HILLEBRANDT BAYOU AND NECHES TIDAL PROJECT UPDATE

Michael Schramm - Texas Water Resources Institute

August 22, 2019

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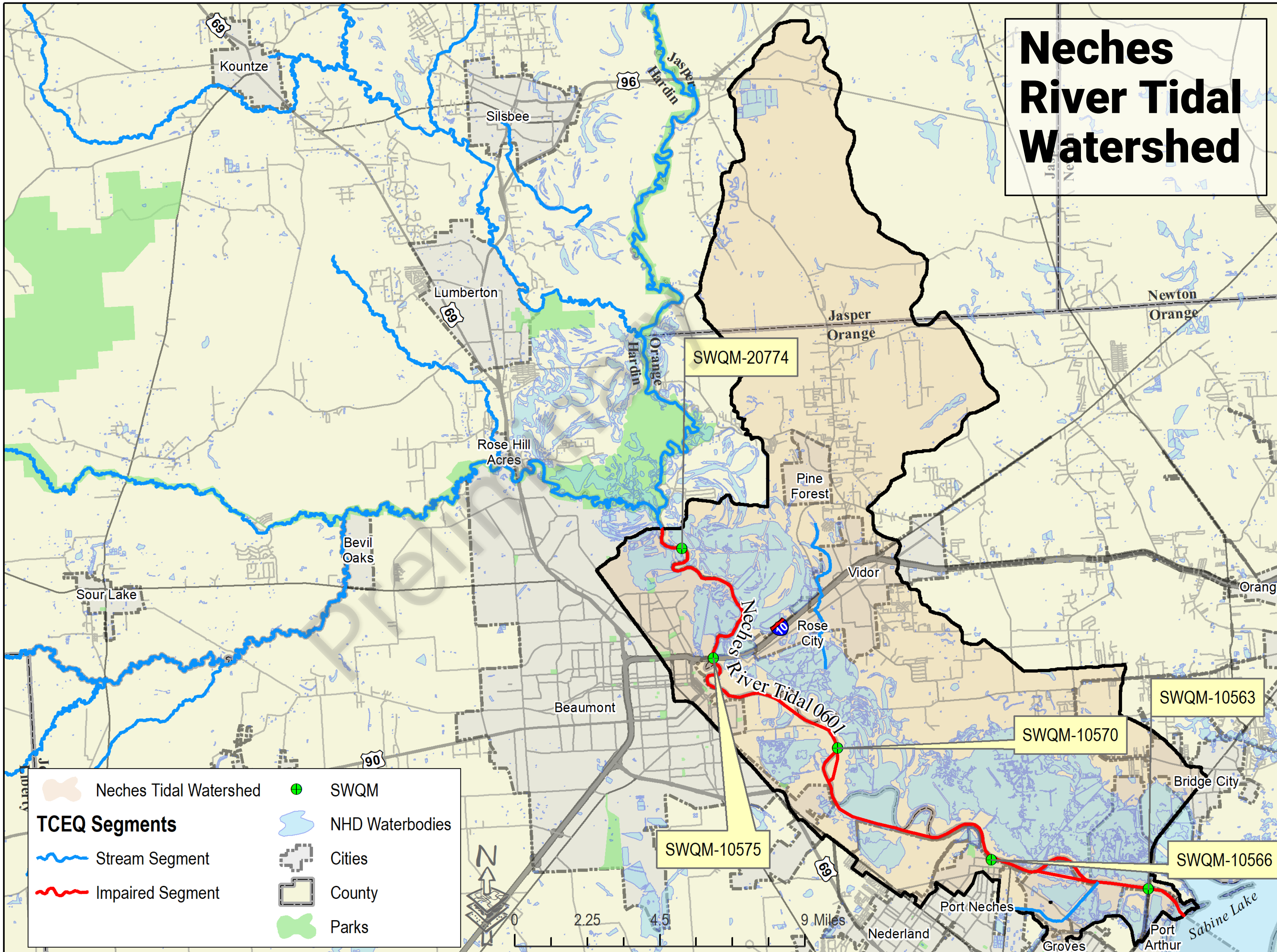
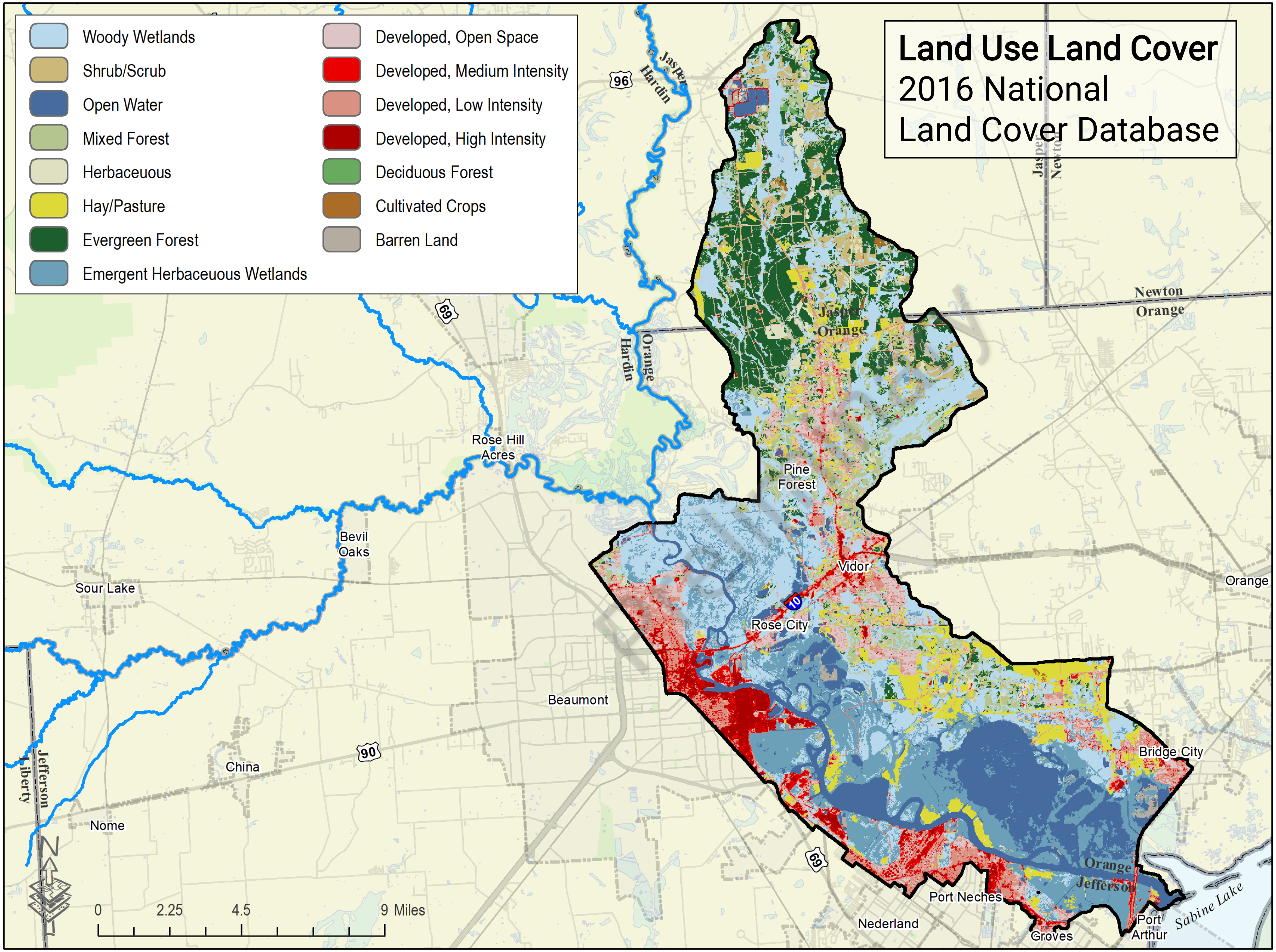
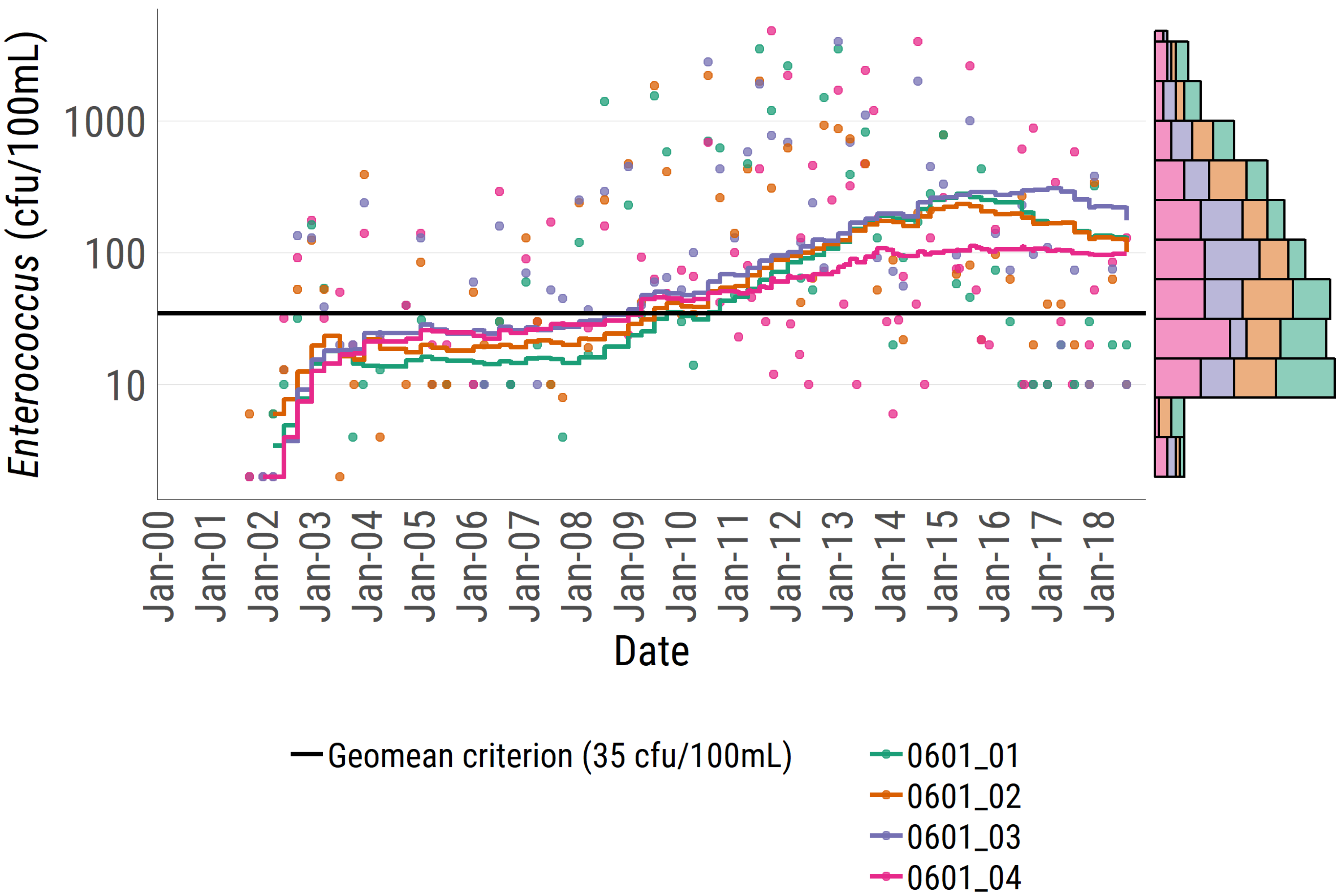
Texas A&M AgriLife Research | Extension


