal costs at landfills. Portland Water District is looking to update their East End Facility in downtown Portland Maine in order to reduce the costs associated with disposing the waste. The current biosolids processing is a rotary press, which results in an output of 56 wtpd, at 20 TS%. This project simulated updates to their current process in order to evaluate different technologies in terms of their effectiveness, operating conditions, and ground footprint space requirements. The final recommendation involves an anaerobic digestion unit to decompose the organic solids thus reducing the amount of waste to dispose, while concurrently creating a useable biogas for energy and heat in a CHP system. And for dewatering, by replacing the rotary press with a thin film dryer, the final biosolids to dispose reduced to 7.88 wtpd, enough to save 2.4 million in yearly disposal costs.

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WATER ENVIRONMENT

NORTHEASTERN UNIVERSITY

GREEN INFRASTRUCTURE IN THE CITY OF BOSTON

Through our collaboration with the City of Boston, we worked to improve permeability in flood-prone areas utilizing GI technologies that would filter harmful pollutants, manage large volumes of water, and improve ecological cycles in these urban areas. With careful analysis of flooding data, traffic data, and maps of historically marginalized communities, we narrowed our focus to locations that needed the most immediate action and would bring the most impact to the surrounding community. At our selected site in East Boston, the Patrick James Kennedy Elementary School, we recommend the redevelopment of the dilapidated northside parking lot and the unoccupied sloped asphalt corridor at the south entrance. Terrascape's final design recommendations include porous paving and bioretention practices to promote water treatment and storage of runoff, increase the tree canopy in a Heat Focus Neighborhood, and provide educational opportunities to students with informative signage. Quantitative projections demonstrate that our design exceeds all three requirements laid out by MassDEP and the City of Boston; the first inch flush stormwater infiltration minimum, the reduction of peak discharge rates for the 2, 10, and 100-year storm, and the removal of 80% Total Suspended Solids and an additional removal of 50% Total Phosphorus.

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WATER ENVIRONMENT

OLD DOMINION UNIVERSITY

LAKE KILBY RESERVOIR SYSTEM WATER QUALITY IMPROVEMENT PLAN

The Lake Kilby Reservoir System consists of Lake Kilby, Lake Meade, Lake Cohoon, and Speight's Run. These lakes are owned and maintained by the City of Portsmouth, Virginia, and serve as the primary raw water reservoirs for the Lake Kilby Water Treatment Plant, which supplies drinking water to customers in Portsmouth, Suffolk, and Chesapeake. These lakes have been previously studied for high levels of soluble manganese, which is difficult and costly to remove. Previous recommendations made to the City of Portsmouth involved large-scale lake oxygenation systems which were unable to be constructed due to the exorbitant cost and Portsmouth's limited water infrastructure budget. Lake Kilby was recently designated as impaired by the Virginia Department of Environmental Quality due to high levels of total phosphorus, coinciding with phosphorus concerns throughout the Chesapeake Bay watershed, as well as local challenges with harmful algal blooms. This report explores strategies to improve water quality in the Lake Kilby Reservoir System which addresses the phosphorus concerns with additional emphasis on strategies that are economically viable. Our team proposes that the City of Portsmouth implement a geochemical treatment program in Lake Kilby and establish an improved sampling program.

