



TEXAS A&M UNIVERSITY
GALVESTON CAMPUS®

Coastal Groundwater Dynamics in Galveston Bay

*Dini Adyasari
Adelide Rianda*

State of the Bay Symposium 2026

Research Topics

- Groundwater-surface water interaction
- Private well water quality

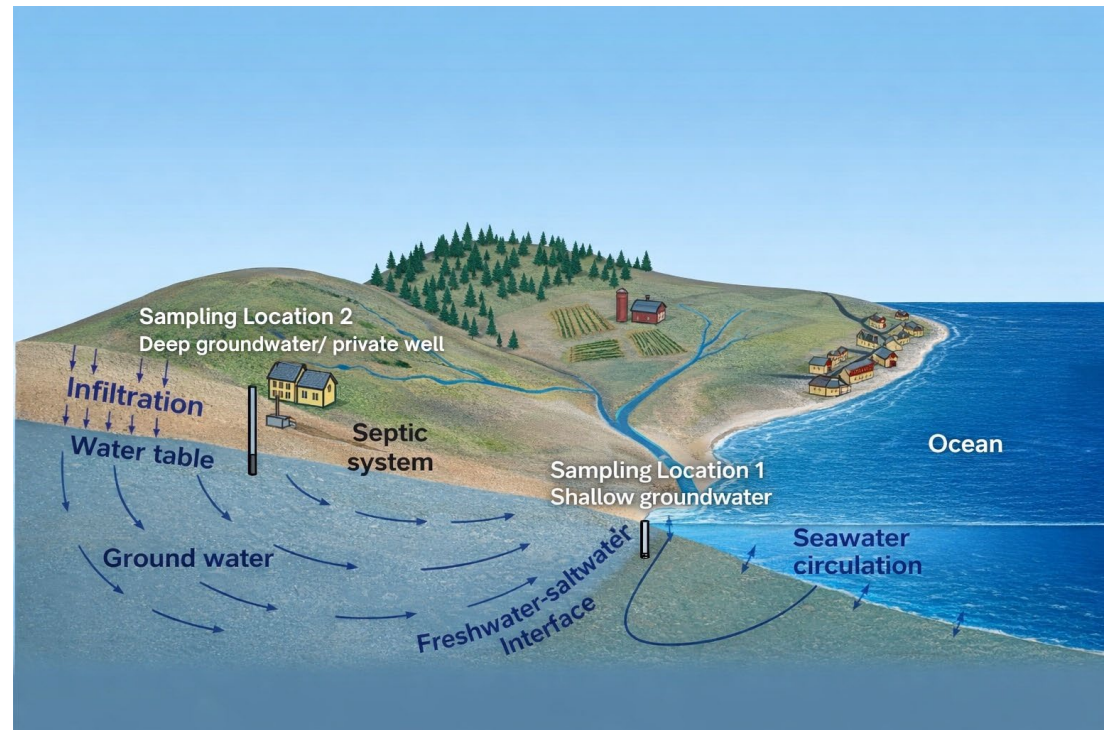


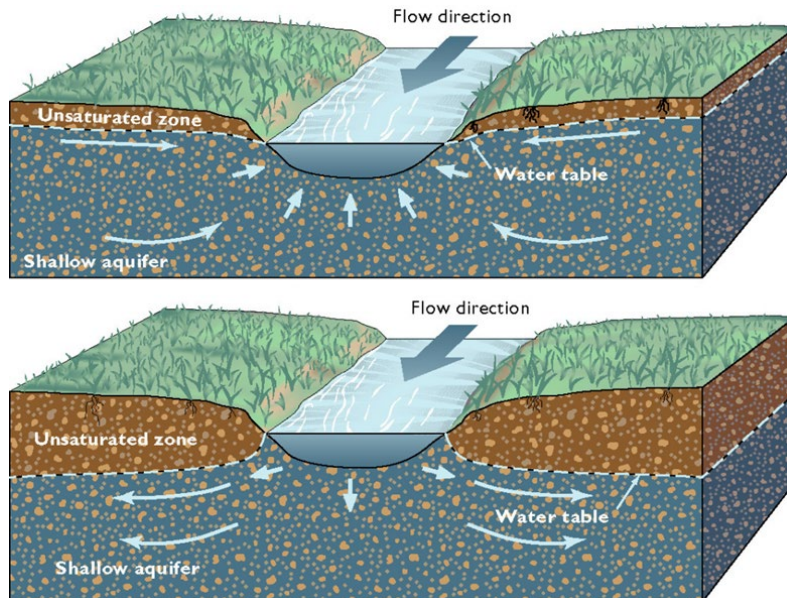
Figure adapted from WHOI



TEXAS A&M UNIVERSITY
GALVESTON CAMPUS®

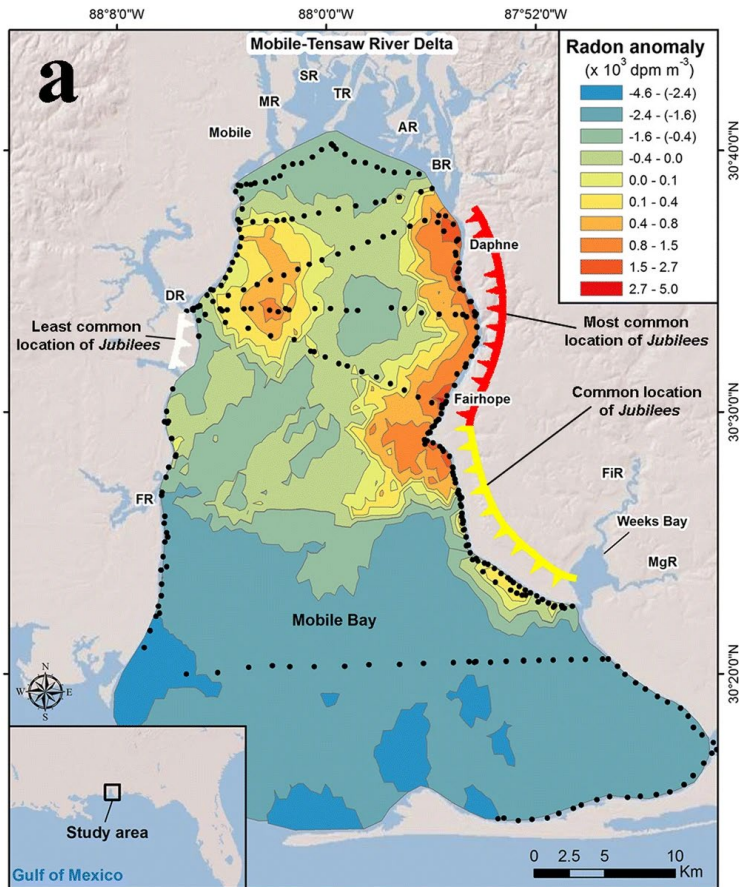
Groundwater-surface water interaction

Groundwater-surface water interaction



- Where are the groundwater discharge hotspots in Galveston Bay?
- Does groundwater act as a pathway for contaminants to surface waters?

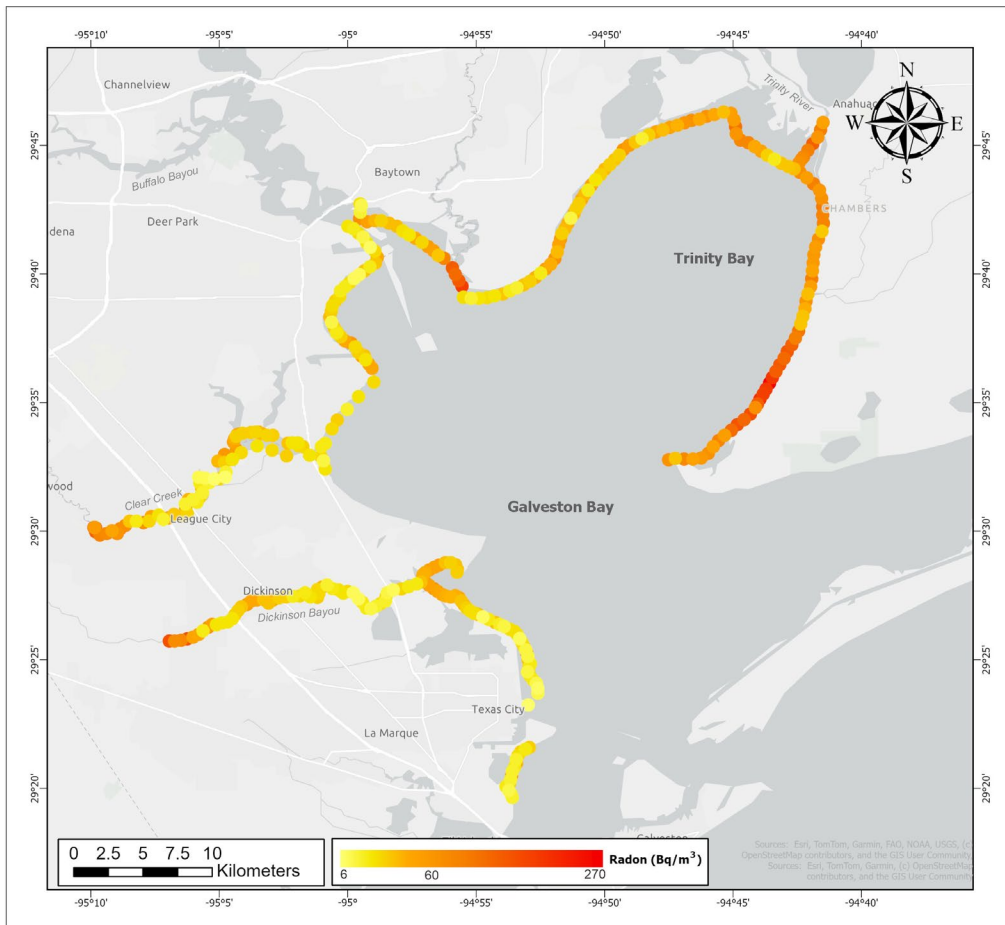
Groundwater-surface water interaction



Case study from Mobile Bay, AL:
Elevated groundwater discharge
(red) is spatially associated with
bottom-water hypoxia.

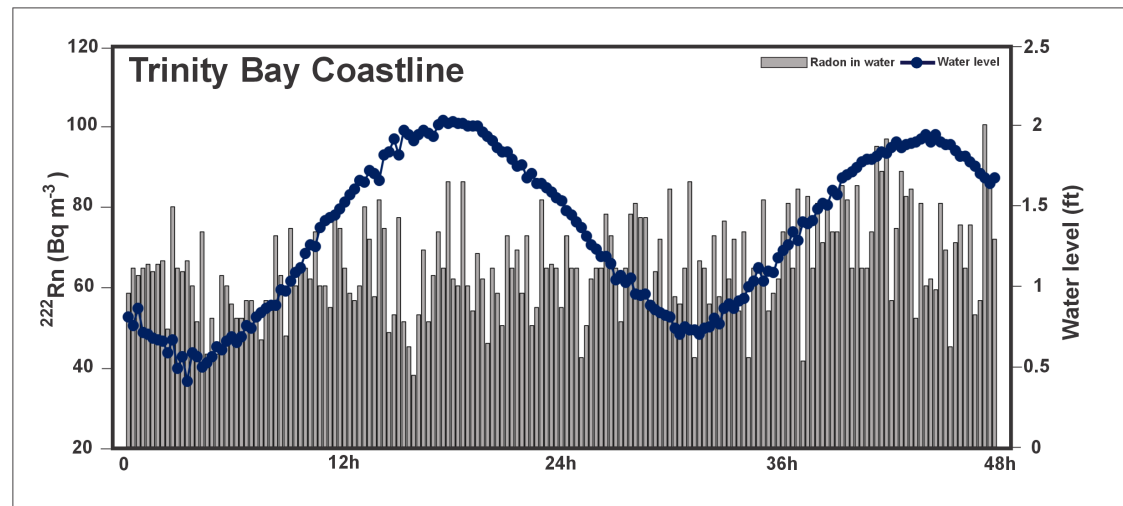
Source: Montiel et al., 2018. DOI:
<https://doi.org/10.1007/s12237-018-0485-5>

Groundwater-surface water interaction



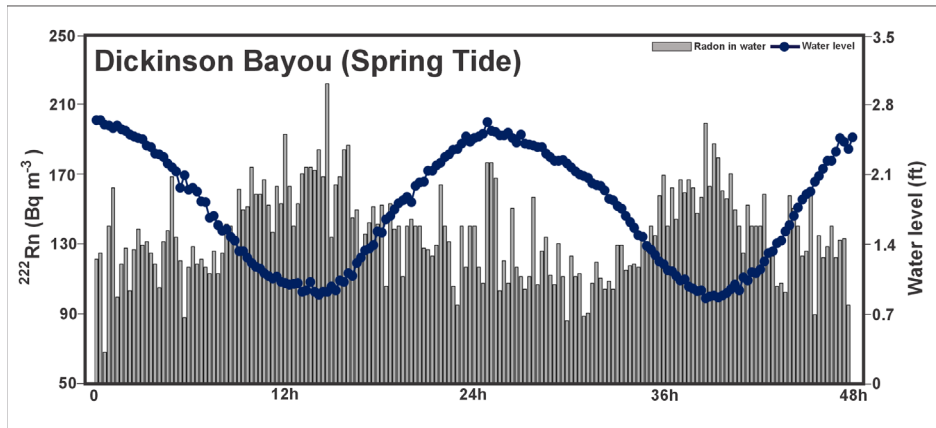
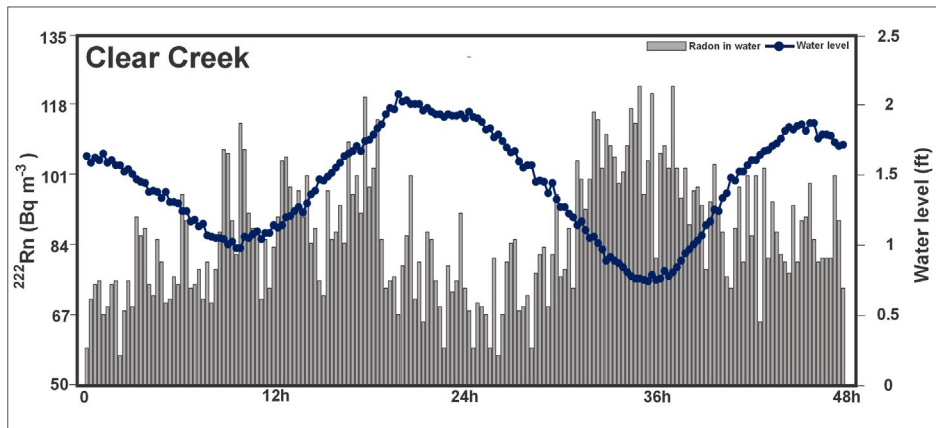
Higher groundwater discharge occurs upstream of tidal streams (Clear Creek and Dickinson Bayou), downstream of Cedar Bayou, and along Trinity Bay shoreline.

