Final Report
Grant Period: November 5, 2021 – November 29, 2023

For Texas On-Site Sewage Facility (OSSF) Research Contract #582-22-31143

Reduction of Wastewater Effluent from On-Site Sewage Facilities (E-Flow)

Report submitted to:

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May 10, 2024

TEXAS A&M AGRILIFE RESEARCH | EXTENSION

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Executive Summary

This research effort addresses one of four eligible projects listed in TCEQ Solicitation 582-21-10767, **RT-2.3.4**, states research is needed to identify technologies and applications that can be:

1. Utilized to eliminate liquid water discharge from on-site sewage facilities; and
2. Coupled with on-site sewage facilities to utilize roof and/or wall space for disposal area.

Under current 285 rules specifications for the design requirements, availability of *adequate and suitable disposal area* will continue to be a challenge for properties served by OSSFs. Residential and commercial properties are constantly faced with choosing between on-site disposal and the use/enjoyment of valuable real estate. In the realm of OSSFs, several aerobic treatment technologies are available to the public, however, adequate, and suitable effluent disposal area is proving to be less than available. The **goal** of this project is to develop design solutions for alternate disposal areas using Enhanced Vapor Effluent Discharge (EVED) technique to reduce effluent volume through increased atmospheric discharge.

While the results from this research project may not reduce costs associated with OSSFs, they will offer an option to trade-off use of valuable real estate space for a disposal system that could offer other beneficial usage. EVED technique, if proven reliable for reducing the liquid discharge, may offer a disposal solution for properties that are not currently suitable for development, especially those limited by space (i.e., available land area) for installing an OSSF. In this research project, we asked the following three research questions:

Q1: What effect does an EVED installed on top of a wetland cell have on liquid effluent discharge as compared to a wetland cell without EVED?

Q2: What is the operating experience of existing green-infrastructure buildings using green-roofs and onsite wastewater systems, in terms of reductions in liquid effluent discharge?

Q3: If an EVED technique evaluated in this project reduces liquid discharge by 50% or more then what modifications, if any, are needed in 30 TAC Chapter 285 to allow use of EVED technologies, such as a semi-climate control greenhouse with forced-air ventilation system?

Two wetland cells that are lined and connected to the two aerobic treatment units (ATUs) operating at the TAMU OSSF research facility were used to evaluate the performance of an EVED technique for reducing liquid discharge. A semi-climate control greenhouse was purchased and installed on top of one of the two wetland cells and both the wetland cells were dosed about 100 Gallons Per Day (GPD) effluent from the ATUs. A tipping bucket type innovative device was installed in the existing effluent collection container at the end of each wetland cell. Influent and effluent volume was recorded daily from mid-November 2022 to mid-November 2023 to determine the reduction in liquid discharge from the wetland cell with the EVED system. Temperature and relative humidity data were also collected from both wetland cells. Monthly averages were calculated from the daily data for influent, effluent, temperature, and relative humidity. Both wetland cells were planted uniformly with salt-tolerant wetland plants purchased from an AgriLife Extension Center in Houston to maximize evapotranspiration losses. Rainfall data were collected using an automated rain-gauge to determine gallons per day rain input into the open wetland cell.

The results from the one-year study showed that the wetland cell with the EVED technology reduced the liquid discharge by 48% compared to 11% from the wetland cell without the EVED technology. Capital cost of installing the semi-climate control greenhouse was $8,500.

Section 1. Introduction and Background

On April 29, 2021, TOGP issued the first Request for Grant Application (RFGA), in which the following four research topics were identified as "Eligible Projects" that must be addressed to make a project eligible for funding (TCEQ RFGA No 582-21-10767, 2021):

1. Wastewater Treatment Challenges at RV Parks
2. Proper Dosing Techniques and Application Rates for Drip Irrigation
3. Aerobic Treatment Units in the Real World (Sampling and New Data)
4. **Reduction of Wastewater Effluent from On-Site Sewage Facilities**

The RFGA stated the following explanation for the 4th research topic:
"Under current rules, adequate and suitable disposal area will continue to be a challenge for properties served by OSSFs. Residential and commercial properties are constantly faced with choosing between on-site disposal and the use/enjoyment of valuable real estate. Research is needed to identify technologies and applications that can be:

1. *Utilized to eliminate liquid water discharge from on-site sewage facilities; and*
2. *Coupled with on-site sewage facilities to utilize roof and/or wall space for disposal area.*

Concepts need to focus on eliminating disease transmission, high component durability, long service life, relatively cost-effective operation, and simple-to-maintain/exchange components. In the realm of OSSFs, treatment is attainable. Adequate and suitable disposal area is proving to be less than available. The goal is to develop solutions for alternate disposal areas."

Texas' population has been growing and is expected to grow during this century. While most of the dwellings in Texas are served by centralized water and wastewater (sewer) systems, about 20% are served by On-Site Sewage Facilities (OSSFs). Texas A&M University (TAMU) research and extension team (TAMU OSSF team) is involved in various activities related to OSSF, including maintaining an inventory of the OSSFs. The total number of dwellings served by OSSFs in Texas at end of year 2022 was more than 2.3 million, which is expected to grow at a rate of about 30,000 per year based on the historical data. Figure 1 shows increasing use of aerobic treatment unit (ATU) spray type OSSFs (measured as number of permits issued per year) in Texas to meet the demands in areas where soil and site conditions are not suitable for septic tank drain field type OSSFs. An ATU approved by TCEQ that meets NSF/ANSI Standard 40 (NSF, 2018), followed by either a chlorine or a UV (Ultraviolet) disinfection unit is required for ATU spray systems.

All OSSFs require a wastewater treatment and an effluent disposal system. §285.33 of the current OSSF regulations specify the criteria for various types of effluent disposal systems and required treatment system before disposal. Three categories of the disposal systems included in the current regulations are (a) Standard disposal system, (b) Proprietary disposal system, and (c) Nonstandard disposal systems. Each of these three categories has multiple sub-categories of disposal systems, which allows a designer to develop a site-specific disposal system design to meet the soil and site criteria specified in the regulations. The goal of the disposal system design is to determine the area (square footage, Sq.Ft.) necessary to dispose of the wastewater flow (gallons per day, GPD) generated by the dwelling based on the loading rate (GPD/Sq.Ft.) for the soil type or site location. Thus, two ways to reduce the required disposal area is either to reduce the liquid discharge volume for disposal or to increase the loading rate for subsurface and land disposal. This research focuses only on the reduction in liquid discharge volume by increasing vapor discharge volume.

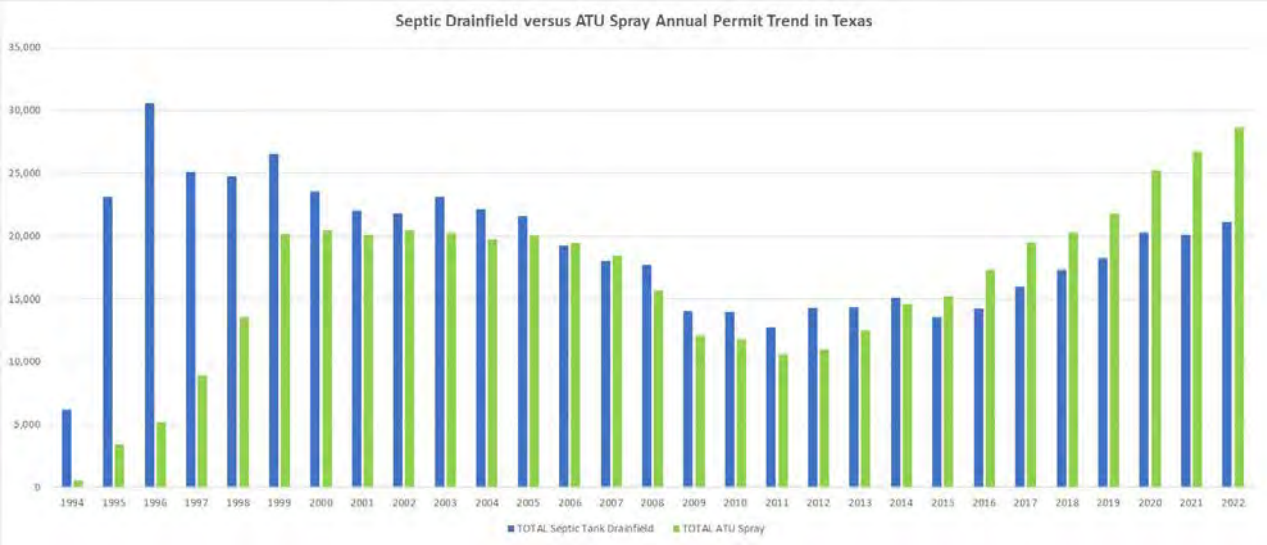


Figure 1: Trend showing increasing use of aerobic treatment unit (ATU) spray in Texas since mid-1990s. The Y-axis shows the number of permits issued in Texas and the X-axis is the year. Data compiled from the TCEQ OARS information received annually since year 2016.

Section 1.1 Sizing criteria specified in 30 Texas Administrative Code Chapter 285 regulations for determining land area for three types of disposal systems.

For subsurface (underground) disposal, OSSF Regulations 285, specifically the §285.91(1) specifies the effluent loading rate based on soil classification as following:

SOIL CLASS (Refer to Table VI)	LONG TERM APPLICATION (R_a) *GALLONS PER ABSORPTIVE AREA (SF) PER DAY
Ia	>0.50
Ib	0.38
II	0.25
III	0.20
IV	0.1

Figure 2: Loading rate for subsurface disposal system based on soil classification from the current OSSF Regulations. (Taken from the 285 Regulations)

The absorptive area required for effluent disposal increases significantly as the soil classification (texture) changes from Class Ib (sandy soil) to Class IV (clay soil). For example, the required absorption area for 100 gallons per day (GPD) system in sandy soil will be about 265 square feet (100 ÷ 0.38) compared to 1,000 square feet for clay soil (100 ÷ 0.1). Actual land area required to install the required square feet of absorption area is typically more and it is calculated using the

formula specified in the OSSF Regulation §285.33(b). Land area requirements can be reduced if the liquid gallons per day flow is reduced by allowing enhanced atmospheric discharge in the form of vapor, i.e., Enhanced Vapor Effluent Discharge (EVED) of the aerobic effluent. The allowable application rates for aerobically treated wastewater (disinfected effluent from a state approved ATU) are specified in §285.90 (1) as shown in Figure 3 based on the geographical location and the rate varies from as low as 0.035 gallons per day per square foot in the eastern part of the state to as high as 0.115 gallons per day per square foot in the western half of the state. Figure 3 shows the allowable loading rate for land application (spray) system. Thus, for 100 GPD system in the eastern part of the state, the area required in the eastern part of the state will be greater than 2,222 square feet (100 ÷ 0.045) compared to less than 1,163 square feet (100 ÷ 0.086) in the western half of the state.

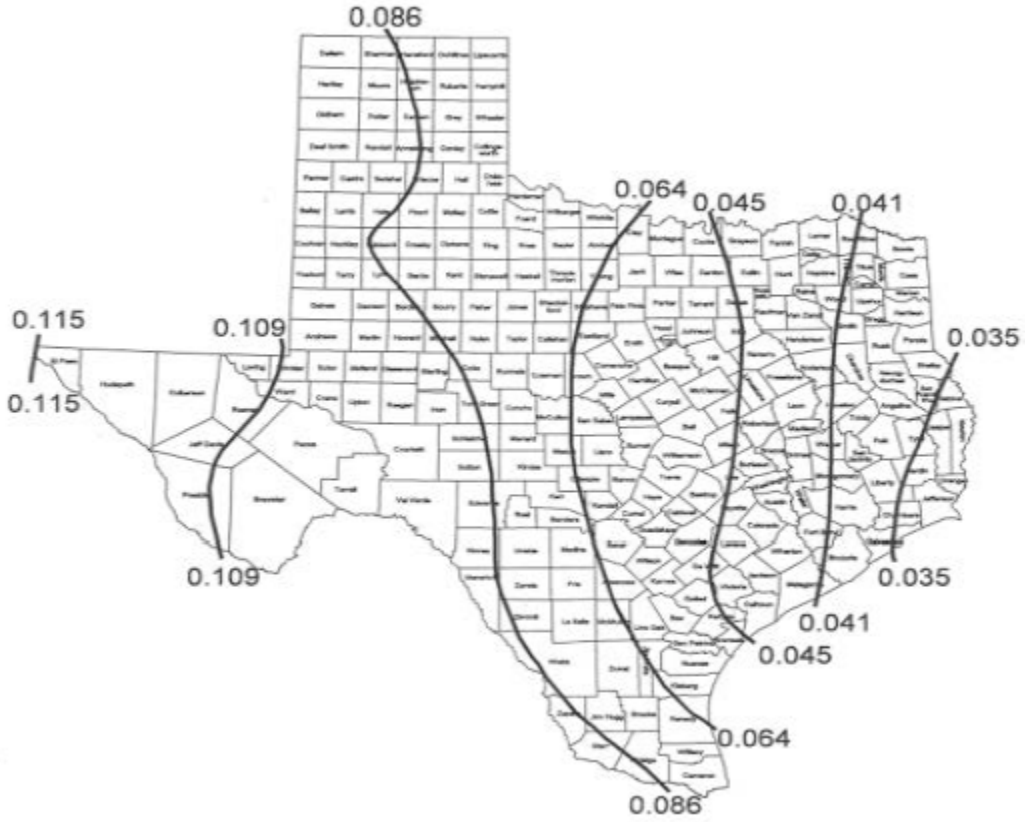


Figure 3: Application (Loading) rate for land application (surface dipsosal) system baesd on geographic location. (Taken from the 285 Regulations)

When soil site conditions are deemed as "unsuitable" for subsurface absorption (disposal) systems, the current 285 regulations allow use of an Evapotranspiration (ET) system in areas where annual average evaporation exceeds the annual average rainfall. The sizing requirements (loading rates) for an ET bed based on the net evaporation rate are specified in the §285.91(7) and are shown in Figure 4. The total area required for an ET system is calculated by the formula specified in §285.33(b)(2)(B), which is A = 1.6 x Q ÷ Ra, where Q is the daily flow (GPD), and Ra is the loading rate (GPD/Sq.Ft.). Information from the TCEQ's OSSF Permitting Database (OARS) indicates that about 17,400 permits were issued for ET systems between 1992 and 2022, which is less than 2% of the total permit issued during that period. Thus, ET systems are not widely used in Texas mainly because it requires a large land area. However, if the overall rate of ET is enhanced

by use of a Greenhouse type structure to cover the ET bed, then it is possible to reduce the area requirement. This research was designed to determine if the land-area requirements can be reduced significantly by using an EVED system in Bryan/College Station area.

REPORTING STATION	NET EVAPORATION*, RET INCHES/DAY
Amarillo	0.21
Austin	0.14
Beaumont	0.04
Big Spring	0.24
Brownsville	0.15
Chilicothe	0.20
Canyon Lake	0.15
College Station	0.12
Corpus Christi	0.15
Daingerfield	0.08
Dallas	0.14
El Paso	0.26
Fort Stockton	0.25
Houston	0.07
Laredo	0.23
Lubbock	0.21
Nacogdoches	0.06
San Antonio	0.15
San Angelo	0.23
Temple	0.15
Throckmorton	0.19
Tyler	0.08

Figure 4: Sizing requirements for an ET bed in Texas. (Taken from 285 Regulations).
NOTE that the conversion factor from inches/day to GPD/Sq.Ft. is 0.623; for example, the net evaporation rate for College Station is 0.12 inches/day = 0.07 GPD/Sq.Ft.

While the Texas OSSF regulations 285 allows the use of ET beds, the permitting records indicate only 17,390 permits issued for this option over the 30-year period between 1992 and 2022. Table 1 shows the list of Counties where >10 ET beds permits were issued in the past 30 years:

Table 1: List of Counties with 10 or more ET bed permits issued in the past 30 years:

County	ET Beds	Total	% ET Beds	County	ET Beds	Total	% ET Beds
GUADALUPE	2,213	9,103	24%	ELLIS	97	10,364	1%
BASTROP	2,123	19,988	11%	BURLESON	74	2,839	3%
CALDWELL	1,260	4,599	27%	VAL VERDE	74	1,773	4%
TRAVIS	1,167	21,695	5%	GONZALES	61	1,487	4%
GRIMES	957	6,055	16%	WISE	60	16,805	0%
HAYS	913	19,724	5%	LEE	57	1,908	3%
BELL	771	13,713	6%	HIDALGO	55	52,286	0%
WILLIAMSON	612	17,638	3%	BURNET	52	14,389	0%
COLLIN	398	20,852	2%	ZAPATA	51	216	24%
HALE	389	3,954	10%	MADISON	46	1,626	3%
TAYLOR	363	6,506	6%	COOKE	42	5,251	1%
BRAZOS	351	8,946	4%	SMITH	42	16,840	0%
MCLENNAN	350	12,303	3%	BROWN	40	2,771	1%
DENTON	326	17,827	2%	FANNIN	39	6,545	1%
FREESTONE	298	4,098	7%	GILLESPIE	39	5,717	1%
TARRANT	288	16,643	2%	LIMESTONE	36	4,483	1%
PARKER	280	30,476	1%	TCEQ	30	5,620	1%
CAMERON	251	13,945	2%	KENDALL	25	7,530	0.3%
COMAL	250	32,244	1%	MITCHELL	24	389	6%
FALLS	239	1,427	17%	GARZA	23	1,160	2%
BEXAR	219	30,688	1%	AUSTIN	22	5,859	0.4%
WASHINGTON	200	4,378	5%	KERR	22	5,327	0.4%
WEBB	196	1,048	19%	DALLAS	21	1,592	1%
FAYETTE	195	5,720	3%	UVALDE	21	2,579	1%
WILSON	174	9,265	2%	NAVARRO	20	3,486	1%
HUNT	173	13,541	1%	ROCKWALL	19	4,917	0.4%
MILAM	168	2,258	7%	LAMPASAS	17	3,752	0.5%
CLAY	144	1,166	12%	JONES	14	1,535	1%
WICHITA	130	1,960	7%	LIVE OAK	14	2,636	1%
CORYELL	124	2,264	5%	LLANO	14	4,211	0.3%
GRAYSON	124	13,785	1%	ORANGE	14	7,014	0.2%
MAVERICK	121	954	13%	ANGELINA	13	10,515	0.1%
KAUFMAN	117	15,866	1%	MEDINA	13	10,232	0.1%
HOOD	109	12,335	1%	PALO PINTO	13	3,105	0.4%
JOHNSON	108	19,150	1%	BOSQUE	12	2,054	1%
ARCHER	106	1,031	10%	ATASCOSA	11	6,532	0.2%
BANDERA	99	5,548	2%	KARNES	10	716	1%

It is interesting to note that the top four counties with more 1,000 ET beds are not located in far west Texas, where the allowable application (loading) rates for ET beds are the highest as shown in Figure 4, thus requiring less area for installation. It is also important to note that almost all the ET beds permitted in Texas are for disposal of septic tank effluent and not aerobic effluent.

Section 1.2 Consideration of options to reduce liquid discharge.

A climate control greenhouse is typically used for reducing water demand to grow crops; however, this research project was designed to determine effectiveness of a greenhouse to reduce liquid discharge, thus reducing land area requirements. TAMU OSSF team operates a hands-on training, research, and demonstration center on RELLIS Campus (Figure 5) with capacity to conduct a field scale applied research project to address the concerns raised under the Phase-I Texas Onsite Grant Program (TOGP-I). The center modified the research site to compare the performance of an EVED system to a non-EVED system. Figure 6 shows the plumbing diagram for the E-Flow project, where two identical ATUs (Clearstream Model N-500) are connected to two wetland cells, one with the Greenhouse (EVED) and one without (non-EVED). Both the wetland cells are identical in size (12' wide x 25' long x 1.5' deep) and both cells were dosed with the same quantity of aerobically treated wastewater (~100 GPD) thus allowing the comparison of effluent rate reduction between EVED and non-EVED systems.

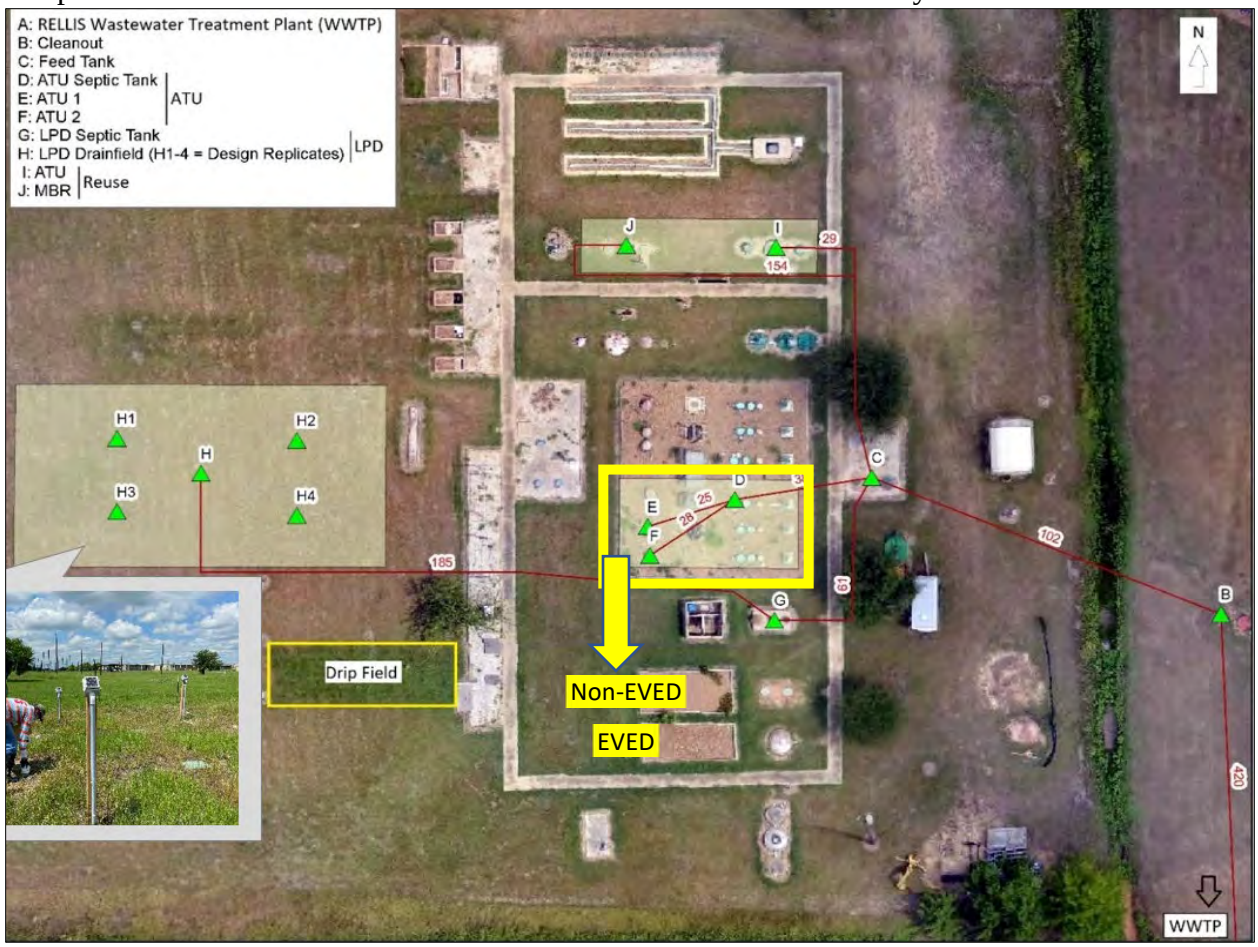


Figure 5: TAMU OSSF Center aerial view showing layout of the two ATUs, location of wetland cells used for evaluating performance of EVED and non-EVED systems and effluent flow line.

The RFGA specified indicated utilization of a roof and/or wall space for disposal area, meaning the concepts of using a green roof and/or green wall for disposal of adequately treated wastewater. While these two concepts were not investigated in this project, several observations were made of an existing green wall on the main campus of the Texas A&M University and an existing green roof that is being used for reuse of AC condensate in downtown Houston. Photo 1 shows both structures. Based on our observations, it was concluded that these structures are not suitable for integrating with an onsite sewage facility due to potential risks to public health from unintended overflow and/or discharge during heavy rain periods, as shown in Photo 2.

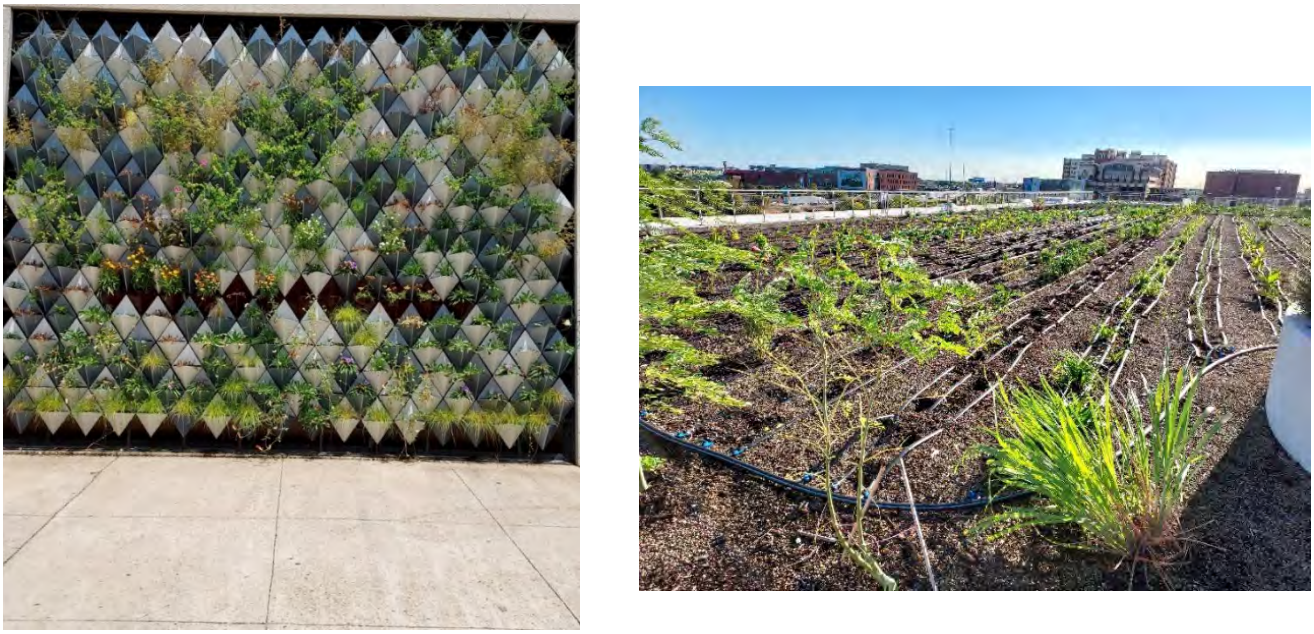


Photo 1: Green wall on TAMU main campus (L) and green roof in Houston (R)

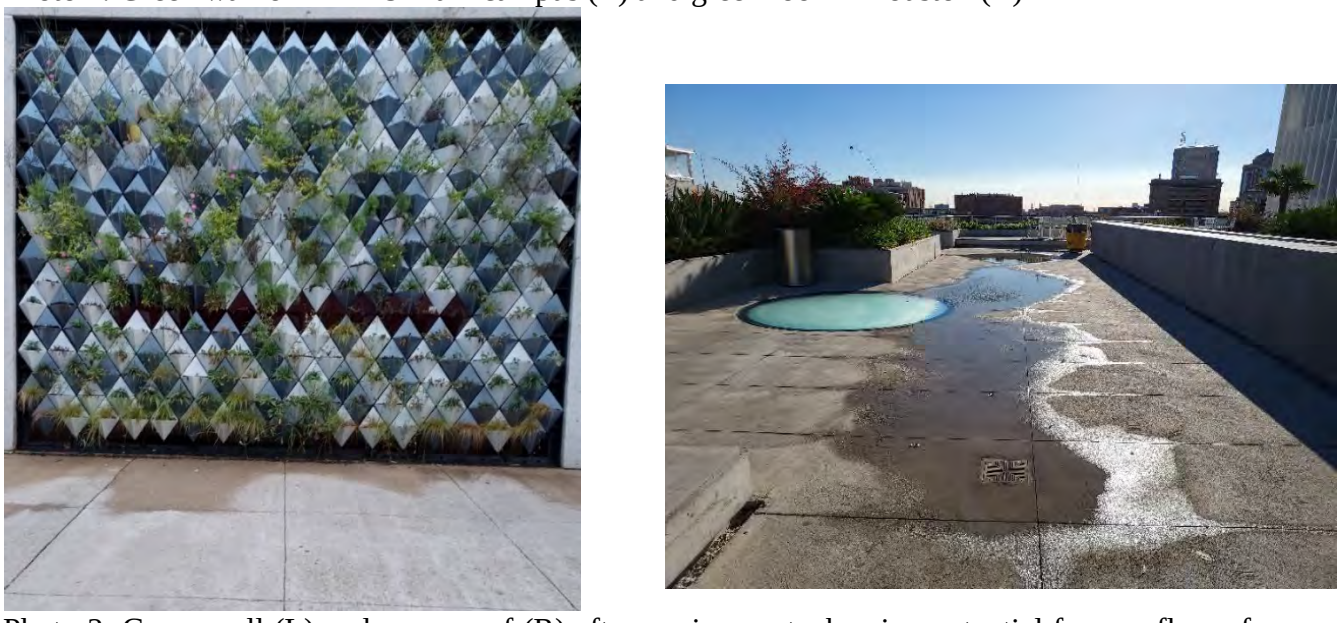


Photo 2: Green wall (L) and green roof (R) after a rain event, showing potential for overflow of effluent, thus not a suitable option for integration with an onsite sewage facility.

Finally, a new idea was conceptualized during the second quarter of this project, related to "dual use" drainfield area. Discussion with a private company (Infiltrator Water Technologies), that has developed design specifications and construction materials for using their traffic load bearing chambers under a parking lot. Dual-use systems will allow OSSF users to use the drainfield area for other beneficial use such as a parking lot. NOTE: TAC 285 regulations may prohibit this, however, discussions outside Texas indicate that this concept is utilized specifically for commercial projects where land is at a premium. An example case study shared by the company is of the Gillette Stadium, Home of the New England Patriots in Boston, MA. For this 68,000-seat stadium, there were two challenges, lack of an adequate amount of water to meet the demand and lack of land area for installation of a disposal system. These challenges were addressed by installing an on-site non-potable reuse system to meet the demand for flushing toilet reusing treated wastewater and use of the large parking lot for installation of a chamber system under the parking lot to dispose of excess effluent. Figure 6 shows photos taken from the case study of this project.

Figure 6: Installation of a chamber system under the parking lot (L), Stadium (M), and reuse water tank to meet the demand of toilet flushing. Photos are shared by Infiltrator.

Infiltrator Water System is ready to offer technical guidance and design documentation for installing a similar system in Texas, when necessary. Dr. Jantrania met with a regulator in one of the counties to discuss a potential application and demonstration of this concept for a commercial facility that is facing challenges for finding land area for installation of a subsurface disposal system but has land area available for the parking lot. However, that project is on hold as of the end of this project, thus no further actions were taken.

The rest of this report includes the details on the installation of an EVED system at the OSSF Center on RELLIS Campus, comparison of liquid discharge quantity from the EVED and non-EVED systems, and data analysis to determine effectiveness of the EVED system for reduction of the liquid discharge. While most of the research efforts were focused on studying the quantity of effluent (GPD), a few samples of the effluent at various points in the systems were also collected during the summer REEU (Research and Extension Experience for Undergraduate) program to determine the quality of the liquid. Sections 2 and 3 contain details on the methods and data analysis, while Section 4 contains the conclusions and final recommendations. Appendix-A includes the quarterly reports submitted during this project and Appendix-B contains the raw data set for the flow quantity (influent and effluent) as well as temperature, rainfall, and RH.

It is important to note that Ryan Gerlich, one of the research team members with the TAMU-OSSF team was instrumental in all aspects of retrofitting the Center for conducting this project.

Section 2. Material and Methods

The final contract for this project was signed on November 5th, 2021, and the concept for this project was discussed during the afternoon session of the 3rd annual meeting of the TOGP advisory committee held on the RELLIS Campus on November 10th, 2021. Due to delays in getting this project started, the QAPP document for the project was submitted to TCEQ in May 2022, which was approved in early October 2022. Thus, the modification of existing wetland to evaluate the EVED and non-EVED systems started only after the approval of the QAPP. During the early months of 2022, the research team did preliminary work to ensure that both the wetland cells and both the ATUs were ready for this project. Since the ATUs were used in the first phase of the TOGP program, they were operational and well maintained. The only modification needed was to connect both the ATUs to the wetland cells so that effluent can be dosed into wetland cells before returning to the RELLIS sewer line through the central discharge tank. The research team also contacted several greenhouse companies to get quotations for a custom build greenhouse that would fit one of the two wetland cells. Figure 7 was prepared to share with the greenhouse companies for the dimension of the greenhouse and the location where it will need to be built. It was decided that the south-side (facing left when seen from the front end) wetland cell will be covered with the greenhouse and the other one would remain open.

Figure 7: Layout of the wetland cells with dimensions and spacing from the nearby structures. NOTE that the wetland cell on the south side is not shown in this figure. However, it is of the same size as the cell shown in this figure. Also, at this point only this wetland cell was receiving ATU effluent, thus it shows vegetation, and the other cell does not.

The wetland cell with the vegetation shown in Figure 7 has a lined bed with wooden frame around it, while the wetland cell on left of it is contained in a concrete container. Both cells were inspected for water leakage and the concrete wall was found to have several cracks, which were repaired using quick-settling concrete. Both cells were flushed using fresh water to remove

previously dosed wastewater and both cells were tested for watertightness by holding a constant water level for a day. Photo 3 shows a few pictures of fixing the concrete wall and holding a constant water level in the cell.

Photo 3: A few pictures of the repair work done to the concrete wall of the wetland cell.

A fully climate control greenhouse with an automated roof opening for removing humidity, as shown in Photo 4, to maximize reduction in liquid discharge has been in operation in Virginia since 1999 with great success (>90% reduction liquid discharge with reuse for toilet flushing). The company that delivered material to build the greenhouse used in Virginia is no longer in business, however, Dr. Jantrania found another company based in Mobile Alabama (Gothic Arch Greenhouse) that offers custom build greenhouse with full automation for climate control. After several phone conversations, the company sent a quotation for the total of $56,922.50 to install the greenhouse for this project. The price was not affordable for this project, nor would it be affordable for a homeowner interested in this type of system to reduce liquid discharge.

