Initiating Water Quality Sampling of Stormwater Treatment Wetlands in Galveston Bay Watershed

GLO Contract No. 19-043-000-B077

Coastal Management Program- Cycle 23

Prepared by:

Christie Taylor

Texas A&M AgriLife Extension Service

Texas Community Watershed Partners

Stormwater Wetland Program Specialist

August 2020

THIS PROJECT IS FUNDED BY A TEXAS COASTAL MANAGEMENT PROGRAM GRANT APPROVED BY THE TEXAS LAND COMMISSIONER PURSUANT TO NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AWARD NO. NA18NOS4190153.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

QAPP	Quality Assurance Project Plan
BMP	Best Management Practices
UTRP	University Texas Recreation Park
PTWB	Proton Therapy Wetland Basin
EG	Exploration Green
TCWP	Texas Community Watershed Partners
TAMU	Texas A&M University
AgriLife	AgriLife Extension Service
TSS	Total Suspended Solids
NO2	nitrate
NO3	nitrite
DO	dissolved oxygen
TPH	total petroleum hydrocarbons
NH3N	ammonia
GI	Green Infrastructure
COC	Chain of Custody

Abstract

Development pressures in the Lower Galveston Bay Area are leading public officials, developers, stakeholders and other conservation minded parties to look at Green Infrastructure (GI), nature based solutions for stormwater mitigation and water quality improvements. Much has been said in recent years about the importance of using natural areas to our advantage. The flood mitigation impacts of GI are easier to see and often well documented, however it is harder to identify the improvements to water quality. Water quality takes a look at water chemistry and bacterial levels. This requires testing and lab analysis of the water. This project looks at the water quality parameters of total suspended solids (TSS), specific conductivity, E.coli bacteria levels, dissolved oxygen (DO) levels, pH, ammonia, nitrate and nitrite levels, total phosphorous, other heavy metals and total petroleum hydrocarbons (TPH). The project samples water at influent (inflow pipes) and effluent (outflow pipes) for three different constructed stormwater wetland basins in Lower Galveston Bay Watershed sub-watersheds. Automated ISCO 6712 samplers are used in combination with grab sample methods (were samplers are not practical) to test stormwater runoff during qualifying rain events of a minimum of 0.1 inches per hour. Samples were collected and field recorded in notebooks and field data forms. Then the samples were sent to Eastex Labs for analysis of the previously stated parameters. Lab results were then tabulated and disseminated through the Texas Community Watershed Partners (TCWP) website a division of Texas A&M University (TAMU) AgriLife Extension Service (AgriLife). The tables were then visually charted using bar graph to show the difference in each of the parameters at individual site and at stormwater wetland projects as a whole. The trends in the charts show that there is some improvement of water quality seen across all three sites no matter the size or establishment of the project itself. Which lends support for the practice of stormwater wetlands in general. Further paired t-test of the influent and effluent sample water quality parameters values from analysis do not show significant changes at an =0.05 and a 95% confidence level. While we conclude this was a good start to this study and there are improvements to water quality through stromwater wetlands more study, over longer durations at more intervals, is needed to address the significance of these improvements.

Introduction

As development increases, so does the requirement for drainage infrastructure, but currently, standard stormwater basins are ecologically and aesthetically bleak. Stormwater wetlands provide a method of combining multiple functions into a single site. Gaining data on the stormwater wetland practice is necessary as the technique is promoted for its multiplicity of benefits. While the water quantity and flooding benefits are well documented and easily identified by the public, there is less documentation of the water quality benefits provided by constructed stormwater wetlands. The project looks at the water quality data aspect of the stormwater wetland BMP and provide quality and comparable data for this BMP in the lower Galveston Bay Watershed. This water quality data can help to verify the effectiveness of the technique, or to guide modifications in the design of subsequent green stormwater infrastructure prototypes.

Texas Community Watershed Partners (TCWP) as part of the TAMU Agrilife Extension developed a QAPP (https://agrilife.org/urbannature/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/) for a water quality monitoring protocol and sampled three stormwater wetland locations designed and planted by TCWP in the Galveston Bay Area. The purpose of this project and QAPP is to generate data of acceptable quality to accurately depict the amount of water quality improvements provided by stormwater wetlands at the selected demonstration sites within the Galveston Bay Watershed as a model of testing that can be applied to other project sites in the future.

Background of Selected Sites

A little bit of history on the three sites selected for this project. These sites are located in 2 sub-watersheds of the Lower Galveston Bay Watershed. The sites were completed at different times and are in variable states of establishment, they have urban and suburban characteristics and are of variable sizes.

A. University of Texas Recreation Park MD Anderson Campus (UTRP) Wetland
   The University of Texas Research Park stormwater wetland is a 0.33-acre stormwater wetland basin on the UT MD Anderson Cancer Center's South Campus in the Texas Medical Center located near 7510 Bertner Rd. Houston, TX. The basin mitigates a 3 acre parking lot expansion, and is in the Brays Bayou watershed which is listed as impaired by the Texas Commission on Environmental Quality (TCEQ). Construction started around July 2016 with planting being completed in September 2017. This wetland has been established for 2 years prior to the start of the stormwater wetland water quality sampling beginning in September 2019.
B. Exploration Green Recreation Park Phase 1 (EG) Stormwater Wetland
   Exploration Green Conservation and Recreation Area is transforming the defunct Clear Lake Golf Course into a stormwater detention facility with five segments ("Phases") each containing an open water lake, constructed wetlands, habitat island, and walking trails. The 200-acre site receives stormwater runoff from an approximately 2000-acre predominantly suburban watershed, which is itself in the Armand Bayou watershed, 303 (d) listed as impaired by the US EPA and TCEQ. Exploration Green Phase 1 is located in Clear Lake City between Diana Ln and Ramada Dr. The inflow and outflow for this Phase of the 5 Phase project are located along the Reseda Dr. side of the detention basin. Phase 1 is a 14-acre lake containing 6 acres of wetlands planted 2016-2018. This wetland was established for roughly 1 year prior to the start of the water quality sampling beginning in December 2019.
C. Proton Therapy Parking Lot Expansion Wetland Basin MD Anderson South Campus (PTWB)
   The PTWB stormwater wetland is located at the corner of Fannin and Old Spanish Trail in 1800 block of Old Spanish Trail. This is a 0.62 acre site that collects stormwater from the parking lot expansion. This site is also located in the Brays Bayou Watershed. This

site was just completed in June 2019 and recently planted in June 2019 – February 2020. As these plants are still growing and filling in this wetland space, it has not had time to establish before the water quality testing began in late February to early March 2020.

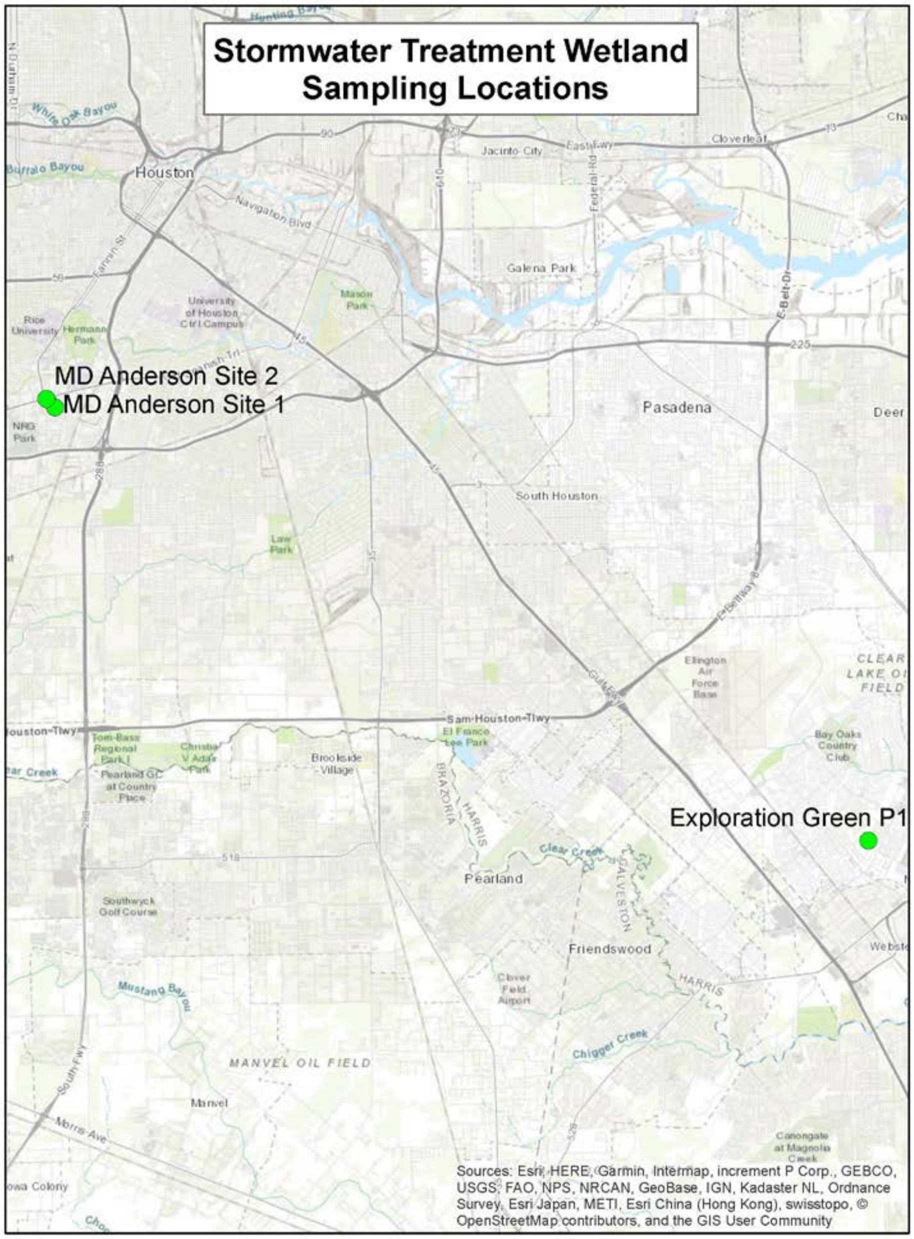

Figure 1.1 Map of Project Sampling Locations

Method

The experimental design of this project aims to demonstrate the effectiveness of constructed stormwater wetlands as a BMP for improved water quality in stormwater detention. Three different constructed wetland sites were chosen. The sites are different sizes and at different stages of establishment. The sites are located in two different sub-watersheds of the Galveston Bay Watershed, Brays Bayou (MD Anderson sites 1(UTRP) and 3(PTWB)) and Clear Creek (Exploration Green).

Table 1.1 Location Description

Location	Site	Sample code	Start Date	End Date	Mode of Sampling	Sample Matrix	Monitoring Frequency
MD Anderson UTRP	Influent	101-#	Sept. 2019	Feb. 2020	automatic	water	Up to 8x within 5 months; with qualifying rainfall event
MD Anderson UTRP	Effluent	102-#	Sept. 2019	Feb. 2020	automatic	water	Up to 16x within 5 months; with qualifying event
Exploration Green Park Phase 1	Influent	201-#	Nov. 2019	June 2020	Grab sample only	water	Up to 8x within 5 months; with qualifying rainfall event
Exploration Green Park Phase 1	Effluent	202-#	Nov. 2019	June 2020	automatic	water	Up to 16x within 5 months; with qualifying event

MD Anderson PTWB	Influent	301-#	Feb. 2020	July 2020	automatic	water	Up to 8x within 5 months; with qualifying rainfall event
MD Anderson PTWB	Effluent	302-#	Feb. 2020	Jul. 2020	automatic	water	Up to 16x within 5 months; with qualifying event

This experiment compares water quality parameters at the influent and effluent sites of each basin location. Automated samples were located at the influent and effluent sites for a minimum of five consecutive months according to the schedule provided in Table B1.1. 5 -8 samples were collected at each influent site and a maximum of 12 samples from each effluent site. Samples were collected from the automated samplers within 8 hours after the rainfall event at both the influent and effluent sites for that location. Then as occasions allowed follow up effluent sample were collected 24-48 hours after rainfall event. Twenty-four hours for smaller shallow basins and forty-eight hours for the larger retention basin at Exploration Green. Rainfall amounts were measured using an ISCO 674 tipping bucket rain gauge at each location. Rainfall amount will be recorded on the field collection data form. Data collected for storms producing 0.29 inches or more of rain preceded by a 48-72 hour dry period. At locations 1 and 3 MD Anderson UTRP and PTWB sites respectively, 4 storm events were tested for the runoff parameters of heavy metals and TPH. The ISCO 6712 automated sampler with the a 730 bubble flow meter with accompanying power supply will be secured at the inflow and outflow points of the constructed wetland and will be used to collect both inflow and outflow composite samples and flow volume data. There will be at least one modem at each location, attached to the influent sampler except at EG it was attached to the outflow sampler because only one sampler was used at this location. The modem allows remote access to the sampler as well as the capability to send text messages to a dedicated number when the sampler program initiates and stops to inform the staff when the sample is ready to be collected and sent to the lab. The use of modems along with monitoring of the weather reports and predicted rainfall amounts from local sources will help to insure the specific hold times for samples are not exceeded.