Neches River Tidal Watershed
Kountze
Silsbee
Lumberton
Rose Hill Acres
Bevil Oaks
Sour Lake
Beaumont
Pine Forest
Vidor
Rose City
Orange
Bridge City
Port Neches
Nederland
Groves
Port Arthur
Sabine Lake
Jasper
Hardin
Orange
Newton
Orange
Jasper
Orange
SWQM-20774
SWQM-10575
SWQM-10570
SWQM-10563
SWQM-10566
Neches River Tidal 0601
Preliminary
Neches Tidal Watershed
SWQM
TCEQ Segments
NHD Waterbodies
Stream Segment
Cities
Impaired Segment
County
Parks
N
0
2.25
4.5
9 Miles
69
96
90
10



Land Use Land Cover
2016 National
Land Cover Database
Woody Wetlands
Shrub/Scrub
Open Water
Mixed Forest
Herbaceuous
Hay/Pasture
Evergreen Forest
Emergent Herbaceuous Wetlands
Developed, Open Space
Developed, Medium Intensity
Developed, Low Intensity
Developed, High Intensity
Deciduous Forest
Cultivated Crops
Barren Land
Rose Hill Acres
Pine Forest
Bevil Oaks
Sour Lake
Vidor
Rose City
Orange
Beaumont
Bridge City
China
Nome
Port Neches
Nederland
Groves
Port Arthur
Sabine Lake
Jasper
Hardin
Orange
Newton
Jefferson
Liberty
0 2.25 4.5 9 Miles

