UPDATES ON STATE FUNDED ONSITE WASTEWATER RESEARCH AT TEXAS A&M UNIVERSITY

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ABSTRACT

At the virtual 2020 NOWRA annual conference, Texas A&M University's On-Site Sewage Facility (OSSF) team members made presentations related to the first round of grant awards made by the Texas Commission on Environmental Quality (TCEQ) to fund three research projects. The field-scale research projects were designed to evaluate: (a) field-performance of aerobic treatment units under high-strength wastewater conditions and different dosing schemes, (b) three types of low-pressure-distribution design concepts, and (c) performance of two types of on-site wastewater reuse technologies under real-world operating conditions. Due to the pandemic shutdown beginning in March of 2020, laboratory and field work involving all three projects was delayed several months. However, progress continued under restricted conditions. By early fall 2020 field installations were completed for all projects and data collection commenced in December. All three experiments then suffered weather-related delays as Texas experienced a sever freezing event in February of 2021. Since March 2021, data collection for all experiments was on track. This paper presents details on the research questions addressed, experimental designs used, data collection plans, technical challenges, and preliminary results. Data collection will continue through July 2021 and final reports are due by mid-December.

INTRODUCTION

Research is necessary for advancement and progression of any industry, including the onsite wastewater industry. However, funding a strong and sustained research program in the field of onsite wastewater treatment systems at a national or state level remains quite challenging. During mid-20th Century, the U. S. Environmental Protection Agency (US EPA) supported and funded several research and demonstration projects to advance the development of both conventional and alternative onsite wastewater treatment and effluent dispersal technologies. Findings from the EPA funded research projects were published routinely until 2006 in the national symposiums conducted by American Society of Agricultural Engineering (ASAE, now knows as ASABE) as well as at the annual national conferences organized by NOWRA.

The value of funding onsite wastewater research, in a sustained manner, at a state level, was recognized by Texas state legislators in the late 1980s, mainly to support growing demand to develop onsite wastewater solutions for sites that were not suitable for conventional septic systems. Typically, population growth outside the sewer area relies on use of onsite wastewater systems, which in Texas are known as **O**n-**S**ite **S**ewage **F**acility or **OSSF**. During most of the 20th Century,

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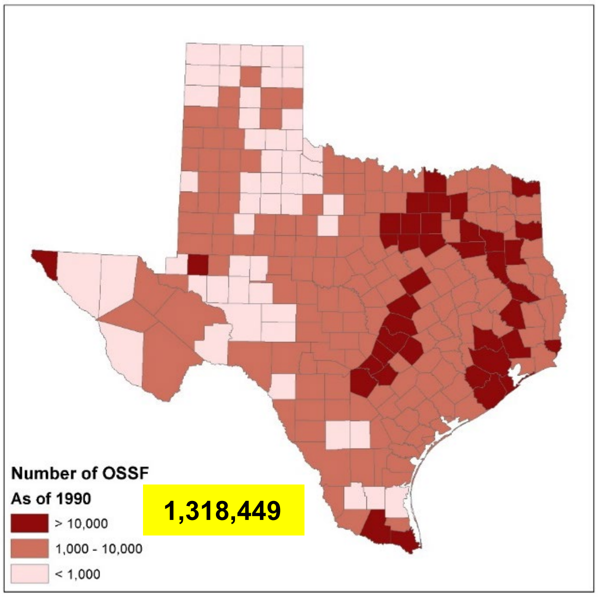
homes and businesses built outside the public sewer area used some form of a conventional septic tank and drain- field system, which relies primarily on soil for treating wastewater. However, since early 1990, use of aerobic systems gained momentum in Texas as use of OSSF in areas where soil and site conditions are not suitable for conventional systems. Figures 1 and 2 shows the change in the numbers of OSSF installed in Texas since 1990 and the distribution of the number of permits issued for conventional septic systems and aerobic treatment with spray systems.



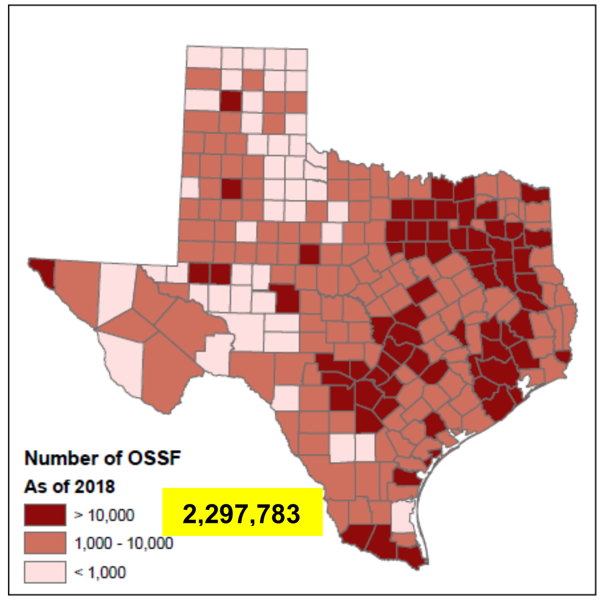


Figure 1. Onsite system density map of Texas as of 1990 (left) and as of 2018 (right). This information was compiled from 1990 Census data and permitting database from TCEQ.