Table1.2 Experimental Method Summary by Location

Location	Inflow Volume	Inflow Pollutant Concentration	Outflow Volume	Outflow Pollutant Concentration	Means of computing Pollution Load Reduction
MD Anderson UTRP Basin	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle.	Direct laboratory measurements of composite samples.	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle. And the automated sampler will be used to take another sample 24 hours later Flow volume will be recorded	Direct laboratory measurements of composite samples.	Measured load of inflow minus measured load of outflow

			from the ISCO 730 bubble flow meter.		
Exploration Green Nature Park Phase 1	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle.	Direct laboratory measurements of composite samples.	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle. And the automated sampler will be used to take another sample 24 hours later Flow volume will be recorded from the ISCO 730	Direct laboratory measurements of composite samples.	Measured load of inflow minus measured load of outflow

			bubble flow meter.		
MD Anderson Site 2 Parking Lot Expansion	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle.	Direct laboratory measurements of composite samples.	Measured with ISCO 730 bubble flow meter attached to ISCO 6712 automated sampler triggered to collect at 15 minute intervals after the minimum flow measure available is met. A 450mL sample will be taken every 30 minutes for the duration of the storm event and composited in a 9L bottle. And the automated sampler will be used to take another sample 24 hours later Flow volume will be recorded from the ISCO 730	Direct laboratory measurements of composite samples.	Measured load of inflow minus measured load of outflow

bubble flow
meter.

Field Sampling Procedures

Field sampling data was documented on Field Data Reporting Form (Appendix B). For all sampling visits, location id, sampling time, sampling date, sample collector's name and signature, rainfall amount, sample volumes, preservatives added to samples are recorded on the Chain of Custody (COC) form supplied by Eastex labs and attached to the copy of the lab analysis for record. Values for measured field parameters are recorded on the Field Data Reporting Form. The field data notebook should also include any visual observations, and time since last recorded rainfall event, etc. Basic rules for recording information for this project included

1. Legible writing in indelible, waterproof ink or pencil with no modifications, single cross-outs, write-overs,
2. Changes should be made by crossing out original entry with 1 single line, entering the change and initial and date corrections,

An YSI Professional Series multiprobe was used to measure dissolved oxygen (DO), specific conductance, pH, and water temperature and this data recorded on the field data reporting form and the field notebook.

Automated Sampling Procedures

Automated samplers will be programmed in accordance with manufacturer user guides for automatic sampler data collection. At least one sampler per location equipped with modem for text messaging from sampler to dedicated staff phone number to alert when the sampler program was running, enabled, done or there was an error with the sampler. Sample bottles and coolers for sample storage and sample pick up were be provided by the lab and transported by AgriLife staff on collection days. Sample types, container types, minimum sample volume, preservation requirements and hold times are specified in Table 1.3. Samples were collected in one 9 liter composite sample jar and separated into the appropriate sample containers for transport to the lab. Then staff contacted a courier for pick-up of samples.

Table 1.3 Sampling Protocol

Parameter	Matrix	Sample Type	Container	Preservation	Sample Volume	Hold Time
E.coli	water	composite	Sterile, plastic	Sodium Thiosulfate $<6^0$ C	100ml	24 hours
TSS	water	composite	Plastic or glass	$<6^0$C	1000ml	7 days
NO3 + NO2	water	composite	Plastic or glass	Sulfuric acid $<6^0$ C	500ml	28 days
Total Phosphorus	water	composite	Plastic or glass	Sulfuric acid $<6^0$ C	500ml	28 days
Ammonia as N	water	composite	Plastic or glass	Sulfuric acid $<6^0$ C	500ml	28 days
Heavy Metals	water	composite	Plastic	On ice $<6^0$ C	1000ml	6 months
Mercury	water	composite	Plastic	On ice $<6^0$ C	1000ml	28 days
TPH	water	composite	Plastic or glass	Hydrochloric acid $<6^0$ C	40ml vials (3x)	14 days to extraction 14 days from extraction to analysis

<u>Sample Labeling</u>

Samples from the field were labelled on the container with an indelible marker. Label includes:

1. Site identification (location id-#)
2. Date and time collected
3. Preservative added, if applicable
4. Sample type(i.e. analysis) to be performed

Sample Handling

Samples were collected at the field site after each qualifying rain event by AgriLife staff and then labeled and appropriately preserved for laboratory analysis. Once preserved, the samples were packaged in secondary containment, 1-2 gallon ziplock bags and placed in coolers by field staff according to laboratory specifications. Samples transferred from TCWP to Eastex lab by courier with proper COC, supplied by laboratory a copy of COC attached in Appendix C.

Analytical Methods

All analytical methods are to follow the Eastex Lab, accredited lab, standard operating procedures for each of the specified test. Any anomalies in the data were communicated to the AgriLife staff by email communications and noted on the appropriate lab reports.

Table 1.4 Measurement Performance Specifications

Parameter	Units	Matrix	Method	PAREMETER CODE	AWRL	Limit of Quantitation (LOQ	PRECISION (RPD of LCS/LCSD)	BIAS (%Rec. of LCS)	LOQ CHECK STANDARD %Rec	Lab
Field Parameters (Water Column)										
Rainfall	Inches	Water	gauge	46529	NA	NA	NA	NA	NA	Field
pH	pH. units	water	YSI multiprobe	00400	NA	NA	NA	NA	NA	Field
DO	mg/L	water	YSI multiprobe	00300	NA	NA	NA	NA	NA	Field
Conductivity	uS/cm	water	YSI multiprobe	00094	NA	NA	NA	NA	NA	Field
Flow	Gallons	water	ISCO flow meter		NA	NA	NA	NA	NA	Field
Temperature	^{0}C	Water	YSI multiprobe		NA	NA	NA	NA	NA	Field
Conventional Parameters (Water)										
Ammonia-N	mg/L	water	SM 4500-N G	00610	0.1	0.02	20	80-120	70-130	Eastex
T-PO4-P	mg/L	water	SM 4500-P E	00665	0.06	0.06	20	80-120	70-130	Eastex
TPH	mg/L	water	TCEQ 1005	NA	NA	NA	NA	NA	NA	Eastex
Heavy metals	mg/L	water	EPA 200.8	NA	NA	NA	NA	NA	NA	Eastex
Mercury	mg/L	water	EPA 245.1	NA	NA	NA	NA	NA	NA	Eastex
NO3 +NO2	mg/L	water	SM 4500-NO3 F	00630	0.05	0.02	20	80-120	70-130	Eastex
E.coli		water	Idexx Laboratories Colilert 18	31699	1	NA	0.5	NA	NA	Eastex
TSS	mg/L	water	SM2540 D	00530	4	1	20	80-120	NA	Eastex

Quality Control Methods

Equipment records are kept on all field equipment and a supply of critical spare parts is maintained by the AgriLife Extension Field Supervisor and documented in the field notebook.

All laboratory tools, gauges, instruments and equipment testing and maintenance requirements are contained within the Eastex laboratory QAMs. Testing and maintenance records are maintained and available from the lab.

All instruments and devices used in obtaining environmental data will be calibrated prior to use as needed. Calibration methods are contained in the manufacturer's instruction manuals. YSI multiprobes will be calibrated before sampling and monthly after sampling begins. Calibration reagents are stored at TCWP offices. The reagents are catalogued as they are received and used. Instruments are rinsed with clean distilled water between uses and stored according to manufacturer instructions.

Data

Data was collected in a field notebook and paper field recording data sheets. All notes, field methods, programming changes, battery test and site visits are recorded in the field notebook. Along with all field data recorded on the paper field data sheets. Field data sheets were also scanned and stored both as paper copies in the binder and electronic copies in shared folders and posted to the stormwater wetland water quality webpage on the TCWP website at the link below:

https://agrilife.org/urbannature/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/

Data collected from both the field and the lab test are compiled in the following tables (Table2.1-2.15).

Table 2.1: Field Reporting Data for MDA UTRP location

MDA UTRP Wetland	Rainfall Amount (inches/hr)	Air Temp. (°C)	H2O Temp. (°C)			DO (mg/ L)			Specific (µS/cm)			Conductivity	pH	
Sampling Events			Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up
9/27/19	0.46	29	28.5	27.2	NA	7.7	5.9	NA	112	128.9	NA	10.64*	10.88*	NA
10/21/19	UNK	23	NA	23.1	NA	NA	6.2	NA	NA	139	NA	NA	10.39*	NA
10/25/19	UNK	11	NA	16.8	NA	NA	7.9	NA	NA	90.2	NA	NA	8.6*	NA

11/7/19	0.11	19	19.5	18.9	-	9.6	8.2	-	61.9	64.7	-	10.48*	8.5*	-
11/8/19	0.00	17	-	-	14.2	-	-	10.3	-	-	275.3	-	-	16.29*
12/10/19	0.03	11	15	14.1	-	10.3	8.8	-	133.4	149.9	-	9.88*	8.51*	-
12/11/19	0.00	12	-	-	13	-	-	7.4	-	-	181.8	-	-	16.33*
1/9/20	0.02	23	20.2	NA	NA	8.2	NA	NA	260.4	NA	NA	7.47	NA	NA
1/11/20	0.13	16	17.7	16.9	NA	9.5	9.2	NA	80.6	73.4	NA	8.04	7.22	NA
1/13/20	0.01	17	14.6	15	NA	11.4	12.4	NA	140	147.8	NA	7.71	7.08	NA
1/28/20	0.02	15	16.5	16.1	-	10.4	9.9	-	80.8	146	-	7.99	7.17	-
1/29/20	0.00	13	-	-	15.1	-	-	13.6	-	-	165.9	-	-	7.21
2/6/20	0.01	5	7.4	7.6	-	13.9	14.0	-	86.3	212.2	-	7.35	7.47	-
2/7/20	0.00	11	-	-	8.4	-	-	9.6	-	-	205.8	-	-	7.13

Table 2.2: Lab Results reported for MDA UTRP location

MDA UTRP Wetland	Location	Sampling Events ID	Nitrogen (mg/L)	Ammonia (mg/L)	TSS (mg/L)	E. coli (mpn/100ml)	Total Phosphate (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH
Reporting Limit			0.02	0.1	1	10	0.06	0.0005	0.003	0.001	0.003	0.0005	0.0002	0.005	0.0005	4.9-5