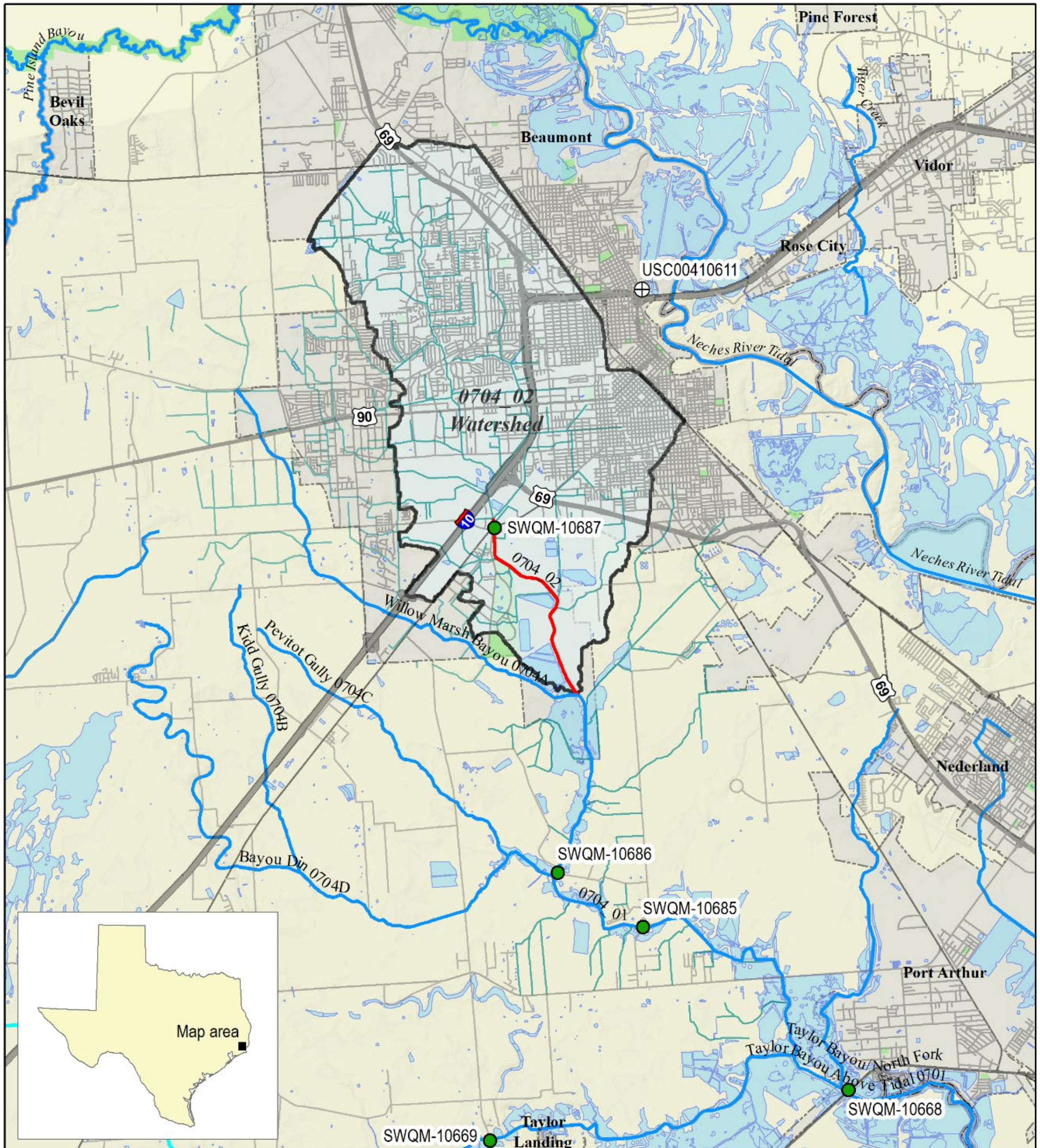
Historical Bacteria Dataset for Neches River Tidal



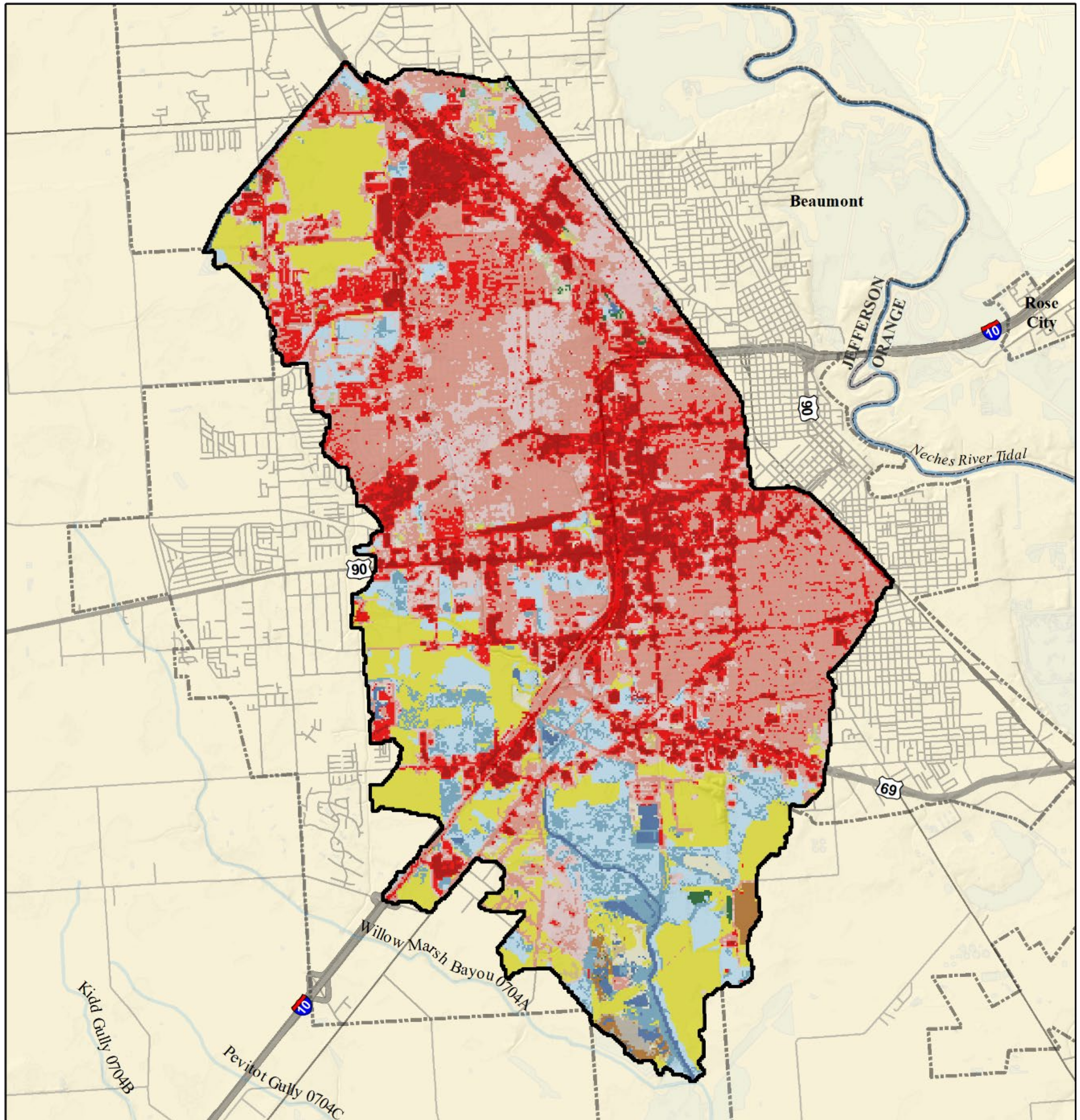
Summary Statistics

- Neches Tidal-
- 210 sq. miles (134,881 acres)
- 47,319 estimated population
- 4,061 estimated on-site sewage facilities
- 32 TPDES/NPDES discharge permits (9 with bacteria reporting requirements)
- 2 MS4 Phase I Permit Holders
- 7 MS4 Phase II Permit Holders