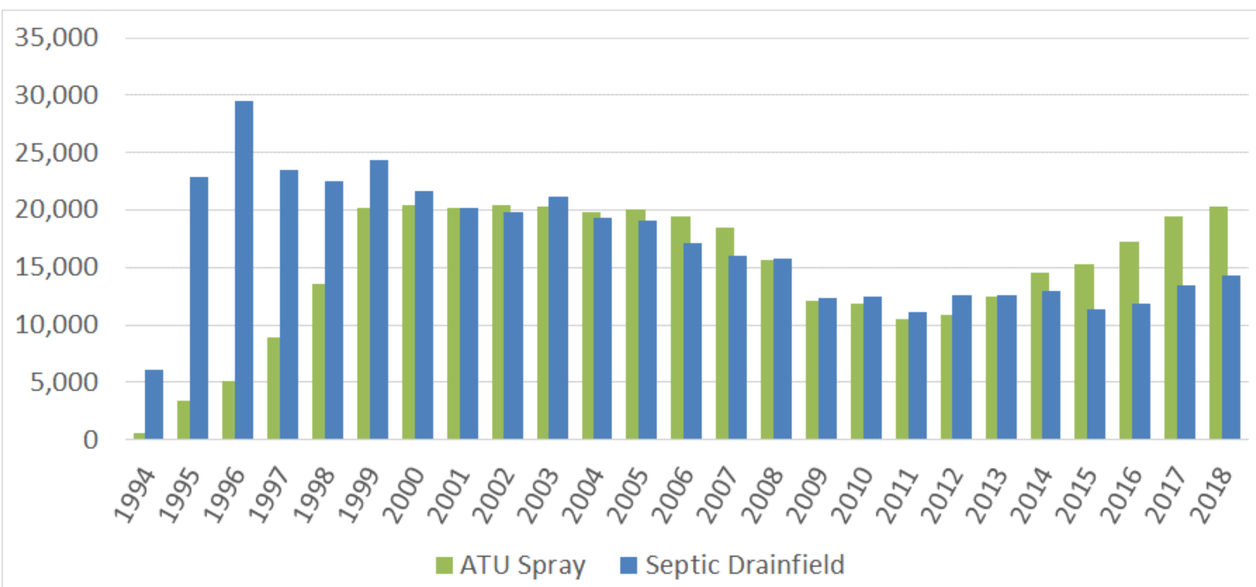


Figure 2: Trend showing increasing use of ATU (*Aerobic Treatment Unit*) Spray in Texas since mid-1990s. Y-axis shows the number of permits issued in Texas and X-axis is the Year.

In the 1989 71st Legislative Session, Texas legislators successfully passed a bill to amend the Title 5 Chapter 367 of the Health and Safety Code giving authority to the local permitting entities to "collect a $10 fee for each on-site wastewater treatment permit application processed." The bill also required the Texas Commission on Environmental Quality (TCEQ, the state regulatory agency, www.tceq.texas.gov) to "support applied research and demonstration projects" related to use of on-site wastewater treatment technology and systems. This was the beginning of a sustained funding process for supporting a state level effort in Texas that advanced use of aerobic treatment technologies in the state. TCEQ regulatory guidance document explains in detail what is the $10 fee is and how it is assessed and collected (TCEQ RG-078, 2003). The research grant program was run by TCEQ under the guidance and supervision of the On-Site Wastewater Treatment Research Council, members of which were appointed by the Governor. Under the state's sunset policy for legislation, every ten to twenty years all laws are required to be renewed in and if not renewed they automatically sunset, i.e., expire. The Health and Safety Code that authorized formation of the Research Council sunset in 2011 and was not renewed, thus ending the funding for research programs, but not ending the collection of $10 fees by TCEQ. Our dataset indicates that approximately 600,000 permits were issued during the past twenty years, generating about $6M research funds. This fund has supported more than 30 research projects over the past 20 years. One of those projects helped to establish an OSSF training and demonstration center on what is now called the Texas A&M System RELLIS Campus in Bryan, TX (Figure 3).

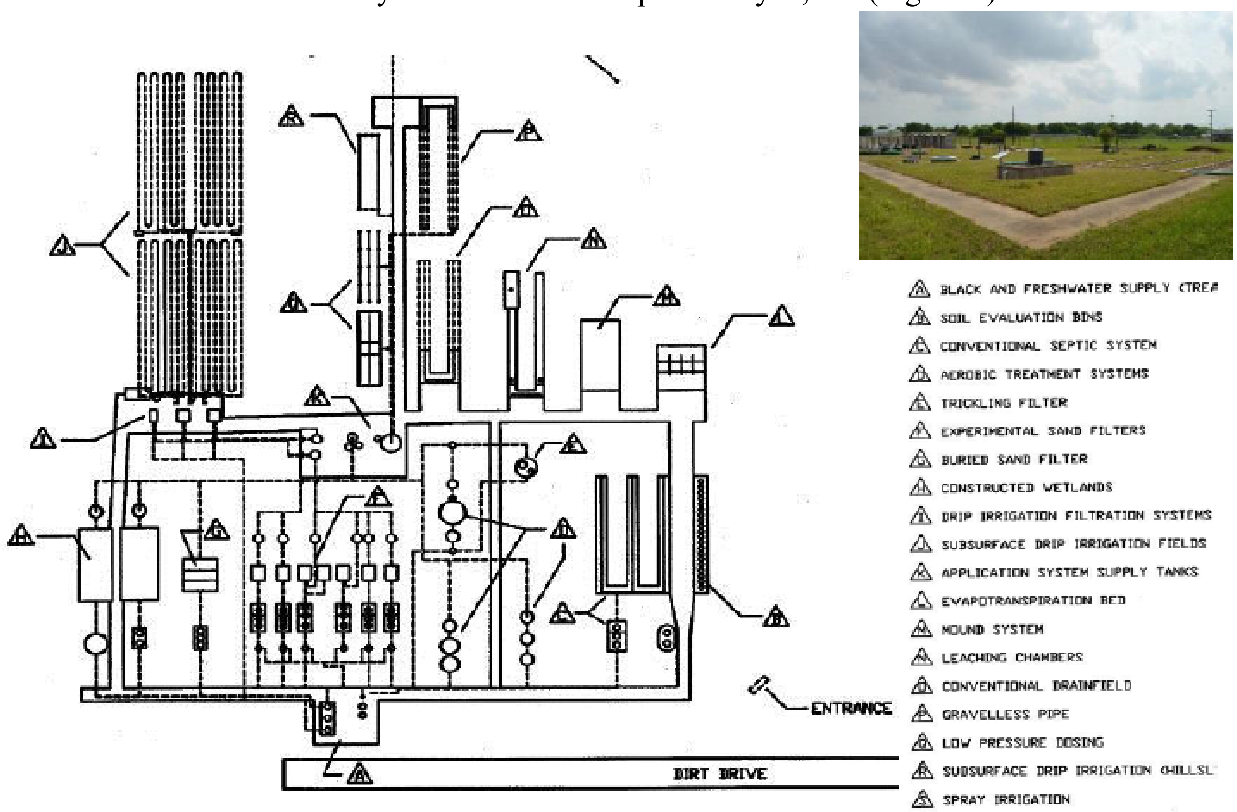


Figure 3: TAMU OSSF Training and Demonstration Center located on the RELLIS Campus in Bryan, TX.