9/27/2019	Inflow	UTRP 101-1	0.19	<0.1	2.9	<10	<1.00	0.00137	0.0114	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<4.98339
	Outflow	UTRP 102-1	0.38	<0.1	2.4	2600	<1.00	0.000777	0.0312	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<4.901961
10/21/2019	Exta	UTRP 102-2	0.15	<0.1	2.4	350	0.347									
11/7/2019	Inflow	UTRP 101-2	0.24	<0.1	1.8	31	<0.02	<0.0005	0.0136	<0.001	<0.003	0.00142	<0.0002	<0.005	<0.0005	<4.95
	Outflow	UTRP 102-3	0.08	4.1	3.5	110	0.0471	<0.0005	0.019	<0.001	<0.003	0.000643	<0.0002	<0.005	<0.0005	<4.92* corrected
11/8/2019	Follow up	UTRP 102-4	<0.02	0.8	2.3	24	0.0258									
12/10/2019	Inflow	UTRP 101-3	0.77	0.1	12.1	10	<0.06	0.00151	0.0237	<0.001	<0.003	0.00131	<0.0002	<0.005	<0.0005	<5.0
	Outflow	UTRP 102-5	0.17	0.2	3.2	906	<0.06	0.000686	0.0371	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<5.0
12/11/2019	Follow up	UTRP 102-6	0.02	0.1	15.8	121	<0.06									
1/11/2020	inflow	UTRP 101-4	0.21	0.2	1.2	63	<0.06	0.000895	0.00811	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<5.0
	outflow	UTRP 102-7	0.08	<0.1	2.6	323	<0.06	<0.0005	0.0161	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<5.0

1/13/2020	Inflow	UTRP 101-5	0.56	<0.1	8.4	85	<0.06
	outflow	UTRP 102-8	0.11	0.5	4	10	<0.06
1/28/2020	Inflow	UTRP 101-6	0.48	0.1	3	<10	<0.06
	outflow	UTRP 102-9	0.09	<0.01	2.3	63	<0.06
1/29/2020	Follow up	UTRP 102-10	0.04	0.3	6.8	<10	<0.06
2/6/2020	Inflow	UTRP 101-7	0.44	0.2	12.2	<10	<0.06
	Outflow	UTRP 102-11	0.02	<0.1	8.4	473	<0.06
2/7/2020	Follow up	UTRP 102-12	<0.02	0.5	7.9	10	<0.06

Rainfall amount from each of three locations depicted below in Figures 1.2, Figure, 1.4, and Figure 1.6 for UTRP, EG, and PTWB respectively. This information was recorded by the ISCO automated sampler and download from the instrument and graphed using the ISCO Flowlink software. Rain fall amount varied by event and time during events.

Flow level data was also recorded by the ISCO automated samplers for each site collected by the samplers. This data is also graphed in the ISCO Flowlink software and depicted in Figures 1.3, 1.5, and 1.7 for UTRP, EG, and PTWB respectively.

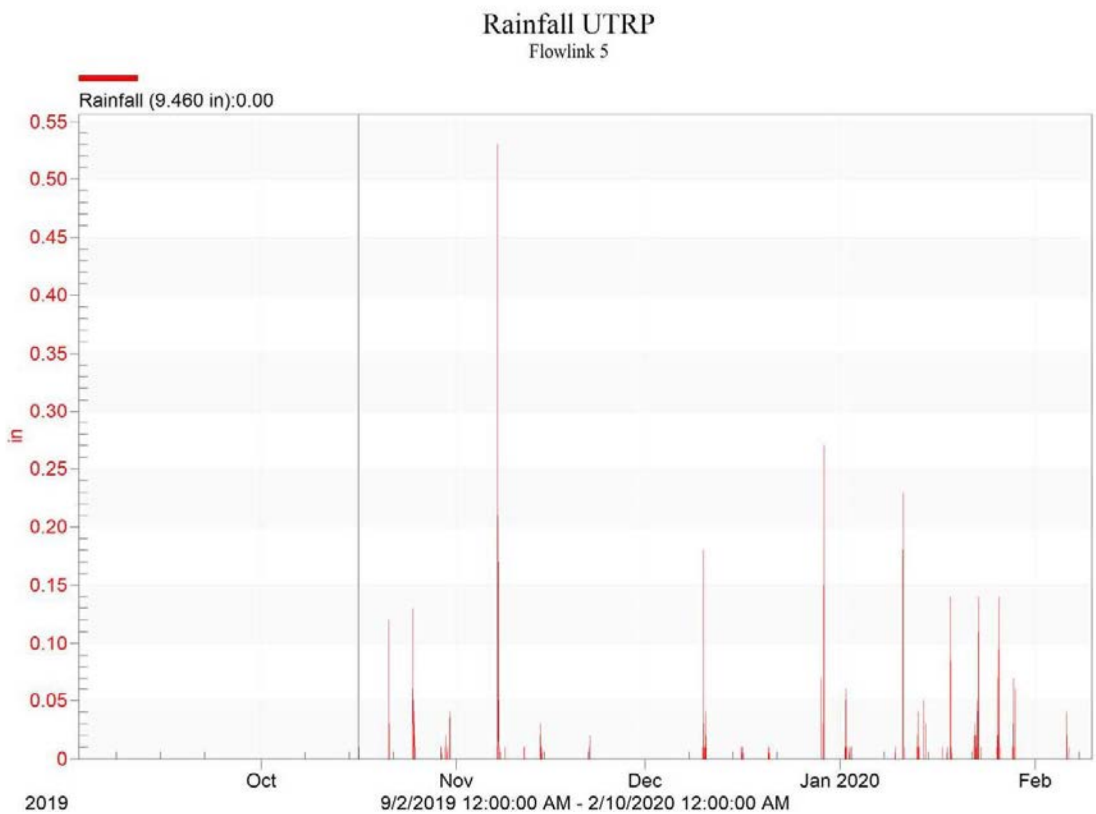

Figure 1.2 Graph 1.1 UTRP Rainfall Rainfall data from September 2019- February 2020 At UTRP Site

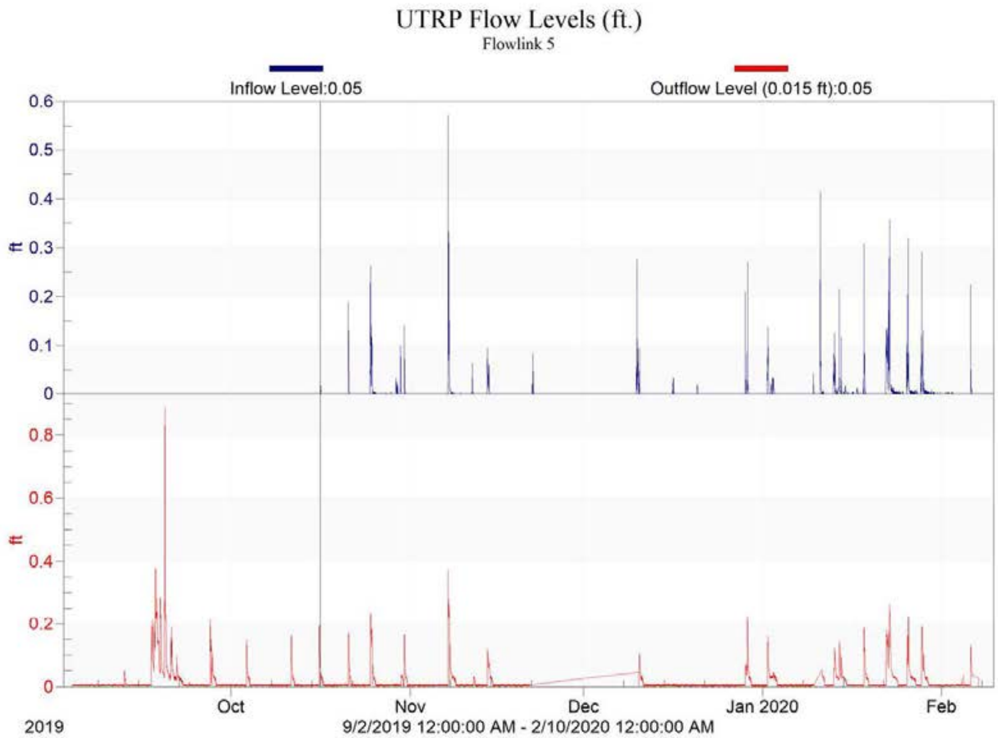

Figure 1.3 Graph 1.2 UTRP Flow Level Comparison Flow level data from Inflow 101 (blue) compared to flow levels from the Outflow 102 (red)

Table 2.3 Field Reporting Data from EG location

Exploration Green Wetland	Air Temp. (°C)	H2O Temp. (°C)			DO (mg/ L)			pH			Specific (µS/cm)	Conductivity	
Sampling Events		Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up	Inflow	Outflow	Outflow Follow up
12/10/19	11	17.5	16.0	15.1	8.4	8.3	8.1	4.6	6.9	9.52	314.4	224.4	276.2
1/11/20	13	17.1	18.3	N/A	8.4	8.2	N/A	7.38	7.76	N/A	237.0	326.3	N/A

1/13/20	16	16.5	16.9	N/A	8.6	8.6	N/A	7.36	7.75	N/A	264.9	297.8	N/A
1/28/20	18	17	15.6	14.4	11.6	9.5	7.8	7.99	6.99	7.42	328.4	318.2	306.9
4/5/20	22	23.9	20	N/A	7.3	8.2	N/A	7.69	7.21	N/A	405.9	135.9	N/A
4/20/20	16	22.7	23.1	N/A	6.6	5.4	N/A	8.35	7.41	N/A	428.5	422.6	N/A
4/29/20	20	25	24.1	N/A	7.5	7.9	N/A	8.12	7.71	N/A	434.9	353.4	N/A
5/6/20	28	26.5	26.5	N/A	6.3	7.5	N/A	8.36	7.61	N/A	464.2	419.8	N/A
5/13/20	22	26.8	25.1	N/A	7.3	6.3	N/A	7.95	7.58	N/A	469.6	455.3	N/A
6/24/20	29	28.3	29.9	N/A	8.0	9.3	N/A	8.03	8.04	N/A	279.6	257.4	N/A

Table 2.4 Lab Results Reported for EG location

Exploration Green Wetland	Location	Sampling Events ID	Nitrate + Nitrite as N	Ammonia as N	TSS	E. coli	Total Phosphorous
Reporting Limit			0.02 mg/L	0.1 mg/L	1.0 mg/L	10 mpn/100 mL	0.06 mg/L
Date							
12/10/19	Inflow	EG 201-1	0.42	0.1	139	4880	0.118
12/10/19	Outflow	EG 202-1	0.42	0.2	24.0	24200	0.141
12/12/19	Follow up	EG 202-2	0.37	0.5	26.0	<10	0.101

1/11/20	Inflow	EG 201-2	0.26	0.1	20.6	4110	0.153
1/11/20	Outflow	EG 202-3	0.23	0.1	23.2	24200	0.118
1/13/20	Inflow	EG 201-3	0.23	<0.1	24.4	4610	0.149
1/13/20	Outflow	EG 202-4	0.2	0.3	15.6	2610	0.0624
1/28/20	Inflow	EG 201-4	0.46	<0.1	31.9	2280	0.156
1/28/20	Outflow	EG 202-5	0.40	0.1	19.1	426	0.126
4/29/20	Inflow	EG- 201-5	1.87	<0.01	34.0	12000	0.149
4/29/20	Outflow	EG-202-7	2.73	0.2	23.2	3260	0.141
05/06/20	inflow	EG 201-6	0.05	0.1	54.0	24200	0.150
05/06/20	outflow	EG 202-8	0.02	0.1	15.6	638	0.163
05/13/20	Inflow	EG 201-7	0.03	<0.1	66.4	8660	0.113
05/13/20	Outflow	EG 202-9	0.05	<0.1	18.0	771	0.142
06/24/20	Inflow	EG 201-8	0.03	<0.1	31.2	9210	0.140
06/24/20	Outflow	EG 202-10	0.02	<0.1	20.0	6130	0.158