Photo 4: Virginia greenhouse project photo in Year 1999 (L) and photo in Year 2019 (R)

With the help from Texas A&M AgriLife Director for the Facilities & Planning, another company in San Antonio, Texas was identified and contacted in late August 2022. The company is called Greenhouse etc. (https://www.greenhousestx.net/) and they offered semi-climate control with manual ventilation controls, and a handle to open and close a window at one end of the

greenhouse, for a total cost of less than $10,000. The final quotation from the company was for $8,341 for complete installation of their product called “11x24 Big Barn Greenhouse.” The company representative came to the Center and installed the greenhouse in one day, indicating that such a system would be feasible to integrate with the OSSF installation work! Photo 5 shows the wetland cells before and after installation of the Greenhouse. Note that in this report, the wetland cell with the Greenhouse is referred to as either Greenhouse or EVED system and the cell without the Greenhouse is referred to as either Open or non-EVED system.

Photo 5: Wetland cells before (L) and after installation of the Greenhouse (R)
NOTE: Ignore the metal frame on the wetland next to the Greenhouse, that was removed before the start of this research project.

Texas A&M AgriLife Extension operates a wetland plant nursery in the Houston area, from which salt talrent wetland plants were obtained for planning in both wetland cells along with the canna lylly orginally present in the open wetland. Equal number of plants were planted in both the cells. Photo 6 shows the wetland with plants planted in early October 2022.

Photo 6: Wetland plants planted in both the cells (October 6, 2022)
NOTE: The planters shown in the open wetland cells were eventually buried inside the gravel.
One final challenge associated with this project was to develop and implement a method for

measuring the gravity discharge from both the wetland cells. A tipping bucket, typically used in a gravity drainfield for even distribution was the answer to address that challenge. Ryan Gerlich from the reseach team designed and built a gravity flow measurement system using the tipping bucket (available from Polylok, Inc.) and Hobo data logger (*HOBO® MX2300 Series Data Logger*) system that will allow to accurately measure the gravity discharge volume on a daily basis from both the cells. Photo 7 shows several pictures of the effluent discharge measurement system installed at the outlet end of both the wetland cells. Each tip of the tipping bucket = 1.5 gallons.

Photo 7: From Left to Right, Tipping bucket, installed at the effluent end, and Hobo data logger.
NOTE: Contact Ryan to get details on how he designed and built this system!

Measuring influent on a daily basis was relatively easy as both the wetlands were dosed using a pump system installed at the end of the two ATUs used for this project, and the ATUs were dosed using two separate pumps operated using a digial control panel with the input from the flow meters. Photo 8 below shows the the digital meters recording the daily flows to the Greehouse (i.e., EVED) and the Open Wetland (i.e., non-EVED) system. Of course, this is not the perfect solution for collecting daily influent data because the digital meter readings are stored for only 7 days, thus one of the graduate students assisting with this project was assigned a task to take digital pictures once a week and maintain a spreadsheet to determine daily flow during this project. In the future, when adequate funding becomes available, TAMU OSSF research team expects to upgrade this system such that the digital data are collected and stored on an annual basis, not just weekly.

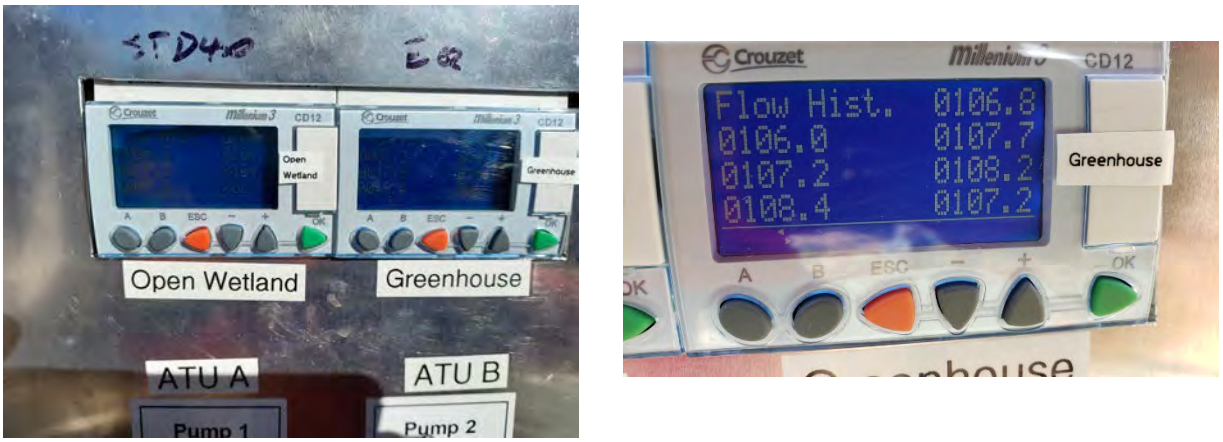


Photo 8: Digital flow recorders for influent (L), and example of the flow data for one week (R).

Overall plumbing diagram for this research project is presented in Figure 8.

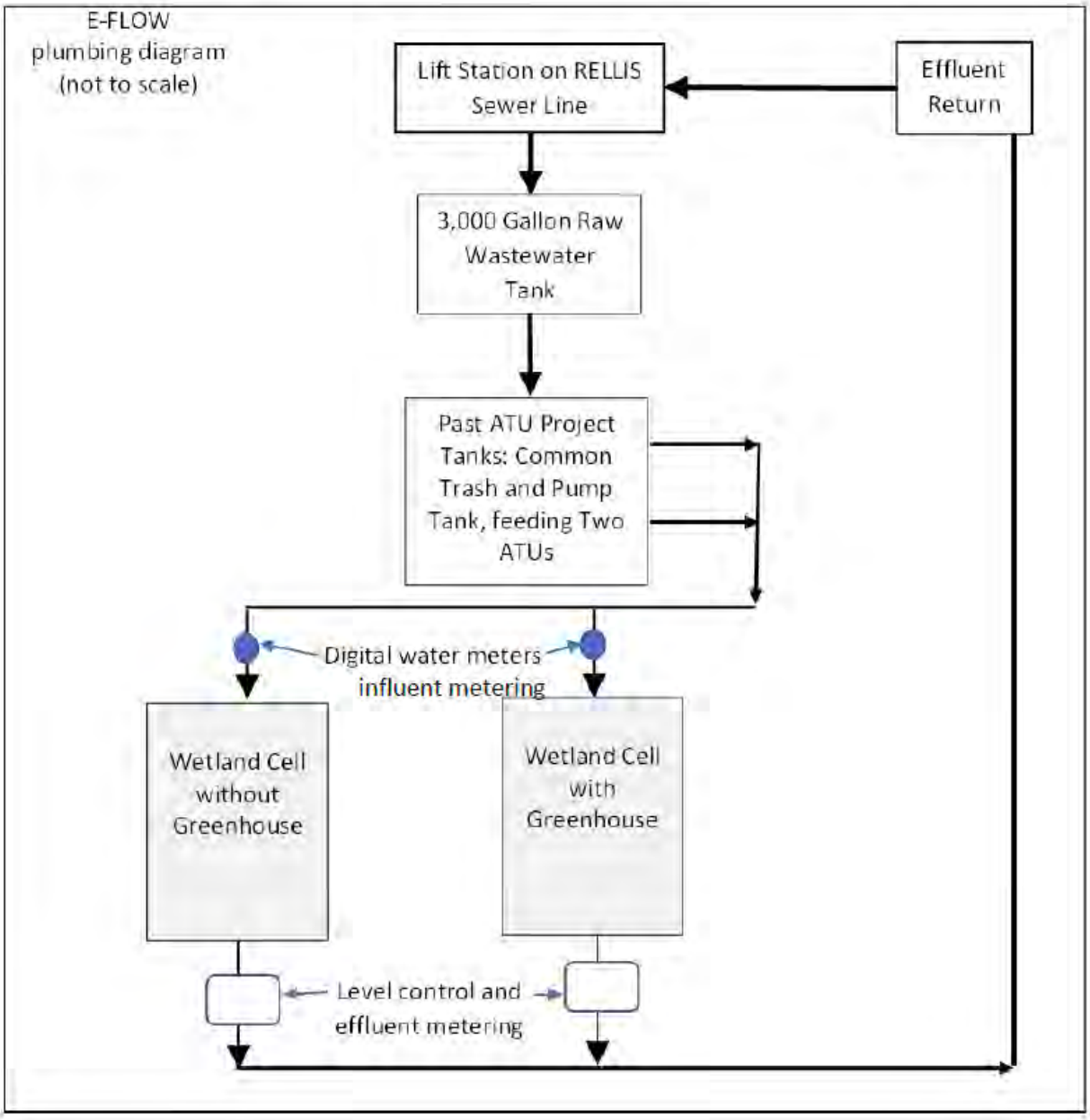


Figure 8: Plumbing configuration for the E-Flow project
NOTE that the two ATUs used in this project are the same as those used in TOGP-I ATU evaluation project. However, for this project, both ATUs were time-dosed hourly and the total flow to each ATU was kept around 100 GPD. Wetland Cell without Greenhouse = non-EVED, and Wetland Cell with Greenhouse = EVED.

Both the systems were set up by mid-November 2022 for the experimenting and data collection started on November 17, 2022, with the goal of collecting one-year of data before the grant required date to end the project. Since the funding agency (TCEQ) agreed to extend the project end date from August 31, 2023, to November 29, 2023, the research team was able to collect and analyze the data set for the **one-year period** starting from November 16, 2022, to November 16, 2023. Graduate students working on this project helped with the data collection on a weekly basis.

Even though under the TOGP-II grant agreement, data collection for this project was officially completed after one year, the TAMU research team plans to continue collecting data after the end date to see the effects of long-term operation of the greenhouse in reducing liquid discharge. It is important to run this type of project for at least three years to understand the effectiveness of a natural system operating in the greenhouse as well as to understand the maintenance requirements of this type of natural system. During the TOGP-III phase, performances of EVED and non-EVED systems will be incorporated in Project 3, *"Flow Equalization or Dosing Refinement"* mainly to determine the reduction in liquid discharge at a higher hydraulic loading rate.

During the second quarter of the project, a new idea was conceptualized related to a "dual use" drainfield area. Dr. Jantrania contacted Infiltrator Water System that offers design specifications and construction materials for installing an effluent disposal system under a parking lot, thus allowing dual use of the area. Dual-use systems will allow OSSF users to use the drainfield area for other beneficial use such as a parking lot. Current 285 regulations may prohibit installation of a drainfield under a parking lot, however, project(s) done outside Texas indicate that this concept is utilized specifically for commercial projects where land is at a premium. To explore a potential field-demonstration site for such a project in Texas, Dr. Jantrania had a daylong meeting in Denton County with the DR during which one of the sites visited would be a potential candidate for installation of an effluent dispersal system under a paved parking lot. The DR shared details of the site including preliminary soil information and his notes from the "pre-development" meeting with the client who is planning to build a store on that site. The Infiltrator Water System agreed to offer their technical guidance to design a disposal system under the parking lot when the project moves forward. However, that project has not moved forward as of November 2023, thus that concept is not going to be able to be studied further at this point.

In late October 2022, Dr. Jantrania visited the green roof facility located in downtown Houston to see if this concept should be further investigated as an alternative site for disposal of treated wastewater. The Green roof located on top of the Post Houston (https://www.posthtx.com/) known as the Skyfarm, a one-acre urban food farm operated by Blackwood Educational Land Institute (https://blackwoodland.org/the-skyfarm-at-post-houston/). The Green Roof facility is built and operated to maximize use of AC condensate water for irrigation needed in the farm operated on the roof. This facility could make a very good place to monitor the amount of water lost through ET from the roof. However, there are no water meters installed at this facility to monitor the flow nor is it possible to monitor the discharge from the roof of excess water, which is diverted into the city stormwater drainage system. Based on the observations made during the site visit, several wet spots and standing water pool were noticed, indicating overflow (see Photo 1 and 2 in Section 1). Based on this observation it is concluded that use of green roof, or a green wall should be ruled-out of consideration for flow-reduction techniques because sizing will not be any different from the current sizing for ET beds which is not feasible for areas with negative ET rates.

During the 4th quarter of this project, a decision was made to integrate this project with the DRIP project allowing both the research projects to use the wetland cells. 300 feet of drip tubing were hand installed just below the gravel surface in both wetland cells and were used to dose the effluent daily. This integration was beneficial to both the projects as both could use the same quality and quantity of aerobic effluent without having to install drip lines in another area where a disposal permit could have been required. Discharge from the wetland is returned to RELLIS sewer.

Section 3. Results and Discussion

The primary objective of this field research was to determine the net-evapotranspiration (net-ET) rate of the EVED and the non-EVED systems installed at the research center on Texas A&M RELLIS Campus, located in Bryan, TX. Actual flow data measurements (influent and effluent) were used to determine the reductions in liquid discharges from the EVED (wetland with the greenhouse, greenhouse wetland) and the non-EVED (wetland without the greenhouse, i.e., open wetland). Both wetlands were dosed uniformly at the rate of about 100 GPD (± 1%), thus allowing to compare the effects of using a greenhouse to reduce the liquid discharge, thus reducing the land needed for an effluent disposal system.

Reduction in liquid discharge = GPD Influent – GPD Effluent

Influent data were collected from the digital flow meter readings (Photo 8) and the effluent flow data were collected using the Hobo data logger that records the number of times the tipping buckets installed at the effluent end tipped per day (Photo 7). Note that one tip = 1.5 gallons.

Temperature and humidity sensors were installed both inside and outside the greenhouse and dedicated Hobo data loggers collected data at four data points per hour. The data loggers were programmed to report daily average Temperature (^{o}F) and Relative Humidity (%). Note that the relative humidity data collection started only in mid-January 2023. The automatic rainfall data logger that was used during the TOGP-I *"LPD"* Project was used to log daily rainfall (inches/day) and the results were converted into GPD rain input to the open wetland (non-EVED) system.

> GPD Rainfall into the open wetland (non-EVED) = Rainfall (inch/day) x conversion factor.
> *NOTE that the wetland area = 300 Square Feet, thus the conversion factor for the wetland is1 inch/day rainfall = 187 GPD*

Table 2 shows the template used for recording daily values of Influent, Effluent, Temperature, Relative Humidity, and Rainfall. At the end of the month, average values for all the parameters were calculated to determine the reduction in liquid discharge for that month for the EVED and non-EVED systems, and to compare the temperature and relative humidity values inside the Greenhouse and outside the Greenhouse. Table 3 shows the monthly average values and the % reduction in liquid discharges from EVED and non-EVED.

Data collection started on November 17, 2022, and continued for 365 days concluding on November 16, 2023. During this year long period, average daily influent flow into EVED (greenhouse) system was 101 GPD and that into non-EVED (open) wetland was 100 GPD, thus within 1% as desired. Table 3 shows monthly averages for influent and effluent values. Since the focus of this study was to determine the reduction in effluent (liquid) discharge from both the systems, variation in the monthly average influent values do not adversely affect the results.

Field observations of the vegetation growth were observed on a regular basis and photos were taken for both the systems. Photos 9 through 16 show the vegetation inside the EVED and non-EVED systems, clearly showing the positive effects of semi-climate control conditions on vegetation grown.

Table 2: Spreadsheet templet developed to store and process monitoring data.

Greenhouse Wetland						Open Wetland						RAIN
Obs #	Date	Avg Temp	Avg RH%	Influent GPD	Effluent GPD	Obs #	Date	Avg Temp	Avg RH%	Influent GPD	Effluent GPD	GPD
1	11/17/22	57.3	N/A	102.4	36	1	11/17/22	51.3	N/A	99.5	15	0
2	11/18/22	60.6	N/A	102.4	51	2	11/18/22	51.9	N/A	99.5	80	0
3	11/19/22	48.6	N/A	102.6	77	3	11/19/22	43.0	N/A	98.5	130	0
4	11/20/22	52.7	N/A	101.8	72	4	11/20/22	43.3	N/A	99.4	85	0
5	11/21/22	50.5	N/A	85.6	51	5	11/21/22	44.6	N/A	83.0	124	0
6	11/22/22	60.3	N/A	102.6	76	6	11/22/22	51.0	N/A	99.6	87	0
7	11/23/22	69.8	N/A	100.7	55	7	11/23/22	61.8	N/A	99.3	77	0
8	11/24/22	65.7	N/A	102.0	100	8	11/24/22	63.9	N/A	99.3	154	131
9	11/25/22	62.5	N/A	102.6	95	9	11/25/22	59.8	N/A	99.3	81	8
10	11/26/22	64.2	N/A	102.8	86	10	11/26/22	56.2	N/A	99.1	272	228
11	11/27/22	63.3	N/A	102.8	69	11	11/27/22	54.8	N/A	99.9	142	0
12	11/28/22	65.4	N/A	102.8	62	12	11/28/22	58.2	N/A	100.5	122	0
13	11/29/22	75.0	N/A	102.4	66	13	11/29/22	71.9	N/A	100.2	85	0
14	11/30/22	60.9	N/A	103.0	52	14	11/30/22	50.2	N/A	99.9	81	0
15	12/01/22	57.3	N/A	102.4	61	15	12/01/22	48.6	N/A	100.3	80	0
16	12/02/22	65.4	N/A	101.8	64	16	12/02/22	62.7	N/A	100.2	81	0
17	12/03/22	65.3	N/A	102.1	64	17	12/03/22	62.2	N/A	100.0	81	0
18	12/04/22	62.9	N/A	102.9	56	18	12/04/22	57.8	N/A	100.1	81	0
19	12/05/22	68.9	N/A	101.6	67	19	12/05/22	65.1	N/A	100.1	80	0
20	12/06/22	53.9	N/A	101.1	64	20	12/06/22	80.7	N/A	100.0	81	0
21	12/07/22	57.1	N/A	101.6	54	21	12/07/22	78.4	N/A	100.0	78	0
22	12/08/22	62.4	N/A	102.3	57	22	12/08/22	42.0	N/A	99.9	42	0
23	12/09/22	64.5	N/A	102.5	62	23	12/09/22	0.0	N/A	100.7	0	0
24	12/10/22	48.6	N/A	102.0	64	24	12/10/22	28.4	N/A	100.0	28	352
25	12/11/22	97.2	N/A	102.3	49	25	12/11/22	0.0	N/A	101.7	0	322
26	12/12/22	80.3	N/A	102.6	97	26	12/12/22	0.0	N/A	101.1	0	0
27	12/13/22	69.8	N/A	102.9	80	27	12/13/22	0.0	N/A	101.4	0	3
28	12/14/22	62.4	N/A	103.1	70	28	12/14/22	26.1	N/A	101.2	26	13
29	12/15/22	58.1	N/A	102.8	62	29	12/15/22	79.5	N/A	101.3	80	0
30	12/16/22	53.9	N/A	103.3	58	30	12/16/22	50.0	N/A	102.3	50	3
335	10/17/23	66.2	63.9	103	17	335	10/17/23	57.7	58.5	101	76	0
336	10/18/23	71.5	63.4	104	10	336	10/18/23	66.0	63.4	100	70	0
337	10/19/23	74.2	64.1	104	25	337	10/19/23	69.3	67.0	101	77	0
338	10/20/23	74.6	58.3	105	25	338	10/20/23	71.8	53.8	101	64	0
339	10/21/23	75.1	63.6	104	26	339	10/21/23	72.4	56.9	101	66	0
340	10/22/23	80.1	66.7	105	44	340	10/22/23	76.5	70.8	101	66	0
341	10/23/23	80.7	69.6	105	52	341	10/23/23	78.0	71.2	100	86	0
342	10/24/23	80.8	68.8	105	64	342	10/24/23	78.4	70.1	101	68	0
343	10/25/23	80.9	74.5	105	58	343	10/25/23	77.2	79.9	101	92	52
344	10/26/23	79.0	76.0	105	60	344	10/26/23	75.3	87.0	101	149	117
345	10/27/23	82.2	74.5	105	85	345	10/27/23	77.2	88.5	101	86	14
346	10/28/23	83.2	71.5	105	80	346	10/28/23	79.1	81.6	101	89	38
347	10/29/23	67.4	74.3	106	77	347	10/29/23	62.1	87.6	101	107	52
348	10/30/23	47.7	76.0	107	66	348	10/30/23	44.7	80.8	101	125	61
349	10/31/23	58.2	61.7	107	57	349	10/31/23	49.3	57.2	102	78	0
350	11/01/23	58.2	67.6	107	30	350	11/01/23	46.03	63.06	103	72	0
351	11/02/23	59.2	69.2	107	36	351	11/02/23	49.59	62.83	102	94	0
352	11/03/23	66.1	68.7	107	30	352	11/03/23	60.03	66.61	103	32	0
353	11/04/23	71.2	70.0	107	36	353	11/04/23	65.15	77.68	103	106	0
354	11/05/23	73.8	70.6	106	35	354	11/05/23	68.26	79.22	102	23	0
355	11/06/23	75.7	71.4	106	42	355	11/06/23	71.05	76.29	102	22	0
356	11/07/23	78.0	67.6	108	42	356	11/07/23	74.01	73.73	106	102	0
357	11/08/23	78.6	70.3	106	41	357	11/08/23	74.83	76.53	102	162	0
358	11/09/23	72.2	82.7	107	53	358	11/09/23	68.67	86.34	102	67	54
359	11/10/23	59.2	85.6	107	68	359	11/10/23	56.15	90.54	102	125	38
360	11/11/23	60.4	85.0	107	60	360	11/11/23	56.43	87.94	102	94	0
361	11/12/23	62.4	83.7	106	66	361	11/12/23	59.38	82.65	103	78	26
362	11/13/23	64.1	82.7	107	67	362	11/13/23	59.85	81.48	103	108	31
363	11/14/23	65.4	79.0	107	54	363	11/14/23	61.22	75.9	103	69	0
364	11/15/23	67.3	70.9	107	52	364	11/15/23	60.44	73.49	103	69	0
365	11/16/23	63.0	84.8	107	59	365	11/16/23	59.34	85.87	102	70	0

NOTE: Appendix B contains all the data for the influent, effluent, temperature, relative humidity, and rainfall recorded during the 365 days observation period.

Table 3: Comparisition of EVED and non-EVED systems on a monthly basis.

Aveage Influent and Discharge By Months							
	Greenhouse, EVED			Open, Not-EVED			*RAIN*
	Influent	Effluent	**% Reduction**	Influent	Effluent	**% Reduction**	*GPD*
Nov-22	101	68	**33%**	98	110	**-11%**	*26*
Dec-22	95	57	**40%**	94	76	**19%**	*47*
Jan-23	105	65	**38%**	103	102	**1%**	*17*
Feb-23	107	64	**40%**	106	104	**1%**	*11*
Mar-23	106	54	**49%**	105	79	**25%**	10
Apr-23	94	66	**30%**	92	148	**-61%**	82
May-23	106	62	**41%**	102	81	**20%**	22
Jun-23	103	50	**52%**	100	74	**26%**	19
Jul-23	90	26	**72%**	99	61	**39%**	3
Aug-23	99	30	**70%**	97	67	**31%**	0
Sep-23	102	48	**52%**	97	82	**15%**	17
Oct-23	104	47	**55%**	101	89	**12%**	25
Nov-23	107	48	**55%**	103	81	**21%**	
AVG	**101**	**53**	**48%**	**100**	**89**	**11%**	**23**
RANG	**90 - 107**	**26 - 68**	**30% - 72%**	**92 - 106**	**61 - 148**	**<0% - 39%**	**0 - 82**

On an annual basis, the average reduction in liquid discharge from the EVED system was 48 GPD, while that from the non-EVED system was 11 GPD. This indicates that the EVED system was able to significantly reduce the liquid discharge (>400%) compared to non-EVED system.

Figure 9 shows the graphical representation of the monthly average flow data, indicating the effects of rain (green line) on the effluent discharge from the non-EVED (open wetland) system (yellow line). Since the greenhouse prevents rainfall addition, the effluent discharge from the EVED (greenhouse) system (red line) is consistently less compared to the non-EVED system.

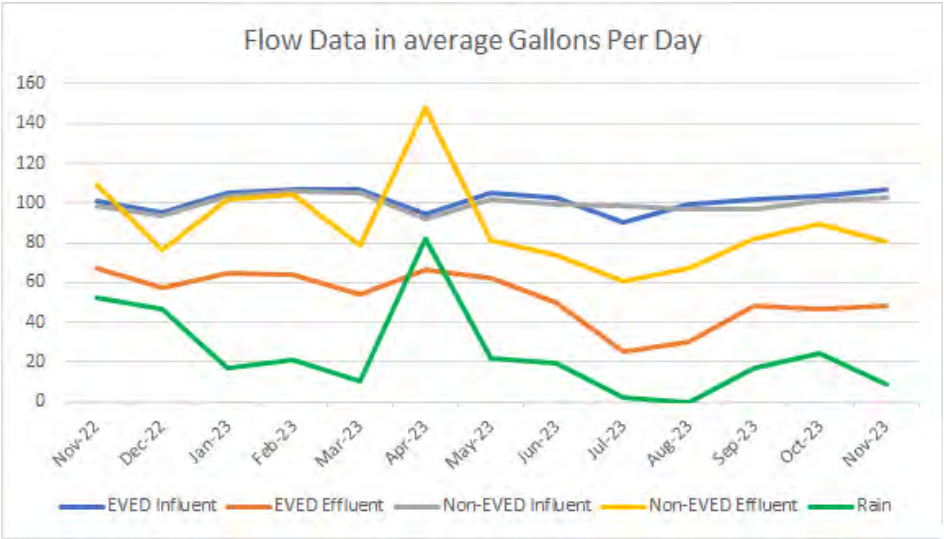


Figure 9: Graphical representation of the EVED and non-EVED systems for reduction in liquid discharge.


Photo 9: Vegetation in EVED and non-EVED systems, early November 2022


Photo 10: Vegetation in EVED and non-EVED systems, early January 2023, effects of freeze.


Photo 11: Vegetation in EVED and non-EVED systems, early March 2023

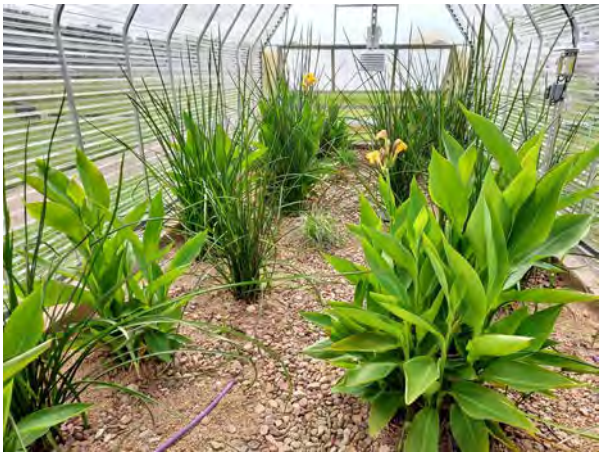



Photo 12: Vegetation in EVED and non-EVED systems, mid-April 2023


Photo 13: Vegetation in EVED and non-EVED systems, mid-July 2023

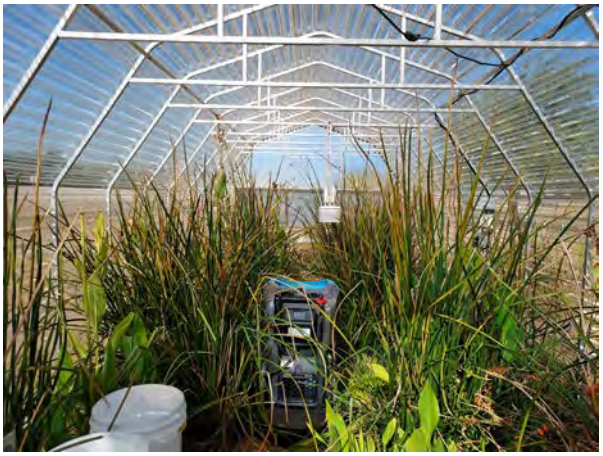



Photo 14: Vegetation in EVED and non-EVED systems, early September 2023


Photo 15: Vegetation in EVED and non-EVED systems, mid-November 2023, end of observation period for TOGP-II.

The E-Flow project was included in the 2023 Reuse Water Quality Research and Extension Experiences for Undergraduates (REEU) program's field activities (reeu.baen.tamu.edu/). During the five-week summer program, undergraduate students studied the concept of the effluent flow reduction technique used in this project, and they collected water-quality samples from six sampling points, Raw WW, ATU effluent, wetland effluent, greenhouse dehumidifier, the distillation unit used to "polish" the effluent from the open wetland, and DW. An automated dehumidifier manufactured by Dri-Eaz (www.legendbrandsrestoration.com/Products/LGR-6000Li-Portable-Dehumidifier) was installed in the greenhouse to harvest water from the humid air when the % RH value exceeded 80%. The dehumidifier generated about 10 gallons of water during the night hours. The results of the water quality analysis are presented in Table 4 below.

	Tank - A	Tank - F	Tank - G	Tank - H	Tank - I	Tank - J
BOD	65	2	0	0	0	0
TSS	64	39	0	0	0	0
Ammonia-N	18	0.02	0	0.3	0.08	0.07
Nitrate/Nitritie-N	0.1	22	6	0.1	0.7	0.2
TKN	23	1	1.4	0.4	0.3	0.2
Total-N	*23.1*	*23*	*7.4*	*0.5*	*1*	*0.4*
Total-P	3.4	4.8	3.2	0.1	0.2	0.2
E. Coli (MPN/100ml)	2,455,219	3,242	11	0	1	0
Turbididty (n=10)	37	26	1.4	0.3	0.7	0.4
	Raw WW (n=10)	ATU (n=10)	EVED-Wetland (n=5)	Dehumidifier (n variable)	Non-EVEDDistllation (n variable)	DW (n variable)
						

Table 4: Summary of the water quality data collected during the 2023 REEU Program.
NOTE: Units for all the parameters are mg/L except for the E. Coli and Turbidity. Unit for E. Coli is MPN/100ml, while that for Turbidity is NTU. Values reported as 0 are the actual values reported by the Laboratory.

A tomato seedling was planted in both the wetland cells on the same day in late March; however, the growth of the tomato plants was significantly different, the one inside the greenhouse grew far better compared to the one outside the greenhouse as shown in the Photos 16 and 17. Also, the plant inside the greenhouse produced significantly more and bigger tomatoes compared to the one outside demonstrating the benefits of growing vegetables inside the greenhouse. The research team wanted to get the tomatoes' quality tested in a food laboratory, however, due to time constraints, that work was not done during this project. A cautionary label was placed on both the plants indicating that reuse/reclaimed wastewater was used to grow the tomatoes, thus they are not for human consumption.

Photo 16: A few days after the tomato seedlings were planted (early April).

Photo 17: Tomato plants and fruits at the end of the REEU program (late June).

During the seven-week period starting September 11, 2023, to October 26, 2023, water quality sampling for influent, effluent, and dehumidify water was conducted. Water quality samples were collected and delivered to Aqua-Tech Laboratories (a certified laboratory close to the research site) by the graduate students assisting on this project.

A total of 425 samples were collected and analyzed for typical constituents of interest.

Tables 5 and 6 give summary statistics for the water quality, which indicates that the effluent from the EVED system meets the requirements of non-potable reuse water quality, thus after adequate disinfection and polishing can be used for toilet flushing.

EVED (Greenhouse) Influent, total = 90		
Ammonia as N	10	
BOD (5 day)	10	
E. Coli	10	
Fecal Coliform	10	
Nitrate/Nitrite as N	10	
Phosphorus-Total	10	
Total Kjeldahl Nitrogen as N	10	
Total Suspended Solids	10	
Turbidity	10	
EVED (Greenhouse) Effluent, total = 100		
Ammonia as N	10	
BOD (5 day)	10	
E. Coli	10	
Fecal Coliform	20	
Nitrate/Nitrite as N	10	
Phosphorus-Total	10	
Total Kjeldahl Nitrogen as N	10	
Total Suspended Solids	10	
Turbidity	10	

non-EVED (Open wetland) Influent, total = 100		
Ammonia as N	10	
BOD (5 day)	10	
E. Coli	10	
Fecal Coliform	20	
Nitrate/Nitrite as N	10	
Phosphorus-Total	10	
Total Kjeldahl Nitrogen as N	10	
Total Suspended Solids	10	
Turbidity	10	
non-EVED (Open wetland) Effluent, total = 90		
Ammonia as N	10	
BOD (5 day)	10	
E. Coli	10	
Fecal Coliform	10	
Nitrate/Nitrite as N	10	
Phosphorus-Total	10	
Total Kjeldahl Nitrogen as N	10	
Total Suspended Solids	10	
Turbidity	10	

Dehumidifier Water, total = 45		
Ammonia as N	5	
BOD (5 day)	5	
E. Coli	5	
Fecal Coliform	5	
Nitrate/Nitrite as N	5	
Phosphorus-Total	5	
Total Kjeldahl Nitrogen as N	5	
Total Suspended Solids	5	
Turbidity	5	

Table 5: Number of samples collected from each location and number of analyses done.

The number of samples collected was strictly based on the funds available to cover the cost of sample analysis, based on the quotation received from the Aqua-Tech Laboratory. All samples were grab samples collected by the graduate students who also delivered the samples to the Aqua-Tech Laboratory.

EVED (Greenhouse) Influent		
Ammonia as N	0	mg/L
BOD (5 day)	1	mg/L
E. Coli	189	MPN/100 mL
Fecal Coliform	143	CFU/100 mL
Nitrate/Nitrite as N	18	mg/L
Phosphorus-Total	4	mg/L
Total Kjeldahl Nitrogen as N	0	mg/L
Total Suspended Solids	7	mg/L
Turbidity	6	NTU
EVED (Greenhouse) Effluent		
Ammonia as N	0	mg/L
BOD (5 day)	0	mg/L
E. Coli	8	MPN/100 mL
Fecal Coliform	146	CFU/100 mL
Nitrate/Nitrite as N	8	mg/L
Phosphorus-Total	4	mg/L
Total Kjeldahl Nitrogen as N	1	mg/L
Total Suspended Solids	2	mg/L
Turbidity	3	NTU

non-EVED (Open wetland) Influent		
Ammonia as N	0	mg/L
BOD (5 day)	1	mg/L
E. Coli	131	MPN/100 mL
Fecal Coliform	204	CFU/100 mL
Nitrate/Nitrite as N	17	mg/L
Phosphorus-Total	4	mg/L
Total Kjeldahl Nitrogen as N	2	mg/L
Total Suspended Solids	37	mg/L
Turbidity	26	NTU
non-EVED (Open wetland) Effluent		
Ammonia as N	0	mg/L
BOD (5 day)	0	mg/L
E. Coli	2	MPN/100 mL
Fecal Coliform	31	CFU/100 mL
Nitrate/Nitrite as N	9	mg/L
Phosphorus-Total	4	mg/L
Total Kjeldahl Nitrogen as N	2	mg/L
Total Suspended Solids	0	mg/L
Turbidity	6	NTU

Dehumidifier Water		
Ammonia as N	1	mg/L
BOD (5 day)	1	mg/L
E. Coli	0	MPN/100 mL
Fecal Coliform	0	CFU/100 mL
Nitrate/Nitrite as N	0	mg/L
Phosphorus-Total	0	mg/L
Total Kjeldahl Nitrogen as N	1	mg/L
Total Suspended Solids	1	mg/L
Turbidity	1	NTU

Table 6: Results from water quality analysis for samples expressed as average values.
NOTE: E. Coli and Fecal Coliform are Geometric Mean, while the other values are Arithmetic Mean.