Even though, the funding for research program ended in Fall of 2011, the $10 fee collection from localities remained in effect, which caused for concerns among both the private and public sector groups interested in research-based information to advance the field of on-site wastewater treatment. Texas has a strong wastewater industry association; TOWA (Texas Onsite Wastewater Association, www.txowa.org) championed efforts to renew the research funding by lobbying state legislators and working with state academic institutions like Texas A&M, Baylor, Texas Tech, and a few others who had been funded during the 1992 to 2012 period. With the help from public and private entities, House Bill 2771 was proposed and passed in the 85th Legislative Session that renewed the requirement for the state regulatory agency to award competitive grants and support applied research and demonstration projects regarding on-site wastewater treatment technology and systems for improving the quality of wastewater treatment and reducing the cost of providing wastewater treatment to consumers (Texas Legislative Online, House Bill 2771, 2017). Starting September 1, 2017, TCEQ reinstated the account to collect the $10 per permit fee and allocated most of the funds to support the research projects under a program called TOGP (**T**exas **O**n-Site Sewage Facility **G**rant **P**rogram). Summary of how the program works is posted on website at https://www.tceq.texas.gov/permitting/ossf/ossf-grant-program

METHODS

On February 4, 2019, TOGP issued the first Request for Grant Application (RFGA), in which following four research topics were identified as "Eligible Projects" that must be addressed to make a project eligible for funding (TCEQ RFGA No 582-19-93772, 2019):

1. Adequacy of Current Designs *of Aerobic Treatment Unit* with Higher Strength Wastewater
2. Dosing vs. Non-Dosing *of Aerobic Treatment Unit*
3. Implementation of Low-Pressure Dose Systems with Various Configurations
4. Black Water Non-Potable Reuse

The RFGA document contained details on each topic, submission process, and selection criteria based on a 100-point scale using nine distinct scoring criteria. A non-mandatory pre-proposal conference was held on February 11 and the response to the RFGA was due on April 1, 2019. The OSSF team from TAMU attended the pre-proposal meeting and clarify several items including an idea that would allow for combining the first and second topics into one project and preparing three responses to be submitted from two different agencies housed within the TAMU System, AgriLife Research and AgriLife Extension. Representatives from TCEQ were receptive to the concept, that allowed OSSF team from TAMU to prepare and submit three proposals to address four topics. Following three project proposals were submitted to TCEQ from TAMU's OSSF team, first from AgriLife Research while second and third from AgriLife Extension:

1. Evaluation of Equalized Dosing and High-Strength Wastewater on the Performance of Aerobic Treatment Units (ATU)
2. Implementation of Low-Pressure Dose Systems with Various Configurations (LPD)
3. Feasibility Study to Evaluate On-Site Treatment of Wastewater for Non-Potable Reuse (Reuse)

A two-page summery on each project with the names of Principal Investigator (PI) and Co-PIs is included in Appendix-A. Total maximum available funding was specified in the RFGA as $420,000. The budget proposed for the first project was ~$210,000 (~50% of the max) while that for the other two projects was ~ $105,000 ensuring the total for all three projects did not exceed the maximum available funds. On May 2, 2019, TAMU OSSF team received three emails from TCEQ indicating that the TOGP committee selected all three proposals for funding and asked the team to follow-up with the detailed instruction contained in the attachment. The sponsored research office at TAMU got involved and finalized the contract agreements with TCEQ to start the projects on September 1, 2019. While some members of the research team focused on finalizing the QAPP (Quality Assurance Project Plan) with TCEQ, others focused on getting the Center set-up to conduct the three research projects. Figure 4 shows aerial view of the Center prepared to conduct all three research projects using the raw wastewater collected daily from the RELLIS sewer line and amended in a feed tank.

Figure 4: Aerial view of the three research project areas showing the ATU, LPD and Reuse project locations at the TAMU's OSSF Center on RELLIS Campus.

Wastewater flow to the Center was increased by reconnecting the existing lift station with the main sewer line to meet the anticipated influent demand from all three research projects. Lift station pump is controlled by the water level in the 3,000-gallon feed tank to ensure adequate supply of raw wastewater and to return excess flow back to the main sewer line. Raw wastewater in the feed tank was amended using a pre-determined amount of modified animal feed (MAF) purchased from a local supplier. Paper presentation by Dr. Wolfe (Wolfe, et al, 2021) gives details on wastewater amendments (MAF) used in the feed-tank as well as in the pump-tank that dosed the ATU project.

Paper presentation by Dr. Bonaiti (Bonaiti, et al., 2021) gives details on the LPD project, while the detailed discussion in this paper focuses on the Reuse project. Main objective of the reuse project was to assess and observe performance of two NSF/ANSI Standard 350 approved onsite reuse technologies under the "real-world" operating conditions and to study the benefits and challenges related to use of a membrane filter in onsite industry. Note that onsite wastewater reuse for indoor use such as toilet flushing is NOT allowed under the TCEQ Rules 285 (On-Site Sewage Facility Rules Compilation, Revised May 2017), however, effluent quality standard necessary for such use are specified in TCEQ Rules 210 (The Use of Reclaimed Water, Subchapter F).

Figure 5 shows the plumbing diagram for the reuse research project. A membrane bioreactor (MBR) system from BioMicrobics™ has been in operation at the Center since April 2016 and has been studied by undergraduate research fellows during Research and Extension Experience for Undergraduate (REEU) program, details on which are presented elsewhere (Jantrania, et al, 2017). Based on the suggestions made by the advisory group in September 2019, a decision was made to include a non-MBR reuse technology to study the benefits and limitations of using MBR for onsite reuse systems. The original plan was to use NSF-Standard 40 Clearstream™ aerobic treatment unit (ATU), which was not certified by NSF as a reuse system, mainly because it was in operation at the Center since the beginning of the Center in 1995. However, during the visit by representatives from Clearstream™ in January 2020, a decision was made to replace the old ATU with a new unit Model 500DA performance of which was evaluated in year 2016 by the Gulf Coast Testing LLC under the ANSI 350 Reuse Technology Standards. Thus, both the technologies used for the reuse research projects have been tested and approved under the same standards NSF/ANSI Standard 350. Detailed test reports for both the technologies (copies obtained from the companies) indicate effluent quality meeting the reuse water standards as following:

1. Average cBOD and TSS <10 mg/L, maximum single sample <30 mg/L
2. Average Turbidity <5 NTU, maximum single sample <10 NTU
3. Geometric mean E. Coli <14 MPN/100 mL, maximum single sample <240 MPN/100 mL

Effluent from MBR was collected in a 500-gallon plastic tank donated by Infiltrator where ozone was injected for final polishing and disinfection, while the effluent from non-MBR was disinfected first by UV and then liquid chlorine was added to maintained residual chlorine level of at least 0.1 mg/L. The Ozone System is manufactured by a local company (Aerobic Guard). Influent and effluent samples were collected from December 2020 to August 2021 using four refrigerated composite samplers (ISCO Model Avalanche manufactured by Teledyne). Figure 6 shows the pictures of both the reuse technologies and composite samplers.

In February 2021 Texas experienced state-wide extreme cold/freezing conditions for one week, resulting in power-outages and frozen pipes at the research site. These conditions provided an opportunity to conduct an unscheduled stress test for both the reuse systems. The research team could not visit the test sites during the month of February, however a graduate student working on the projects was able to get to the site once and took several pictures of the site but could not conduct close observations due to icy conditions. Following the deep-freeze, no major problems were encountered other than two broken pressure lines and one broken meter connection. Effluent quality appeared to be normal. Lab samples were not collected during the freezing period, thus effluent quality data are not available during that time.

