Floating treatment wetlands:

A pilot-study and large-scale field trial of the stormwater treatment potential in urban catchments in a subtropical environment

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Stormwater Runoff – "Pollutant Soup"

Image courtesy of DrDrainage Media

Stormwater ponds

Pros

- Stormwater attenuation
- Stormwater treatment
  - Sedimentation
  - Possible biological uptake mechanisms

Cons

- Extreme water level fluctuations
  - Damaging to bank planted vegetation
- Accumulation of nutrients such as N & P
- Less effective at removing dissolved particulates & finer particulates
  - Headley & Tanner, 2006
- Regular dredging may be needed

Image courtesy of Biomatrix

Wetlands and created wetlands

- Provide water filtration and nutrient uptake
- Loss of natural wetlands since 1700s
  - Fluet-Chouinard et al. 2023
- Require large amount of land
- Sensitive to temperature and flow fluctuations

Image courtesy of BioMatrix

What are floating treatment wetlands (FTWs)?

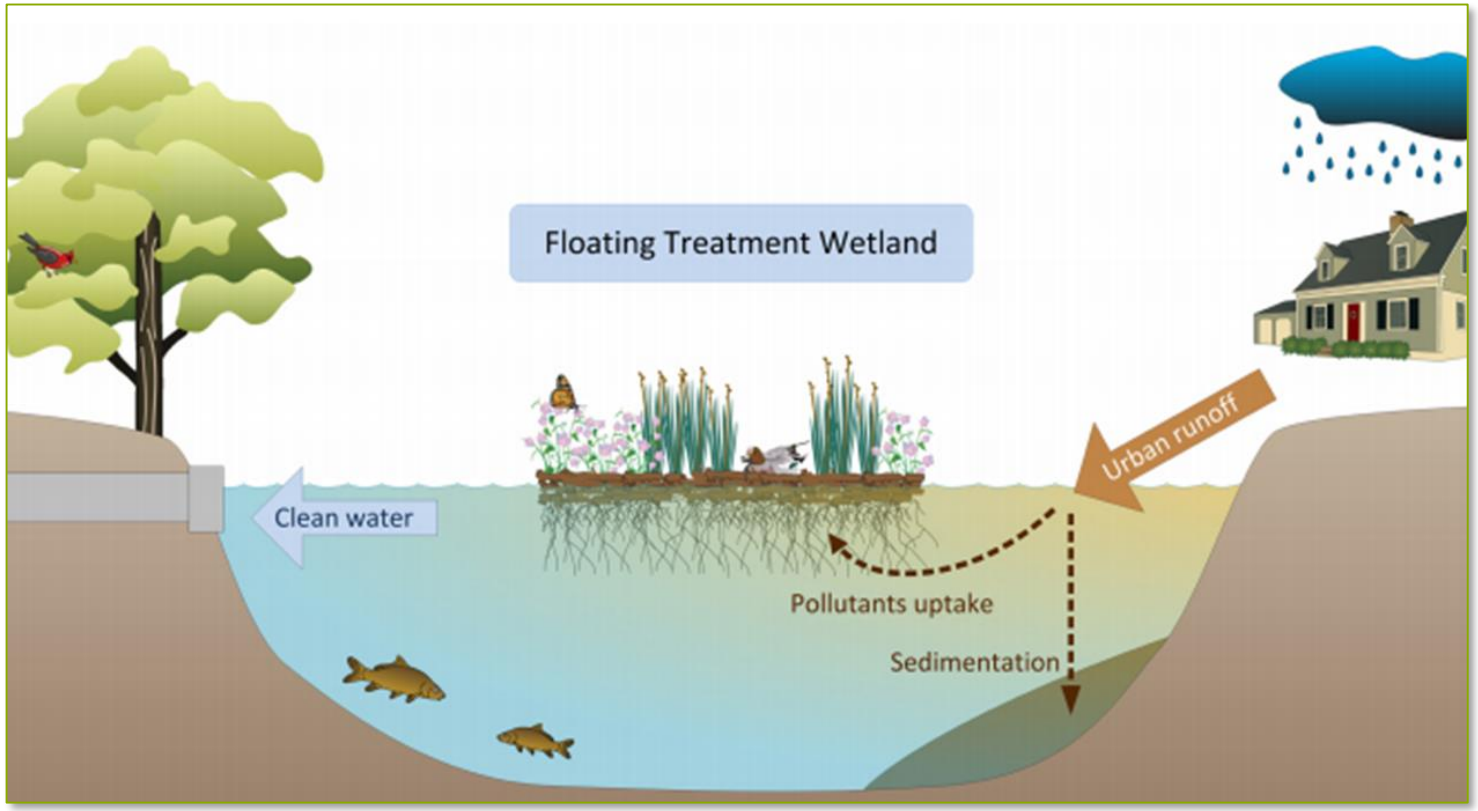


Figure 1. Diagram of a floating treatment wetland receiving urban runoff.

Artificial islands that utilize plants to reduce pollutants in water

Buoyant mats anchored to the bottom or shore

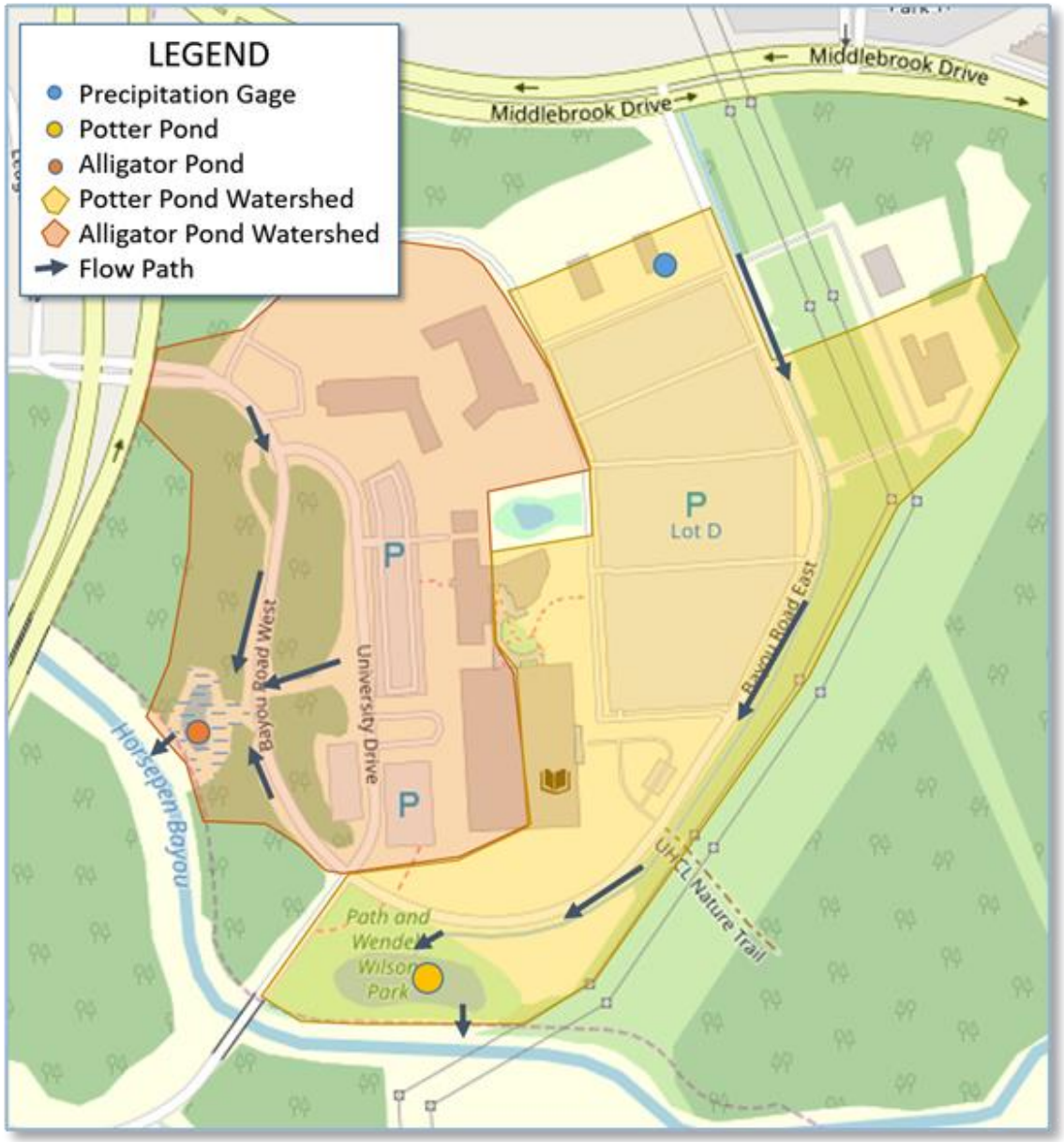
Rise and fall with fluctuating water levels

Native wetland plant species

Roots suspended in water column

Purpose of study

- Partnered with Harris County Flood Control District (HCFCD)
  - Phase 1 MS4 co-permittee
  - Reduce pollutant loads
- HCFCD interested in building and evaluating FTWs for use in flood control basins
  - Monitoring & assessing the performance at enhancing targeted pollutant reductions in Harris County