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WATER ENVIRONMENT

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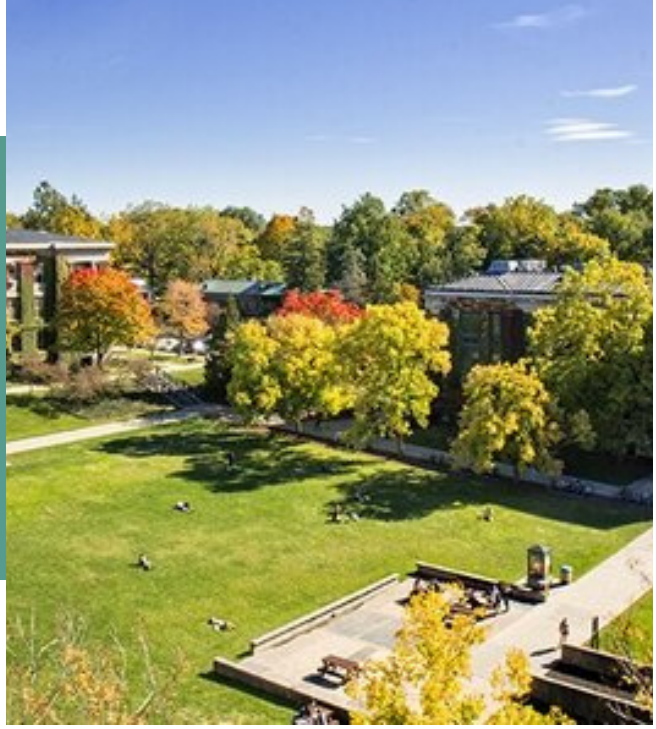

MOHAWK VALLEY STREAM RESTORATION PROJECT

In the town of Marcy, New York, two potable water transmission lines transport water for approximately 128,000 people. As of October 2019, these lines have been exposed to environmental harm after a large storm event eroded the soil covering them in a small ephemeral stream. Two alternatives have been researched and evaluated as a final design solution. Option one, Pipe Suspension, involves removing the old pipe system and replacing it with an elevated truss bridge to support pipes crossing over the stream along with casing pipes to ensure the transmission lines are properly protected from the environment. Option two, Instream Modification, involves backfilling the stream to recover the transmission mains in 5 feet of soil cover while using a series of check dams and vegetative geogrids. These will be in place to ensure that the water velocity, during a storm event, will not cause the bed or bank soil to erode. Our major considerations included maximizing the water mains protection, minimizing social impact, and minimizing the probable cost. Option one was found to sufficiently protect the pipe but the cost was about double option two and involved significant social impacts. After extensive analysis, option two is the final recommendation.

MEMBER ASSOCIATION

New York Water Environment Association

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WASTEWATER

SUNY UNIVERSITY AT BUFFALO

LAKESIDE CAMPGROUND WASTEWATER TREATMENT DESIGN

Our team designed a treatment system for wastewater generated by 250 tent and trailer campsites at a lakeside campground on the shore of Lake Ontario. The site is kept anonymous per request from the partner and the SDC guidelines. We were provided with the State Pollutant Discharge Elimination System (SPDES) permit, wastewater flowrates and water quality data. The data indicated that there were large fluctuations in flow and water quality based on seasonal attendance at the campground. The highest and lowest monthly maximum flow rate varied by a factor of 30. It was decided that the wastewater treatment system shall be designed to handle a maximum flow of 20,000 GPD, while also being capable of handling the lowest flowrate recorded. Three alternatives were researched and analyzed based on their flexibility in small scale scenarios: membrane bioreactor (MBR), sequencing batch reactor (SBR), and septic tank - sewage lagoon hybrid system. The alternative selected was an SBR system with a detailed design including pumps, basin sizing, activated sludge design, aeration, disinfection, sludge management, and other considerations. We focused on our primary design goal to adhere to the SPDES permit, putting a high emphasis on system flexibility and mindfulness of the local ecosystem.

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WATER ENVIRONMENT

TEXAS TECH UNIVERSITY

PECAN CREEK WATER RECLAMATION PLANT IMPROVEMENT AND EXPANSION PROJECT

The City of Denton's Pecan Creek Water Reclamation Plant (PCWRP) is expanding from an annual average daily flow of 21 MGD to 26 MGD and a peak two-hour flow from 46 MGD to 69 MGD. The proposed design in this report focuses on upgrading and replacing treatment units that will not meet TCEQ requirements following the expansion. The design also reduces phosphorous in effluent water to below 0.2 mg/L, in accordance with a new discharge permit. The design considers operator and plant preferences and upgrades the biological nutrient removal system to an anaerobic - anoxic - aerobic (A2/0) for improved phosphorus removal. Other proposed units include primary and secondary clarifiers with increased capacity, improved solid handling processes (gravity belt thickener, anaerobic digesters), and phosphorus polishing and stripping units. An Opinion of Probably Construction Costs (OPCC) and an annual operation and maintenance analysis are provided to estimate the costs for improving the treatment plant. The construction sequencing for the proposed design is also evaluated. The recommended changes will allow PCWRP to comply with TCEQ requirements and TPDES permit limits.

