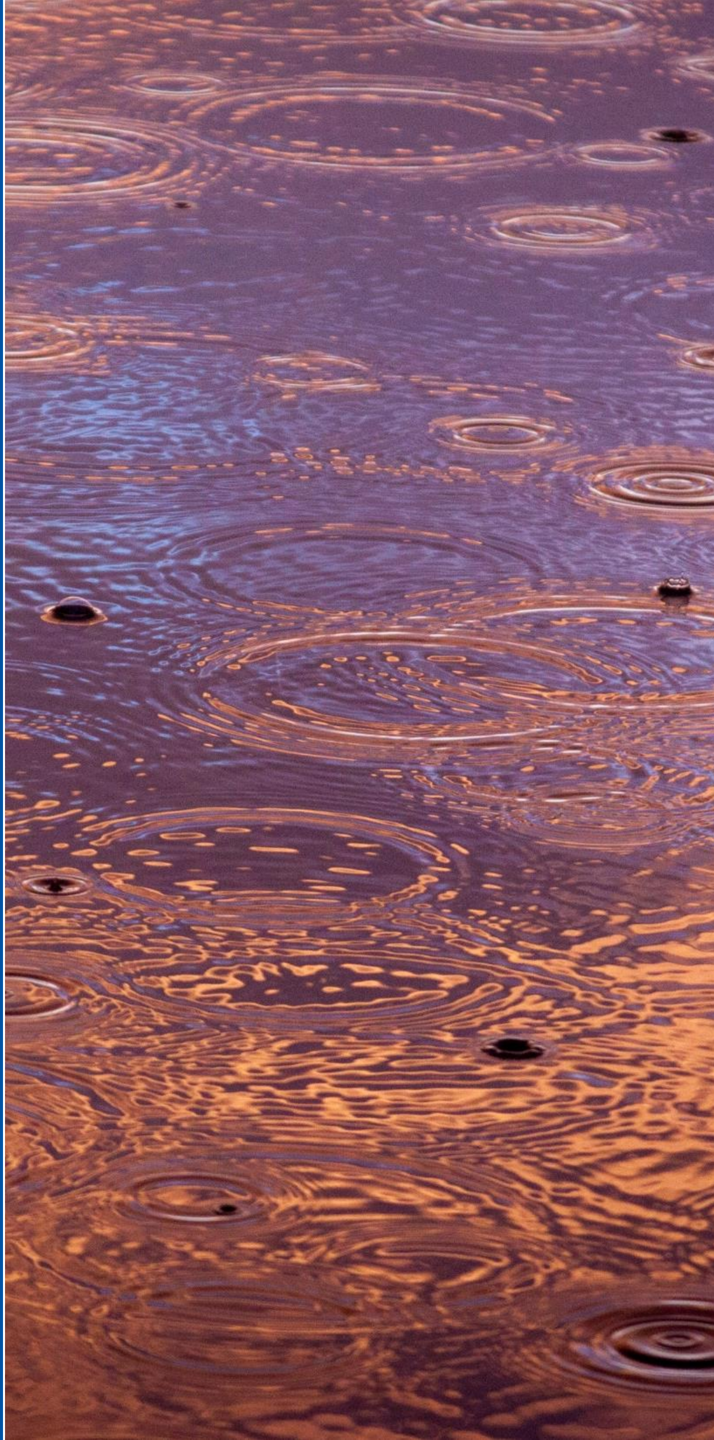
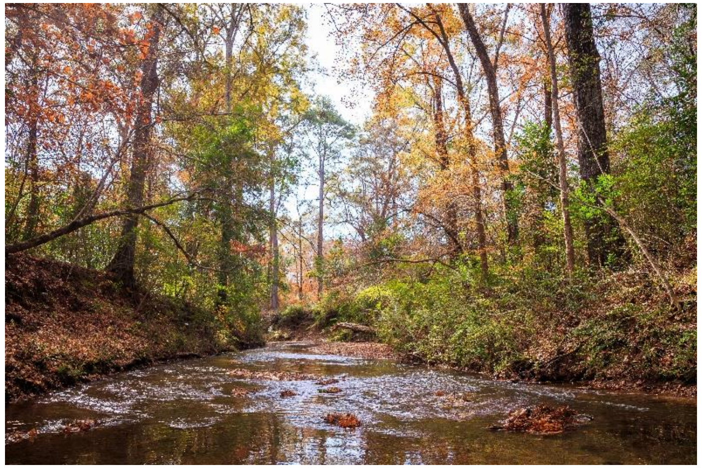
Texas Water Resources Institute
make every drop count

Hillebrandt Bayou and Neches River Tidal TMDL and I-Plan

The meeting will start at 10:00 AM.

If you have issues with sound, please join by phone. Use the chat box below if there are other issues.





Texas Water Resources Institute
make every drop count

Texas A&M AgriLife Research | Extension

Hillebrandt Bayou and Neches River Tidal Technical Support Documents

Michael Schramm | Research Specialist
Lucas Gregory | Research Scientist
Texas Water Resources Institute

August 14, 2020

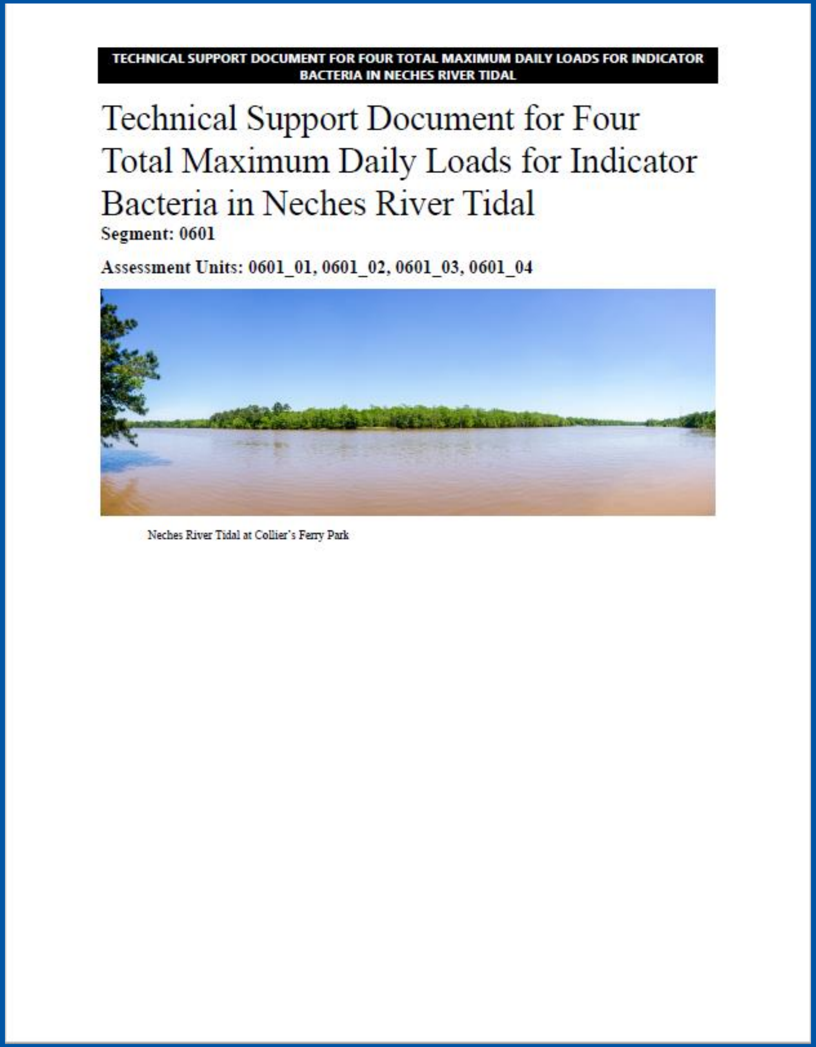
Before we start:

1) Please mute your microphones.
2) If you have questions, please use the chat box and our moderator will chime in to make sure your question is addressed.
3) The slides and meeting notes will be posted online after the meeting at:
   https://www.tceq.texas.gov/waterquality/tmdl/nav/118-hillebrandtbayou-bacteria
   https://www.tceq.texas.gov/waterquality/tmdl/nav/118-nechestidal-bacteria
4) Please sign in using our webform, the link will be posted in the chat box.

Project Team
Michael Schramm – Texas Water Resources Institute
Dania Grundmann – Texas Commission on Environmental Quality, TMDL Program

Zoom Moderator
Lucas Gregory – Texas Water Resources Institute

Reminder:
If you are interested in being on the coordination committee or planning workgroups please let me know.


TECHNICAL SUPPORT DOCUMENT FOR FOUR TOTAL MAXIMUM DAILY LOADS FOR INDICATOR BACTERIA IN NECHES RIVER TIDAL

Technical Support Document for Four Total Maximum Daily Loads for Indicator Bacteria in Neches River Tidal

Segment: 0601

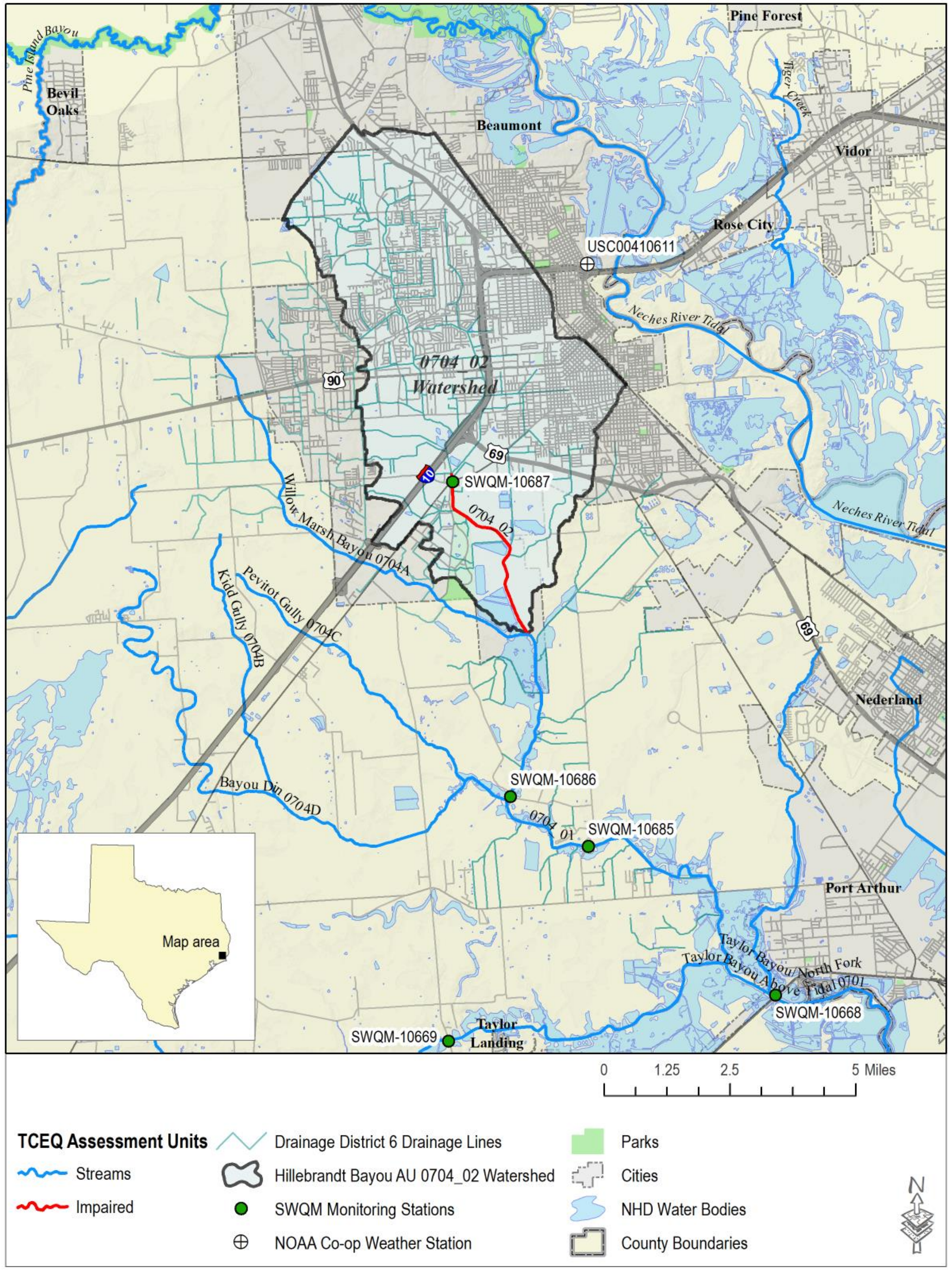
Assessment Units: 0601_01, 0601_02, 0601_03, 0601_04

Neches River Tidal at Collier's Ferry Park

Technical Support Document (TSD): provides data and basis for Total Maximum Daily Load (TMDL) by describing potential sources of indicator bacteria within the watershed and basis for the load allocation calculations.

Hillebrandt Bayou TSD:
https://www.tceq.texas.gov/assets/public/waterquality/tmdl/118hillebrandt/118-hillebrandt-tsd-2020june.pdf

Neches River Tidal TSD:
https://www.tceq.texas.gov/assets/public/waterquality/tmdl/118nechestidal/118-nechestidal-bacteria-tsd-2020july.pdf

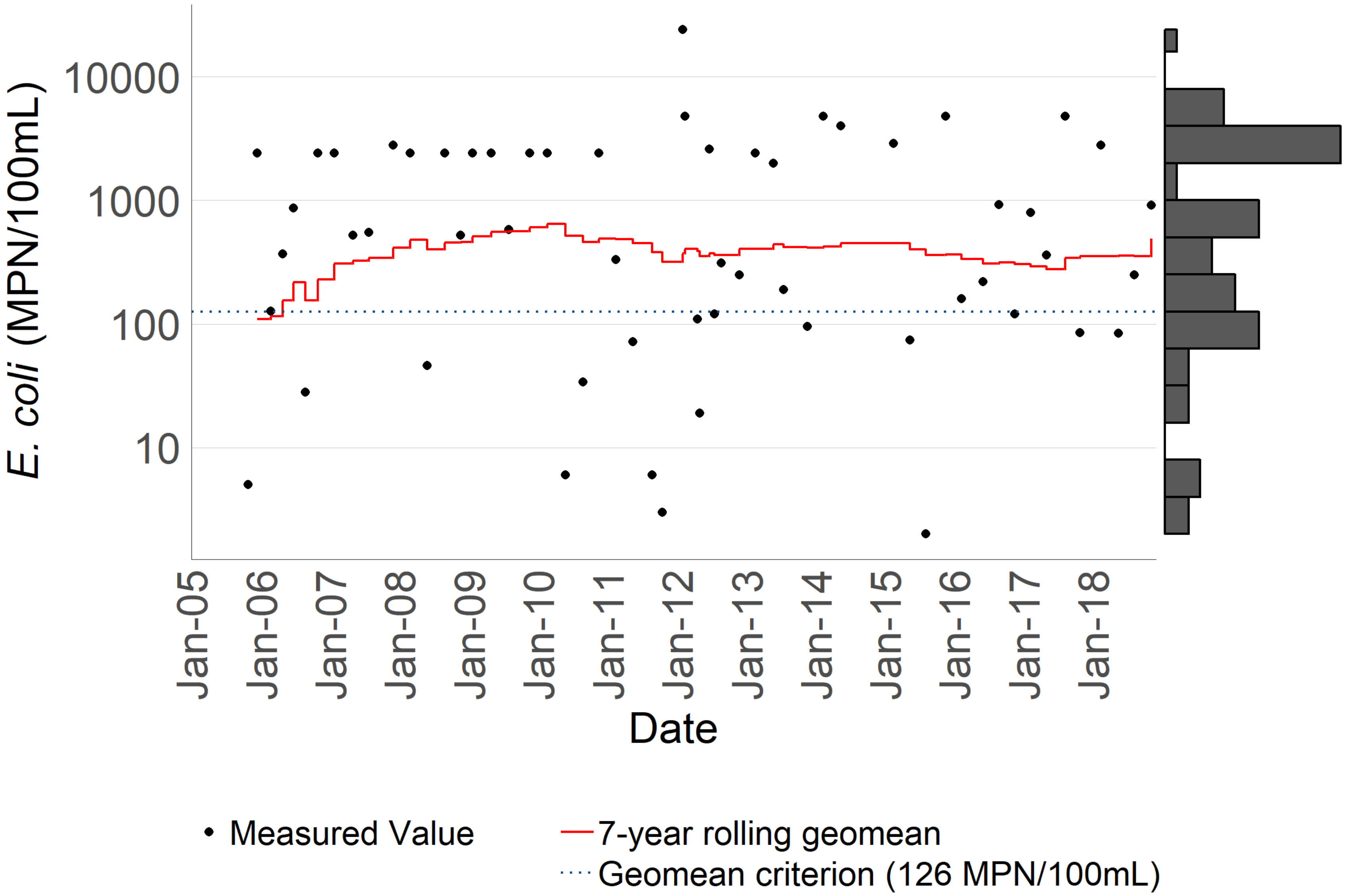


Hillebrandt Bayou Watershed

- **Impaired assessment unit (AU)** is the portion of the water body above the confluence with Willow Marsh Bayou
- 36 mi^2
- 70% developed land cover
- *E. coli* geometric mean of **453 cfu/100mL** (Dec 2011 through November 2018)