Results from the Aqua-Tech laboratory showing the raw data used for developing Tables 5 and 6 are included in Appendix B.

Section 4. Conclusions and Recommendations

In this research project, we asked the following three research questions:

Q1: What effect does an EVED installed on top of a wetland cell have on liquid effluent discharge as compared to a wetland cell without EVED?
Q2: What is the operating experience of existing green-infrastructure buildings using green-roofs and onsite wastewater systems, in terms of reductions in liquid effluent discharge?
Q3: If an EVED technique evaluated in this project reduces liquid discharge by 50% or more, then what modifications, if any, are needed in 285 regulations to allow use of EVED technologies, such as a semi-climate control greenhouse with forced-air ventilation system?

Based on the flow quantity data collected during the 365 day-observation period (from November 17, 2022, to November 16, 2023), answer to the Q1 and Q3 are as follows:

A1: The EVED system studied in this project (a 300 square-feet wetland cell operating inside a semi-automated greenhouse with forced-air ventilation system) was able to reduce the liquid discharge 4.36 times (436%) more than the non-EVED system (similar size wetland cell operating without the greenhouse, i.e., open wetland) when both the wetland cells were dosed with 100 GPD aerobic effluent. This significant increase in the reduction of the liquid discharge is the result of primarily two reasons: (1) increased net evapotranspiration (net-ET) rate achieve by enhanced plant growth inside the greenhouse, 0.26 inch/day, on an annual average basis compared to 0.06 inch/day outside the greenhouse, and (2) removal of the excess water addition due to rainfall on open wetland (8,160 gallons of rain along with 36,500 gallons of effluent during the yearlong observation period).

A3: While the wetland operating in a semi-automated greenhouse with forced-air ventilation (EVED system) studied in this project was very effective in reducing the liquid discharge compared to the open wetland (non-EVED system), it did not reduce the liquid discharge by 50% or more on an annual basis. The annual average reduction rate was 48% for the EVED system compared to 11% for the non-EVED system. The lowest monthly reduction rate observed for the EVED system was 30% in April, while that for the non-EVED system was negative 61% due to rain input, *i.e., the monthly average effluent GPD was > influent GPD*. While the results from this study indicate and support the use of a semi-automated greenhouse structure to reduce liquid discharge, thus reducing the land area requirements, they are not adequate to recommend regulatory changes at this point. Additional data collection is needed to study the performance of the EVED system at an influent flow rate >100 GPD to determine the sizing criteria in terms of the EVED system volume compared to the GPD influent flow rate. Such a study is planned for the TOGP-III under Project #3. Water quality data collected during the REEU program and during the past few weeks of this project period (during September and October 2023), indicate that both the EVED and non-EVED systems can treat the aerobic effluent to indoor non-potable reuse water quality after final disinfection and polishing necessary to meet the esthetic and public health requirements. Thus, it is possible to integrate use of the EVED system with the reuse system to get additional reduction in liquid discharge quantity.

Based on the visual observations made of a green roof operating in downtown Houston, Q2 is answered as following:

A2: While the experience in using a green roof for disposal of AC condensate is quite positive at a large commercial facility (The Post) in downtown Houston, such a structure is not adequate for disposal of aerobically treated effluent due to potential for human contact during excessive rainy days. It is also important to note that the excess (unused) AC condensate at the Houston facility is discharged into the city storm drainage system.

The following five recommendations are made for further investigation of liquid discharge reduction concepts:

1. Continue the flow data collection of the EVED and non-EVED systems for at least two more years with increased influent flow volume up to 350 GPD and develop sizing criteria in terms of optimum volume of the greenhouse needed to reduce maximum gallons per day liquid discharge in relation to the influent flow volume.

2. Integrate the use of an EVED system with indoor non-potable reuse of treated wastewater for toilet flushing and for growing consumable vegetables, to maximize the reduction of liquid discharge and thoroughly investigate non-potable reuse water quality and the quality of vegetables to ensure their quality for meeting public health standards.

3. Study the air quality inside the greenhouse to determine potential for public health concerns from airborne pathogens when the effluent is released using fogging nozzles to maximize humidity inside the greenhouse. NOTE that this idea to use fogging nozzles to maximize humidity inside the greenhouse was recommended by one of the TOGP advisory board members, however, was not implemented due to the concerns raised about the potential public health impact as our research facility is a public place.

4. Conduct a field demonstration related to a “dual use” drainfield area concept, whereby the land area used for a parking lot or something similar can also be used for a drainfield, thus reducing the demand for a dedicated land area for effluent disposal systems. One of the leading companies in the onsite wastewater industry is ready to offer technical assistance and design guidance for such a demonstration in Texas.

5. Finally, a design concept for a drip system installed at a depth greater than five feet (deep installed drip system) has been successfully used in Virginia for more than ten years, which is worth studying in Texas. A demonstration of this concept at our research center would allow us to evaluate this concept and develop design standards for Texas. This concept, if successful would allow the use of drip systems in areas that are deemed unsuitable under the current regulations and industry standards for use of drip systems.

Appendix-A Quarterly Reports

During the grant period, eight quarterly progress reports were submitted. All those reports are included in this Appendix.

Quarterly Progress Report #1
Work Period: November 5, 2021 – November 30, 2021

For Texas On-Site Sewage Facility (OSSF) Research Contracts
#582- 22-31143, #582-22-31192, and #582-22-10767

Reduction of wastewater effluent from on-site sewage facilities
Understanding problems and identifying solutions for Texas OSSFs using drip irrigation
A sampling program to collect and store data for addressing wastewater treatment challenges at RV parks

Report submitted to:

Donna Cosper, P.E., Project Manager
Program Support and Texas OSSF Research Grant Program
Texas Commission on Environmental Quality
P.O. Box 13087, MC - 235
Austin, Texas 78711-3087
Donna.Cosper@tceq.texas.gov

Report Submitted by:

Anish Jantrania, Associate Professor & Extension Specialist
Gabriele Bonaiti, Extension Program Specialist
June Wolfe III, Associate Research Scientist

Texas A&M AgriLife Research & Extension
ajantrania@tamu.edu
g.bonaiti@tamu.edu
jwolfe@brc.tamus.edu

December 15, 2021

Following tasks were completed during the first quarter of these projects:

1. Project contracts were signed, and funding accounts were established by the Texas A&M Extension Services and Texas A&M AgriLife Sponsored Research Services. Appendix A contains the signature page of each contract.

2. A Texas On-Site Sewage Facility (OSSF) Grant Program (TOGP) Advisory Committee Meeting was held to review results from the first round of TOGP projects funded by the Texas Commission on Environmental Quality (TCEQ) under Request For Grant Applications (RFGA) Number 582-19-93772 and to discuss plans for the second round of TOGP projects funded by TCEQ under RFGA Number 582-21-10767. The meeting was conducted at the Texas A&M RELLIS Campus in Bryan on November 10, 2021, from 10am to 3pm. Twenty-one people representing academic, onsite wastewater industry, and Texas regulatory interests were in attendance.

   In the morning session, Principal Investigators (PI) Jantrania, Bonaiti, and Wolfe presented Blackwater Reuse, Low Pressure Drip, and Aerobic Treatment Unit research results and findings, respectively. TOGP Advisory Committee comments and interests were noted and considered during preparation of the final reports. At this time, it was also learned that contracts for the second round of TOGP research projects had been finalized.

   During the afternoon session, PIs discussed preliminary plans and methodologies for the upcoming projects funded through the TOGP's second round RFGA. TOGP Advisory Committee comments and interests were noted and will be included as the projects progress. The meeting concluded with a visit to the RELLIS OSSF Research and Training Center where the group discussed the upcoming activities and observed the facility's amenities for conducting research, providing demonstrations, and supporting education and work-force development programs.

   Overall, the TOGP Advisory Committee was pleased with the Texas A&M OSSF Team's ability to deliver quality research and recommended supporting the Team's future activities. Appendix-B contains the meeting agenda and pictures taken during the day.

Appendix – A: Contract signature pages

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Contract Signature Page

TCEQ Contract 582-22-31143: Texas On-Site Sewage Facility Research Grant

The Maximum TCEQ Obligation is $106,115.00

The Effective Date is the date of last signature.

The Expiration Date is 08/31/2023.

Parties to the Contract	Texas Commission on Environmental Quality (TCEQ)	Texas A&M AgriLife Extension Service
By (Authorized Signature)		Digitally signed by Lesli Kerth Date: 2021.11.02 14:01:48 -05'00'
Printed Name	JARED L. WARE for ~~Keith Sheedy~~	for Julie Bishop
Title	~~Acting~~ Deputy Director	Associate Executive Director
Date of Signature	11/05/2021	11/2/2021
Vendor ID Number		17460005378
Procurement and Contracts Representative (Authorized Signature)	Aaron Stoke	
Printed Name	Aaron Stoke	
Public Purchasing Certification	CTPM06151707	
Date	Nov. 2, 2021	

TA

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Contract Signature Page

TCEQ Contract 582-22-31192: Texas On-Site Sewage Facility Research Grant

The Maximum TCEQ Obligation is $106,089.00

The Effective Date is the date of last signature.

The Expiration Date is 08/31/2023.

Parties to the Contract	Texas Commission on Environmental Quality (TCEQ)	Texas A&M AgriLife Extension Service
By (Authorized Signature)		Digitally signed by Lesli Kerth Date: 2021.11.03 13:30:49 -05'00'
Printed Name	JARED L WARE for ~~Keith Sheedy~~	for Julie Bishop
Title	~~Acting~~ Deputy Director	Associate Executive Director
Date of Signature	11/05/2021	11/3/2021
Vendor ID Number		17460005378
Procurement and Contracts Representative (Authorized Signature)	Aaron Stoke	
Printed Name	Aaron Stoke	
Public Purchasing Certification	CTPM06151707	
Date	Nov. 3, 2021	

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Contract Signature Page

TCEQ Contract 582-22-10767: Texas On-Site Sewage Facility Research Grant

The Maximum TCEQ Obligation is $ 212,246.00

The Effective Date is the date of last signature.

The Expiration Date is 08/31/2023.

Parties to the Contract	Texas Commission on Environmental Quality (TCEQ)	Texas A&M AgriLife Research
By (Authorized Signature)		Digitally signed by Lesli Kerth Date: 2021.11.02 13:21:18 -05'00'
Printed Name	JARED L. WARE for ~~Keith Sheedy~~	for Julie Bishop
Title	~~Acting~~ Deputy Director	Associate Executive Director
Date of Signature	11/05/2021	11/2/2021
Vendor ID Number		17460005410
Procurement and Contracts Representative (Authorized Signature)	Aaron Stoke	
Printed Name	Aaron Stoke	
Public Purchasing Certification	CTPM06151707	
Date	Nov. 2, 2021	

TA

Appendix – B: TOGP Advisory Committee Meeting agenda and photos

AGENDA

TOGP discussion meeting #3

Wednesday November 10, 2021
10:00 AM – 3:00 PM
Ag & Workforce Education Building Room 1102,
Texas A&M RELLIS Campus, 1244 7th Street Bryan, TX 77870

10:00 – 10:30	**Welcome, Introduction,** **Updates on all three projects** Anish Jantrania and all participants
10:30 – 11:00	**Project #1 (RT 2.3.1 and RT 2.3.2 – ATU)** **Results and Discussion** June Wolfe
11:00 – 11:30	**Project #2 (RT 2.3.3 – LPD)** **Results and Discussion** Gabriele Bonaiti
11:30 – Noon	**Project #3 (RT 2.3.4 – Reuse)** **Results and Discussion** Anish Jantrania
Noon – 1:15	**LUNCH and Discussion**
1:15 – 2:15	**Group Discussion focused on the final draft report and TOGP Round 2 Projects** Anish Jantrania and all participants
2:15 – 3:00	**Visit the Research Site (OSSF Center)**
Around ~ 3:00	**Adjourn (From the OSSF Center)**

The Texas A&M AgriLife OSSF Team presents results from first round TOGP projects and discusses plans for second round TOGP projects during the Texas Onsite Grant Program Advisory Committee meeting held at the RELLIS Campus on November 10, 2021. Top: presentations; Bottom: field visit to the RELLIS OSSF Research and Training Center.

Quarterly Progress Report #2
Work Period: December 1, 2021 – February 28, 2022

For Texas On-Site Sewage Facility (OSSF)
Research Contract
#582- 22-31143

Reduction of wastewater effluent from on-site sewage facilities

Report submitted to:

Donna Cosper, P.E., Project Manager
Program Support and Texas OSSF Research Grant Program
Texas Commission on Environmental Quality
P.O. Box 13087, MC - 235
Austin, Texas 78711-3087
Donna.Cosper@tceq.texas.gov

Report Submitted by:

Anish Jantrania, Associate Professor & Extension Specialist
Texas A&M AgriLife Extension & Research
ajantrania@tamu.edu

March 15, 2022

The following tasks were completed during Year 1 Quarter 2:

1. Initiated search for a vendor to design and construct a greenhouse at the research center, met with one vendor who is interested in offering his design-build service and he visited the center to get details on the size of the wetland where greenhouse is proposed. Plumbing to divert ATU effluent to the wetland cells, where the greenhouse will be added, was completed.

2. Started discussions with greenhouse facilities managers operating on TAMU west-campus. A set of small greenhouses is operating on the roof of Building #1515 (Plant Pathology and Microbiology Building) while a standalone large greenhouse is operating on the roof of Building #1516 (Horticulture Field Laboratory). Both are good candidates for investigation to determine water loses. (See photos in Appendix A).

3. A new idea is being conceptualized related to "dual-use" drainfield area. Discussion with a private company that offers design specifications and construction materials for this concept has started. Dual-use systems will allow OSSF users to use the drainfield area for other beneficial use such as a parking lot. NOTE: TAC 285 regulations may prohibit this, however, discussions outside Texas indicate that this concept is utilized specifically for commercial projects where land is at a premium. We plan to explore this concept further during next quarter before making any decision for including it in this project.

4. Learned about a LEED Certified commercial building in Houston that has Green Roof and Reuse system to conserve water. We plan to explore this situation further during the next quarter and schedule a site visit to determine if this facility would add benefit to this project.

The following tasks will be addressed during Quarter 3:

1. Finalize and submit QAPP for TCEQ review along with the other two projects.

2. Evaluate proposals for at least two vendors to build a greenhouse at the Center.

3. Develop and install a metering device to control and measure greenhouse influent.

4. Explore the idea of using a commercial facility parking lot as a drainfield area and prepare a short report for consideration by the advisory group

5. Visit the commercial building in Houston that has a green roof and reuse system in use for water conservation, part of LEED certification.

Appendix – A: Examples of greenhouse on roof of two buildings on TAMU West Campus:

Building #1515, multiple greenhouses on roof top

Building #1516, one large greenhouse on roof top

Quarterly Progress Report #3
Work Period: March 1, 2022 – May 30, 2022

For Texas On-Site Sewage Facility (OSSF)
Research Contract
#582- 22-31143

Reduction of wastewater effluent from on-site sewage facilities

Report submitted to:

Donna Cosper, P.E., Project Manager
Program Support and Texas OSSF Research Grant Program
Texas Commission on Environmental Quality
P.O. Box 13087, MC - 235
Austin, Texas 78711-3087
Donna.Cosper@tceq.texas.gov

Report Submitted by:

Anish Jantrania, Associate Professor & Extension Specialist
Texas A&M AgriLife Extension & Research
ajantrania@tamu.edu

June 15, 2022

The following tasks were completed during Year 1 Quarter 3:

5. Continued search for a vendor to design and construct a greenhouse at the research center, received a quotation from one vendor located in Alabama, see details in Appendix-A. Since the quoted price for installation of a greenhouse is more than $55K, it will neither be affordable for this project or for a typical homeowner who may be interested in using such an option, in future depending on the results of this project.

6. Met with the research assistant Cooper Svajda, who manages operations of greenhouses on the roof of Building #1515 (Plant Pathology and Microbiology Building). Cooper has provided valuable suggestions and indicated that he would do search on "Hoop Houses" which may be a simpler and affordable way to go for this project. I will stay in touch with Cooper during the next quarter to get additional information and quotations for a hoop house. Cooper has received details on the dimensions of the wetland cell (Appendix-B for details) that we are planning to use for installation of a greenhouse structure.

7. Had a daylong meeting in Denton County with the DR of Denton County, Leslie Freeman, during which one of the sites visited would be a potential candidate for installation of an effluent dispersal system under a paved parking lot. Leslie has shared details of the site including preliminary soil information and his notes from the "pre-development" meeting with the client who is planning to build a store on that site. Once the project moves forward, Leslie will share the concept with the client and organized a meeting with the OSSF designer to discuss the ideas of conducting a field scale research project.

8. Requested assistance from the AgriLife Director for Facilities & Construction, David DeLeon, who has helped with the installation of the field laboratory at our center last year. David visited our center last month to get more information on our plans for the greenhouse installation and he has agreed to offer his help on moving our project forward next quarter. He will send his "greenhouse" expert from his team to meet with us early June.

9. Worked with other Dr. Wolfe on finalizing the QAPP document, which was submitted to TCEQ for review in May.

The following tasks will be addressed during Quarter 4:

6. Work with the AgriLife facilities and construction team as well as with Cooper Svajda to get more affordable option for installation of the greenhouse.

7. Visit the Wooster Polytechnic Institute campus during July to learn more about their energy efficient evaporating system, which may be helpful in the greenhouse to reduce humidity.

8. As far as possible, complete installation of a greenhouse and metering devices at the Center to start data collection at the start of the next quarter.

9. Visit the commercial building in Houston during July ASABE meeting to learn more about that project and possible addition to this research project.

Appendix A – Quotation received for installation of a greenhouse for this project based on the dimension details shown in Appendix-B:

Gothic Arch Greenhouses

Gothic Arch Greenhouses, Inc.
PO Box 1564
Mobile, AL 36633
800-531-4769 (toll-free)
251-471-5238 (local)
251-471-5465 (fax)

GREENHOUSE PROPOSAL

Date:	5/23/2022
Presented By:	W.H.S
Proposal Valid:	*Valid thru July 19th, 2022*
Proposal	A
Customer #:	A.Jantrania-TX.77087
Quote To:	Anish Jantrania
	RELLIS Campus, Texas A&M Univ.
	Bryan, TX. 77807
Telephone:	254-774-6014
Cell:	
E-Mail:	ajantrania@tamu.edu

Primary Standard Structure, Cover, Door ~ Materials Only	**(Delivered)**		**$27,639.50**
Model	**1 ea. TR-12 x24-TWPC ~ TR series 'Free-Standing' style Greenhouse**		

SPECIFICATIONS

Frame	**Standard CC Aluminum Frame with limited lifetime warranty**		
Dimensions OD	**12' 8-1/2" W x 24' 11-1/2"L x 8' 6-3/4" *Ridge Hgt. x 5' 6" Sidewall Hgt** **~ designed to mount on an approx. TBD" H foundation (provided & verified by owner)** ***Add foundation wall height to Ridge Hgt to obtain final overall hgt from grade.**		
Roof Pitch	5 to 12		
Load	32# Ground Snow & 85 mph Wind Load Rating		*Included*
Optional	*Upgrade to a 103 MPH Wind Load* **'Not' included in Total**	**ADD**	**$2,652.00**
Frame Color	**Standard Colors: White, Green, or Brown**		*Included*
Glazing	***Roof, Sides & Ends ~ Twin-Wall Insulated 6mm Polycarbonate***		**Included**
Eave Design	**Straight Eave Design**		*Included*
Ridge Vents	**4 ea 24" x 48" Roof Vents w/**		*Included*
Note	***Ridge Vents must beclosed down during extreme wind conditions by 80mph***		
	4 ea 24v Electric Vent Openers (Black or white)		*Included*
	1 ea Vent Opener Control Panel with Remote. (10 Amps)		
	1 ea Temperature/Humidity Controller		
Doors	**1 ea. 32" x 76" ~ Single Storm Door Unit, Single Glass**		*Included*

Optional Accessories:	*Items below 'NOT' included in total		
Ventilation System:	Includes: 1 ea. 14" Exhaust Fan, 2 ea. Motorized Intake Shutters, w/Thermostat. & Penetration Panels & Cross Braces (Metal Shutter Fans Painted to Suit the Greenhouse)	ADD	$2,280.00
2 ea.	Insect Screens for Motorized Intake Shutters	ADD	$390.00
4 ea.	24" x 48" Side Wall Vents w/Passive Auto Openers	ADD	$2,280.00
4 ea.	Insect Screens for Side Wall Vents	ADD	$780.00
1 ea.	HD-45 ~ Nat'l or LP t Gas Heater (36,000 Btu) w/Hanger & Tstat	ADD	$1,805.00
1 ea.	Decorative Ridge Cresting w/One End Finial	ADD	Inquire

TOTAL COST ESTIMATE ~ Materials Only		
	Stnd. Greenhouse, Cover, Vent, Door & Fgt	$27,639.50
	Options, Upgrades & Accessories	10,187.00
	Engineer Stamped Drawings ~	Inquire
	Calc Pkg ~ if needed to obtain building permit	Inquire
	Decorative Accessories	Inquire
	Sub-Total:	TBD
Option A	2% Discount if paid w/ Cert. Ck or Wire Transfer	TBD
	Total	TBD
	OR	
Option B	50% Deposit w/Bal. due 2 weeks prior to shipping	TBD
	*Crating/Shipping- Standard Greenhouse Only	Included
	Total Due:	TBD

Engineer Stamped Drawings ~ if needed to obtain building permit	ADD	Inquire
Calc Pkg ~ if needed to obtain building permit	ADD	Inquire
Installation	ADD	$29,283.00

1 ea. TR-12 x24-TWPC ~ TR series 'Free-Standing' style Greenhouse
4 ea Roof Vents
1 ea Single Storm Door Unit
1 ea. 14" Exhaust Fan, 2 ea. Motorized Intake Shutters, & Insect Screens
Hanging gas heater
4 ea 24" x 48" Side Wall Vents &Insect Screens
1 set Decorative Ridge Cresting w/One End Finial

GAG, Inc. is not responsible for: Demo and removal of old greenhouse.
Site Preparation – Including, but not limited to, clearing of old materials, foundation work, and leveling of site.
** Utilities and/ or wiring– Including, but not limited to, running of utilities from source, internal wiring and/or plumbing of structure, Conduit electricity and electrical connections, water and plumbing connections, and gas connections and/ or venting of heater.*
**Storage – Including, but not limited to, storing of materials prior to and during installation.*
**Removal of crating materials and job debris away from job site.*
**Building Permits – Including, but not limited to, construction permits, fire or occupancy certifications, or any judgement of fitness of previously existing structures at the Location.*

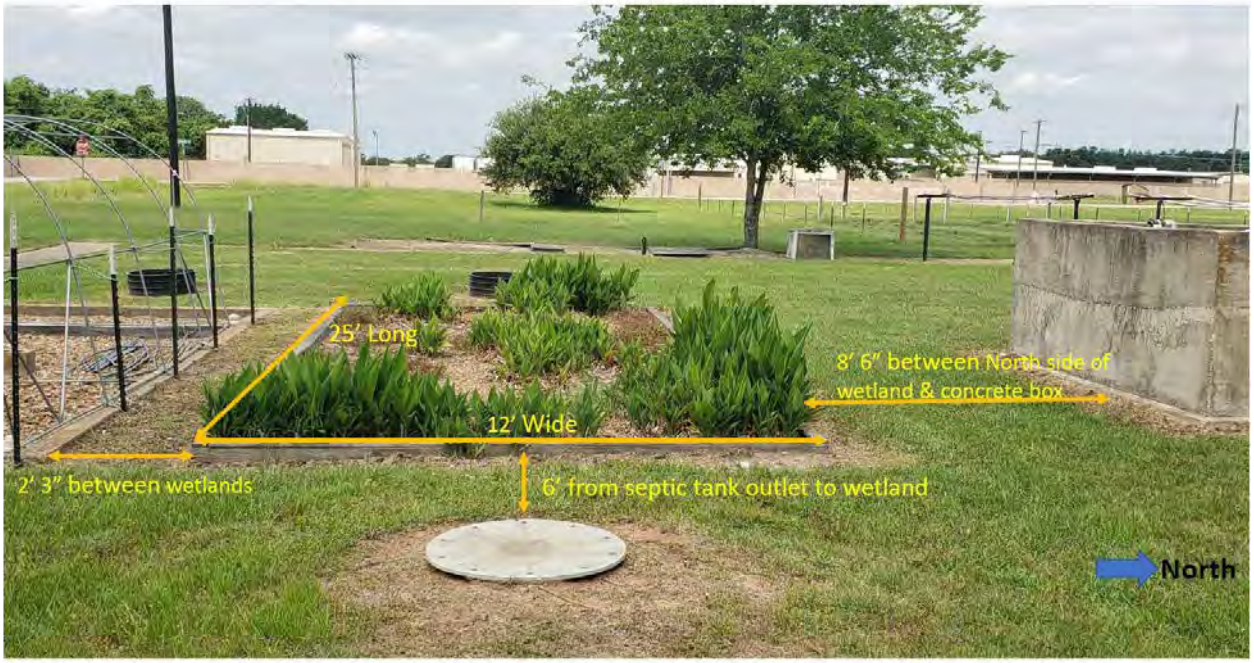
TERMS:

A 2% Full Payment with Order Discount if paid by Certified Check or Wire Transfer - T/T). Otherwise, a 50% deposit and balance due with order is required. Customer will be responsible for the unloading and inspection of materials as they arrive at the job site. Allow approx. 28 +weeks for production after approval of Eng. Drawings.

DISCLAIMER: PRICE GIVEN EXCLUDES: INSTALLATION, TAX, UNLOADING OF FREIGHT, PERMITS, BONDING, SITE PREPARATION, CAULK, ANCHORS, MASONRY, PE STAMP, ELECTRIC WIRING & HOOKUPS, PLUMBING & DUCTING, FINAL CLEANING/WASHING, AND ANY OTHER ACCESSORIES/SERVICES NOT SHOWN IN QUOTE. PRICES SUBJECT TO CHANGE WITHOUT NOTICE. CHECK LOCAL BUILDING CODES PRIOR TO ORDERING.

Material ~ $27,639.50 + Installation ~$29,283.00; thus Total ~$56,922.50

Appendix-B: Dimension details shared with public and private sectors for obtaining pricing.



Quarterly Progress Report #4
Work Period: June 1, 2022 – August 31, 2022

For Texas On-Site Sewage Facility (OSSF)
Research Contract
#582- 22-31143

Reduction of wastewater effluent from on-site sewage facilities

Report submitted to:

Donna Cosper, P.E., Project Manager
Program Support and Texas OSSF Research Grant Program
Texas Commission on Environmental Quality
P.O. Box 13087, MC - 235
Austin, Texas 78711-3087
Donna.Cosper@tceq.texas.gov

Report Submitted by:

Anish Jantrania, Associate Professor & Extension Specialist
Texas A&M AgriLife Extension & Research
ajantrania@tamu.edu

September 15, 2022

The following tasks were completed during Year 1 Quarter 4:

10. Worked with the AgriLife Director for Facilities & Construction, David DeLeon, his team members, and Research Assistant - Cooper Svajda. Identified a company in San Antonio (Greenhouse etc., https://www.greenhousestx.net/) offering an ideal product for this project. Received a quotation for the "11x24 Big Barn Greenhouse". Completed assessment of project needs and finalized a bid to purchase and install greenhouse on one of the two wetland cells. See Appendix-A, photos show the before and after greenhouse installation with construction photos.

11. Worked with Ryan Gerlich, TAMU OSSF Team member, to determine best method to measure gravity outflow from wetland cells. After evaluating several options, Ryan concluded that a modified "Dipper", available from the PolyLock, combined with an event-counting datalogger, available from Hobo, is best option for measuring and recording discharge flow from the wetland cells. Ryan completed installation of one Dipper for the wetland cell with the Greenhouse (experimental cell) and demonstrated that the product accurately measures a 1.5 Gallons per tip from the wetland cell. The datalogger will be installed next which will include an electronic switch attached to the Dipper which will count and record each time the dipper empties, thus allowing discharge flow measurement per month. NOTE – we have received two additional Dippers from PolyLock that will allow us to install one on the other wetland cell (Control Cell) and replace the one that Ryan used for the experimental cell. See photos in Appendix-B showing details of the Dipper and installation in the experimental cell.

12. With the greenhouse installed and the wetland discharge flow measurement system designed, the experimental set-up almost complete. The experiment will focus on measuring the wetland effluent discharge flow, on a monthly basis, from the experimental wetland cell (wetland + greenhouse) and the control wetland cell. Difference between these readings will provide an indication of effluent flow reduction attributable to a greenhouse installed on a wetland designed based on loading rates prescribed in current 285 rules.

13. Organized a meeting with the Drip Project PI (Dr. Bonaiti) and local drip system designer/distributor (Mr. Jim Prochaska, JNM Technologies) to discuss ways to conduct both the Drip and the Effluent Flow Reduction projects simultaneously at the TAMU AgriLife OSSF Center. Based on discussions, both wetland cells will be dosed using ~300 ft of drip tubing (maximum possible) laid out uniformly ~6 inches below the gravel. Conducting project efforts is expected to provide synergism with respect to cost and time. More on this in the next report.

14. Worked with Dr. Wolfe to address draft QAPP comments received from TCEQ. Returned an updated draft QAPP to TOGP for 2nd review on 18 August 2022.

The following tasks will be addressed during Quarter 5:

10. Finalize the flow rate calculations and hypothesis needed to test during this experiment; use the Evapotranspiration (ET) system sizing calculations from the current OSSF Regulations Section 285.33(b)(2) and the net evaporation rate for College Station presented in Section 285.91(7).

11. Work with Ryan and Dr. Wolfe on completing the flow measuring systems for both the wetland cells, calibrate the devices and start measuring the effluent flow.

12. Compete the installation of maximum allowable drip tubing on both the wetland cells and start time dosing both the cells with ATU effluent at 100 GPD monthly average flow as soon as the QAPP is finalized and approved by all parties.

13. Discuss the current status of the project with the TOGP advisory group during the 4th annual meeting on RELLIS Campus during the next quarter.

14. Work on scheduling a meeting with the building management company that is responsible for the commercial building in Houston that has a reuse plus the effluent flow reduction technology (green roof) installed several years back. (NOTE, this task has not been completed due to scheduling challenges with the building management company)

Appendix A – 11x24 Big Barn Greenhouse Installation at TAMU OSSF Research Center.

Before - Wetland cell on the left (with concrete sidewalls) ready for Greenhouse installation

11x24 Big Barn Greenhouse installation day.

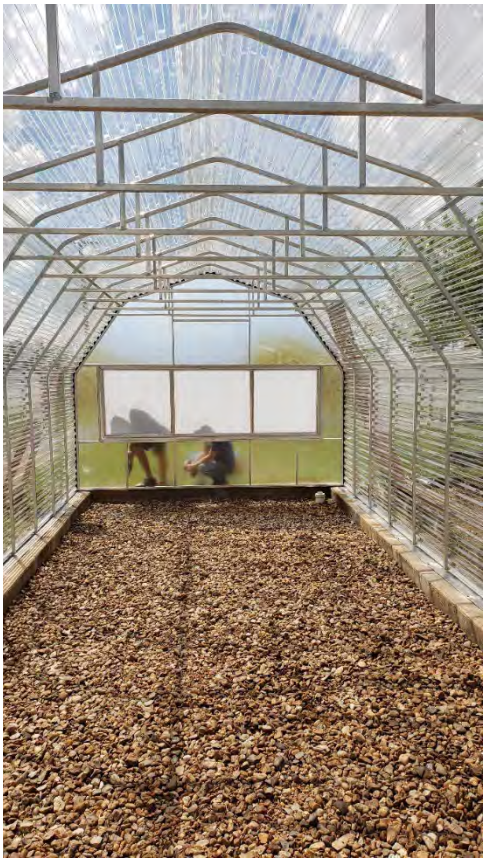


Photo on the left showing the wetland cell covered with the Greenhouse and big window at the back end, and on the right showing one of the two fans to be installed in the front windows.

View from the back end of the Greenhouse, note the large window at the back end has an adjustable opening mechanism to control the air flow through the Greenhouse.

After - View from the front, both the window in the front has fans and louvers that opens automatically when the fans are turn on at a set temperature point.