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WATER ENVIRONMENT

TORONTO METROPOLITAN UNIVERSITY

HIGHPOINT POND RETROFIT

HydroSphere Solutions of Toronto Metropolitan University is pleased to present our final design for the retrofit of Highpoint Pond in Milton, Ontario to the Water Environment Federation (WEF) Student Design Competition. As Highpoint Pond was constructed in the 1980s, it does not meet modern stormwater management standards and must be retrofitted to become an offline facility as well as meet water quality targets and water quantity targets specified by the Town of Milton and local guidelines. Several design constraints had to be considered during the design process as well, such as local endangered and threatened fish species, the capacity of a connecting culvert under a major highway, ensuring the accommodation of the large drainage area of 691 hectares, and the need to plan for future rainfall events and climate change. To rise to this challenge, HydroSphere Solutions reviewed the project site, local and municipal guidelines and best practices, suitable stormwater management technologies and practices, and Low Impact Development practices. Then, multiple conceptual solutions could be created. These solutions were explored, evaluated and ranked via a data-based approach, and the design which best fit the Town of Milton's needs was selected, modeled, simulated, and further refined as necessary.

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WASTEWATER

UNIVERSIDAD DE COSTA RICA

WASTEWATER TREATMENT SYSTEM FOR HORQUETAS, SARAPIQUÍ, COSTA RICA

The project proposal for the design of a wastewater treatment system in the community of Horquetas de Sarapiqui, Costa Rica, responds to the need to address the wastewater problem in the area. They usually use septic tanks, but these are not correctly designed; because of that a new treatment system is necessary. The main objective is to develop an agile, economical, and sustainable system that treats wastewater, thus reducing pollution caused by poorly designed septic tanks, without altering the ecosystem and the native landscape of the area and its residents. The design is based on biological and physical-chemical treatment technologies, adhering to the parameters granted, in which a 20-year population projection was contemplated. When the costs of the system are calculated, it is found that the system will be significantly expensive. The most expensive part of the system is sanitary sewerage (it represents a 99% of the cost), so it is recommended to opt for more centralized options such as small treatment plants and even, for families separated from the population, the design of septic tanks for each case. In conclusion, this project not only addresses a critical environmental problem, but also promotes sustainable development in Horquetas de Sarapiqui.

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WATER ENVIRONMENT

UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER

TRIPLE-PRONG RAINFALL AND RUNOFF MANAGEMENT DESIGN

Thunderbird Rainwater Solutions presents the Triple-Prong Design to mitigate risks associated with rainwater runoff in Vancouver's Olympic Village neighbourhood. Located in the lush Pacific rainforest and along the False Creek inlet, the Triple-Prong focuses on the co-existence of Vancouver's natural ecosystem, built environment, and local communities by interweaving engineering and Indigenous Ways of Knowing. This design consists of three projects strategically placed within Olympic Village to work cohesively in handling rainwater. The first prong repurposes existing traffic medians into biofiltration and bioretention cells. This median design treats and captures rainwater, and creates a large green space, promoting the physical and mental well-being of those in the area. The second prong revitalises Pocket Park, a local green space. Pocket Park's new design aims to increase community engagement by creating a welcoming and usable space in the neighbourhood. The third prong is a constructed wetland, intended as the first step in reimagining the False Creek shoreline, to restore the coastline's natural protection in anticipation of sea level rise. By implementing all three designs, the Triple-Prong Design can create a more welcoming neighbourhood with a futuristic vision of coexistence between natural and built environment, meeting all three pillars of sustainability.