UHCL Watersheds

Yellow – MS1 (Potter Pond) watershed

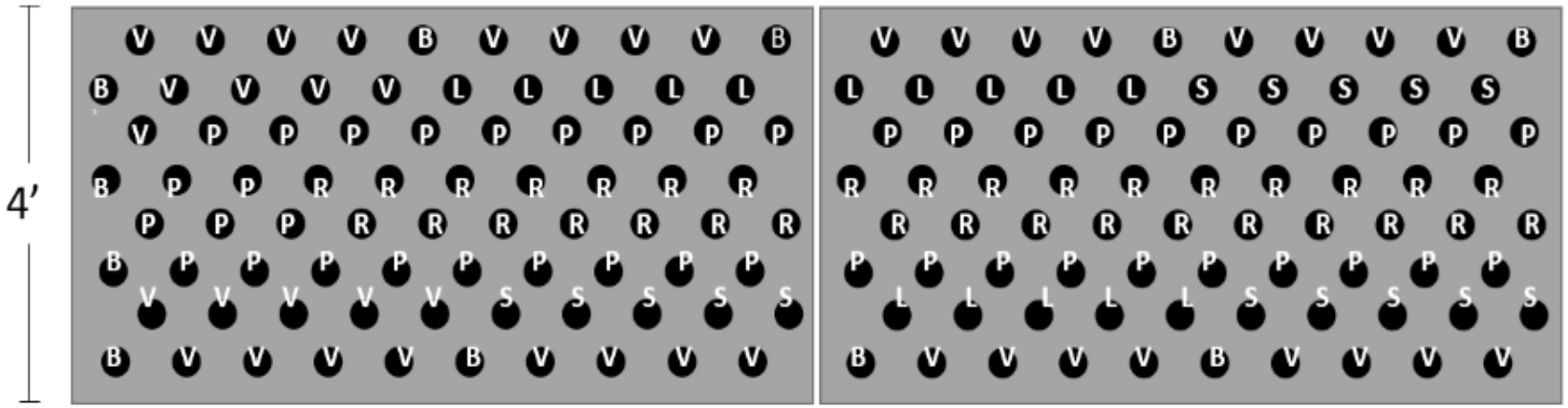
Orange – MS2 (Alligator Pond) watershed

Methods of Pilot-Study

- Thorough literature review
- Preliminary scoring matrix
  - mat types
  - native Texas wetland plant species
- Selected 4 mat types to compare
  - MS1
    - 3 commercially available
  - MS2
    - 1 DIY method

Image courtesy of EIH

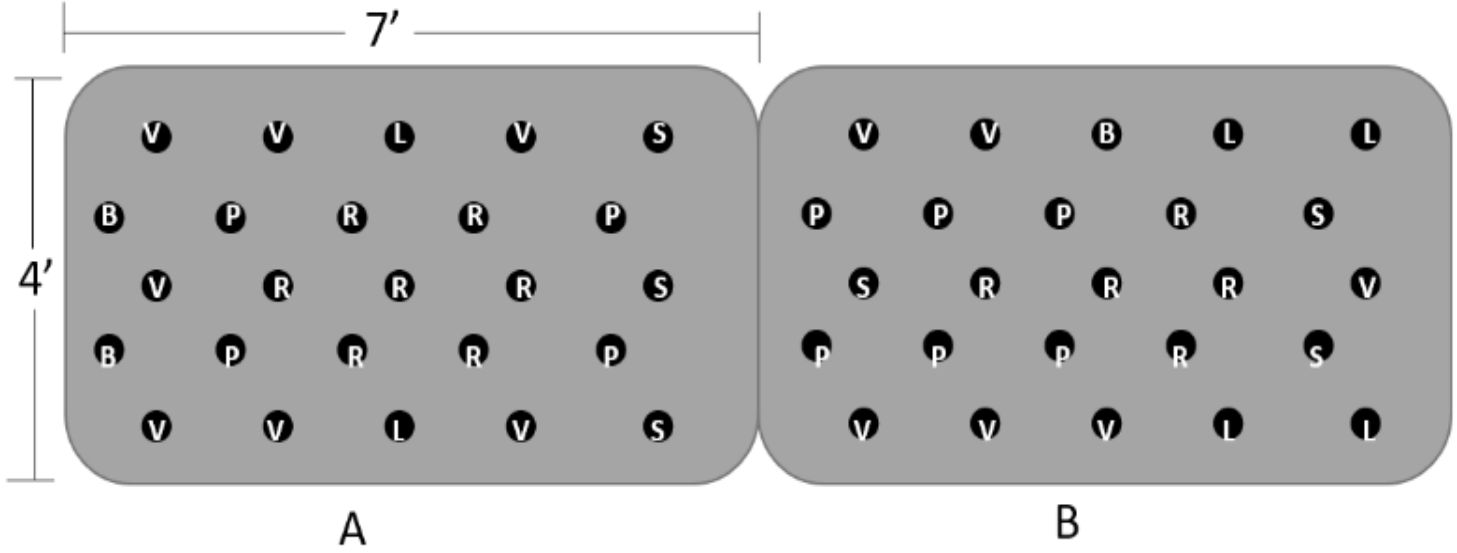
Beemats



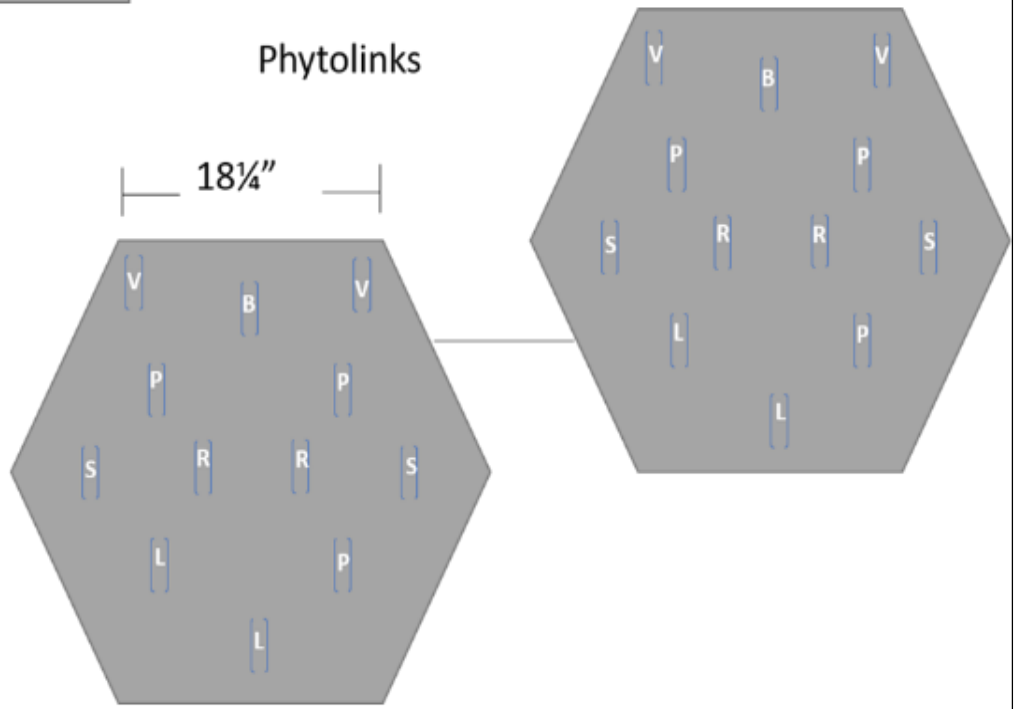
Legend:

V = Virginia iris	B = Blue water hyssop
L = Swamp lily	S = Swamp smartweed
P = Pickerelweed	R = Common rush

Biohaven



Phytolinks



Methods - continued

- Selected 6 plant species
  - MS1 – utilized all 6 species on every mat
  - MS2 – focused on 3 plant species + control
- Installed monitoring equipment and released tracer dye to isolate main flow path
- Tracked the construction and planting requirements

Image courtesy of EIH

Common rush – *Juncus effuses*

- Large, fibrous root system
- Peer-reviewed studies demonstrating great nutrient uptake capabilities and success in previous FTW studies
  - Borne et al. 2015
  - Chang et al. 2013
  - Wang and Sample 2014

Image courtesy of USDA Plants

Pickerelweed – *Pontederia cordata*

- Large, fibrous root systems
- Attractive flowers for pollinators
- Peer-reviewed studies demonstrating great nutrient uptake capabilities and success in previous FTW studies
  - Borne et al. 2015
  - Chang et al. 2013
  - Wang and Sample 2014

Image courtesy of USDA Plants

Swamp smartweed – *Polygonum hydropiperoides*

- Fast growth
- Nutria resistant
- Attractive flowers for pollinators
- Nutrient and heavy metal removal
  - Martins et al. 2010
  - Núñez et al. 2011

Blue water hyssop – *Bacopa caroliniana*

- High resiliency to wildlife disturbance
  - Nutria and waterfowl in particular
- Has a lemony scent, which gives it insecticidal properties
- Nutrient removal
  - Liu et al. 2019
  - Ariyakot and Pholchan 2019

Images courtesy of USDA Plants

Swamp lily – *Crinum americanum*

- Attractive flowers for pollinators
- Nutrient removal
  - Carvalho and Martin 2001

Virginia iris – *Iris virginica*

- High resiliency to wildlife disturbance
- Attractive flowers for pollinators
- Nutrient removal
  - Turk et al. 2017
  - White and Lott 2017