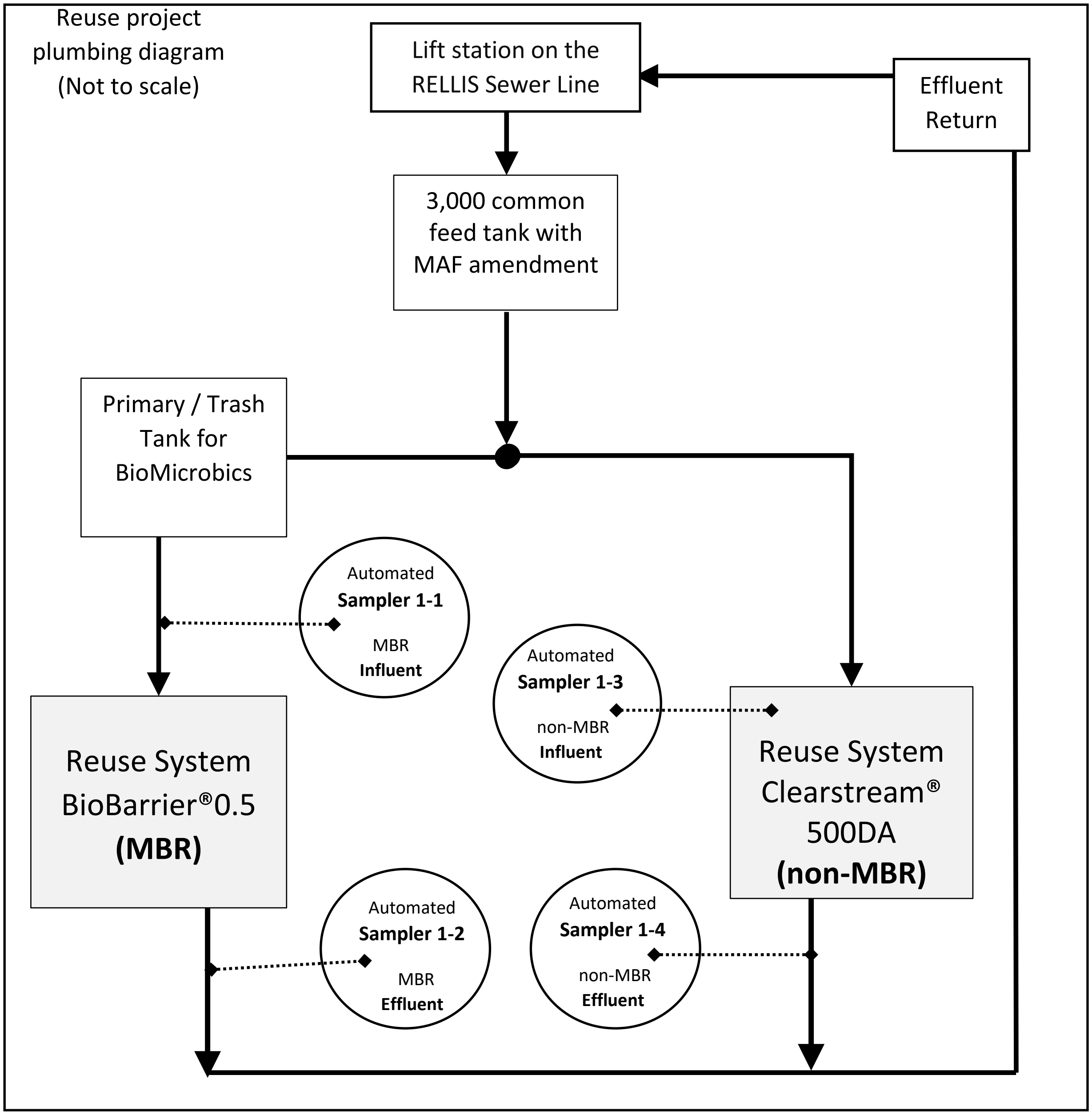


Figure 5: Flow path for the Reuse project. Note that the influent to both the reuse technologies was the same, however the daily flow rate varies due to the configuration of influent pipe.

Field evaluation of both the reuse systems started in December 2020 and ended in August 2021, during which following three abnormal conditions which are typically found in real-world were simulated during the effluent sampling period:

1. Turn off disinfection systems (Ozone for MBR and UV + Chlorine for non-MBR),
2. Increase BOD loading by adding one to two pounds of MAF in the trash tank, and
3. Turn off aeration systems to simulate failure and/or power outage conditions.

While first two abnormal conditions were simulated successfully, the third one was not because the MBR system is not designed to operate when aeration is turned off for more than one hour.

TCEQ Rule 285 specifies that maintenance, testing, and reporting requirements aerobic treatment units and licensed service providers are available for servicing of these units. Thus, above mentioned abnormal operating conditions are not expected to last for more than three days. One of the goals of this research project is to determine if any additional requirements are needed for reuse technologies when they are approved for wide-spread use.

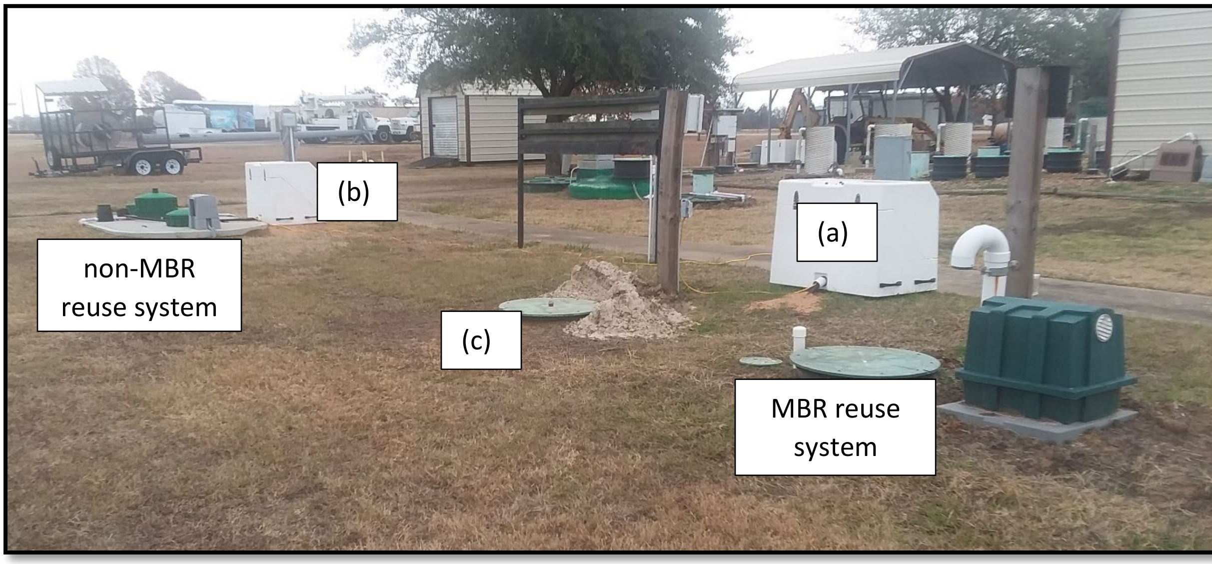


Figure 6: Field layout of the MBR and non-MBR reuse systems. (a) and (b) are the weather-proof boxes each housing two refrigerated composite samplers. (c) is ozone tank for MBR effluent.