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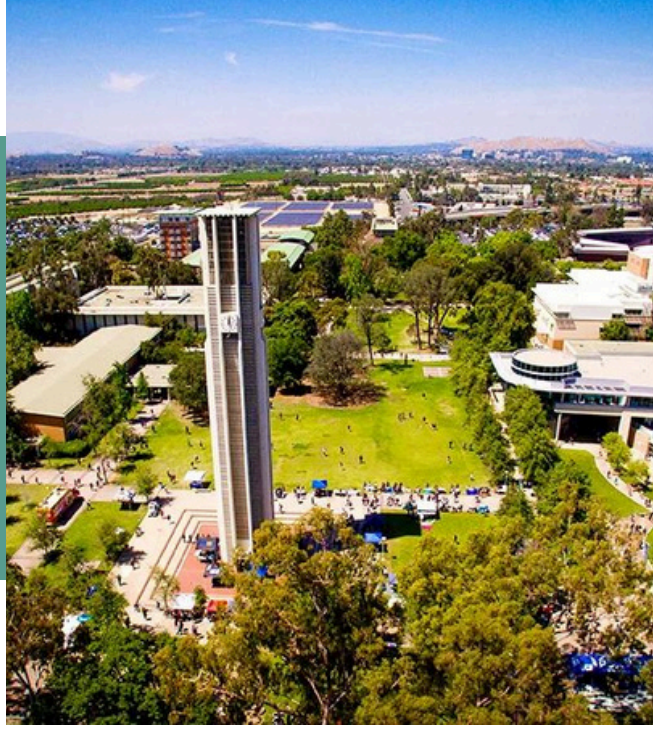
WATER ENVIRONMENT

UNIVERSITY OF CALIFORNIA, RIVERSIDE



EPA P3

Rising ammonia concentrations pose a significant environmental threat, yet current treatment technologies often overlook water conservation. This study introduces a novel 3-phase ammonia scrubber system designed to reduce ammonia concentrations by up to 99% while conserving water usage. Various filtration techniques were employed within the system, with initial results showing a 65-67% reduction in ammonia concentrations through biochar adsorption. Further testing is needed to validate these findings and assess the efficiency of the wood chip bioreactor. This research presents a promising approach to sustainable ammonia removal with minimized water consumption.

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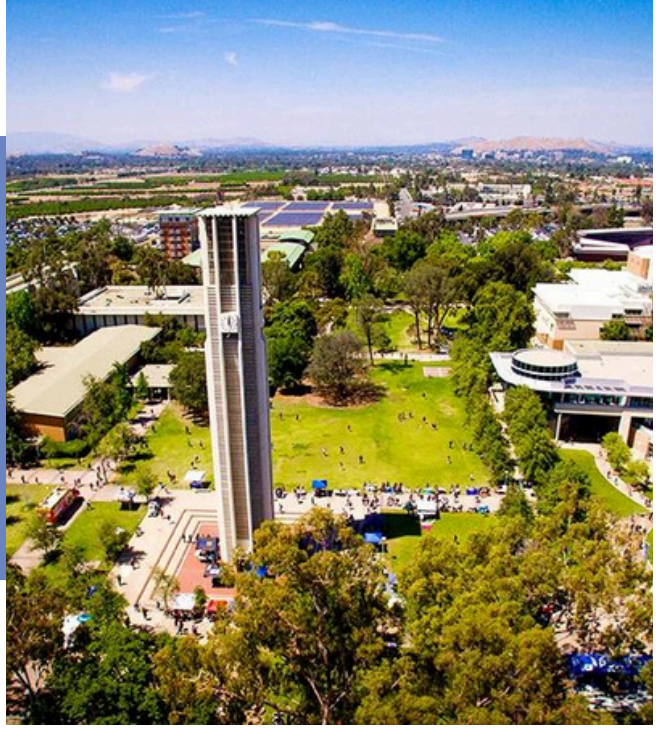
WASTEWATER