Images courtesy of USDA Plants

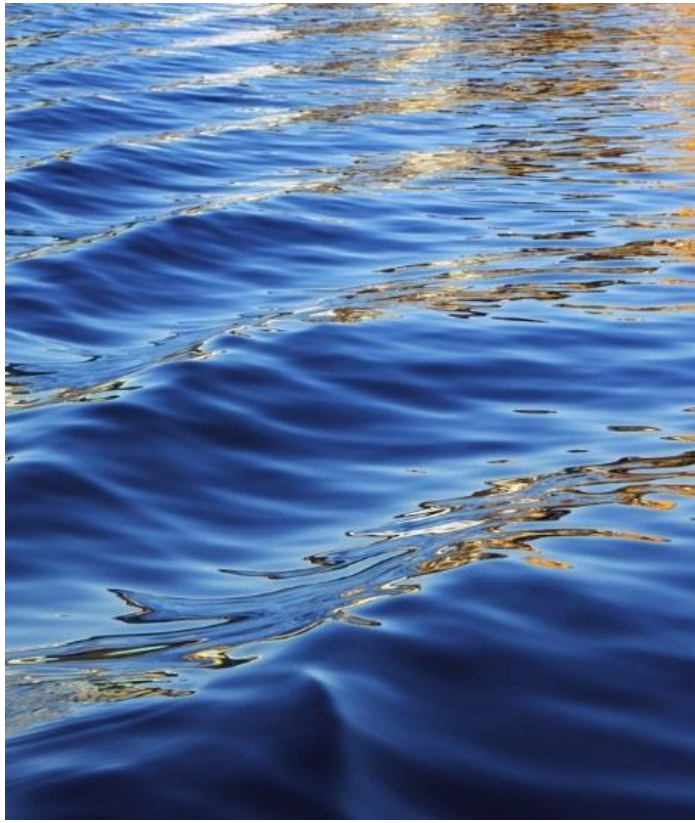
Methods of pilot-study continued

- **Monitored rain events and ambient conditions with and without the FTWs installed**
  - Measured flow (during rain events)
  - Collected sonde readings
  - Collected secchi readings
  - Collected water samples
    - **bacteria**
    - **suspended solids**
    - **Nutrients (TN + TP)**
    - oil and grease
- Game cameras to monitor wildlife activity
- Monitored vegetation composition and growth
- Tracked needed maintenance for mats
- Noted any degradation or malfunction

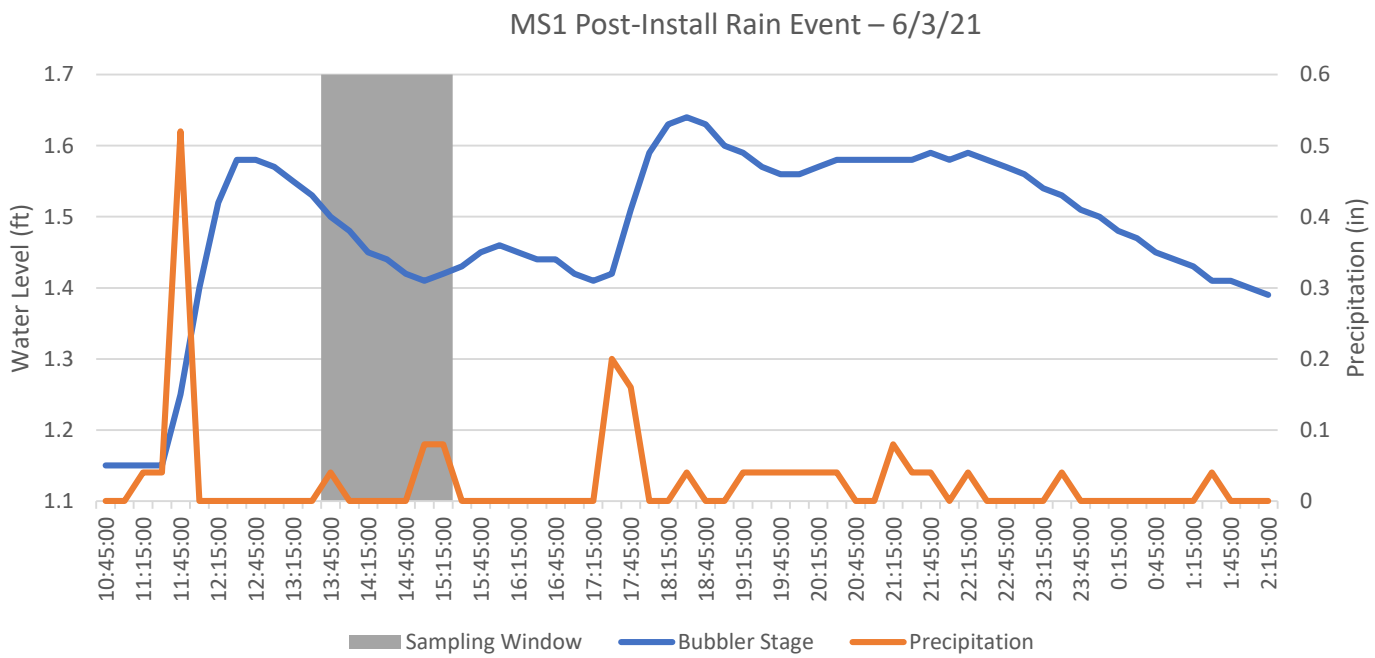
Monitoring Station 1

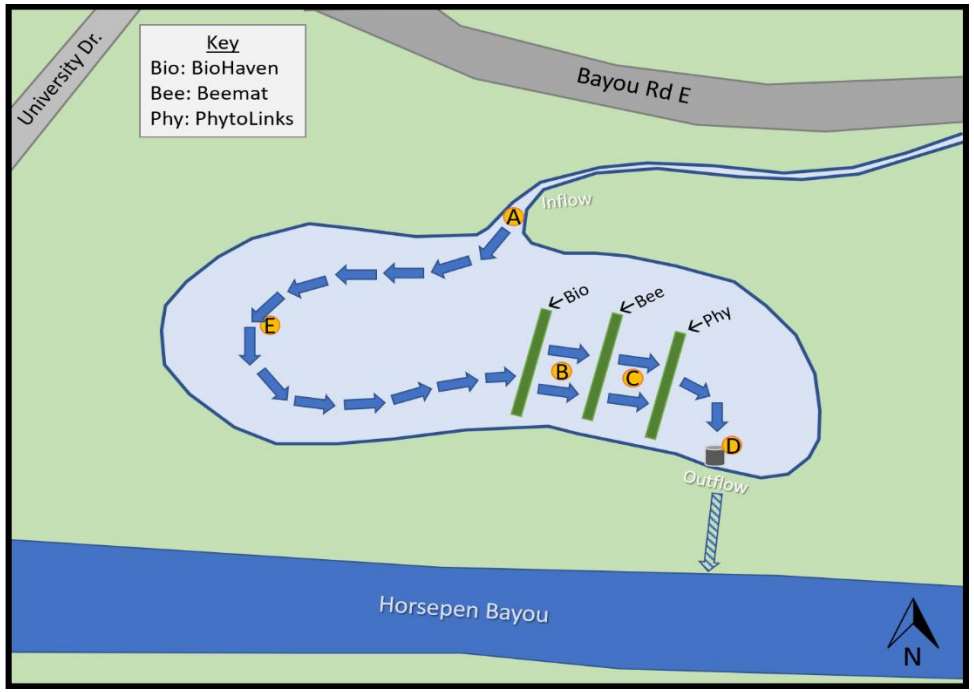
Methods continued -

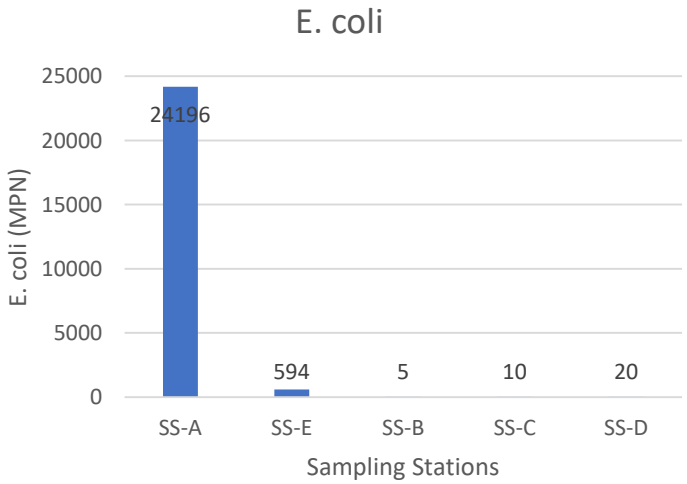
$$\% \text{ Removal Efficiency} = \frac{(\text{Influent conc.} - \text{Effluent conc.})}{\text{Influent concentration}} \times 100$$