RESULTS AND DISCUSSION

The entire two-year project period was divided into eight quarters for each project were submitted to TCEQ as required by the contract. Research program officially kicked-off with in-person meeting on RELLIS Campus on September 12th, 2019 (before COVID). 24 people representing industry, regulatory agency, and academia participated in the meeting and informal advisory group was formed with the intent to offer suggestions to the TAMU OSSF team on all aspects of three research projects. The second meeting of the group was held virtually on November 18th, 2020 (during COVID), and the final meeting is planned for early November 2021.

During the second and third quarters (February to May 2020), TAMU OSSF team, like the rest of the world, experienced major delays due to the COVID Pandemic shutdown. Field installation of on-site treatment units for ATU and Reuse projects as well as the construction of LPD filed took longer time than originally planned due to campus-wide requirements of social distances and fear of exposure to the virus. However, all the necessary field work was completed by the end of fifth quarter (November 2020), about six months later than planned.

Amount of daily wastewater flow from the RELLIS sewer to the Center was increased from less than 500 gallons per day (GPD) to more than 1,500 GPD by realigning the sewer line connections to the existing lift station. The required maximum flow to run all three projects was about 1,500

GPD. All treatment units, LPD field, and automatic composite samplers were operational by end of November 2020.

Field data collections began in December 2020 and concluded in August 2021. A detailed sampling scheduled was established for all three projects and was shared with a local private laboratory whose services were retained to collect samples, perform necessary analysis, and prepare monthly reports. Details on sampling process and data collections for ATU and LPD projects are presented by others at this conference. Summary of total number of samples collected for all three projects and preliminary data analysis of the raw wastewater (lift station), amended wastewater (feed-tank) are presented in Table 1 and 2 respectively. Note that the detailed data analysis work for the reuse project is expected to start in mid-September and final reports for all three projects are due to TCEQ on November 30, 2021.

Table 1: Number of samples collected for seven parameters from various locations and projects.

	Common for all Projects		Research Project			TOTAL
Parameter\Location	Lift Station	Feed Tank	ATU	LPD	Reuse	
BOD (5 day)	102	118	276	24	231	751
Total Suspended Solids	79	82	237	24	265	687
E. Coli					252	252
Turbidity					245	245
Ammonia as N	N/A	N/A	N/A	N/A	94	94
Nitrate/Nitrite as N					94	94
Total Kjeldahl Nitrogen as N					94	94
	181	*200*	*513*	*48*	*1275*	**2217**

The private contract lab visited the research site 10 times a month for nine months and collected samples from lift station, feed tank, four sampling points on Reuse project, three sampling points on ATU project, and one sampling point on the LPD project. Preliminary analysis of the data set downloaded from the lab's website shows total of 2,217 sample results of which 1,275 sample results are for the Reuse project. Only two effluent quality parameters (BOD5 and TSS) were analyzed for the ATU and LPD project, however five additional parameters (E. Coli, Turbidity, and three Nitrogen parameters) were analyzed for the Reuse project.

Table 2: Average BOD5 and TSS measured in Lift Station and Feed Tank during the sampling period. NOTE the variability in both the parameters was reduced in Feed Tank due to addition of MAF daily.

	Lift Station			Feed Tank		
Parameter	Min	Max	Avg	Min	Max	Avg
BOD (5 day), mg/L	ND	>2,200	185	125	1,210	364
TSS, mg/L	8	11,000	690	100	1,020	251

One of the major challenges faced for conducting onsite wastewater research in real-world using real wastewater flow from a campus sewer line is to reduce the variability in wastewater quality and obtain an average BOD5 and TSS levels within the range typically expected from an individual home. To achieve this goal, 10 lb/day of MAF was added in the feed tank which helped in both raising the average BOD5 from 185 to 364 mg/L and reduced variability as shown in Figure 7.

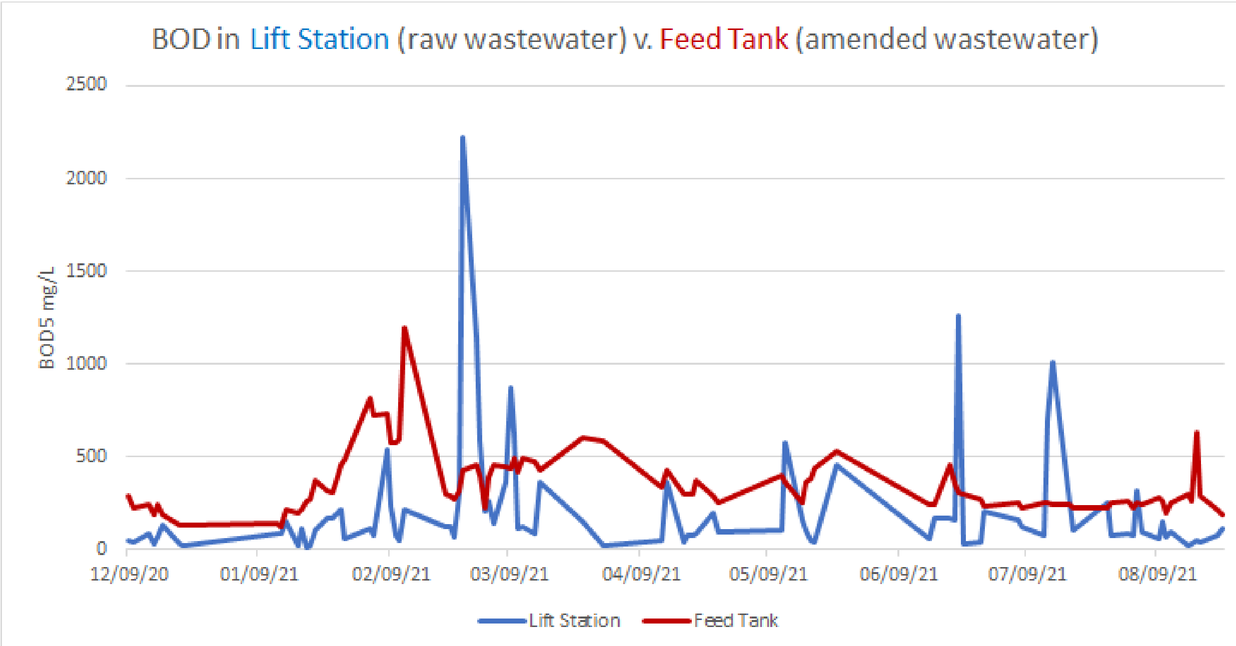


Figure 7: Effects of amending raw wastewater by daily addition of MAF in feed tank effluent BOD5. Similar effects were observed for TSS also.