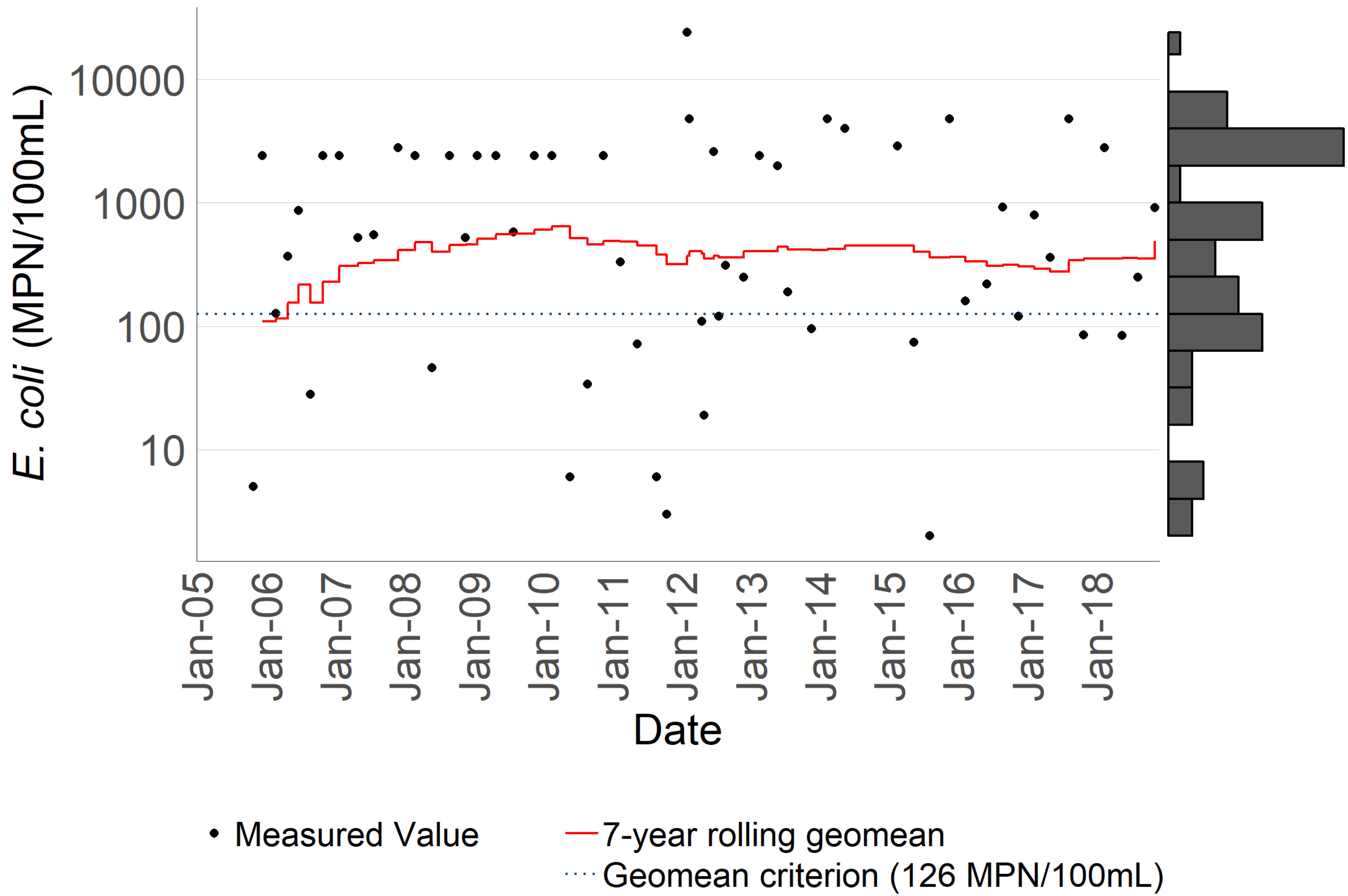
Hillebrandt Bayou Watershed



Land Use Land Cover
2016 National
Land Cover Database



Historical Bacteria Dataset for AU0704_02



Summary Statistics

- Hillebrandt Bayou-
- 36.02 sq. miles (23,053 acres)
- 97,617 estimated population
- 4 estimated on-site sewage facilities
- 0 TPDES/NPDES discharge permits
- 2 MS4 Phase I Permit Holders

Draft 2018 Texas Integrated Report Assessment Results

Water Body	Assessment Unit (AU)	Parameter	Data Range	No. of Samples	Station Geometric Mean (MPN/100mL)
Neches River Tidal	0601_01	Enterococcus	12/01/09 - 11/30/16	28	170.01
Neches River Tidal	0601_02	Enterococcus	12/01/09 - 11/30/16	28	166.22
Neches River Tidal	0601_03	Enterococcus	12/01/09 - 11/30/16	28	300.31
Neches River Tidal	0601_04	Enterococcus	12/01/09 - 11/30/16	28	102.89
Hillebrandt Bayou	0704_02	*E. coli*	12/01/09 - 11/30/16	26	254.74

ALLOCATION TOOL PROCESS

Load Duration Curve

- Load Duration Curve (LDC) – Method for using observed data to estimate and visualize streamflows and measured pollutant concentrations.
- Advantages –
  - Requires less watershed specific data than deterministic models (eg. SWAT);
  - Relatively simple, visualize under what conditions exceedances occur and broadly link types of bacteria sources
- Weaknesses –
  - No predictive capabilities, cannot evaluate how practices will impact bacteria loadings;
  - Does not quantify specific sources

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

Hillebrandt Bayou Daily Flow

- No USGS stream gage to provide daily flows
- Drainage Area Ratio (DAR) method used to estimate the flow duration curve and daily streamflows
- Nearest streamgages are predominately rural watersheds, DAR modified to account for difference in land cover