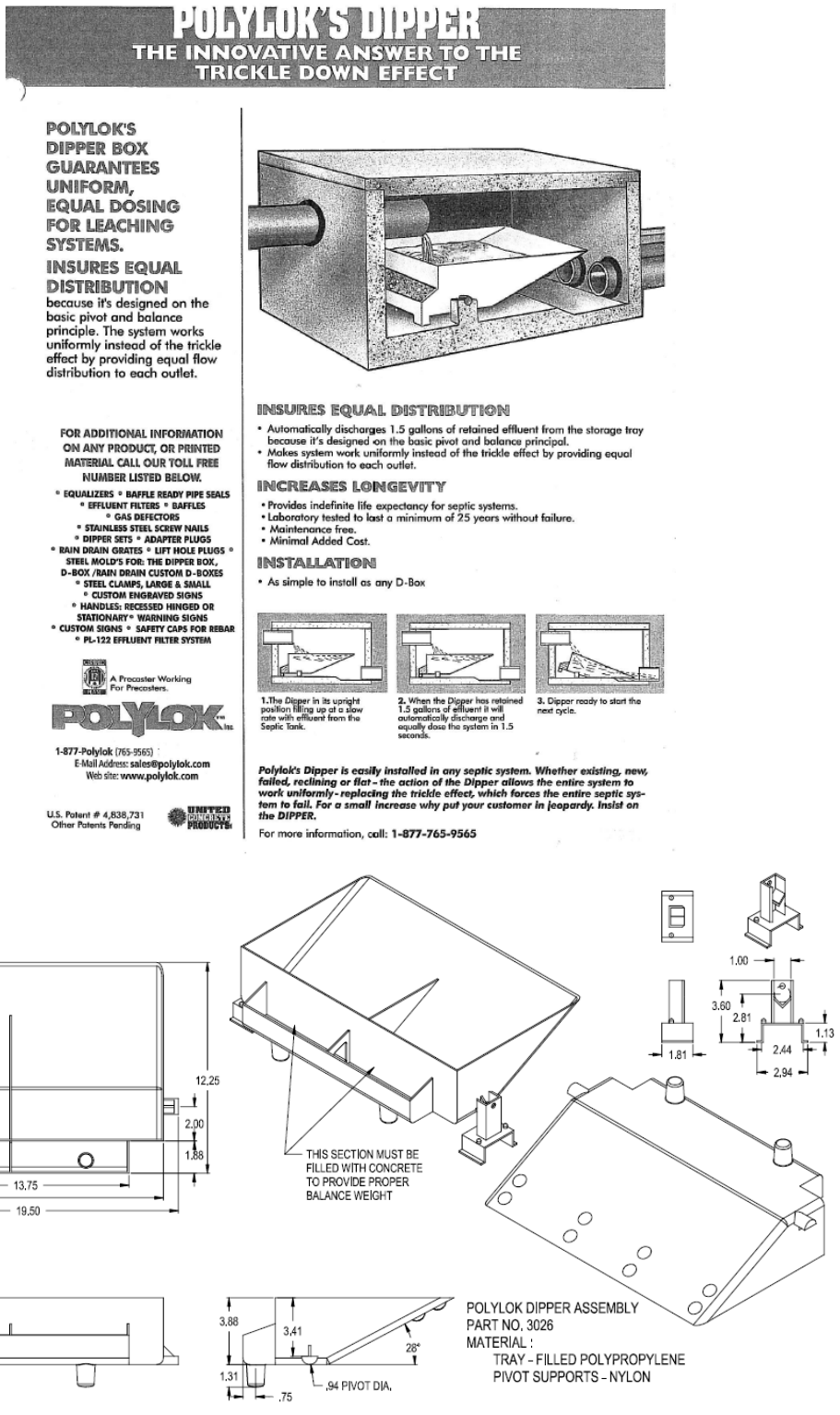
Next steps will be to set-up influent distribution systems in both wetland cells, connect two ATUs effluent pump tank with the influent distribution systems, re-plant the wetland cells, install the effluent flow measuring devices and start dosing the wetland cells 100 GPD ATU effluent. Data collection will begin after the QAPP is approved.

BEFORE GREENHOUSE

AFTER GREENHOUSE

Addition of the Greenhouse at our research facility will be quite useful for future projects related to Onsite Wastewater Reuse and we are looking forward to discussing ideas on how to build future reuse projects using this newly added Greenhouse during our meeting with the TOGP advisory group.

Appendix-B: Details on the “Dipper” from PolyLock to be used for the effluent flow measurement from both wetland cells.



Technical details on the “Dipper” from the PolyLock website https://www.polylok.com/dipper-prod-128.html

Dipper set on a riser lid, ready for installation in the wetland effluent collection tank.

Dipper with the concrete weight installed in the wetland effluent collection tank.
(Video clip is also available to see how the flow will be measured).

NOTE – an electronic switch with a counter will be installed next, which will allow us to record number of times dipper tips per month, and Ryan confirmed that each tip = 1.5 gallons, which is also the weight of the concrete used in the small tray shown on the bottom left of the Dipper.

Quarterly Progress Report #5
Work Period: September 1, 2022 – November 30, 2022

For Texas On-Site Sewage Facility (OSSF)
Research Contract
#582- 22-31143

Reduction of wastewater effluent from on-site sewage facilities

Report submitted to:

Donna Cosper, P.E., Project Manager
Program Support and Texas OSSF Research Grant Program
Texas Commission on Environmental Quality
P.O. Box 13087, MC - 235
Austin, Texas 78711-3087
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Report Submitted by:

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December 15, 2022

The following tasks were completed during Year 2 Quarter 1:

15. Worked with Dr. Wolfe and Dr. Bonaiti to finalize the Quality Assurance Project Plan (QAPP) addressing current Texas Onsite Grant Program (TOGP) contracts (i.e., 582-22-10767 Real world RV/ATU data, 582-22-31192 Drip irrigation, and 582-22-31143 Effluent reduction). The signed QAPP became effective 4 October 2022.

16. Continued working with Ryan Gerlich, TAMU OSSF Team member, to finalize the wetland plant selection, purchasing of the plants from Houston Extension office, designing the drip layout for both the wetland cells, and finalizing operating instructions for the Greenhouse once all the installation work is completed. On October 20, 2022, both the wetland started receiving 100 GPD from the ATUs as planned. Before this date, the open cell wetland received 200 GPD of ATU effluent (combined flow from both the ATUs) while the Greenhouse wetland received 100 GPD tap water. TDS measurement taken on this day reflected the effects of ATU effluent (TDS values in ppm were 850 for tap water, 1060 for effluent from Greenhouse wetland, and 1600 for the effluent from open wetland). We plan to measure TDS values quarterly to see the effects on wetland cells. Appendix-A contains photos showing the status of the Greenhouse and Open Wetland Cells. NOTE the as of the end of this quarter, Greenhouse is operated only using the Temperature control system. We are still evaluating use of Humidity control system to work with Temperature control for operating the Greenhouse, along with use of dehumidification system.

17. Organize and conducted a day long TOGP Advisory Committee meeting on 12 October 2022 at the RELLIS Campus in Bryan. This was the fourth annual meeting held on RELLIS Campus, attended by 24 representatives from TCEQ and TOWA, to present progress reports regarding current TOGP projects and discuss other matters related to future of OSSF research program at TAMU. After the morning sessions and lunch indoor, the participants visited the research facility to see the progress on E-Flow and DRIP projects. Appendix-B contains several photos from the center visit.

18. After several unsuccessful attempts to visit the green roof facility in Houston area, I was able to organize a day long visit with the Houston Green Infrastructure coordinators in late October who gave me a detailed tour of the Green roof located on top of the Post Houston (https://www.posthtx.com/) known as the Skyfarm, a one-acre urban food farm operated by Blackwood Educational Land Institute (https://blackwoodland.org/the-skyfarm-at-post-houston/). Appendix-C contains several photos from the site visit. The facility is built and operated to maximize use of condensate water for irrigation needed in the farm operated on the roof. This facility could make a very good place to monitor the amount of water lost through ET from the roof. However, there are no water meters installed at this facility to monitor the flow nor it is possible to monitor the discharge from the roof of excess water. Based on the observations made during my visit where I noticed several wet spots and standing water pool, I have concluded use of green roof, or a green wall should be ruled-out of consideration for flow-reduction techniques because sizing will not be any different from the current sizing for ET beds which is not feasible for areas with negative ET rates. Note that a green wall project operated on TAMU main campus also discharges water during wet/humid weather conditions as shown in photos included in Appendix-C.

19. Finalized the mathematical model for assessing the effluent flow reduction technology (i.e., wetland operating in the greenhouse OR Enhanced Vaporization Effluent Disposal or EVED™) by comparing the daily discharge quantities (Gallons Per Day) from the two wetland cells, one with the Greenhouse and one without. Calculations shown in the following table:

Wetland Dimensions			Greenhouse		7.48	Gal/cub.ft.	
L =	25	ft	L =	24	0.6	gpd/sq.ft.	
W =	12	ft	W =	11			
D =	1	ft water	H =	9	Avg		
Void =	50%		Void =	100%			
Surface Area =	300	sq.ft.	Surface Area =		Calculate SA of Building?		
Water Volume =	150	cub.ft.	Volume =	2376	cub.ft.		
College Station Data							
Evap - Rainfall =	**0.12**	**inches/day**					
	0.01	cub.ft./day/sq.ft.					
Loading Rate for ET Bed =	**0.07**	**gpd/sq.ft. in College Station area**					
For a home with	225	GPD Flow					
	3,008	sq.ft. min ET bed needed					
WE GOT ONLY	300	sq.ft. of Wetland beds!					
Research Question: CAN THIS AREA REQUIREMENT BE REDUCED BY NEW E-FLOW DESIGNS?							
GPD for Wetland ONLY=	22		GPD with Greenhous	45	2	times; ASSUMED VALUE	
					50%	If true then the area needed	
GPD Inflow =	100		GPD Inflow =	100			
GPD Outflow =	78	COMPARE THESE	GPD Outflow =	55	CHECK ACTUAL VALUES AT THE END		

Inflow and outflow data collection systems were installed and calibrated during the month of November and data collection started on November 17th. Following table shows the difference in daily effluent quantity from both the wetland cells and rainfall:

Greenhouse Wetland				Open Wetland				RAIN
Obs #	Date	Avg Temp	Effluent GPD	Obs #	Date	Avg Temp	Effluent GPD	inch
1	11/17/22	57.3	36	1	11/17/22	51.3	15	
2	11/18/22	60.6	51	2	11/18/22	51.9	80	
3	11/19/22	48.6	77	3	11/19/22	43.0	130	
4	11/20/22	52.7	72	4	11/20/22	43.3	85	
5	11/21/22	50.5	51	5	11/21/22	44.6	124	0.84
6	11/22/22	60.3	76	6	11/22/22	51.0	87	
7	11/23/22	69.8	55	7	11/23/22	61.8	77	
8	11/24/22	65.7	100	8	11/24/22	63.9	154	0.62
9	11/25/22	62.5	95	9	11/25/22	59.8	81	
10	11/26/22	64.2	86	10	11/26/22	56.2	272	1.1
11	11/27/22	63.3	69	11	11/27/22	54.8	142	
12	11/28/22	65.4	62	12	11/28/22	58.2	122	
13	11/29/22	75.0	66	13	11/29/22	71.9	85	
14	11/30/22	60.9	52	14	11/30/22	50.2	81	

Average daily effluent discharge from the Greenhouse Wetland was 68 GPD and that for Open Wetland was 110 GPD, indicating effects of rainy days in mid-November.

20. Started conversation with a homeowner in central Texas who also has a business building rainwater harvesting tanks and an OSSF for wastewater management. They are interested in "donating" their home to conduct a field research and demonstration project that could combined previously TOGP funded REUSE project and the current E-FLOW project. To minimize the land area required for effluent disposal and to maximize reuse potential for treated effluent, we believe that combining these two concepts is the way to move forward and develop design, construction, and operation recommendations for a new type of OSSF in Texas. More on this subject in the next quarterly project report.

The following tasks will be addressed during Quarter 6:

15. Ensure that the flow data collection systems (flow meters on ATU pumps and Dippers on the wetland discharge end) are working properly with no hick-ups and decide when to officially start the data collection for the final reporting. Also, work with Dr. Bonaiti to start collecting rainfall data from the automatic rainfall gauge that was used in previously funded LPD project. This will allow for better understanding of effects of rain events on effluent discharges from both the wetlands.

16. Investigate various instrumentations available for measuring humidity inside and outside the Greenhouse and acquire one that is most suitable for use in this project. Also, look into use of a dehumidifier inside the Greenhouse to make water during high humidity conditions and connect operation of one of the fans and the humidifier when humidity exceed a pre-determined value. This will help us study effects on flow reduction by adding these items.

17. Train the new hire who is staring in early January to take responsibilities for data collection and field observations.

18. Start the process with the Texas A&M Office of Sponsored Research Services managers to send request to TCEQ for extending completion deadlines for this and the other two projects by nine months in order to get adequate time for proper completion of field work and data processing plus preparing final reports.

19. Continue discussion with the homeowner who is interested in field demonstration project to combine both REUS and E-FLOW project and try to find funding for such a project during next year or so.

Appendix A – Current status of the E-Flow Project Site.

Planting both inside and outside Greenhouse wetland cells (early October)

Plants' growth inside Greenhouse wetland in about a month (from early October to early November)

Photos taken on November 18th a few days after the first freeze on November 13th in BCS area, plants doing better inside Greenhouse than outside during cold temperatures.

Appendix-B: TOGP Group visiting the Research Center after the morning session during the 4th annual meeting on RELLIS Campus (top two pics) and visitors from Australia on the day after the TOGP meeting…

TOGP Group visiting the site during the afternoon of the 4th Annual Meeting on RELLIS.

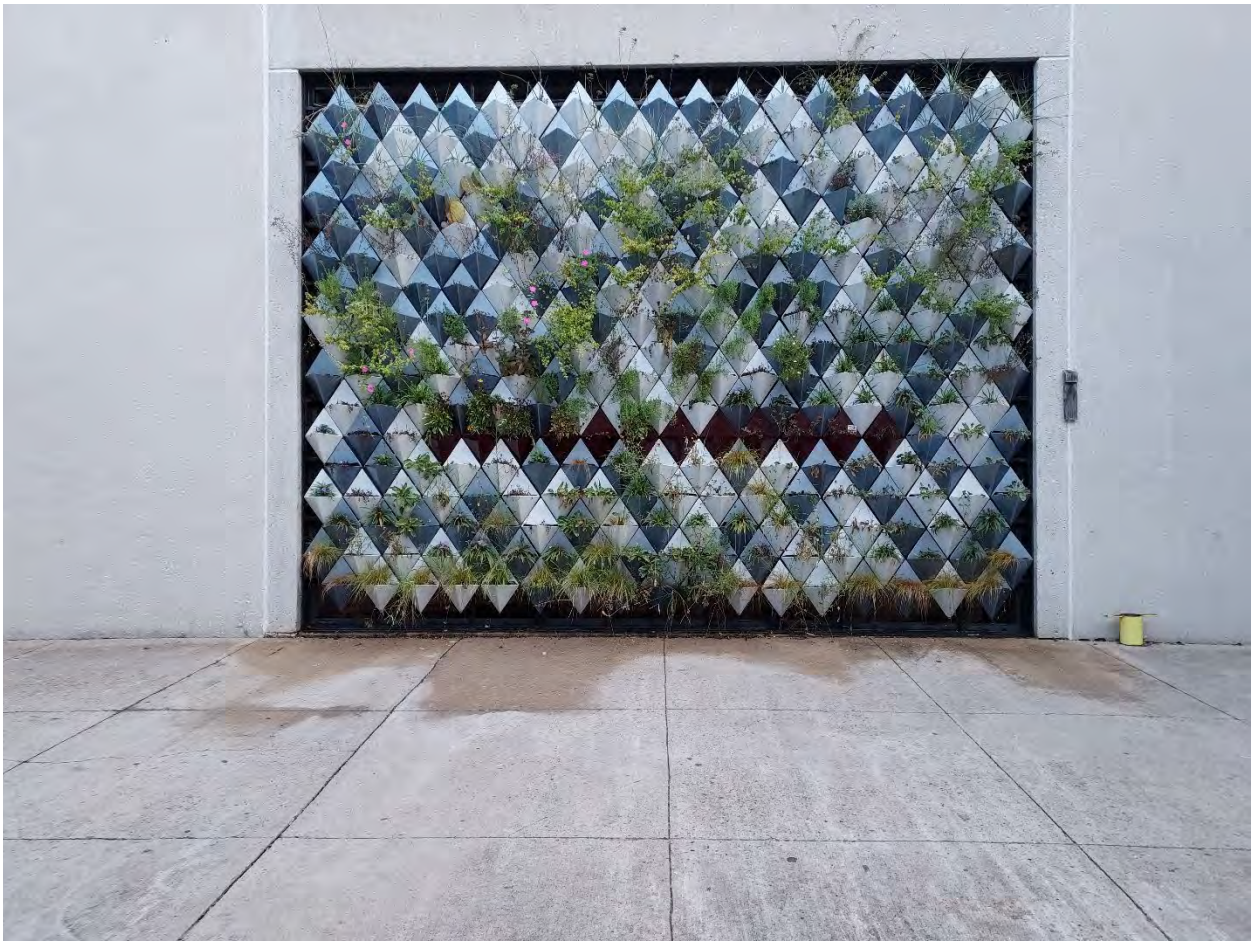
Visitors from Australia inside the Greenhouse the day after the TOGP Meeting, October 13th …

Appendix C: Photos from the visit to the Green Roof in Houston (October 25, 2022). Note that there no rainy days for more than week before this visit, however standing water was observed on the roof strongly indicating potential for surfacing if this concept and questioning if this concept should be considered for effluent flow reduction.

The building entrance and the LEED Certification signage

The Green Roof covering about one-acre space, and big wet spot indicating over irrigation and/or lack of ET losses.

Similar observations were made around the Green Wall that is in operation on the main campus.



Green Wall operating on TAMU Main Campus, showing wetness indication of excess irrigation (September 7, 2022)

Quarterly Progress Report #6
Work Period: December 1, 2022 – February 28, 2023

For Texas On-Site Sewage Facility (OSSF)
Research Contract
#582- 22-31143

Reduction of wastewater effluent from on-site sewage facilities

Report submitted to:

Donna Cosper, P.E., Project Manager
Program Support and Texas OSSF Research Grant Program
Texas Commission on Environmental Quality
P.O. Box 13087, MC - 235
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Report Submitted by:

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March 22, 2023

The following tasks were completed during Year 2 Quarter 2:

21. Data collection for inflow and outflow from both wetland cells continued during this quarter. Added an electric heater in the greenhouse to protect plants from winter freezing. Raw data from Hobo data logger are now available for both the wetland systems as well as the inflow data from ATUs. Monthly averages are calculated to determine the % reduction in flows from both wetland systems. Examples of raw data tables and the summary of monthly averages are shown in Appendix-A.

22. The greenhouse system experience freezing conditions in December, during which temperatures inside the Greenhouse dropped below 40 degrees and plants experienced stressful conditions. However, plants inside the Greenhouse were better overall than the plants outside (see Appendix-B).

23. In mid-January, relative humidity sensors were installed for measuring Relative Humidity (RH) as percent for both wetlands (i.e., inside and outside greenhouse). RH datalogging intervals are set to match the tipping bucket effluent dataloggers, once every 15 minutes. RH sensors began logging at 4PM on January 11, 2023. Average temperature and relative humidity data for this quarter are show in Appendix-A.

24. The greenhouse system experienced a pest infestation (i.e., spider mites) in February causing visible plant damage (see photos in Appendix-C). The TAMU Extension Plant Specialist was contacted for guidance. The use of soapy water was recommended as a low-toxicity solution. Two applications were made with some success. Additional, a stronger method may be employed (i.e., pesticide application) if the problem continues.

25. Mr. Josh Segura, a new Research Technician for the TAMU OSSF Research Center, was trained and will work as needed with Mr. Ryan Gerlich on data collection and management of both wetland systems.

The following tasks will be addressed during Quarter 7:

20. Review of the raw data set to ensure that flow parameters (inflow, outflow), temperature, and relative humidity data are properly synched (i.e., pre-set frequency of 15 minutes for temperature, relative humidity, and influent flow to match with ATU dosing frequency.

21. Investigate options to increase evapotranspiration (ET) rate inside the greenhouse with plans to implement them during Quarter 7. Selected option(s) will be implemented uniformly in both wetlands, inside and outside the greenhouse.

22. Continue investigation of options to eliminate pest infestation inside the greenhouse and implement options as necessary to resolve the situation.

23. Continue working with the Texas A&M Office of Sponsored Research Services managers on the request to TCEQ for extending completion deadlines and or budget revisions for

this and the other two projects by nine months to allow adequate time for proper completion of field work and data processing plus preparing final reports.

24. Continue discussion with the homeowner who is interested in field demonstration project to combine both REUSE and E-FLOW project and try to find funding for such a project during next year.

Appendix A:

Data from HOBO datalogger, processed, and stored in spreadsheet format – daily data example:

Greenhouse Wetland						Open Wetland						RAIN
Obs #	Date	Avg Temp	Avg RH%	Influent GPD	Effluent GPD	Obs #	Date	Avg Temp	Avg RH%	Influent GPD	Effluent GPD	GPD
1	11/17/22	57.3	N/A	102.4	36	1	11/17/22	51.3	N/A	99.5	15	
2	11/18/22	60.6	N/A	102.4	51	2	11/18/22	51.9	N/A	99.5	80	
3	11/19/22	48.6	N/A	102.6	77	3	11/19/22	43.0	N/A	98.5	130	
4	11/20/22	52.7	N/A	101.8	72	4	11/20/22	43.3	N/A	99.4	85	
5	11/21/22	50.5	N/A	85.6	51	5	11/21/22	44.6	N/A	83.0	124	
6	11/22/22	60.3	N/A	102.6	76	6	11/22/22	51.0	N/A	99.6	87	
7	11/23/22	69.8	N/A	100.7	55	7	11/23/22	61.8	N/A	99.3	77	
8	11/24/22	65.7	N/A	102.0	100	8	11/24/22	63.9	N/A	99.3	154	131
9	11/25/22	62.5	N/A	102.6	95	9	11/25/22	59.8	N/A	99.3	81	8
10	11/26/22	64.2	N/A	102.8	86	10	11/26/22	56.2	N/A	99.1	272	228
11	11/27/22	63.3	N/A	102.8	69	11	11/27/22	54.8	N/A	99.9	142	0
12	11/28/22	65.4	N/A	102.8	62	12	11/28/22	58.2	N/A	100.5	122	0
13	11/29/22	75.0	N/A	102.4	66	13	11/29/22	71.9	N/A	100.2	85	0
14	11/30/22	60.9	N/A	103.0	52	14	11/30/22	50.2	N/A	99.9	81	0
15	12/01/22	57.3	N/A	102.4	61	15	12/01/22	48.6	N/A	100.3	80	0
16	12/02/22	65.4	N/A	101.8	64	16	12/02/22	62.7	N/A	100.2	81	0
17	12/03/22	65.3	N/A	102.1	64	17	12/03/22	62.2	N/A	100.0	81	0

Monthly Average Summary Table and % Discharge Reduction Comparisons:

Aveage Influent and Discharge By Months							
	Greenhouse			Open			*RAIN*
	Influent	Effluent	**% Reduction**	Influent	Effluent	**% Reduction**	*GPD*
Nov-22	101	68	**33%**	98	110	**-11%**	*53*
Dec-22	95	57	**40%**	94	76	**19%**	*47*
Jan-23	105	65	**38%**	103	102	**1%**	*17*
Feb-23	107	64	**40%**	106	104	**1%**	*21*
Mar-23							
Apr-23							
May-23							
Jun-23							
Jul-23							
Aug-23							

NOTE: GPD (Gallons per Day) RAIN is calculated based on the open wetland size and monthly average rainfall recorded at the site.

Average Temperature and Relative Humidity data collected so far:

Aveage Temp and % RH By Months			
Greenhouse		Open	
Temp	%RH	Temp	%RH
61.2	N/A	54.4	N/A
64.9	N/A	61.9	N/A
61.0	66.6	55.1	73.7
63.5	67.7	56.5	74.8

Appendix B – Effects of freezing weather on plants inside and outside greenhouse.


Photos taken on December 11, 2022 (before freezing conditions)


Photos taken on December 22, 2022 (during freezing conditions)


Photos taken on February 23, 2022 (second freezing event)

Appendix-C: Pest infestation inside the Greenhouse

Spider Mite infestation noticed inside the greenhouse (photo taken February 23, 2023)

Spider Mite infestation following two applications of soapy water (photo taken March 13, 2023).

Quarterly Progress Report #7
Work Period: March 1, 2023 – May 31, 2023

For Texas On-Site Sewage Facility (OSSF)
Research Contract
#582- 22-31143

Reduction of wastewater effluent from on-site sewage facilities

Report submitted to:

Donna Cosper, P.E., Project Manager
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Report Submitted by:

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June 15, 2023

The following tasks were completed during Year 2 Quarter 3:

26. Data collection for inflow and outflow from both wetland cells continued during this quarter. Added a dehumidifier in the greenhouse to "harvest" water and to determine both quantity and quality of that water (see photos in Appendix-A). Greenhouse wetland monitoring is added to the REEU research platform thus the federal funds from that project will be used to pay for water quality monitoring. Monthly averages are calculated to determine the % reduction in flows from both wetland systems. A draft version of the average data table is included in Appendix-B. Note that the values presented in the draft table may change once we conduct our final analysis at the end of this project.

27. Attended the Texas Onsite Wastewater Association (TOWA) annual conference in Waco, TX from March 6 to 8 and delivered an oral presentation entitled "AgriLife Research and Extension Updates" and assisted in two other presentations, one made by Dr. Bonaiti on Drip Project and the other by Dr. Wolfe on RV/ATU project. All three presentations were well attended and there seems to be a great amount of interest in final reports for all three projects. During these presentations, we also made several contacts for future site visits to learn more about the challenges faced in these subjects.

28. Travelled to Hood County with Dr. Bonaiti and spent two days with the county health department staff visiting several sites to see operating conditions of existing drip systems and to see new installations. Purpose of this trip to really understand drip systems problems based on real-world experience by regulators, designers, and installer. Several photos from the site visits are included in Appendix-C. Information gathered from the site visits will be used to develop recommendations for improvement for drip design, installation, and operation later this year.

29. Traveled to the Dallas area with Dr. Wolfe and met with a private RV park owner/engineer interested in monitoring an aerobic/drip system. While Dr. Wolfe has offered his assistance in developing a monitoring plan for this site, I plan to work with the owner/engineer to design a different type of drip system based on the design concept presented in my book and based on my experience with this design that has been successfully operating in Virginia for more than 10 years. I plan to revisit this site later this year, time permitting.

30. Worked to get the Center ready for the REEU program in which 12 undergraduate students will be spending five weeks to learn about water quality sampling and analysis. This project is included on the research platform and students will collect water quality samples from the aerobic treatment unit that is feeding the wetland covered by the greenhouse, effluent from that wetland, as well as the dehumidify water to be collected from the dehumidifier. See the research plan details in Appendix-D.

31. Continued discussion with the TAMU-SRS staff about getting the extension for completing this and the other projects. We will need six more months to complete all the work for all three projects.

The following tasks will be addressed during Quarter 8:

25. Continue review and analysis of the raw data set to ensure that flow parameters (inflow, outflow), temperature, and relative humidity data are properly synched and start recording the amount of dehumidify water removed from the Greenhouse as well as any effluent removed from the wetland cells for the REEU projects.

26. Continue dosing the wetland cells using the drip tubing to support the drip research project and to see if drip dosing enhances the evaporation losses.

27. Continue monitoring of the pest infestation inside the greenhouse and implement options as necessary to control the situation.

28. Continue working with the Texas A&M Office of Sponsored Research Services managers on the request to TCEQ for extending completion deadlines and or budget revisions for this and the other two projects by nine months to allow adequate time for proper completion of field work and data processing plus preparing final reports.

29. Continue discussion with the homeowner who is interested in field demonstration project to combine both REUSE and E-FLOW project and try to find funding for such a project during next year.

Appendix A – Difference between the two wetland cells and dehumidifier operation inside the Greenhouse to harvest atmospheric water.


Photos taken on April 19, 2023 (wetland vegetation growth more inside Greenhouse)


Photos taken on May 22, 2023 (Dehumidifier operating inside Greenhouse and water collected)

Photos taken on May 23, 2023 (water quality samples installed for REEU sample collection)

Appendix-B: Example of E-FLOW data recording spreadsheet, daily and monthly values.

Data from HOBO datalogger, processed, and stored in spreadsheet format – daily data example (note that the yellow high-lighted cells mean missing or erroneous data):

Greenhouse Wetland						Open Wetland						RAIN
Obs #	Date	Avg Temp	Avg RH%	Influent GPD	Effluent GPD	Obs #	Date	Avg Temp	Avg RH%	Influent GPD	Effluent GPD	GPD
	04/15/23	79.1	68.3	106.3	0	150	04/15/23	75.2	67.3	104.7	58	0
	04/16/23	72.9	57.0	105.8	0	151	04/16/23	62.7	49.1	104.9	55	0
	04/17/23	71.4	62.2	106.1	77	152	04/17/23	63.4	57.5	105	55	0
	04/18/23	73.4	70.9	107.3	52	153	04/18/23	68.5	70.0	104.9	57	5
	04/19/23	77.2	73.6	107.2	53	154	04/19/23	72.6	75.5	104.9	60	0
	04/20/23	75.5	84.0	13.7	86	155	04/20/23	71.9	85.8	13.3	515	427
	04/21/23	74.4	77.0	58.1	87	156	04/21/23	68.2	80.5	56.8	124	5
	04/22/23	73.6	64.3	35.6	53	157	04/22/23	67.3	60.5	32.2	55	0
	04/23/23	68.5	67.6	0.0	0	158	04/23/23	59.2	71.1	0	0	0
	04/24/23	70.6	68.8	0.0	27	159	04/24/23	60.3	70.2	0	60	0
	04/25/23	72.8	74.9	17.6	104	160	04/25/23	66.7	74.1	17.3	69	0
	04/26/23	77.0	77.7	106.6	97	161	04/26/23	72.0	81.8	103.7	181	415
	04/27/23	74.2	74.8	106.5	105	162	04/27/23	66.4	77.6	102.7	708	174
	04/28/23	69.9	76.4	106.5	69	163	04/28/23	65.2	80.8	103.4	270	164
	04/29/23	67.4	65.3	62.4	51	164	04/29/23	61.0	67.8	60.8	72	0
	04/30/23	77.2	64.7	106.4	49	165	04/30/23	67.8	61.0	104.1	89	0
	05/01/23	78.2	65.2	107.6	76	166	05/01/23	69.8	57.7	104.6	37	0
	05/02/23			107.2	62	167	05/02/23	71.7	75.1	105	87	0
	05/03/23	77.1	73.9	106.2	49	168	05/03/23	73.9	72.3	104.7	48	0
	05/04/23	79.4	69.6	106	58	169	05/04/23	73.0	81.1	104.1	61	0
	05/05/23	78.1	78.0	106.3	73	170	05/05/23	80.1	76.3	103.6	74	42
	05/06/23	83.6	73.1	106.3	82	171	05/06/23	77.1	76.6	104.1	68	2
	05/07/23			106.1	47	172	05/07/23	76.8	77.5	103.5	90	0
	05/08/23			106.1	54	173	05/08/23	75.0	83.7	103.4	44	0
	05/09/23			106.6	167	174	05/09/23	71.1	87.2	104	151	38
	05/10/23	80.4	74.6	106.2	103	175	05/10/23	71.2	89.2	103.9	176	136
	05/11/23	80.4	77.0	105.3	79	176	05/11/23	78.0	83.1	103.5	74	0
	05/12/23	78.8	79.2	105.4	54	177	05/12/23	80.0	80.4	103.2	59	0
	05/13/23	75.6	84.9	105.9	78	178	05/13/23	71.8	87.9	102.8	156	127
	05/14/23	77.1	83.5	105.4	89	179	05/14/23	72.6	85.6	102.1	291	153
	05/15/23	81.8	79.9	105.5	87	180	05/15/23	73.8	86.4	101.6	200	101
	05/16/23	83.0	77.6	105.9	73	181	05/16/23	73.3	83.2	102	89	0
	05/17/23	77.2	83.7	105.3	63	182	05/17/23	74.7	74.2	101.4	67	0
	05/18/23	77.0	83.4	105.2	63	183	05/18/23	77.0	69.4	102.1	58	0
	05/19/23	78.8	80.5	104.8	64	184	05/19/23	79.5	69.8	101.6	61	0
	05/20/23	78.4	78.8	105.5	69	185	05/20/23	74.7	76.4	101.2	69	14

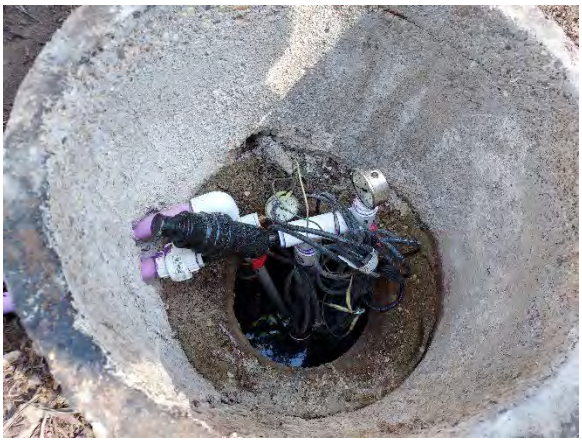
Monthly Average Summary Table and % Discharge Reduction Comparisons:

Aveage Influent and Discharge By Months								Aveage Temp and % RH By Months			
	Greenhouse			Open			*RAIN*	Greenhouse		Open	
	Influent	Effluent	**% Reduction**	Influent	Effluent	**% Reduction**	*GPD*	Temp	%RH	Temp	%RH
Nov-22	101	68	**33%**	98	110	**-11%**	*53*	61.2	N/A	54.4	N/A
Dec-22	95	57	**40%**	94	76	**19%**	*47*	64.9	N/A	61.9	N/A
Jan-23	105	65	**38%**	103	102	**1%**	*17*	61.0	66.6	55.1	73.7
Feb-23	107	64	**40%**	106	104	**1%**	*11*	63.5	67.7	56.5	74.8
Mar-23	106	54	**49%**	105	79	**25%**	10	70.3	70.3	64.4	69.3
Apr-23	94	66	**30%**	92	148	**-61%**	82	72.1	74.2	66.0	74.0
May-23	106	62	**41%**	102	81	**20%**	22	79.6	74.9	75.1	75.6
Jun-23											
Jul-23											
Aug-23											
Sep-23											
Oct-23											
Nov-23											
Dec-23											

NOTE: GPD (Gallons per Day) RAIN is calculated based on the open wetland size and monthly average rainfall recorded at the site.

Appendix-C: Drip sites visited in Hood County.

The drip system has not been working properly since the start-up, effluent surfacing at several locations and the homeowner is not happy with the system. The owner is in the process of getting another contractor to work on repairs based on the suggestions developed during the visit.



New installation in progress, note the gravel material used by this installer to allow drip system work better than otherwise on sites with clay soil. This site will be revisited after 3 years to study system performance. On the right, filter used in this system.

Screen filter typically used in drip system, to be cleaned during the routine maintenance service.

Appendix-D: Treatment trains to be studied during this year REEU program in June.