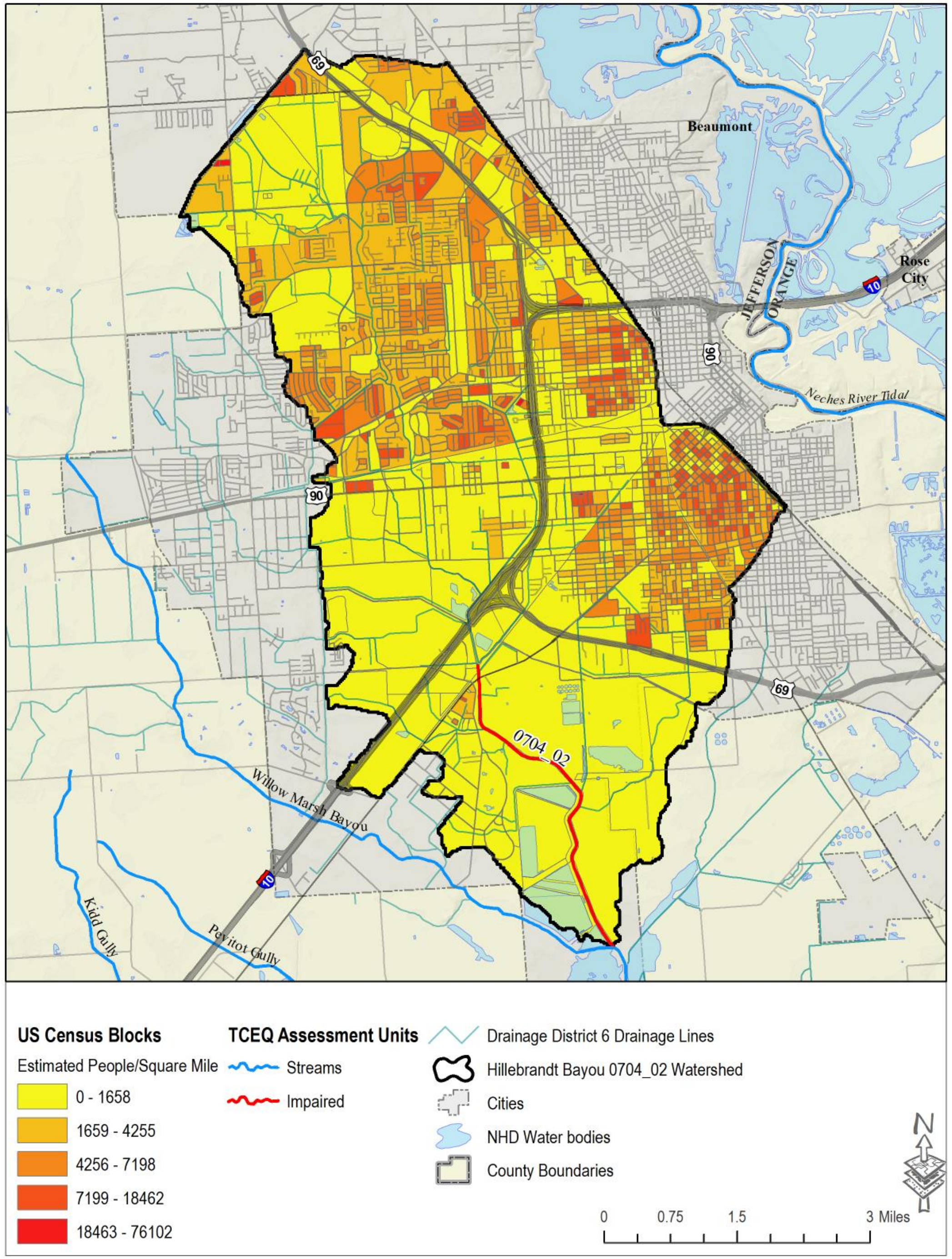
Texas Water Resources Institute
make every drop count

Historical Bacteria Dataset for AU0704_02



TCEQ (2019)

Texas Water Resources Institute
make every drop count

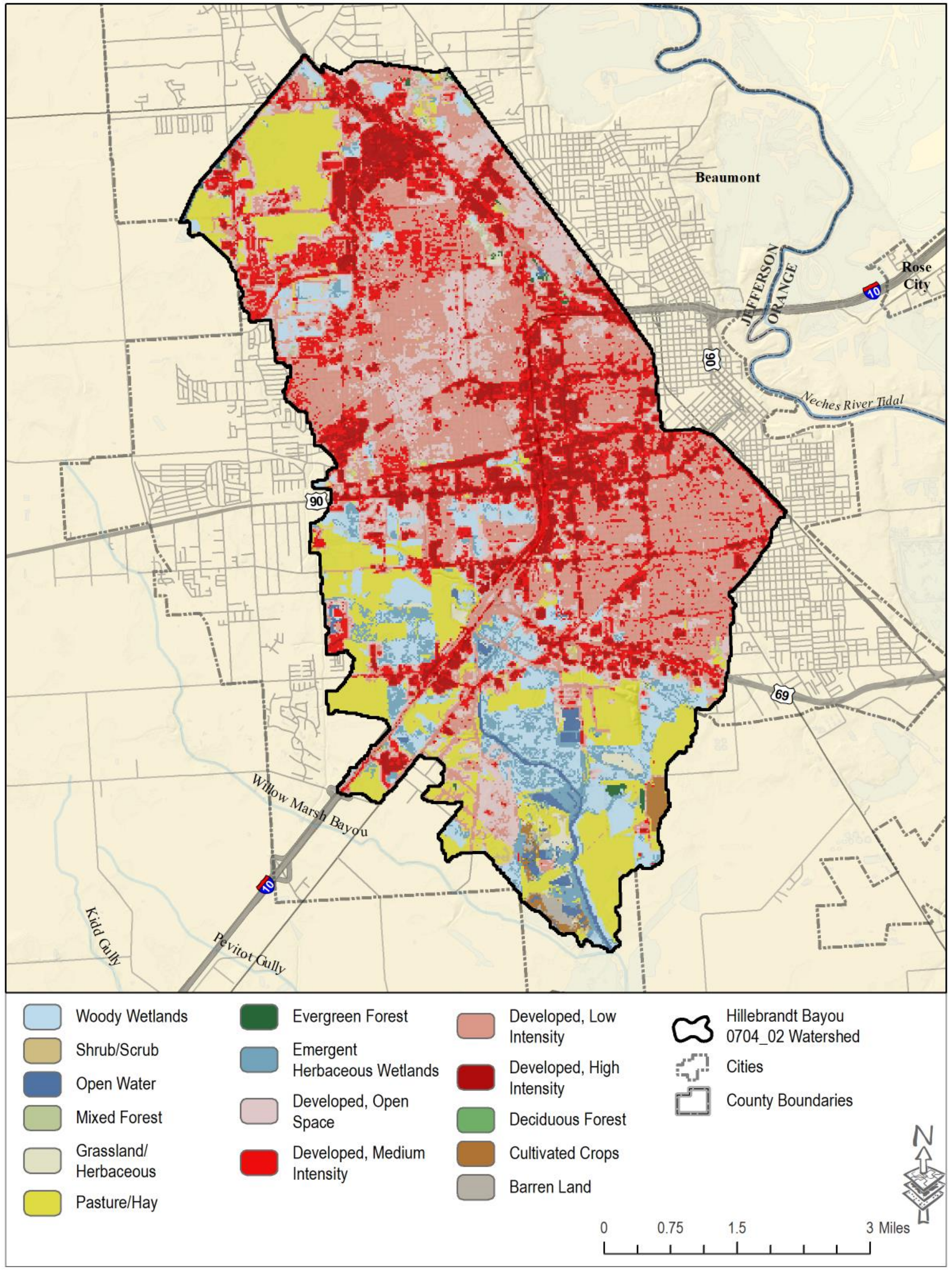


Watershed Population

- 2010 population 61,273 (estimated)
- 2070 population 93,961 (estimated)
- 39.5% population **increase** anticipated between 2020 and 2070

Sources: US Census Bureau 2010 Census Block Data (2010)
Texas Water Development Board Regional Water Plan Population Projections (2019)

Texas Water Resources Institute
make every drop count



Land Cover

- 70% Developed (Open, Medium, Low, and High classifications)
  - residential, commercial, industrial
- 14% Undeveloped (classified as Pasture/Hay in the figure)
- 14% Wetlands (Woody Wetlands, Emergent Herbaceous Wetlands, and Open Water classifications)

Source: 2016 National Land Cover Dataset

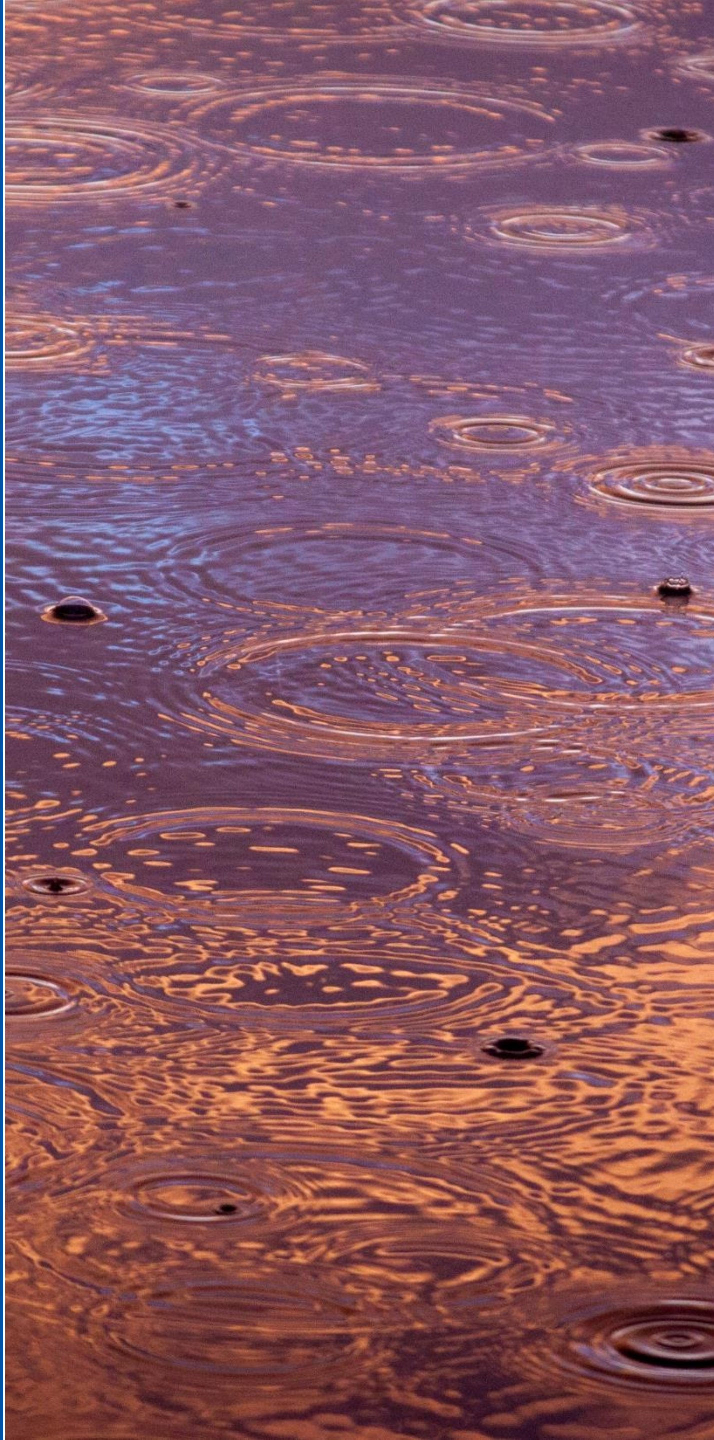
Texas Water Resources Institute
make every drop count

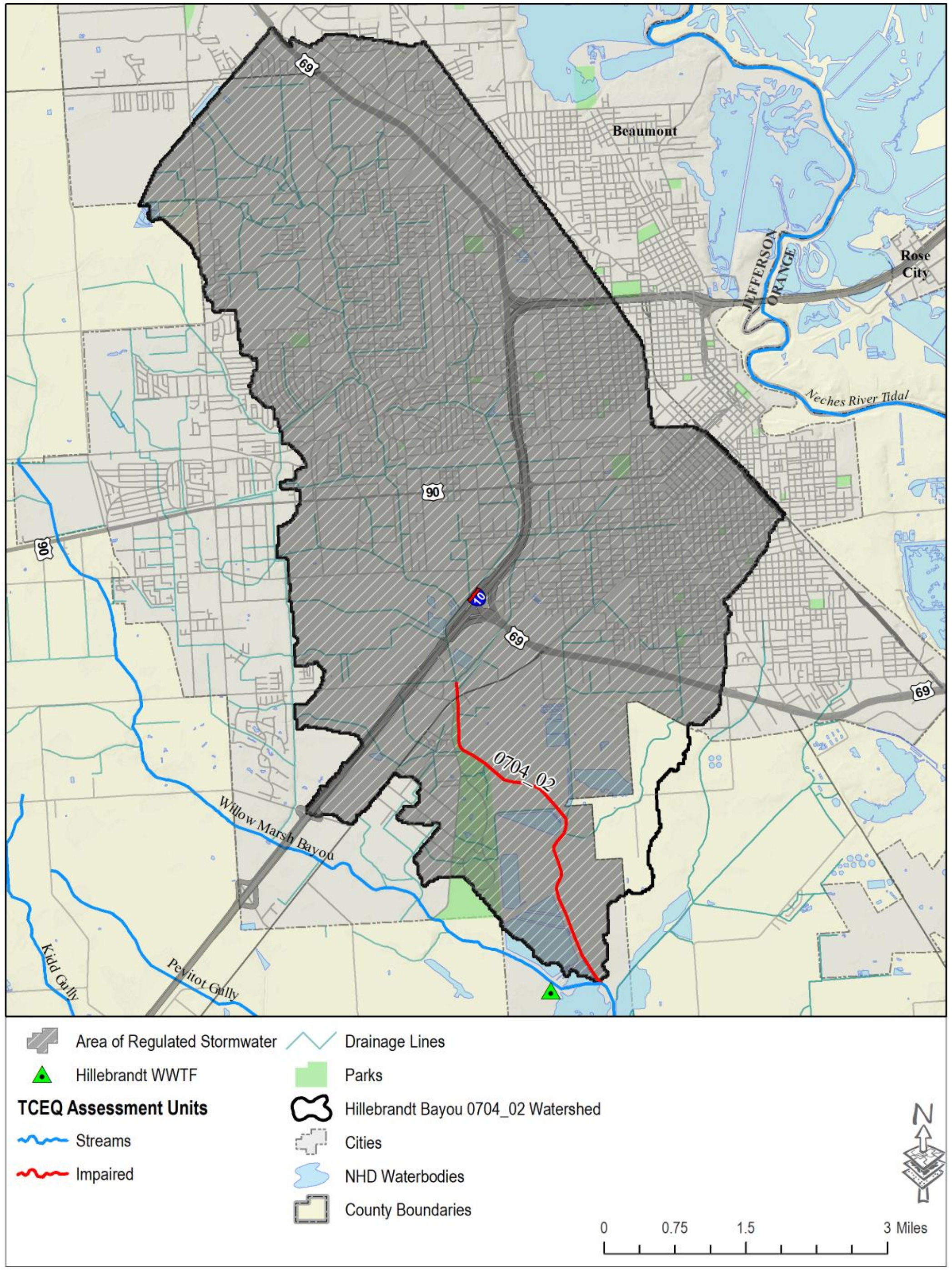
Texas Water Resources Institute
make every drop count

Potential Sources of Indicator Bacteria

Typically we consider:

Regulated sources
Sanitary sewer overflows
Septic systems (On Site Sewage Facilities or OSSFs)
Pet waste
Wildlife
Livestock





Regulated Stormwater Area

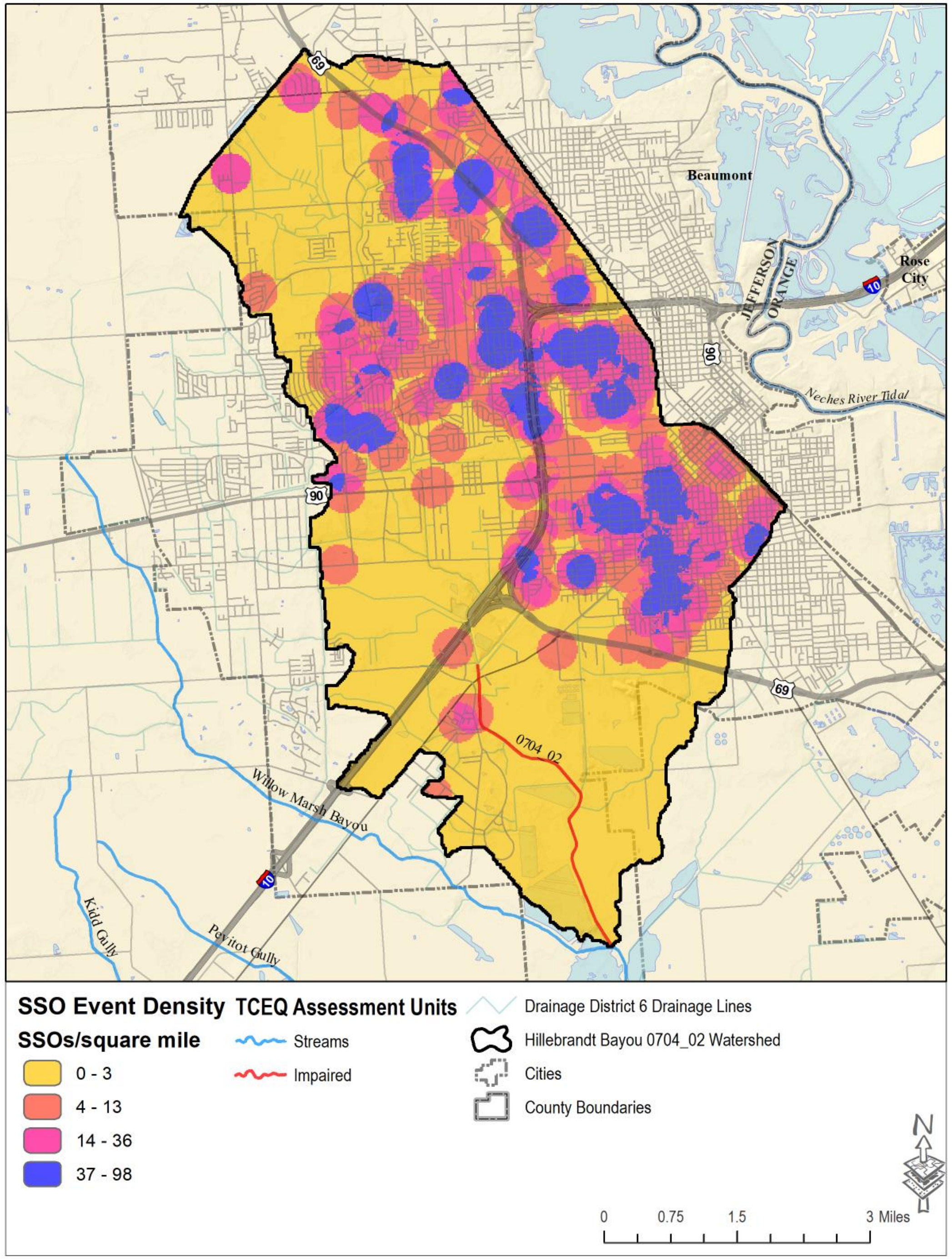
- 35 square miles or 97% of the watershed

Wastewater Treatment Facilities (WWTFs)

- No permitted wastewater discharges
- Hillebrandt WWTF discharges outside of watershed

Source: TCEQ Permits

Texas Water Resources Institute
make every drop count



Sanitary Sewer Overflows

- 404 reported incidents from 2005-2018

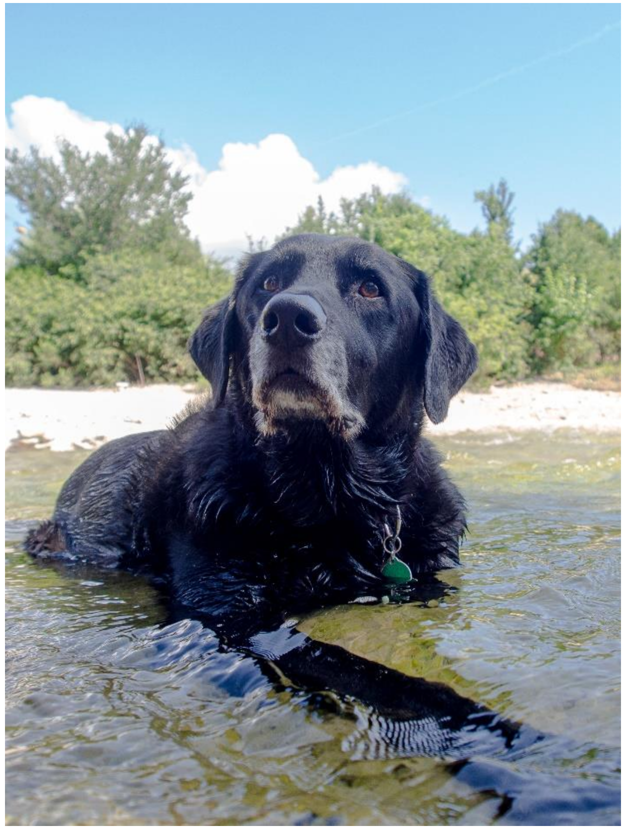
Source: TCEQ databases

Texas Water Resources Institute
make every drop count

Pets, Wildlife, and Livestock

Dogs	16,385
Cats	17,900
Cattle	661
Deer	32
Feral Hogs	170

Other wildlife aren't quantified since inadequate data are available to estimate population



Sources:
American Veterinary Medical Association (2018-2019) Demographic Data
USDA National Agricultural Statistics Service 2017 Census of Agriculture (2019)
TPWD Survey Data (2018)
Texas A&M AgriLife Statewide Wild Pig Estimates (2012)

TMDL Allocations

- The **TMDL** establishes the **daily allowable load** (volume) of *E. coli* the stream can assimilate and meet water quality standards.
- **Allocations** in the TMDL are like a budget and distributes the daily load to different general categories (regulated point sources, unregulated nonpoint sources, future growth, and margin of safety).
- The TSD uses a **Load Duration Curve** approach to determine the allowable load.