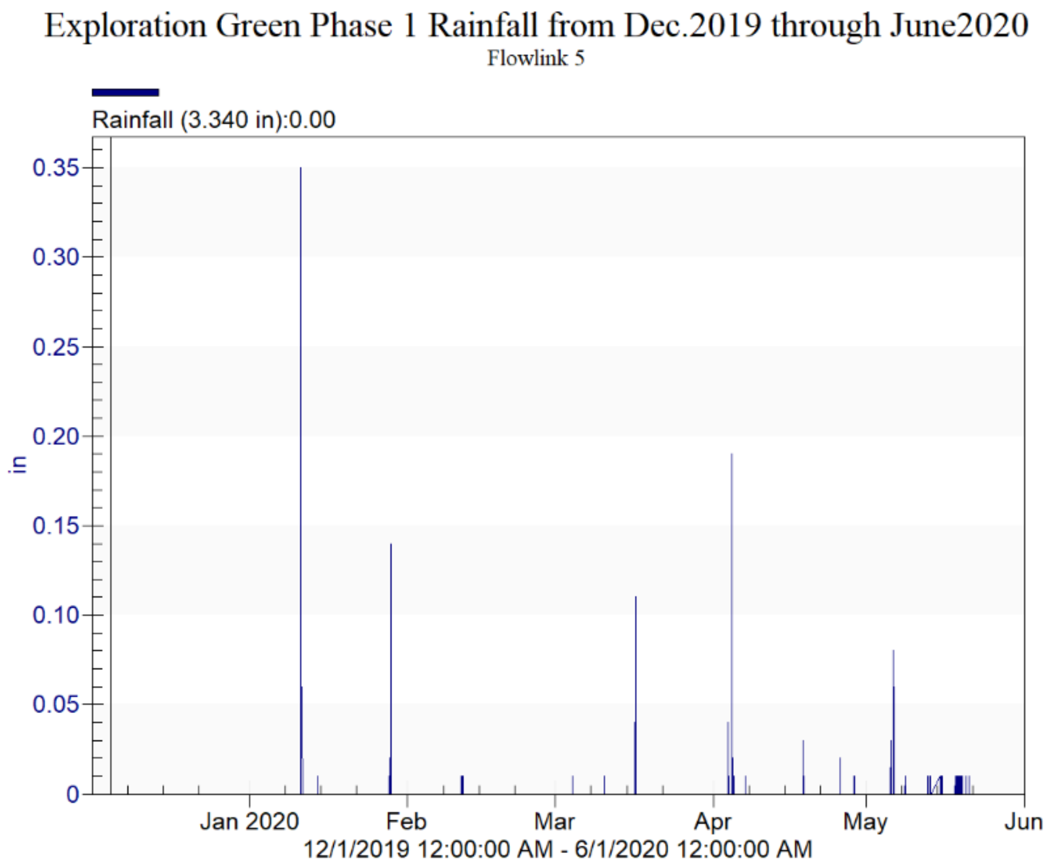

Figure 1.4 Graph 2.2 EG Rainfall Rainfall data from December 2019- June 2020

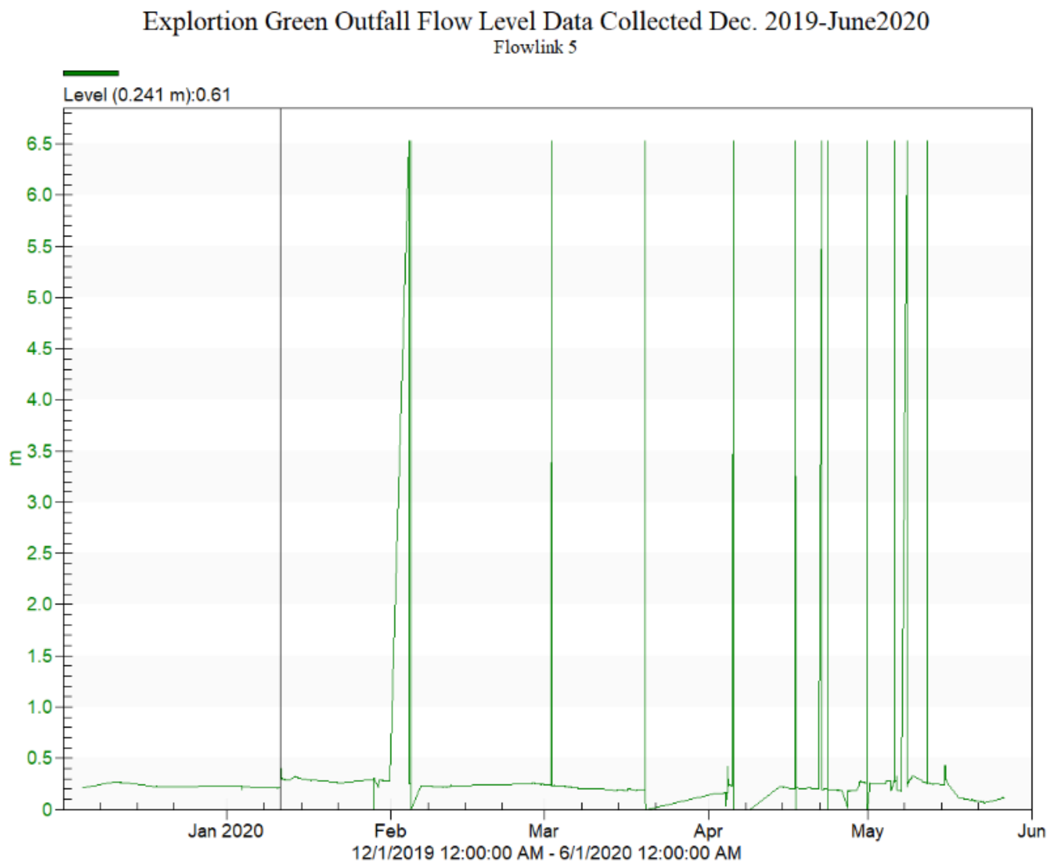

Figure 1.5 Graph 2.3 EG Outfall flow level Flow level data from EG Phase 1 Outfall from Dec.2019-June 2020

Table 2.5 Field Reporting Data from PTWB location

PTWB Wetland	Rainfall Amount (inches/hr)	Air Temp. (°C)	H2O (°C)	Temp.	DO (mg/ L)		Specific Conductivity (μS/cm)		pH	
Sampling Event			Inflow	Outflow	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow

4/28/2020	0.03	31	25.7	N/A	7.9	N/A	312.2	N/A	8.75	N/A
4/29/2020	0.08	21	20.2	21	8.8	9.2	128.5	133.1	8.33	8.33
5/6/2020	0.04	19	24.5	24.3	7.4	8.3	126.1	109.2	8.61	8.56
5/15/2020	0.07	22	24.8	25.1	8.2	8.2	89.9	101.9	8.49	8.83
6/22/2020	0.11	22	25.3	26.5	6.9	6	102	119.1	8.51	7.74
7/22/2020	0.03	27.7	30.1	29.6	6.8	8.4	260.1	206.4	8.76	8.67

Table 2.6 Lab Report Results for PTWB location

MDA PTWB Wetland	Location	Sampling Events ID	Nitrogen (mg/L)	Ammonia (mg/L)	TSS (mg/L)	E. coli (mpn/100ml)	Total Phosphate (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)	TPH (mg/L)
Reporting Limit			0.02	0.1	1	10	0.06	0.0005	0.003	0.001	0.003	0.0005	0.0002	0.005	0.0005	5
Date																
4/29/2020	Inflow	PTWB 301-1	1.17	0.1	7.3	161	<0.06									

4/29/2020	Outflow	PTWB 302-1	2.26	<0.1	51.2	9800	<0.06									
5/6/2020	Inflow	PTWB 301-2	11	0.2	12	733	<0.06	0.00171	0.0191	<0.001	0.00529	<0.0005	<0.0002	<0.005	<0.0005	<5.0
5/6/2020	Outflow	PTWB 302-2	0.58	0.1	24.8	1920	<0.06	0.00159	0.0274	<0.001	0.00451	0.0008	<0.0002	<0.005	<0.0005	<5.0
5/15/2020	Inflow	PTWB 301-3	0.13	<0.1	16.8	1300	<0.06	0.00098	0.00996	<0.001	0.00302	<0.0005	<0.0002	<0.005	<0.0005	<5.0
5/15/2020	Outflow	PTWB 302-3	0.11	<0.1	4.5	4840	<0.06	0.00133	0.0239	<0.001	0.00482	0.000774	<0.0002	<0.005	<0.0005	<5.0
6/22/2020	inflow	PTWB 301-4	0.12	<0.1	1.4	20	<0.06	0.000517	0.00589	<0.001	<0.003	<0.0005	<0.0002	<0.005	<0.0005	<5.0
6/22/2020	outflow	PTWB 302-4	0.24	<0.1	3.6	10	<0.06	0.00152	0.0255	<0.001	0.00370	<0.0005	<0.0002	<0.005	<0.0005	<5.0
7/22/2020	Inflow	PTWB 301-5														
7/22/2020	outflow	PTWB 302-5														

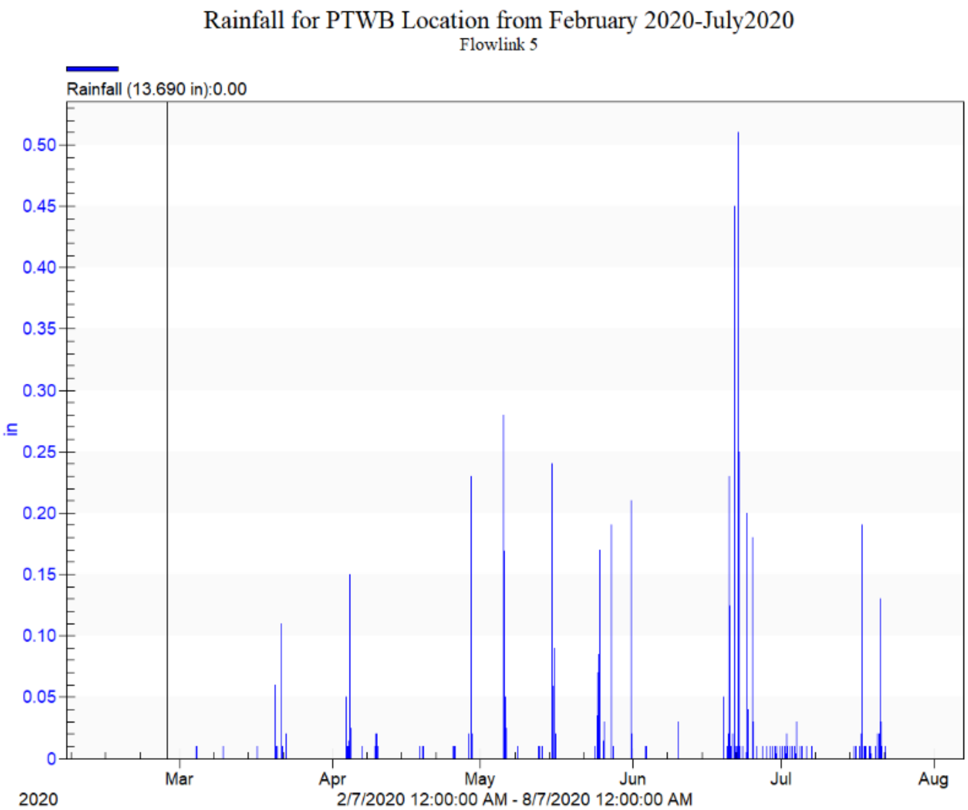

Figure 1.6 Graph 3.1 PTWB Rainfall Rainfall at PTWB site from March - July 2020

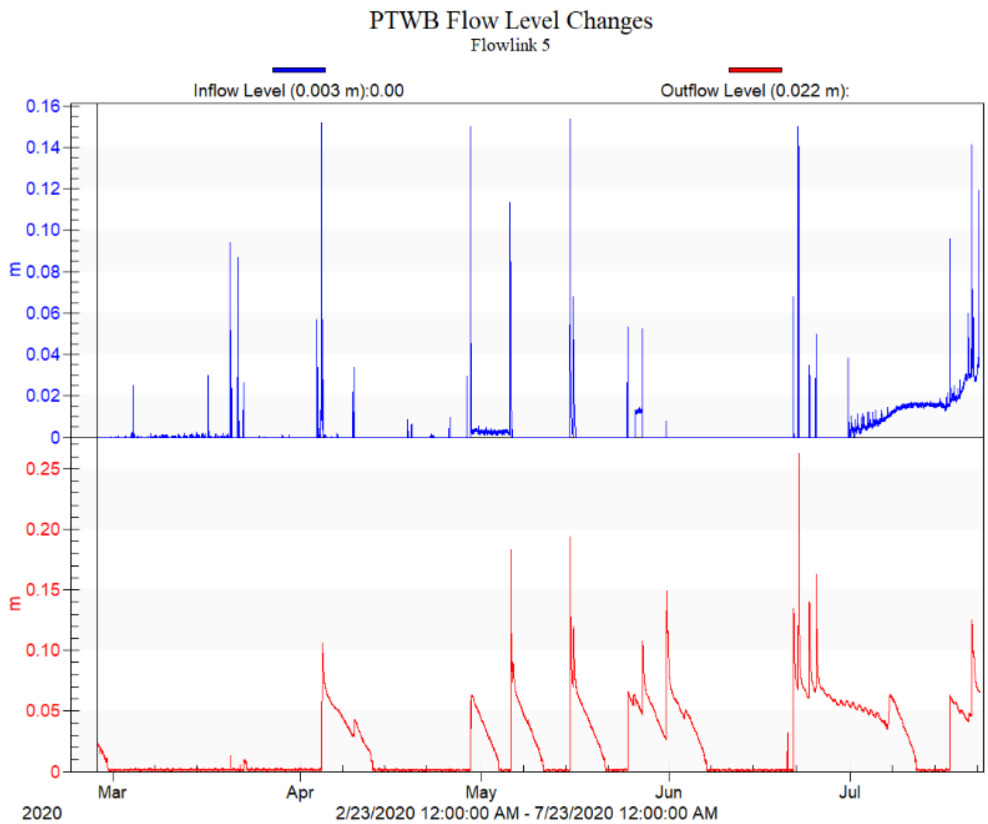

Figure 1.7 Graph 3.2 PTWB Flow Level Comparison Flow Level comparison from Inflow 301 (blue) compared to Outflow 302 (red) for the period from March - July 2020

Data for all sites divided by specific parameters tabulated in Tables 2.7-2.15 below.