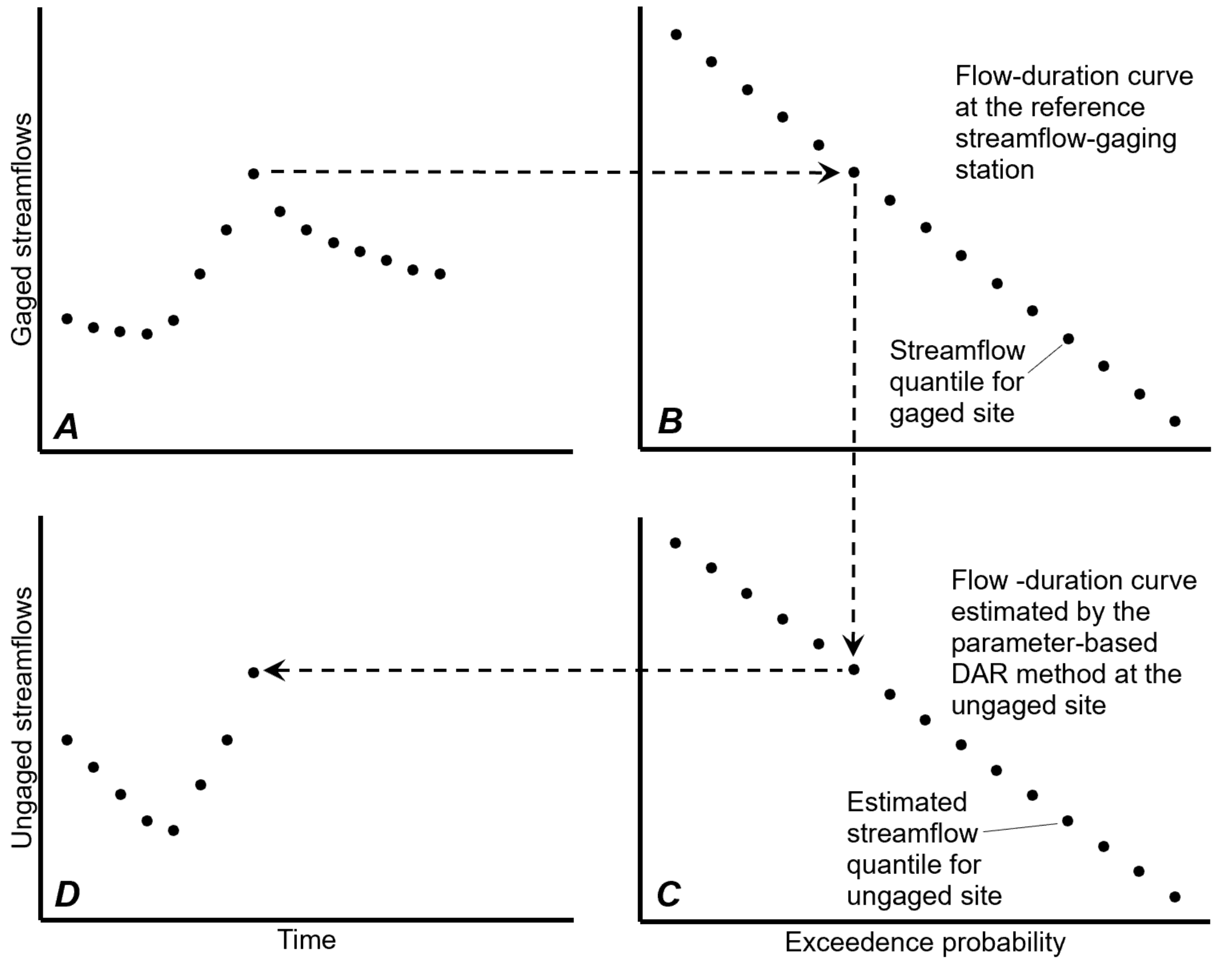
Hillebrandt Bayou Daily Flow

- Drainage Area Ratio – Daily streamflow in an ungaged basin equals 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