General Process for Developing Load Duration Curves

Develop Daily Flows

- Identify location of interest
- Use USGS daily streamflows if available
- Estimate daily streamflows using Drainage Area Ratio

Plot Flow Duration Curve

- Calculate the percent exceedance for every daily mean streamflow value
- Plot flow values against the exceedance values

Develop Load Duration Curve

- Convert daily flow to allowable load (concentration times volume)
- Plot allowable load against exceedance values
- Overlay measured concentrations converted to daily loads

Texas Water Resources Institute
make every drop count

Hillebrandt Bayou (0704_02) Daily Flow

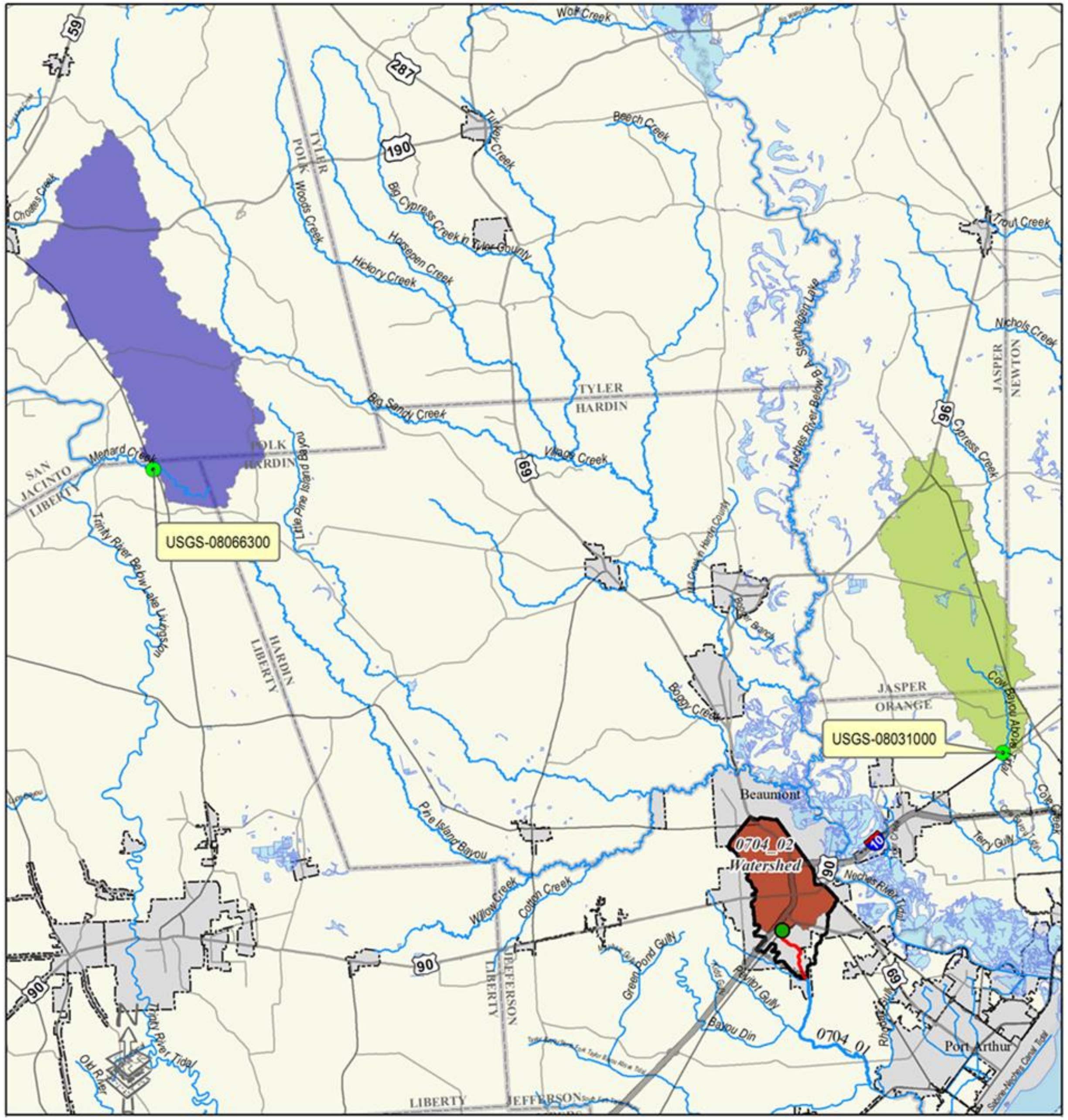
- No USGS stream gage to provide daily flows
- **Drainage Area Ratio (DAR)** method used to estimate mean daily streamflows in the target watershed and develop the flow duration curve

Hillebrandt Bayou (0704_02) Daily Flow

- **Drainage Area Ratio** – Daily streamflow in an ungaged basin is similar to the **daily streamflow** in a nearby gaged basin, multiplied by **the ratio of the drainage areas**.
- For example if the ungaged basin is half the size of the gaged basin, the daily streamflow is approximately half

Hillebrandt Bayou (0704_02) Daily Flow

- Drainage Area Ratio – **Assumes** ungaged watershed has **similar hydrology and land cover** as gaged watershed.
- Additional **correction factors** added (to account for influence of developed areas and wetlands)
- **Parameter optimization** used to weight developed area and wetland area terms
- Streamflows are **corrected** for **permitted discharges**
- Appendix A in the Technical Support Document covers this in detail

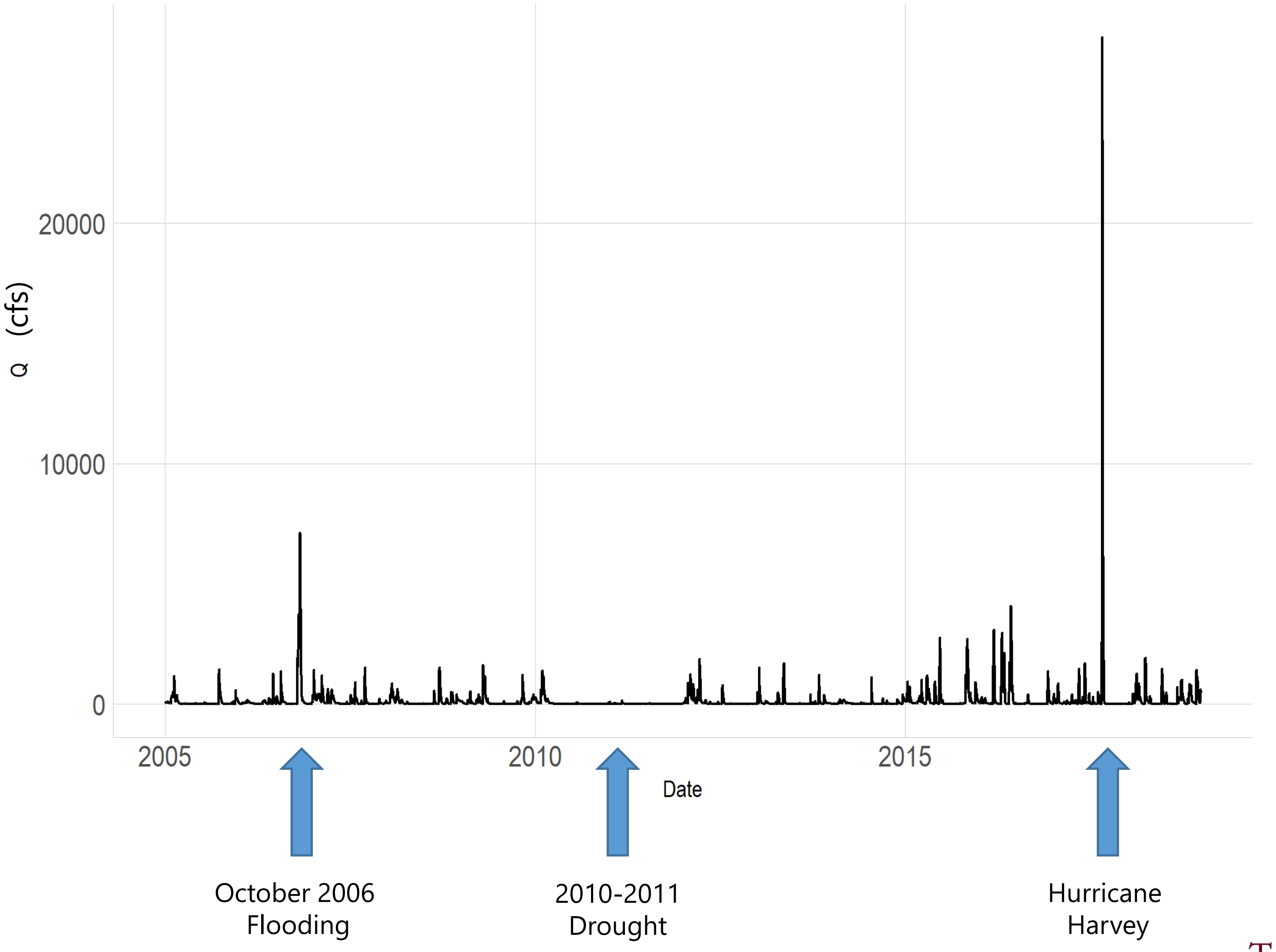


Hillebrandt Bayou (0704_02) Daily Flow

- USGS gages at Menard Creek and Cow Bayou were used to **estimate daily flows** in Hillebrandt Bayou using the **Drainage Area Ratio**.
- January 1, 2005 through December 31, 2018

Texas Water Resources Institute
make every drop count

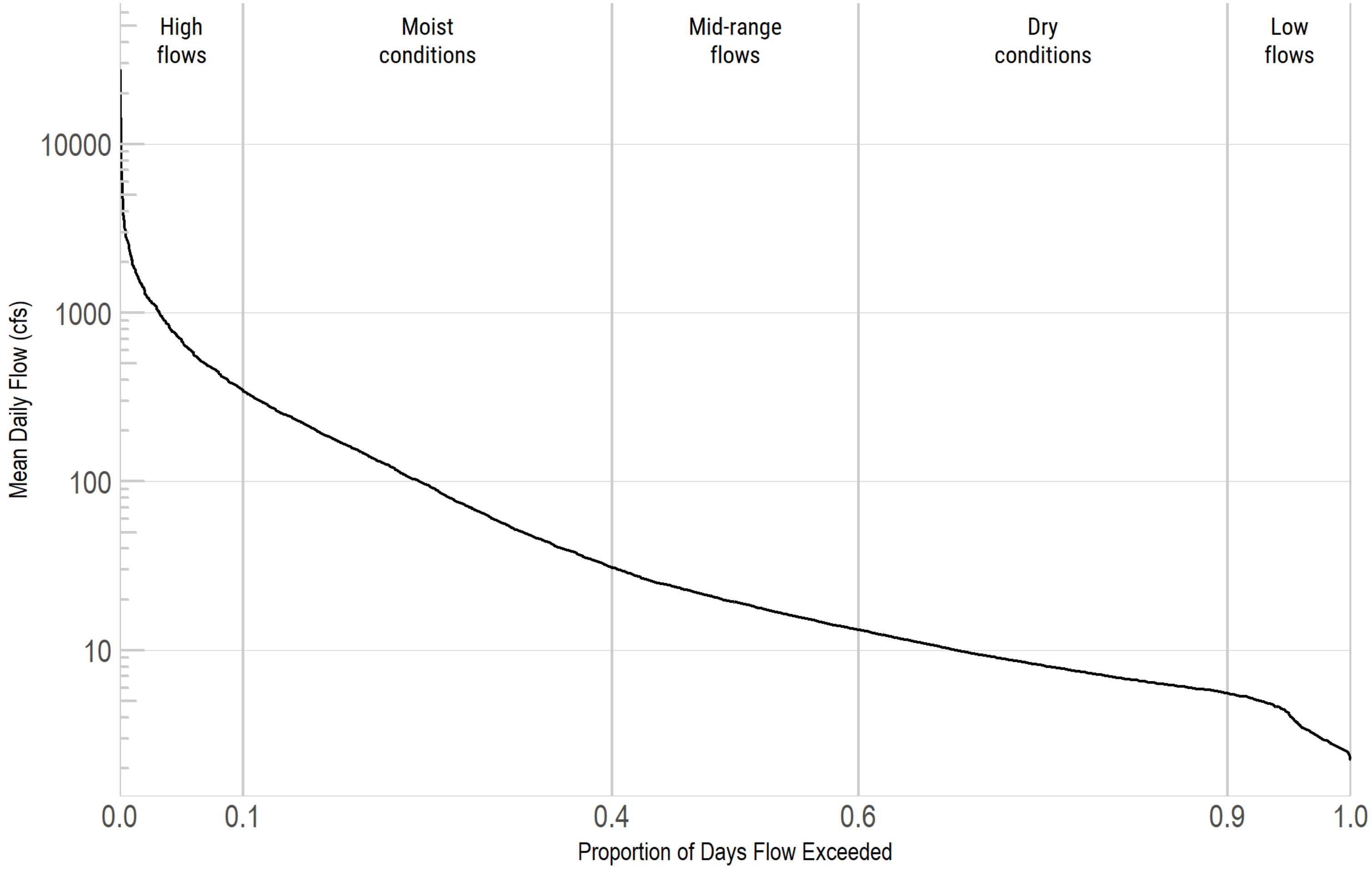
Hillebrandt Bayou (0704_02) Daily Streamflow



* Q = Mean Daily Discharge

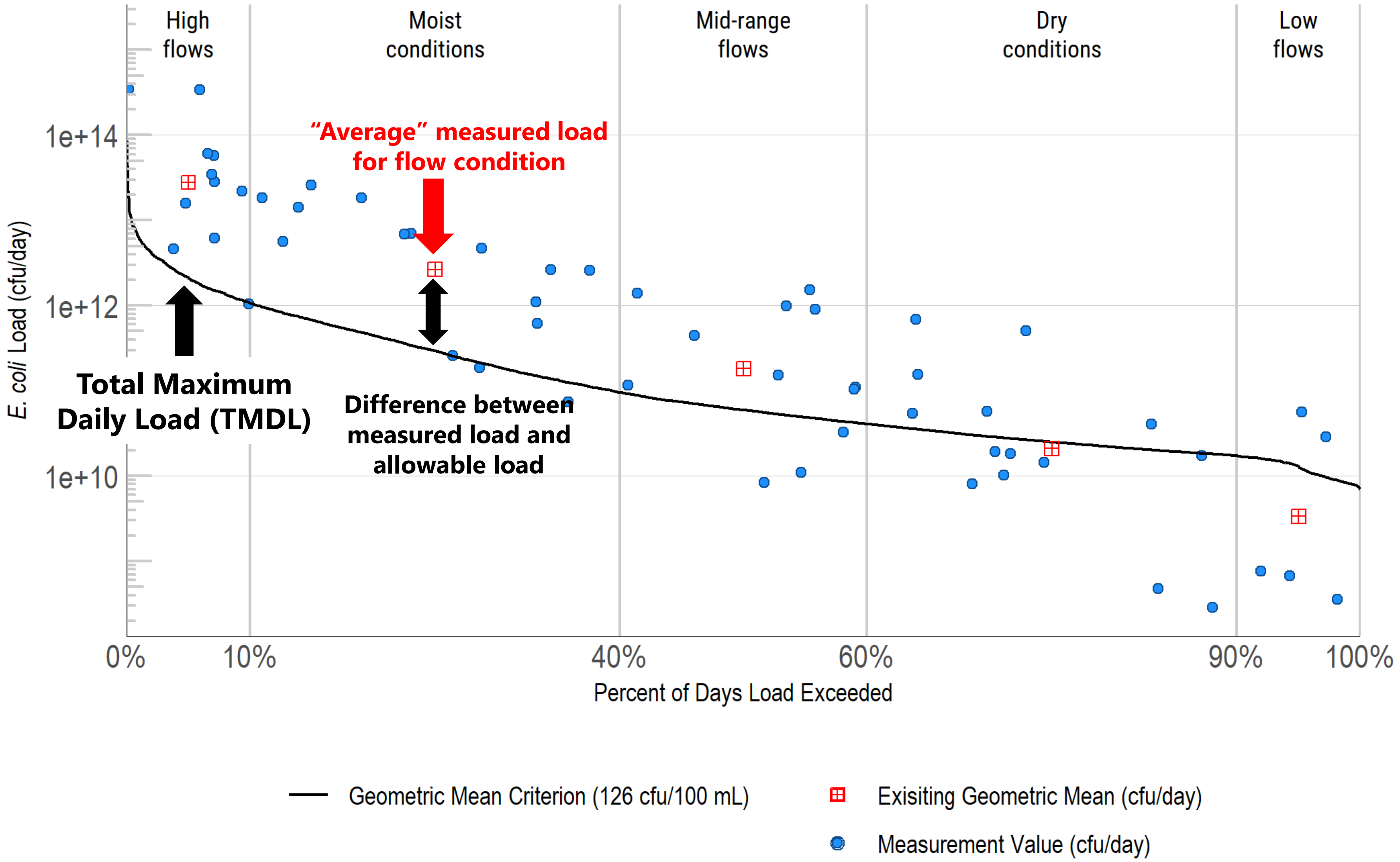
Texas Water Resources Institute
make every drop count