Table 2.7 DO (mg/ L): all three locations

	MDA UTRP Wetland			Exploration Green Phase 1			MDA Proton Therapy Wetland	
Sampling Events	101 Inflow	102 Outflow	102 Follow up	201 Inflow	202 Outflow	202 Follow up	301 Inflow	302 Outflow
9/27/2019	7.7	5.9						
11/7/2019	9.6	8.2	10.3					
12/10/2019	10.3	8.8	7.4	8.4	8.3	8.1		
1/9/2020	8.2	9.2						
1/11/2020	9.5	12.4		8.4	8.2			

1/13/2020	11.4	9.9		8.6	8.6			
1/28/2020	10.4	9.9	13.6	11.6	9.5	7.8		
2/6/2020	13.9	14	9.6					
4/5/2020				7.3	8.2			
4/20/2020				6.6	5.4			
4/29/2020				7.5	7.9		8.8	9.2
5/6/2020				6.3	7.5		7.4	8.3
5/13/2020				7.3	6.3			
5/15/2020							8.2	8.2
6/22/2020							6.9	6
6/24/2020				8	9.3			
7/22/2020							6.8	8.4

Table 2.8 Specific Conductivity (µS/cm): all three locations

	MDA UTRP Wetland			Exploration Green Phase 1			MDA Proton Therapy Wetland	
Sampling Events	Inflow	Outflow	follow up	Inflow	Outflow	follow up	Inflow	Outflow
9/27/2019	112	128.9						
11/7/2019	61.9	64.7	275.3					
11/8/2019								
12/10/2019	133.4	149.9	181.8	314.4	224.4	276.2		
1/11/2020	80.6	73.4		326.3	237			
1/13/2020	140	147.8		297.8	264.9			
1/28/2020	80.8	146	165.9	328.4	318.2	306.9		
2/6/2020	86.3	212.2	205.8					
4/5/2020				405.9	135.9			

4/20/2020				428.5	422.6			
4/29/2020				434.9	353.4		128.5	133.1
5/6/2020				464.2	419.8		126.1	109.2
5/13/2020				469.6	455.3			
5/15/2020							89.9	101.9
6/22/2020							102	119.1
6/24/2020				279.6	257.4			
7/22/2020							260.1	206.4

Table 2.9 pH all three locations

	MDA UTRP Wetland			Exploration Green Phase 1			MDA Proton Therapy Wetland	
Sampling Events	Inflow	Outflow	follow up	Inflow	Outflow	follow up	Inflow	Outflow
9/27/2019	10.64*	10.88*						
11/7/2019	10.48*	8.5*	16.29*					
12/10/2019	9.88*	8.51*	16.33*	4.6*	6.9*	9.52*		
1/11/2020	8.04	7.22		7.76	7.38			
1/13/2020	7.71	7.08		7.75	7.36			
1/28/2020	7.99	7.17	7.21	7.99	6.99	7.42		
2/6/2020	7.35	7.47	7.13					
4/5/2020				7.69	7.21			
4/20/2020				8.35	7.41			
4/29/2020				8.12	7.71		8.33	8.33
5/6/2020				8.36	7.61		8.61	8.56
5/13/2020				7.95	7.58			
5/15/2020							8.49	8.83
6/22/2020							8.51	7.74
6/24/2020				8.03	8.04			
7/22/2020							8.76	8.67

Table 2.10 TSS: Total Suspended Solids combined for all 3 locations

TSS	Inflow	Outflow	Difference
	2.9	2.4	0.5
	1.8	3.5	-1.7
	12.1	3.2	8.9
	1.2	2.6	-1.4
	8.4	4	4.4
	3	2.3	0.7
	12.2	8.4	3.8
	139	24	115
	20.6	23.2	-2.6
	24.4	15.6	8.8
	31.9	19.1	12.8
	34	23.2	10.8
	54	15.6	38.4
	66.4	18	48.4
	31.2	20	11.2
	7.3	51.2	-43.9
	12	24.8	-12.8
	16.8	4.5	12.3
	1.4	3.6	-2.2
	33.2	3.9	29.3

Table 2.11 E.Coli data for all three locations

E. coli	Inflow	Ouflow	Difference
	0	2600	-2600
	31	110	-79
	10	906	-896
	63	323	-260
	85	10	75
	0	63	-63
	0	473	-473
	4880	24200	-19320
	4110	24200	-20090
	4610	2610	2000
	2280	426	1854
	12000	3260	8740
	24200	638	23562

8660	771	7889
9210	6130	3080
161	9800	-9639
733	1920	-1187
1300	4840	-3540
20	10	10
10	0	10

Table 2.12 Phosphate: Phosphate data for all 3 locations

Phosphate Inflow	Outflow	Difference
0	0.0471	-0.0471
0.118	0.141	-0.023
0.153	0.118	0.035
0.149	0.0624	0.0866
0.156	0.126	0.03
0.149	0.141	0.008
0.15	0.163	-0.013
0.113	0.142	-0.029
0.14	0.158	-0.018

Table 2.13 Ammonia: Ammonia data for all 3 locations

AmmoniaInflow	Outflow	Difference
0	4.1	-4.1
0.1	0.2	-0.1
0.2	0	0.2
0	0.5	-0.5
0.1	0	0.1
0.2	0	0.2
0.1	0.2	-0.1
0.1	0.1	0
0	0.3	-0.3
0	0.1	-0.1
0	0.2	-0.2
0.1	0.1	0

0.1	0	0.1
0.2	0.1	0.1
0.1	0	0.1
0.1	0	0.1

Table 2.14 Nitrogen: Nitrogen data for All 3 locations

Nitrogen	Inflow	Outflow	Difference
	0.19	0.38	-0.19
	0.24	0.08	0.16
	0.77	0.17	0.6
	0.21	0.08	0.13
	0.56	0.11	0.45
	0.48	0.09	0.39
	0.44	0.02	0.42
	0.42	0.42	0
	0.26	0.23	0.03
	0.23	0.2	0.03
	0.46	0.4	0.06
	1.87	2.73	-0.86
	0.5	0.02	0.48
	0.03	0.05	-0.02
	0.03	0.02	0.01
	1.17	2.26	-1.09
	11	0.58	10.42
	0.13	0.11	0.02
	0.12	0.24	-0.12
	0.13	0.02	0.11

Table 2.15 Heavy Metals: Data analysis of metals reported in both UTRP and PTWB locations

Lead								
inflow	0	0.0014	0.00131	0	0	0	0	0
outflow	0	0.000643	0	0	0.0008	0.000774	0	0
difference	0	0.000777	0.00131	0	-0.0008	-0.000774	0	0

Arsenic								
Inflow	0.00137	0	0.00151	0.000895	0.00171	0.00098	0.000517	0.00316
Outflow	0.000777	0	0.000686	0	0.00159	0.00133	0.00152	0.00213

Difference	0.000593	0	0.000824	0.000895	0.00012	-0.00035	-0.001	0.00103

Barium								
Inflow	0.0114	0.0136	0.0237	0.00811	0.0191	0.00996	0.00589	0.056
Outflow	0.0312	0.019	0.0371	0.0161	0.0274	0.0239	0.0255	0.0495
Difference	-0.0198	-0.0054	-0.0134	-0.00799	-0.0083	-0.01394	-0.01961	0.0065

All the data tables are also available on the stormwater wetland water quality webpage.

Results

The initial analysis of each site date was to average the parameter values recorded for each site. The averages are recorded in Tables 3.1-3.3for the site UTRP, EG, and PTWB respectively. Then bar charts were created to show the differences between the influent and effluent samples. The charts for UTRP are shown in Figures 1.8-1.11. The charts created for EG are shown in Figures 1.12-1.14. The charts from the last location PTWB are shown in Figures 1.15-1.18.

Table 3.1: Initial Analysis of data from MDA UTRP location

		Nitrogen (mg/L)	**Ammonia (mg/L)**	**TSS (mg/L)**	**E. coli (mpn/100ml)**	**Total Phosphate (mg/L)**	**Arsenic (mg/L)**	**Barium (mg/L)**	**Cadmium (mg/L)**	**Chromium (mg/L)**	**Lead (mg/L)**	**Mercury (mg/L)**	**Selenium (mg/L)**	**Silver (mg/L)**	**TPH (mg/L)**
Inflow Mean Values		**0.413**	**0.09**	**5.9**	**27.0**	**0.179**	**0.000944**	**0.014203**	**NR**	**NR**	**0.000683**	**NR**	**NR**	**NR**	**NR**
Outflow Mean Values		**0.133**	**0.69**	**3.8**	**640.7**	**0.171**	**0.000366**	**0.02585**	**NR**	**NR**	**0.000161**	**NR**	**NR**	**NR**	**NR**
Inflow Mean Values	**Subset**	**0.483**	**0.10**	**7.3**	**10.3**	**0.040**									
Outflow Mean Values	**Subset**	**0.090**	**1.08**	**4.4**	**388.0**	**0.049**									