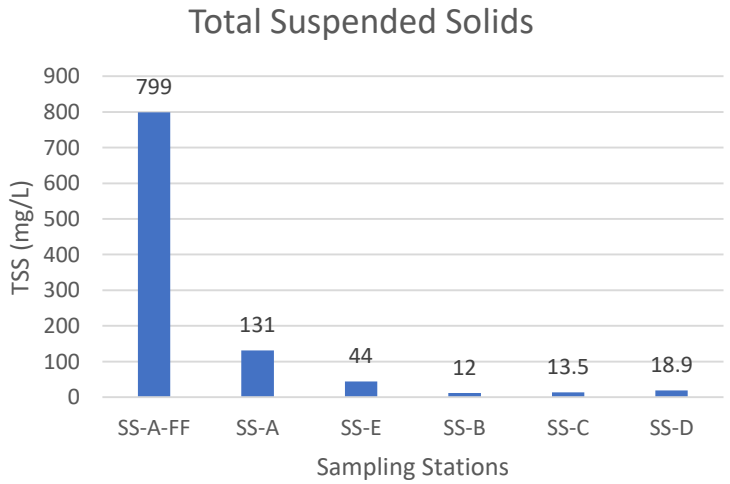


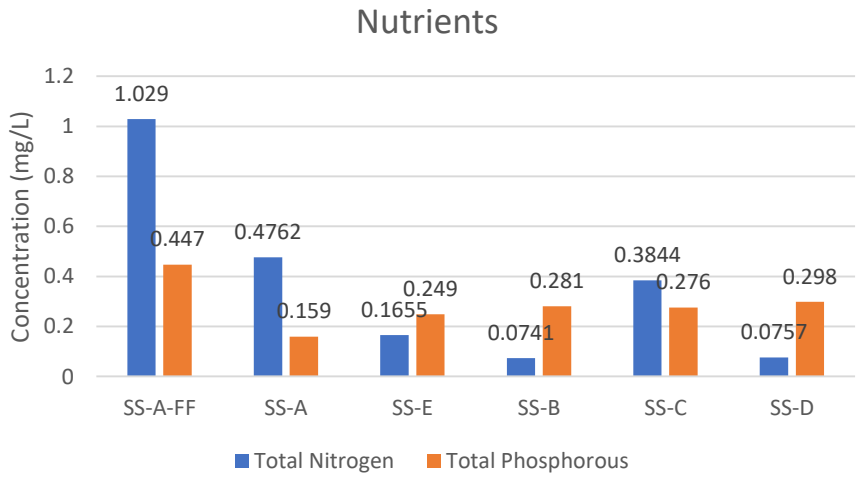
Rain Event – 6/3/21



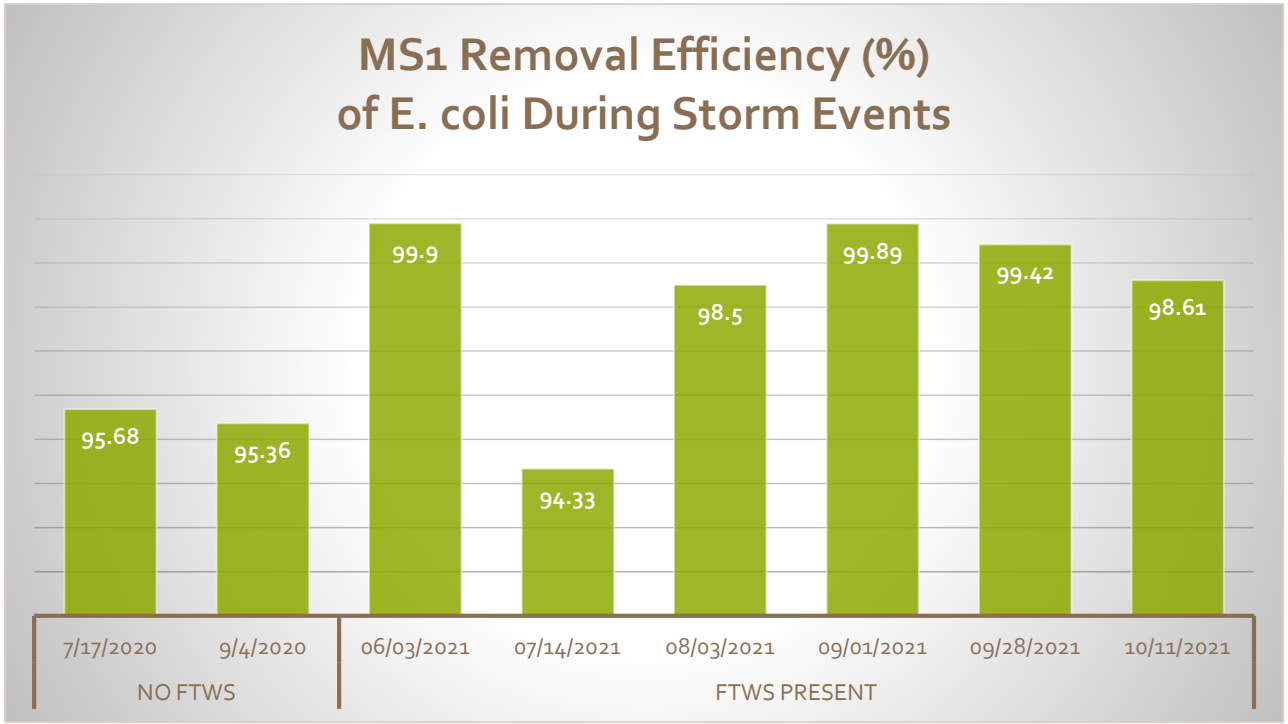


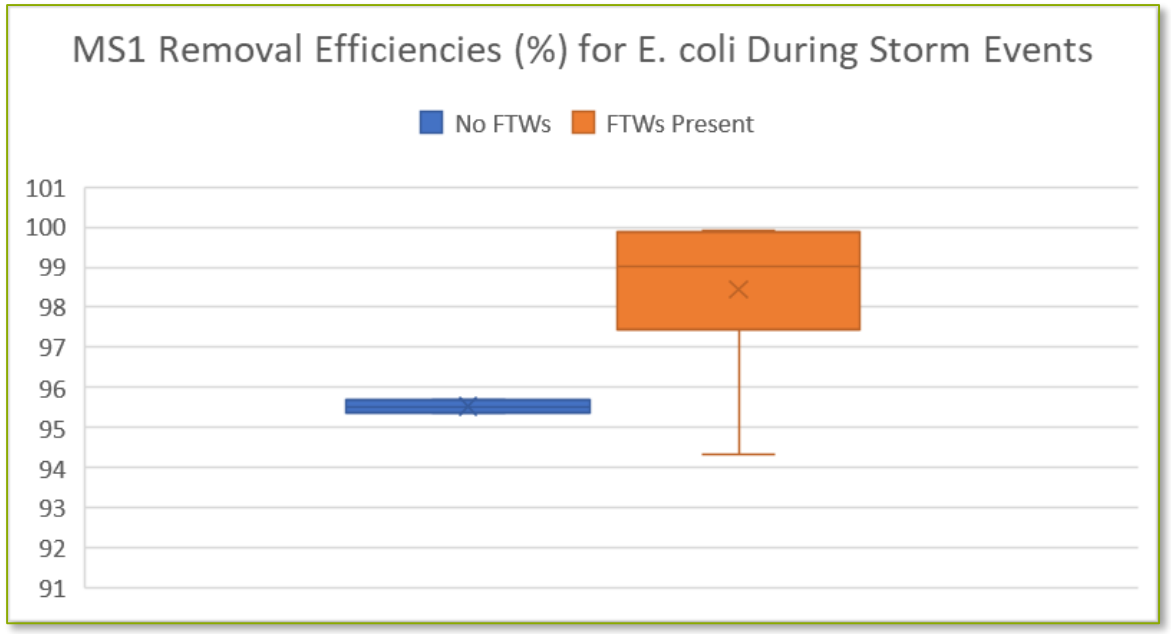






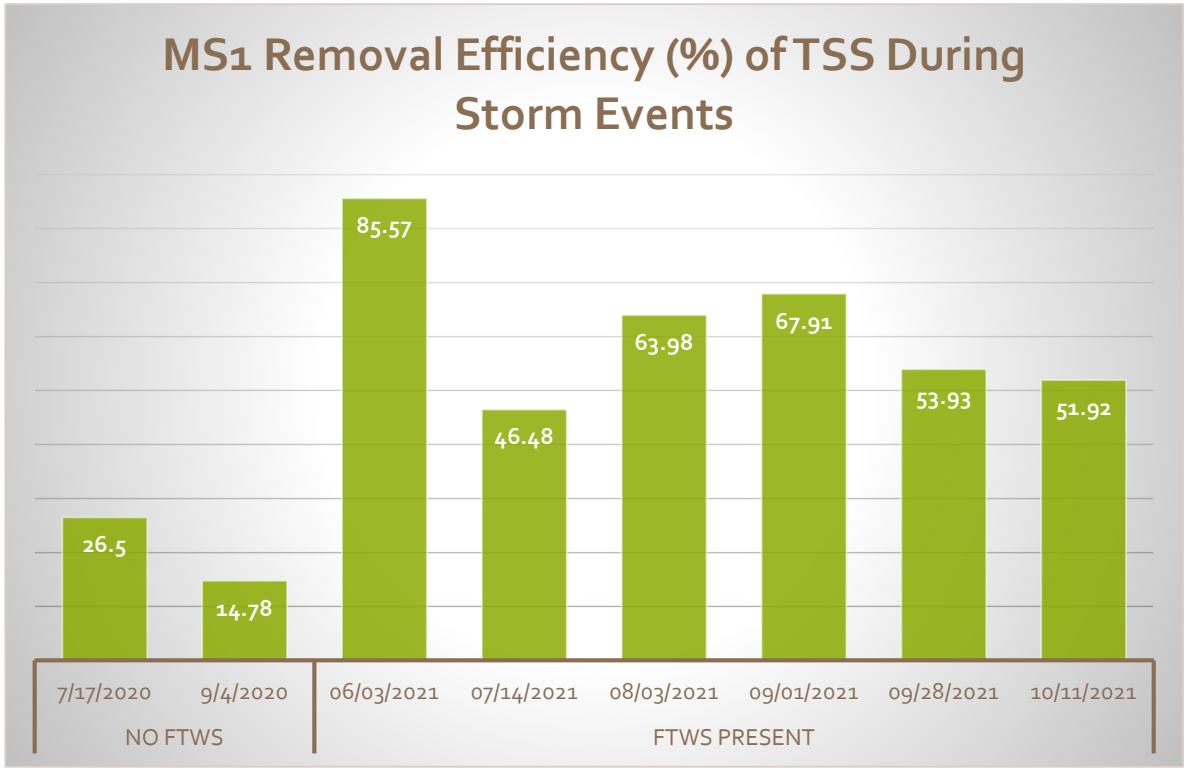
Water Quality – *E.coli*