UNIVERSITY OF CALIFORNIA, RIVERSIDE



TDS REDUCTION PROJECT

As population increases, water conservation increases in California, specifically Riverside County. The Western Riverside County Regional Wastewater Authority (WRCRWA) wastewater treatment facility, located in Eastvale, CA, provides services to five nearby communities. Presently, WRCRWA is expecting a decrease of 52 gallons of wastewater per person per day (g/p/d) to a projected ultimate goal of 42 g/p/d. This is equivalent to a total of 14 million gallons per day (MGD) of wastewater to a projected ultimate goal of 11 MGD. With this in mind, current TDS levels are expected to reach 795 milligrams per liter (mg/L) if no treatment is implemented for the reduction of TDS in wastewater. The proposed solution is the addition of Reverse Osmosis treatment with chemical pretreatment. Treating 44% (4,840,000 gallons) of water leaving the dechlorination stage with reverse osmosis, including a flushing system and a neutralization tank will result in a 78% permeate recovery. As a result, the final TDS concentration will be reduced to 495 mg/L in combined effluent, meeting NPDES and Title 22 Recycled Water Regulation. The RO permeate can be sold for revenue to offset costs. Our RO design will be able to potentially decrease PFAS concentration combatting future regulations.

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WASTEWATER

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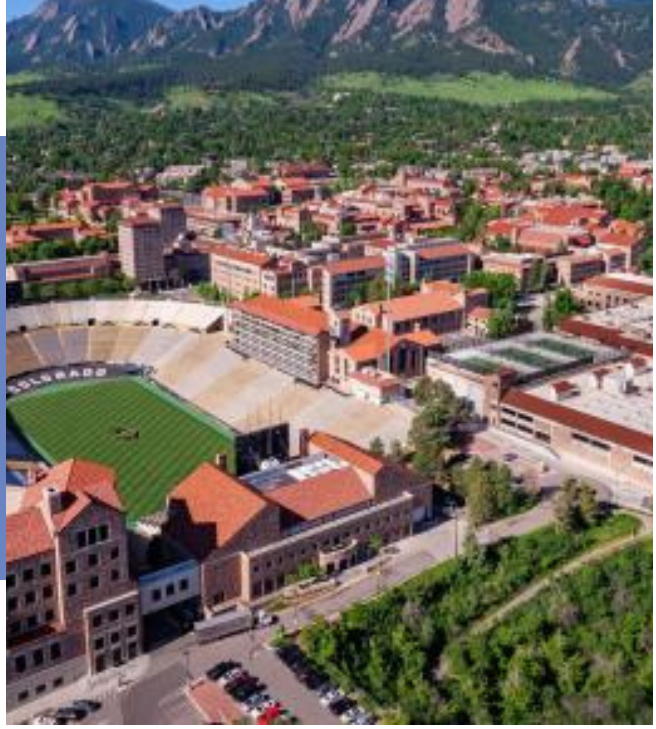

SOUTH PLATTE RENEW BIOSOLIDS UPDATES WITH PFAS CONSIDERATIONS

Solid Consultants is competing in the Rocky Mountain Water Environment Association (RMWEA) Student Design Competition, working with South Platte Renew (SPR). Through this competition, we upgraded the end-of-life solids handling process at SPR. Specifically, we assessed the solids process after the dissolved air flotation thickeners (DAFTs) through the biosolids end-use. The criteria for determining solutions are cost, regulatory compliance, public perception of SPR, safety, sustainability, and technical feasibility. The alternatives assessment is separated into two categories: treatment (referring specifically to anaerobic digestion) and post-treatment (occurring after the dewatering process). While the screening of alternatives assessed pretreatment, all options were removed as they occurred before the DAFT. After the screening of alternatives, we developed a multi-criteria decision matrix (MCDM). Using the MCDM, Solid Consultants' recommended process for treatment is temperature-phased anaerobic digestion (TPAD) with pyrolysis and bio-drying for post-treatment. This ensures excellent quality (EQ) biochar, which can become a new revenue stream for SPR. The net present value (NPV) of the system is -$41,200,000 over a 20-year lifespan. Solid Consultants is excited to move forward with SPR and create a preliminary design review (PDR) for the solids handling train with our proposed solution for the RMWEA competition