Groundwater-surface water interaction



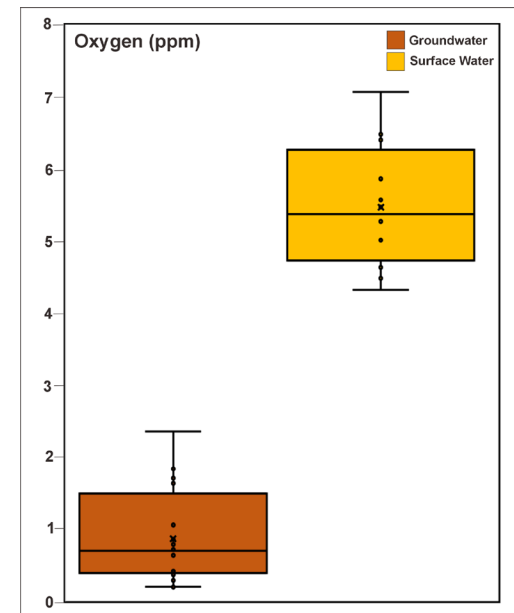
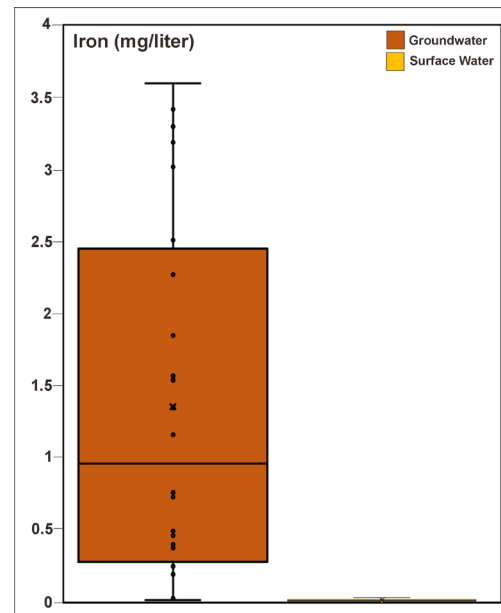
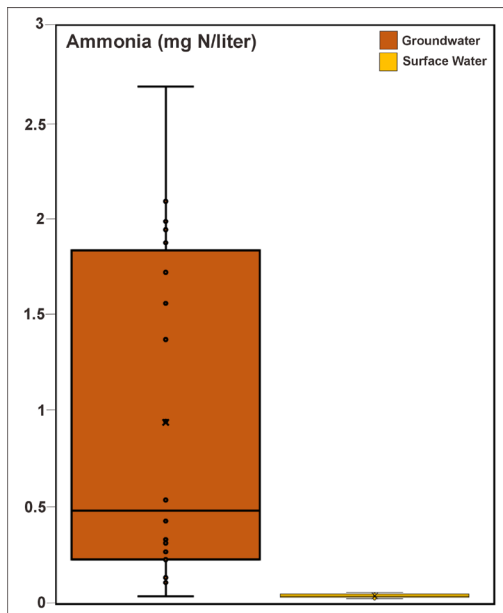
Groundwater discharge in Trinity Bay shoreline remains relatively stable across the tidal cycle due to (1) enhanced infiltration and (2) substantial subsurface storage.

Groundwater-surface water interaction



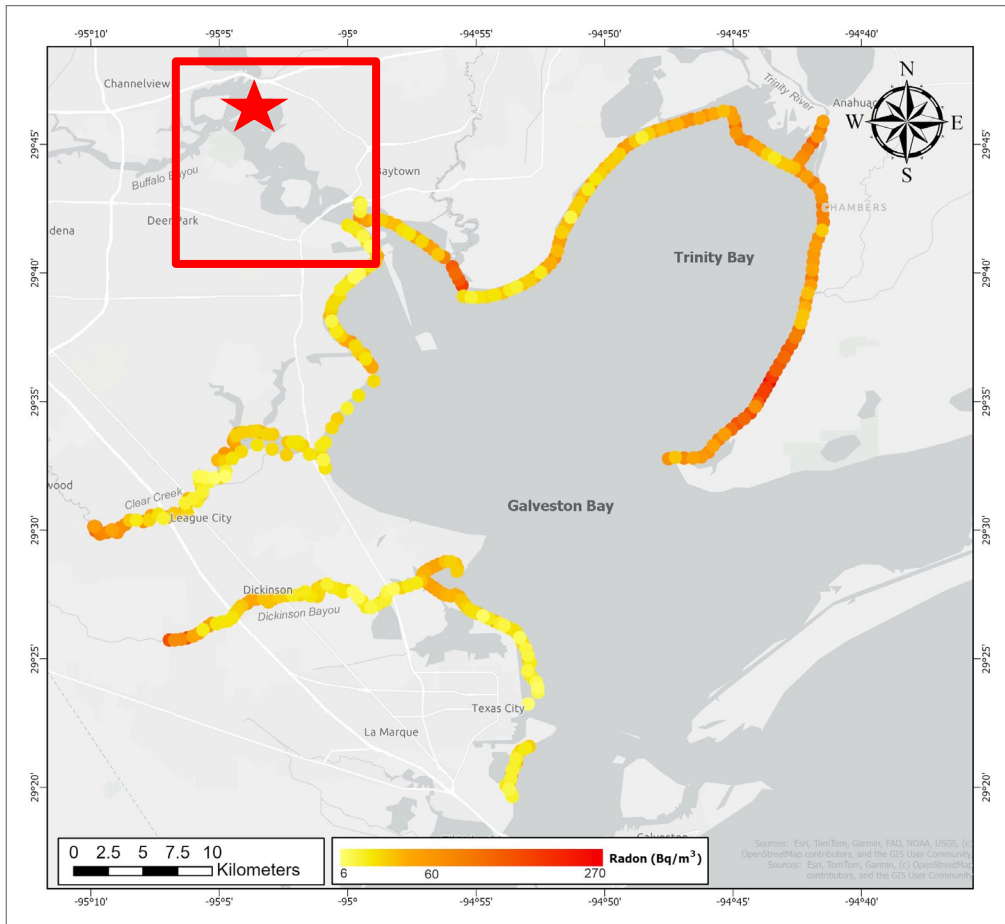
Higher groundwater discharge (radon) occurs during low tide due to a stronger hydraulic gradient.

Shallow groundwater quality



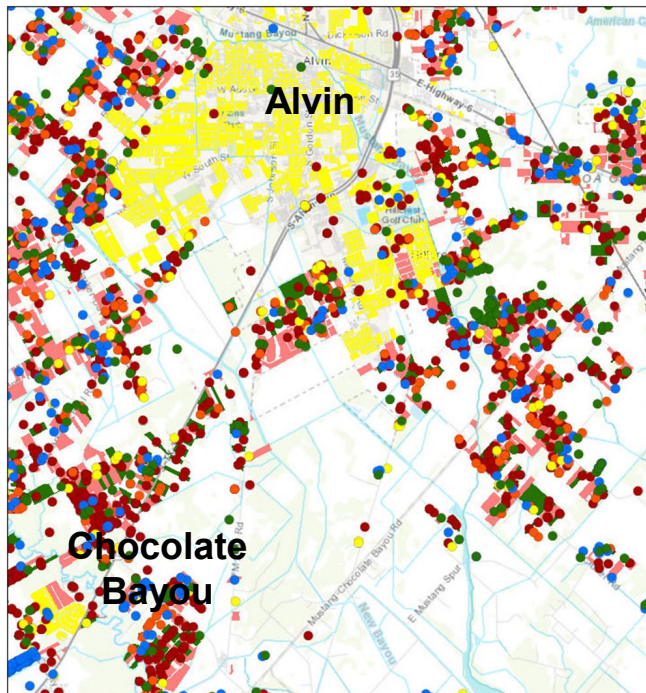
- Groundwater has much higher ammonium (24×) and iron (130×) than bay water.
- Groundwater discharge therefore delivers anoxic, ammonia- and iron-rich water to the bay.
- Is it also a pathway for fecal bacteria? Or other contaminants?

Current and future research

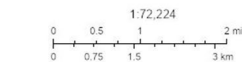


- Groundwater-surface water interaction in San Jacinto River (San Jacinto River Superfund site)
- Nutrients, metals, organic contaminants (PCB, PAH, PFAS), bacteria

Current and future research



15/10/2024, 14:01:52



Houston-Galveston Area Council, City of Alvin, Brazoria County, Texas Parks & Wildlife, Esri, HERE, Garmin, INCREMENT P, USGS, MET/NASA, NSA, EPA, USGS

City of Alvin, Brazoria County, Texas Parks & Wildlife, Esri, HERE, Garmin, INCREMENT P, USGS, MET/NASA, NSA, EPA, USGS | Houston-Galveston Area Council | Web AppBuilder for ArcGIS

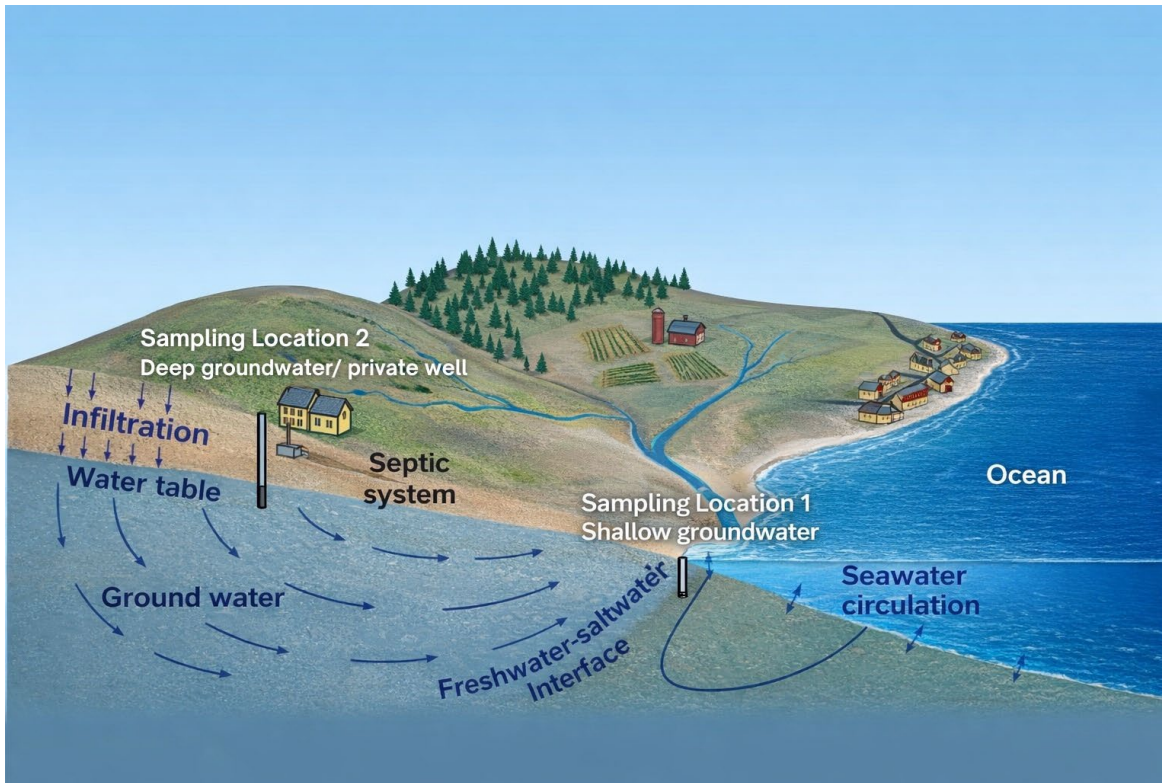
- Tracing the sources of fecal contamination in Chocolate Bayou