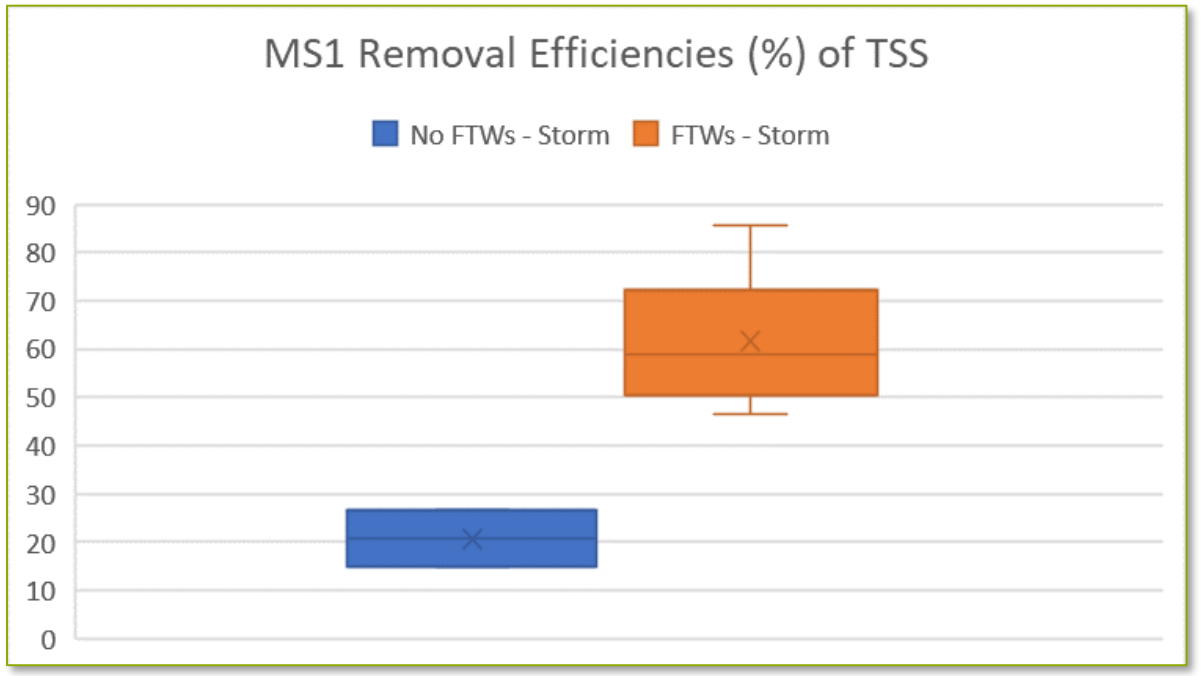




p=0.0204, t-test

Water Quality - TSS





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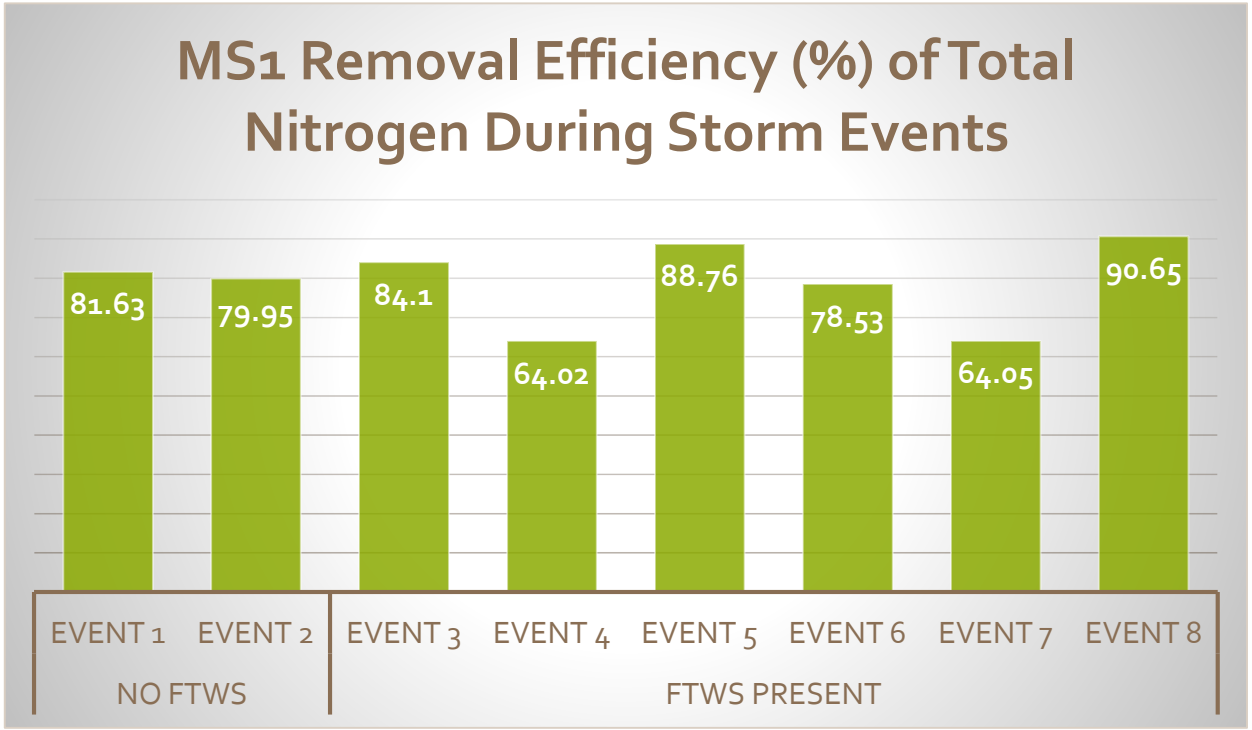
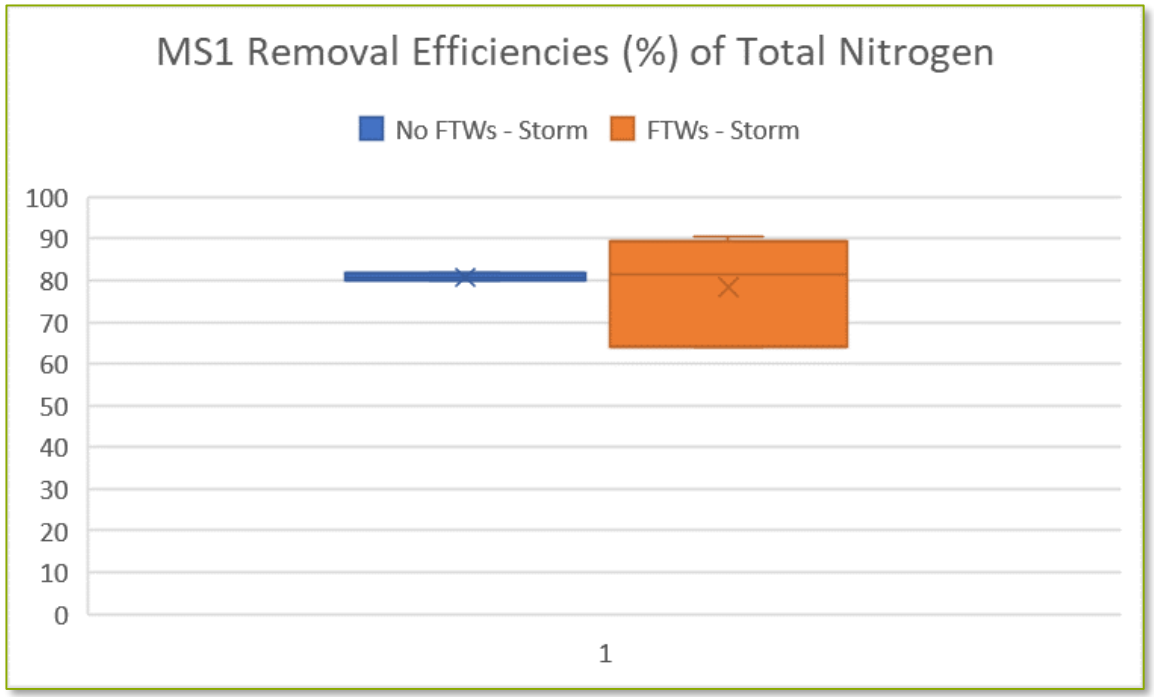
Water Quality – Total Nitrogen