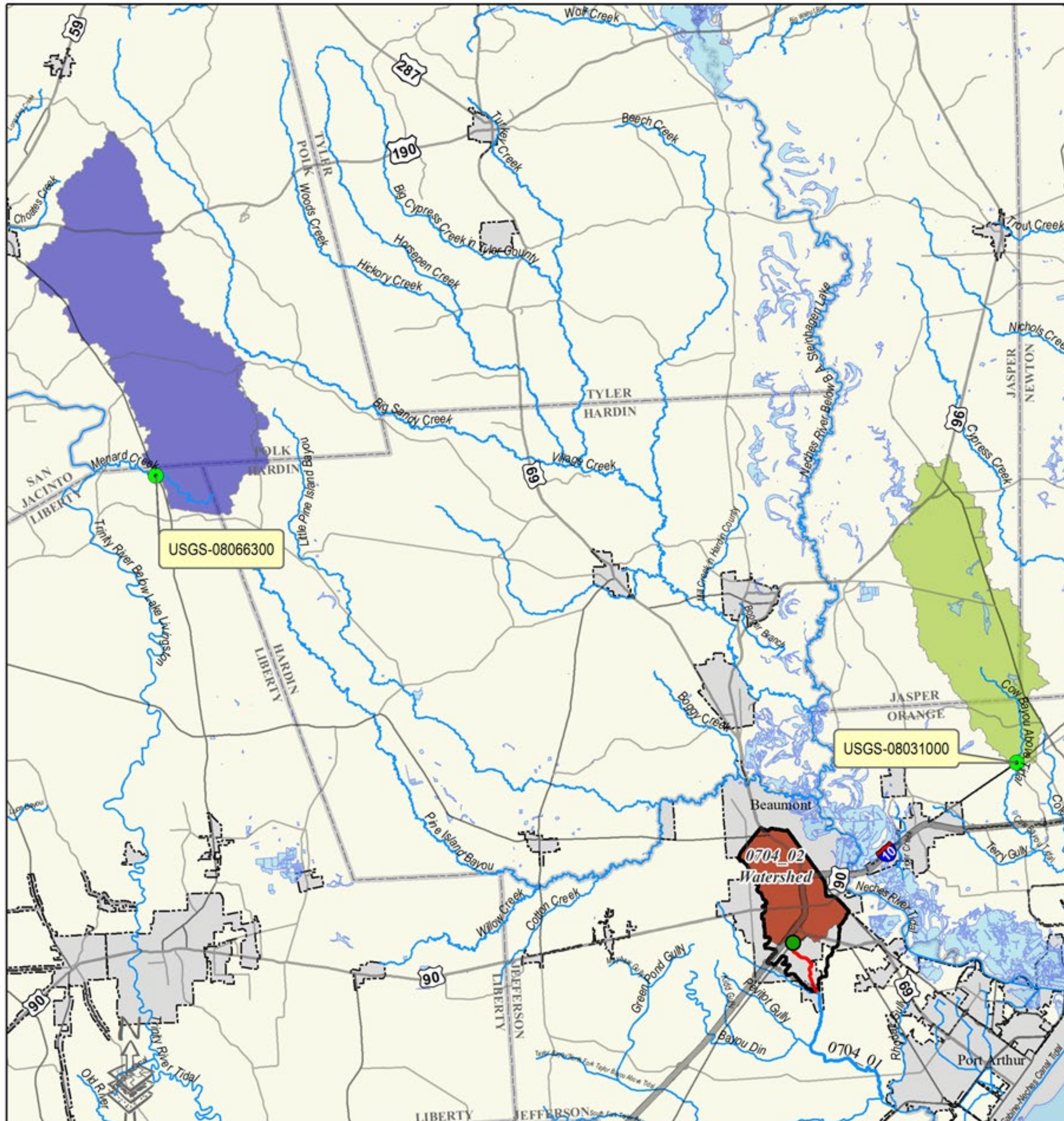
Hillebrandt Bayou Daily Flow

- Drainage Area Ratio – Assumes ungaged watershed has similar hydrology and land cover as gaged watershed.
- Additional terms and parameters for developed area ratio and wetland area ratio
- Parameter optimization used to weight developed area and wetland area terms
- Streamflows are corrected for permitted discharges

Hillebrandt Bayou Daily Flow



Hillebrandt Bayou Daily Flow



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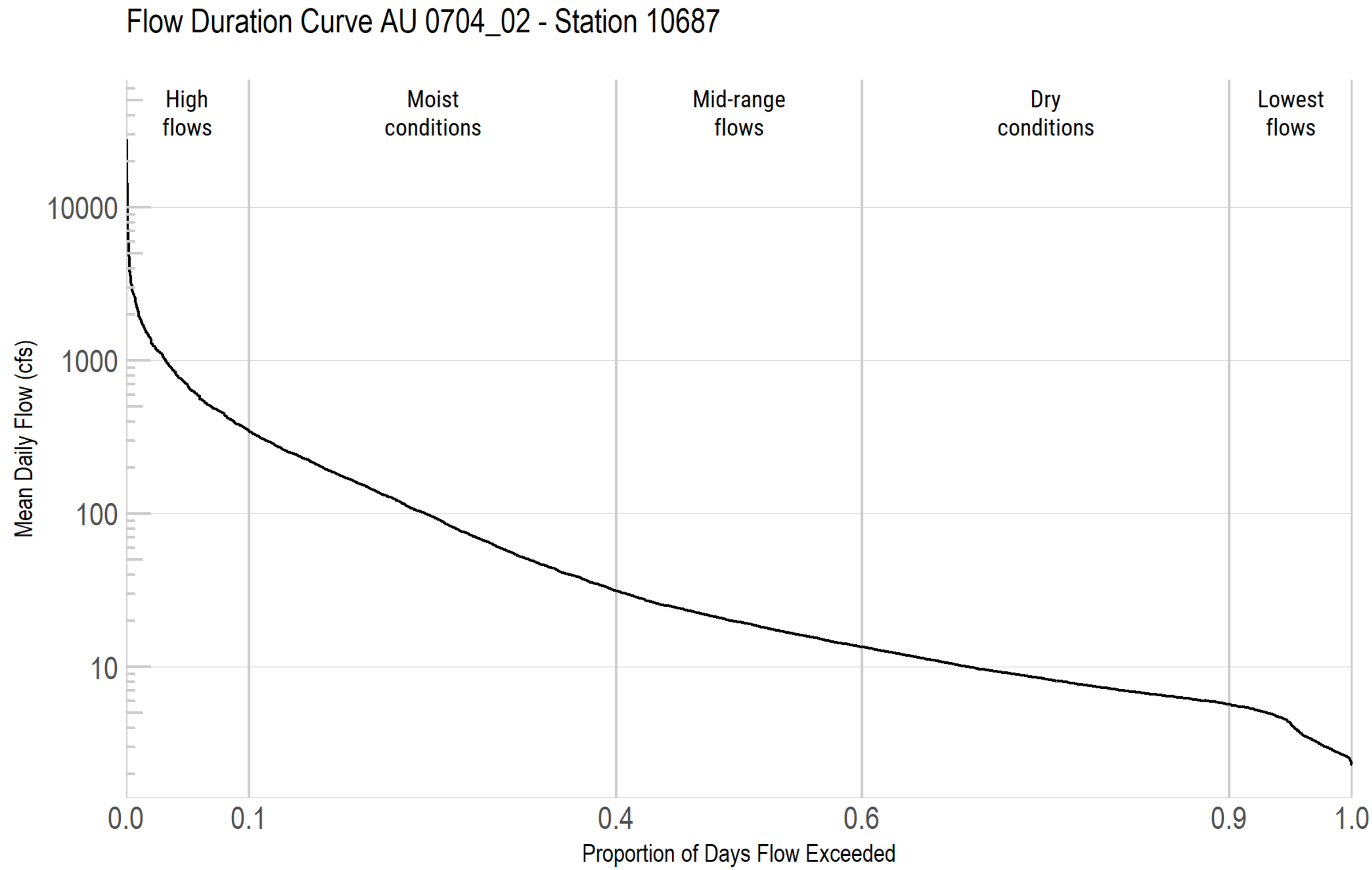
Hillebrandt Bayou Flow Duration Curve