Average Daily Flow (GPD) to the MBR and non-MBR systems was calculated from the weekly meter readings recorded by the graduate student working on these projects. Efforts were made to dose both the systems equally, due to hydraulics challenges experience after the deep freeze in February, the MBR system consistently received higher flow compared to non-MBR. Table 3 shows GPD data for both the reuse systems from December to July.

Table 3: Average Daily Flow as calculated from weekly meter readings to the Reuse technologies.

	Avg Daily Flow (GPD)	
Month	non-MBR	MBR
December	219	219
January	275	275
February	223	241
March	242	250
April	227	278
May	218	271
June	217	267
July	207	264
August	211	267

Effluent quality data analysis is still underway and expected to be completed before the Mega Conference in October. However, preliminary review of the data indicates that both the systems met the reuse effluent quality standards during the normal operating conditions but failed to meet the standards during the month of February due to abnormal operating conditions caused by deep freeze and when the disinfection systems were turned off. However, increasing organic loading did not affect the final effluent quality.

CONCLUSIONS

Unlike many other states, value of funding onsite wastewater research was recognized by Texas state legislators in the late 1980s. A state law passed in 1989 authorized the state agency to collect $10 per permit to support research related to onsite wastewater subject. The state funded research programs started in 1991 and ended in 2011, however during that 20-year period approximately $6.25 million worth of research projects were funds. One of those projects established a research and training center for onsite wastewater treatment on a Texas A&M University Campus that is still active in conducting state and federally funded research and extension programs. The research funding was reinstated in 2017 and first round of funding was awarded to TAMU in 2019 that has supported three research projects for a two-year period.

Three research projects were conducted on the OSSF Center on TAMU RELLIS Campus in Bryan, TX where amended raw wastewater from the campus sewer was used for answering the four questions raised in the Request for Grant Application issued by TCEQ. The COVID Pandemic delayed the field work by several weeks from March 2020 to June 2020, which delayed the start of field sampling till December 2020. From December 2020 to August 2021, more than 2200 samples were collected by a private lab and preliminary data analysis indicate that the TAMU research team will be able to answer for all four questions in their final report. The final report is expected to be submitted to TCEQ by November 30, 2021. Meanwhile, the TAMU team responded to the second round of TOGP RFGA in June 2021 and is waiting to hear back from TCEQ about continuing the state funded research program to find answers for new questions. More states should adopt the Texas model for funding onsite wastewater research programs.

LITERATURE

Bonaiti G., Jantrania A., Wolfe W, Gerlich R., 2021, "Onsite Wastewater Research Program at the Texas A&M University: Low-Pressure Dosing Research," Paper Presentation at the Mega Conference organized by National Association Wastewater Recycling Association (NOWRA) in San Marcos, TX.

Jantrania A. and Munster C., 2017, "Getting Undergraduate Students Excited About Onsite Wastewater Treatment and Reuse," Paper Presentation at the Mega Conference organized by National Association Wastewater Recycling Association (NOWRA) in Dover, DE.

TCEQ, 2003, On-Site Wastewater Treatment Research Council Fee, RG-078, Revised September 2003. Texas Commission on Environmental Quality.

TCEQ, 2017, On-Site Sewage Facility (OSSF) Rules 285 Compilation, RG-472. (https://www.tceq.texas.gov/rules/indxpdf.html#285)

TCEQ, 2016, Use of Graywater and Alternative Onsite Water, Rules 210, Subchapter F. (https://www.tceq.texas.gov/assistance/water/reclaimed_water.html)

Wolf J., Jantrania A., Gerlich R., Bonaiti G., 2021, "Development and Application of a Synthetic High Strength Waste Formulation for Evaluating Aerobic Treatment Unit Performance," Paper Presentation at the Mega Conference organized by National Association Wastewater Recycling Association (NOWRA) in San Marcos, TX.

APPENDIX-A

Two-page description for the ATU, LPD, and Reuse projects.

Evaluation of Equalized Dosing and High-Strength Wastewater on the Performance of Aerobic Treatment Units (ATU)

Wolfe, Jantrania, Gerlich, and Bonaiti

Summary:

This research effort addresses two of the four eligible projects listed in TCEQ Solicitation 582-19-9377, **RT-2.3.1** and **RT-2.3.2**, questioning the adequacy of National Sanitation Foundation (NSF) Standard 40 (STD40) Aerobic Treatment Unit (ATU) designs under increasing organic strength, and the effect of equalized dosing on STD40 ATU designs. Multiple concentration-flow-dosing combinations will be evaluated to answer questions regarding ATU performance under changing water-use paradigms. Two identical ATUs will be installed and operated in parallel to address both topics simultaneously in order to maximize experimental efficiency. Four flow rates at 7 organic concentrations yielding 5 organic loads will be evaluated under demand-dosed and equalized time-dosed operation. Performance will be assessed by measuring differences in influent and effluent BOD_5 and TSS concentrations. Effect of equalized time dosing will be determined by comparison to simultaneous demand dosing results.

Objectives:

1. Identify the ATU most commonly used in Texas, based on issued permits and expert opinion;
2. Select experimental scenarios based on TCEQ rules, feedback from TCEQ, and TOWA;
3. Install two identical ATUs at the AgriLife On Site Sewage Training Center;
4. Utilize a common tank upstream of parallel ATU trains to control influent concentrations;
5. Assess individual ATU performance by using influent and effluent BOD/TSS concentrations and comparing them between demand dose and equalized time dose conditions.

Goal Matrix:

Goal 2 - Dosing Method

Goal 1 – Organic strength (BOD5,		STD40	Equalized
	STD40	ATU **Baseline** (adequate based on NSF report)	Does ATU performance **improve**?
	Increasing	Is ATU design **adequate*** for use?	Does ATU performance **improve**?

*Adequate = meets NSF Standard 40 effluent requirements

Note: STD40 = 3 doses per day, @35%, 25%, and 40% flow and Equalized = 12 equal doses per day

Research Questions:

Q1: Is current ATU design adequate when BOD5/TSS concentration increases due to:
(a) water conservation fixtures and/or (b) graywater reuse?
Q2: Does equalized time dosing improve ATU performance under:
(a) STD40 design concentration (b) increased concentrations and loads?