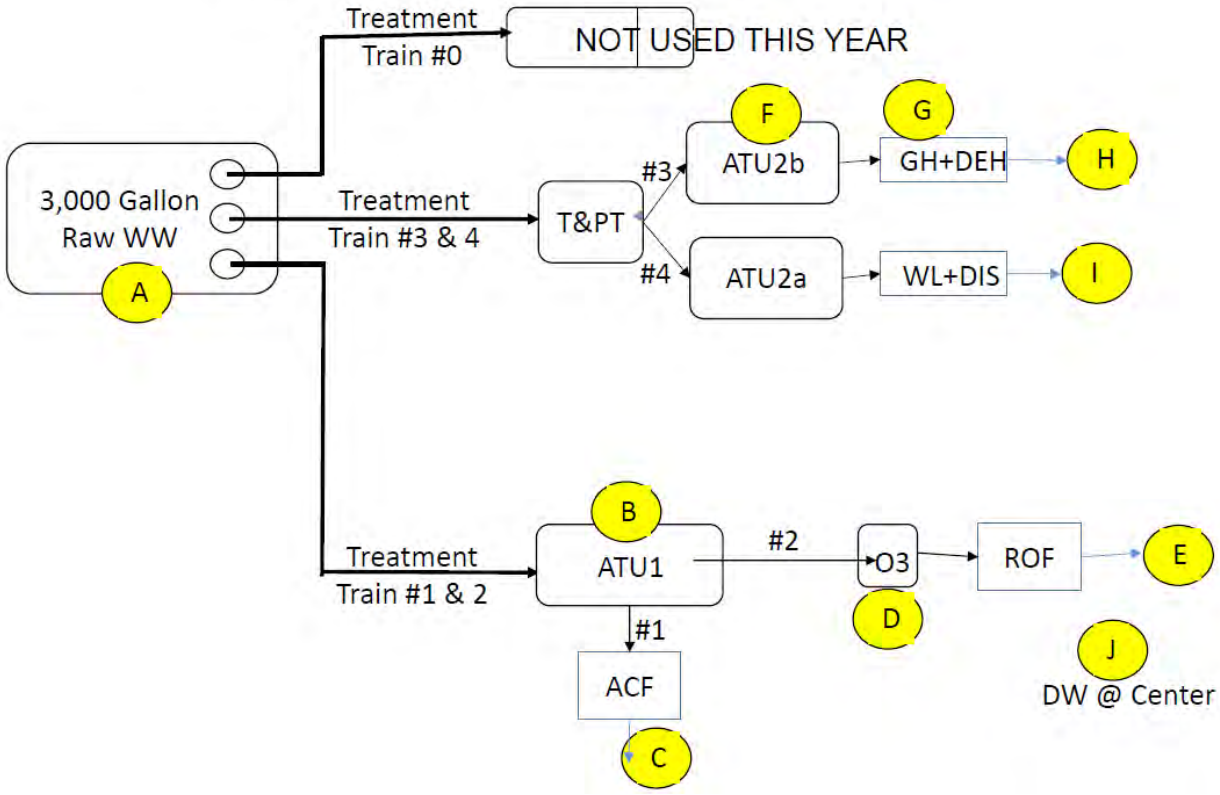
2023 REEU Research Program

- **Research topics –**
  - Evaluate effectiveness of the following four Treatment Trains to meet Type I and II and III reuse water quality standards.
  - Determine energy consumption for the four Treatment Trains.
  - Conduct the Taste Test of the Water Quality and the Greenhouse Produce (voluntary basis only).

- **FOUR TREAMTENT TRAINS:**
  1. Raw WW ➡ ATU1➡ACF
  2. Raw WW ➡ ATU1➡O3+ROF
  3. Raw WW ➡ ATU2a➡WL+DIS
  4. Raw WW ➡ ATU2b➡GH+DEH

WW: Raw Wastewater
ATU1: NSF 350 Unit
ATU2a & b: NSF 40 Units
ACF: Activated Carbon Filter
O3: Ozonation Tank
ROF: Reverse Osmosis Filter
WL: Wetland Cell
DIS: Distillation
GH: Greenhouse covering WL
DEH: Dehumidifier

Treatment Trains and Sampling Points



Quarterly Progress Report #8
Work Period: June 1, 2023 – August 31, 2023

For Texas On-Site Sewage Facility (OSSF)
Research Contract
#582- 22-31143

Reduction of wastewater effluent from on-site sewage facilities

Report submitted to:

Donna Cosper, P.E., Project Manager
Program Support and Texas OSSF Research Grant Program
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September 15, 2023

The following tasks were completed during Year 2 Quarter 4:

32. Requested and received a three month extension from TCEQ to complete the project. The date of completion is November 30, 2023, instead of August 31, 2023. This extension was needed as the start date of this project was delayed by *more than three months* in 2021.

33. Continued inflow and outflow data collection (see **Appendix A** for the daily average values and monthly summary table of effluent flow reduction rates).

34. Included Reuse Water Quality Research and Extension Experiences for Undergraduates (REEU) 2023 program in project activities (see https://reeu.baen.tamu.edu/). REEU fellows studied effluent flow reduction needs/concepts and collected water-quality samples from four sampling points: ATU effluent, wetland effluent, greenhouse dehumidifier, and from the distillation unit used to "polish" the effluent from open wetland. See **Appendix B** for water-quality results and REEU photos.

35. Worked with the TCEQ and TOWA leadership to finalize a date for the 5th annual TOGP annual meeting to discuss details on this and upcoming research programs. The meeting date is set for **September 26** on RELLIS Campus. Invitation responses indicate that more than 2/3rd of the group plans to participate.

The following tasks will be addressed during extended Quarter 9:

1. Continue effluent quantity data collection and start the effluent quality monitoring program to add value to the data collected during the REEU-2023 program.

2. Engage two graduate research assistants on an hourly wadge basis to assists with effluent quality samples, deliver samples to the certified laboratory, and retain services from the laboratory for conducting sample analysis and reporting results during September and October. Complete the sampling and analysis by October end so that results can be included in the draft final report which is due on November 30th.

3. Organize the 5th annual TOGP advisory group meeting on September 26th and present the content of the draft final report for this project.

4. Complete the data collection by the end of October and prepare the draft final report for submission by November 30.

5. Work with the SRS team to ensure that all/most of the funds are drawn-down available for this project.

Appendix-A: Example of E-FLOW data recording spreadsheet, daily average values and monthly summary. Data from HOBO datalogger, processed, and stored in spreadsheet format – daily data example (Note: yellow high-lighted cells have missing or erroneous data):

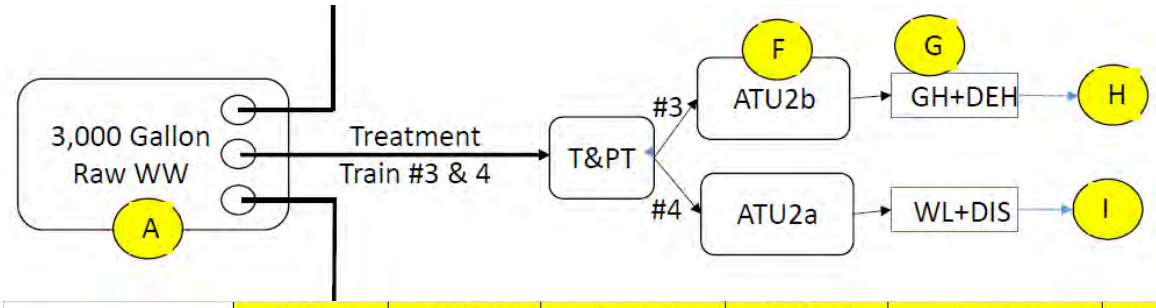
Greenhouse Wetland						Open Wetland						RAIN
Obs #	Date	Avg Temp	Avg RH%	Influent GPD	Effluent GPD	Obs #	Date	Avg Temp	Avg RH%	Influent GPD	Effluent GPD	GPD
246	07/20/23	90.8	63.0	102.2	0	246	07/20/23	89.0	58.9	100.4		0
247	07/21/23	89.6	63.5	102.5	53	247	07/21/23	87.9	57.8	100.7		0
248	07/22/23	90.5	61.6	102.8	29	248	07/22/23	89.8	54.8	100.2		0
249	07/23/23	90.6	62.0	103.1	27	249	07/23/23	89.1	53.7	100.8		0
250	07/24/23	89.5	63.1	104	41	250	07/24/23	87.3	59.1	100.3		0
251	07/25/23	90.0	62.5	103.1	24	251	07/25/23	87.8	59.4	100.9		0
252	07/26/23	90.0	62.4	103.6	30	252	07/26/23	88.1	57.3	101	37	0
253	07/27/23	89.8	62.6	117.9	38	253	07/27/23	87.6	58.3	115.1	65	0
254	07/28/23	88.6	62.2	103.4	52	254	07/28/23	86.6	56.9	101.6	78	0
255	07/29/23	89.1	62.7	104	29	255	07/29/23	87.1	57.5	101.8	80	0
256	07/30/23	89.9	62.6	121.1	23	256	07/30/23	88.4	55.2	119.7	69	0
257	07/31/23	91.3	61.6	103.6	62	257	07/31/23	90.3	52.7	102.8	75	0
258	08/01/23	91.7	60.9	103.7	29	258	08/01/23	90.6	51.5	102.3	74	0
259	08/02/23	91.6	57.6	103.5	18	259	08/02/23	90.4	49.3	101.4	68	0
260	08/03/23	91.4	61.3	102.9	25	260	08/03/23	89.5	57.1	101.3	58	0
261	08/04/23	92.2	59.9	103.3	30	261	08/04/23	84.2	71.3	101.6	64	0
262	08/05/23	92.2	59.9	103.7	29	262	08/05/23	90.6	56.0	101	60	0
263	08/06/23	92.1	59.2	103.4	26	263	08/06/23	90.7	55.5	101.5	57	0
264	08/07/23	92.6	59.3	102.9	26	264	08/07/23	91.2	55.7	101.7	69	0
265	08/08/23	92.3	60.1	102.5	23	265	08/08/23	90.3	57.9	101.1	70	0
266	08/09/23	92.3	60.9	33.9	24	266	08/09/23	90.7	58.5	33.6	76	0
267	08/10/23	93.0	59.5	102.8	24	267	08/10/23	91.5	56.6	100.9	56	0
268	08/11/23	92.8	59.4	101.8	25	268	08/11/23	91.4	56.4	100.3	64	0
269	08/12/23	92.5	61.5	101.3	33	269	08/12/23	90.9	59.8	100.7	76	0
270	08/13/23	92.2	60.1	72.2	24	270	08/13/23	90.6	57.6	71.5	72	0
271	08/14/23	91.6	61.5	102.1	25	271	08/14/23	90.5	56.3	100	39	0
272	08/15/23	89.4	51.8	101.7	21	272	08/15/23	89.4	39.8	100.6	68	0
273	08/16/23	85.8	54.3	102.2	25	273	08/16/23	85.7	37.5	100.4	67	0
274	08/17/23	88.8	58.5	101.7	35	274	08/17/23	88.5	48.9	100	68	0
275	08/18/23	91.1	55.8	101.9	38	275	08/18/23	90.3	48.2	100.3	100	0
276	08/19/23	91.1	58.9	101.5	33	276	08/19/23	90.1	52.5	100.9	58	0
277	08/20/23	93.1	54.6	102.5	35	277	08/20/23	93.5	45.2	100	51	0
278	08/21/23	91.9	53.7	102.3	27	278	08/21/23	92.3	43.2	101.9	56	0
279	08/22/23	91.3	61.4	102.3	34	279	08/22/23	90.3	54.3	103.1	77	0
280	08/23/23	90.4	61.6	101.7	36	280	08/23/23	89.5	53.9	100.9	74	0
281	08/24/23	92.6	56.4	102.7	34	281	08/24/23	92.7	46.6	101	77	0
282	08/25/23	93.4	53.5	101.5	42	282	08/25/23	92.9	44.7	101.6	27	0
283	08/26/23	91.2	57.8	101.8	33	283	08/26/23	90.6	49.3	101.3	10	0

Monthly Average Summary Table and % Discharge Reduction Comparisons:

	Aveage Influent and Discharge By Months							Aveage Temp and % RH By Months			
	Greenhouse, EVED			Open, Non-EVED			*RAIN*	Greenhouse		Open	
	Influent	Effluent	**% Reduction**	Influent	Effluent	**% Reduction**	*GPD*	Temp	%RH	Temp	%RH
Nov-22	101	68	**33%**	98	110	**-11%**	*53*	61.2	N/A	54.4	N/A
Dec-22	95	57	**40%**	94	76	**19%**	*47*	64.9	N/A	61.9	N/A
Jan-23	105	65	**38%**	103	102	**1%**	*17*	61.0	66.6	55.1	73.7
Feb-23	107	64	**40%**	106	104	**1%**	*11*	63.5	67.7	56.5	74.8
Mar-23	106	54	**49%**	105	79	**25%**	10	70.3	70.3	64.4	69.3
Apr-23	94	66	**30%**	92	148	**-61%**	82	72.1	74.2	66.0	74.0
May-23	106	62	**41%**	102	81	**20%**	22	79.6	74.9	75.1	75.6
Jun-23	103	50	**52%**	100	74	**26%**	19	86.4	69.8	83.4	70.9
Jul-23	90	26	**72%**	99	61	**39%**	3	89.6	66.0	87.4	62.1
Aug-23	99	30	**70%**	97	67	**31%**	0	90.9	58.7	89.7	52.1
Sep-23											
Oct-23											

NOTE: GPD (Gallons per Day) RAIN is calculated based on the open wetland size and monthly average rainfall recorded at the site.

Appendix-B: REEU-2023 Research program and inclusion of the E-Flow Treatment Trains # 3&4 Sampling Points.



	Tank - A	Tank - F	Tank - G	Tank - H	Tank - I	Tank - J
BOD	65	2	0	0	0	0
TSS	64	39	0	0	0	0
Ammonia-N	18	0.02	0	0.3	0.08	0.07
Nitrate/Nitritie-N	0.1	22	6	0.1	0.7	0.2
TKN	23	1	1.4	0.4	0.3	0.2
Total-N	*23.1*	*23*	*7.4*	*0.5*	*1*	*0.4*
Total-P	3.4	4.8	3.2	0.1	0.2	0.2
E. Coli (MPN/100ml)	2,455,219	3,242	11	0	1	0
Turbididty (n=10)	37	26	1.4	0.3	0.7	0.4
	Raw WW (n=10)	ATU (n=10)	EVED-Wetland (n=5)	Dehumidifier (n variable)	Non-EVEDDistllation (n variable)	DW (n variable)
						

Number of Samples	Tank - A	Tank - F	Tank - G	Tank - H	Tank - I	Tank - J
BOD	10	10	5	2	2	1
TSS	10	10	5	2	2	1
Ammonia-N	10	10	5	5	5	2
Nitrate/Nitritie-N	10	10	5	5	5	2
TKN	10	10	5	5	5	2
E. Coli	10	10	5	2	2	1
TP	10	10	5	5	5	2
Turbidity	10	10	10	10	10	10

REEU Fellows working on the E-Flow Project – water quality sample collection:



Appendix-B Raw Data Sets and Lab Reports

Greenhouse Wetland						Open Wetland						RAIN
Obs #	Date	Avg Temp	Avg RH%	Influent GPD	Effluent GPD	Obs #	Date	Avg Temp	Avg RH%	Influent GPD	Effluent GPD	GPD
1	11/17/22	57.3	N/A	102.4	36	1	11/17/22	51.3	N/A	99.5	15	0
2	11/18/22	60.6	N/A	102.4	51	2	11/18/22	51.9	N/A	99.5	80	0
3	11/19/22	48.6	N/A	102.6	77	3	11/19/22	43.0	N/A	98.5	130	0
4	11/20/22	52.7	N/A	101.8	72	4	11/20/22	43.3	N/A	99.4	85	0
5	11/21/22	50.5	N/A	85.6	51	5	11/21/22	44.6	N/A	83.0	124	0
6	11/22/22	60.3	N/A	102.6	76	6	11/22/22	51.0	N/A	99.6	87	0
7	11/23/22	69.8	N/A	100.7	55	7	11/23/22	61.8	N/A	99.3	77	0
8	11/24/22	65.7	N/A	102.0	100	8	11/24/22	63.9	N/A	99.3	154	131
9	11/25/22	62.5	N/A	102.6	95	9	11/25/22	59.8	N/A	99.3	81	8
10	11/26/22	64.2	N/A	102.8	86	10	11/26/22	56.2	N/A	99.1	272	228
11	11/27/22	63.3	N/A	102.8	69	11	11/27/22	54.8	N/A	99.9	142	0
12	11/28/22	65.4	N/A	102.8	62	12	11/28/22	58.2	N/A	100.5	122	0
13	11/29/22	75.0	N/A	102.4	66	13	11/29/22	71.9	N/A	100.2	85	0
14	11/30/22	60.9	N/A	103.0	52	14	11/30/22	50.2	N/A	99.9	81	0
15	12/01/22	57.3	N/A	102.4	61	15	12/01/22	48.6	N/A	100.3	80	0
16	12/02/22	65.4	N/A	101.8	64	16	12/02/22	62.7	N/A	100.2	81	0
17	12/03/22	65.3	N/A	102.1	64	17	12/03/22	62.2	N/A	100.0	81	0
18	12/04/22	62.9	N/A	102.9	56	18	12/04/22	57.8	N/A	100.1	81	0
19	12/05/22	68.9	N/A	101.6	67	19	12/05/22	65.1	N/A	100.1	80	0
20	12/06/22	53.9	N/A	101.1	64	20	12/06/22	80.7	N/A	100.0	81	0
21	12/07/22	57.1	N/A	101.6	54	21	12/07/22	78.4	N/A	100.0	78	0
22	12/08/22	62.4	N/A	102.3	57	22	12/08/22	42.0	N/A	99.9	42	0
23	12/09/22	64.5	N/A	102.5	62	23	12/09/22	0.0	N/A	100.7	0	0
24	12/10/22	48.6	N/A	102.0	64	24	12/10/22	28.4	N/A	100.0	28	352
25	12/11/22	97.2	N/A	102.3	49	25	12/11/22	0.0	N/A	101.7	0	322
26	12/12/22	80.3	N/A	102.6	97	26	12/12/22	0.0	N/A	101.1	0	0
27	12/13/22	69.8	N/A	102.9	80	27	12/13/22	0.0	N/A	101.4	0	3
28	12/14/22	62.4	N/A	103.1	70	28	12/14/22	26.1	N/A	101.2	26	13
29	12/15/22	58.1	N/A	102.8	62	29	12/15/22	79.5	N/A	101.3	80	0
30	12/16/22	53.9	N/A	103.3	58	30	12/16/22	50.0	N/A	102.3	50	3
31	12/17/22	61.3	N/A	104.0	54	31	12/17/22		N/A	103.6	81	0
32	12/18/22		N/A	103.9	61	32	12/18/22		N/A	103.2	81	0
33	12/19/22		N/A	69.0	22	33	12/19/22		N/A	69.4	365	494
34	12/20/22	70.8	N/A	104.8	0	34	12/20/22		N/A	104.2	102	16
35	12/21/22	72.9	N/A	103.5	71	35	12/21/22	81.8	N/A	104.3	47	0
36	12/22/22	46.5	N/A	105.0	73	36	12/22/22	55.7	N/A	104.9	82	0
37	12/23/22		N/A	48.4	47	37	12/23/22	2.3	N/A	47.8	56	0
38	12/24/22		N/A	17.6	0	38	12/24/22	23.9	N/A	17.3	2	0
39	12/25/22	51.8	N/A	57.1	0	39	12/25/22	88.6	N/A	56.3	24	0
40	12/26/22	48.6	N/A		52	40	12/26/22	82.9	N/A		89	0
41	12/27/22	66.6	N/A		49	41	12/27/22	81.8	N/A		83	0
42	12/28/22	79.3	N/A		67	42	12/28/22	311.3	N/A		82	0
43	12/29/22	93.0	N/A	105.2	79	43	12/29/22	93.2	N/A	104.0	311	255
44	12/30/22	74.0	N/A	104.3	93	44	12/30/22	82.9	N/A	103.2	93	3
45	12/31/22	60.2	N/A	105.5	74	45	12/31/22	85.2	N/A	103.4	83	0
46	01/01/23	70.8	N/A	104.3	60	46	01/01/23	66.8	N/A	103.5	85	0
47	01/02/23	74.5	N/A	104.4	85	47	01/02/23	73.4	N/A	102.8	90	19
48	01/03/23	69.8	N/A	104.6	75	48	01/03/23	63.7	N/A	102.7	110	40
49	01/04/23	63.1	N/A	105.1	55	49	01/04/23	56.1	N/A	102.9	83	0
50	01/05/23	60.9	N/A	105.0	71	50	01/05/23	52.5	N/A	103.2	83	0
51	01/06/23	65.6	N/A	105.4	70	51	01/06/23	60.5	N/A	103.4	83	0
52	01/07/23	70.0	N/A	104.3	53	52	01/07/23	66.5	N/A	102.5	87	16
53	01/08/23	63.6	N/A	104.1	62	53	01/08/23	57.3	N/A	103.5	82	5
54	01/09/23	62.2	N/A	105.5	69	54	01/09/23	56.4	N/A	102.9	83	0
55	01/10/23	68.5	N/A	104.5	58	55	01/10/23	64.6	N/A	103.1	83	0
56	01/11/23	74.4	68.3	103.8	60	56	01/11/23	71.2	74.7	102.5	82	0
57	01/12/23	62.6	47.2		51	57	01/12/23	57.8	49.7		81	0
58	01/13/23	58.1	47.7	104.5	45	58	01/13/23	47.0	52.8	102.8	80	0
59	01/14/23	58.0	53.0	105.4	54	59	01/14/23	48.2	60.5	103.0	81	0
60	01/15/23	64.3	66.7	105.0	43	60	01/15/23	59.9	75.4	102.5	82	0

NOTE: Yellow highlighted cells indicate missing data due to malfunctioning of the data collection and/or recording system.

61	01/16/23	67.3	78.6	104.9	57	61	01/16/23	63.8	86.4	101.8	87	3
62	01/17/23	67.0	79.2	104.5	59	62	01/17/23	61.9	91.2	101.9	81	0
63	01/18/23	69.3	66.0	104.2	56	63	01/18/23	67.2	65.6	102.9	108	54
64	01/19/23	63.7	44.3	104.2	66	64	01/19/23	55.8	41.9	102.4	81	0
65	01/20/23	53.6	62.2	104.5	51	65	01/20/23	50.5	61.2	103.3	75	0
66	01/21/23	55.4	75.0	105.2	51	66	01/21/23	50.5	82.9	102.8	82	0
67	01/22/23	56.9	57.2	105.2	63	67	01/22/23	46.6	66.4	103.3	81	0
68	01/23/23	57.6	53.5	105.0	69	68	01/23/23	47.4	56.3	103.4	81	0
69	01/24/23	49.7	77.9	105.2	93	69	01/24/23	47.3	83.8	102.7	201	174
70	01/25/23	52.1	62.4	104.9	73	70	01/25/23	43.7	73.3	104.0	82	0
71	01/26/23	54.3	60.2	104.9	55	71	01/26/23	41.7	72.5	104.8	81	0
72	01/27/23	49.5	67.9	105.5	52	72	01/27/23	43.8	74.8	104.1	80	0
73	01/28/23	60.4	86.2	105.5	85	73	01/28/23	59.0	91.7	103.9	109	67
74	01/29/23	63.0	85.9	104.8	105	74	01/29/23	59.7	93.9	103.5	504	102
75	01/30/23	42.2	81.7	105.5	86	75	01/30/23	35.1	96.9	104.0	81	38
76	01/31/23	42.3	78.0	105.7	70	76	01/31/23	32.9	96.1	104.3	81	19
77	02/01/23	41.7	79.9	106.6	122	77	02/01/23	33.1	96.8	105.2	350	27
78	02/02/23	44.8	80.2	106.0	122	78	02/02/23	36.2	97.2	104.7	425	30
79	02/03/23	57.2	73.0	105.6	88	79	02/03/23	42.6	89.4	103.9	70	35
80	02/04/23	61.9	67.8	105.5	74	80	02/04/23	47.3	82.5	104.6	81	35
81	02/05/23	66.7	65.9	105.5	69	81	02/05/23	55.9	82.3	104.3	80	35
82	02/06/23	69.7	71.1	104.8	64	82	02/06/23	63.0	83.6	103.7	80	24
83	02/07/23	68.7	84.0	105.2	60	83	02/07/23	66.8	87.6	104.0	83	16
84	02/08/23	54.3	82.4	105.0	110	84	02/08/23	50.2	92.6	104.1	206	16
85	02/09/23	61.6	66.9	105.8	82	85	02/09/23	53.4	77.0	104.8	83	13
86	02/10/23	55.3	61.3	106.0	66	86	02/10/23	48.4	68.8	104.0	77	8
87	02/11/23	50.1	65.1	105.9	60	87	02/11/23	41.8	77.9	104.4	76	5
88	02/12/23	59.4	62.7	105.8	59	88	02/12/23	48.5	70.9	104.9	78	8
89	02/13/23	63.0	68.4	105.8	60	89	02/13/23	56.1	75.3	104.8	77	0
90	02/14/23	70.9	64.1	105.3	61	90	02/14/23	66.8	62.5	104.8	77	0
91	02/15/23	71.4	76.2	105.6	56	91	02/15/23	68.2	79.4	104.7	77	0
92	02/16/23	55.9	57.0	105.8	61	92	02/16/23	52.4	58.6	105.1	90	0
93	02/17/23	54.7	51.0	107.6	50	93	02/17/23	41.8	54.7	106.1	76	37
94	02/18/23	53.5	61.6	107.9	52	94	02/18/23	43.9	63.7	107.6	80	0
95	02/19/23	65.6	66.0	108.0	51	95	02/19/23	57.3	72.5	106.9	78	0
96	02/20/23	74.8	73.8	107.6	48	96	02/20/23	70.3	78.9	107.8	78	0
97	02/21/23	75.4	73.3	107.5	50	97	02/21/23	71.5	77.9	106.9	77	0
98	02/22/23	78.4	67.1	107.0	42	98	02/22/23	75.4	68.7	107.1	75	0
99	02/23/23	75.5	64.8	107.6	51	99	02/23/23	70.9	67.0	107.5	75	0
100	02/24/23	63.5	57.6	107.6	48	100	02/24/23	58.5	61.8	107.5	75	5
101	02/25/23	66.2	63.2	108.0	43	101	02/25/23	57.7	73.1	108	74	0
102	02/26/23	72.4	70.4	108.3	44	102	02/26/23	68.1	75.1	107.8	74	0
103	02/27/23	73.7	50.5	108.6	47	103	02/27/23	69.1	46.1	106.9	72	0
104	02/28/23	70.9	69.4	108.3	47	104	02/28/23	66.4	71.8	107.9	73	0
105	03/01/23	77.1	76.4	107.6	52	105	03/01/23	74.4	78.3	106.3	133	0
106	03/02/23	75.0	82.5	107.7	73	106	03/02/23	72.4	85.3	106.5	103	103
107	03/03/23	66.4	58.0	107.9	95	107	03/03/23	57.5	61.7	107.9	73	26
108	03/04/23	68.3	62.4	107.0	41	108	03/04/23	60.6	65.1	107	72	0
109	03/05/23	71.3	65.1	108.0	48	109	03/05/23	64.1	70.8	106.8	72	0
110	03/06/23	73.6	75.1	106.2	47	110	03/06/23	68.3	78.7	107.3	73	0
111	03/07/23	76.7	81.1	106.5	41	111	03/07/23	72.8	82.1	107.1	72	0
112	03/08/23	78.4	73.5	105.9	50	112	03/08/23	73.5	75.0	106.2	64	0
113	03/09/23	77.4	73.0	105.3	59	113	03/09/23	72.6	74.6	105.3	62	0
114	03/10/23	70.9	73.0	105.8	42	114	03/10/23	62.7	81.2	106.4	73	0
115	03/11/23	76.4	73.0	106.2	48	115	03/11/23	71.9	75.6	105.9	70	0
116	03/12/23	70.0	72.6	106.0	49	116	03/12/23	65.2	75.9	104.9	74	0
117	03/13/23	67.9	64.6		54	117	03/13/23	57.7	55.7		72	0
118	03/14/23	65.8	64.3	106.0	41	118	03/14/23	56.8	52.0	105.2	72	0
119	03/15/23	69.2	60.4	106.4	47	119	03/15/23	60.1	58.2	105.3	186	0
120	03/16/23	68.0	84.8	106.7	66	120	03/16/23	66.3	84.6	104.9	87	167
121	03/17/23	57.0	61.0	107.0	73	121	03/17/23	48.8	59.9	105.3	74	19
122	03/18/23	55.4	61.9	106.3	52	122	03/18/23	49.4	52.0	104.7	76	0
123	03/19/23	61.2	60.6	106.2	48	123	03/19/23	46.2	51.1	104.9	95	0
124	03/20/23	52.8	68.5	107.3	53	124	03/20/23	47.3	62.9	104.8	81	0
125	03/21/23	65.0	83.5	107.2	56	125	03/21/23	62.4	84.7	104.8	23	7
126	03/22/23	76.8	78.6	106.2	60	126	03/22/23	72.9	79.5	105	23	0
127	03/23/23	79.4	74.8	105.3	34	127	03/23/23	75.7	76.1	104.4		0
128	03/24/23	77.6	71.8	105.1	71	128	03/24/23	73.2	70.6	103.6		0
129	03/25/23	69.5	62.1	105.8	48	129	03/25/23	63.2	56.1	103.8		0
130	03/26/23	67.0	81.5	106.0	53	130	03/26/23	61.6	77.2	104.6		2

131	03/27/23	73.0	73.8	106.0	45		131	03/27/23	66.9	70.5	104.2		0
132	03/28/23	71.9	51.8	106.3	49		132	03/28/23	64.4	46.6	104		0
133	03/29/23	69.7	59.6	106.0	60		133	03/29/23	62.1	56.0	103.5		0
134	03/30/23	72.1	76.9	106.5	69		134	03/30/23	69.2	77.2	103.7		0
135	03/31/23	80.1	72.8	106.6	56		135	03/31/23	76.7	72.7	103		0
136	04/01/23	73.6	65.2	106.0	49		136	04/01/23	67.6	62.8	103.8		0
137	04/02/23	74.3	74.6	107.3	58		137	04/02/23	70.8	70.4	104.3		5
138	04/03/23	80.1	76.6	106.8	43		138	04/03/23	76.9	77.4	103.5		0
139	04/04/23	80.2	76.8	106.7	48		139	04/04/23	77.3	77.4	103.2		0
140	04/05/23	71.6	72.2	107.0	54		140	04/05/23	67.5	68.7	104.2	64	52
141	04/06/23	56.0	89.4	107.4	99		141	04/06/23	53.3	90.1	103.9	617	845
142	04/07/23	56.8	90.7	107.5			142	04/07/23	52.6	91.9	103.7	128	373
143	04/08/23	64.7	85.7	108.1			143	04/08/23	58.2	88.0	104.9	87	0
144	04/09/23	71.3	83.7	107.4			144	04/09/23	64.1	82.1	104.7	67	0
145	04/10/23	71.5	82.1	106.3			145	04/10/23	63.6	80.1	105.3	61	0
146	04/11/23	71.2	76.1	107.1			146	04/11/23	63.2	73.0	104.4	69	0
147	04/12/23	70.9	72.5	106.4			147	04/12/23	63.5	72.5	104.5	62	0
148	04/13/23	73.4	69.7	106.5			148	04/13/23	65.5	70.3	103.9	61	0
149	04/14/23	72.2	82.0	106.0			149	04/14/23	68.0	84.1	103.3	61	0
150	04/15/23	79.1	68.3	106.3			150	04/15/23	75.2	67.3	104.7	58	0
151	04/16/23	72.9	57.0	105.8			151	04/16/23	62.7	49.1	104.9	55	0
152	04/17/23	71.4	62.2	106.1	77		152	04/17/23	63.4	57.5	105	55	0
153	04/18/23	73.4	70.9	107.3	52		153	04/18/23	68.5	70.0	104.9	57	5
154	04/19/23	77.2	73.6	107.2	53		154	04/19/23	72.6	75.5	104.9	60	0
155	04/20/23	75.5	84.0	13.7	86		155	04/20/23	71.9	85.8	13.3	515	427
156	04/21/23	74.4	77.0	58.1	87		156	04/21/23	68.2	80.5	56.8	124	5
157	04/22/23	73.6	64.3	35.6	53		157	04/22/23	67.3	60.5	32.2	55	0
158	04/23/23	68.5	67.6	0.0	0		158	04/23/23	59.2	71.1	0	0	0
159	04/24/23	70.6	68.8	0.0	27		159	04/24/23	60.3	70.2	0	60	0
160	04/25/23	72.8	74.9	17.6	104		160	04/25/23	66.7	74.1	17.3	69	0
161	04/26/23	77.0	77.7	106.6	97		161	04/26/23	72.0	81.8	103.7	181	415
162	04/27/23	74.2	74.8	106.5	105		162	04/27/23	66.4	77.6	102.7	708	174
163	04/28/23	69.9	76.4	106.5	69		163	04/28/23	65.2	80.8	103.4	270	164
164	04/29/23	67.4	65.3	62.4	51		164	04/29/23	61.0	67.8	60.8	72	0
165	04/30/23	77.2	64.7	106.4	49		165	04/30/23	67.8	61.0	104.1	89	0
166	05/01/23	78.2	65.2	107.6	76		166	05/01/23	69.8	57.7	104.6	37	0
167	05/02/23			107.2	62		167	05/02/23	71.7	75.1	105	87	0
168	05/03/23	77.1	73.9	106.2	49		168	05/03/23	73.9	72.3	104.7	48	0
169	05/04/23	79.4	69.6	106	58		169	05/04/23	73.0	81.1	104.1	61	0
170	05/05/23	78.1	78.0	106.3	73		170	05/05/23	80.1	76.3	103.6	74	42
171	05/06/23	83.6	73.1	106.3	82		171	05/06/23	77.1	76.6	104.1	68	2
172	05/07/23			106.1	47		172	05/07/23	76.8	77.5	103.5	90	0
173	05/08/23			106.1	54		173	05/08/23	75.0	83.7	103.4	44	0
174	05/09/23			106.6	167		174	05/09/23	71.1	87.2	104	151	38
175	05/10/23	80.4	74.6	106.2	103		175	05/10/23	71.2	89.2	103.9	176	136
176	05/11/23	80.4	77.0	105.3	79		176	05/11/23	78.0	83.1	103.5	74	0
177	05/12/23	78.8	79.2	105.4	54		177	05/12/23	80.0	80.4	103.2	59	0
178	05/13/23	75.6	84.9	105.9	78		178	05/13/23	71.8	87.9	102.8	156	127
179	05/14/23	77.1	83.5	105.4	89		179	05/14/23	72.6	85.6	102.1	291	153
180	05/15/23	81.8	79.9	105.5	87		180	05/15/23	73.8	86.4	101.6	200	101
181	05/16/23	83.0	77.6	105.9	73		181	05/16/23	73.3	83.2	102	89	0
182	05/17/23	77.2	83.7	105.3	63		182	05/17/23	74.7	74.2	101.4	67	0
183	05/18/23	77.0	83.4	105.2	63		183	05/18/23	77.0	69.4	102.1	58	0
184	05/19/23	78.8	80.5	104.8	64		184	05/19/23	79.5	69.8	101.6	61	0
185	05/20/23	78.4	78.8	105.5	69		185	05/20/23	74.7	76.4	101.2	69	14
186	05/21/23	79.5	72.2	106.1	57		186	05/21/23	70.9	79.1	100.8	69	0
187	05/22/23	81.4	69.9	104.9	44		187	05/22/23	74.1	69.3	100.5	67	0
188	05/23/23	83.6	67.2	104	53		188	05/23/23	75.8	74.2	100.7	65	0
189	05/24/23	80.2	71.2	104.9	67		189	05/24/23	75.4	73.0	100.7	87	42
190	05/25/23	78.5	74.2	104.4	54		190	05/25/23	76.2	69.5	100.1	65	0
191	05/26/23	79.9	66.4	104.3	55		191	05/26/23	77.9	60.6	100.2	61	0
192	05/27/23	80.2	73.7	103.8	62		192	05/27/23	76.8	64.4	100.1	61	0
193	05/28/23	80.2	73.5	103.8	45		193	05/28/23	77.4	66.1	99.2	60	0
194	05/29/23	80.7	70.5	105.3	36		194	05/29/23	76.6	69.2	100	56	0
195	05/30/23	81.0	64.7	104.8	48		195	05/30/23	77.4	69.8	99.7	55	0
196	05/31/23	81.0	66.6	103.9	49		196	05/31/23	78.5	67.5	99.3	51	0
197	06/01/23	81.5	65.7	104.6	53		197	06/01/23	79.5	67.4	100.1	56	0
198	06/02/23	81.3	68.3	102.1	47		198	06/02/23	80.1	65.5	99.6	57	0
199	06/03/23	81.8	67.0	103.1	33		199	06/03/23	80.6	63.5	100.5	184	206
200	06/04/23	82.7	65.0	103.7	55		200	06/04/23	74.8	72.4	100.2	90	2