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WATER ENVIRONMENT

UNIVERSITY OF FLORIDA

OPTIMIZING STORMWATER CLARIFICATION SYSTEMS WITH AI FOR NUTRIENT REDUCTION

The Aqua Machina project scope encompasses the design of a clarification system receiving loads from a paved urban land use; a stormwater management condition found commonly across Florida and the USA. Considering the environmental and ecological conditions of the state and predicated on the promulgated 2024 Florida Clean Waterways Act, the design is based on load reduction for nutrients (total nitrogen, TN; total phosphorous, TP) and particulate matter (PM) as total suspended solids (TSS). The project encompasses four clarifier design alternatives: (A1) Regulatory Presumptive Guidance, (A2) No Baffles, (A3) Baffled, and (A4) Baffles Optimized with Artificial Intelligence (AI). These alternatives were developed using a large historical database of water chemistry and rainfall-runoff from an impervious parking area at the University of Florida, the client. Using a unit operations approach combined with AI (machine learning algorithms, specifically neural networks), the designs aim to examine clarifier configurations to minimize infrastructure resource expenditures and compare these to current regulatory guidelines for stormwater clarifier design in Florida. This project supports the client's AI initiatives and 2020-2030 Campus Master Plan stormwater goals, while also addressing public outreach and education. By incorporating AI, the project enhances the potential for optimizing stormwater treatment and control designs.

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WASTEWATER

UNIVERSITY OF NEVADA, LAS VEGAS

FROM DESERT TO DEVELOPMENT: INNOVATING WASTEWATER SOLUTIONS FOR ELDORADO VALLEY

Eldorado Valley (EV), located southeast of Henderson (COH) and southwest of Boulder City (BC), Nevada, is an undeveloped desert basin with limited water resources. COH recently annexed 8,000 acres here, planning mixed commercial, industrial, and residential development. Currently, there are no water or wastewater utilities serving EV. The area faces infrastructure challenges, requiring a maximum delivery capacity of 2,040 gallons per minute, with treated wastewater returning to Lake Mead to meet regulations. Our project aims to enhance the capacity and efficiency of EV's water and wastewater management systems to support current needs and future expansion while maintaining environmental standards. We propose designing wastewater infrastructure for EV by evaluating two alternatives. The first involves pumping wastewater to COH's Water Reclamation Facility. The second involves pumping to BC's facility, including existing facility and outfall upgrades. Both alternatives involve sewer interceptors, force mains, and lift stations. The final design aims to accommodate anticipated wastewater volumes and improve the overall resilience of the region's water systems.

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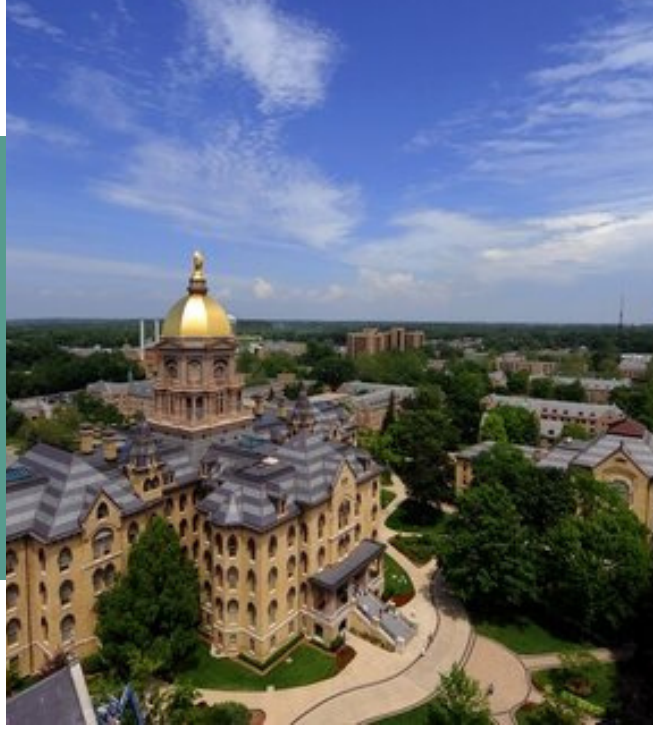
WATER ENVIRONMENT