Experimental Design:

Research Topics 2.3.1 and 2.3.2						
Test Run*	Week	Unit A (demand dose)		Unit B (equalized dose)		Load
		[gal/day]	[mg/L]	[gal/day]	[mg/L]	[lb/day]
TR1	6	225.0	300	225.0	300	0.56
TR2	12	180.0	375	180.0	375	0.56
TR3	18	157.5	430	157.5	430	0.56
TR4	24	112.5	600	112.5	600	0.56
TR5	30	112.5	800	112.5	800	0.75
TR6	36	157.5	900	157.5	900	1.18
TR7	42	180.0	1000	180.0	1000	**1.50**
TR8	48	225.0	1000	225.0	1000	**1.88**
**6 weeks per run: 2-week equilibration, 2-week sampling, 2-week review and prep for next run*						

Hypotheses (generalized)

TR1-4

H_O: Current Standard 40 ATU design is adequate* under increasing BOD5/TSS concentrations resulting from water conservation fixtures and/or greywater reuse flow reductions

H_a: Current Standard 40 ATU design is not adequate

TR5-8

H_O: Current Standard 40 ATU design with equalized dosing is adequate* under increasing BOD5/TSS concentrations and loads due water conservation fixtures and/or greywater reuse flow reductions

H_a: Current Standard 40 ATU design with equalized dosing is not adequate

*meets NSF Standard 40 effluent requirement

Deliverables:

1. Determination of the most common ATU make/brand used in Texas;
2. Justification for experimental influent concentration, flow, and dosing schedule selections;
3. Experimental design with formal research questions and testable hypotheses;
4. Field and laboratory reports and records for all measurements;
5. Quarterly progress and budgetary reports;
6. Final report describing all results and findings.

<u>Implementation of Low-Pressure Dose Systems with Various Configurations (LPD)</u>

Bonaiti, Gerlich, Jantrania, and Wolfe

Summary:
This research effort addresses one of the four eligible projects listed in TCEQ Solicitation 582-19-9377, **RT-2.3.3**, which questions the adequacy of North Carolina State Sea Grant College Publication UNC-S82-03 currently used to aid in low-pressure dosing field design. The Solicitation suggests that "research is needed into whether the design can be improved" in terms of effluent distribution over time, and ability to maintain the distribution system.

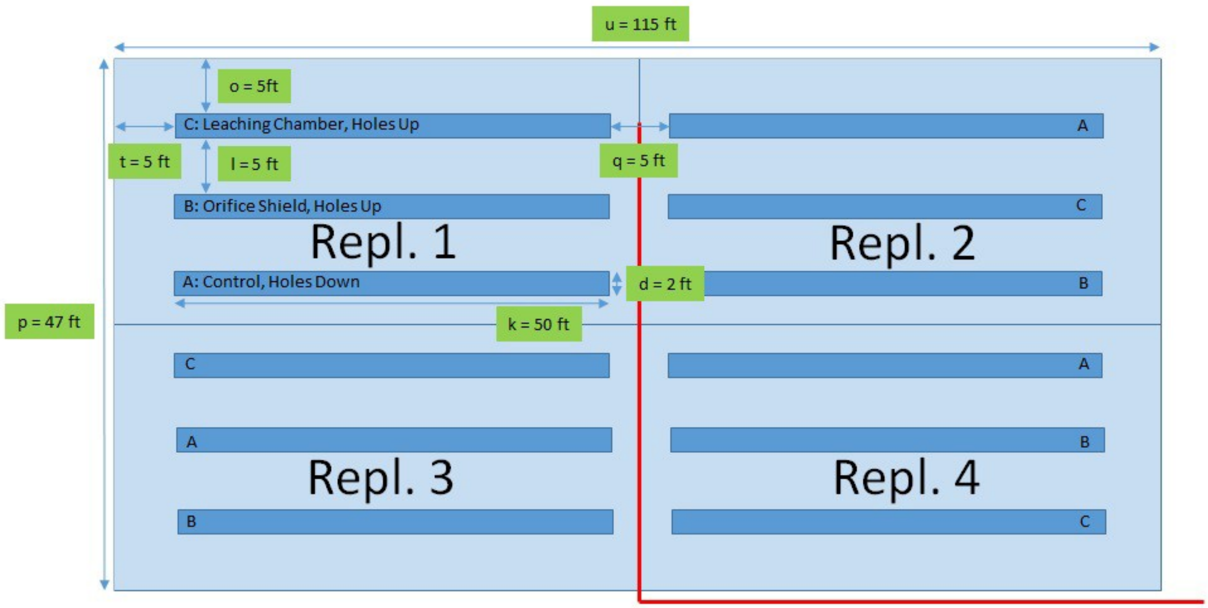
Texas A&M AgriLife Research will compare two new designs of low-pressure dosing trenches with the control. Both the new designs will have the distribution holes facing up, but one design will use orifice shields on top of each hole, and the other design will use leaching chambers in which the distribution pipe will be placed. The control configuration will be designed with holes facing down following 30 Texas Administrative Code (TAC) Chapter 285, and Publication UNC-S82-03. Septic tank effluent will be used to load the trenches at a loading rate based on the soil textures outlined in 30 (TAC), Chapter 285.

The experiment will be run for a period of one year. Soil moisture probes, pressure gauges, and a video camera will be used to observe and measure the uniformity of effluent distribution in the trenches, pressure on the distribution lines, and bio-mat build up. Monitoring will be conducted on a weekly basis. Raw wastewater and septic tank effluent samples will be collected and analyzed for Total Suspended Solids (TSS) and 5-day Biochemical Oxygen Demand (BOD5) on a monthly basis to determine if the strength is within the desired range.

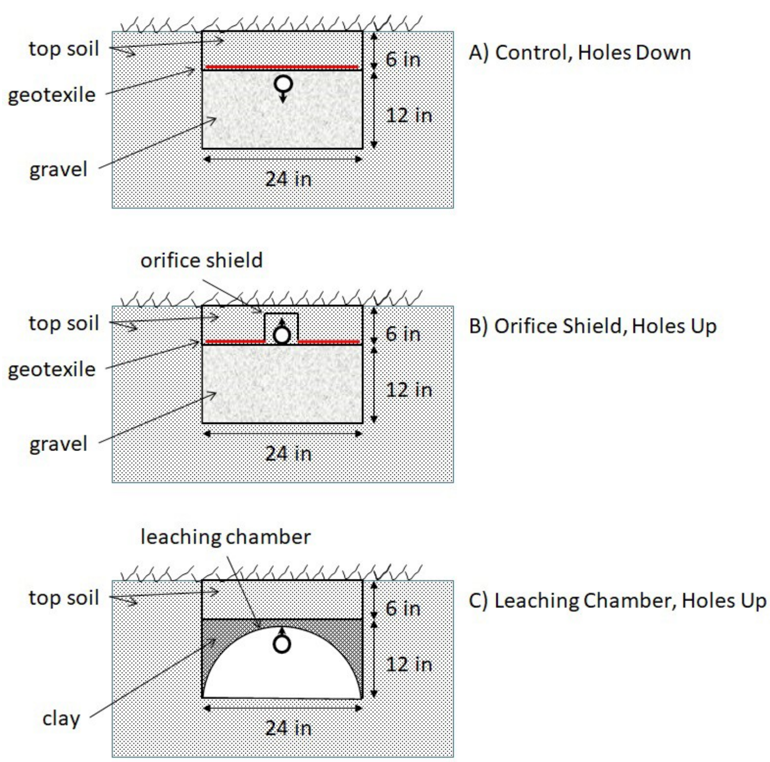
Goals:
1. Identify problems reported by regulators, owners and designers of LPD systems in Texas
2. Evaluate alternative LPD system designs
3. Develop LPD design recommendations to overcome those problems