201	06/05/23	81.0	70.9	103.9	54	201	06/05/23	75.0	78.0	100.5	62	0
202	06/06/23	82.0	67.2	103.2	60	202	06/06/23	77.5	70.8	100.7	59	0
203	06/07/23	82.5	67.0	102.9	56	203	06/07/23	79.0	68.7	100.2	66	0
204	06/08/23	79.9	74.0	102.74	49	204	06/08/23	74.8	80.4	100.2	191	164
205	06/09/23	84.4	72.0	102.8	49	205	06/09/23	80.5	73.1	100.1	72	0
206	06/10/23	86.2	71.5	102.3	57	206	06/10/23	82.2	73.3	99.9	234	209
207	06/11/23	84.9	72.8	103.7	73	207	06/11/23	81.0	73.2	100.5	77	0
208	06/12/23	86.6	73.3	102.7	47	208	06/12/23	83.4	74.3	100.5	60	0
209	06/13/23	86.5	72.3	102.6	35	209	06/13/23	83.6	73.3	100.2	53	0
210	06/14/23	87.1	74.5	103.2	45	210	06/14/23	84.5	74.6	99.7	56	0
211	06/15/23	89.0	71.3	102.4	53	211	06/15/23	86.4	74.5	99.7	59	0
212	06/16/23	89.5	70.2	102.5	31	212	06/16/23	87.6	71.9	99.6	59	0
213	06/17/23	88.7	71.6	102.5		213	06/17/23	86.0	75.2	99.6	59	0
214	06/18/23	89.8	68.2	102.5		214	06/18/23	87.6	70.2	99.8	52	0
215	06/19/23	90.0	68.6	102.8		215	06/19/23	87.7	71.3	99.8	56	0
216	06/20/23	90.3	68.4	102.5		216	06/20/23	87.9	70.9	99.6	56	0
217	06/21/23	88.3	72.4	102.3		217	06/21/23	85.4	72.9	99.4	56	0
218	06/22/23	86.1	74.2	102.9		218	06/22/23	83.7	72.0	99.7	69	0
219	06/23/23	89.2	71.2	102.2		219	06/23/23	87.2	70.3	99.2	60	0
220	06/24/23	87.6	70.9	101.7		220	06/24/23	86.0	69.3	99.1	60	0
221	06/25/23	89.2	70.2	101.3		221	06/25/23	87.6	69.2	97.9	59	0
222	06/26/23	88.4	69.0	101.1		222	06/26/23	86.2	68.8	98.5	59	0
223	06/27/23	89.4	66.7	101.1		223	06/27/23	87.3	65.4	99	57	0
224	06/28/23	88.8	68.0	101.5		224	06/28/23	86.6	66.0	99.6	52	0
225	06/29/23	89.5	67.5	100.2		225	06/29/23	87.2	66.2	100.2	45	0
226	06/30/23	88.6	65.5	100.9		226	06/30/23	86.2	63.5	99.5	50	0
227	07/01/23	88.1	69.4	101.8		227	07/01/23	86.1	65.7	99.1	53	0
228	07/02/23	87.7	68.5	101.6		228	07/02/23	86.0	63.3	99.6	52	0
229	07/03/23	87.4	71.9	101.1		229	07/03/23	84.8	67.2	100.3	51	0
230	07/04/23	87.1	74.3	100.7		230	07/04/23	84.5	71.8	99.2	60	0
231	07/05/23	86.8	73.6	101.3		231	07/05/23	84.2	71.4	100.2	55	0
232	07/06/23	84.9	78.2	101.7		232	07/06/23	80.2	80.4	100.3	89	59
233	07/07/23	85.7	72.2	102.1		233	07/07/23	82.1	73.3	100.1	68	0
234	07/08/23	88.2	71.1	101.3		234	07/08/23	85.7	70.5	100.8	65	0
235	07/09/23	89.9	67.7	101		235	07/09/23	88.0	65.2	100.6	62	0
236	07/10/23	90.3	67.9	101.8		236	07/10/23	88.3	65.1	101.1	61	0
237	07/11/23	89.9	67.3	102.2		237	07/11/23	88.5	64.7	100.9	62	0
238	07/12/23	90.8	65.1	102.1	24	238	07/12/23	89.4	63.0	100.8	67	0
239	07/13/23	91.4	64.6	102.6	19	239	07/13/23	89.6	62.7	100.5	67	0
240	07/14/23	90.7	64.5	103.3	23	240	07/14/23	88.8	62.5	100	52	0
241	07/15/23	97.1	68.3	21.4	3	241	07/15/23	89.5	60.2	21.2	10	0
242	07/16/23	89.4	66.1	47.1	0	242	07/16/23	88.3	61.1	100.2	68	0
243	07/17/23	90.7	62.4	42.2	0	243	07/17/23	88.5	58.2	101.3	47	0
244	07/18/23	91.1	62.3	81.4	6	244	07/18/23	89.2	58.5	100.2		0
245	07/19/23	91.0	61.9	33.6	26	245	07/19/23	88.8	58.8	99.9		0
246	07/20/23	90.8	63.0	102.2	0	246	07/20/23	89.0	58.9	100.4		0
247	07/21/23	89.6	63.5	102.5	53	247	07/21/23	87.9	57.8	100.7		0
248	07/22/23	90.5	61.6	102.8	29	248	07/22/23	89.8	54.8	100.2		0
249	07/23/23	90.6	62.0	103.1	27	249	07/23/23	89.1	53.7	100.8		0
250	07/24/23	89.5	63.1	104	41	250	07/24/23	87.3	59.1	100.3		0
251	07/25/23	90.0	62.5	103.1	24	251	07/25/23	87.8	59.4	100.9		0
252	07/26/23	90.0	62.4	103.6	30	252	07/26/23	88.1	57.3	101	37	0
253	07/27/23	89.8	62.6	117.9	38	253	07/27/23	87.6	58.3	115.1	65	0
254	07/28/23	88.6	62.2	103.4	52	254	07/28/23	86.6	56.9	101.6	78	0
255	07/29/23	89.1	62.7	104	29	255	07/29/23	87.1	57.5	101.8	80	0
256	07/30/23	89.9	62.6	121.1	23	256	07/30/23	88.4	55.2	119.7	69	0
257	07/31/23	91.3	61.6	103.6	62	257	07/31/23	90.3	52.7	102.8	75	0
258	08/01/23	91.7	60.9	103.7	29	258	08/01/23	90.6	51.5	102.3	74	0
259	08/02/23	91.6	57.6	103.5	18	259	08/02/23	90.4	49.3	101.4	68	0
260	08/03/23	91.4	61.3	102.9	25	260	08/03/23	89.5	57.1	101.3	58	0
261	08/04/23	92.2	59.9	103.3	30	261	08/04/23	84.2	71.3	101.6	64	0
262	08/05/23	92.2	59.9	103.7	29	262	08/05/23	90.6	56.0	101	60	0
263	08/06/23	92.1	59.2	103.4	26	263	08/06/23	90.7	55.5	101.5	57	0
264	08/07/23	92.6	59.3	102.9	26	264	08/07/23	91.2	55.7	101.7	69	0
265	08/08/23	92.3	60.1	102.5	23	265	08/08/23	90.3	57.9	101.1	70	0
266	08/09/23	92.3	60.9	33.9	24	266	08/09/23	90.7	58.5	33.6	76	0
267	08/10/23	93.0	59.5	102.8	24	267	08/10/23	91.5	56.6	100.9	56	0
268	08/11/23	92.8	59.4	101.8	25	268	08/11/23	91.4	56.4	100.3	64	0
269	08/12/23	92.5	61.5	101.3	33	269	08/12/23	90.9	59.8	100.7	76	0
270	08/13/23	92.2	60.1	72.2	24	270	08/13/23	90.6	57.6	71.5	72	0
271	08/14/23	91.6	61.5	102.1	25	271	08/14/23	90.5	56.3	100	39	0
272	08/15/23	89.4	51.8	101.7	21	272	08/15/23	89.4	39.8	100.6	68	0
273	08/16/23	85.8	54.3	102.2	25	273	08/16/23	85.7	37.5	100.4	67	0
274	08/17/23	88.8	58.5	101.7	35	274	08/17/23	88.5	48.9	100	68	0
275	08/18/23	91.1	55.8	101.9	38	275	08/18/23	90.3	48.2	100.3	100	0
276	08/19/23	91.1	58.9	101.5	33	276	08/19/23	90.1	52.5	100.9	58	0
277	08/20/23	93.1	54.6	102.5	35	277	08/20/23	93.5	45.2	100	51	0
278	08/21/23	91.9	53.7	102.3	27	278	08/21/23	92.3	43.2	101.9	56	0
279	08/22/23	91.3	61.4	102.3	34	279	08/22/23	90.3	54.3	103.1	77	0
280	08/23/23	90.4	61.6	101.7	36	280	08/23/23	89.5	53.9	100.9	74	0

281	08/24/23	92.6	56.4	102.7	34	281	08/24/23	92.7	46.6	101	77	0
282	08/25/23	93.4	53.5	101.5	42	282	08/25/23	92.9	44.7	101.6	27	0
283	08/26/23	91.2	57.8	101.8	33	283	08/26/23	90.6	49.3	101.3	10	0
284	08/27/23	89.5	60.5	102.2	34	284	08/27/23	89.1	53.9	101.6	0	0
285	08/28/23	86.7	66.9	102.4	33	285	08/28/23	84.8	64.1	93.4	135	0
286	08/29/23	87.6	59.4	102.5	45	286	08/29/23	87.0	49.5	101.3	133	0
287	08/30/23	85.9	55.8	102.1	35	287	08/30/23	85.7	42.3	101.5	70	0
288	08/31/23	86.4	57.6	101.9	35	288	08/31/23	86.3	42.3	101.4	66	0
289	09/01/23	86.1	57.9	102.8	41	289	09/01/23	86.0	43.4	101	81	0
290	09/02/23	86.9	58.1	101.8	36	290	09/02/23	86.7	42.3	100.9	62	0
291	09/03/23	89.2	59.4	102.1	34	291	09/03/23	87.9	51.8	101.3	62	0
292	09/04/23	89.8	62.4	101.5	34	292	09/04/23	88.5	59.5	101.8	68	0
293	09/05/23	92.0	60.1	101.7	53	293	09/05/23	90.6	57.6	101.1	67	0
294	09/06/23	91.5	60.3	100.4	35	294	09/06/23	89.7	58.1	100.9	61	0
295	09/07/23	92.5	57.3	100.7	35	295	09/07/23	91.3	52.6	100	80	0
296	09/08/23	92.4	54.3	100.1	27	296	09/08/23	91.8	47.4	100.6	48	0
297	09/09/23	88.9	59.5	100.9	37	297	09/09/23	88.0	51.0	99.8	57	0
298	09/10/23	86.6	53.8	101.1	31	298	09/10/23	86.0	40.1	99.4	57	0
299	09/11/23	81.7	58.3	100.9	39	299	09/11/23	81.1	43.9	100.5	70	0
300	09/12/23	85.9	59.1	101.6	34	300	09/12/23	85.1	49.1	101.8	69	0
301	09/13/23	82.4	70.4	33.6	48	301	09/13/23	78.6	72.0	33.4	65	9
302	09/14/23	83.5	71.7	101	63	302	09/14/23	78.6	80.2	100.3	83	40
303	09/15/23	83.7	71.6	101	77	303	09/15/23	78.1	79.9	100.6	294	336
304	09/16/23	82.4	72.1	101.8	74	304	09/16/23	77.3	80.9	101.6	1	0
305	09/17/23	83.4	64.3	102.1	62	305	09/17/23	80.6	65.5	101.8	14	0
306	09/18/23	82.6	58.8	101.7	47	306	09/18/23	80.5	51.7	43.0	149	0
307	09/19/23	84.0	58.9	102.0	40	307	09/19/23	81.4	53.9	50.5	48	0
308	09/20/23	85.6	61.7	101.9	47	308	09/20/23	83.1	59.5	102.6	59	0
309	09/21/23	87.2	62.9	101.2	53	309	09/21/23	85.0	62.8	100.4	76	0
310	09/22/23	88.0	63.0	101.0	53	310	09/22/23	85.5	64.0	100.4	68	0
311	09/23/23	89.4	62.6	101.1	53	311	09/23/23	86.9	65.0	100.8	75	0
312	09/24/23	90.3	63.0	100.9	52	312	09/24/23	87.7	65.1	100.4	74	0
313	09/25/23	86.0	68.9	102.1	89	313	09/25/23	82.5	71.4	100.3	59	0
314	09/26/23	84.8	66.2	101.9	52	314	09/26/23	80.7	71.7	100.8	145	0
315	09/27/23	86.1	64.8	102.6	32	315	09/27/23	82.8	67.3	101.1	90	131
316	09/28/23	85.4	63.7	101.3	70	316	09/28/23	82.4	64.0	101.5	65	0
317	09/29/23	85.5	63.0	102.5	45	317	09/29/23	82.5	62.9	101.0	78	0
318	09/30/23	84.8	60.7	102.9	56	318	09/30/23	82.3	57.1	101.0	74	0
319	10/01/23	82.8	61.6	102.5	53	319	10/01/23	80.9	54.1	101.8	73	0
320	10/02/23	82.8	60.9	103	53	320	10/02/23	80.8	52.5	103	73	0
321	10/03/23	81.8	69.9	103	72	321	10/03/23	77.0	75.9	102	41	0
322	10/04/23	86.9	69.9	102	39	322	10/04/23	83.0	76.2	101	78	2
323	10/05/23	79.0	74.2	102	82	323	10/05/23	73.8	82.6	100	58	420
324	10/06/23	79.9	64.0	102	69	324	10/06/23	75.7	66.1	102	374	0
325	10/07/23	73.5	58.9	103	61	325	10/07/23	67.8	50.7	101	68	0
326	10/08/23	71.2	63.6	103	58	326	10/08/23	64.8	52.0	101	76	0
327	10/09/23	75.1	62.2	103	38	327	10/09/23	69.3	57.7	101	76	0
328	10/10/23	73.4	75.0	103	0	328	10/10/23	68.9	78.4	101	66	5
329	10/11/23	73.9	72.0	102	2	329	10/11/23	67.9	79.9	101	102	2
330	10/12/23	75.3	73.3	102	24	330	10/12/23	70.1	78.8	100	81	0
331	10/13/23	78.9	65.4	103	45	331	10/13/23	74.9	68.8	101	91	0
332	10/14/23	69.2	60.0	103	48	332	10/14/23	64.2	50.2	101	62	0
333	10/15/23	67.1	60.3	105	50	333	10/15/23	60.5	55.4	102	81	0
334	10/16/23	65.6	61.2	104	7	334	10/16/23	57.2	56.8	101	68	0
335	10/17/23	66.2	63.9	103	17	335	10/17/23	57.7	58.5	101	76	0
336	10/18/23	71.5	63.4	104	10	336	10/18/23	66.0	63.4	100	70	0
337	10/19/23	74.2	64.1	104	25	337	10/19/23	69.3	67.0	101	77	0
338	10/20/23	74.6	58.3	105	25	338	10/20/23	71.8	53.8	101	64	0
339	10/21/23	75.1	63.6	104	26	339	10/21/23	72.4	56.9	101	66	0
340	10/22/23	80.1	66.7	105	44	340	10/22/23	76.5	70.8	101	66	0
341	10/23/23	80.7	69.6	105	52	341	10/23/23	78.0	71.2	100	86	0
342	10/24/23	80.8	68.8	105	64	342	10/24/23	78.4	70.1	101	68	0
343	10/25/23	80.9	74.5	105	58	343	10/25/23	77.2	79.9	101	92	52
344	10/26/23	79.0	76.0	105	60	344	10/26/23	75.3	87.0	101	149	117
345	10/27/23	82.2	74.5	105	85	345	10/27/23	77.2	88.5	101	86	14
346	10/28/23	83.2	71.5	105	80	346	10/28/23	79.1	81.6	101	89	38
347	10/29/23	67.4	74.3	106	77	347	10/29/23	62.1	87.6	101	107	52
348	10/30/23	47.7	76.0	107	66	348	10/30/23	44.7	80.8	101	125	61
349	10/31/23	58.2	61.7	107	57	349	10/31/23	49.3	57.2	102	78	0
350	11/01/23	58.2	67.6	107	30	350	11/01/23	46.03	63.06	103	72	0
351	11/02/23	59.2	69.2	107	36	351	11/02/23	49.59	62.83	102	94	0
352	11/03/23	66.1	68.7	107	30	352	11/03/23	60.03	66.61	103	32	0
353	11/04/23	71.2	70.0	107	36	353	11/04/23	65.15	77.68	103	106	0
354	11/05/23	73.8	70.6	106	35	354	11/05/23	68.26	79.22	102	23	0
355	11/06/23	75.7	71.4	106	42	355	11/06/23	71.05	76.29	102	22	0
356	11/07/23	78.0	67.6	108	42	356	11/07/23	74.01	73.73	106	102	0
357	11/08/23	78.6	70.3	106	41	357	11/08/23	74.83	76.53	102	162	0
358	11/09/23	72.2	82.7	107	53	358	11/09/23	68.67	86.34	102	67	54
359	11/10/23	59.2	85.6	107	68	359	11/10/23	56.15	90.54	102	125	38
360	11/11/23	60.4	85.0	107	60	360	11/11/23	56.43	87.94	102	94	0
361	11/12/23	62.4	83.7	106	66	361	11/12/23	59.38	82.65	103	78	26
362	11/13/23	64.1	82.7	107	67	362	11/13/23	59.85	81.48	103	108	31
363	11/14/23	65.4	79.0	107	54	363	11/14/23	61.22	75.9	103	69	0
364	11/15/23	67.3	70.9	107	52	364	11/15/23	60.44	73.49	103	69	0
365	11/16/23	63.0	84.8	107	59	365	11/16/23	59.34	85.87	102	70	0

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/27/23 16:43

G031136

TAMU - Ag. Eng. -E-Flow / S1 (GH-I)

Collected: 09/12/23 13:25 by CLIENT
Received: 09/12/23 14:40 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031136

Lab ID# G031136-01	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<2	mg/L		1	2	2	Bryan	09/13/23 07:10 CTG	SM5210 B 2016	M166530	NEL
Total Suspended Solids	10	mg/L		1	3	3	Bryan	09/13/23 16:39 DLC	SM2540 D 2015	M166606	NEL
Total Kjeldahl Nitrogen as N	0.28	mg/L		0.13	0.13	0.20	Bryan	09/19/23 14:18 KMA	EPA 351.2 R2.0	M166647	NEL
Nitrate/Nitrite as N	15	mg/L		0.02	0.17	0.20	Bryan	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166919	ANR
Turbidity	9.4	NTU		0.2	0.2	0.4	Bryan	09/13/23 13:38 ATG	SM2130 B 2011	M166592	NEL
Microbiological Analyses											
Fecal Coliform	10	CFU/100 mL	A-01, M5	1	10	10	Bryan	09/12/23 16:45 HDH	SM9222 D 2015	M166479	NEL
E. Coli	73.8	MPN/100 mL	A-01	1.0	1.0	1.0	Bryan	09/12/23 15:59 HDH	SM9223 B 2004	M166478	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	3.80	mg/L	MS-01	0.082	0.041	0.050	Bryan	09/15/23 11:21 ABM	EPA 200.7 R4.4	M166619	NEL

G031136-01 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	Bryan	09/21/23 11:10 KMA	SM4500-NH3 G 2011	M166967	NEL

TAMU - Ag. Eng. -E-Flow / S2 (OP-I)

Collected: 09/12/23 13:30 by CLIENT
Received: 09/12/23 14:40 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031136

Lab ID# G031136-02	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<2	mg/L		1	2	2	Bryan	09/13/23 07:10 CTG	SM5210 B 2016	M166530	NEL
Total Suspended Solids	24	mg/L		1	7	7	Bryan	09/14/23 10:38 DLC	SM2540 D 2015	M166646	NEL
Total Kjeldahl Nitrogen as N	1.58	mg/L		0.13	0.13	0.20	Bryan	09/19/23 14:18 KMA	EPA 351.2 R2.0	M166647	NEL
Nitrate/Nitrite as N	14	mg/L		0.02	0.17	0.20	Bryan	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166919	ANR
Turbidity	14	NTU		0.2	0.2	0.4	Bryan	09/13/23 13:38 ATG	SM2130 B 2011	M166592	NEL
Microbiological Analyses											
Fecal Coliform	40	CFU/100 mL		1	10	10	Bryan	09/12/23 16:45 HDH	SM9222 D 2015	M166479	NEL
E. Coli	9.7	MPN/100 mL		1.0	1.0	1.0	Bryan	09/12/23 15:59 HDH	SM9223 B 2004	M166478	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	3.95	mg/L	MS-01	0.082	0.041	0.050	Bryan	09/15/23 11:24 ABM	EPA 200.7 R4.4	M166619	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/27/23 16:43

G031136

G031136-02 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	*Bryan*	09/21/23 11:10 KMA	SM4500-NH3 G 2011	M166967	NEL

TAMU - Ag. Eng. -E-Flow / S3 (DH)

Collected: 09/12/23 14:10 by CLIENT
Received: 09/12/23 14:40 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G031136

Lab ID# G031136-03	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	2	mg/L		1	1	1	*Bryan*	09/13/23 07:10 CTG	SM5210 B 2016	M166530	NEL
Total Suspended Solids	2	mg/L		1	1	1	*Bryan*	09/14/23 13:29 SDH	SM2540 D 2015	M166680	NEL
Ammonia as N	1.20	mg/L		0.05	0.05	0.05	*Bryan*	09/18/23 12:05 KMA	SM4500-NH3 G 2011	M166796	NEL
Total Kjeldahl Nitrogen as N	1.71	mg/L		0.13	0.13	0.20	*Bryan*	09/19/23 14:18 KMA	EPA 351.2 R2.0	M166647	NEL
Nitrate/Nitrite as N	0.28	mg/L		0.02	0.02	0.02	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166919	ANR
Turbidity	0.9	NTU		0.2	0.2	0.4	*Bryan*	09/13/23 13:38 ATG	SM2130 B 2011	M166592	NEL
Microbiological Analyses											
Fecal Coliform	<1	CFU/100 mL		1	1	1	*Bryan*	09/12/23 17:07 HDH	SM9222 D 2015	M166479	NEL
E. Coli	<1.0	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/12/23 15:59 HDH	SM9223 B 2004	M166478	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	0.073	mg/L	MS-01	0.082	0.041	0.050	*Bryan*	09/15/23 11:27 ABM	EPA 200.7 R4.4	M166619	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/27/23 16:43

G031136

TAMU - Ag. Eng. -E-Flow / S4 (GH-E)

Collected: 09/12/23 13:51 by CLIENT
Received: 09/12/23 14:40 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031136

Lab ID# G031136-04	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<2	mg/L		1	2	2	*Bryan*	09/13/23 07:10 CTG	SM5210 B 2016	M166530	NEL
Total Suspended Solids	<1	mg/L		1	1	1	*Bryan*	09/14/23 10:38 DLC	SM2540 D 2015	M166646	NEL
Nitrate/Nitrite as N	4.0	mg/L		0.02	0.17	0.20	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166919	ANR
Turbidity	1.5	NTU		0.2	0.2	0.4	*Bryan*	09/13/23 13:38 ATG	SM2130 B 2011	M166592	NEL
Microbiological Analyses											
Fecal Coliform	800	CFU/100 mL	M5	1	100	100	*Bryan*	09/12/23 17:07 HDH	SM9222 D 2015	M166479	NEL
E. Coli	<1.0	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/12/23 15:59 HDH	SM9223 B 2004	M166478	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	5.19	mg/L	M5-01	0.082	0.041	0.050	*Bryan*	09/15/23 11:30 ABM	EPA 200.7 R4.4	M166619	NEL

G031136-04 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	*Bryan*	09/21/23 11:10 KMA	SM4500-NH3 G 2011	M166967	NEL
Total Kjeldahl Nitrogen as N	1.93	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M166903	NEL

TAMU - Ag. Eng. -E-Flow / S5 (OP-E)

Collected: 09/12/23 13:40 by CLIENT
Received: 09/12/23 14:40 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031136

Lab ID# G031136-05	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<2	mg/L		1	2	2	*Bryan*	09/13/23 07:10 CTG	SM5210 B 2016	M166531	NEL
Total Suspended Solids	1	mg/L		1	1	1	*Bryan*	09/14/23 13:29 SDH	SM2540 D 2015	M166680	NEL
Nitrate/Nitrite as N	11	mg/L		0.02	0.17	0.20	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166919	ANR
Turbidity	4.6	NTU		0.2	0.2	0.4	*Bryan*	09/13/23 13:38 ATG	SM2130 B 2011	M166592	NEL
Microbiological Analyses											
Fecal Coliform	<1000	CFU/100 mL	M5	1	1000	1000	*Bryan*	09/12/23 17:19 HDH	SM9222 D 2015	M166479	NEL
E. Coli	<1.0	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/12/23 15:59 HDH	SM9223 B 2004	M166478	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	5.52	mg/L		0.082	0.041	0.050	*Bryan*	09/15/23 12:11 ABM	EPA 200.7 R4.4	M166620	NEL

Form: C:\ELMNT\FORMAT\ATL 051923 FIN_LS.RPT

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

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G031136

G031136-05 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	09/21/23 11:10 KMA	SM4500-NH3 G 2011	M166967	NEL
Total Kjeldahl Nitrogen as N	**1.92**	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M166903	NEL

Explanation of Notes

A-01	Fecal Coliform/E. Coli ratio is outside expected parameters. Review concluded it may be due to sample matrix and container differences.
BOD-07	Optional second BOD/CBOD GG was outside expected range. Results accepted on one required passing GG.
M5	This result is estimated as no plates contained colony counts within the method-specified range.
MS-01	The MS and/or MSD recovery was outside acceptance limits. Investigation concludes it is a sample- specific matrix effect and the batch was accepted based on acceptable LCS and /or LCSD recovery.
SL-01	The dried residue did not yield between 2.5 and 200 mg as specified in the method. Due to holding time constraints or insufficient sample volume, the sample cannot be reanalyzed.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.
Report Printed: 9/27/23 16:43
G031137

TAMU - Ag. Eng. -E-Flow / S1
Collected: 09/13/23 11:20 by CLIENT
Received: 09/13/23 12:21 by Hannah Cline
Type Grab
Matrix Non Potable
C-O-C # G031137

Lab ID# G031137-01	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<2	mg/L		1	2	2	*Bryan*	09/14/23 07:53 VML	SM5210 B 2016	M166614	NEL
Total Suspended Solids	13	mg/L		1	2	2	*Bryan*	09/14/23 13:29 SDH	SM2540 D 2015	M166680	NEL
Total Kjeldahl Nitrogen as N	1.08	mg/L		0.13	0.13	0.20	*Bryan*	09/19/23 14:18 KMA	EPA 351.2 R2.0	M166647	NEL
Nitrate/Nitrite as N	14	mg/L		0.02	0.17	0.20	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166919	ANR
Turbidity	7.1	NTU		0.2	0.2	0.4	*Bryan*	09/13/23 13:38 ATG	SM2130 B 2011	M166592	NEL
Microbiological Analyses											
Fecal Coliform	290	CFU/100 mL		1	10	10	*Bryan*	09/13/23 17:12 HDH	SM9222 D 2015	M166537	NEL
E. Coli	276	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/13/23 14:49 HDH	SM9223 B 2004	M166536	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	3.75	mg/L		0.082	0.041	0.050	*Bryan*	09/15/23 12:16 ABM	EPA 200.7 R4.4	M166620	NEL

G031137-01 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	*Bryan*	09/21/23 11:10 KMA	SM4500-NH3 G 2011	M166968	NEL

TAMU - Ag. Eng. -E-Flow / S2
Collected: 09/13/23 11:33 by CLIENT
Received: 09/13/23 12:21 by Hannah Cline
Type Grab
Matrix Non Potable
C-O-C # G031137

Lab ID# G031137-02	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<2	mg/L		1	2	2	*Bryan*	09/14/23 07:53 VML	SM5210 B 2016	M166614	NEL
Total Suspended Solids	<1	mg/L		1	1	1	*Bryan*	09/14/23 13:29 SDH	SM2540 D 2015	M166680	NEL
Nitrate/Nitrite as N	4.0	mg/L		0.02	0.10	0.12	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166919	ANR
Turbidity	1.6	NTU		0.2	0.2	0.4	*Bryan*	09/13/23 13:38 ATG	SM2130 B 2011	M166592	NEL
Microbiological Analyses											
Fecal Coliform	<100	CFU/100 mL		1	100	100	*Bryan*	09/13/23 17:12 HDH	SM9222 D 2015	M166537	NEL
E. Coli	<1.0	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/13/23 14:49 HDH	SM9223 B 2004	M166536	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	5.20	mg/L		0.082	0.041	0.050	*Bryan*	09/15/23 12:19 ABM	EPA 200.7 R4.4	M166620	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/27/23 16:43

G031137

G031137-02 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	*Bryan*	09/21/23 11:10 KMA	SM4500-NH3 G 2011	M166958	NEL
Total Kjeldahl Nitrogen as N	1.77	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M166903	NEL

TAMU - Ag. Eng. -E-Flow / S3

Collected: 09/13/23 11:35 by CLIENT
Received: 09/13/23 12:21 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G031137

Lab ID# G031137-03	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	2	mg/L		1	1	1	*Bryan*	09/14/23 07:53 VML	SM5210 B 2016	M166614	NEL
Total Suspended Solids	2	mg/L		1	1	1	*Bryan*	09/14/23 13:29 SDH	SM2540 D 2015	M166680	NEL
Ammonia as N	1.20	mg/L		0.05	0.05	0.05	*Bryan*	09/18/23 12:05 KMA	SM4500-NH3 G 2011	M166796	NEL
Total Kjeldahl Nitrogen as N	1.70	mg/L		0.13	0.13	0.20	*Bryan*	09/19/23 14:18 KMA	EPA 351.2 R2.0	M166647	NEL
Nitrate/Nitrite as N	0.29	mg/L		0.02	0.02	0.02	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166919	ANR
Turbidity	0.9	NTU		0.2	0.2	0.4	*Bryan*	09/13/23 13:38 ATG	SM2130 B 2011	M166592	NEL
Microbiological Analyses											
Fecal Coliform	<1	CFU/100 mL		1	1	1	*Bryan*	09/13/23 17:36 HDH	SM9222 D 2015	M166537	NEL
E. Coli	<1.0	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/13/23 14:49 HDH	SM9223 B 2004	M166536	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	0.069	mg/L		0.062	0.041	0.050	*Bryan*	09/15/23 12:23 ABM	EPA 200.7 R4.4	M166620	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/27/23 16:43

G031137

TAMU - Ag. Eng. -E-Flow / S4

Collected: 09/13/23 11:27 by CLIENT
Received: 09/13/23 12:21 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031137

Lab ID# G031137-04	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	09/14/23 07:53 VML	SM5210 B 2016	M166614	NEL
Total Suspended Solids	**21**	mg/L		1	7	7	*Bryan*	09/14/23 13:29 SDH	SM2540 D 2015	M166680	NEL
Nitrate/Nitrite as N	**14**	mg/L		0.02	0.17	0.20	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166919	ANR
Turbidity	**14**	NTU		0.2	0.2	0.4	*Bryan*	09/13/23 13:38 ATG	SM2130 B 2011	M166592	NEL
Microbiological Analyses											
Fecal Coliform	**10**	CFU/100 mL	M5	1	10	10	*Bryan*	09/13/23 17:36 HDH	SM9222 D 2015	M166537	NEL
E. Coli	**45.9**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/13/23 14:49 HDH	SM9223 B 2004	M166536	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**3.94**	mg/L		0.082	0.041	0.050	*Bryan*	09/15/23 12:26 ABM	EPA 200.7 R4.4	M166620	NEL

G031137-04 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	09/21/23 11:10 KMA	SM4500-NH3 G 2011	M166967	NEL
Total Kjeldahl Nitrogen as N	**1.56**	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M166903	NEL

TAMU - Ag. Eng. -E-Flow / S5

Collected: 09/13/23 11:43 by CLIENT
Received: 09/13/23 12:21 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031137