Follow Up Mean Values	Subset	0.020	0.10	5.7	38.8	0.044

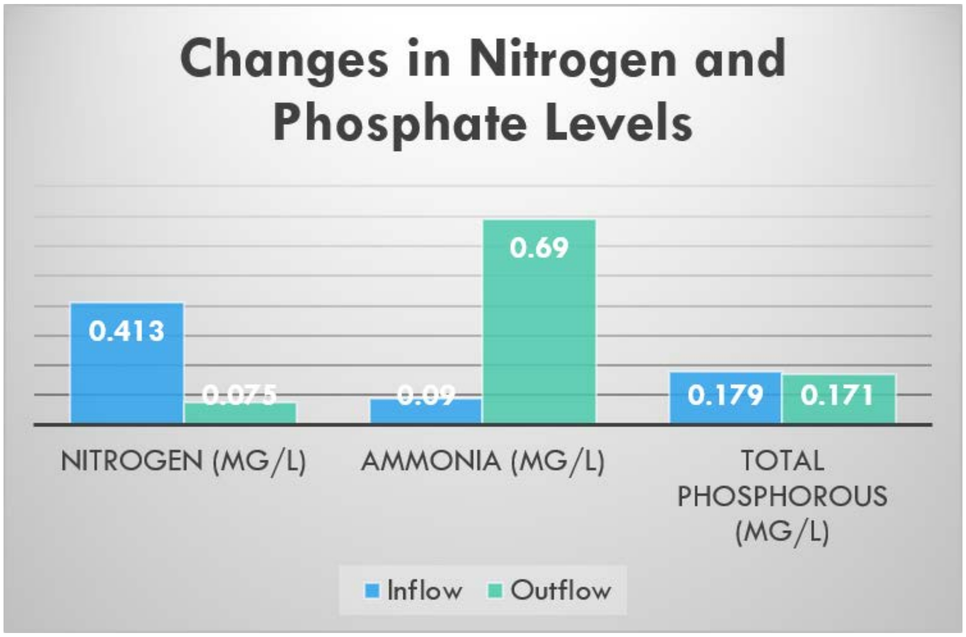

Figure 1.8 Changes in nitrogen and phosphorous at UTRP

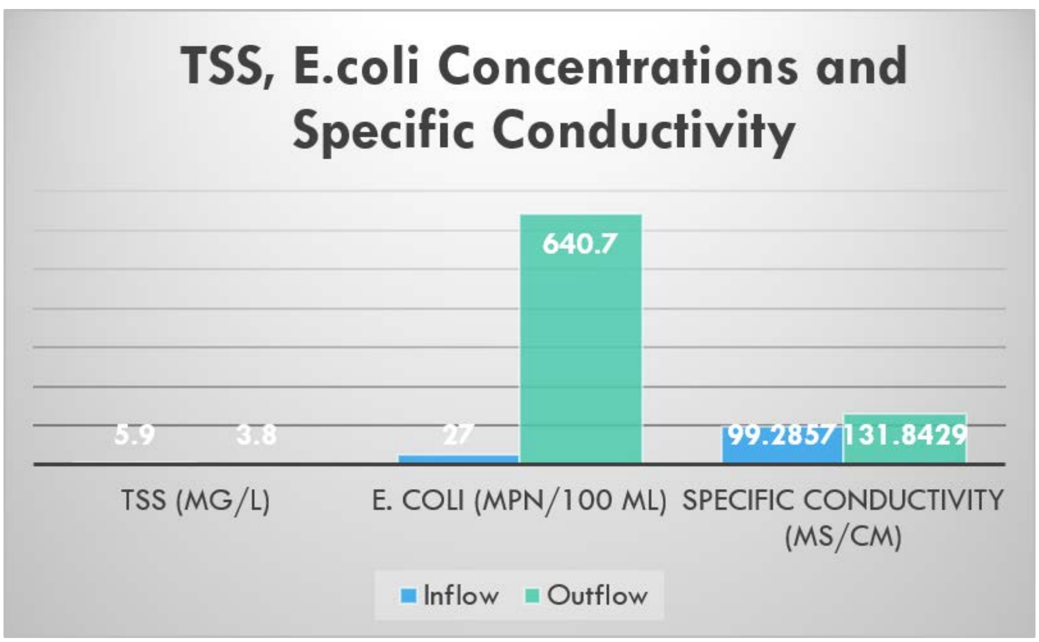

Figure 1.9 Changes in Total suspended solids, E.coli, and Specific conductivity at UTRP

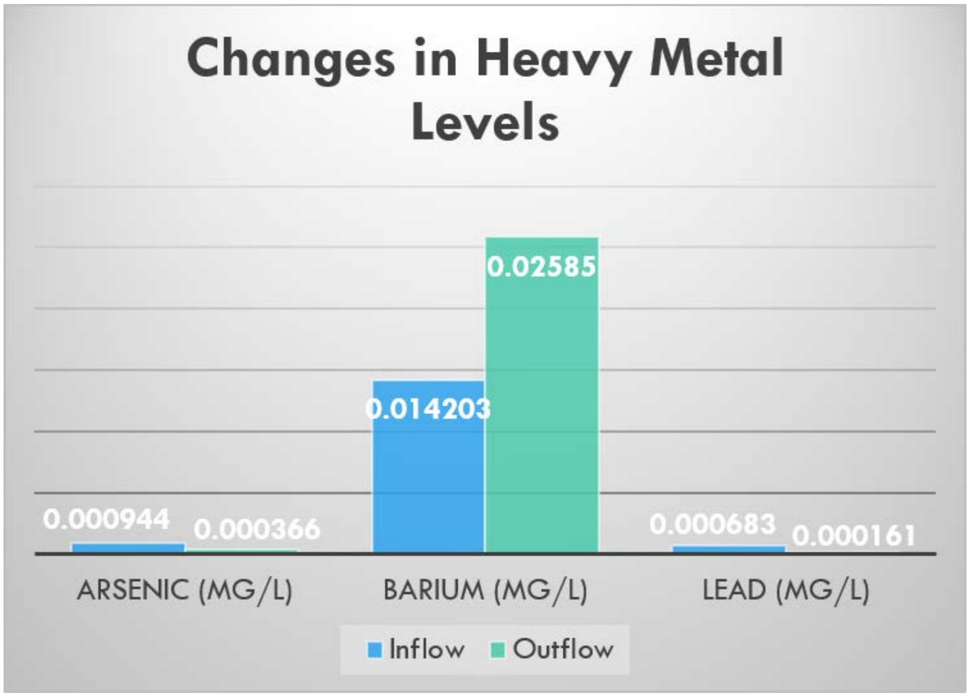

Figure 1.10 Changes in heavy metals present at UTRP

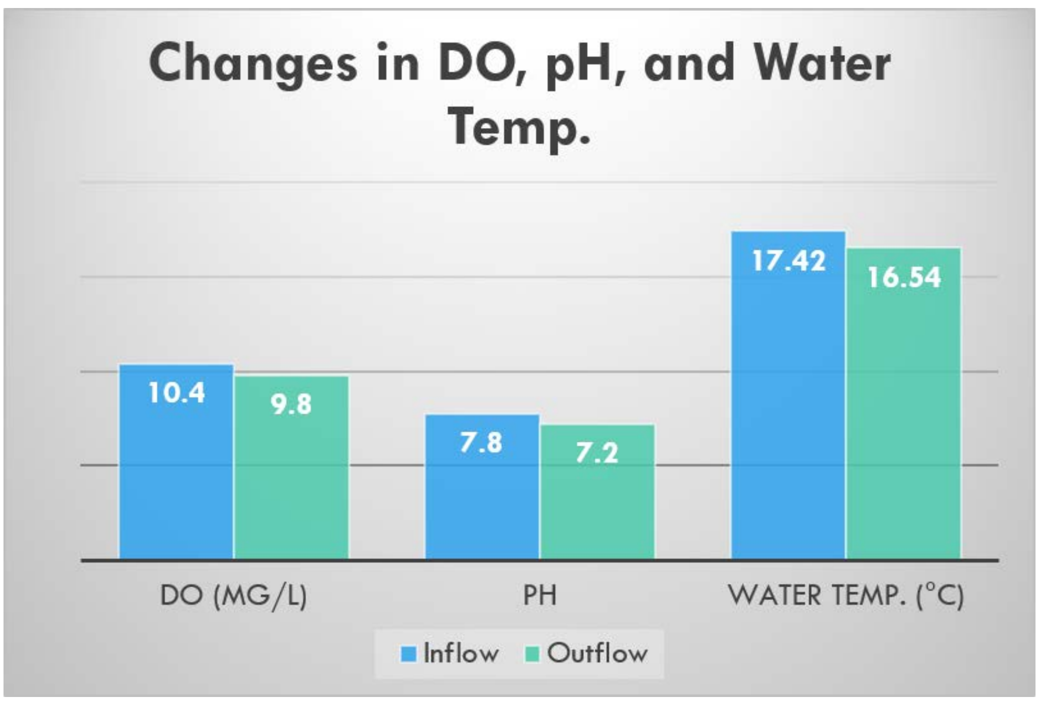

Figure 1.11 Changes in dissolved oxygen, pH, and water temperature at UTRP

Table 3.2: Initial Analysis of data from Exploration Green site locations

Mean Values	Nitrogen	Ammonia	TSS	E. Coli	Total Phosphorous	DO	Specific Conductivity	pH
Inflow	0.475	0.0375	50.2	8743.8	0.141	7.98	374.96	8
Outflow	0.509	0.125	19.8	7779.4	0.1314	7.94	308.89	7.5
Difference	-0.034	-0.0875	30.4	964.38	0.0096	0.04	66.07	0.5

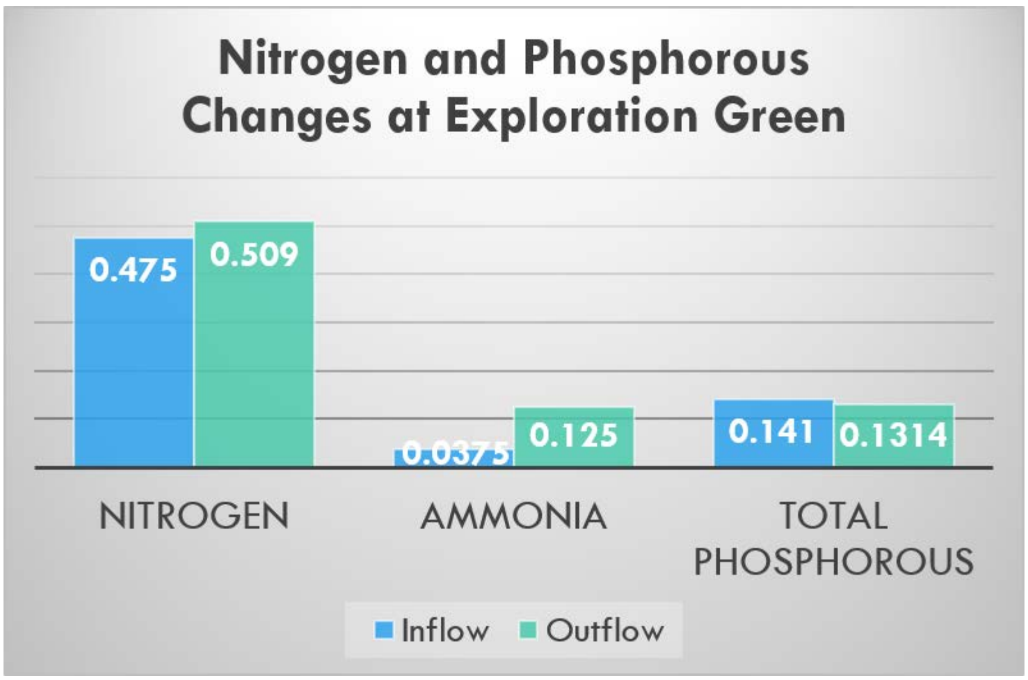

Figure 1.12 Changes in nitrogen and phosphorous levels at Exploration Green

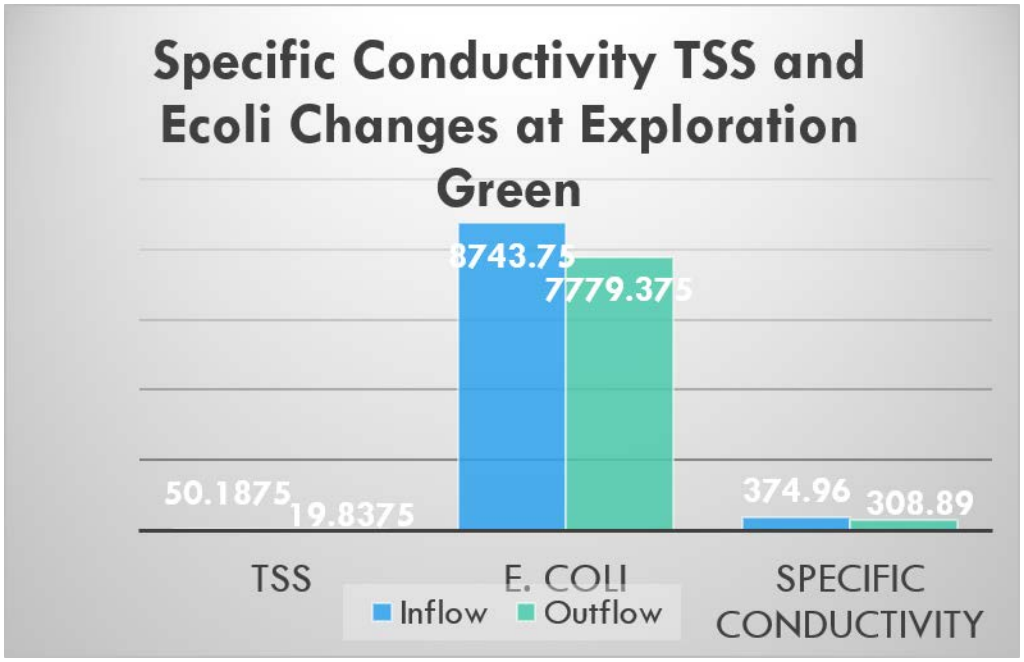

Figure 1.13 Changes in specific conductivity, total suspended solids and E. coli levels at Exploration Green