Hillebrandt Bayou (0704_02) Flow Duration Curve



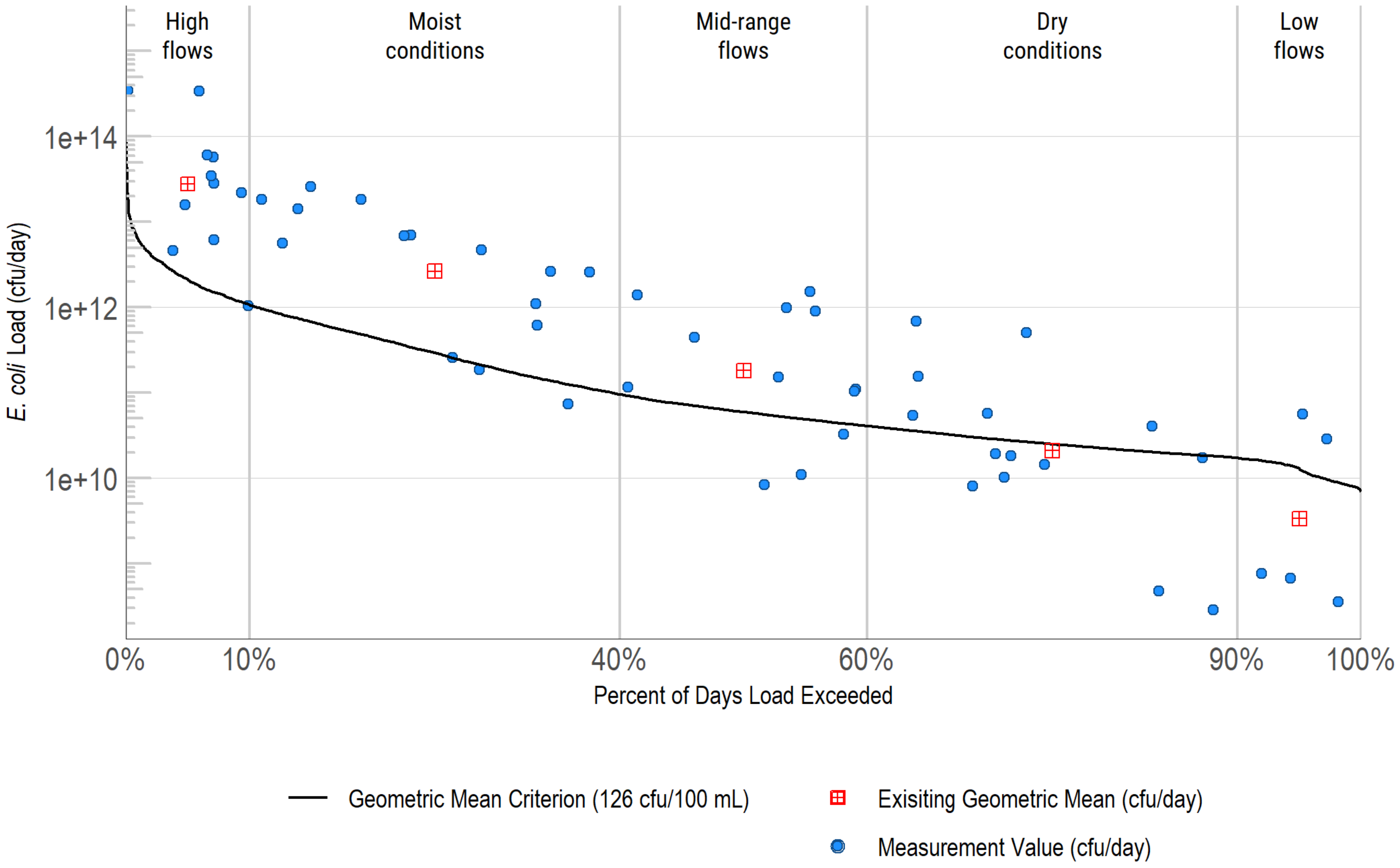
Texas Water Resources Institute
make every drop count

Hillebrandt Bayou (0704_02) Load Duration Curve



Texas Water Resources Institute
make every drop count

Load Duration Curve – Hillebrandt Bayou



Texas Water Resources Institute
make every drop count

Percent Reductions – Hillebrandt Bayou

Flow Regime	Median Flow (cfs)	Geometric Mean Concentration (cfu/day)	Existing Load (billion cfu/day)	Allowable Load (billion cfu/day)	Percent Reduction Required (%)
High Flows	682	1,662	27,726	2,102	92
Moist Conditions	95	1,138	2,644	293	89
Mid-Range Flows	19	386	182	59	67
Dry Conditions	8	106	21	25	NA
Low Flows	4	33	3	13	NA

Total Maximum Daily Load

- TMDL* = Water Quality Criterion x Volume of water per day
- The TMDL may include allocations for permitted WWTF discharges, regulated stormwater discharges, unregulated stormwater, future growth (FG), and margin of safety (MOS).
- WLA_{WWTF} – Permitted wastewater discharge load allocation
- WLA_{SW} – Regulated stormwater discharge load allocation
- LA – Unregulated stormwater load allocation
- FG – Future growth calculation
- MOS – Margin of Safety

* billion colony forming units per day

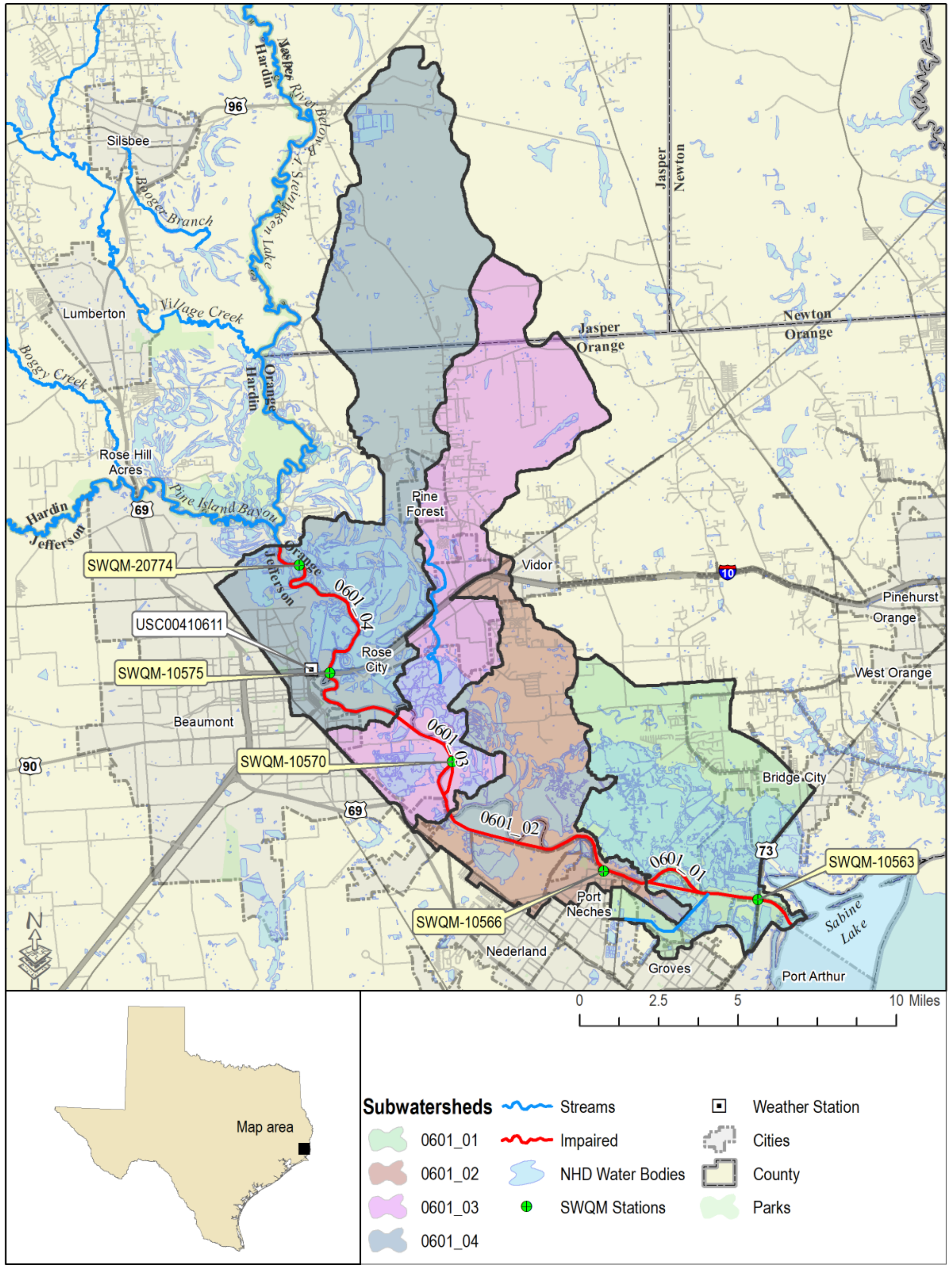
Load Allocations

Based on 5% exceedance flow of 681.844 cubic feet per second

TMDL = WLA + LA + FG + MOS

Total Maximum Daily Load:	2,101.907 billion cfu/day
Margin of Safety (5%):	105.095 billion cfu/day
Waste Load Allocation WWTF:	0 billion cfu/day
Waste Load Allocation Stormwater:	1,856.664 billion cfu/day
Load Allocation (Unregulated):	53.484 billion cfu/day
Future Growth:	86.664 billion cfu/day

Neches River Tidal (0601) Watershed

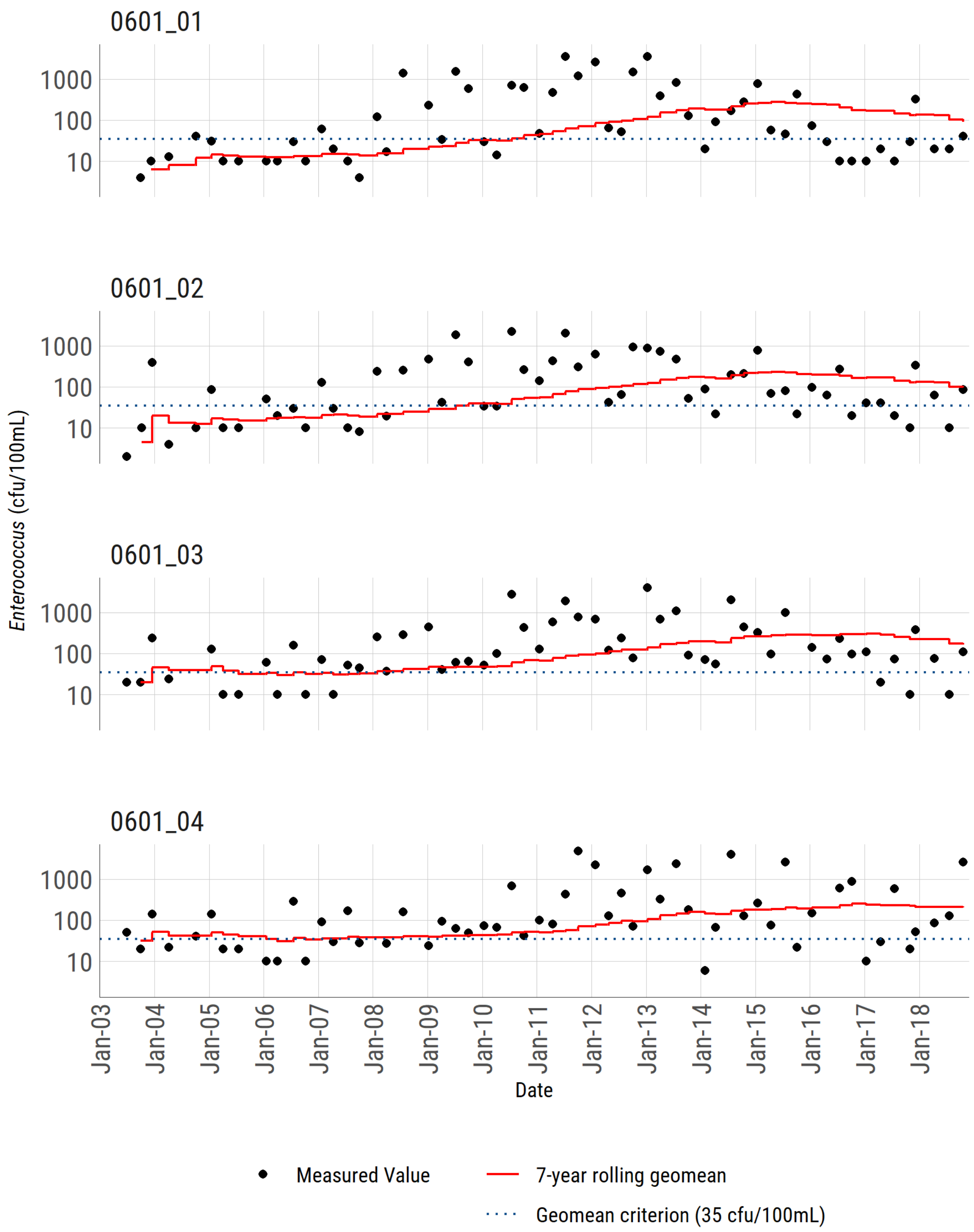


- Four impaired assessment units between Saltwater Barrier and confluence with Sabine Lake.
- 211 mi^2
- **Enterococci** geometric mean:
  - 99 cfu/100 ml Enterococci – (0601_04)
  - 159 cfu/100 ml Enterococci – (0601_03)
  - 97 cfu/100 ml Enterococci – (0601_02)
  - 86 cfu/100 ml Enterococci – (0601_01)
  - Dec 2011 through November 2018
- Water quality goal is 35 cfu/100 ml Enterococci

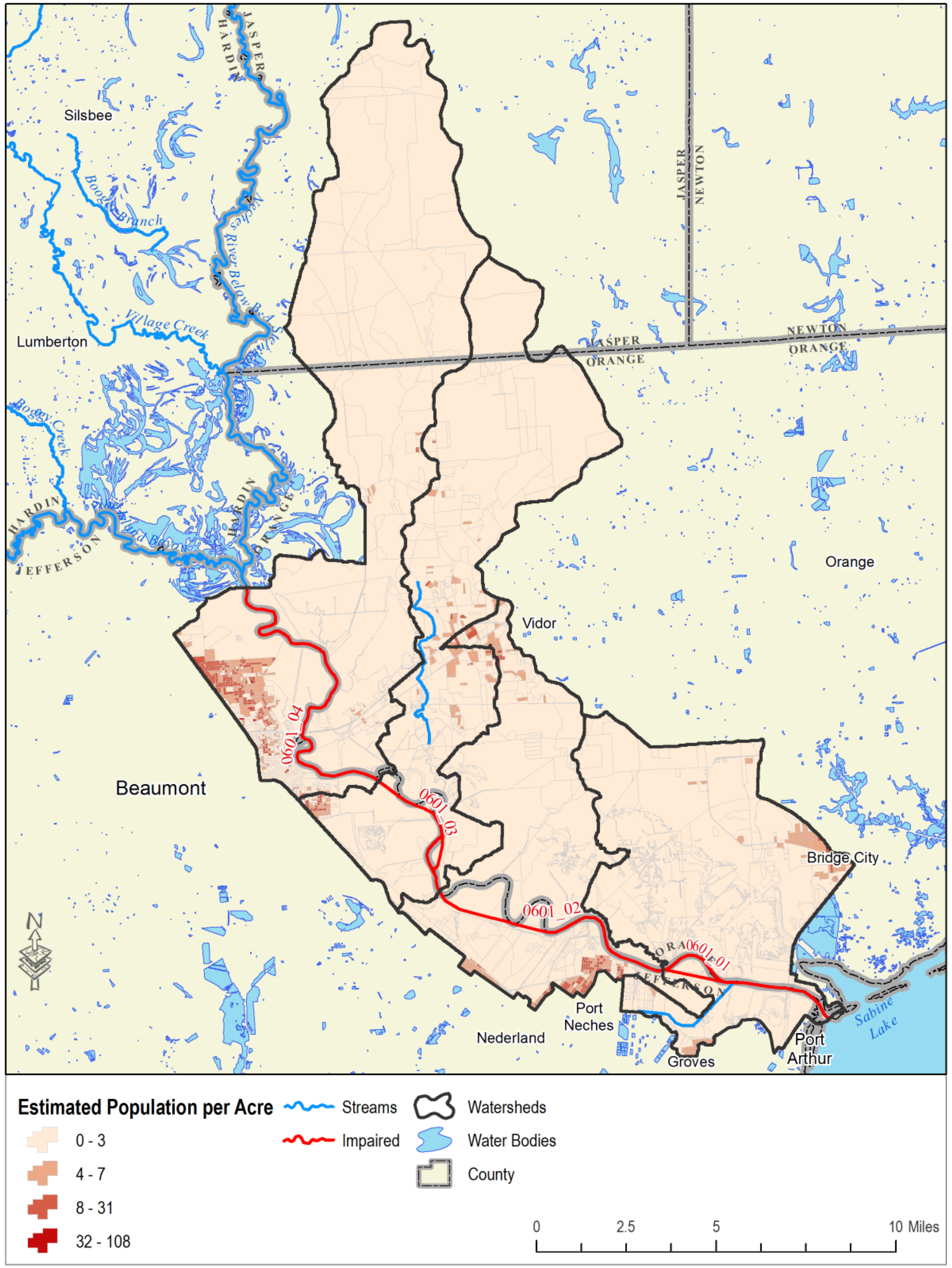
Source: 2020 TCEQ Texas Integrated Report