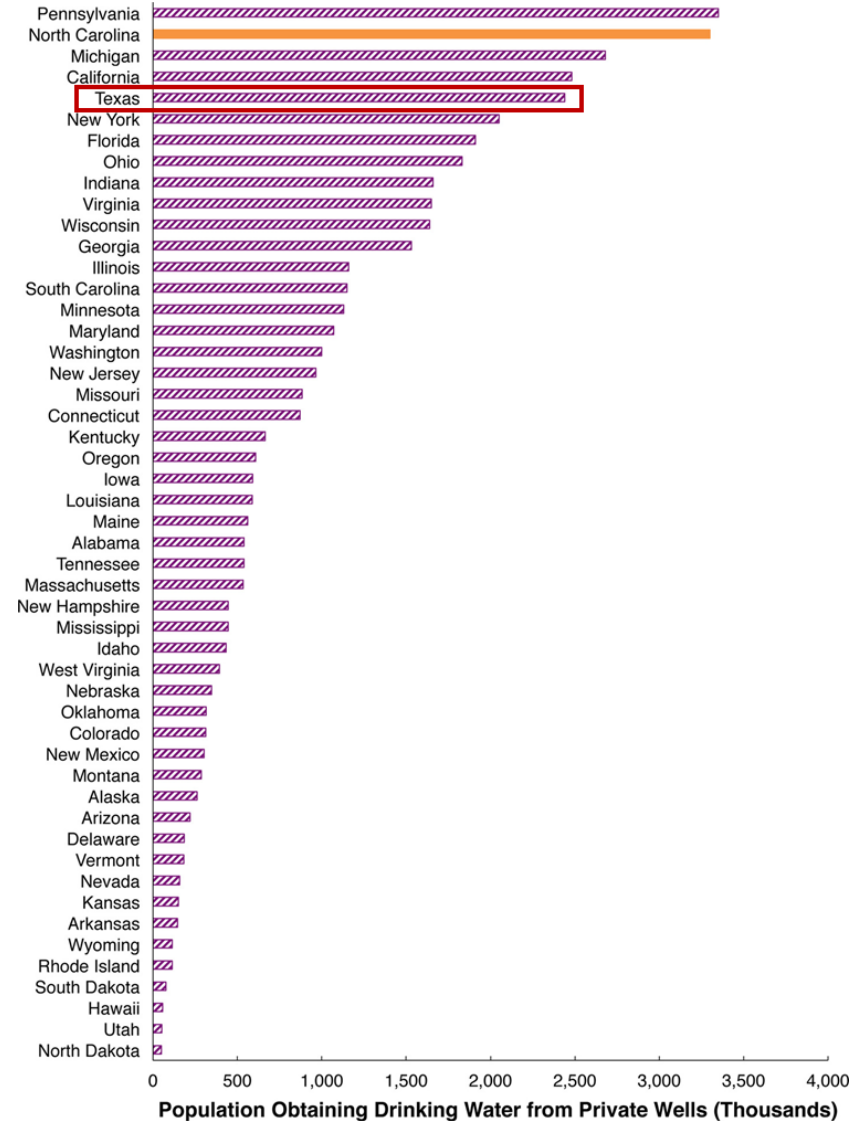
TEXAS A&M UNIVERSITY
GALVESTON CAMPUS®

Private Well Water Quality

Shallow vs deep groundwater



Background



Source: Gibson and Pieper, 2017. DOI:
<https://doi.org/10.1289/EHP890>



ATM Texas A&M University
College of Marine Sciences & Maritime Studies
Department of Marine and Coastal Environmental Science

FREE WELL WATER TESTING AND COMMUNITY SURVEY

Texas A&M University at Galveston is offering free water quality testing.
We are currently recruiting private well owners to participate.

About this study

Purpose : This research aims to evaluate private well water quality and household use to address water issues and protect future drinking water resources.
Eligibility Criteria & Location : Properties privately owned and equipped with a water well within Galveston, Harris, Calhoun, Jackson, or Matagorda County, Texas; participants must be 18 years of age or older.
Time Commitment : Total estimated time: 1-1.5 hours (Well sampling: ~30-60 minutes; Questionnaire: ~10-12 minutes)
Contact Person : Dr. Dini Adyasari, Department of Marine and Coastal Environmental Science, Texas A&M University, Galveston, TX 77573 (Scan QR on the other side for details)

What Will Be Tested?
We will analyse your well water for:

**Regulated Parameters
(EPA Primary & Secondary Standards)**
Fecal bacteria (E. Coli & Total Coliform)
Nutrients (nitrate, ammonia, phosphate)
Heavy metals
Inorganic ions/salts
Organic chemicals
PFAS ("Forever Chemicals")

**Contaminants of Concern
(Unregulated or Emerging)**
Microplastics
Radon

More information on the other side

tamughydrogeologylab@gmail.com [f @TAMUGhydrogeologylab](https://www.facebook.com/TAMUGhydrogeologylab)

IRB Number: _____ IRB Approval Date: _____

HOWDY!

Texas A&M University at Galveston is offering FREE private well water testing for our community. Curious about what's in your water? We'd love to help you find out. Interested? Just scan the QR code to sign up! Once you register, we will reach out to schedule the sampling. Participants will receive a personalized well water quality report.



bit.ly/TAMUGPrivateWellSurvey

Have questions?
Reach out anytime!
Email : tamughydrogeologylab@gmail.com
Facebook: TAMUG Hydrogeology Lab



- EPA Primary Drinking Water Standard
- EPA Secondary Drinking Water Standard
- Emerging contaminants (PFAS and microplastics)

Preliminary results (n = 35)

Parameters	EPA Drinking Water	Exceedance Rate
Total coliform	Primary	57%
Iron	Secondary	6%
Chloride	Secondary	34%
Sulfate	Secondary	3%
TDS	Secondary	57%
Radon	N/A - WHO	7%

E. Coli is 0

- Naturally mineralized groundwater
- Saltwater intrusion?
- Well leakage or plumbing problem?

Preliminary results (n = 35)

Within acceptable limits:

Heavy metals

Fluoride

Nitrate + Nitrite

pH

Pending analysis:

PFOA & PFOS (PFAS)

PCBs

PAHs

Microplastics



Current and Future Research



Texas A&M University
College of Marine Sciences & Maritime Studies
Department of Marine and Coastal Environmental Science

FREE WELL WATER TESTING & COMMUNITY SURVEY

Texas A&M University at Galveston is offering free water quality testing. We are currently recruiting private well owners to participate, and each will receive a personalized well water quality report.

About this study



Purpose

This research aims to evaluate private well water quality and household use to protect future drinking water resources.



Eligibility Criteria & Location

Properties privately owned and equipped with a water well within Galveston, Harris, Calhoun, Jackson, or Matagorda County, Texas; participants must be 18 years of age or older.



Time Commitment

Total estimated time: 1-1.5 hours
Well sampling: 30-60 minutes
Questionnaire: 10-12 minutes



Contact Person

Dr. Dini Adyasari
Department of Marine and Coastal Environmental Science
Texas A&M University, Galveston
TX 77573
Scan QR for details

What Will Be Tested?

We will analyse your well water for:

Regulated Parameters (EPA Primary & Secondary Standards)

- Fecal bacteria (*E. Coli* & Total Coliform)
- Nutrients (nitrate, ammonia, phosphate)
- Heavy metals
- Inorganic ions/salts
- Organic chemicals
- PFAS ("Forever Chemicals")



Contaminants of Concern (Unregulated or Emerging)

- Microplastics
- Radon



If you would like to participate, please contact us via:
Email: tamughydrogeologylab@gmail.com
Facebook message:
@TAMUGhydrogeologylab
or scan the QR code.



We will reach out to schedule the sampling and provide more information.

bit.ly/TAMUGPrivateWellsSurvey



TEXAS A&M
UNIVERSITY

GALVESTON CAMPUS®

Questions?

Application of MALDI-TOF Mass Spectrometry to detect the source of *Enterococcus* contamination of Mustang Bayou

Christopher Howard MS

&

Michael G. LaMontagne PhD

Department of Biology and Biotechnology



University
of Houston
Clear Lake



Public Health Concern

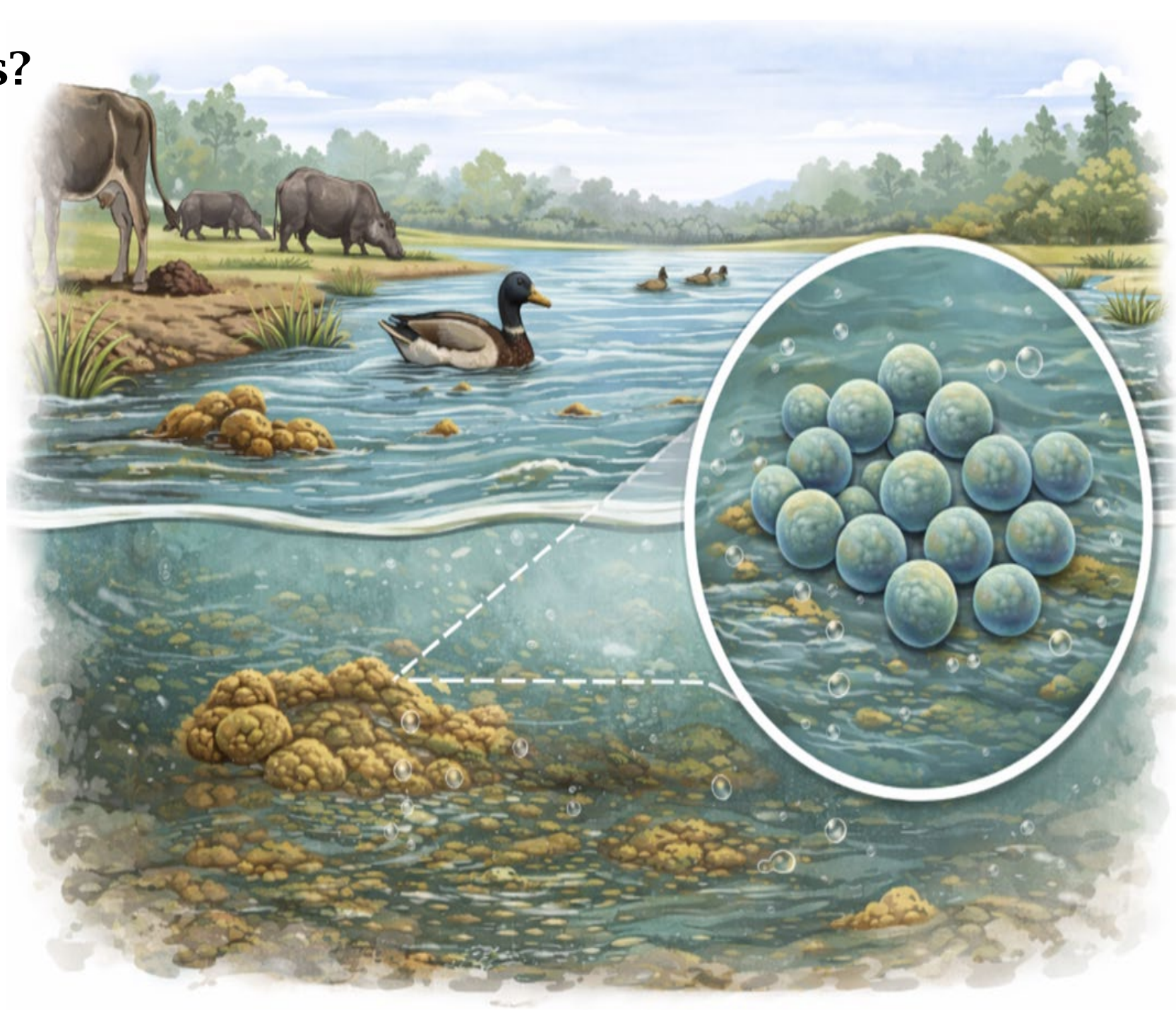
- Coastal tributaries are chronically impacted by fecal contamination.
- Aging onsite sewage facilities (OSSF) are common in Galveston Bay watersheds.
- Antibiotic resistance increases the public health concern.



(Holcomb & Stewart, 2020; Wade et al., 2006; Wade et al., 2010; Wade et al., 2022; DeFlorio-Barker et al., 2017; Ahmed et al., 2021; García-Aljaro, 2019; Harwood, 2014; Wu et al., 2020; Rechenburg et al., 2006; Sercu et al.; Sowah et al., 2017; Alarcon et al., 2025, EPA, 2000; EPA, 2002; Capps et al., 2020; Madamba, 2023; Sidhu et al., 2023; Howard, 2025; Schramm et al., 2022, Rochelle-Newall et al., 2015; Morrison et al., 2014; Morrison et al., 2017

Why *Enterococcus* matters?

- *Enterococcus* is the primary indicator for recreational water quality.
- Elevated levels are linked to increased illness risk
- Counts can persist and vary due to environmental process.
- Monitoring focuses on tidally influenced recreational waters
- Upstream oligohaline zones may be an underrepresented contamination sources.



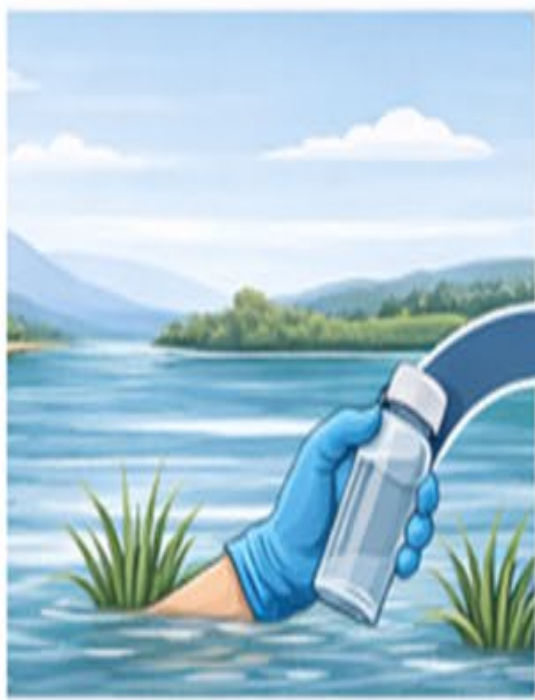
(USEPA, 2017; TCEQ, 2022; Wade et al, 2010; Rochelle-Newall et al., 2015; Morrison et al., 2014 Morrison et al, 2017)

Research questions

- Can strain level MALDI TOF MS resolve human associated *Enterococcus* signals?
- Does community level 16S rRNA sequencing data independently support human associated fecal contamination?