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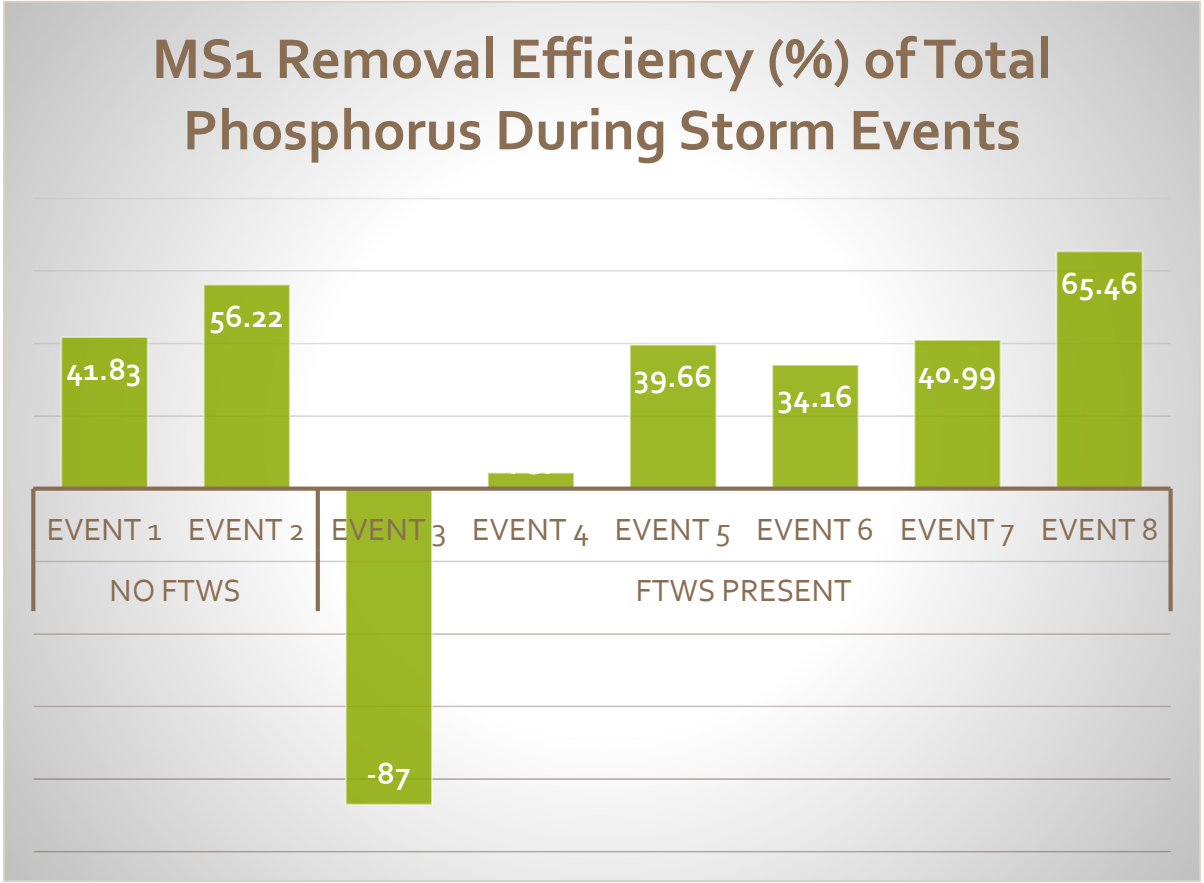
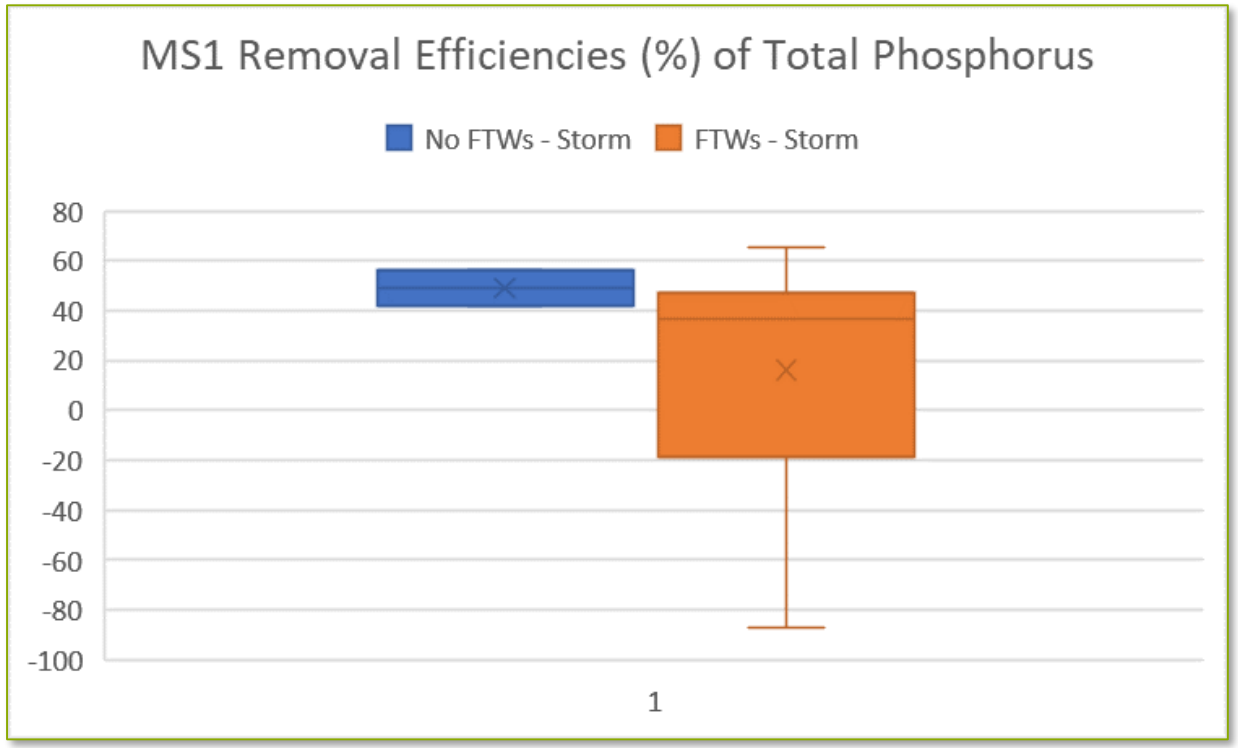
Water Quality – Total Phosphorus