Texas Water Resources Institute
make every drop count

Historical Bacteria Dataset for 0601



Texas Water Resources Institute
make every drop count

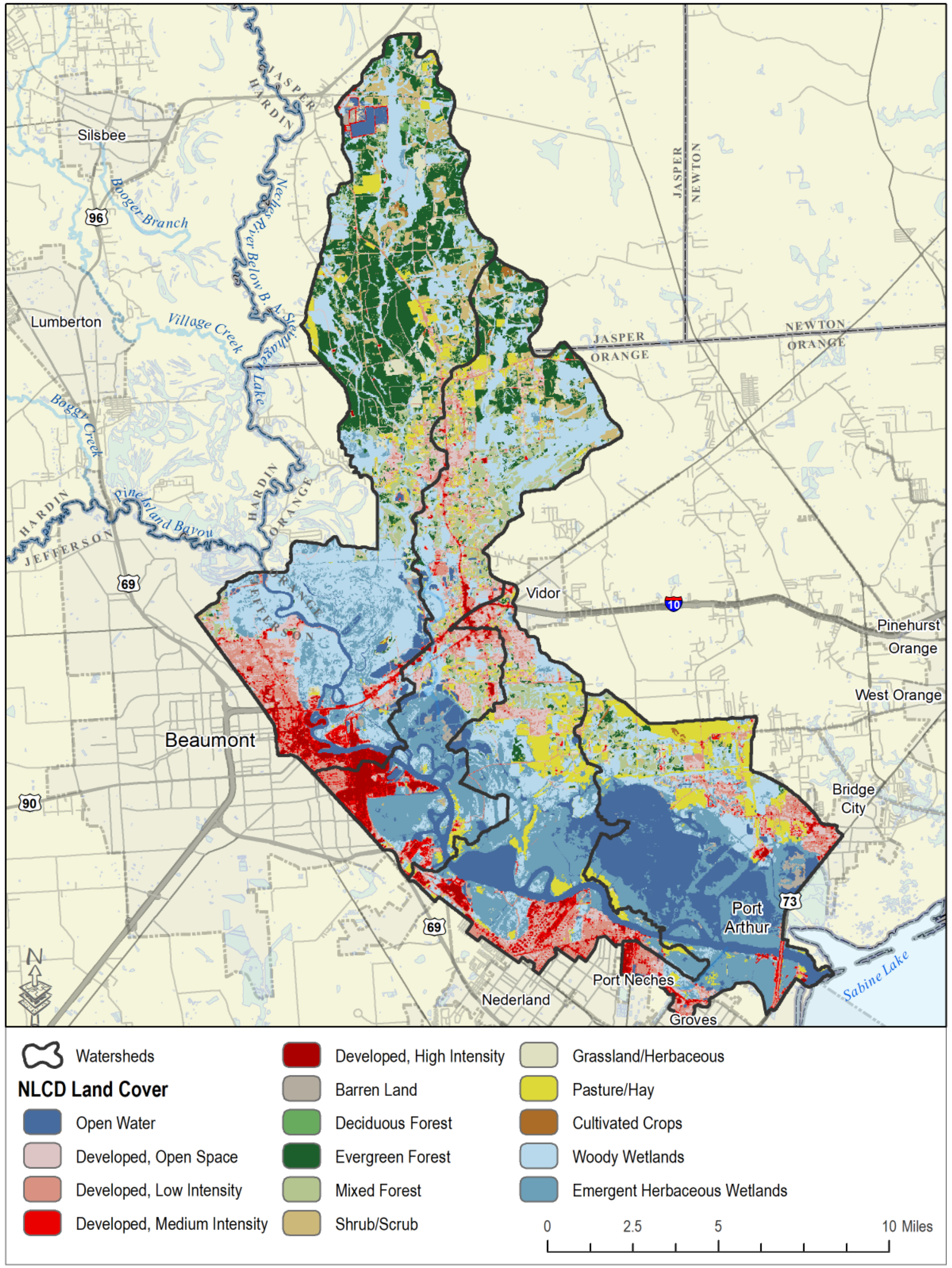


Watershed Population

- 2010 population 49,937 (estimated)
- 2070 population 65,920 (estimated)
- 25.1% population **increase** anticipated between 2020 and 2070

Sources: US Census Bureau 2010 Census Block Data (2010)
Texas Water Development Board Regional Water Plan Population Projections (2019)

Texas Water Resources Institute
make every drop count

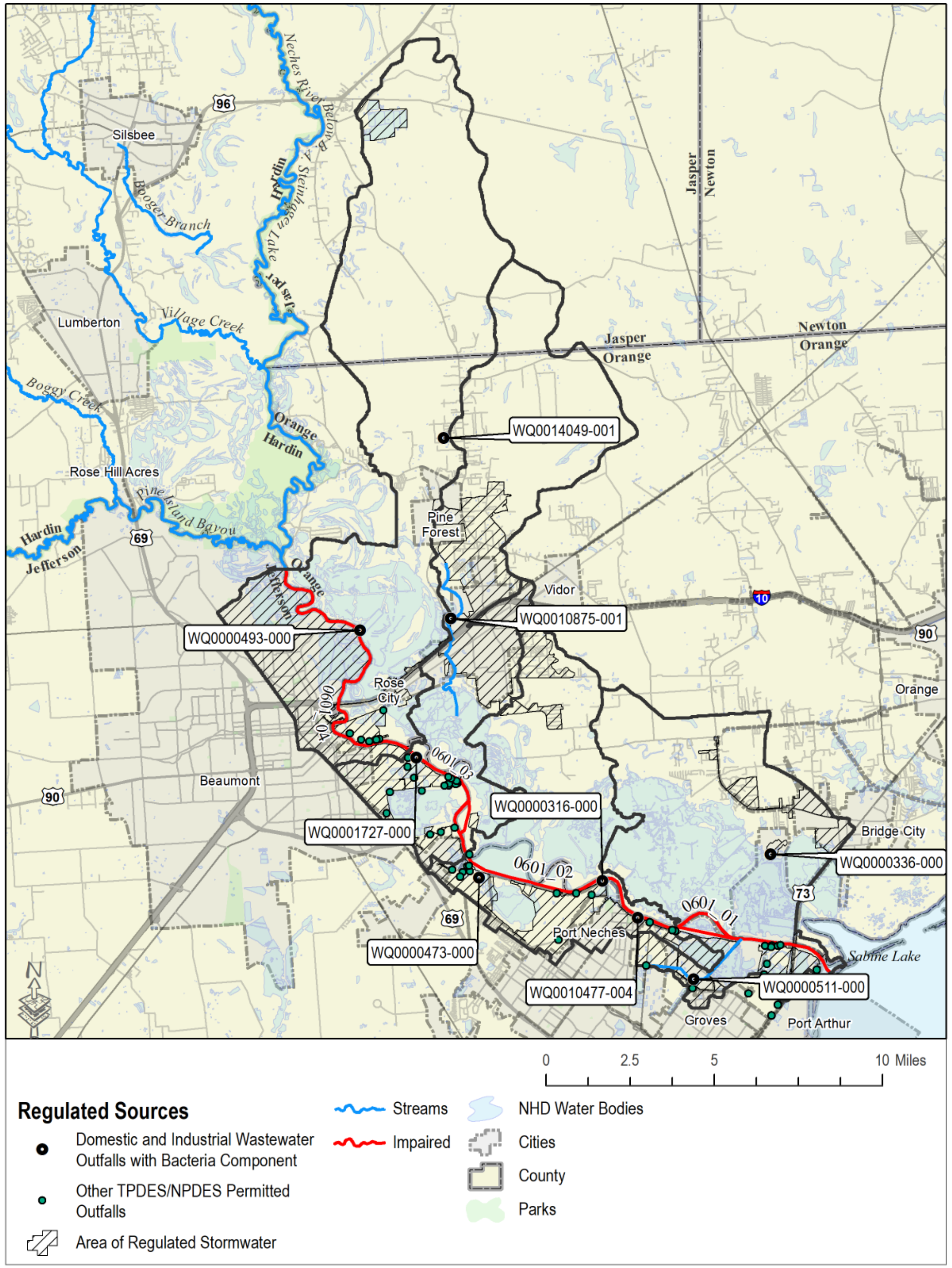


Land Cover

- Primarily developed along the western bank of Neches Tidal
- Increasing forest and grazeable acreage in Orange and Jasper counties
- Substantial wetlands and open water

Source: 2016 National Land Cover Dataset

Texas Water Resources Institute
make every drop count



Regulated Sources

Regulated Point Sources

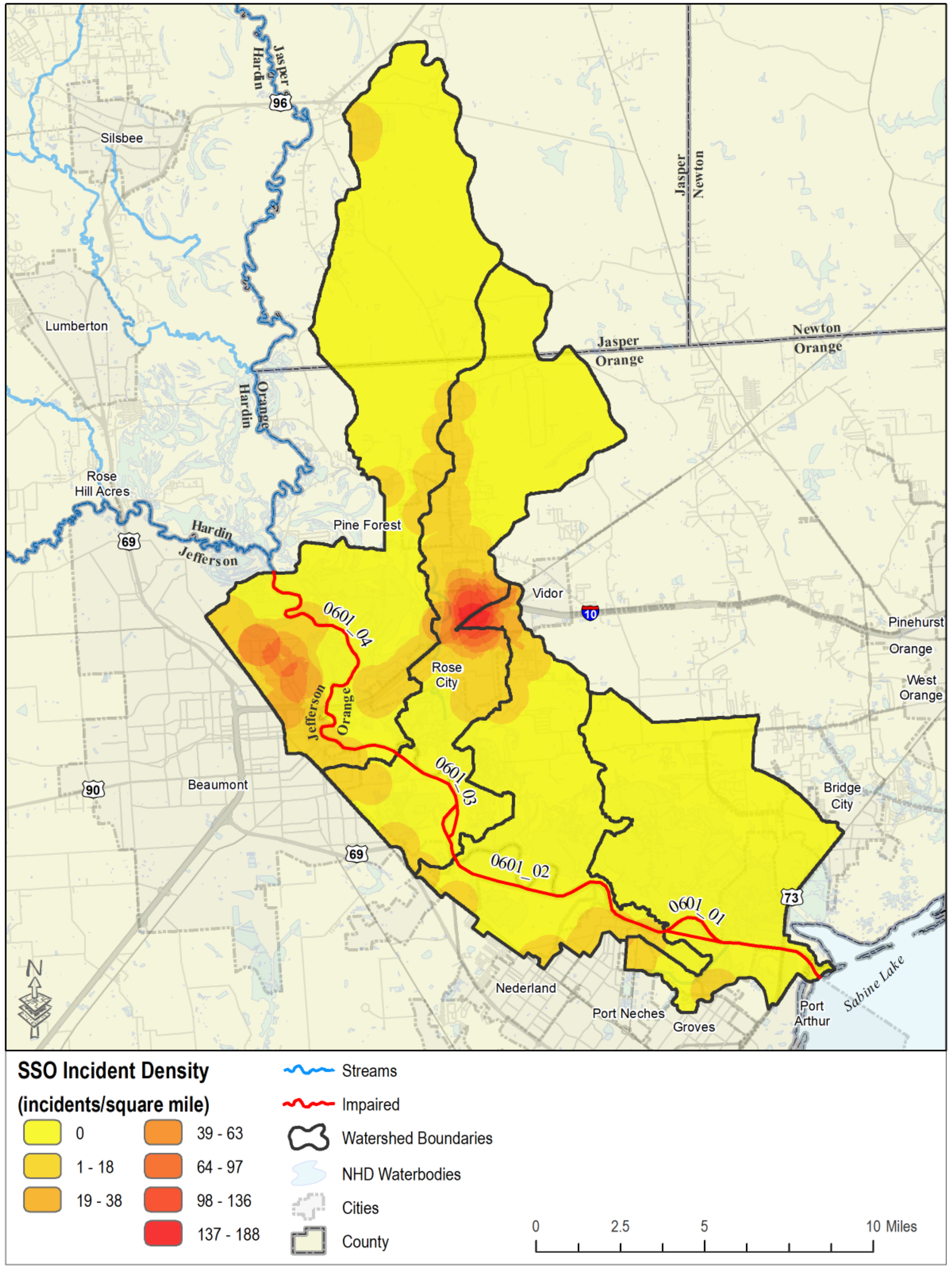
- 9 permitted domestic or industrial discharges-**with bacteria reporting limits**

Regulated Stormwater

- Phase I MS4 permit (Beaumont and Jefferson County DD6)
- Combined Phase I and II (TxDOT)
- 10 Phase II MS4 permits
- 23 Individual Industrial WWTFs with regulated stormwater
- **49 mi² of regulated stormwater**

Source: TCEQ Permits

Texas Water Resources Institute
make every drop count

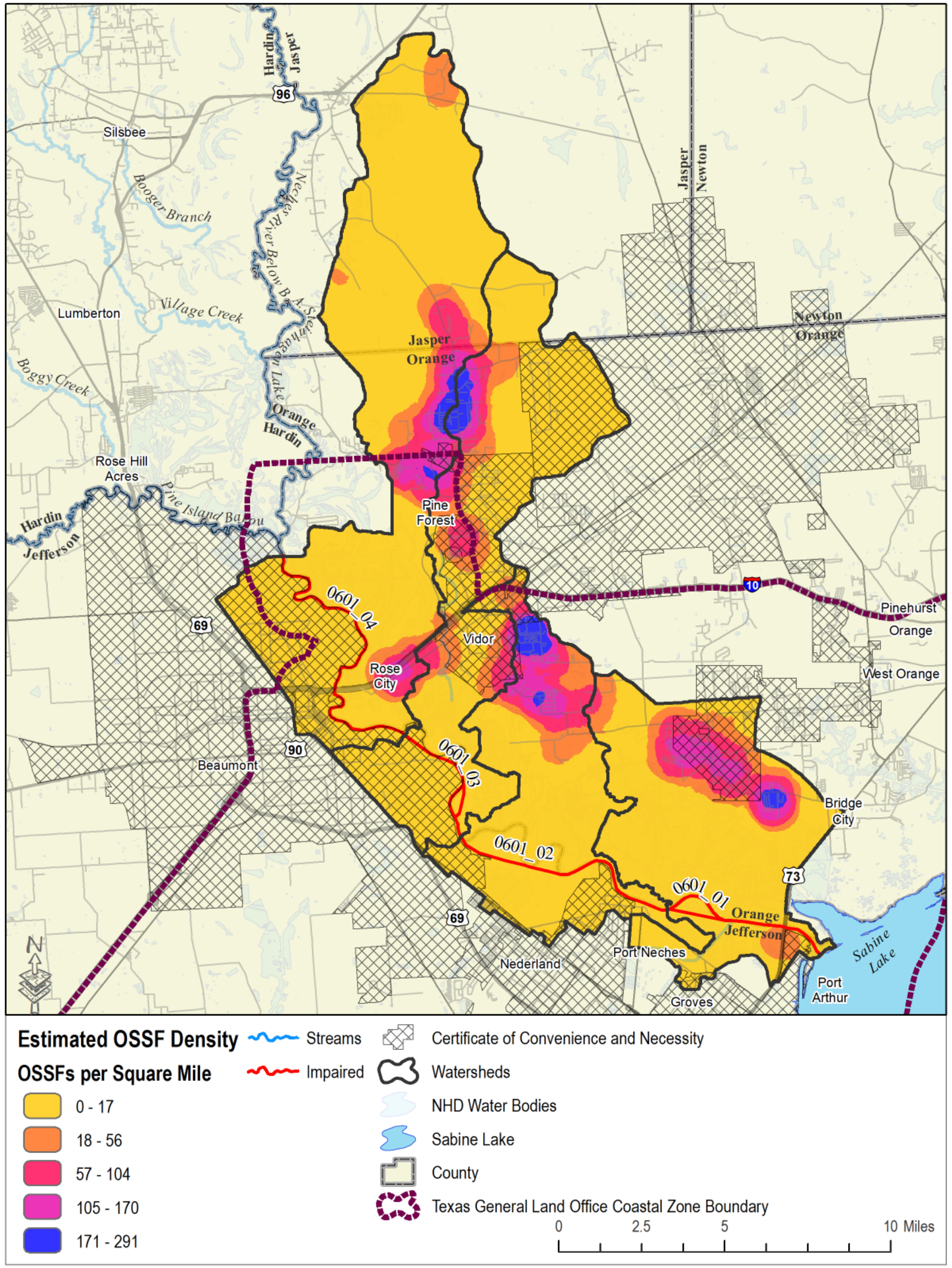


Sanitary Sewer Overflows

- 838 reported incidents from 2005-2018

Source: TCEQ databases

Texas Water Resources Institute
make every drop count



OSSFs (Septic Systems)

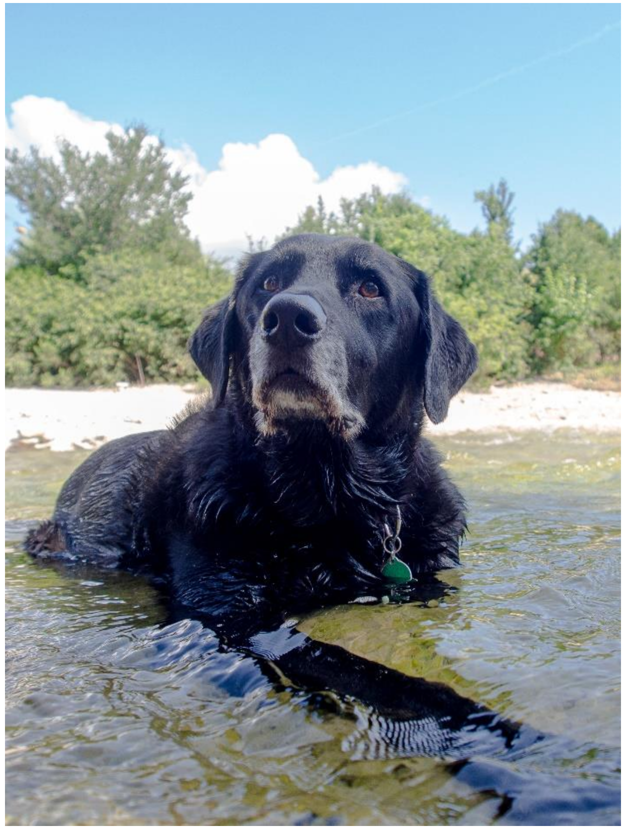
- Approximately 4,059 OSSFs
- Estimated failure rate in this part of the state is 12-19%

Sources:
TCEQ Coastal OSSF Database and Statewide 911 Address Database
Reed, Stowe, and Yanke, LLC. (2001). *Study to Determine the Magnitude of, and Reasons for, Chronically Malfunctioning On-site Sewage Facility Systems in Texas.* URL: www.tceq.texas.gov/assets/public/compliance/compliance_support/regulatory/ossf/StudyToDetermine.pdf

Pets, Wildlife, and Livestock

Dogs	12,769
Cats	9,503
Cattle	3,010
Pigs	123
Goats/Sheep	263
Horses	228
Deer	438
Feral Hogs	2,334