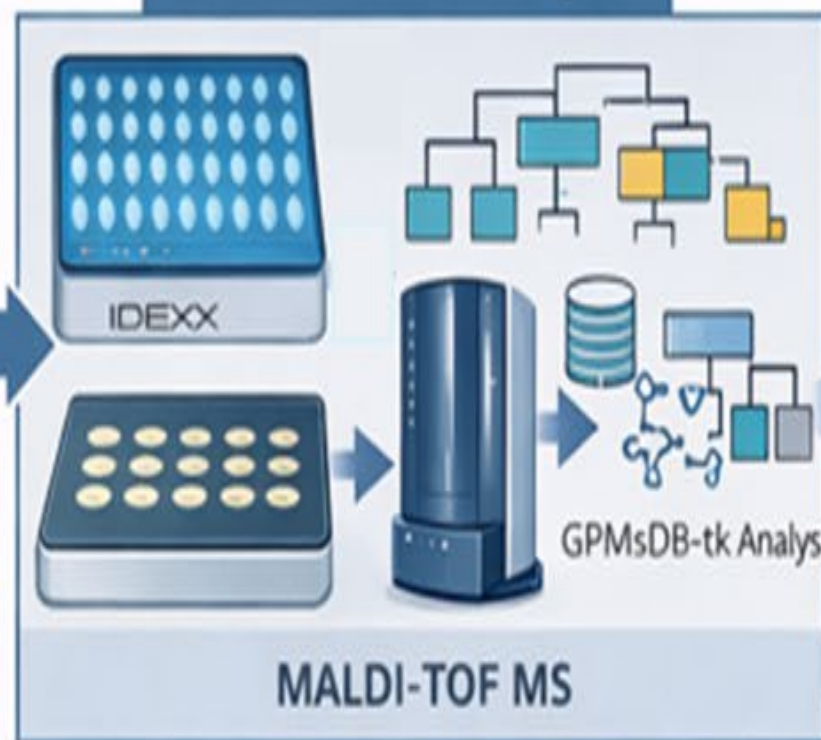


Aging OSSF Inputs



Surface Water Sampling

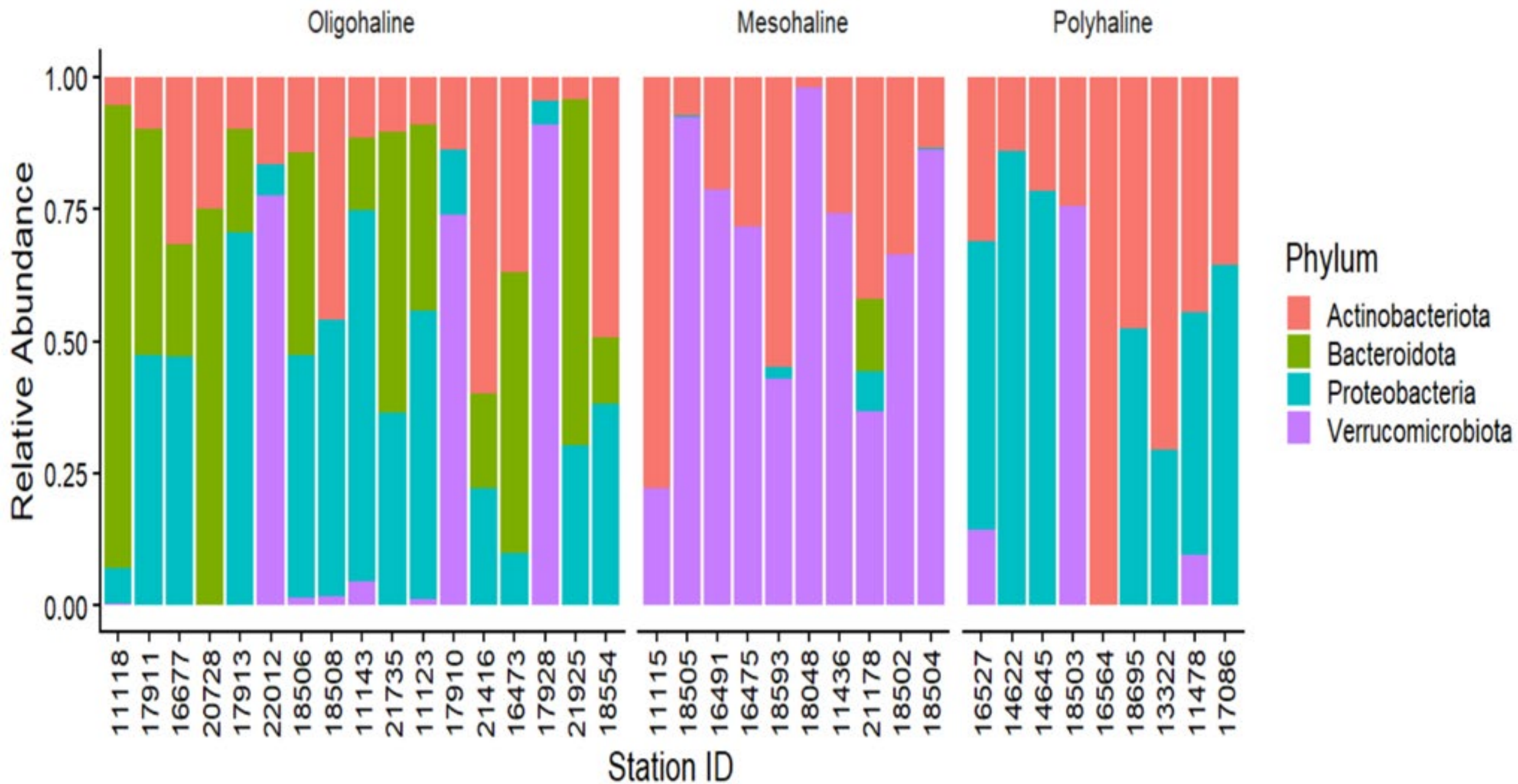
Isolate-Level Analysis

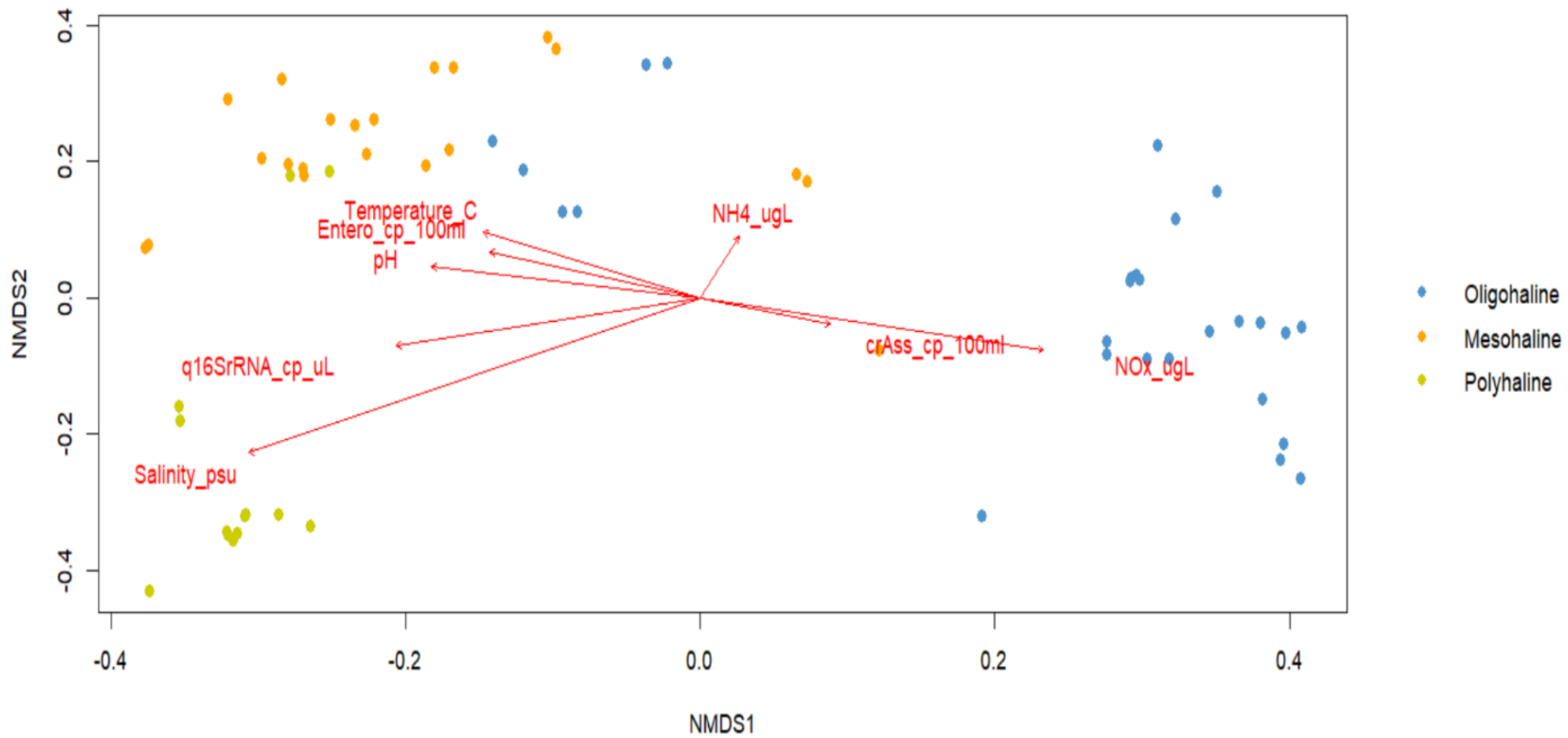


Human-Associated
Enterococcus
Contamination Detected

Community-Level Analysis





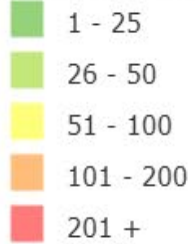


Dickinson Bayou-Frontal Gulf of Mexico Sub-watershed HUC ID:120402040200

Watershed Boundary Dataset HUC 12s - HU12

Permitted OSSFs Per SqMi

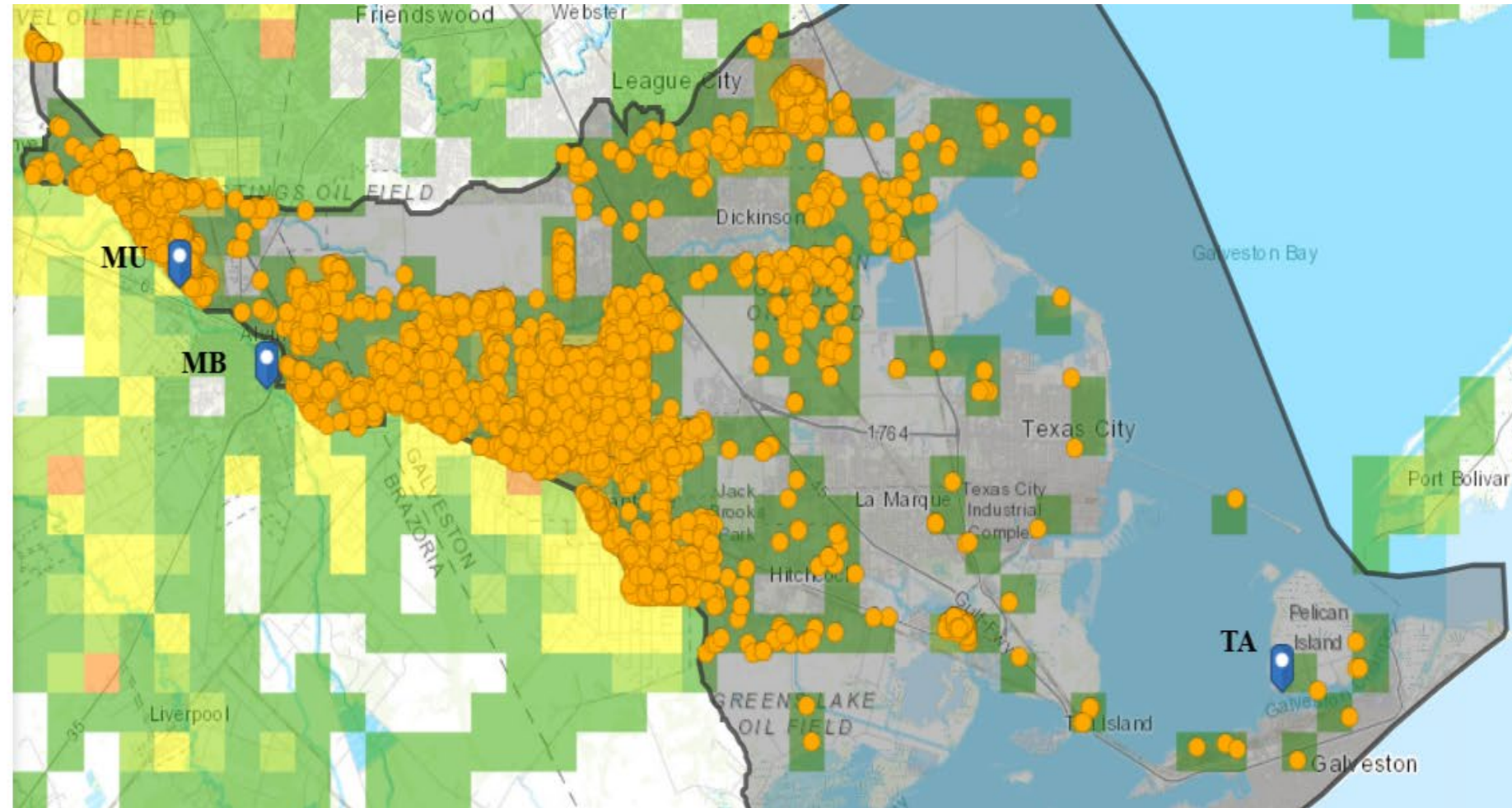
Permitted_OSSFs_Per_SqMi