UNIVERSITY OF NOTRE DAME



SOUTH BEND DRINKING WATER TREATMENT PLANT MEDIA REPLACEMENT

The North Wellfield Water Treatment Plant is one of the nine drinking water treatment plants serving the city of South Bend. The North Wellfield Water Treatment is also the largest of the nine plants which produces half of South Bend's drinking water at maximum production. The current filtration media has been in use since 1999. The plant needs a replacement of media for more effective filtration due to the age of media and loss of media from backwashing. In addition, repairs to the inner coating of the five filtration tanks must be completed. Our team is working on selecting new media for the gravity filtration tanks by analyzing current contaminant removal, cost estimating, and looking at specifications for different media options.

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WASTEWATER

UNIVERSITY OF SOUTH FLORIDA

FALKENBURG ADVANCED WASTEWATER TREATMENT FACILITY PROCESS INTENSIFICATION

The Hillsborough County Advanced Wastewater Treatment Facility (AWWTF) currently operates at approximately 92% of its permitted 12 million gallons per day (MGD) annual average daily flow (AADF). As the service area expands, the facility approaches its treatment capacity. Our team has been commissioned to investigate opportunities for process intensification to enhance the existing biological nutrient removal process without expanding the site footprint or constructing new tanks. The goal is to increase treatment capacity while upholding current effluent standards within limited site space. Various process intensification options have been explored, including Integrated Fixed Film Activated Sludge (IFAS), Mobile Organic Biofilm (MOB), Activated Granular Sludge (AGS), Densified Activated Sludge (DAS), Membrane Bioreactors (MBR), and Membrane Aerated Biofilm Reactors (MABRs). These processes underwent an evaluation using a pairwise comparison, supported by wastewater treatment process simulation software, to identify the most suitable retrofit solution given the site constraints. The proposed solution was an MBR system; given that FAWWTP had previously complained about the oxidation ditches' footprint and efficiency, the proposed design retrofits the existing basins into a modified Bardenpho process with an MBR.

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WATER ENVIRONMENT

UNIVERSITY OF TENNESSEE KNOXVILLE

AUTOMATED INTAKE VALVE CONTROL SYSTEMS FOR RURAL COMMUNITY WATER SYSTEM

Remote villages across Panama lack reliable infrastructure to consistently deliver clean water without being damaged. River fed gravity water systems are commonly used to supply nearby mountain communities, but the systems are susceptible to damage from storm debris transported by the elevated water levels and water quality issues leading to piping obstruction from high sedimentation. To protect the intake from damage via debris and prevent sedimentation buildup within the existing piping, a protected automated water intake system is required to control water intake during high turbidity and increased water levels. Considering socioeconomic conditions and introducing the appropriate levels of technology, a “high-tech” and “low-tech” solution were designed to meet the needs within the community of Wala, Panama. Furthermore, both of the developed systems are transferrable to rural communities experiencing similar environmental conditions. Prototypes of an electrically powered and mechanically powered automated intake system were developed to test accuracy of each actuation method and provide proof of concept for system designs. An operational guide was created, and life-cycle cost was estimated for both control system solutions, influenced by the results of the prototyping. Each solution promotes continued access to clean water while encouraging rural community self-sufficiency and system ownership.