Lab ID# G031137-05	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	09/14/23 07:53 VML	SM5210 B 2016	M166614	NEL
Total Suspended Solids	**<1**	mg/L		1	1	1	*Bryan*	09/14/23 13:29 SDH	SM2540 D 2015	M166680	NEL
Nitrate/Nitrite as N	**10**	mg/L		0.02	0.17	0.20	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166919	ANR
Turbidity	**4.6**	NTU		0.2	0.2	0.4	*Bryan*	09/13/23 13:38 ATG	SM2130 B 2011	M166592	NEL
Microbiological Analyses											
Fecal Coliform	**<1000**	CFU/100 mL	M5	1	1000	1000	*Bryan*	09/13/23 17:36 HDH	SM9222 D 2015	M166537	NEL
E. Coli	**<1.0**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/13/23 14:49 HDH	SM9223 B 2004	M166536	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**5.25**	mg/L		0.082	0.041	0.050	*Bryan*	09/15/23 12:29 ABM	EPA 200.7 R4.4	M166620	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

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G031137

G031137-05 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	09/21/23 11:10 KMA	SM4500-NH3 G 2011	M166967	NEL
Total Kjeldahl Nitrogen as N	**1.90**	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M166903	NEL

Explanation of Notes

M5 This result is estimated as no plates contained colony counts within the method-specified range.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/27/23 16:43

G031138

TAMU - Ag. Eng. -E-Flow / S1 (GH-I)

Collected: 09/19/23 13:10 by CLIENT
Received: 09/19/23 14:27 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031138

Lab ID# G031138-01

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	2	mg/L		1	2	2	*Bryan*	09/20/23 07:22 CTG	SM5210 B 2016	M166888	NEL
Total Suspended Solids	10	mg/L		1	3	3	*Bryan*	09/21/23 14:27 SDH	SM2540 D 2015	M167016	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	*Bryan*	09/25/23 11:45 KMA	SM4500-NH3 G 2011	M167131	NEL
Total Kjeldahl Nitrogen as N	1.82	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M166903	NEL
Nitrate/Nitrite as N	14	mg/L		0.02	0.17	0.20	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166920	ANR
Turbidity	19	NTU		0.2	0.2	0.4	*Bryan*	09/20/23 11:39 ATG	SM2130 B 2011	M166930	NEL
Microbiological Analyses											
Fecal Coliform	30	CFU/100 mL		1	2	2	*Bryan*	09/19/23 16:23 HDH	SM9222 D 2015	M166851	NEL
E. Coli	21.3	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/19/23 15:42 HDH	SM9223 B 2004	M166850	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	3.78	mg/L		0.082	0.041	0.050	*Bryan*	09/26/23 12:54 ABM	EPA 200.7 R4.4	M167006	NEL

TAMU - Ag. Eng. -E-Flow / S2 (GH-E)

Collected: 09/19/23 13:55 by CLIENT
Received: 09/19/23 14:27 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031138

Lab ID# G031138-02

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<2	mg/L		1	2	2	*Bryan*	09/20/23 07:22 CTG	SM5210 B 2016	M166888	NEL
Total Suspended Solids	<1	mg/L		1	1	1	*Bryan*	09/21/23 14:27 SDH	SM2540 D 2015	M167016	NEL
Ammonia as N	0.07	mg/L		0.05	0.05	0.05	*Bryan*	09/25/23 11:45 KMA	SM4500-NH3 G 2011	M167131	NEL
Total Kjeldahl Nitrogen as N	1.62	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M166903	NEL
Nitrate/Nitrite as N	1.7	mg/L		0.02	0.10	0.12	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166920	ANR
Turbidity	1.3	NTU		0.2	0.2	0.4	*Bryan*	09/20/23 11:39 ATG	SM2130 B 2011	M166930	NEL
Microbiological Analyses											
Fecal Coliform	1400	CFU/100 mL	M5	1	100	100	*Bryan*	09/19/23 16:23 HDH	SM9222 D 2015	M166851	NEL
E. Coli	1.0	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/19/23 15:42 HDH	SM9223 B 2004	M166850	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	4.59	mg/L		0.082	0.041	0.050	*Bryan*	09/26/23 12:57 ABM	EPA 200.7 R4.4	M167006	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/27/23 16:43

G031138

TAMU - Ag. Eng. -E-Flow / S3 (DH)

Collected: 09/19/23 13:35 by CLIENT
Received: 09/19/23 14:27 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031138

Lab ID# G031138-03

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<1**	mg/L		1	1	1	*Bryan*	09/20/23 07:22 CTG	SM5210 B 2016	M166889	NEL
Total Suspended Solids	**<1**	mg/L		1	1	1	*Bryan*	09/21/23 14:27 SDH	SM2540 D 2015	M167016	NEL
Ammonia as N	**1.14**	mg/L		0.05	0.05	0.05	*Bryan*	09/25/23 11:45 KMA	SM4500-NH3 G 2011	M167131	NEL
Total Kjeldahl Nitrogen as N	**1.24**	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M166903	NEL
Nitrate/Nitrite as N	**0.25**	mg/L		0.02	0.02	0.02	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166920	ANR
Turbidity	**0.4**	NTU		0.2	0.2	0.4	*Bryan*	09/20/23 11:39 ATG	SM2130 B 2011	M166930	NEL
Microbiological Analyses											
Fecal Coliform	**<1**	CFU/100 mL		1	1	1	*Bryan*	09/19/23 16:23 HDH	SM9222 D 2015	M166851	NEL
E. Coli	**<1.0**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/19/23 15:42 HDH	SM9223 B 2004	M166850	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**0.127**	mg/L		0.082	0.041	0.050	*Bryan*	09/26/23 13:00 ABM	EPA 200.7 R4.4	M167006	NEL

TAMU - Ag. Eng. -E-Flow / S4 (OP-I)

Collected: 09/19/23 13:20 by CLIENT
Received: 09/19/23 14:27 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031138

Lab ID# G031138-04

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**3**	mg/L		1	2	2	*Bryan*	09/20/23 07:22 CTG	SM5210 B 2016	M166889	NEL
Total Suspended Solids	**104**	mg/L		1	20	20	*Bryan*	09/21/23 14:27 SDH	SM2540 D 2015	M167016	NEL
Ammonia as N	**0.06**	mg/L		0.05	0.05	0.05	*Bryan*	09/25/23 11:45 KMA	SM4500-NH3 G 2011	M167131	NEL
Total Kjeldahl Nitrogen as N	**7.09**	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M166903	NEL
Nitrate/Nitrite as N	**14**	mg/L		0.02	0.17	0.20	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166920	ANR
Turbidity	**130**	NTU		0.2	0.2	0.4	*Bryan*	09/20/23 11:39 ATG	SM2130 B 2011	M166930	NEL
Microbiological Analyses											
Fecal Coliform	**540**	CFU/100 mL		1	20	20	*Bryan*	09/19/23 16:32 HDH	SM9222 D 2015	M166851	NEL
E. Coli	**18.9**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/19/23 15:42 HDH	SM9223 B 2004	M166850	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**4.74**	mg/L		0.082	0.041	0.050	*Bryan*	09/26/23 13:03 ABM	EPA 200.7 R4.4	M167006	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/27/23 16:43

G031138

TAMU - Ag. Eng. -E-Flow / S5 (OP-E)

Collected: 09/19/23 13:40 by CLIENT
Received: 09/19/23 14:27 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G031138

Lab ID# G031138-05	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	09/20/23 07:22 CTG	SM5210 B 2016	M166889	NEL
Total Suspended Solids	**2**	mg/L		1	1	1	*Bryan*	09/21/23 14:27 SDH	SM2540 D 2015	M167016	NEL
Ammonia as N	**0.06**	mg/L		0.05	0.05	0.05	*Bryan*	09/25/23 11:45 KMA	SM4500-NH3 G 2011	M167131	NEL
Total Kjeldahl Nitrogen as N	**2.94**	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M166903	NEL
Nitrate/Nitrite as N	**5.2**	mg/L		0.02	0.17	0.20	*Bryan*	09/20/23 12:02 KMA	SM4500-NO3-F 2011	M166920	ANR
Turbidity	**14**	NTU		0.2	0.2	0.4	*Bryan*	09/20/23 11:39 ATG	SM2130 B 2011	M166930	NEL
Microbiological Analyses											
Fecal Coliform	**<10000**	CFU/100 mL	M5, R-01	1	10000	10000	*Bryan*	09/19/23 16:32 HDH	SM9222 D 2015	M166851	NEL
E. Coli	**2.0**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/19/23 15:42 HDH	SM9223 B 2004	M166850	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**4.11**	mg/L		0.082	0.041	0.050	*Bryan*	09/26/23 13:06 ABM	EPA 200.7 R4.4	M167006	NEL

Explanation of Notes

BOD-07	Optional second BOD/CBOD GG was outside expected range. Results accepted on one required passing GG.
M5	This result is estimated as no plates contained colony counts within the method-specified range.
R-01	The Reporting Limit for this analyte has been raised to account for matrix interference.
SL-01	The dried residue did not yield between 2.5 and 200 mg as specified in the method. Due to holding time constraints or insufficient sample volume, the sample cannot be reanalyzed.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/29/23 16:55

G031482

TAMU - Ag. Eng. -E-Flow / S1 (GH-I)

Collected: 09/20/23 10:24 by CLIENT
Received: 09/20/23 12:46 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031482

Lab ID# G031482-01

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	2	mg/L		1	2	2	*Bryan*	09/21/23 07:30 CTG	SM5210 B 2016	M166959	NEL
Total Suspended Solids	9	mg/L	SL-02	1	4	4	*Bryan*	09/22/23 12:06 MRH	SM2540 D 2015	M167077	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	*Bryan*	09/26/23 11:40 KMA	SM4500-NH3 G 2011	M167183	NEL
Total Kjeldahl Nitrogen as N	1.13	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M167013	NEL
Nitrate/Nitrite as N	15	mg/L		0.02	0.17	0.20	*Bryan*	09/27/23 14:20 KMA	SM4500-NO3-F 2011	M167268	ANR
Turbidity	6.4	NTU	G-01	0.2	0.2	0.4	*Bryan*	09/20/23 11:39 ATG	SM2130 B 2011	M166930	NEL
Microbiological Analyses											
Fecal Coliform	40	CFU/100 mL	M5	1	10	10	*Bryan*	09/20/23 17:00 HDH	SM9222 D 2015	M166913	NEL
E. Coli	70.8	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/20/23 14:38 HDH	SM9223 B 2004	M166912	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	3.90	mg/L		0.082	0.041	0.050	*Bryan*	09/26/23 13:16 ABM	EPA 200.7 R4.4	M167006	NEL

TAMU - Ag. Eng. -E-Flow / S2 (GH-E)

Collected: 09/20/23 10:33 by CLIENT
Received: 09/20/23 12:46 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031482

Lab ID# G031482-02

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<2	mg/L		1	2	2	*Bryan*	09/21/23 07:30 CTG	SM5210 B 2016	M166959	NEL
Total Suspended Solids	<1	mg/L		1	1	1	*Bryan*	09/22/23 12:06 MRH	SM2540 D 2015	M167077	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	*Bryan*	09/26/23 11:40 KMA	SM4500-NH3 G 2011	M167183	NEL
Total Kjeldahl Nitrogen as N	1.71	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M167013	NEL
Nitrate/Nitrite as N	2.0	mg/L		0.02	0.10	0.12	*Bryan*	09/27/23 14:20 KMA	SM4500-NO3-F 2011	M167268	ANR
Turbidity	1.5	NTU	G-01	0.2	0.2	0.4	*Bryan*	09/20/23 11:39 ATG	SM2130 B 2011	M166930	NEL
Microbiological Analyses											
Fecal Coliform	3000	CFU/100 mL		1	100	100	*Bryan*	09/20/23 17:16 HDH	SM9222 D 2015	M166913	NEL
E. Coli	<1.0	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/20/23 14:38 HDH	SM9223 B 2004	M166912	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	4.48	mg/L		0.082	0.041	0.050	*Bryan*	09/26/23 13:19 ABM	EPA 200.7 R4.4	M167006	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/29/23 16:55

G031482

TAMU - Ag. Eng. -E-Flow / S3 (DH)

Collected: 09/20/23 11:00 by CLIENT
Received: 09/20/23 12:46 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031482

Lab ID# G031482-03

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<1**	mg/L		1	1	1	*Bryan*	09/21/23 07:30 CTG	SM5210 B 2016	M166959	NEL
Total Suspended Solids	**<1**	mg/L		1	1	1	*Bryan*	09/22/23 12:06 MRH	SM2540 D 2015	M167077	NEL
Ammonia as N	**1.18**	mg/L		0.05	0.05	0.05	*Bryan*	09/26/23 11:40 KMA	SM4500-NH3 G 2011	M167183	NEL
Total Kjeldahl Nitrogen as N	**1.33**	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M167013	NEL
Nitrate/Nitrite as N	**0.27**	mg/L		0.02	0.02	0.02	*Bryan*	09/27/23 14:20 KMA	SM4500-NO3-F 2011	M167268	ANR
Turbidity	**0.4**	NTU	G-01	0.2	0.2	0.4	*Bryan*	09/20/23 11:39 ATG	SM2130 B 2011	M166930	NEL
Microbiological Analyses											
Fecal Coliform	**<1**	CFU/100 mL		1	1	1	*Bryan*	09/20/23 17:16 HDH	SM9222 D 2015	M166913	NEL
E. Coli	**<1.0**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/20/23 14:38 HDH	SM9223 B 2004	M166912	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**0.104**	mg/L		0.082	0.041	0.050	*Bryan*	09/26/23 13:22 ABM	EPA 200.7 R4.4	M167006	NEL

TAMU - Ag. Eng. -E-Flow / S4 (OP-I)

Collected: 09/20/23 10:40 by CLIENT
Received: 09/20/23 12:46 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031482

Lab ID# G031482-04

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**2**	mg/L		1	2	2	*Bryan*	09/21/23 07:30 CTG	SM5210 B 2016	M166959	NEL
Total Suspended Solids	**120**	mg/L		1	20	20	*Bryan*	09/21/23 14:27 SDH	SM2540 D 2015	M167017	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	09/26/23 11:40 KMA	SM4500-NH3 G 2011	M167183	NEL
Total Kjeldahl Nitrogen as N	**3.49**	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M167013	NEL
Nitrate/Nitrite as N	**15**	mg/L		0.02	0.17	0.20	*Bryan*	09/27/23 14:20 KMA	SM4500-NO3-F 2011	M167268	ANR
Turbidity	**40**	NTU	G-01	0.2	0.2	0.4	*Bryan*	09/20/23 11:39 ATG	SM2130 B 2011	M166930	NEL
Microbiological Analyses											
Fecal Coliform	**230**	CFU/100 mL		1	10	10	*Bryan*	09/20/23 17:16 HDH	SM9222 D 2015	M166913	NEL
E. Coli	**109**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/20/23 14:38 HDH	SM9223 B 2004	M166912	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**4.40**	mg/L		0.082	0.041	0.050	*Bryan*	09/26/23 13:25 ABM	EPA 200.7 R4.4	M167006	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 9/29/23 16:55

G031482

TAMU - Ag. Eng. -E-Flow / S5 (OP-E)

Collected: 09/20/23 10:44 by CLIENT
Received: 09/20/23 12:46 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G031482

Lab ID# G031482-05	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	09/21/23 07:30 CTG	SM5210 B 2016	M166959	NEL
Total Suspended Solids	**<1**	mg/L		1	1	1	*Bryan*	09/21/23 14:27 SDH	SM2540 D 2015	M167017	NEL
Ammonia as N	**0.05**	mg/L		0.05	0.05	0.05	*Bryan*	09/26/23 11:40 KMA	SM4500-NH3 G 2011	M167183	NEL
Total Kjeldahl Nitrogen as N	**3.85**	mg/L		0.13	0.13	0.20	*Bryan*	09/26/23 12:30 KMA	EPA 351.2 R2.0	M167013	NEL
Nitrate/Nitrite as N	**4.4**	mg/L		0.02	0.10	0.12	*Bryan*	09/27/23 14:20 KMA	SM4500-NO3-F 2011	M167268	ANR
Turbidity	**8.4**	NTU	G-01	0.2	0.2	0.4	*Bryan*	09/20/23 11:39 ATG	SM2130 B 2011	M166930	NEL
Microbiological Analyses											
Fecal Coliform	**<10000**	CFU/100 mL	M5, R-01	1	10000	10000	*Bryan*	09/20/23 17:16 HDH	SM9222 D 2015	M166913	NEL
E. Coli	**<1.0**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	09/20/23 14:38 HDH	SM9223 B 2004	M166912	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	**4.97**	mg/L		0.082	0.041	0.050	*Bryan*	09/26/23 13:28 ABM	EPA 200.7 R4.4	M167006	NEL

Explanation of Notes

BOD-07	Optional second BOD/CBOD GG was outside expected range. Results accepted on one required passing GG.
G-01	This sample was added to an analytical run already in progress. See the prep time for when this sample was added.
M5	This result is estimated as no plates contained colony counts within the method-specified range.
R-01	The Reporting Limit for this analyte has been raised to account for matrix interference.
SL-02	The dried residue did not yield between 2.5 and 200 mg as specified in the method. The sample was not re-analyzed due to extended filtration time.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G031483

TAMU - Ag. Eng. -E-Flow / S1

Collected: 10/16/23 10:00 by CLIENT
Received: 10/16/23 11:06 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031483

Lab ID# G031483-01

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	10/18/23 07:30 VML	SM5210 B 2016	M168197	NEL
Total Suspended Solids	**6**	mg/L		1	2	2	*Bryan*	10/16/23 13:13 SDH	SM2540 D 2015	M168126	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/23/23 10:49 KMA	SM4500-NH3 G 2011	M168433	NEL
Total Kjeldahl Nitrogen as N	**<0.20**	mg/L		0.13	0.13	0.20	*Bryan*	10/17/23 15:00 KMA	EPA 351.2 R2.0	M168171	NEL
Nitrate/Nitrite as N	**18**	mg/L		0.02	0.17	0.20	*Bryan*	10/18/23 11:48 KMA	SM4500-NO3-F 2011	M168236	ANR
Turbidity	**3.6**	NTU	C-02	0.2	0.2	0.4	*Bryan*	10/16/23 11:38 ATG	SM2130 B 2011	M168114	NEL
Microbiological Analyses											
Fecal Coliform	**240**	CFU/100 mL	F2	1	10	10	*Bryan*	10/16/23 14:11 HDH	SM9222 D 2015	M167932	NEL
E. Coli	**1120**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/16/23 12:48 HDH	SM9223 B 2004	M168094	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	**3.65**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 11:54 MRG	EPA 200.7 R4.4	M168261	NEL

TAMU - Ag. Eng. -E-Flow / S2

Collected: 10/16/23 10:10 by CLIENT
Received: 10/16/23 11:06 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G031483

Lab ID# G031483-02

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	10/18/23 07:30 VML	SM5210 B 2016	M168197	NEL
Total Suspended Solids	**<1**	mg/L		1	1	1	*Bryan*	10/16/23 13:13 SDH	SM2540 D 2015	M168126	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/23/23 10:49 KMA	SM4500-NH3 G 2011	M168433	NEL
Total Kjeldahl Nitrogen as N	**1.42**	mg/L		0.13	0.13	0.20	*Bryan*	10/17/23 15:00 KMA	EPA 351.2 R2.0	M168171	NEL
Nitrate/Nitrite as N	**12**	mg/L		0.02	0.26	0.30	*Bryan*	10/18/23 11:48 KMA	SM4500-NO3-F 2011	M168236	ANR
Turbidity	**2.9**	NTU		0.2	0.2	0.4	*Bryan*	10/16/23 11:38 ATG	SM2130 B 2011	M168114	NEL
Microbiological Analyses											
Fecal Coliform	**540 (see sample memo)**	CFU/100 mL	F2	1	20	20	*Bryan*	10/16/23 14:11 HDH	SM9222 D 2015	M167932	NEL
E. Coli	**260**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/16/23 12:48 HDH	SM9223 B 2004	M168094	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	**3.81**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 11:58 MRG	EPA 200.7 R4.4	M168261	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G031483

G031483-02 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**110 (See sample memo)**	CFU/100 mL	M5	1	4	4	*Bryan*	10/16/23 14:11 HDH	SM9222 D 2015	M167932	NEL

Positive and negative colonies for some fecal coliform plates were confirmed as per SM9222 methodology. Colonies that exhibited positive atypical morphology were originally counted as positive. This result is the first Fecal Coliform result on the report under "Microbiological analyses." Because these colonies were confirmed as negative after the secondary method was completed, ATL included that data as the second Fecal Coliform result under the ID labeled "re-analysis." Management wished to present all data as, while the confirmation test showed some colonies to be negative, their morphology most closely resembled positive colonies.

TAMU - Ag. Eng. -E-Flow / S4

Collected: 10/16/23 10:12 by CLIENT
Received: 10/16/23 11:06 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G031483

Lab ID# G031483-04	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	10/18/23 07:30 VML	SM5210 B 2016	M168197	NEL
Total Suspended Solids	**8**	mg/L		1	2	2	*Bryan*	10/16/23 13:13 SDH	SM2540 D 2015	M168126	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/23/23 10:49 KMA	SM4500-NH3 G 2011	M168433	NEL
Total Kjeldahl Nitrogen as N	**0.54**	mg/L	MS-01	0.13	0.13	0.20	*Bryan*	10/24/23 12:41 KMA	EPA 351.2 R2.0	M168346	NEL
Nitrate/Nitrite as N	**18**	mg/L		0.02	0.26	0.30	*Bryan*	10/18/23 11:48 KMA	SM4500-NO3-F 2011	M168236	ANK
Turbidity	**13**	NTU		0.2	0.2	0.4	*Bryan*	10/16/23 11:38 ATG	SM2130 B 2011	M168114	NEL
Microbiological Analyses											
Fecal Coliform	**600 (see sample memo)**	CFU/100 mL	F2	1	10	10	*Bryan*	10/16/23 14:41 HDH	SM9222 D 2015	M167932	NEL
E. Coli	**921**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/16/23 12:46 HDH	SM9223 B 2004	M168094	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	**3.63**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 12:01 MRG	EPA 200.7 R4.4	M168261	NEL

G031483-04 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**460 (see sample memo)**	CFU/100 mL		1	10	10	*Bryan*	10/16/23 14:41 HDH	SM9222 D 2015	M167932	NEL

Positive and negative colonies for some fecal coliform plates were confirmed as per SM9222 methodology. Colonies that exhibited positive atypical morphology were originally counted as positive. This result is the first Fecal Coliform result on the report under "Microbiological analyses." Because these colonies were confirmed as negative after the secondary method was completed, ATL included that data as the second Fecal Coliform result under the ID labeled "re-analysis." Management wished to present all data as, while the confirmation test showed some colonies to be negative, their morphology most closely resembled positive colonies.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G031483

TAMU - Ag. Eng. -E-Flow / S5

Collected: 10/16/23 10:00 by CLIENT
Received: 10/16/23 11:06 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G031483

Lab ID# G031483-05	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	10/18/23 07:30 VML	SM5210 B 2016	M168197	NEL
Total Suspended Solids	**<1**	mg/L		1	1	1	*Bryan*	10/16/23 13:13 SDH	SM2540 D 2015	M168126	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/23/23 10:49 KMA	SM4500-NH3 G 2011	M168433	NEL
Total Kjeldahl Nitrogen as N	**0.98**	mg/L	MS-01	0.13	0.13	0.20	*Bryan*	10/24/23 12:41 KMA	EPA 351.2 R2.0	M168346	NEL
Nitrate/Nitrite as N	**11**	mg/L		0.02	0.10	0.12	*Bryan*	10/18/23 11:48 KMA	SM4500-NO3-F 2011	M168236	ANR
Turbidity	**5.3**	NTU		0.2	0.2	0.4	*Bryan*	10/16/23 11:38 ATG	SM2130 B 2011	M168114	NEL
Microbiological Analyses											
Fecal Coliform	**<2**	CFU/100 mL	F2, M5	1	2	2	*Bryan*	10/16/23 14:41 HDH	SM9222 D 2015	M167932	NEL
E. Coli	**14.8**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/16/23 12:48 HDH	SM9223 B 2004	M168094	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**3.36**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 12:04 MRG	EPA 200.7 R4.4	M168261	NEL

Explanation of Notes

BOD-07	Optional second BOD/CBOD GG was outside expected range. Results accepted on one required passing GG.
C-02	Result confirmed by re-analysis.
F2	Verified fecal coliform count/100mL.
M5	This result is estimated as no plates contained colony counts within the method-specified range.
MS-01	The MS and/or MSD recovery was outside acceptance limits. Investigation concludes it is a sample- specific matrix effect and the batch was accepted based on acceptable LCS and /or LCSD recovery.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G032179

TAMU - Ag. Eng. -E-Flow / S1 (GH-I)

Collected: 10/17/23 10:40 by CLIENT
Received: 10/17/23 12:19 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G032179

Lab ID# G032179-01	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	10/18/23 07:30 VML	SM5210 B 2016	M168197	NEL
Total Suspended Solids	**5**	mg/L	G-01	1	2	2	*Bryan*	10/17/23 11:57 SDH	SM2540 D 2015	M168176	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/23/23 10:49 KMA	SM4500-NH3 G 2011	M168463	NEL
Total Kjeldahl Nitrogen as N	**<0.20**	mg/L	MS-01	0.13	0.13	0.20	*Bryan*	10/24/23 12:41 KMA	EPA 351.2 R2.0	M168346	NEL
Nitrate/Nitrite as N	**19**	mg/L		0.02	0.17	0.20	*Bryan*	10/18/23 11:48 KMA	SM4500-NO3-F 2011	M168236	ANR
Turbidity	**3.3**	NTU	G-01	0.2	0.2	0.4	*Bryan*	10/17/23 10:34 ATG	SM2130 B 2011	M168173	NEL
Microbiological Analyses											
Fecal Coliform	**140**	CFU/100 mL		1	4	4	*Bryan*	10/17/23 15:33 HDH	SM9222 D 2015	M168163	NEL
E. Coli	**308**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/17/23 14:39 HDH	SM9223 B 2004	M168162	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**3.44**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 12:07 MRG	EPA 200.7 R4.4	M168261	NEL

TAMU - Ag. Eng. -E-Flow / S2 (GH-E)

Collected: 10/17/23 11:40 by CLIENT
Received: 10/17/23 12:19 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G032179

Lab ID# G032179-02	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	10/18/23 07:30 VML	SM5210 B 2016	M168197	NEL
Total Suspended Solids	**<1**	mg/L	G-01	1	1	1	*Bryan*	10/17/23 11:57 SDH	SM2540 D 2015	M168176	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/23/23 10:49 KMA	SM4500-NH3 G 2011	M168463	NEL
Total Kjeldahl Nitrogen as N	**0.37**	mg/L	MS-01	0.13	0.13	0.20	*Bryan*	10/24/23 12:41 KMA	EPA 351.2 R2.0	M168346	NEL
Nitrate/Nitrite as N	**11**	mg/L		0.02	0.26	0.30	*Bryan*	10/18/23 11:48 KMA	SM4500-NO3-F 2011	M168236	ANR
Turbidity	**2.9**	NTU	G-01	0.2	0.2	0.4	*Bryan*	10/17/23 10:34 ATG	SM2130 B 2011	M168173	NEL
Microbiological Analyses											
Fecal Coliform	**640 (see sample memo)**	CFU/100 mL		1	20	20	*Bryan*	10/17/23 15:33 HDH	SM9222 D 2015	M168163	NEL
E. Coli	**51.2**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/17/23 14:39 HDH	SM9223 B 2004	M168162	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**3.68**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 12:16 MRG	EPA 200.7 R4.4	M168261	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G032179

G032179-02 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**80 (see sample memo)**	CFU/100 mL	M5	1	20	20	*Bryan*	10/17/23 15:33 HDH	SM9222 D 2015	M168163	NEL

Positive and negative colonies for some fecal coliform plates were confirmed as per SM9222 methodology. Colonies that exhibited positive atypical morphology were originally counted as positive. This result is the first Fecal Coliform result on the report under "Microbiological analyses." Because these colonies were confirmed as negative after the secondary method was completed, ATL included that data as the second Fecal Coliform result under the ID labeled "re-analysis." Management wished to present all data as, while the confirmation test showed some colonies to be negative, their morphology most closely resembled positive colonies.

TAMU - Ag. Eng. -E-Flow / S4 (OP-I)

Collected: 10/17/23 10:58 by CLIENT
Received: 10/17/23 12:19 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G032179

Lab ID# G032179-04	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	10/18/23 07:30 VML	SM5210 B 2016	M168197	NEL
Total Suspended Solids	**23**	mg/L	G-01	1	5	5	*Bryan*	10/17/23 11:57 SDH	SM2540 D 2015	M168176	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/23/23 10:49 KMA	SM4500-NH3 G 2011	M168463	NEL
Total Kjeldahl Nitrogen as N	**0.29**	mg/L	MS-01	0.13	0.13	0.20	*Bryan*	10/24/23 12:41 KMA	EPA 351.2 R2.0	M168346	NEL
Nitrate/Nitrite as N	**18**	mg/L		0.02	0.17	0.20	*Bryan*	10/18/23 11:48 KMA	SM4500-NO3-F 2011	M168236	ANK
Turbidity	**12**	NTU	G-01	0.2	0.2	0.4	*Bryan*	10/17/23 10:34 ATG	SM2130 B 2011	M168173	NEL
Microbiological Analyses											
Fecal Coliform	**260 (see sample memo)**	CFU/100 mL		1	10	10	*Bryan*	10/17/23 15:33 HDH	SM9222 D 2015	M168163	NEL
E. Coli	**345**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/17/23 14:39 HDH	SM9223 B 2004	M168162	NEL
Metals (Total)											
Phosphorus-Total	**3.54**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 12:57 MRG	EPA 200.7 R4.4	M168269	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

G032179-04 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**160 (see sample memo)**	CFU/100 mL	M5	1	10	10	*Bryan*	10/17/23 15:33 HDH	SM9222 D 2015	M168163	NEL

Positive and negative colonies for some fecal coliform plates were confirmed as per SM9222 methodology. Colonies that exhibited positive atypical morphology were originally counted as positive. This result is the first Fecal Coliform result on the report under "Microbiological analyses." Because these colonies were confirmed as negative after the secondary method was completed, ATL included that data as the second Fecal Coliform result under the ID labeled "re-analysis." Management wished to present all data as, while the confirmation test showed some colonies to be negative, their morphology most closely resembled positive colonies.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G032179

TAMU - Ag. Eng. -E-Flow / S5 (OP-E)

Collected: 10/17/23 11:30 by CLIENT
Received: 10/17/23 12:19 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G032179

Lab ID# G032179-05	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	10/18/23 07:30 VML	SM5210 B 2016	M168197	NEL
Total Suspended Solids	**<1**	mg/L	G-01	1	1	1	*Bryan*	10/17/23 11:57 SDH	SM2540 D 2015	M168177	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/23/23 10:49 KMA	SM4500-NH3 G 2011	M168463	NEL
Total Kjeldahl Nitrogen as N	**1.08**	mg/L	MS-01	0.13	0.13	0.20	*Bryan*	10/24/23 12:41 KMA	EPA 351.2 R2.0	M168346	NEL
Nitrate/Nitrite as N	**11**	mg/L		0.02	0.10	0.12	*Bryan*	10/18/23 11:48 KMA	SM4500-NO3-F 2011	M168236	ANR
Turbidity	**4.5**	NTU	G-01	0.2	0.2	0.4	*Bryan*	10/17/23 10:34 ATG	SM2130 B 2011	M168173	NEL
Microbiological Analyses											
Fecal Coliform	**<100**	CFU/100 mL	M5	1	100	100	*Bryan*	10/17/23 15:33 HDH	SM9222 D 2015	M168163	NEL
E. Coli	**10.9**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/17/23 14:39 HDH	SM9223 B 2004	M168162	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**3.21**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 13:00 MRG	EPA 200.7 R4.4	M168269	NEL

Explanation of Notes

BOD-07	Optional second BOD/CBOD GG was outside expected range. Results accepted on one required passing GG.
G-01	This sample was added to an analytical run already in progress. See the prep time for when this sample was added.
M5	This result is estimated as no plates contained colony counts within the method-specified range.
MS-01	The MS and/or MSD recovery was outside acceptance limits. Investigation concludes it is a sample- specific matrix effect and the batch was accepted based on acceptable LCS and /or LCSD recovery.
Ratio	The ratio results are outside normal parameters. The results fall within the established acceptable laboratory variance.
SL-01	The dried residue did not yield between 2.5 and 200 mg as specified in the method. Due to holding time constraints or insufficient sample volume, the sample cannot be reanalyzed.
SL-02	The dried residue did not yield between 2.5 and 200 mg as specified in the method. The sample was not re-analyzed due to extended filtration time.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G032180

TAMU - Ag. Eng. -E-Flow / S1 (GH-I)

Collected: 10/18/23 12:10 by CLIENT
Received: 10/18/23 13:18 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G032180

Lab ID# G032180-01

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<2	mg/L		1	2	2	*Bryan*	10/19/23 07:35 CTG	SM5210 B 2016	M168291	NEL
Total Suspended Solids	4	mg/L		1	1	1	*Bryan*	10/18/23 14:01 SDH	SM2540 D 2015	M168263	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	*Bryan*	10/24/23 11:34 KMA	SM4500-NH3 G 2011	M168484	NEL
Total Kjeldahl Nitrogen as N	<0.20	mg/L	MS-01	0.13	0.13	0.20	*Bryan*	10/24/23 12:41 KMA	EPA 351.2 R2.0	M168346	NEL
Nitrate/Nitrite as N	19	mg/L		0.02	0.17	0.20	*Bryan*	10/25/23 11:24 KMA	SM4500-NO3-F 2011	M168540	ANR
Turbidity	2.5	NTU		0.2	0.2	0.4	*Bryan*	10/19/23 06:54 ATG	SM2130 B 2011	M168282	NEL
Microbiological Analyses											
Fecal Coliform	226	CFU/100 mL	F2	1	3	3	*Bryan*	10/18/23 15:50 HDH	SM9222 D 2015	M168218	NEL
E. Coli	219	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/18/23 15:13 HDH	SM9223 B 2004	M168217	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	3.43	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 13:03 MRG	EPA 200.7 R4.4	M168269	NEL

TAMU - Ag. Eng. -E-Flow / S2 (GH-E)

Collected: 10/18/23 12:40 by CLIENT
Received: 10/18/23 13:18 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G032180

Lab ID# G032180-02

	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<2	mg/L		1	2	2	*Bryan*	10/19/23 07:35 CTG	SM5210 B 2016	M168291	NEL
Total Suspended Solids	<1	mg/L		1	1	1	*Bryan*	10/18/23 14:01 SDH	SM2540 D 2015	M168263	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	*Bryan*	10/24/23 11:34 KMA	SM4500-NH3 G 2011	M168484	NEL
Total Kjeldahl Nitrogen as N	0.48	mg/L	MS-01	0.13	0.13	0.20	*Bryan*	10/24/23 12:41 KMA	EPA 351.2 R2.0	M168346	NEL
Nitrate/Nitrite as N	8.9	mg/L		0.02	0.17	0.20	*Bryan*	10/25/23 11:24 KMA	SM4500-NO3-F 2011	M168540	ANR
Turbidity	2.7	NTU		0.2	0.2	0.4	*Bryan*	10/19/23 06:54 ATG	SM2130 B 2011	M168282	NEL
Microbiological Analyses											
Fecal Coliform	2900 (see sample memo)	CFU/100 mL	F2	1	100	100	*Bryan*	10/18/23 15:50 HDH	SM9222 D 2015	M168218	NEL
E. Coli	21.3	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/18/23 15:13 HDH	SM9223 B 2004	M168217	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	3.48	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 13:06 MRG	EPA 200.7 R4.4	M168269	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G032180

G032180-02 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**67 (see sample memo)**	CFU/100 mL	F2	1	17	17	*Bryan*	10/18/23 15:50 HDH	SM9222 D 2015	M168218	NEL

Positive and negative colonies for some fecal coliform plates were confirmed as per SM9222 methodology. Colonies that exhibited positive atypical morphology were originally counted as positive. This result is the first Fecal Coliform result on the report under "Microbiological analyses." Because these colonies were confirmed as negative after the secondary method was completed, ATL included that data as the second Fecal Coliform result under the ID labeled "re-analysis." Management wished to present all data as, while the confirmation test showed some colonies to be negative, their morphology most closely resembled positive colonies.