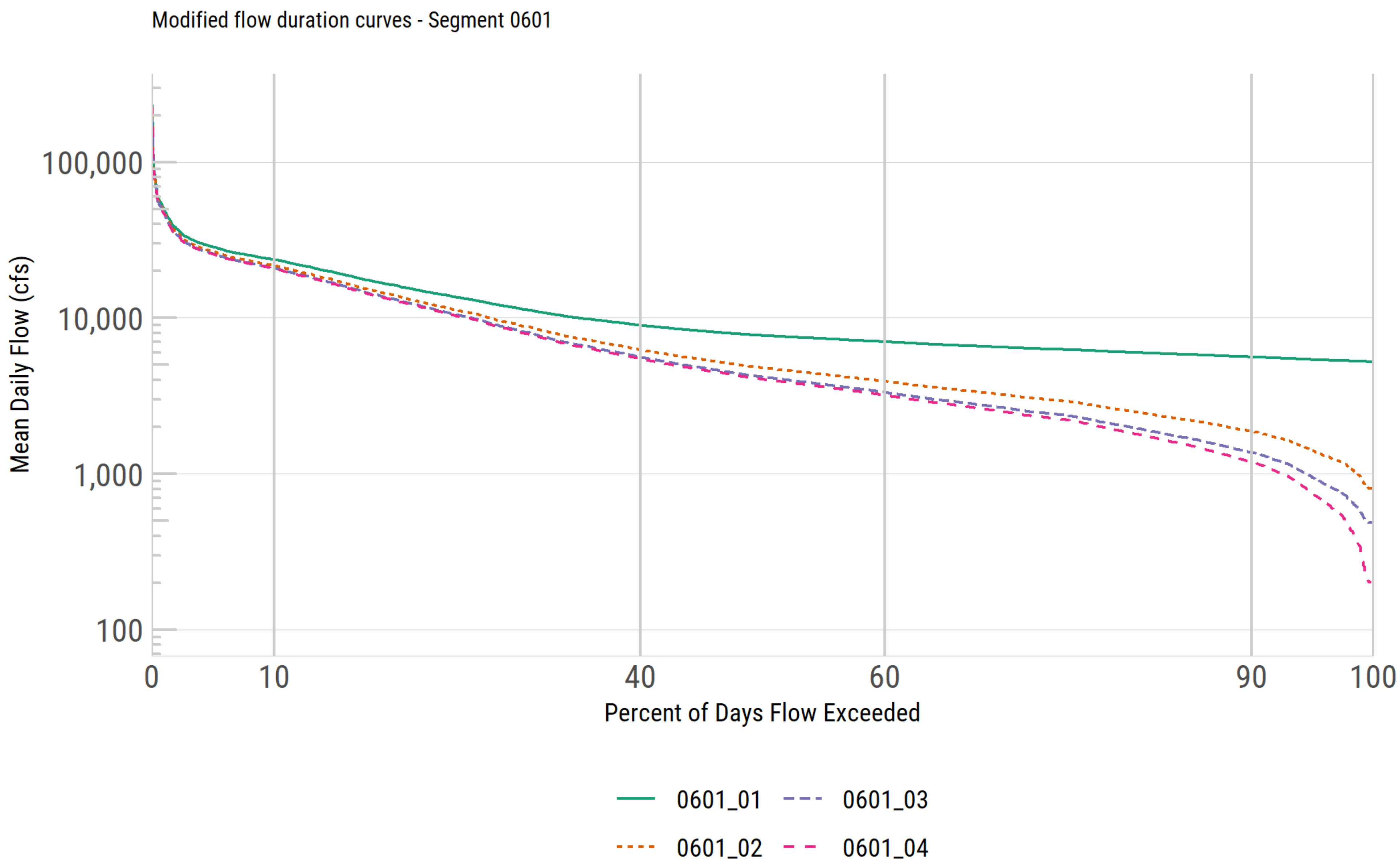
Other wildlife aren't quantified since inadequate data are available to estimate population



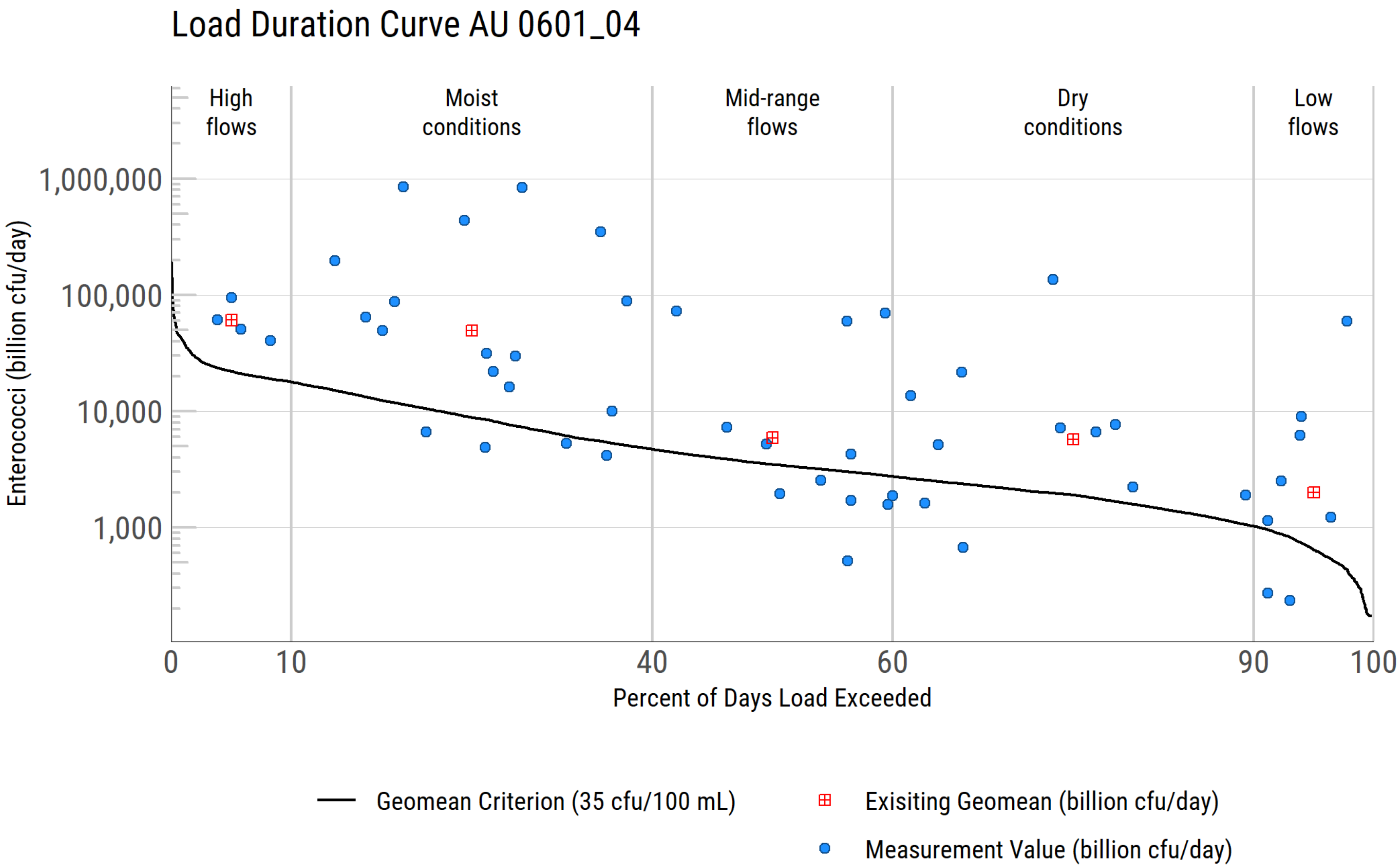
Sources:
American Veterinary Medical Association (2018-2019) Demographic Data
USDA National Agricultural Statistics Service 2017 Census of Agriculture (2019)
TPWD Survey Data (2018)
Texas A&M AgriLife Statewide Wild Pig Estimates (2012)

TMDL Allocations

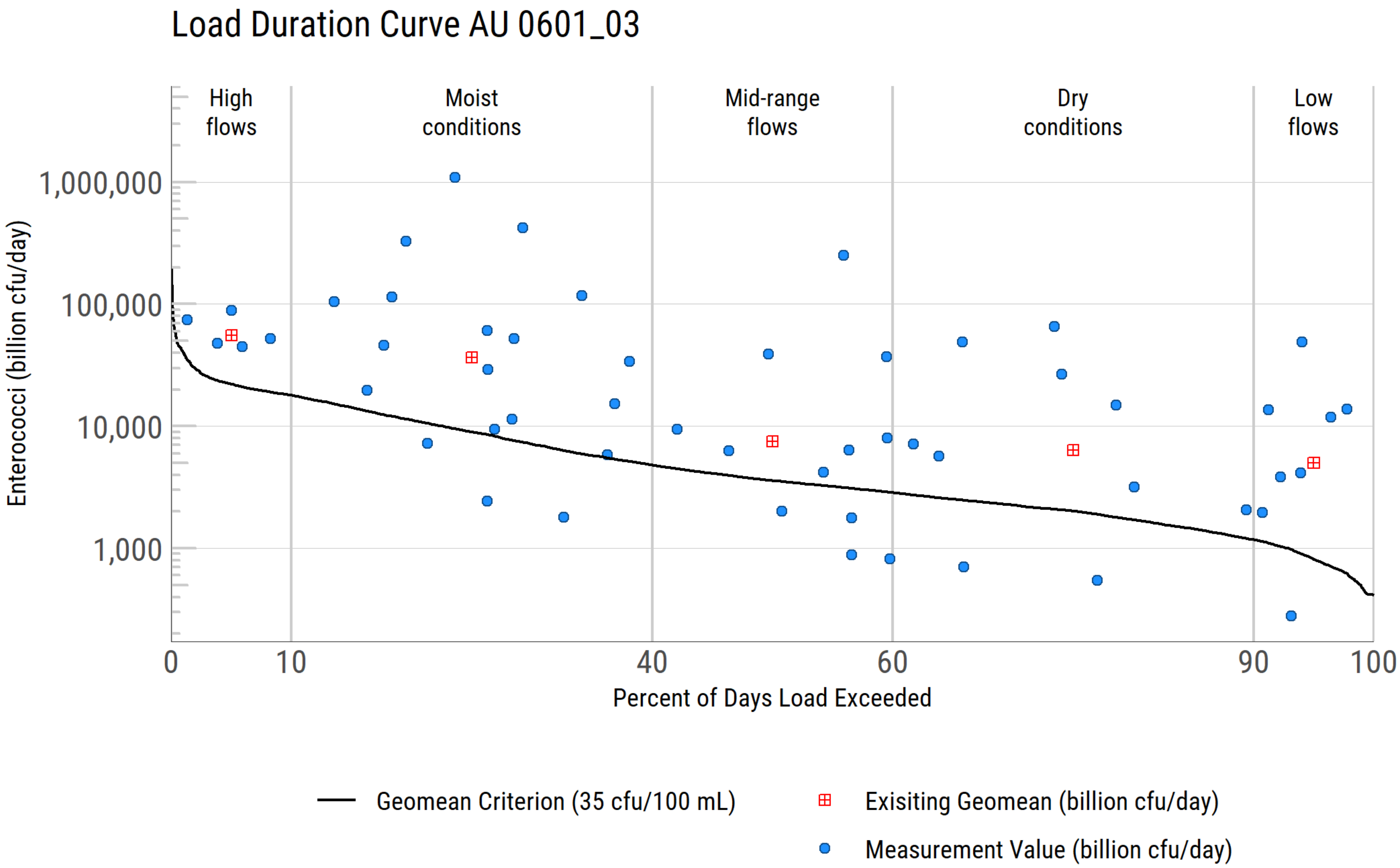
- A **Modified Load Duration Curve** was used to determine the TMDLs and load allocations in the Neches River Tidal.
- The Modified LDC **accounts for the volume of tidal saltwater** that enters the system and provides additional capacity.
- The amount of freshwater was determined using the freshwater inflows from the USGS gage at the Saltwater Barrier plus flows determined using the drainage area ratio approach.
- The amount of saltwater was determined using a salinity regression and mass balance equation.



Texas Water Resources Institute
make every drop count

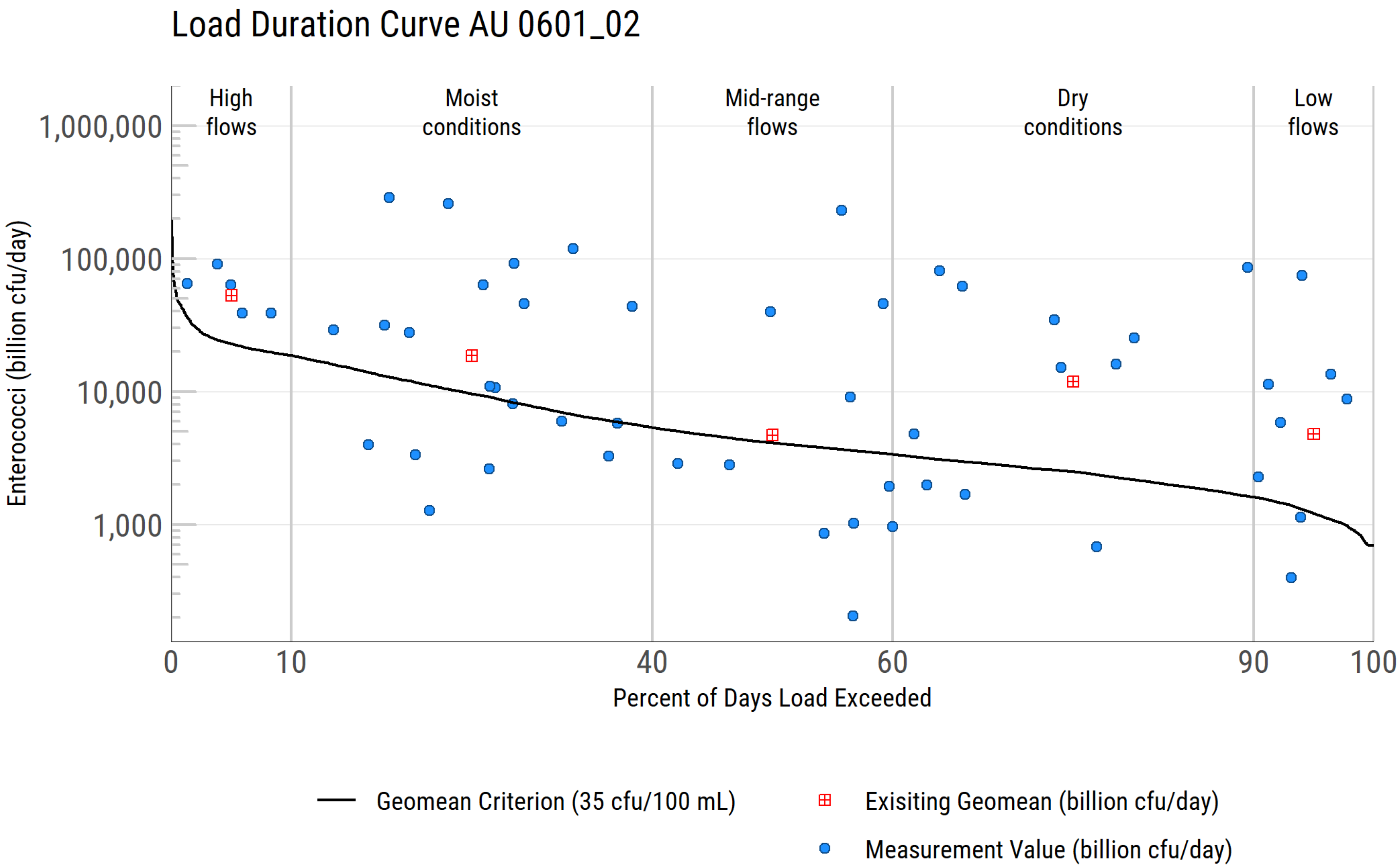


Flow Regime	Percent Reduction Required
High Flows	64
Moist Conditions	82
Mid-Range Flows	41
Dry Conditions	67
Low Flows	68



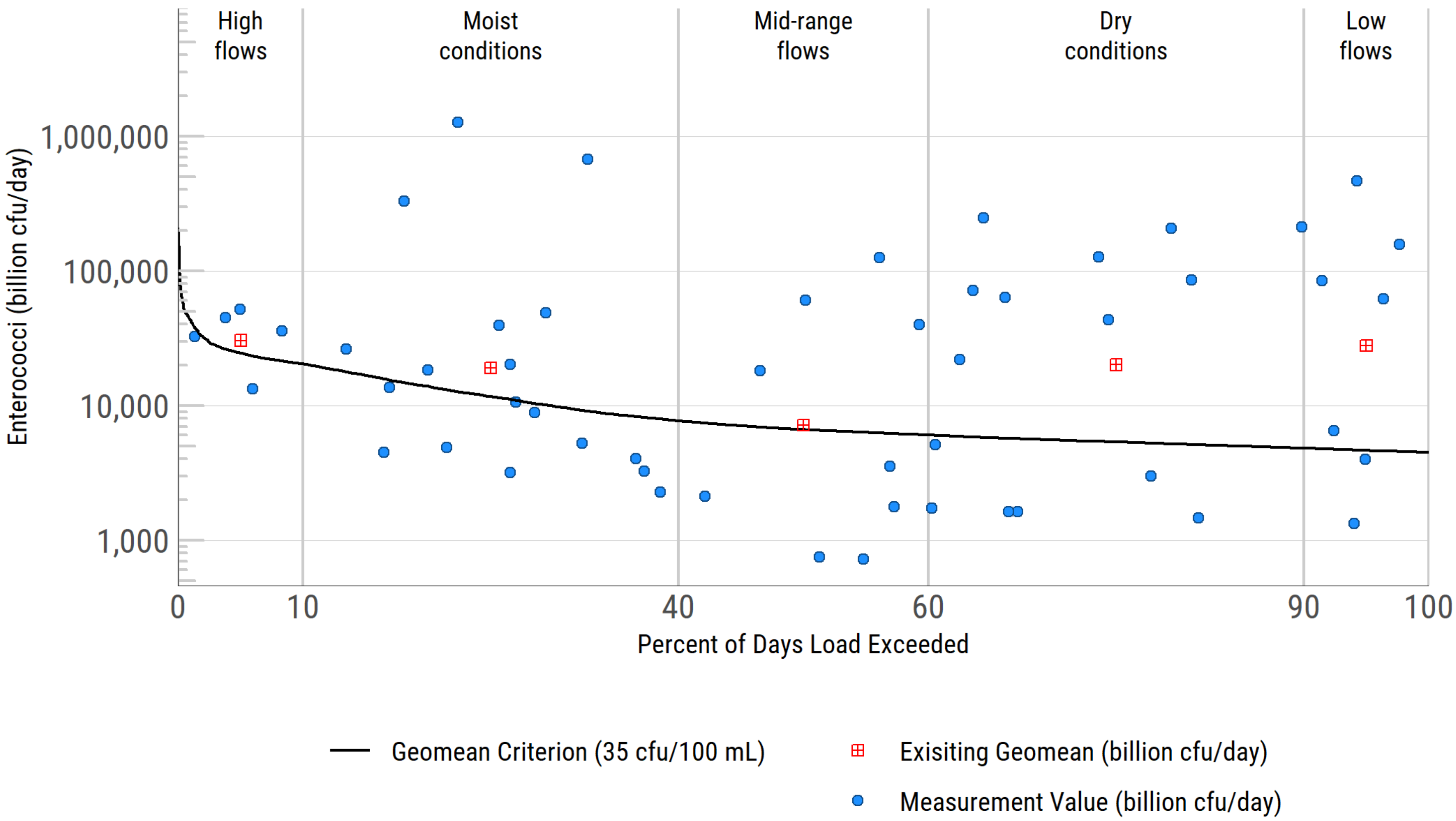
Flow Regime	Percent Reduction Required
High Flows	60
Moist Conditions	76
Mid-Range Flows	52
Dry Conditions	68
Low Flows	84