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Mat Differences

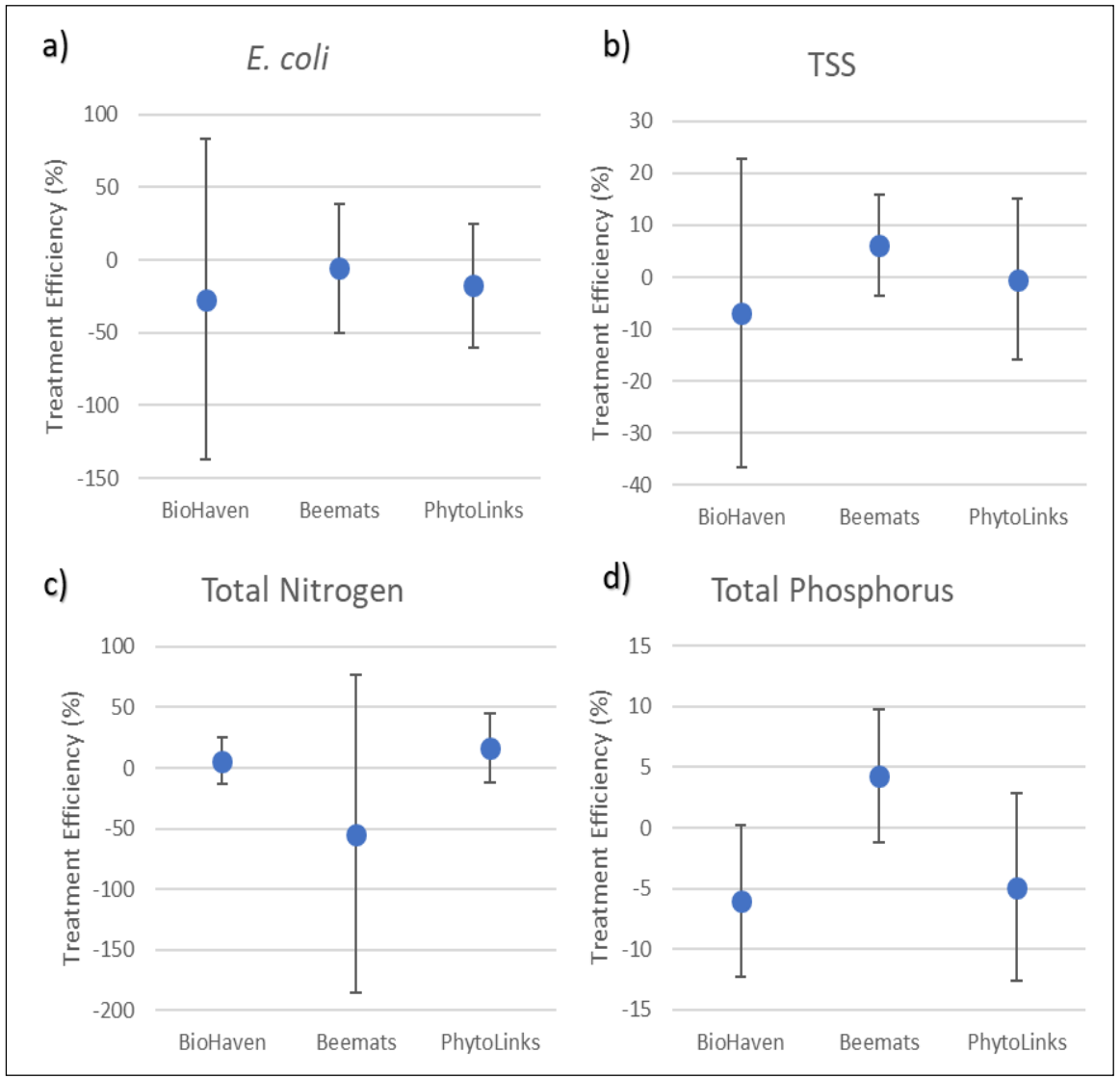


Image courtesy of EIH

Mat Differences

Images courtesy of EIH

Vegetation Composition

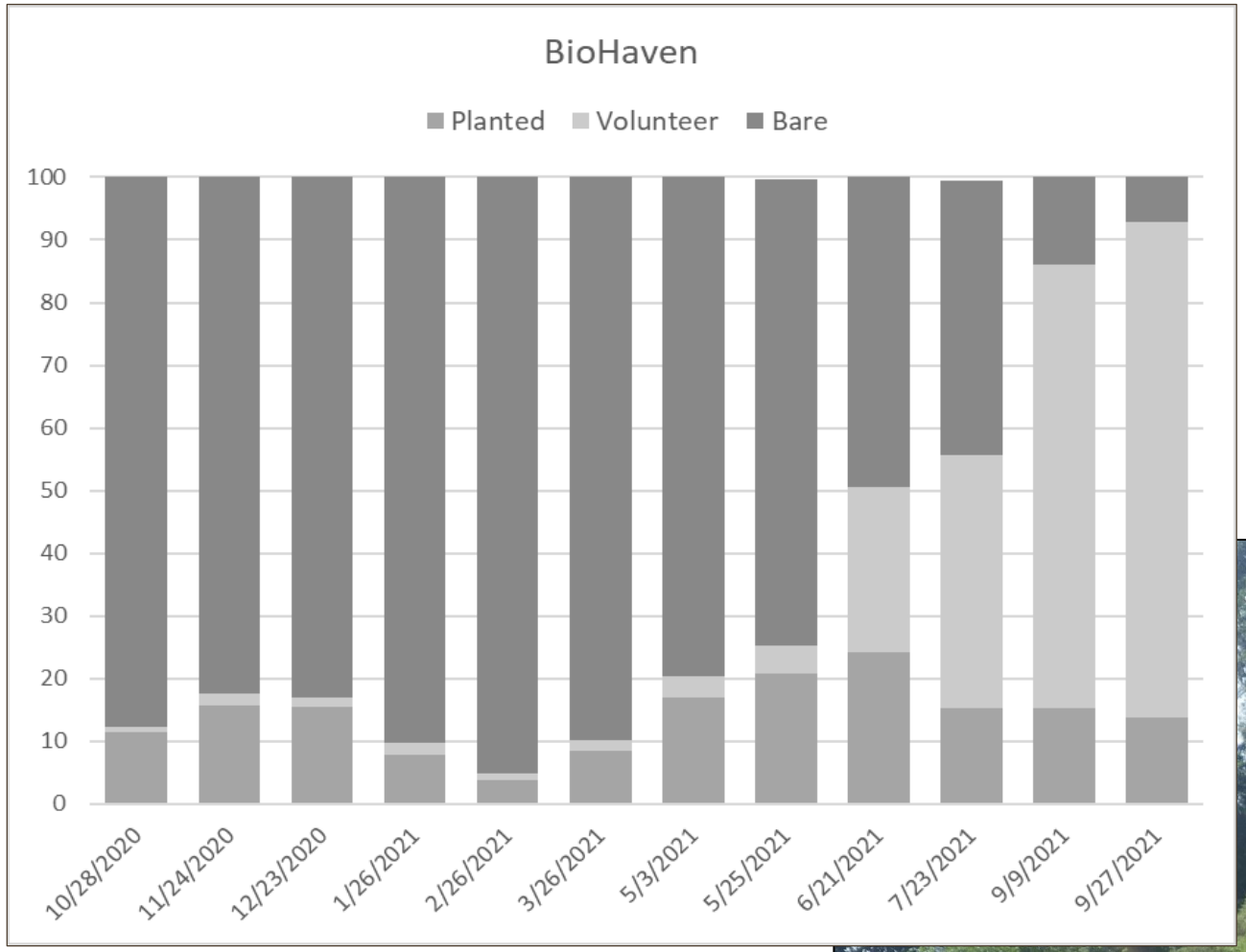
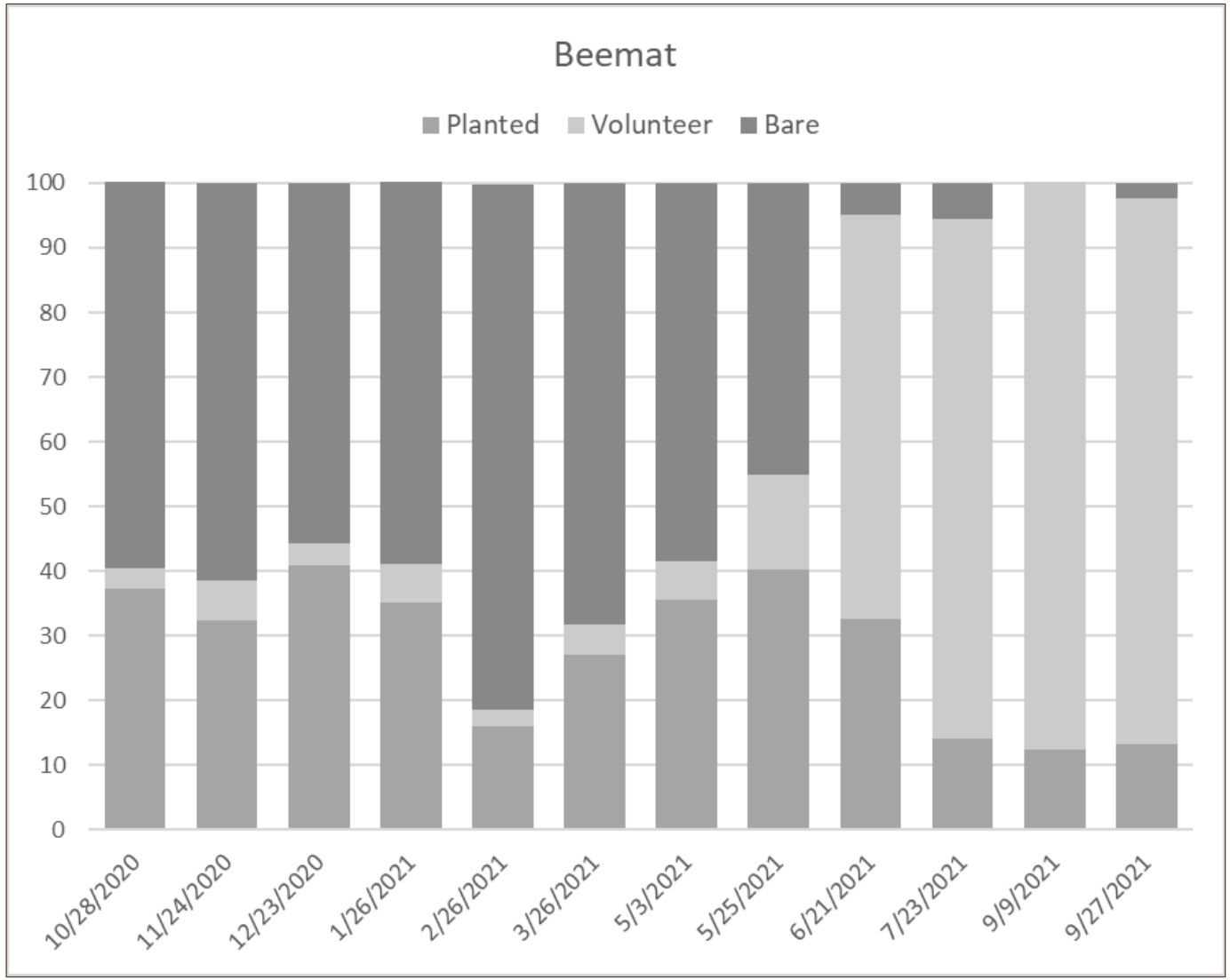