Water Features

Major Streams

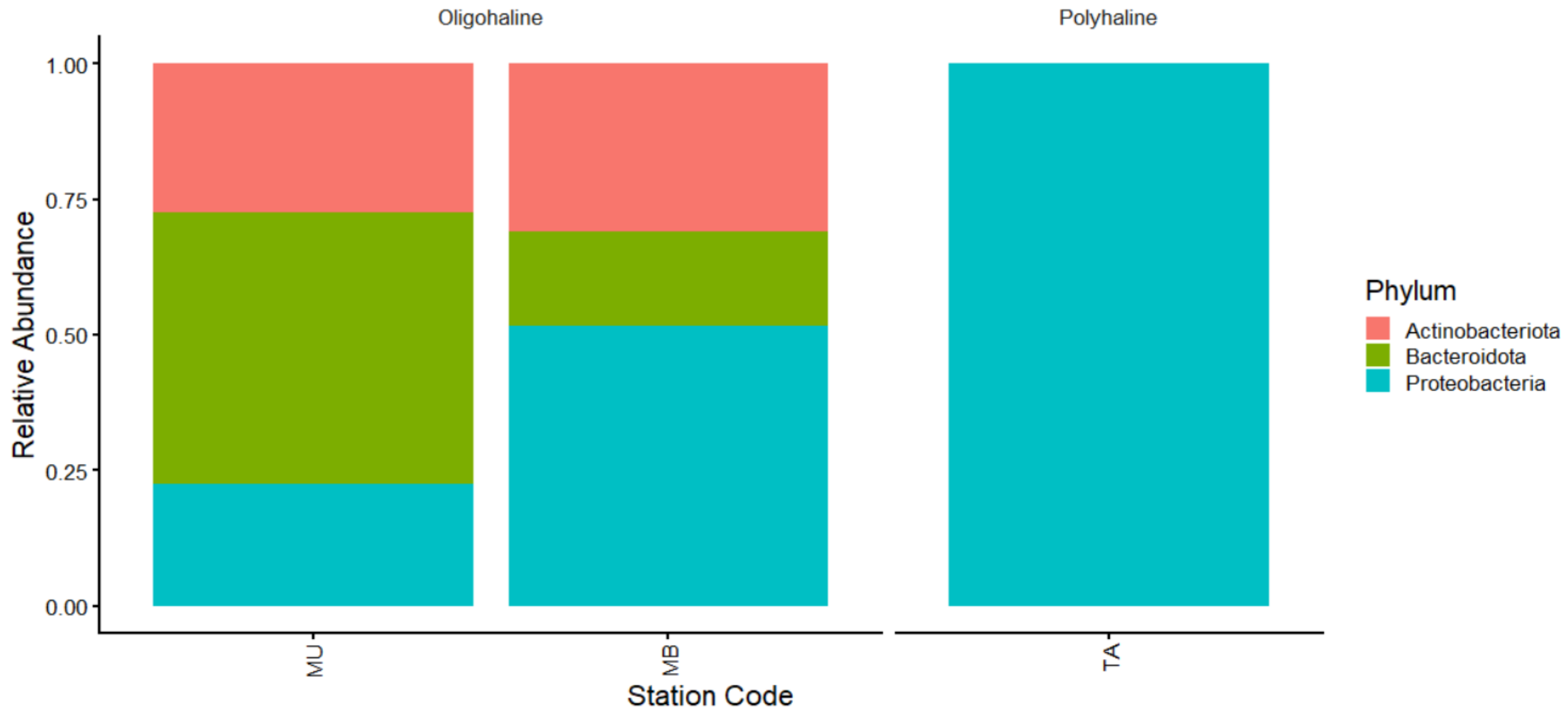
Water Bodies



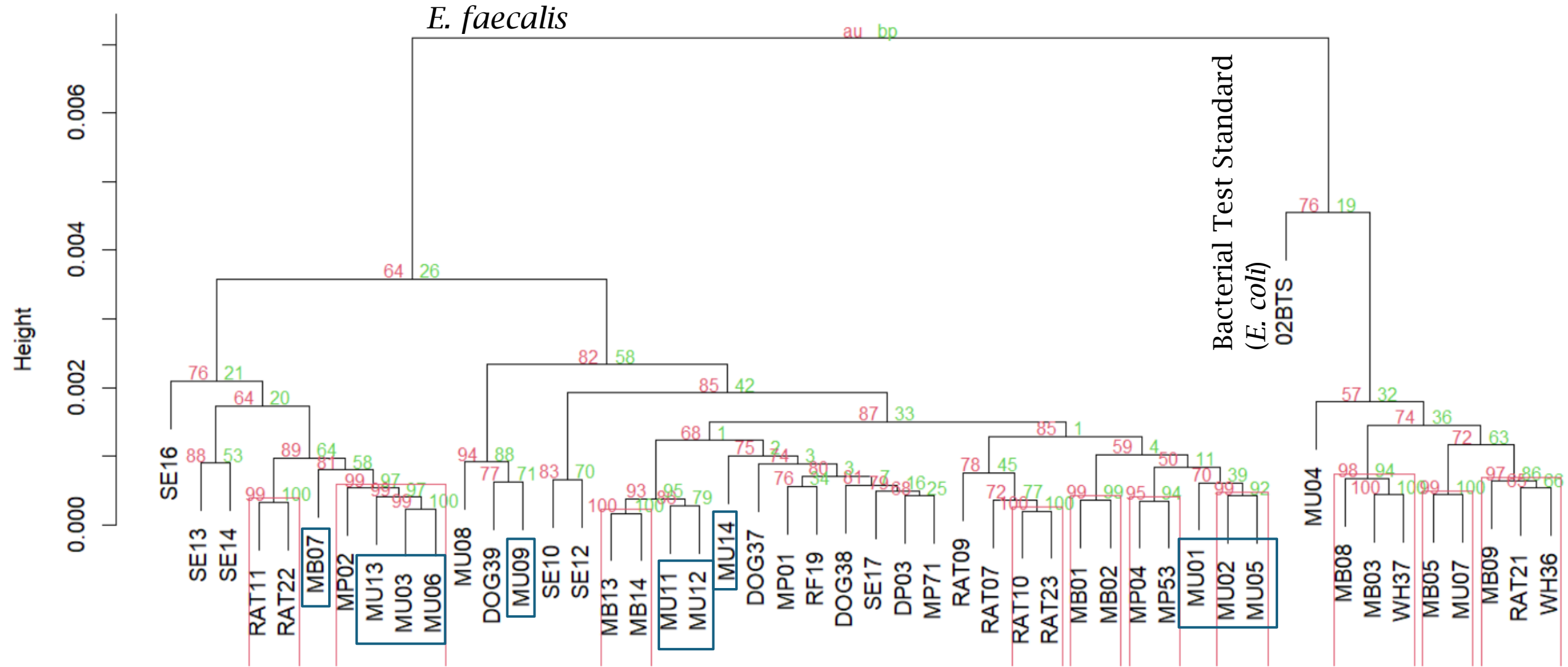
MU = Mustang Bayou at Cardinal Rd.
MB = Mustang Bayou at East South St.
TA = TAMUG

- 3,594 permitted OSSF in the watershed
 - 535 less than 5 years old.
 - 630 from 5 to 10 years old.
 - 307 from 11 to 15 years old.
 - 121 from 16 to 20 years old.
 - 2,001 greater than 20 years old.

<https://datalab.h-gac.com/ossf>

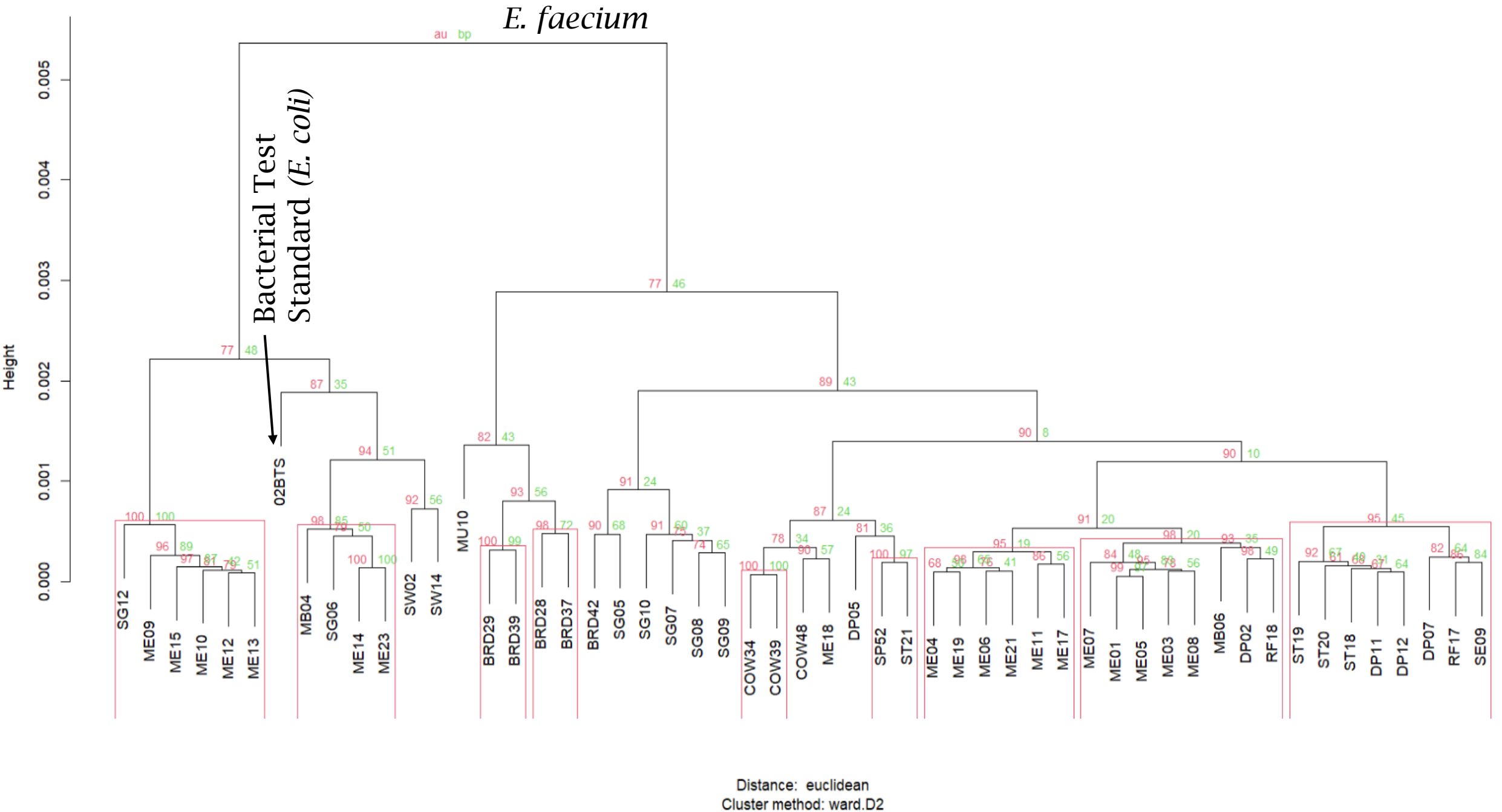


Cluster dendrogram with p-values (%)