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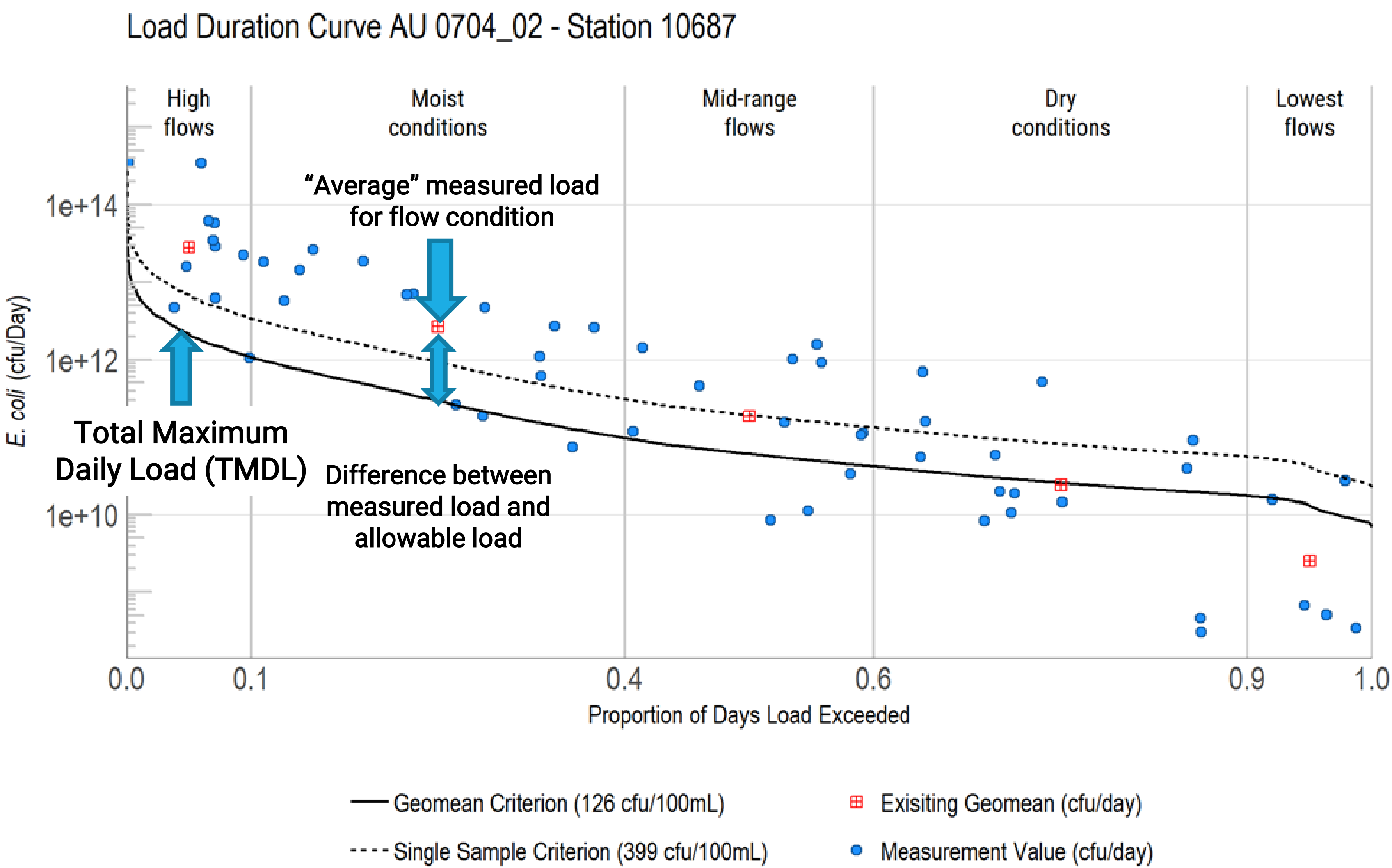
Hillebrandt Bayou Load Duration Curve



Total Maximum Daily Load

- TMDL* = Water Quality Criteria x Volume of water per day
- The TMDL includes 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

$$TMDL = WLA_{WWTF} + WLA_{SW} + LA + FG + MOS$$

* billion colony forming units per day

Process for Developing Load Duration Curves in Tidal Streams

Develop Daily Flows

- Identify location of interest
- Use USGS daily streamflows if available
- Estimate daily streamflows using Drainage Area Ratio
- **Account for volume of tidal water moving into Neches River**

Plot Flow Duration Curve

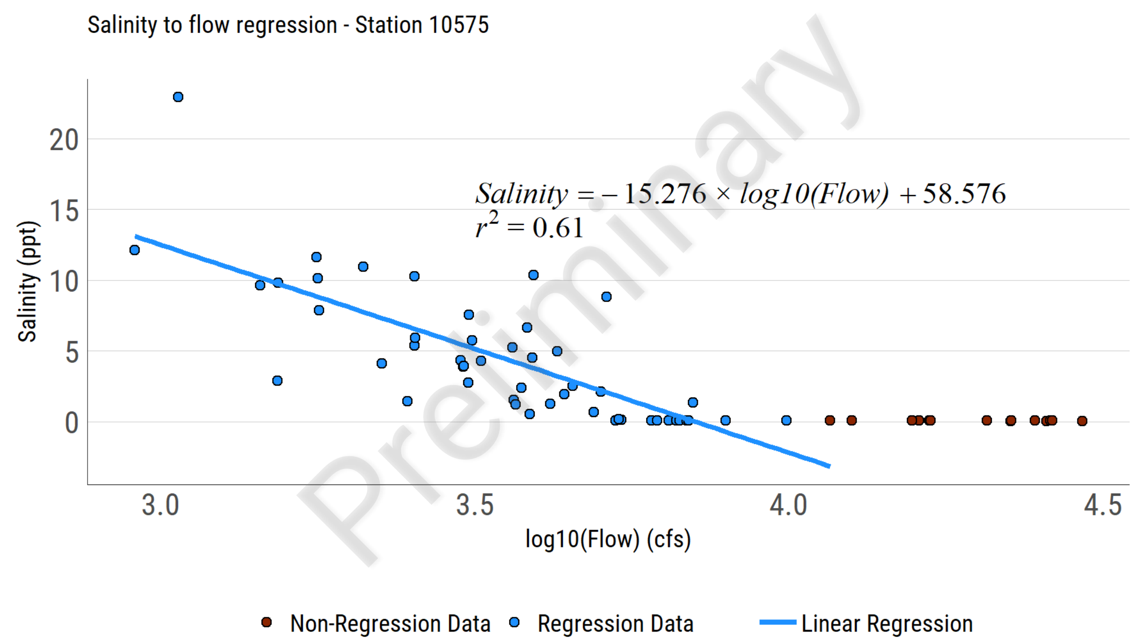
- Calculate the percent exceedance for every daily mean streamflow value
- Plot flow values against the exceedance values