Photo of BioHavens captured 9/27/21

Image courtesy of EIH

Photo of Beemats captured 9/27/21

Vegetation Composition



Images courtesy of EIH

Vegetation Composition

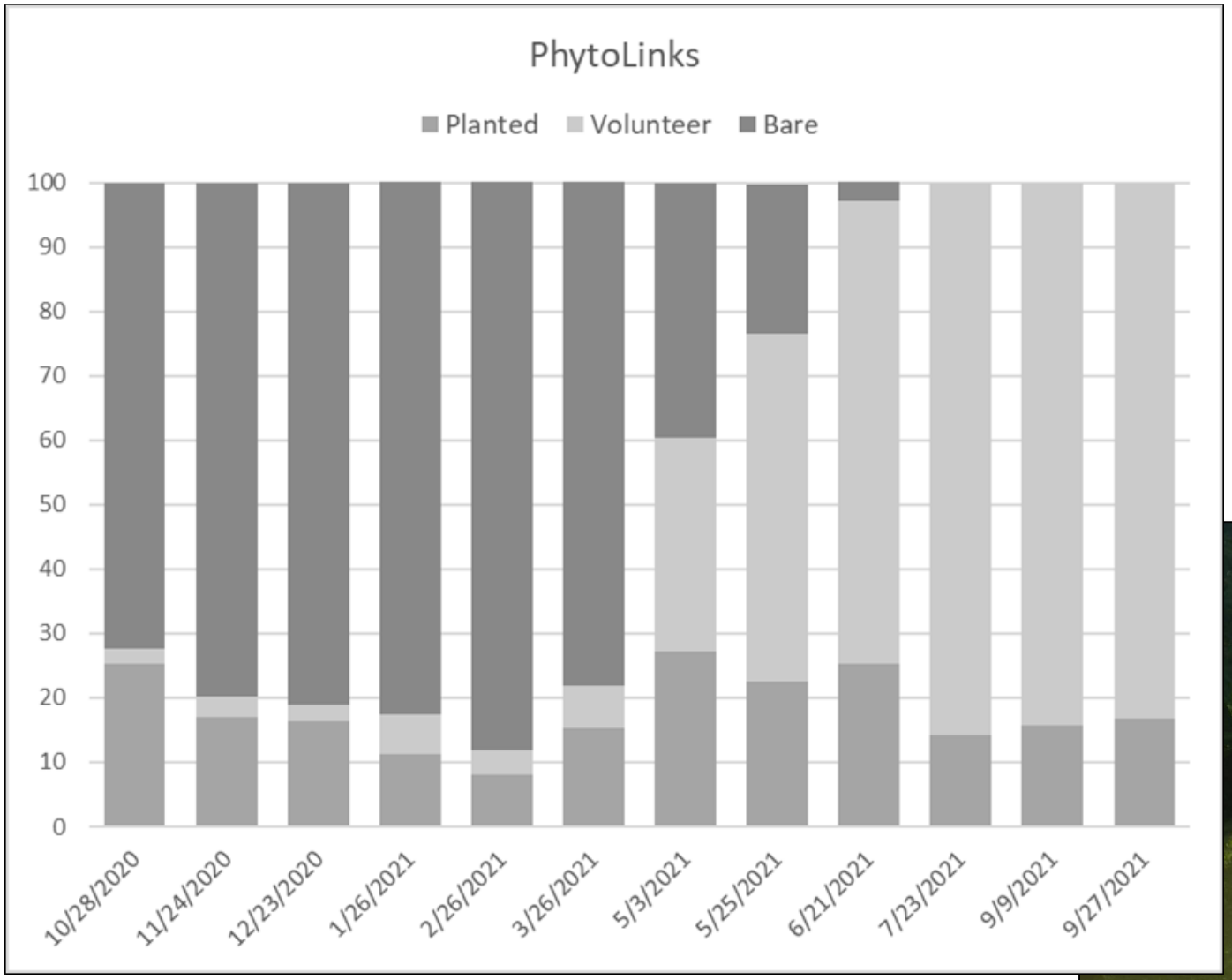


Photo of PhytoLinks captured 9/27/21

Image courtesy of EIH

Wildlife Sightings


Banded sphinx caterpillar on BioHaven


Great egret with sunfish on PhytoLinks

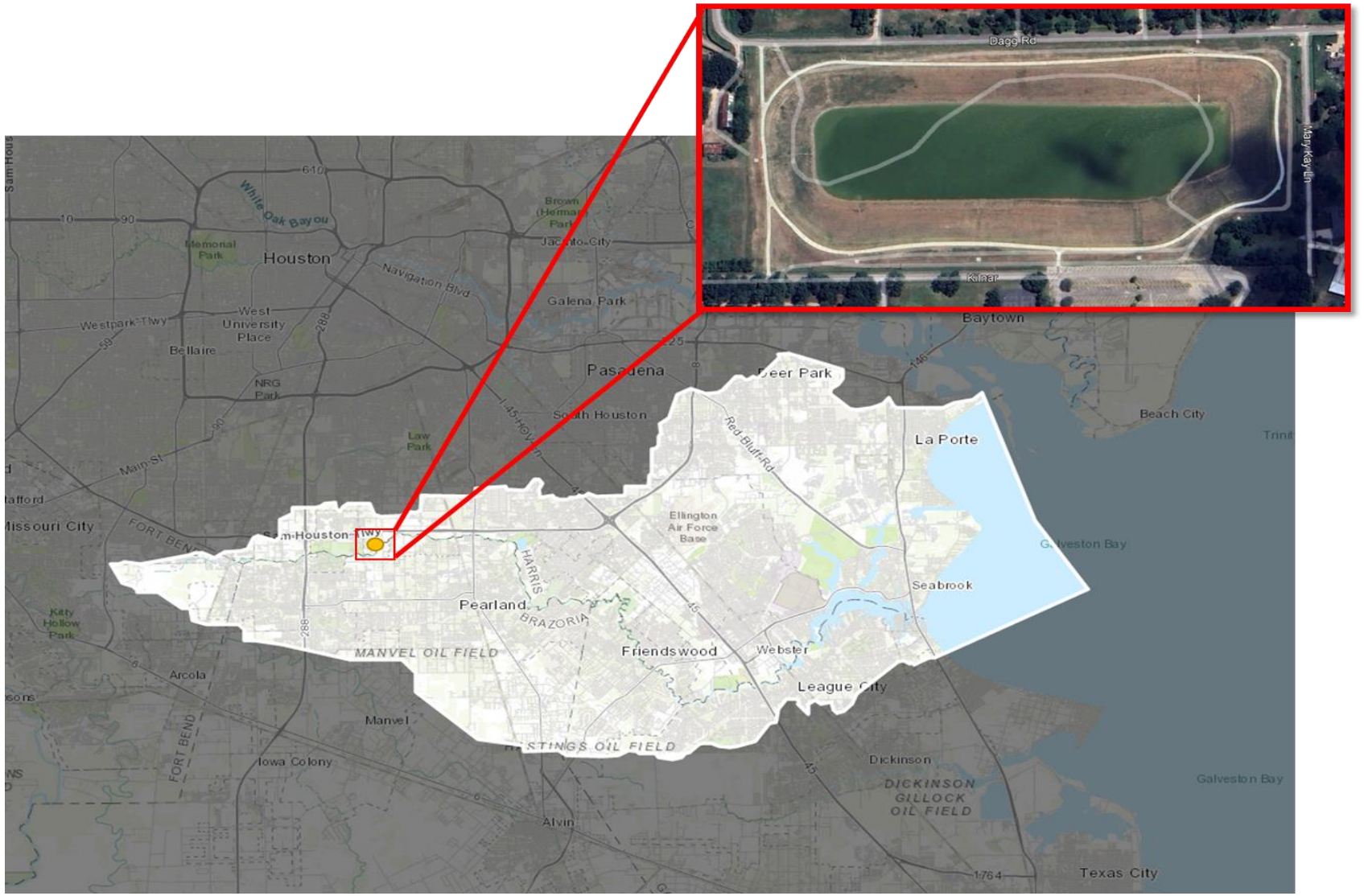
4 juvenile alligators on BeeMats

Lessons Learned

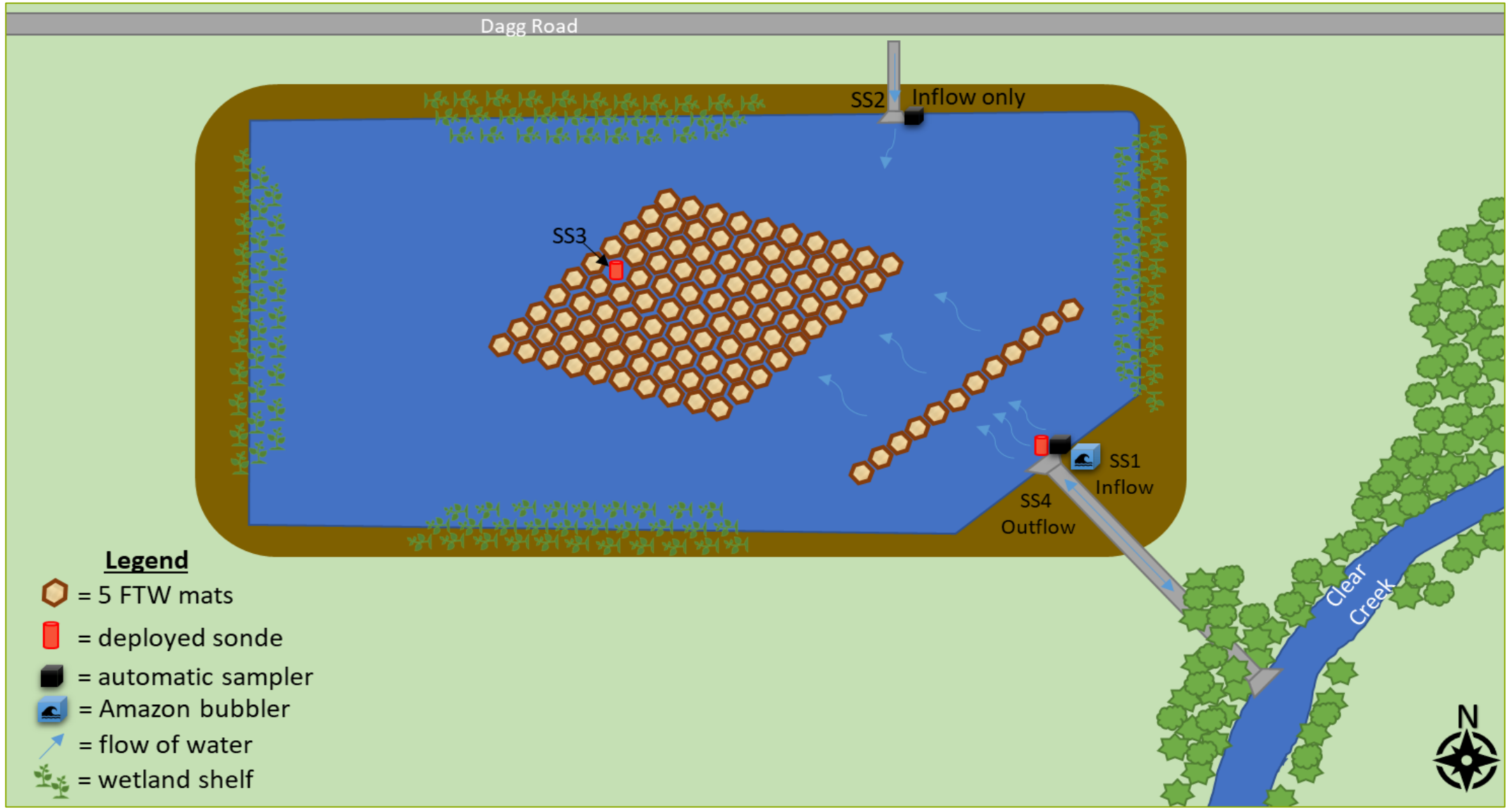
- More sampling events needed
- Higher percent cover of FTWs in relation to pond surface area
- Removal of plants before winter senescence is recommended
  - Would require re-planting each season
- Source of plants and seed bank
- Vegetation on banks of ponds may interfere
- Protection for plants during establishment period needed

Image courtesy of EIH

Phase 2: Large-scale field trial in Pearland, TX



Lawson Basin Layout and Preliminary Treatment System Design



Questions?

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