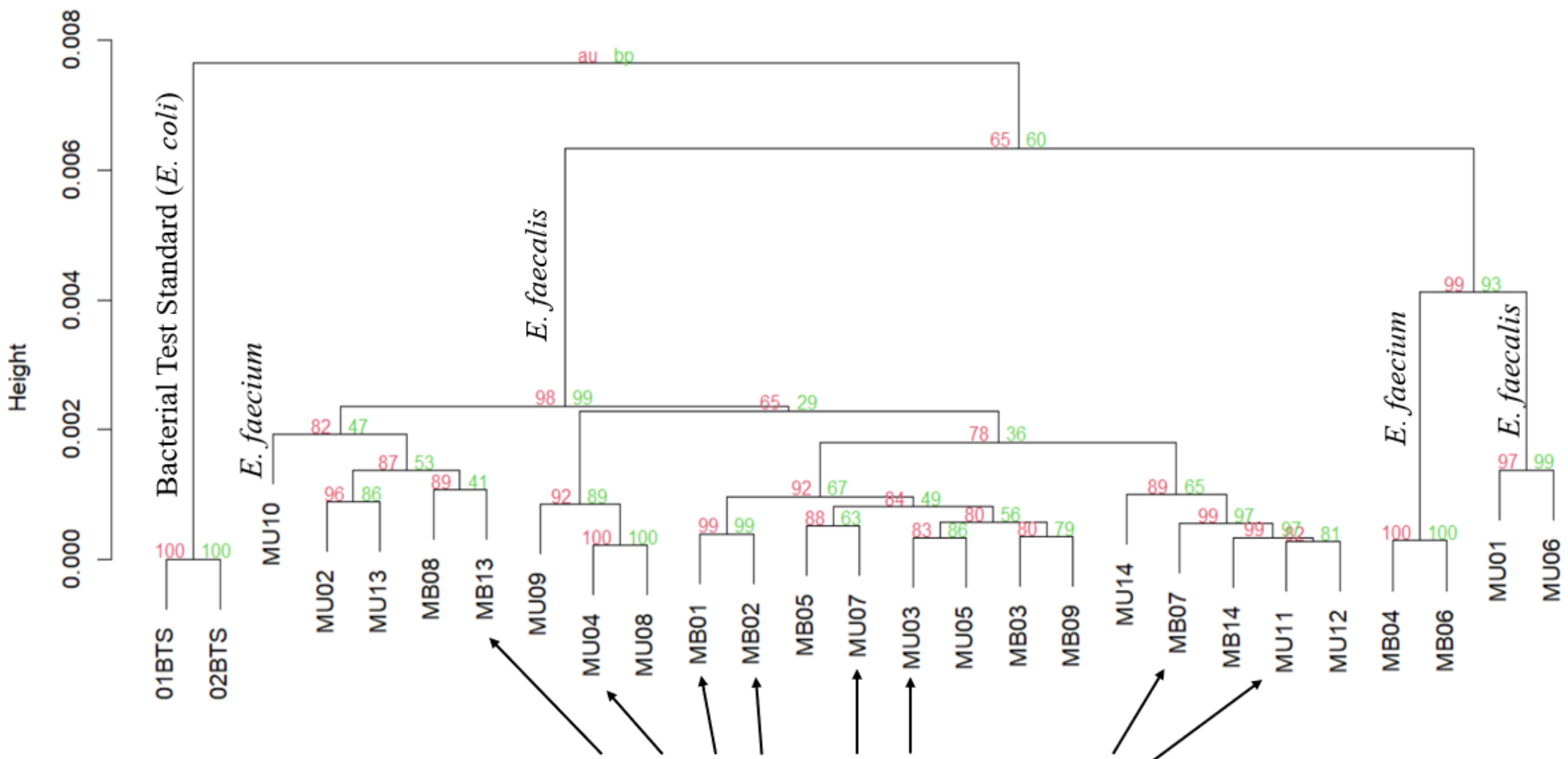


Distance: euclidean
Cluster method: ward.D2

Cluster dendrogram with p-values (%)



Cluster dendrogram with p-values (%)



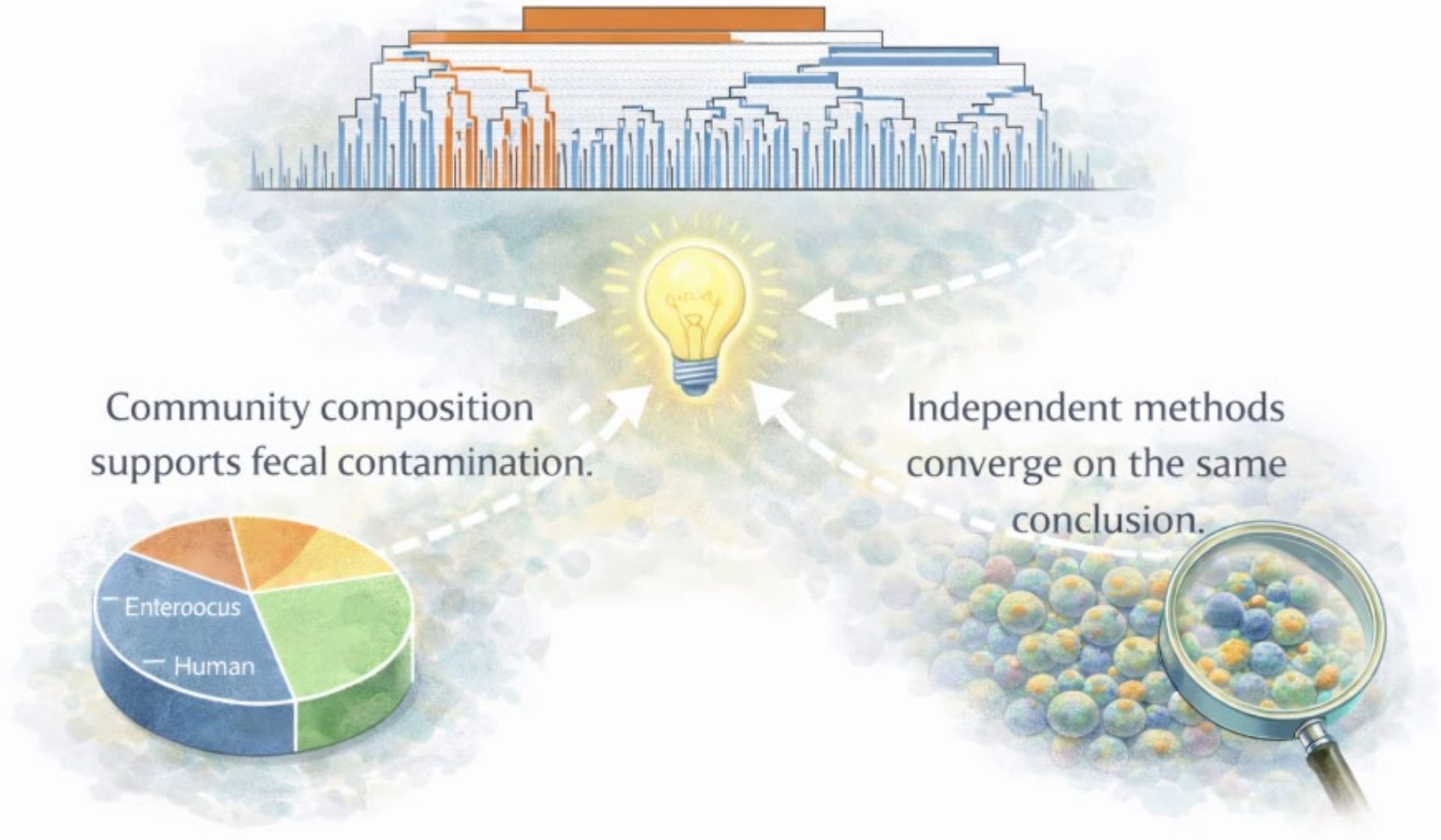
MU = Mustang Bayou @ Cardinal Rd.
 MB = Mustang Bayou @ East South St.

GCF_000007785 *E. faecalis* V583 VRE

Distance: euclidean
 Cluster method: ward D2

Merging of Evidence

Strain level spectral similarity to *E. faecalis* V583 VRE.



Conclusion

- Mustang Bayou shows evidence of human associated fecal contamination
- MALDI TOF can support source attribution inference at the strain level.
- Integration with 16S rRNA sequencing strengthens the interpretation



Acknowledgments and Questions

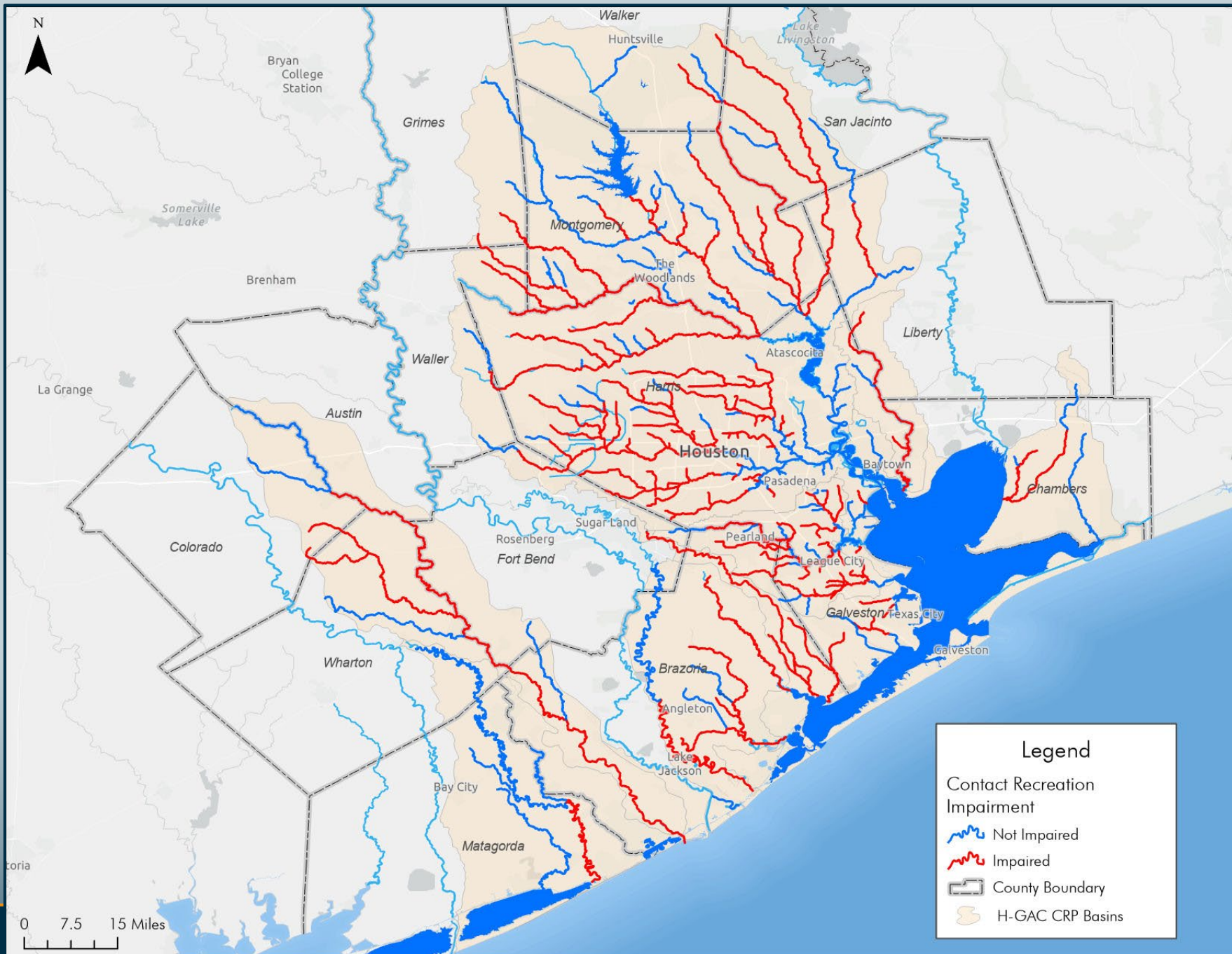


Targeted Bacteria Monitoring: A Holistic Overview of the Houston-Galveston Area Council's Projects



Background

- Fecal Indicator Bacteria (FIB) continue to be the Houston-Galveston region's most prevalent pollutant
 - 44% of stream miles in the region are impaired for contact recreation
- How can we address these impairments?
 - H-GAC, at the request of the BIG, initiated the **targeted monitoring program** in 2013 to conduct geographically focused bacteria sampling
 - **Goal:** Identify and report elevated bacteria sources and illicit discharges. Then refer them to the appropriate jurisdiction for action



Rank	AU_ID	Seven Year Geomean cfu/100 mL	Results	Ratio	Segment Name
1	1007T_01	6,933.54	54	55.03	Bintliff Ditch
2	1017_04	3,781.42	102	30.01	White Oak Bayou Above Tidal
3	1007I_01	3,564.22	54	28.29	Plum Creek Above Tidal
4	1007F_01	3,079.44	54	24.44	Berry Bayou Above Tidal
5	1007H_01	2,421.62	52	19.22	Pine Gully Above Tidal
6	1017B_02	2,308.77	54	18.32	Cole Creek
7	1004J_01	2,253.68	28	17.89	White Oak Creek
8	1007K_01	2,245.70	107	17.82	Country Club Bayou Above Tidal
9	1016C_01	2,180.21	55	17.30	Unnamed Trib. of Greens Bayou
10	1017E_01	2,062.39	55	16.37	Unnamed Trib. of White Oak Bayou
11	1013C_01	1,894.46	53	15.04	Unnamed Non-Tidal Trib. of Buffalo Bayou Tidal
12	1007B_01	1,891.83	489	15.01	Brays Bayou Above Tidal
13	1017_03	1,763.48	54	14.00	Whiteoak Bayou Above Tidal
14	1013A_01	1,597.49	110	12.68	Little White Oak Bayou
15	1016D_01	1,485.62	55	11.79	Unnamed Tributary of Greens Bayou
16	1017A_01	1,413.49	53	11.22	Brickhouse Gully/Bayou
17	1007U_01	1,365.28	55	10.84	Mimosa Ditch
18	1014O_01	1,268.88	55	10.07	Spring Branch
19	1103G_01	332.67	28	9.50	Gum Bayou
20	2432A_02	1,119.96	29	8.89	Mustang Bayou
21	1007E_01	1,108.76	54	8.80	Willow Waterhole Bayou Above Tidal
22	1101D_01	305.43	4	8.73	Robinson Bayou
23	1006D_02	1,062.24	173	8.43	Halls Bayou
24	1007G_01	962.46	53	7.64	Kuhlman Gully Above Tidal

Methods

- **Purpose** – identify illicit discharges or any other sources of FIB during dry weather conditions (>72 hours with no significant rainfall)
- **3 phase project**
 - Desktop review
 - Windshield survey
 - Field investigation



Methods

- **Field Investigation:** Intensive survey where team walks or kayaks specific sections of the water body
 - downstream → upstream
- Sample from all flowing sources
- Results with highest bacteria levels are referred to local jurisdictions for corrective action
- Methodology formalized in 2016

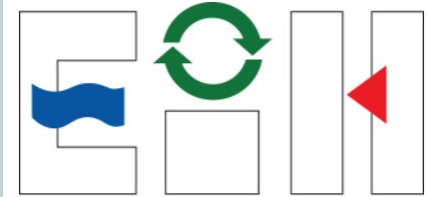


Results

- **27** AUs visited between 2016 and 2025
- **1,275** total samples collected during field investigations
- **319** referrals made to local jurisdictions
- **74%** of referrals >399 MPN/100 mL single grab standard
- **12%** of referrals were greater than the methods detection limit



BAYOU PRESERVATION
ASSOCIATION
celebrate. protect. restore.