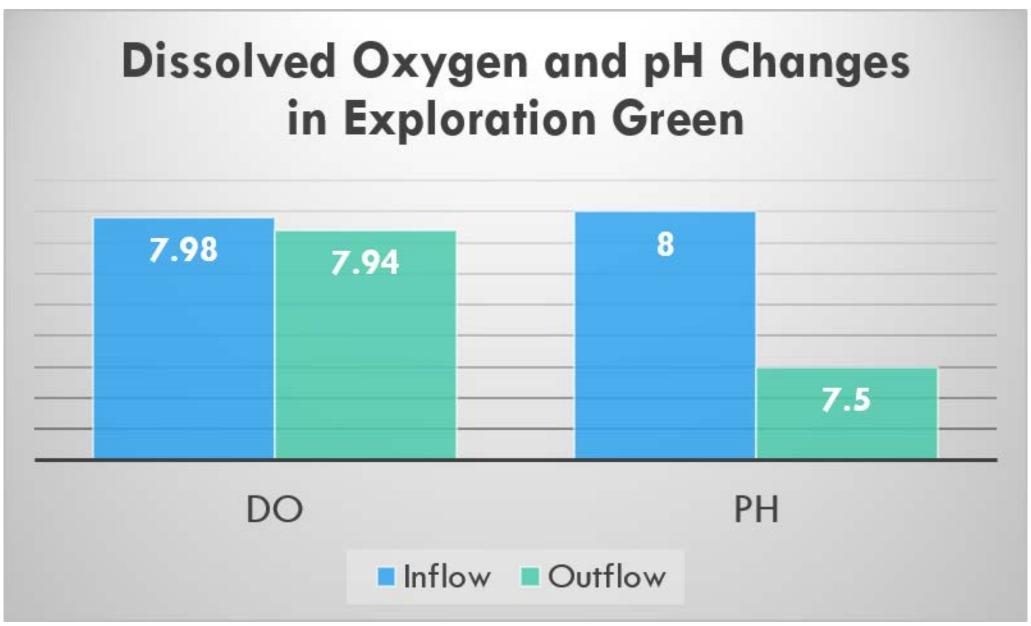

Figure 1.14 Changes in dissolved oxygen and pH at Exploration Green

Table 3.3: Initial Analysis of data from Proton Therapy Wetland Basin site locations

Mean Values	DO	Specific Conductivity	pH	Water temp.	NO2 & NO3	NH3N	E. coli	TSS	Total Phosphate	Arsenic	Barium	Chromium	Lead
Inflow	7.62	141.32	8.54	24.98	2.51	0.1	444.8	3314	0	0.00159175	0.0227375	0.0020775	0
Outflow	8.02	133.94	8.426	25.3	0.642	0.02	3314	17.6	0	0.0016425	0.031575	0.0040925	0.0003935
Difference	-0.29	7.38	0.114	-0.32	1.87	0.08	-2869	3296	0	-0.00005075	-0.0088375	-0.00202	-0.000394

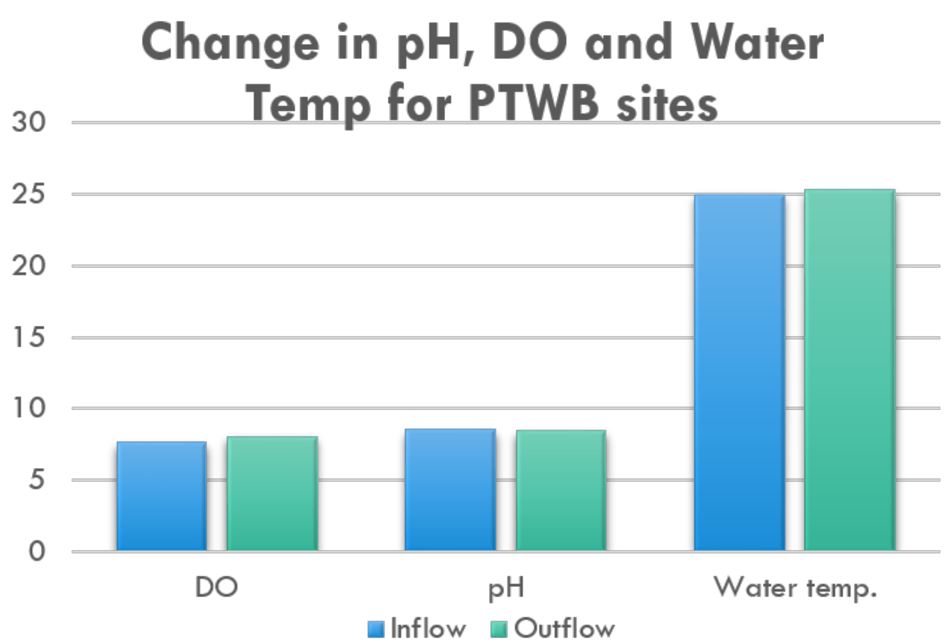

Figure 1.15 Changes in pH, DO, and water temp at PTWB

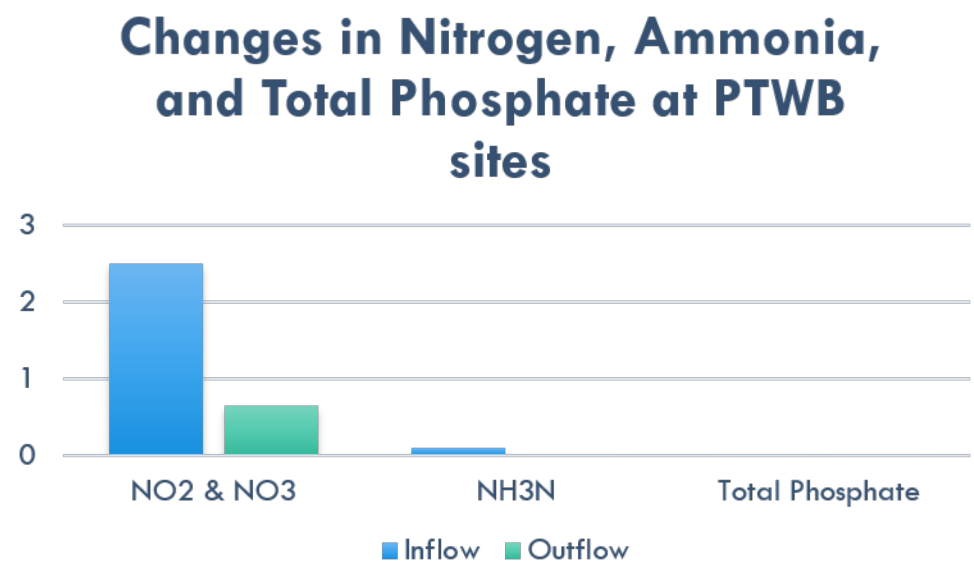

Figure 1.16 Changes in nitrogen and phosphorous at PTWB

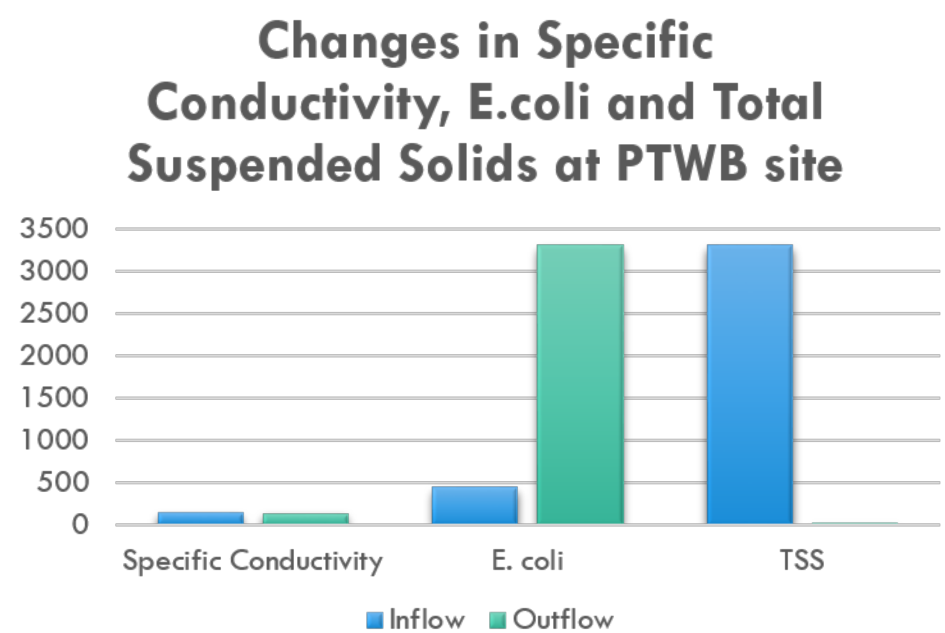

Figure 1.17 Changes in specific conductivity, E.coli, and TSS at PTWB

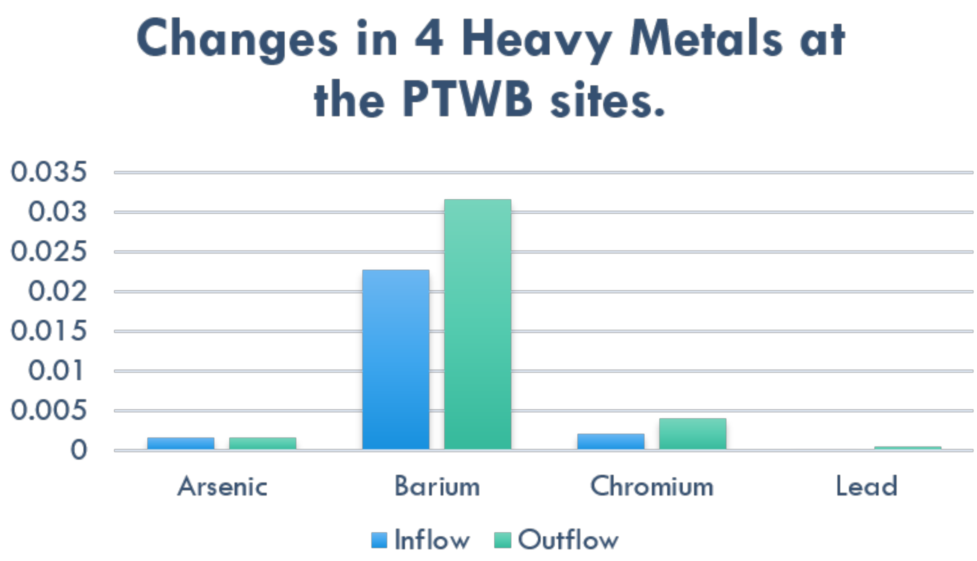

Figure 1.18 Changes in heavy metals identified at the PTWB site

Further analysis of the data was done by conducting paired t-test for each of the parameters identified in the previous tables combining all the results from the three project sample locations, two project sample locations for the heavy metal parameters. The results for the paired t-test with an *alpha =0.05* and a 95% confidence level are reported in the following Tables 3.4-3.12. These tests show no significant change in any of the parameters identified.