TAMU - Ag. Eng. -E-Flow / S4 (OP-I)
Collected: 10/18/23 12:22 by CLIENT
Received: 10/18/23 13:18 by Hannah Cline
Type Grab
Matrix Non Potable
C-O-C # G032180

Lab ID# G032180-04	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	10/19/23 07:35 CTG	SM5210 B 2016	M168291	NEL
Total Suspended Solids	**16**	mg/L		1	5	5	*Bryan*	10/18/23 14:01 SDH	SM2540 D 2015	M168263	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/24/23 11:34 KMA	SM4500-NH3 G 2011	M168464	NEL
Total Kjeldahl Nitrogen as N	**<0.20**	mg/L	J, MS-01 (0.14)	0.13	0.13	0.20	*Bryan*	10/24/23 12:41 KMA	EPA 351.2 R2.0	M168346	NEL
Nitrate/Nitrite as N	**17**	mg/L		0.02	0.17	0.20	*Bryan*	10/25/23 11:24 KMA	SM4500-NO3-F 2011	M168540	ANW
Turbidity	**9.1**	NTU		0.2	0.2	0.4	*Bryan*	10/19/23 06:54 ATG	SM2130 B 2011	M168282	NEL
Microbiological Analyses											
Fecal Coliform	**253 (see sample memo)**	CFU/100 mL	F2	1	7	7	*Bryan*	10/18/23 15:50 HDH	SM9222 D 2015	M168218	NEL
E. Coli	**201**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/18/23 15:13 HDH	SM9223 B 2004	M168217	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	**3.10**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 13:09 MRG	EPA 200.7 R4.4	M168269	NEL

G032180-04 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**200 (see sample memo)**	CFU/100 mL	F2, M5, Micro-Log	1	7	7	*Bryan*	10/18/23 15:50 HDH	SM9222 D 2015	M168218	NEL

Positive and negative colonies for some fecal coliform plates were confirmed as per SM9222 methodology. Colonies that exhibited positive atypical morphology were originally counted as positive. This result is the first Fecal Coliform result on the report under "Microbiological analyses." Because these colonies were confirmed as negative after the secondary method was completed, ATL included that data as the second Fecal Coliform result under the ID labeled "re-analysis." Management wished to present all data as, while the confirmation test showed some colonies to be negative, their morphology most closely resembled positive colonies.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G032180

TAMU - Ag. Eng. -E-Flow / S5 (OP-E)

Collected: 10/18/23 12:33 by CLIENT
Received: 10/18/23 13:18 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G032180

Lab ID# G032180-05	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<2**	mg/L		1	2	2	*Bryan*	10/19/23 07:35 CTG	SM5210 B 2016	M168291	NEL
Total Suspended Solids	**<1**	mg/L		1	1	1	*Bryan*	10/18/23 14:01 SDH	SM2540 D 2015	M168263	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/24/23 11:34 KMA	SM4500-NH3 G 2011	M168484	NEL
Total Kjeldahl Nitrogen as N	**0.89**	mg/L	MS-01	0.13	0.13	0.20	*Bryan*	10/24/23 12:41 KMA	EPA 351.2 R2.0	M168346	NEL
Nitrate/Nitrite as N	**10**	mg/L		0.02	0.17	0.20	*Bryan*	10/25/23 11:24 KMA	SM4500-NO3-F 2011	M168540	ANY
Turbidity	**4.5**	NTU		0.2	0.2	0.4	*Bryan*	10/19/23 06:54 ATG	SM2130 B 2011	M168282	NEL
Microbiological Analyses											
Fecal Coliform	**17**	CFU/100 mL	M5	1	4	4	*Bryan*	10/18/23 15:50 HDH	SM9222 D 2015	M168218	NEL
E. Coli	**1.0**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/18/23 15:13 HDH	SM9223 B 2004	M168217	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**3.19**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 13:12 MRG	EPA 200.7 R4.4	M168269	NEL

Explanation of Notes

BOD-07	Optional second BOD/CBOD GG was outside expected range. Results accepted on one required passing GG.
F2	Verified fecal coliform count/100mL.
J	Analyte detected below the SQL but above the MDL.
M5	This result is estimated as no plates contained colony counts within the method-specified range.
Micro-Log	Log10 duplicate range is outside typical range.
MS-01	The MS and/or MSD recovery was outside acceptance limits. Investigation concludes it is a sample- specific matrix effect and the batch was accepted based on acceptable LCS and/or LCSD recovery.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G032181

TAMU - Ag. Eng. -E-Flow / S1

Collected: 10/24/23 12:12 by CLIENT
Received: 10/24/23 13:32 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G032181

Lab ID# G032181-01	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<1	mg/L		1	1	1	Bryan	10/25/23 07:20 CTG	SM5210 B 2016	M168519	NEL
Total Suspended Solids	4	mg/L		1	1	1	Bryan	10/24/23 15:02 SDH	SM2540 D 2015	M168504	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	Bryan	10/30/23 11:40 KMA	SM4500-NH3 G 2011	M168744	NEL
Total Kjeldahl Nitrogen as N	<0.20	mg/L	J (0.15)	0.13	0.13	0.20	Bryan	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168802	NEL
Nitrate/Nitrite as N	20	mg/L		0.02	0.26	0.30	Bryan	10/25/23 11:24 KMA	SM4500-NO3-F 2011	M168541	ANR
Turbidity	2.1	NTU		0.2	0.2	0.4	Bryan	10/25/23 11:34 ATG	SM2130 B 2011	M168559	NEL
Microbiological Analyses											
Fecal Coliform	309	CFU/100 mL		1	3	3	Bryan	10/24/23 16:47 HDH	SM9222 D 2015	M168493	NEL
E. Coli	308	MPN/100 mL		1.0	1.0	1.0	Bryan	10/24/23 16:06 HDH	SM9223 B 2004	M168494	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	4.02	mg/L		0.082	0.041	0.050	Bryan	10/26/23 14:13 MRG	EPA 200.7 R4.4	M168551	NEL

TAMU - Ag. Eng. -E-Flow / S2

Collected: 10/24/23 12:17 by CLIENT
Received: 10/24/23 13:32 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G032181

Lab ID# G032181-02	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<1	mg/L		1	1	1	Bryan	10/25/23 07:20 CTG	SM5210 B 2016	M168519	NEL
Total Suspended Solids	<1	mg/L		1	1	1	Bryan	10/24/23 15:02 SDH	SM2540 D 2015	M168504	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	Bryan	10/30/23 11:40 KMA	SM4500-NH3 G 2011	M168744	NEL
Total Kjeldahl Nitrogen as N	1.48	mg/L		0.13	0.13	0.20	Bryan	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168802	NEL
Nitrate/Nitrite as N	7.2	mg/L		0.02	0.17	0.20	Bryan	10/25/23 11:24 KMA	SM4500-NO3-F 2011	M168541	ANR
Turbidity	2.0	NTU		0.2	0.2	0.4	Bryan	10/25/23 11:34 ATG	SM2130 B 2011	M168559	NEL
Microbiological Analyses											
Fecal Coliform	340 (see sample memo)	CFU/100 mL		1	10	10	Bryan	10/24/23 16:47 HDH	SM9222 D 2015	M168493	NEL
E. Coli	18.1	MPN/100 mL		1.0	1.0	1.0	Bryan	10/24/23 16:06 HDH	SM9223 B 2004	M168494	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	2.94	mg/L		0.082	0.041	0.050	Bryan	10/26/23 14:16 MRG	EPA 200.7 R4.4	M168551	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G032181

G032181-02 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**6 (see sample memo)**	CFU/100 mL	M5	1	6	6	*Bryan*	10/24/23 16:47 HDH	SM9222 D 2015	M168493	NEL

Positive and negative colonies for some fecal coliform plates were confirmed as per SM9222 methodology. Colonies that exhibited positive atypical morphology were originally counted as positive. This result is the first Fecal Coliform result on the report under "Microbiological analyses." Because these colonies were confirmed as negative after the secondary method was completed, ATL included that data as the second Fecal Coliform result under the ID labeled "re-analysis." Management wished to present all data as, while the confirmation test showed some colonies to be negative, their morphology most closely resembled positive colonies.

TAMU - Ag. Eng. -E-Flow / S4

Collected: 10/24/23 12:20 by CLIENT
Received: 10/24/23 13:32 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G032181

Lab ID# G032181-04	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**2**	mg/L		1	1	1	*Bryan*	10/25/23 07:20 CTG	SM5210 B 2016	M168519	NEL
Total Suspended Solids	**25**	mg/L		1	4	4	*Bryan*	10/24/23 15:02 SDH	SM2540 D 2015	M168504	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/30/23 11:40 KMA	SM4500-NH3 G 2011	M168744	NEL
Total Kjeldahl Nitrogen as N	**0.71**	mg/L		0.13	0.13	0.20	*Bryan*	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168802	NEL
Nitrate/Nitrite as N	**22**	mg/L		0.02	0.43	0.50	*Bryan*	10/25/23 11:24 KMA	SM4500-NO3-F 2011	M168541	ANK
Turbidity	**14**	NTU		0.2	0.2	0.4	*Bryan*	10/25/23 11:34 ATG	SM2130 B 2011	M168559	NEL
Microbiological Analyses											
Fecal Coliform	**560 (see sample memo)**	CFU/100 mL		1	20	20	*Bryan*	10/24/23 16:47 HDH	SM9222 D 2015	M168493	NEL
E. Coli	**548**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/24/23 16:06 HDH	SM9223 B 2004	M168494	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	**3.10**	mg/L		0.082	0.041	0.050	*Bryan*	10/26/23 14:19 MRG	EPA 200.7 R4.4	M168551	NEL

G032181-04 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**487 (see sample memo)**	CFU/100 mL		1	7	7	*Bryan*	10/24/23 16:47 HDH	SM9222 D 2015	M168493	NEL

Positive and negative colonies for some fecal coliform plates were confirmed as per SM9222 methodology. Colonies that exhibited positive atypical morphology were originally counted as positive. This result is the first Fecal Coliform result on the report under "Microbiological analyses." Because these colonies were confirmed as negative after the secondary method was completed, ATL included that data as the second Fecal Coliform result under the ID labeled "re-analysis." Management wished to present all data as, while the confirmation test showed some colonies to be negative, their morphology most closely resembled positive colonies.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/3/23 16:51

G032181

TAMU - Ag. Eng. -E-Flow / S5

Collected: 10/24/23 12:30 by CLIENT
Received: 10/24/23 13:32 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G032181

Lab ID# G032181-05	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<1	mg/L		1	1	1	Bryan	10/25/23 07:20 CTG	SM5210 B 2016	M168519	NEL
Total Suspended Solids	<1	mg/L		1	1	1	Bryan	10/24/23 15:02 SDH	SM2540 D 2015	M168504	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	Bryan	10/30/23 11:40 KMA	SM4500-NH3 G 2011	M168744	NEL
Total Kjeldahl Nitrogen as N	2.04	mg/L		0.13	0.13	0.20	Bryan	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168770	NEL
Nitrate/Nitrite as N	9.2	mg/L		0.02	0.43	0.50	Bryan	10/25/23 11:24 KMA	SM4500-NO3-F 2011	M168541	ANR
Turbidity	3.4	NTU		0.2	0.2	0.4	Bryan	10/25/23 11:34 ATG	SM2130 B 2011	M168559	NEL
Microbiological Analyses											
Fecal Coliform	6	CFU/100 mL	M5	1	6	6	Bryan	10/24/23 16:47 HDH	SM9222 D 2015	M168493	NEL
E. Coli	1.0	MPN/100 mL		1.0	1.0	1.0	Bryan	10/24/23 16:06 HDH	SM9223 B 2004	M168494	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	4.04	mg/L		0.082	0.041	0.050	Bryan	10/26/23 14:22 MRG	EPA 200.7 R4.4	M168551	NEL

Explanation of Notes

BOD-07	Optional second BOD/CBOD GG was outside expected range. Results accepted on one required passing GG.
J	Analyte detected below the SQL but above the MDL.
M5	This result is estimated as no plates contained colony counts within the method-specified range.
SL-01	The dried residue did not yield between 2.5 and 200 mg as specified in the method. Due to holding time constraints or insufficient sample volume, the sample cannot be reanalyzed.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/13/23 11:35

G034973

TAMU - Ag. Eng. -E-Flow / S1 (GH-I)

Collected: 10/25/23 11:05 by CLIENT
Received: 10/25/23 12:17 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G034973

Lab ID# G034973-01	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<1	mg/L		1	1	1	Bryan	10/26/23 08:02 CTG	SM5210 B 2016	M168603	NEL
Total Suspended Solids	5	mg/L		1	1	1	Bryan	10/26/23 14:35 SDH	SM2540 D 2015	M168655	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	Bryan	10/31/23 13:40 KMA	SM4500-NH3 G 2011	M168809	NEL
Total Kjeldahl Nitrogen as N	<0.20	mg/L		0.13	0.13	0.20	Bryan	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168770	NEL
Nitrate/Nitrite as N	23	mg/L		0.02	0.26	0.30	Bryan	11/01/23 11:36 KMA	SM4500-NO3-F 2011	M168868	ANR
Turbidity	2.7	NTU	G-01	0.2	0.2	0.4	Bryan	10/25/23 11:34 ATG	SM2130 B 2011	M168559	NEL
Microbiological Analyses											
Fecal Coliform	1100	CFU/100 mL	M5	1	100	100	Bryan	10/25/23 16:48 HDH	SM9222 D 2015	M168560	NEL
E. Coli	613	MPN/100 mL		1.0	1.0	1.0	Bryan	10/25/23 14:36 HDH	SM9223 B 2004	M168561	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	3.83	mg/L		0.082	0.041	0.050	Bryan	11/08/23 13:51 ABM	EPA 200.7 R4.4	M168648	NEL

TAMU - Ag. Eng. -E-Flow / S2 (GH-E)

Collected: 10/25/23 11:40 by CLIENT
Received: 10/25/23 12:17 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G034973

Lab ID# G034973-02	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<1	mg/L		1	1	1	Bryan	10/26/23 08:02 CTG	SM5210 B 2016	M168603	NEL
Total Suspended Solids	<1	mg/L		1	1	1	Bryan	10/26/23 14:35 SDH	SM2540 D 2015	M168655	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	Bryan	10/31/23 13:40 KMA	SM4500-NH3 G 2011	M168810	NEL
Total Kjeldahl Nitrogen as N	1.47	mg/L		0.13	0.13	0.20	Bryan	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168803	NEL
Nitrate/Nitrite as N	6.8	mg/L		0.02	0.17	0.20	Bryan	11/01/23 11:36 KMA	SM4500-NO3-F 2011	M168868	ANR
Turbidity	1.7	NTU	G-01	0.2	0.2	0.4	Bryan	10/25/23 11:34 ATG	SM2130 B 2011	M168559	NEL
Microbiological Analyses											
Fecal Coliform	1700 (see sample memo)	CFU/100 mL	M5	1	100	100	Bryan	10/25/23 16:48 HDH	SM9222 D 2015	M168560	NEL
E. Coli	5.2	MPN/100 mL		1.0	1.0	1.0	Bryan	10/25/23 14:36 HDH	SM9223 B 2004	M168561	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	2.71	mg/L		0.082	0.041	0.050	Bryan	11/08/23 13:54 ABM	EPA 200.7 R4.4	M168648	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/13/23 11:35

G034973

G034973-02 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**6 (see sample memo)**	CFU/100 mL	M5	1	6	6	*Bryan*	10/25/23 16:48 HDH	SM9222 D 2015	M168560	NEL

Positive and negative colonies for some fecal coliform plates were confirmed as per SM9222 methodology. Colonies that exhibited positive atypical morphology were originally counted as positive. This result is the first Fecal Coliform result on the report under "Microbiological analyses." Because these colonies were confirmed as negative after the secondary method was completed, ATL included that data as the second Fecal Coliform result under the ID labeled "re-analysis." Management wished to present all data as, while the confirmation test showed some colonies to be negative, their morphology most closely resembled positive colonies.

TAMU - Ag. Eng. -E-Flow / S4 (OP-I)

Collected: 10/25/23 11:20 by CLIENT
Received: 10/25/23 12:17 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G034973

Lab ID# G034973-04	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**2**	mg/L		1	1	1	*Bryan*	10/26/23 08:02 CTG	SM5210 B 2016	M168603	NEL
Total Suspended Solids	**35**	mg/L		1	4	4	*Bryan*	10/26/23 14:35 SDH	SM2540 D 2015	M168655	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/31/23 13:40 KMA	SM4500-NH3 G 2011	M168809	NEL
Total Kjeldahl Nitrogen as N	**1.48**	mg/L		0.13	0.13	0.20	*Bryan*	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168803	NEL
Nitrate/Nitrite as N	**23**	mg/L		0.02	0.26	0.30	*Bryan*	11/01/23 11:36 KMA	SM4500-NO3-F 2011	M168868	ANK
Turbidity	**19**	NTU	G-01	0.2	0.2	0.4	*Bryan*	10/25/23 11:34 ATG	SM2130 B 2011	M168559	NEL
Microbiological Analyses											
Fecal Coliform	**430 (see sample memo)**	CFU/100 mL		1	10	10	*Bryan*	10/25/23 16:48 HDH	SM9222 D 2015	M168560	NEL
E. Coli	**613**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/25/23 14:36 HDH	SM9223 B 2004	M168561	NEL

Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	**3.81**	mg/L		0.082	0.041	0.050	*Bryan*	11/08/23 13:57 ABM	EPA 200.7 R4.4	M168648	NEL

G034973-04 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**400 (see sample memo)**	CFU/100 mL		1	4	4	*Bryan*	10/25/23 16:48 HDH	SM9222 D 2015	M168560	NEL

Positive and negative colonies for some fecal coliform plates were confirmed as per SM9222 methodology. Colonies that exhibited positive atypical morphology were originally counted as positive. This result is the first Fecal Coliform result on the report under "Microbiological analyses." Because these colonies were confirmed as negative after the secondary method was completed, ATL included that data as the second Fecal Coliform result under the ID labeled "re-analysis." Management wished to present all data as, while the confirmation test showed some colonies to be negative, their morphology most closely resembled positive colonies.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/13/23 11:35

G034973

TAMU - Ag. Eng. -E-Flow / S5 (OP-E)

Collected: 10/25/23 11:30 by CLIENT
Received: 10/25/23 12:17 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G034973

Lab ID# G034973-05	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<1**	mg/L		1	1	1	*Bryan*	10/26/23 08:02 CTG	SM5210 B 2016	M168603	NEL
Total Suspended Solids	**<1**	mg/L		1	1	1	*Bryan*	10/26/23 14:35 SDH	SM2540 D 2015	M168655	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/31/23 13:40 KMA	SM4500-NH3 G 2011	M168810	NEL
Total Kjeldahl Nitrogen as N	**1.53**	mg/L		0.13	0.13	0.20	*Bryan*	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168803	NEL
Nitrate/Nitrite as N	**10**	mg/L		0.02	0.17	0.20	*Bryan*	11/01/23 11:36 KMA	SM4500-NO3-F 2011	M168868	ANR
Turbidity	**3.5**	NTU	G-01	0.2	0.2	0.4	*Bryan*	10/25/23 11:34 ATG	SM2130 B 2011	M168559	NEL
Microbiological Analyses											
Fecal Coliform	**<100**	CFU/100 mL	M5	1	100	100	*Bryan*	10/25/23 16:48 HDH	SM9222 D 2015	M168560	NEL
E. Coli	**3.0**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/25/23 14:36 HDH	SM9223 B 2004	M168561	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**2.92**	mg/L		0.082	0.041	0.050	*Bryan*	11/08/23 14:00 ABM	EPA 200.7 R4.4	M168648	NEL

Explanation of Notes

BOD-07	Optional second BOD/CBOD GG was outside expected range. Results accepted on one required passing GG.
G-01	This sample was added to an analytical run already in progress. See the prep time for when this sample was added.
M5	This result is estimated as no plates contained colony counts within the method-specified range.

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/13/23 12:43

G034974

TAMU - Ag. Eng. -E-Flow / S1 (GH-I)

Collected: 10/26/23 10:43 by CLIENT
Received: 10/26/23 12:31 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G034974

Lab ID# G034974-01	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<1	mg/L		1	1	1	Bryan	10/27/23 07:30 CTG	SM5210 B 2016	M168667	NEL
Total Suspended Solids	3	mg/L		1	1	1	Bryan	10/26/23 14:35 SDH	SM2540 D 2015	M168655	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	Bryan	10/31/23 13:40 KMA	SM4500-NH3 G 2011	M168812	NEL
Total Kjeldahl Nitrogen as N	<0.20	mg/L		0.13	0.13	0.20	Bryan	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168802	NEL
Nitrate/Nitrite as N	23	mg/L		0.02	0.26	0.30	Bryan	11/01/23 11:36 KMA	SM4500-NO3-F 2011	M168869	ANR
Turbidity	2.2	NTU		0.2	0.2	0.4	Bryan	10/26/23 15:24 ATG	SM2130 B 2011	M168659	NEL
Microbiological Analyses											
Fecal Coliform	>= 400	CFU/100 mL		1	100	100	Bryan	10/26/23 14:14 ATA	SM9222 D 2015	M168600	NEL
E. Coli	135	MPN/100 mL		1.0	1.0	1.0	Bryan	10/26/23 13:14 ATA	SM9223 B 2004	M168601	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	3.81	mg/L		0.082	0.041	0.050	Bryan	11/08/23 14:09 ABM	EPA 200.7 R4.4	M168648	NEL

TAMU - Ag. Eng. -E-Flow / S2 (GH-E)

Collected: 10/26/23 11:36 by CLIENT
Received: 10/26/23 12:31 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G034974

Lab ID# G034974-02	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	<1	mg/L		1	1	1	Bryan	10/27/23 07:30 CTG	SM5210 B 2016	M168667	NEL
Total Suspended Solids	<1	mg/L		1	1	1	Bryan	10/26/23 14:35 SDH	SM2540 D 2015	M168655	NEL
Ammonia as N	<0.05	mg/L		0.05	0.05	0.05	Bryan	10/31/23 13:40 KMA	SM4500-NH3 G 2011	M168812	NEL
Total Kjeldahl Nitrogen as N	1.62	mg/L		0.13	0.13	0.20	Bryan	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168770	NEL
Nitrate/Nitrite as N	7.5	mg/L		0.02	0.17	0.20	Bryan	11/01/23 11:36 KMA	SM4500-NO3-F 2011	M168869	ANR
Turbidity	1.7	NTU		0.2	0.2	0.4	Bryan	10/26/23 15:24 ATG	SM2130 B 2011	M168659	NEL
Microbiological Analyses											
Fecal Coliform	>6000 (see sample memo)	CFU/100 mL		1	100	100	Bryan	10/26/23 14:14 ATA	SM9222 D 2015	M168600	NEL
E. Coli	5.2	MPN/100 mL		1.0	1.0	1.0	Bryan	10/26/23 13:14 ATA	SM9223 B 2004	M168601	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	2.74	mg/L		0.082	0.041	0.050	Bryan	11/08/23 14:12 ABM	EPA 200.7 R4.4	M168648	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/13/23 12:43

G034974

G034974-02 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**>= 0 (see sample memo)**	CFU/100 mL		1	100	100	*Bryan*	10/26/23 14:14 ATA	SM9222 D 2015	M168600	NEL

TAMU - Ag. Eng. -E-Flow / S3 (DH)

Collected: 10/26/23 11:45 by CLIENT
Received: 10/26/23 12:31 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G034974

Lab ID# G034974-03	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<1**	mg/L		1	1	1	*Bryan*	10/27/23 07:30 CTG	SM5210 B 2016	M168657	NEL
Total Suspended Solids	**<1**	mg/L		1	1	1	*Bryan*	10/26/23 14:35 SDH	SM2540 D 2015	M168655	NEL
Ammonia as N	**0.63**	mg/L		0.05	0.05	0.05	*Bryan*	10/31/23 13:40 KMA	SM4500-NH3 G 2011	M168812	NEL
Total Kjeldahl Nitrogen as N	**0.73**	mg/L		0.13	0.13	0.20	*Bryan*	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168802	NEL
Nitrate/Nitrite as N	**0.05**	mg/L		0.02	0.02	0.02	*Bryan*	11/01/23 11:36 KMA	SM4500-NO3-F 2011	M168869	ANR
Turbidity	**<0.4**	NTU	J (0.2)	0.2	0.2	0.4	*Bryan*	10/26/23 15:24 ATG	SM2130 B 2011	M168659	NEL
Microbiological Analyses											
Fecal Coliform	**<1**	CFU/100 mL		1	1	1	*Bryan*	10/26/23 14:14 ATA	SM9222 D 2015	M168600	NEL
E. Coli	**<1.0**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/26/23 13:14 ATA	SM9223 B 2004	M168601	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**0.078**	mg/L		0.082	0.041	0.050	*Bryan*	11/08/23 14:15 ABM	EPA 200.7 R4.4	M168648	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/13/23 12:43

G034974

TAMU - Ag. Eng. -E-Flow / S4 (OP-I)

Collected: 10/26/23 10:56 by CLIENT
Received: 10/26/23 12:31 by Hannah Cline

Type: Grab | *Matrix*: Non Potable | *C-O-C #*: G034974

Lab ID# G034974-04	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**1**	mg/L		1	1	1	*Bryan*	10/27/23 07:30 CTG	SM5210 B 2016	M168667	NEL
Total Suspended Solids	**14**	mg/L		1	4	4	*Bryan*	10/26/23 14:35 SDH	SM2540 D 2015	M168656	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/31/23 13:40 KMA	SM4500-NH3 G 2011	M168812	NEL
Total Kjeldahl Nitrogen as N	**<0.20**	mg/L		0.13	0.13	0.20	*Bryan*	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168802	NEL
Nitrate/Nitrite as N	**22**	mg/L		0.02	0.26	0.30	*Bryan*	11/01/23 11:36 KMA	SM4500-NO3-F 2011	M168869	ANR
Turbidity	**7.4**	NTU		0.2	0.2	0.4	*Bryan*	10/26/23 15:24 ATG	SM2130 B 2011	M168659	NEL
Microbiological Analyses											
Fecal Coliform	**300 (see sample memo)**	CFU/100 mL		1	10	10	*Bryan*	10/26/23 14:14 ATA	SM9222 D 2015	M168600	NEL
E. Coli	**727**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/26/23 13:14 ATA	SM9223 B 2004	M168601	NEL
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.											
Metals (Total)											
Phosphorus-Total	**3.70**	mg/L		0.082	0.041	0.050	*Bryan*	11/08/23 14:18 ABM	EPA 200.7 R4.4	M168648	NEL

G034974-04 - re-analysis	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
Microbiological Analyses											
Fecal Coliform	**300 (see sample memo)**	CFU/100 mL		1	10	10	*Bryan*	10/26/23 14:14 ATA	SM9222 D 2015	M168600	NEL

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Analytical Report

TAMU - Department of Biological and Ag. Eng.

Report Printed: 11/13/23 12:43

G034974

TAMU - Ag. Eng. -E-Flow / S5 (OP-E)

Collected: 10/26/23 11:20 by CLIENT
Received: 10/26/23 12:31 by Hannah Cline

Type: Grab
Matrix: Non Potable
C-O-C #: G034974

Lab ID# G034974-05	Result	Units	Notes	MDL	Adj MDL	SQL	Lab	Analyzed	Method	Batch	
General Chemistry											
BOD (5 day)	**<1**	mg/L		1	1	1	*Bryan*	10/27/23 07:30 CTG	SM5210 B 2016	M168667	NEL
Total Suspended Solids	**<1**	mg/L		1	1	1	*Bryan*	10/26/23 14:35 SDH	SM2540 D 2015	M168656	NEL
Ammonia as N	**<0.05**	mg/L		0.05	0.05	0.05	*Bryan*	10/31/23 13:40 KMA	SM4500-NH3 G 2011	M168812	NEL
Total Kjeldahl Nitrogen as N	**1.76**	mg/L		0.13	0.13	0.20	*Bryan*	10/31/23 14:09 KMA	EPA 351.2 R2.0	M168802	NEL
Nitrate/Nitrite as N	**9.3**	mg/L		0.02	0.17	0.20	*Bryan*	11/01/23 11:36 KMA	SM4500-NO3-F 2011	M168869	ANR
Turbidity	**3.5**	NTU		0.2	0.2	0.4	*Bryan*	10/26/23 15:24 ATG	SM2130 B 2011	M168659	NEL
Microbiological Analyses											
Fecal Coliform	**>= 300**	CFU/100 mL		1	100	100	*Bryan*	10/26/23 14:14 ATA	SM9222 D 2015	M168600	NEL
E. Coli	**1.0**	MPN/100 mL		1.0	1.0	1.0	*Bryan*	10/26/23 13:14 ATA	SM9223 B 2004	M168601	NEL

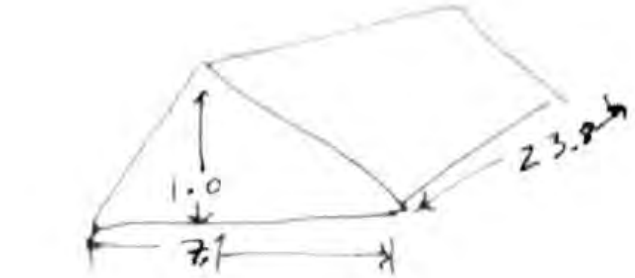
Results run by SM 9223B are reported as MPN (Most Probable Number). MPN is comparable to CFU (Colony Forming Units). Both MPN and CFU are allowed in most permits.

Metals (Total)											
Phosphorus-Total	**2.95**	mg/L		0.082	0.041	0.050	*Bryan*	11/08/23 14:21 ABM	EPA 200.7 R4.4	M168648	NEL

Explanation of Notes

BOD-07	Optional second BOD/CBOD GG was outside expected range. Results accepted on one required passing GG.
J	Analyte detected below the SQL but above the MDL.

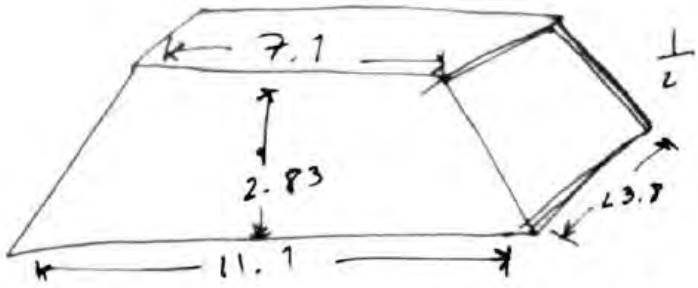
Appendix-C Greenhouse Dimension and Volume Calculations



$\frac{1 \times 7.1 \times 23.8}{2}$

$= \frac{169.1}{2} =$

$\frac{164}{2} = 84.49$

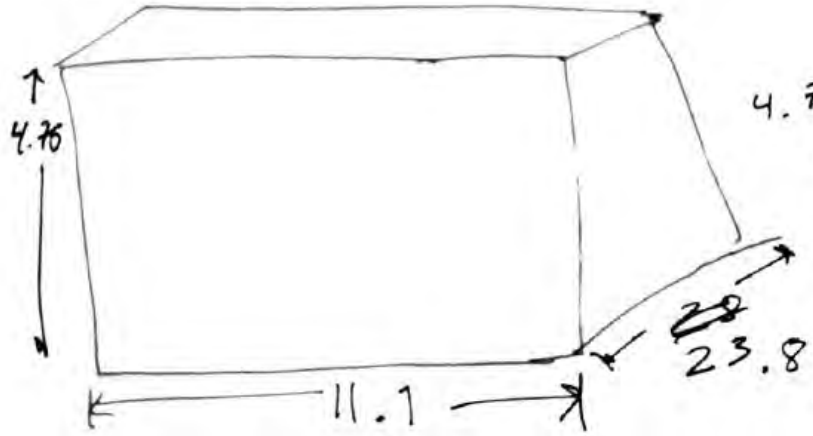


$\frac{1}{2}(7.1+11.1) \times 2.83 \times 23.8$

$= 9.1$

$= 39.44 \times 2.83 \times 23.8$

$= 612.92$



$4.75 \times 11.1 \times 23.8$

$= 1,254.86$

Total Volume

$1,254.86 + 612.92 + 84.49 = 1952.27 Ft^3$

Greenhouse Volume			
TOP - Triangle			
Height =	1	ft	
Base =	7.1	ft	
Length =	23.8	ft	
Volume1 =	84.49	cub.ft.	Triangular Priam Your way!
MIDDLE -Prisam			
Height =	2.83	ft	
Length =	23.8	ft	
Long Base =	11.1	ft	
Short Base =	7.1	ft	
Voulume2 =	612.9	cub.ft.	https://www.omnicalculator.com/math/trapezoidal-prism-volume
BOTTOM - Rectangular			
Height =	4.75	ft	
Width =	11.1	ft	
Length =	23.8	ft	
Volume3 =	1254.9	cub.ft.	https://www.omnicalculator.com/math/rectangular-prism-volume
TOTAL VOLUME =	**1,952**	**cub. ft.**	