Environmental Institute of Houston



Success Stories



Little White Oak Bayou



- Monitored in 2016
- Faulty sewer system junction box

Little White Oak Bayou



Little White Oak Bayou

- The City of Houston (COH) raised the junction box 5 feet higher to reduce chances of overflows
 - Cleared the main line and service lines
- Visited area again in 2023 and COH identified a collapsed sewer line
 - Repairs were completed about 6 weeks after the field investigation took place

Plum Creek



- Monitored in 2020
- Sanitary sewer overflow was initially observed
- City of Houston investigated further and identified broken sewer gravity main line



Pine Gully

- Monitored in 2023
- Sanitary sewer overflow at an apartment complex
- Blockage was cleared
- Referred to the Houston Health Department for education and increased inspection

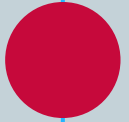




PROS



CONS



Identify areas that would otherwise go unnoticed (illicit discharges)



Resolve sewer leaks and blockages sooner rather than later



Provide jurisdictions with areas for education & outreach events (FOG program)

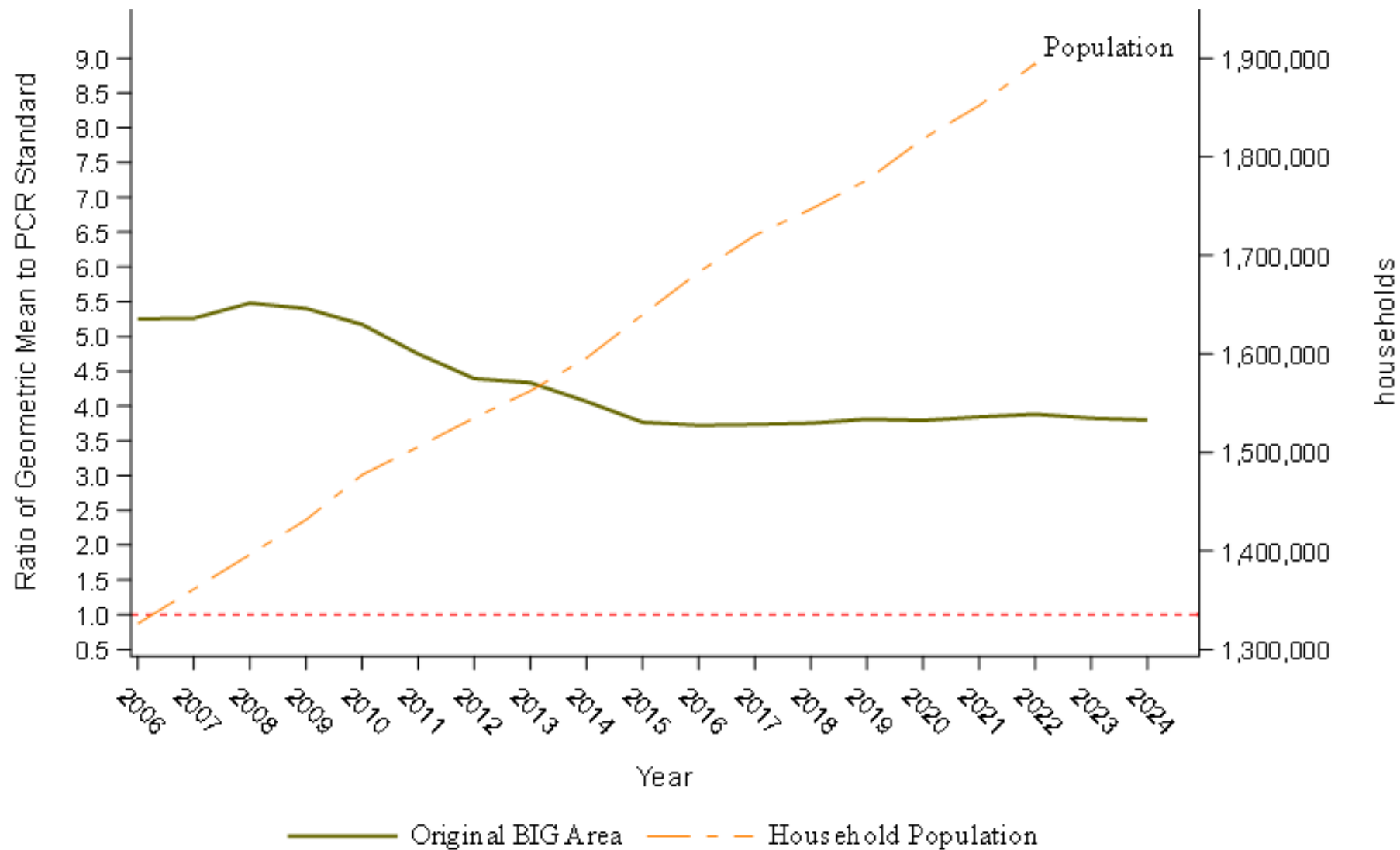
Voluntary participation with jurisdictions (we typically don't know if or when repairs are made)

Budget dependent to not only sample but to address and follow through with repairs

Continuous monitoring needed



Moving Seven-Year Geometric Mean - All Monitoring Stations in BIG Area Expressed as Multiple of Primary Contact Recreation Standard



Reference Line represents the Primary Contact Recreation (PCR) Standard
 PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

Contact Information

Cornell Evans, Jr.

Planner-Water Resources

cornell.evans@h-gac.com

713-499-6666

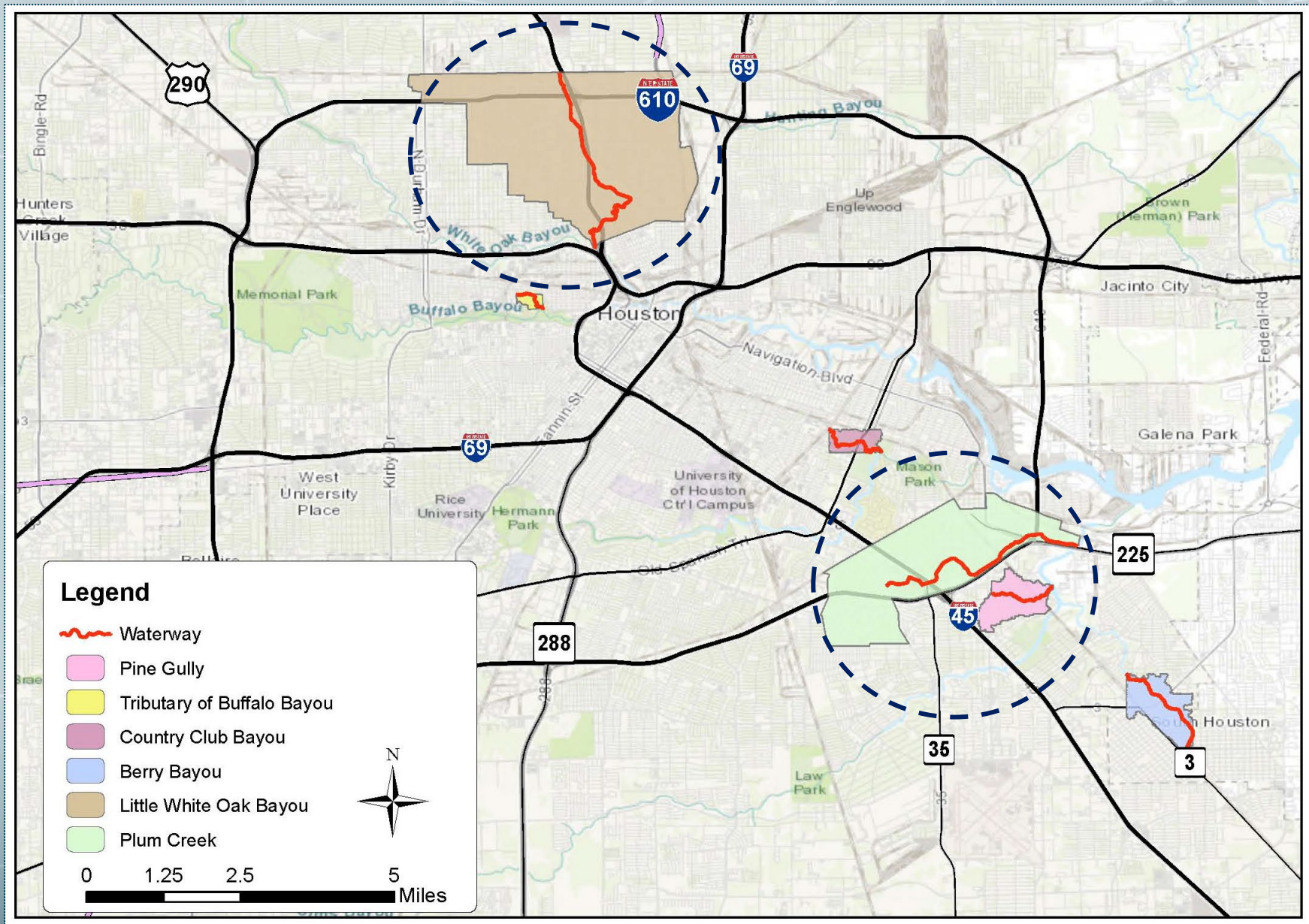
Erica Underwood

Program Specialist

erica.underwood@h-gac.com

832-681-2698







Developing a TMDL for the stormwater-dominated Poenisch Park Recreational Beach

Sam Bickley
TMDL Program
TCEQ

TMDL – Total Maximum Daily Load

- a) Determines the maximum amount (load) of a pollutant that a water body can receive and still meet the water quality standards and maintain its uses, and
- b) Allocates this load to regulated (point) and unregulated (nonpoint) sources in the watershed.

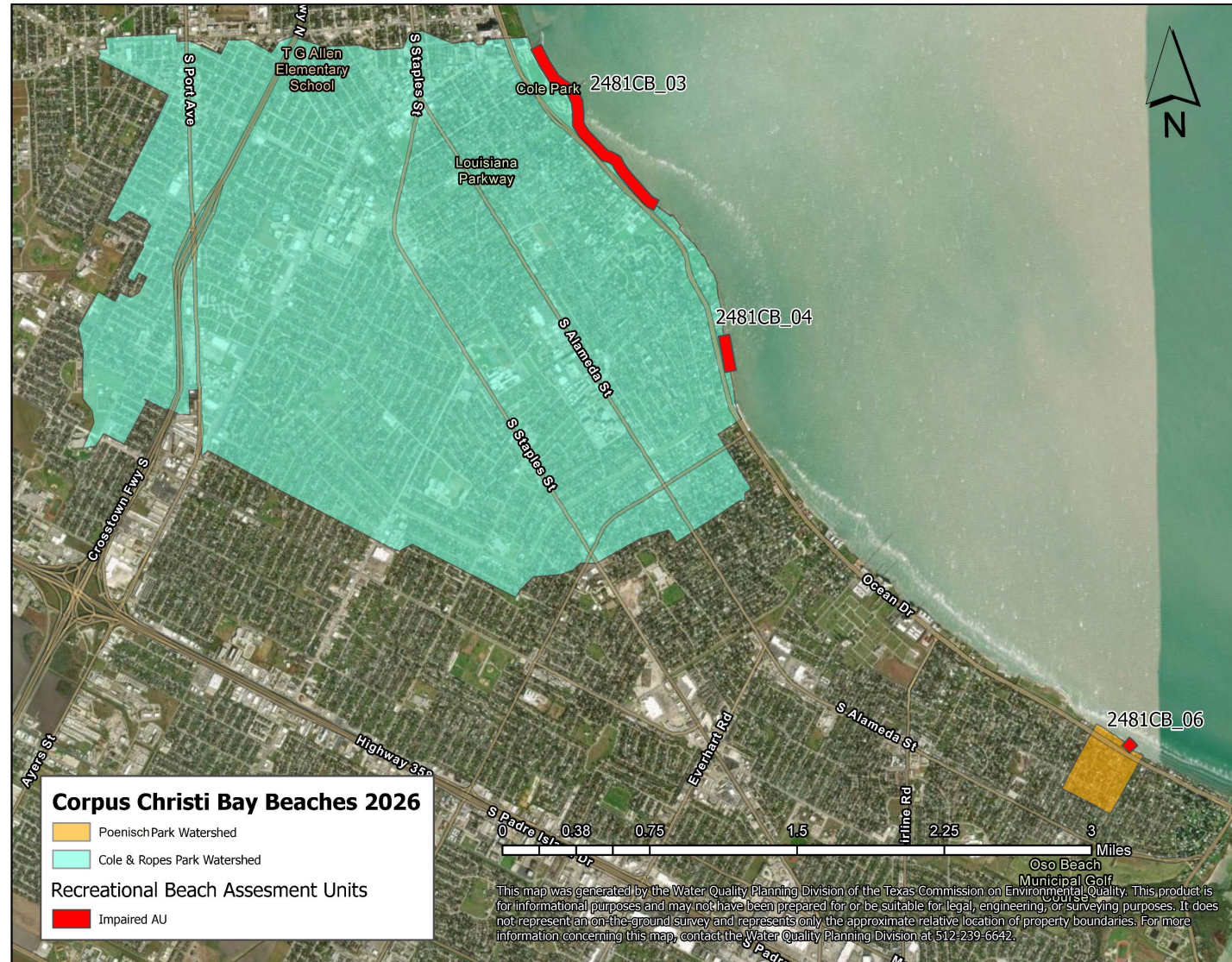
Designated Use Category: Primary Contact Recreation 1