Texas Water Resources Institute
make every drop count



Flow Regime	Percent Reduction Required
High Flows	57
Moist Conditions	48
Mid-Range Flows	13
Dry Conditions	79
Low Flows	75

Load Duration Curve AU 0601_01



Flow Regime	Percent Reduction Required
High Flows	19
Moist Conditions	39
Mid-Range Flows	7
Dry Conditions	73
Low Flows	83

Texas Water Resources Institute
make every drop count

TMDL Allocations

Based on 5% exceedance flow, load reported as billion cfu/day

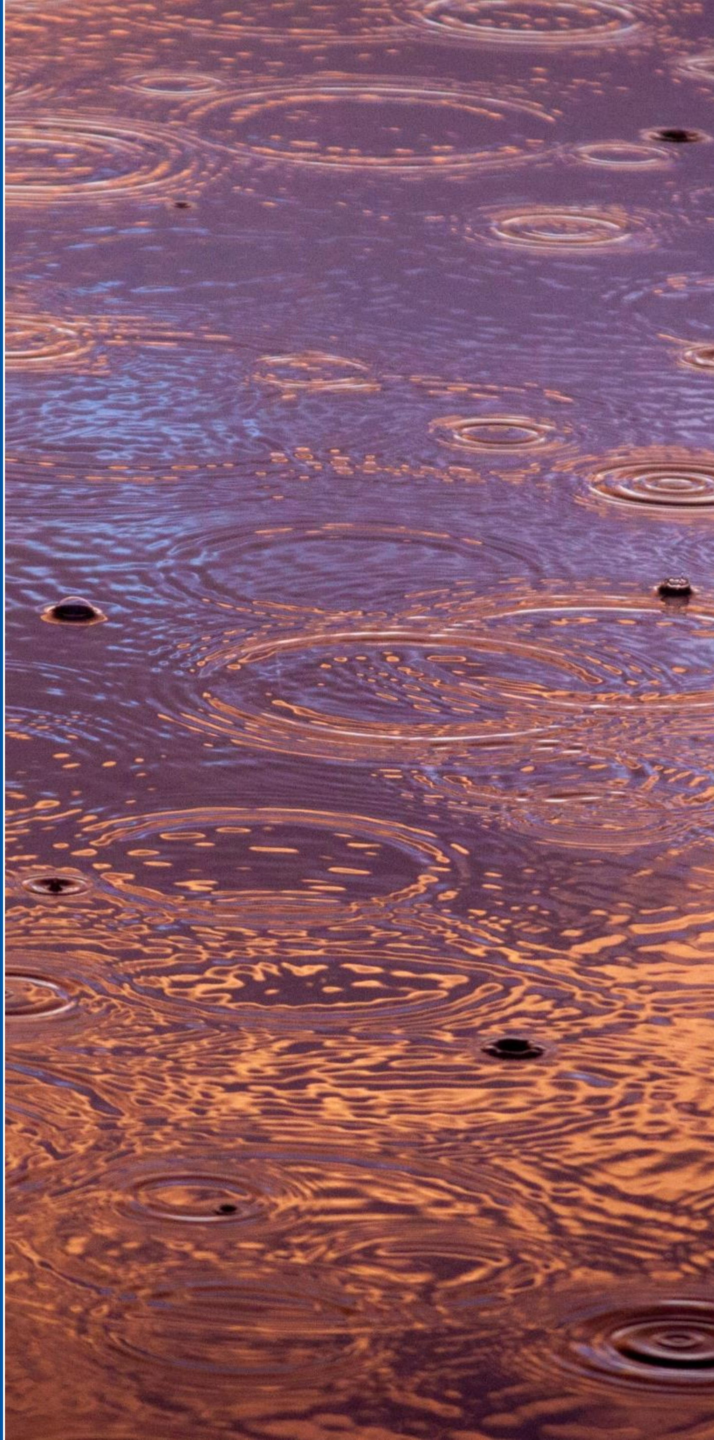
TMDL = WLA + LA + FG + MOS

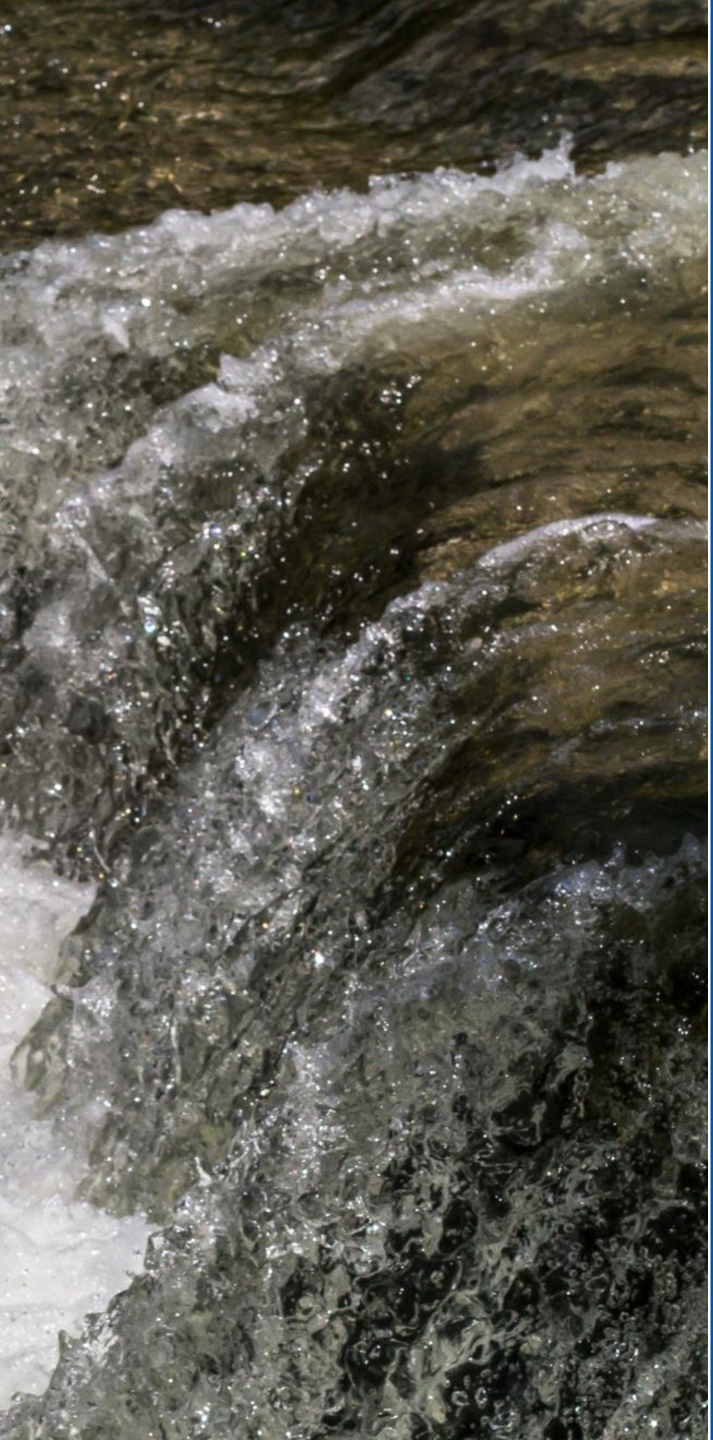
AU	0601_01	0601_02	0601_03	0601_04
Flow	28,589	26,678	25,864	25,662
Total Maximum Daily Load:	24,480.762	22,844.372	22,147.344	21,974.371
Margin of Safety (5%):	1,224.038	1,142.219	1,107.367	1,098.719
Waste Load Allocation WWTF:	144.417	144.417	117.946	86.148
Waste Load Allocation Stormwater:	5,376.722	5,444.936	4,888.828	4,236.648
Load Allocation (Unregulated):	17,699.336	16,076.551	16,003.599	16,531.233
Future Growth:	36.249	36.249	29.604	21.623

Texas Water Resources Institute
make every drop count

Next Steps:

- August 19th meeting focused on permitting
- I will be in touch soon about scheduling a coordination committee meeting (September meeting date is likely)
- Let me know if there are people you'd like to hear from in upcoming meetings (for example, TCEQ Stormwater, TSSWCB, etc.)





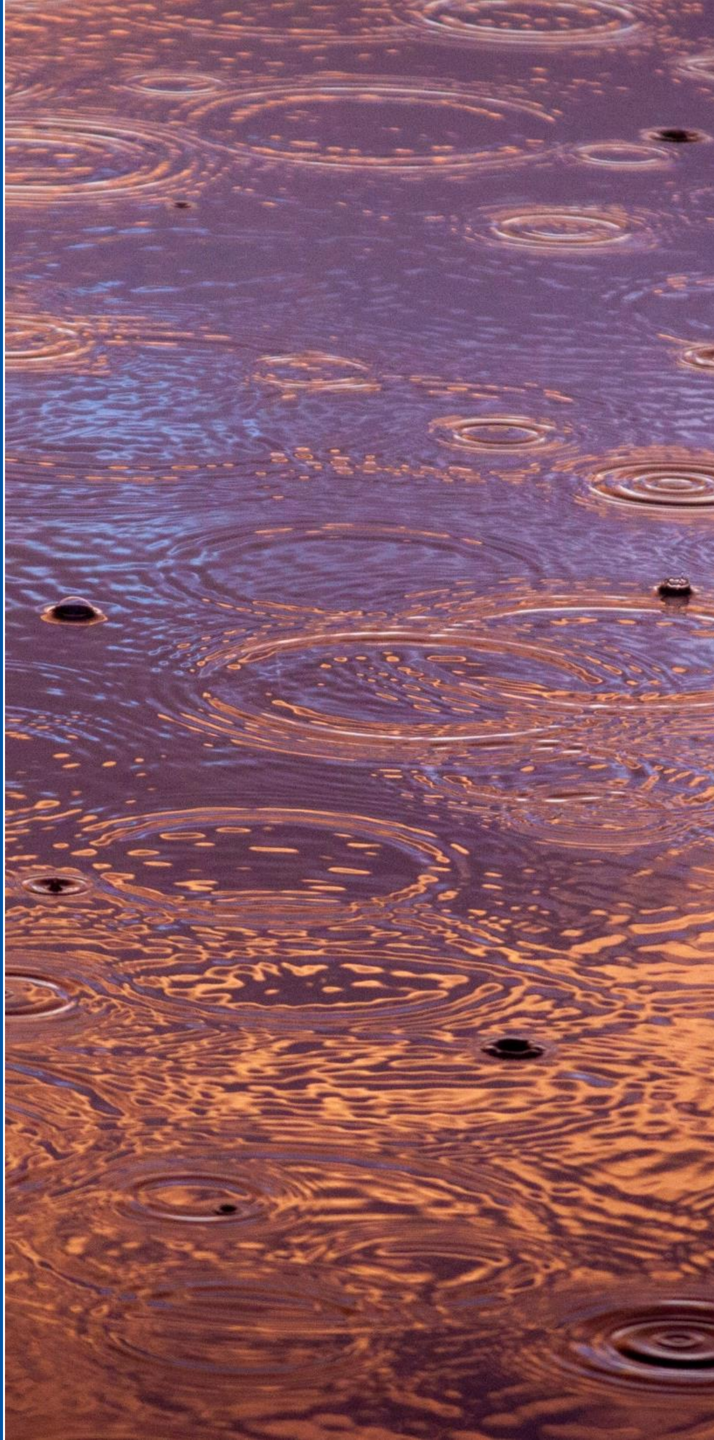
Thank You!

Contact Info:
Michael Schramm – Michael.Schramm@ag.tamu.edu
Dania Grundmann – Dania.Grundmann@tceq.texas.gov
Lucas Gregory – lfgregory@ag.tamu.edu

Texas Water Resources Institute
make every drop count

Texas Water Resources Institute
make every drop count

Extra Slides



Hillebrandt Bayou Drainage Area Ratio

- $Y = X \left(\frac{A_y}{A_x}\right)^{\phi} \times \left(\frac{D_y}{D_x}\right)^{\psi} \times \left(\frac{W_y}{W_x}\right)^{\omega}$

- Y = streamflow for the ungaged location,
- X = streamflow for the gaged location,
- A_y = drainage area for the ungaged location,
- A_x = drainage area for the gaged location,
- D_y = developed area for the ungaged location,
- D_x = developed area for the gaged location,
- W_y = wetland area for the ungaged location,
- W_x = wetland area for the gaged location,
- ϕ, ψ , ω = estimated parameters.

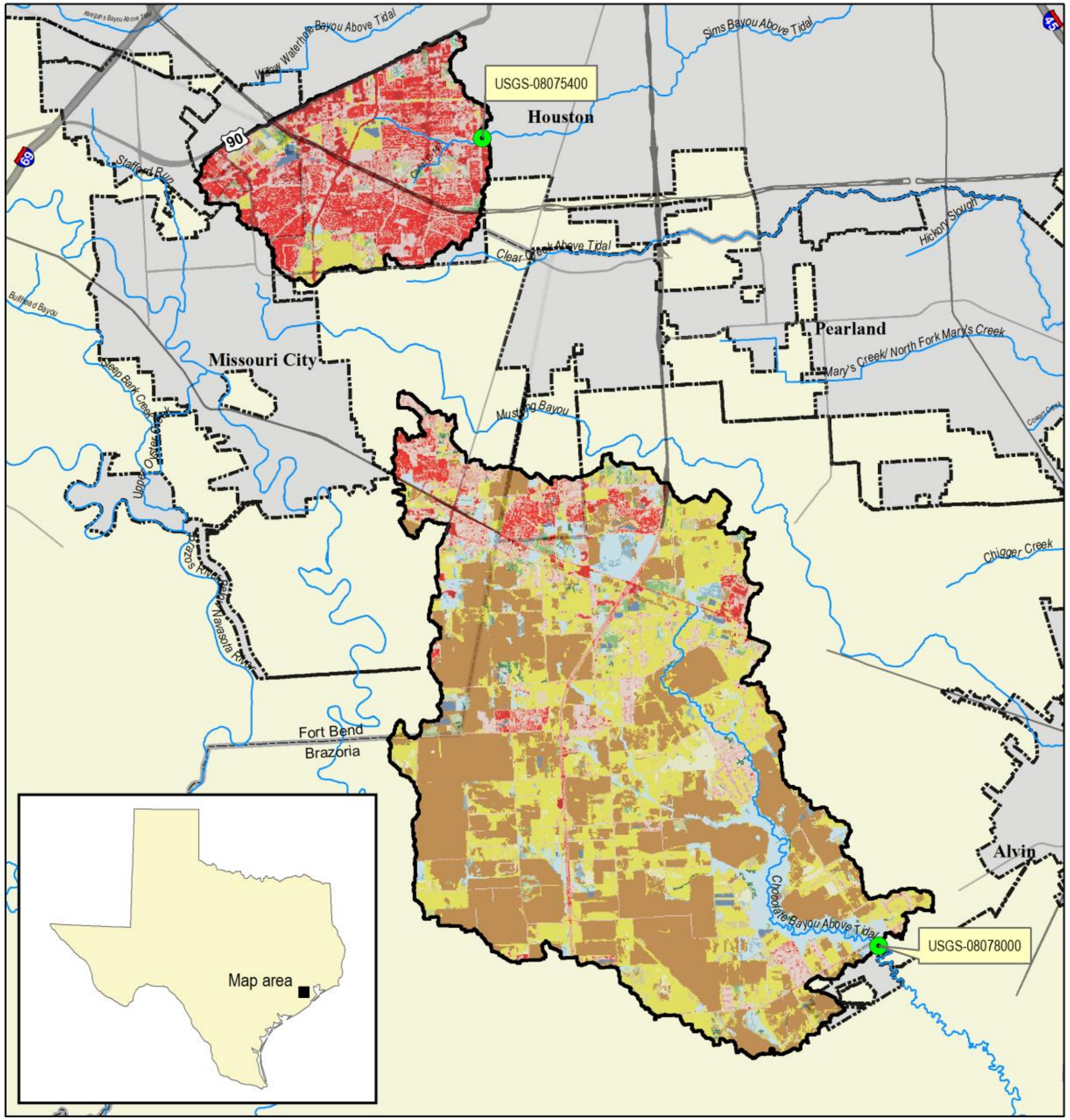
Parameter estimation using quasi-Newton optimization process to minimize RMSE between predicted and measured daily streamflow. Values of ϕ from empirical estimates in Asquith (2006).