Tasks:
- (September 1 - November 30, 2019): Create survey form based on interviews with regulators, owners, and license holders
- (December 1, 2019 - February 29, 2020): Obtain TCEQ approval of survey and conduct interviews and public education.
- (September 1, 2019 - February 29, 2020): Identify alternative LPD system designs and maintenance schemes based on literature review and additional surveys.
- (March 1 - May 31, 2020): Select design configurations, obtain TCEQ approval of experimental design, and obtain permit from county.
- (March 1 - August 31, 2020): Obtain permit and construct experimental LPD system.
- (June 1,2020-May 31, 2021): Run experiment, monitor waste distribution uniformity and maintenance requirements, and conduct statistical analysis on the data.
- (June 1 - August 31, 2021): Submit final report documenting surveys and field demonstration and recommendations for improving LPD design and maintenance along with suggested changes to Texas regulations

Experimental design



Cross section of the trenches for the three designs



Feasibility Study to Evaluate On-Site Treatment of Wastewater for Non-Potable Reuse (Reuse)

Jantrania, Gerlich, Bonaiti, and Wolfe

Summary:
This research effort addresses one of the four eligible projects listed in TCEQ Solicitation 582-19-9377, **RT-2.3.4**, questioning the need for modification of standard on-site wastewater treatment-train or maintenance requirements to improve quality and reliability of effluent for non-potable reuse purposes. The National Sanitation Foundation and American National Standards Institute (NSF/ANSI) Standard 350 are used for performance evaluation of on-site residential and commercial water reuse treatment technologies. However, most used aerobic treatment unit (ATU) in Texas is the NSF/ANSI Standard 40 units. NSF/ANSI Standard 350 effluent quality requirements are similar to those for toilet flushing reuse effluent quality specified in the TCEQ Chapter 210.82(8), but NSF/ANSI Standard 40 effluent quality requirements are not. BioMicrobics Model BioBarrier® MBR 0.5 and Clearstream® Model 500-DA on-site wastewater treatment technologies have been certified under NSF/ANSI Standards 350 as onsite wastewater reuse technologies. Both units will be used under "normal" and "abnormal" operating conditions in this project. Performance will be assessed by measuring *E. coli* and TSS concentrations in effluent to determine if the reuse water quality standards as specified in 30 TAC §210.82(8) are met under various operating conditions. Information on non-residential reuse facility operating in Harris County and at TXDOT rest area will be gathered, analyzed, and used along with the results from our experiment to determine the need for modification in technical or regulatory requirements.

Goals

1. To compare performance of two NSF/ANSI-350 approved technologies in a real-world operating condition against the effluent quality standards specified in 30 TAC §210.82(8);
2. To collect performance information on commercial reuse systems operating in Harris County and at TXDOT facilities;
3. To prepare a concise report specifying the need for modifications of standard on-site wastewater treatment-train or maintenance requirements to improve quality and reliability of effluent for non-potable reuse purposes.

Objectives:

1. Perform necessary changes to the BioBarrier® and Clearstream® on-site wastewater treatment technologies and get them ready for this experiment;
2. Finalize "normal" and "abnormal" operating conditions and operate the unit to collect data;
3. Conduct phone interview and site visits with Harris County and TXDOT to gather design and operational information on their non-potable reuse facilities;
4. Prepare data sets on effluent quality observed at the center and at other reuse facilities for analysis to determine answers to the research questions;
5. Prepare detailed and summary reports along with PowerPoint presentation for submittal.

Research Questions

Q1: Do NSF/ANSI-350 approved technologies with and without a membrane filter operating in a real-world condition meet the effluent quality requirements specified in 30 TAC §210.82(8)?
Q2: Is the experience with existing on-site reuse facilities operating in Harris County and at TXDOT rest-facilities satisfactory?
Q3: Are modifications needed to a standard on-site wastewater treatment train or maintenance requirements to improve quality and reliability of effluent for non-potable reuse?

Deliverables:

1. Experimental design specifying real world operating conditions for performance evaluation of the BioBarrier® MBR and Clearstream® units operating at the research center.
2. Justification for the experimental design conditions to simulate real-world operation.
3. Effluent quality data collected during the experimental evaluation of both the technologies;
4. Data and information gathered from Harris County and TXDOT facilities operating effluent reuse system for toilet flushing.
5. Quarterly progress and budgetary reports.
6. Final report describing all results and findings.

Revised Experimental Design:

- Operate reuse system under "normal" conditions (NC)
    - Influent flow within ±10% 225 GPD, BOD/TSS 300 mg/L, blower operation according to manufacturer's recommendations, alarm(s) attended within 24-hours.
- Operate reuse system under "abnormal" conditions (AC-1, AC-2, AC-3)
    - Disinfection unit malfunction from Thursday to Monday, fixed late Monday afternoon (AC-1).
    - Friends visiting for a few days adding extra waste (BOD and TSS) loading, (AC-2)
    - Power outage causing total shutdown of aeration and disinfection systems for Friday afternoon to Monday morning, about 48 hours (AC-3)

Reuse systems operation schedule for "normal" (NC) and "abnormal" (AC) conditions:

Test Run/Month	Operating Conditions	
TR0/December	NC	
TR1/January	NC	
TR2/February	NC & AC	NC till Feb 10; then AC due to unplanned natural conditions deep-freeze for a week and another week slow warming up
TR3/March	NC & AC-1 and AC-2	Recovering from deep-freeze to normal conditions and then turn off disinfection systems Thursday to Tuesday (3/18-3/23) while increasing BOD load by adding 1 lb./day chickenfeed in trash-tank.
TR4/April	NC & AC-3	Turn-off aeration units over the weekend from Friday (4/16) to Monday (4/19); abandon within hours, MBR design
TR5/May	NC	
TR6/June-Aug	NC	