- Primary contact recreation activities are those involving a significant risk of ingestion of water, such as wading or swimming.
- The primary contact recreation 1 use is not met if the **geometric mean** of all indicator bacteria is greater than:
 - 126 cfu/100 mL for *E. coli* in non-tidal segments (freshwater)
 - 35 cfu/100 mL for Enterococci in tidal segments (saltwater)

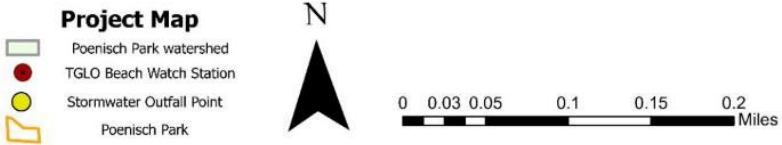
Recreational beach assessment and TMDLs

- Beach Action Value of 104 cfu/100 ml
- Recreational beaches not assessed using a geometric mean
 - Beach advisories <25% of the time—Fully Supporting
 - Beach advisories 20-25% of the time—Concern and Fully Supporting
 - Beach advisories < 20% of the time—Delisted and Fully Supporting
 - Beach advisories \geq 25% of the time—Not Supporting

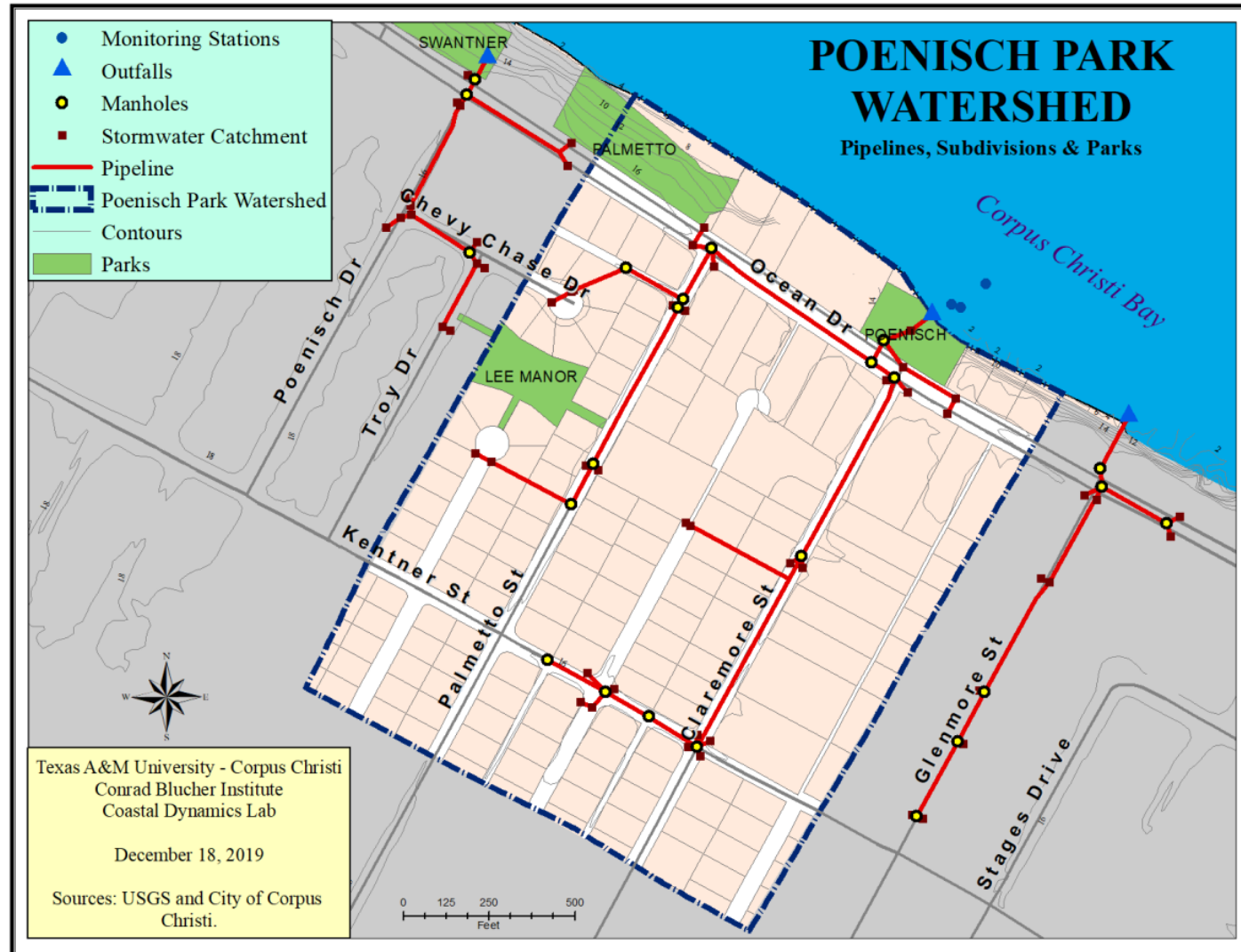
Poenisch Park is one of three impaired recreational beaches along Corpus Christi Bay.



The Poenisch Park watershed is small and stormwater-dominated.



The Poenisch Park watershed is small and stormwater-dominated.



Mostly dry conditions, but wet when it rains.



Dry – no precipitation in last 72 hours
Mean 68 cfu/100 ml



Wet – precipitation within the last 72 hours
Mean 401 cfu/100 ml

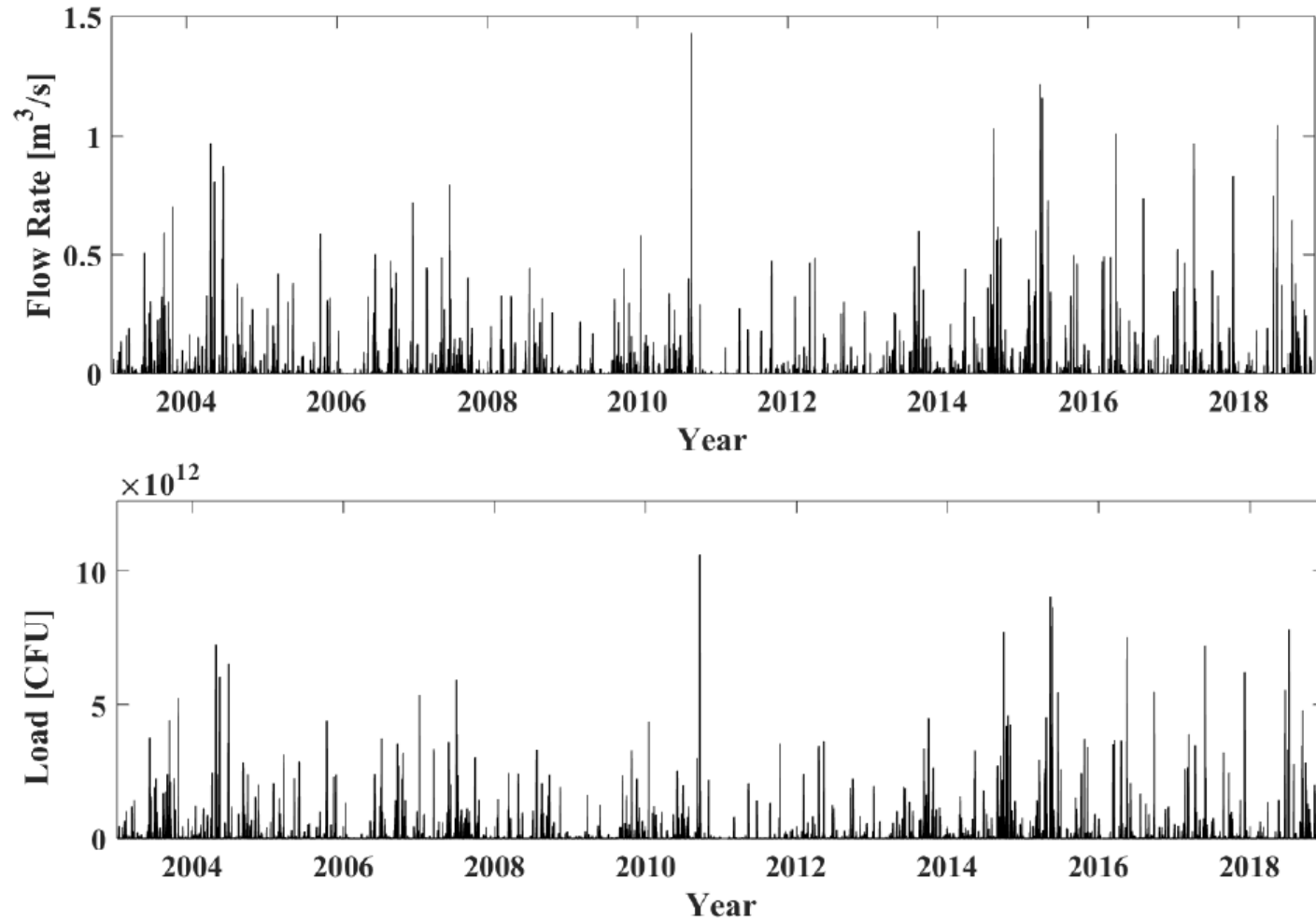
What questions do these problems pose?

- Lack of flow data
 - Common at a beach because where is the flow?
 - Texas A & M – Corpus Christi
 - measured stormwater discharge during storm events
- Modeling – what model is appropriate
 - Larger mechanistic models (list some here) require lots of data that isn't available for such a small watershed
 - Some models may assume decay of bacteria (die off) over time, but this watershed saw high transit, not a lot of decay time

Model approach

- A small model was used that estimated runoff volume at the outfall based on land cover in the watershed
- Estimated Enterococci concentrations by combining runoff estimate with land cover in the watershed
- Enterococci model results were calibrated and validated based on TGLO data
- Flow model results calibrated based on field data collection at the outfall

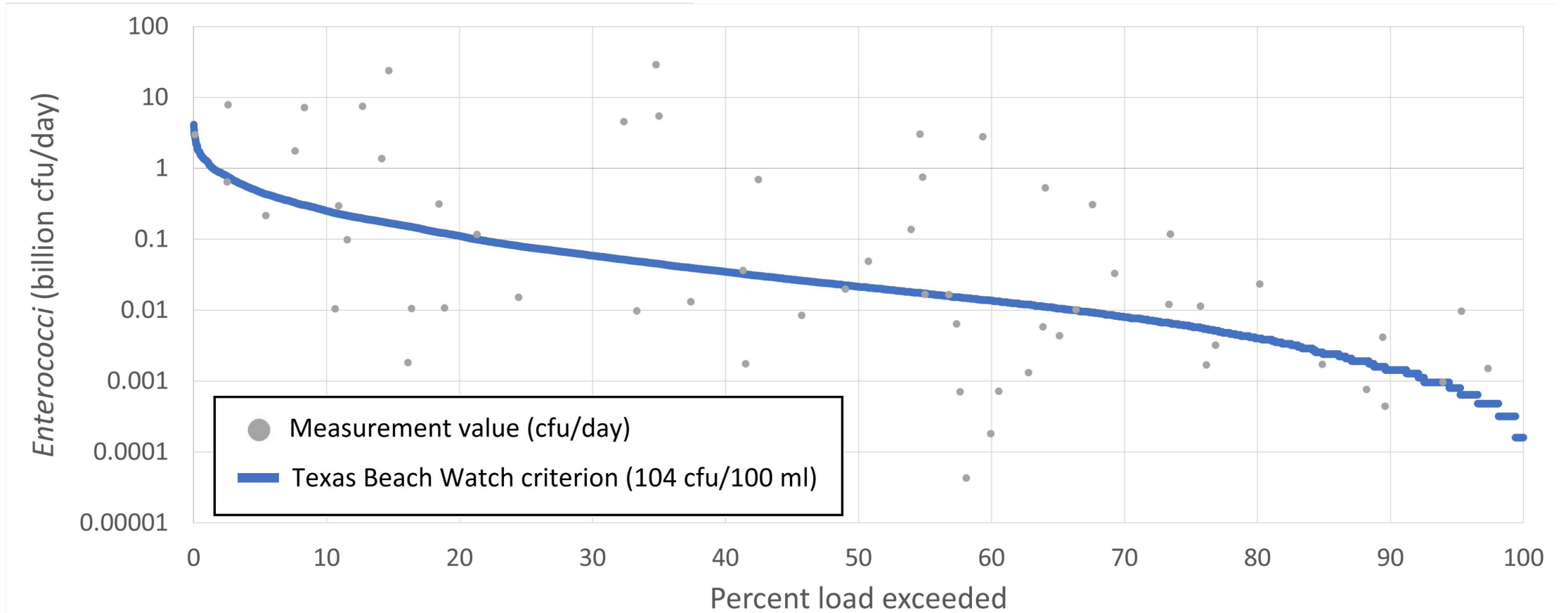
Model results



TMDL results

Table 7. Summary of allowable loading calculation

AU	5% Exceedance Flow (cfs)	TMDL (Billion cfu/Day)
2481CB_06	4.365	11.107



Implications for future work

- Currently, there are 6 impaired recreational beaches in Texas
- Corpus Christi Bay Recreational Beaches had 3 impaired beaches, but 2 adopted TMDLs and an implementation plan to improve WQ in progress
- No clearly preferred approach for developing recreational beach TMDLs either within Texas or across the US
- Site-specific – not every recreational beach will have a stormwater outfall