Texas Water Resources Institute
make every drop count

Watersheds used to develop DAR parameters for Hillebrandt Bayou

Sims Bayou (USGS 08075400)

Chocolate Bayou (USGS 0807800)

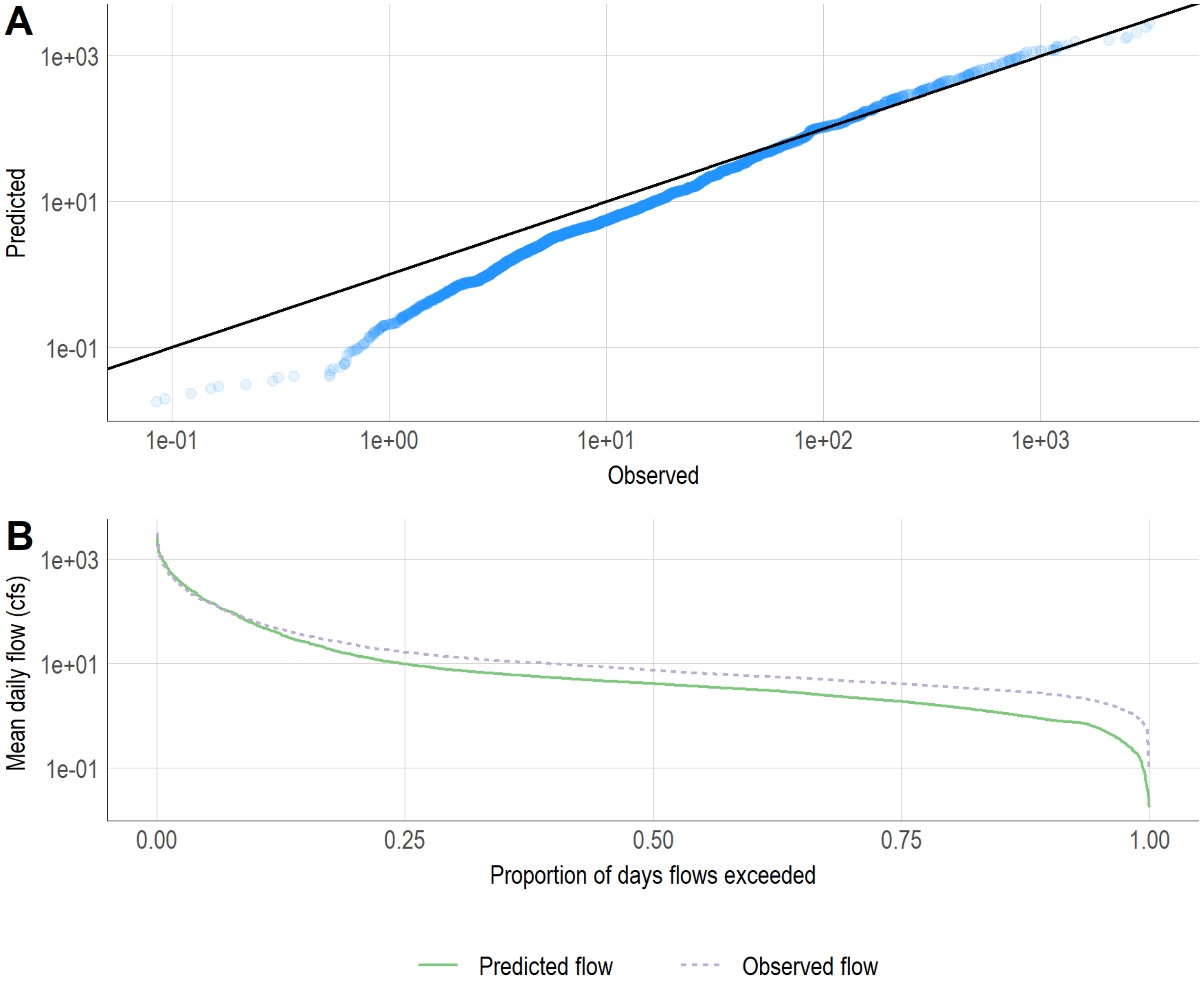


Texas Water Resources Institute
make every drop count

DAR Parameters

Goodness of Fit, observed and predicted streamflow values along the FDC:

- RMSE: 29.53cfs
- NSE: 0.96



Texas Water Resources Institute
make every drop count

Modified Load Duration Curve – Neches River Tidal

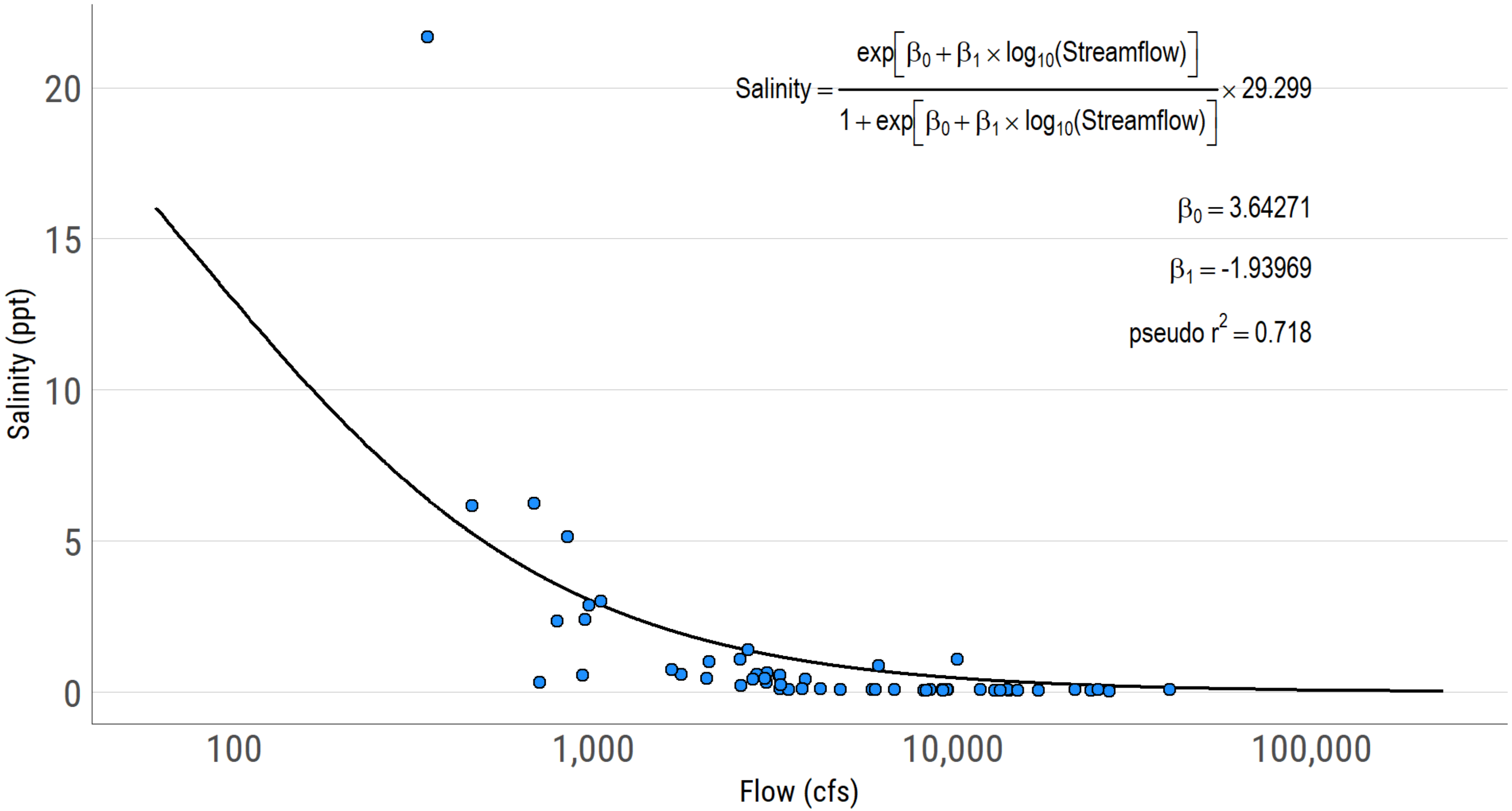
1. Develop salinity to streamflow regression equations at each monitoring station to so we can estimate salinity at mean daily flow values.
2. Use a mass-balance equation to estimate the amount of seawater required to achieve the regression estimated salinity values.

$V_s = V_r/(S_s/S_t - 1)$ For S_t > than background salinity, otherwise $V_s = 0$

$$V_S + V_F = V_T$$

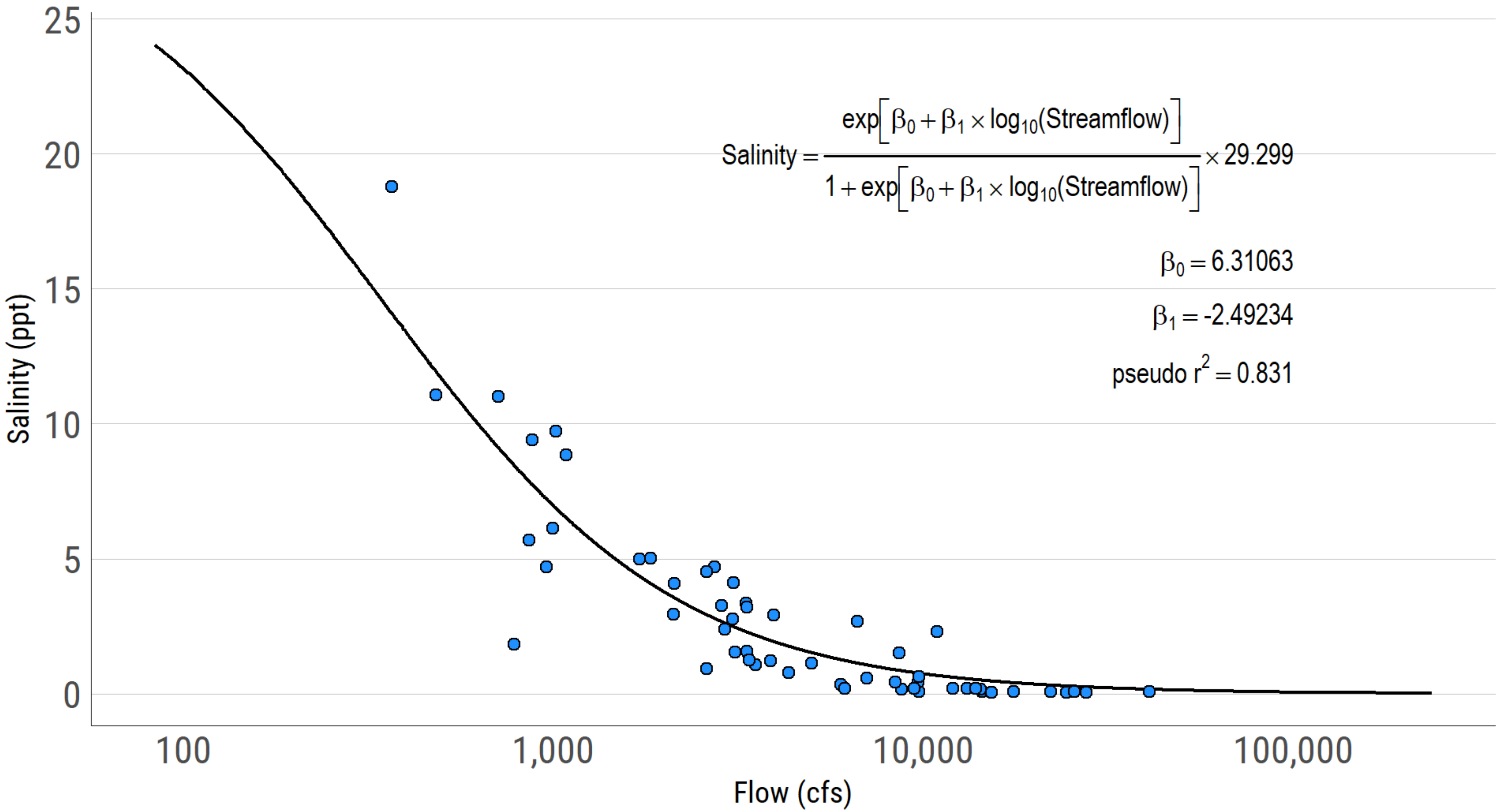
Texas Water Resources Institute
make every drop count

Mean daily streamflow × salinity regression 0604_04



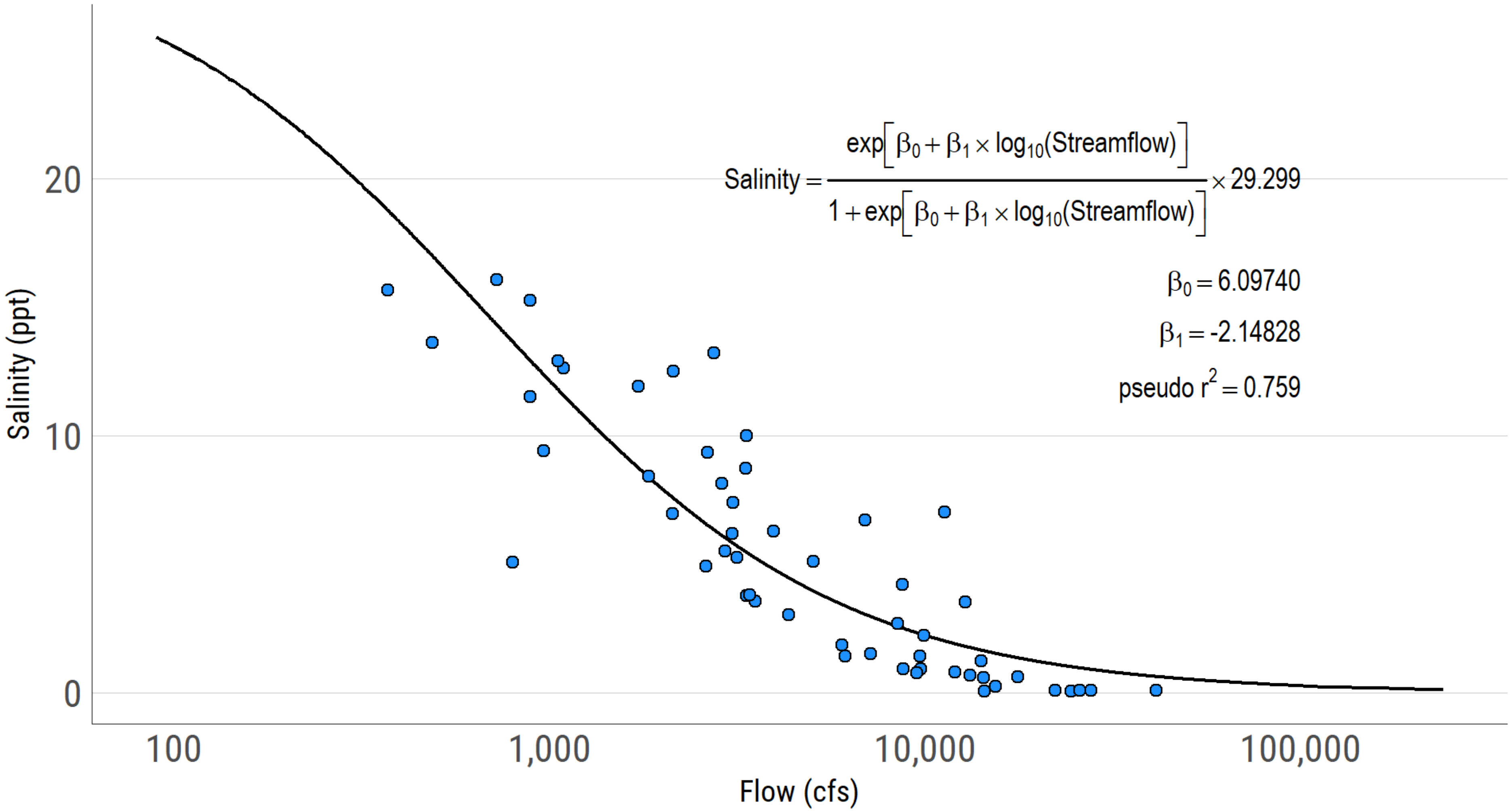
Texas Water Resources Institute
make every drop count

Mean daily streamflow × salinity regression 0604_03

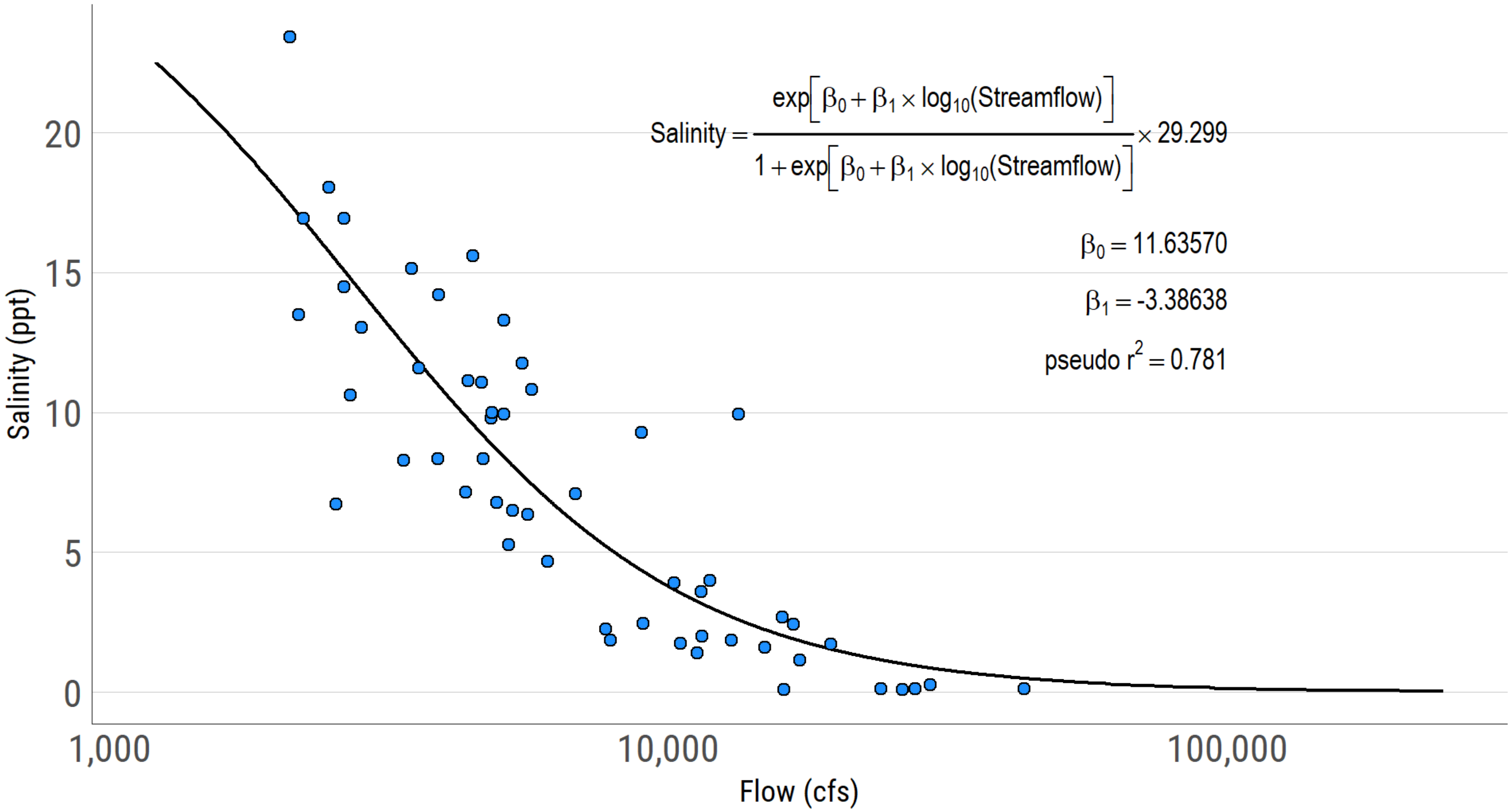


Texas Water Resources Institute
make every drop count

Mean daily streamflow × salinity regression 0604_02



Mean daily streamflow × salinity regression 0604_01



Texas Water Resources Institute
make every drop count