Table 3.4 Analysis of DO:

	Inflow	Outflow	difference
average	9.0793103	8.772414	0.306897
t-test	0.3485493		
t-crit	2.048		

Table 3.5 Analysis of Specific Conductivity:

	inflow	outflow	difference
average	219.8714	217.6214	2.25
t-test score	0.889651		
t-critical	2.052		

Table 3.6 Analysis of pH:

	inflow	outflow	difference
average	8.053333333	7.624762	0.428571
t-score	0.00004577348		
t critical	2.086		

Table 3.7 Analysis of TSS:

TSS:	Inflow	Outflow	Difference
sum	513.8	273.1	240.7
mean	25.69	13.655	12.035
t-test	0.095284		
t-crit	2.093		

Table 3.8 Analysis of E. coli bacteria data

E. coli	Inflow	Outflow	Difference
sum	72363	83290	-10927
mean	3618.15	4164.5	-546.35
t-test	0.792677		
t-crit	2.093	Accept H0: no change	

Table 3.9 Analysis of Phosphate:

Phosphate	Inflow	Outflow	Difference
sum	1.128	1.0985	0.0295
mean	0.125333	0.122056	0.0032778
t-test	0.817973		
t-crit	2.306	Accept H0: no change	

Table 3.10 Analysis of Ammonia:

Ammonia	Inflow	Outflow	Difference
sum	1.4	5.9	-4.5
mean	0.0875	0.36875	-0.28125
t-test	0.294446		
t-crit	2.131		
	Accept H0: no change		

Table 3.11 **Analysis of Nitrogen:**

Nitrogen	Inflow	Outflow	Difference
sum	19.24	8.21	11.03
mean	0.962	0.4105	0.5515
t-test	0.308727		
t-crit	2.093	Accept H0: no change	

Table 3.12 Analysis of heavy metals data:

Lead	sum	mean	t-test	t-crit
inflow	0.00273	0.00034125	0.805643	2.365
outflow	0.002217	0.000277125		
difference	0.000513	0.000064125		

Arsenic	sum	mean	t-test	t-crit
Inflow	0.010142	0.00126775	0.325361	2.365
Outflow	0.008033	0.001004125		
Difference	0.002109	0.000263625		

Barium	sum	mean	t-test	t-crit
Inflow	0.14776	0.01847	0.011817	2.365
Outflow	0.2297	0.0287125		

Difference	-0.08194	-0.0102425

There were 8 heavy metal parameters tested, only four parameters gave any results over the reporting limit the other parameters were not reported by the lab. Also, there were no incidences of TPH reported for the samples tested at either of the locations.

Conclusions

In conclusion AgriLife found that this is a good start to some baseline information on constructed stormwater wetlands in the Lower Galveston Bay Watershed. We found trends to improving water quality in all three project locations, not dependent on the size or establishment of the stormwater wetland. We saw decreases in specific conductivity, pH, TSS, phosphate, nitrogen, chromium, lead, arsenic. While these are promising improvements, the t-test results do not let us reject the null hypothesis, no change between the inflow and outflow samples. We saw increases in ammonia levels. While no definitive causes were identified, this could be due to increased habitat and bird activity in stormwater wetlands. We also saw an increase in E. coli bacteria at the outflow locations. This could be a result of the longer hold times in stormwater sampling from the traditional 8 hours for water quality to 24 hours for our stormwater samples. Most samples were test I well under the 24- hour limit. We know bacteria can live longer on sediment and other surfaces so if there are more significant decreases in TSS the bacterial amounts may also decrease, but the data from this study show bacteria are not closely correlated to the amount of suspended solids. It is also thought that animals typically do not use the restroom on the concrete parking lot surfaces, the sources of the runoff in the inflow pipes. So it is thought that the increases are from surface flow off the grass areas rather than the inflow pipes. We saw increases in barium from the two sites that were tested for heavy metal parameters. We do not know why this is the case but it could be tied to location, being in the medical center. Maybe there are more sources we are unaware of in this location. These findings make a case for more sampling to be added in these and other stormwater wetland projects in the area over a longer duration to try to identify differences seasonally and prove the trends merit more of these types of green infrastructure projects.

APPENDICES

Appendix A: Field Data Recording Sheet

Field Data Recording Sheet

Date: ____________________ Collected By: ____________________

Location: ____________________ Event #: ________________

Site ID:		Rainfall Amount		Air Temp.		Water Temp.		DO		Specific Conductance		pH		24 Hr.	48 Hr.		Bottle Collected #:

Field Observations:

Appendix B: Chain of Custody

EASTEX ENVIRONMENTAL LABORATORY, INC.

P. O. Box 1089 * Coldspring, TX 77331 | P. O. Box 631375 * Nacogdoches, TX 75963-1375
(800) 525-0508 * FAX (936) 653-3172 | (936) 569-8879 * FAX (936) 569-8951
www.eastexlab.com

REPORT TO:	INVOICE TO:
(1) Company	(2) Company
Address	Address
Attn.	Attn.
Phone #	Phone #
Fax #	Fax #
	P.O. #
Sampler's Name (please print)	Sampler's Signature

Project Number	(3) Project Name	(7) Containers
Remarks:		

Order ID	(4) Sample ID	Date	Time	(5) C/G	DO	PH	Cl2	Flow	Temp	(6) Matrix	# Con	Size	Type	Pres	(8) ANALYSIS REQUESTED									

Relinquished By: (Signature)	Received By: (Signature)	Date	Time	Received Iced: Yes / No
Relinquished By: (Signature)	Received By: (Signature)	Date	Time	Received Iced: Yes / No
Relinquished By: (Signature)	Received and/or Checked In By: (Signature)	Date	Time	Received Iced: Yes / No

LAB USE ONLY Sample Condition Acceptable Yes / No	Temp °C	* Therm ID	Logged In By: (Signature)	Date	Time	White Copy-Follows Samples Yellow Copy-Laboratory Pink copy-Client Copy
Alternate Check In (Signature) Date Time						*SEE BACK FOR INSTRUCTIONS*

Chain of Custody Revision 2: 03/24/17

* Thermometer has 0.0 factor and recorded temperature is actual temperature.

Eastex Environmental Laboratory, Inc.

INSTRUCTIONS

Please be complete and accurate when filling out the Chain-of-Custody sheet, as all Information will be printed on the final lab report.

1 REPORT TO:	Name of company, address, #'s, and where you want the report sent.
2 INVOICE TO:	Name of company, address, #'s, and where you want the report sent.
3 PROJECT NAME:	What you will call this sample.
4 SAMPLE ID:	How you will refer to this sample.
5 SAMPLE TYPE:	C3=3pt Comp. C6=6pt Comp. C12=12hr Comp. C24=24hr Comp. G=Grab
6 MATRIX:	DW=Drinking Water WW=Wastewater SO=Soil/Sludge OL=Oils FL=Filter LE=Leachate SD=Solid RE=Resin OT=Other
7 CONTAINER(S)	
SIZE:	1=Gallon 2=1/2 Gallon 3=Quart/Liter 4=Pint 5=1/2 pt (250 ml) 6=125 ml/4 oz. 7=60 mls/2 oz 8-Vial 9=Other
TYPE:	P=Plastic G=Glass T=Teflon S=Sterile
PRESERVATIVE:	C=Chilled S=Sulfuric Acid N=Nitric Acid B=Base/Caustic Z=Zn Acetate H=Hydrochloric Acid ST=Sodium Thiosulfate O=Other
8 ANALYSIS REQUESTED	Please be as specific as possible when listing which samples get what results.

Appendix C: Eastex Lab Bid and Requirement Specifications

Eastex Environmental Laboratory PO Box 1089 Coldspring, Texas 77331

Christina Taylor
Extension Program Specialist
Stormwater Wetlands Program
Texas Community Watershed Partners
Texas A&M AgriLife Extension Service

March 6, 2018

Response for Bid – Texas Community Watershed Partners Stormwater Quality Project
Grant Award Number NA18NOS4190153

Thank you for the opportunity to bid on your analyses.

Eastex Environmental Laboratory is very familiar with the analysis requirements for this task. We are an approved Clean River Program Laboratory and have been meeting the bacteriological holding times for these projects in the Houston/Galveston area. We have 3-4 Field Technicians in the Houston/Galveston area daily and coordinate sample pick-up for similar tasks regularly.

We are TNI accredited, HUB Certified laboratory and have been servicing the Houston/Galveston area for the past 32 years meeting our clients analytical needs. Eastex Environmental performs all items in the tasks at our facilities under our scope of accreditation. All analytical procedures will be conducted according to NELAP procedures, EPA Standards, AWWA and TCEQ guidelines. The procedures include the following, as a minimum requirement: comparisons against known standards in each run; one in ten sample duplicates and a monthly review against known spiked samples. Detection Limits will be our normal reporting limits unless otherwise specified by project requirements. The price includes sample bottles, pick-up, coolers as needed and delivery of data.

Enclosed you will find the following:

Section 1 – Bid Documents

Bid Specification with Scope of Services,

Section 2 - HUB Certificate,

Once again, thank you for this opportunity. If you need any additional information or any further assistance, please feel free to call me at 936-653-3249 or 1-800-525-0508. You may also visit our website at www.eastexlabs.com .

Respectfully,

Kathleen Harrott

Kathleen Harrott, Technical Director, Eastex Environmental Laboratory, Inc.

Appendix D: Eastex Laboratory NELAP Accreditations

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

August 08, 2018

CERTIFIED MAIL 9485 5090 0527 6008 6739 69

Ms. Tiffany Guerrero
Eastex Environmental Laboratory, Inc. - Coldspring
P. O. Box 1089
Coldspring, TX 77331-1089

Re: Amendment application

Dear Ms. Guerrero:

Based on the amendment request submitted on April 05, 2018, I am enclosing an updated NELAP accreditation certificate and Fields of Accreditation listing. They replace the previous ones issued on November 01, 2017.

Please review the enclosures for accuracy and completeness. Your laboratory's accreditation is valid until the expiration date on the certificate and scope, contingent on continued compliance with the standards for accreditation and requirements of the state of Texas.

Please let me know if I can provide any additional information regarding this matter. You may also contact me at (512) 239-1990 or *ken.lancaster@tceq.texas.gov*.

Sincerely,

Kristy M. Beaver
for Ken Lancaster
Manager, Laboratory & Quality Assurance Section

Enclosures

Appendix E: LAB REPORTS

See the lab report links at the follow website
https://tcwp.tamu.edu/stormwater/wetlands/stormwater-wetland-water-quality-monitoring-project/

https://tcwp.tamu.edu/files/2020/02/UTRP101-1.pdf

https://tcwp.tamu.edu/files/2020/02/UTRP102-1.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-2.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-2.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-3.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-4.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-3.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-5.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-4.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-6.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-7.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-5.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-8.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-9.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-6.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-10.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-11.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-101-7.pdf

https://tcwp.tamu.edu/files/2020/04/UTRP-102-12.pdf

https://tcwp.tamu.edu/files/2020/04/EG-201-1.pdf

https://tcwp.tamu.edu/files/2020/04/EG-201-2.pdf

https://tcwp.tamu.edu/files/2020/04/EG-201-3.pdf https://tcwp.tamu.edu/files/2020/05/EG-201-4.pdf

https://tcwp.tamu.edu/files/2020/05/EG201-5.pdf

https://tcwp.tamu.edu/files/2020/06/Eg-201-6.pdf

https://tcwp.tamu.edu/files/2020/06/EG-201-7.pdf

https://tcwp.tamu.edu/files/2020/07/EG-201-8.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-1.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-2.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-3.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-4.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-5.pdf

https://tcwp.tamu.edu/files/2020/04/EG-202-6.pdf

https://tcwp.tamu.edu/files/2020/05/EG202-7.pdf

https://tcwp.tamu.edu/files/2020/06/EG-202-8.pdf

https://tcwp.tamu.edu/files/2020/06/EG-202-9.pdf

https://tcwp.tamu.edu/files/2020/07/EG-202-10.pdf

https://tcwp.tamu.edu/files/2020/05/PTWB-301-1.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-301-2.pdf

https://tcwp.tamu.edu/files/2020/06/PTWB-301-3.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-301-4.pdf

https://tcwp.tamu.edu/files/2020/08/PTWB-301-5.pdf

https://tcwp.tamu.edu/files/2020/05/PTWB-302-1.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-302-2.pdf

https://tcwp.tamu.edu/files/2020/06/PTWB-302-3.pdf

https://tcwp.tamu.edu/files/2020/07/PTWB-302-4.pdf

https://tcwp.tamu.edu/files/2020/08/PTWB-302-5.pdf