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WASTEWATER

UTAH STATE UNIVERSITY

WASTEWATER TREATMENT FOR THE LITTLE MOUNTAIN SERVICE AREA

This document proposes alternatives and recommends a solution for the expansion of the Little Mountain Service Area (LMSA) wastewater treatment system, west of Ogden, Utah. The current wastewater system includes sewer collection piping, lift stations, and a three-cell lagoon system. LMSA's population is expected to grow significantly, and the existing system cannot treat the expected wastewater flow after development. Future discharge limits are also an issue that requires treatment expansion. The recommended solution is Type II reuse based on cost, sustainability, and adaptability. Type II reuse will be completed using a mechanical plant with a primary clarifier for anaerobic digestion and chemical phosphorus removal. This proposal was developed in response to the Water Environment Federation's Technical Exhibition and Conference (WEFTEC) 2024 Student Design Competition.

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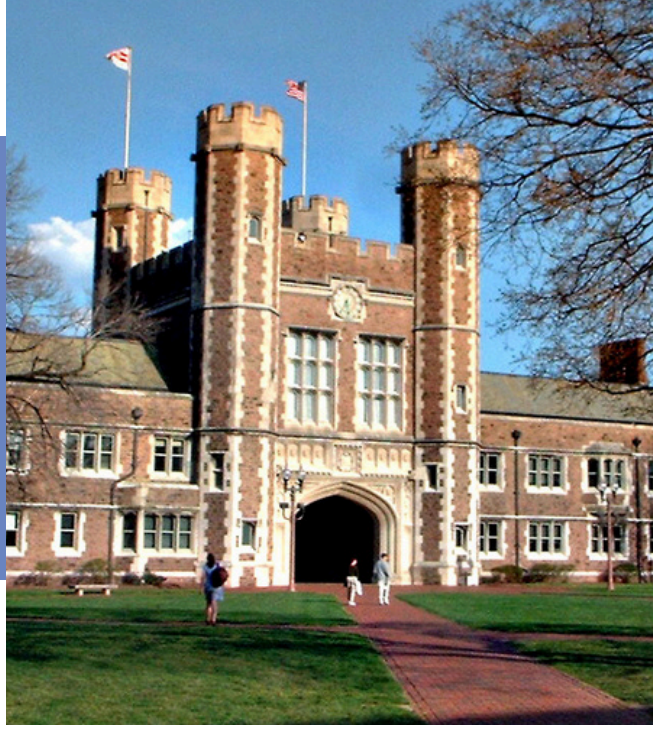
WASTEWATER

WASHINGTON UNIVERSITY IN ST. LOUIS



EFFICIENT MEMBRANE-ASSISTED BIOGAS UPGRADING FOR WASTEWATER TREATMENT

This project aims to enhance the operational sustainability of the local brewery plant by integrating an anaerobic digestion system to treat brewery wastewater. The primary objectives are to address waste management challenges and to produce renewable natural gas (RNG) as a valuable byproduct. Employing a novel up-flow three-phase membrane-assisted Hydrogen delivery biogas upgrading system for anaerobic digestion, the brewery can efficiently treat the complex, organic-rich composition of brewery effluent. Concurrently, the generated pipeline-quality RNG with its high Methane concentration can provide energy for plant operations or generate revenue utilizing the existing network of U.S. natural gas pipelines. Accounting for the Hydrogen cost, carbon reduction tax benefits, and methane production benefits, facilities expect to make $34,914 in annual profit through the anaerobic digestion process. The scale-up strategies for the existing wastewater treatment plants include the installation of hydrogen delivery modules or up-flow anaerobic sludge blanket (UASB) reactors. With over 1200 water treatment facilities equipped with anaerobic digesters and over 500 landfill gas projects, the project holds great potential. Implementing the membrane-assisted Hydrogen delivery biogas upgrading system promises to revolutionize sustainability practices in brewery plants, ensuring both environmental stewardship and economic viability for years to come.

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THANK YOU!

JUDGES:

We would like to thank our judges for volunteering their time. We are grateful for their presence and knowledge during the competition.

- Myriam Bou-Mekhayel
- Dan Christian
- Kaitie Gellerman
- Hazem Gheith
- Ray Gosen
- Isabel Hall
- Jonathan Perret
- James Reitmeier
- Maryam Shahab
- Grace Wang
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- Grace Hesselbacher
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