Develop Load Duration Curve

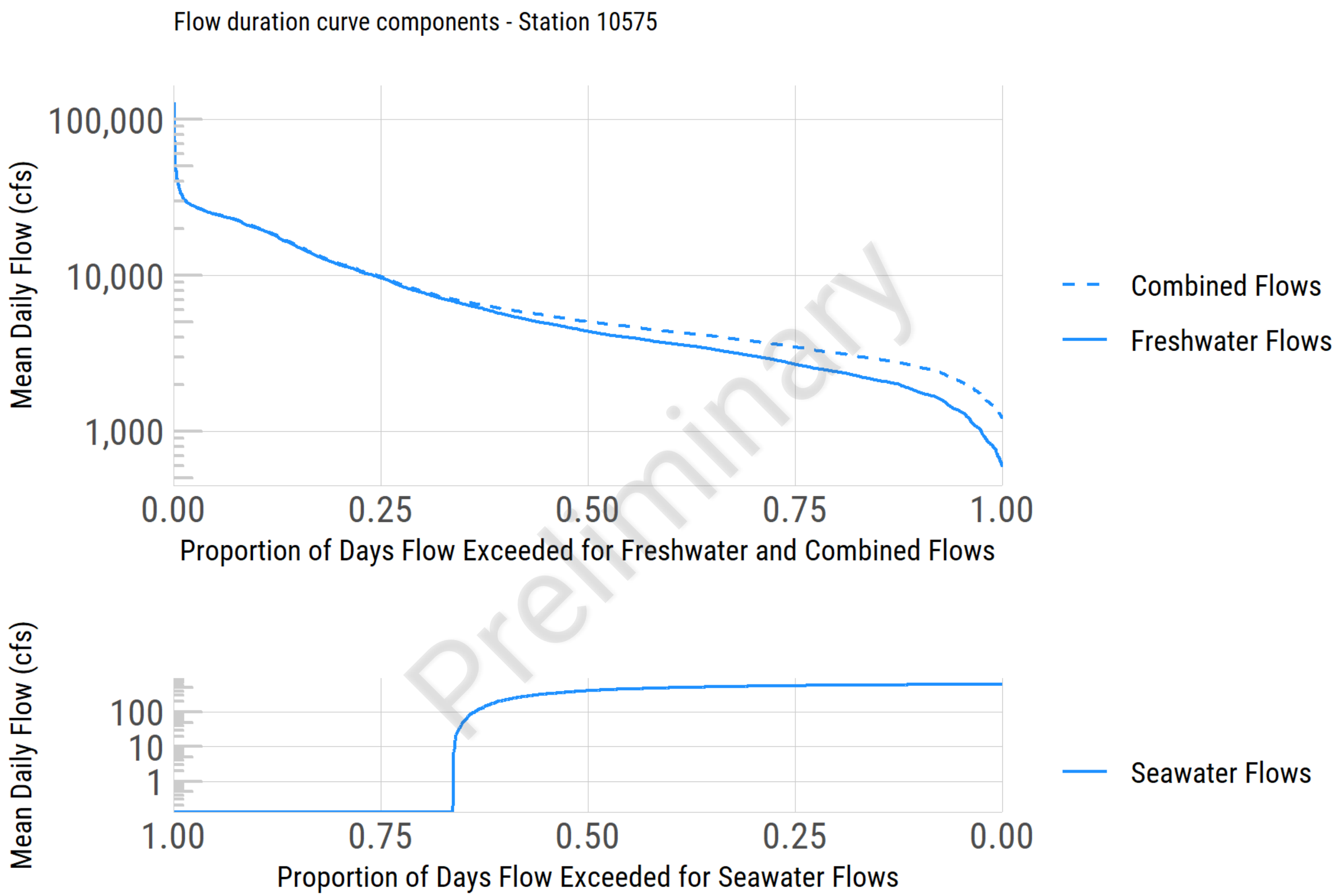
- Convert daily flow to allowable load (concentration times volume)
- Plot allowable load against exceedance values
- Overlay measured concentrations converted to daily loads

Modified Load Duration Curve

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.



Modified Flow Duration Curve



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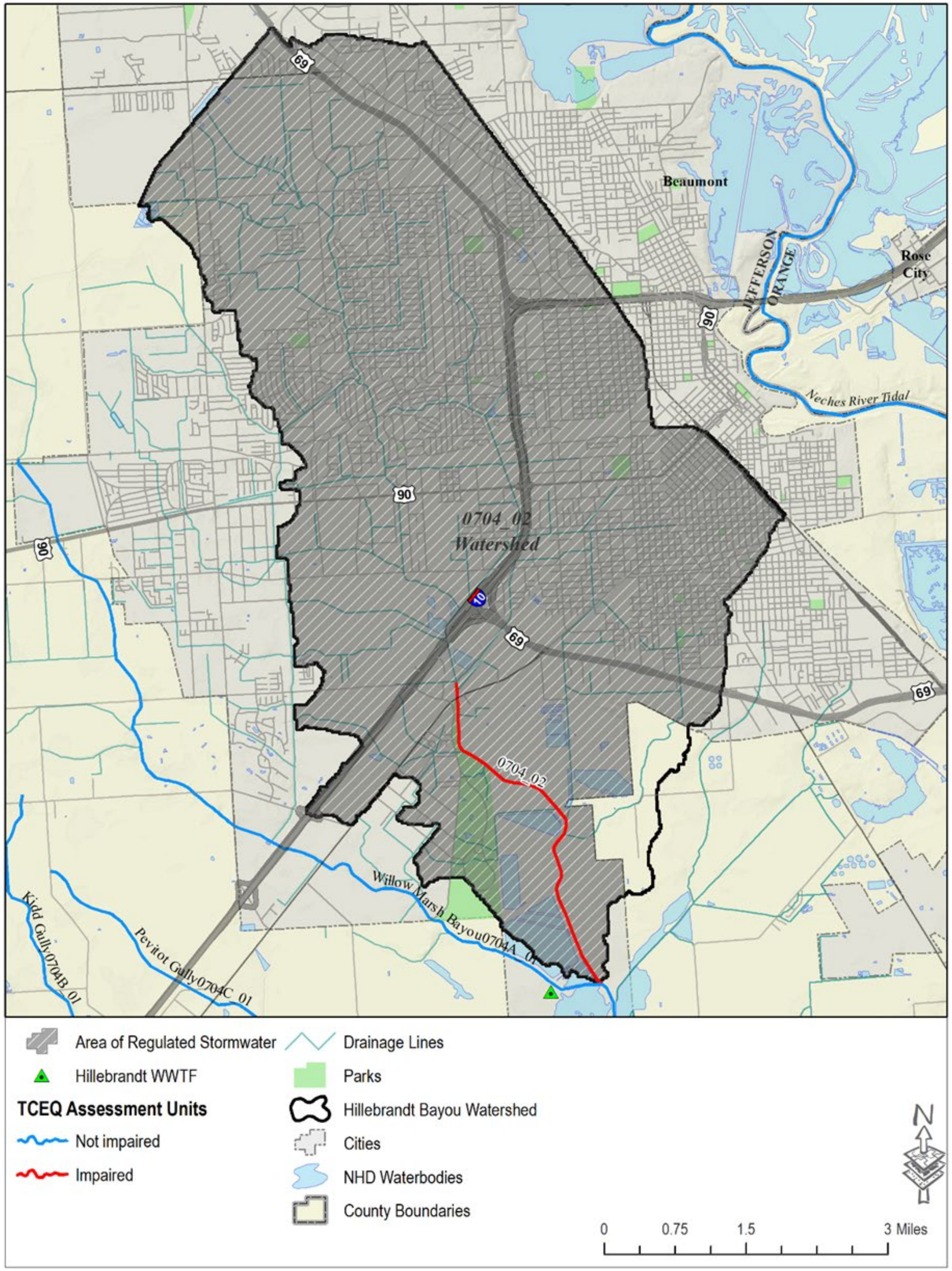
http://twri.tamu.edu/neches/lower-neches
https://www.tceq.texas.gov/waterquality/tmdl/nav/118-nechestidal-bacteria
https://www.tceq.texas.gov/waterquality/tmdl/nav/118-hillebrandtbayou-bacteria

EXTRA SLIDES

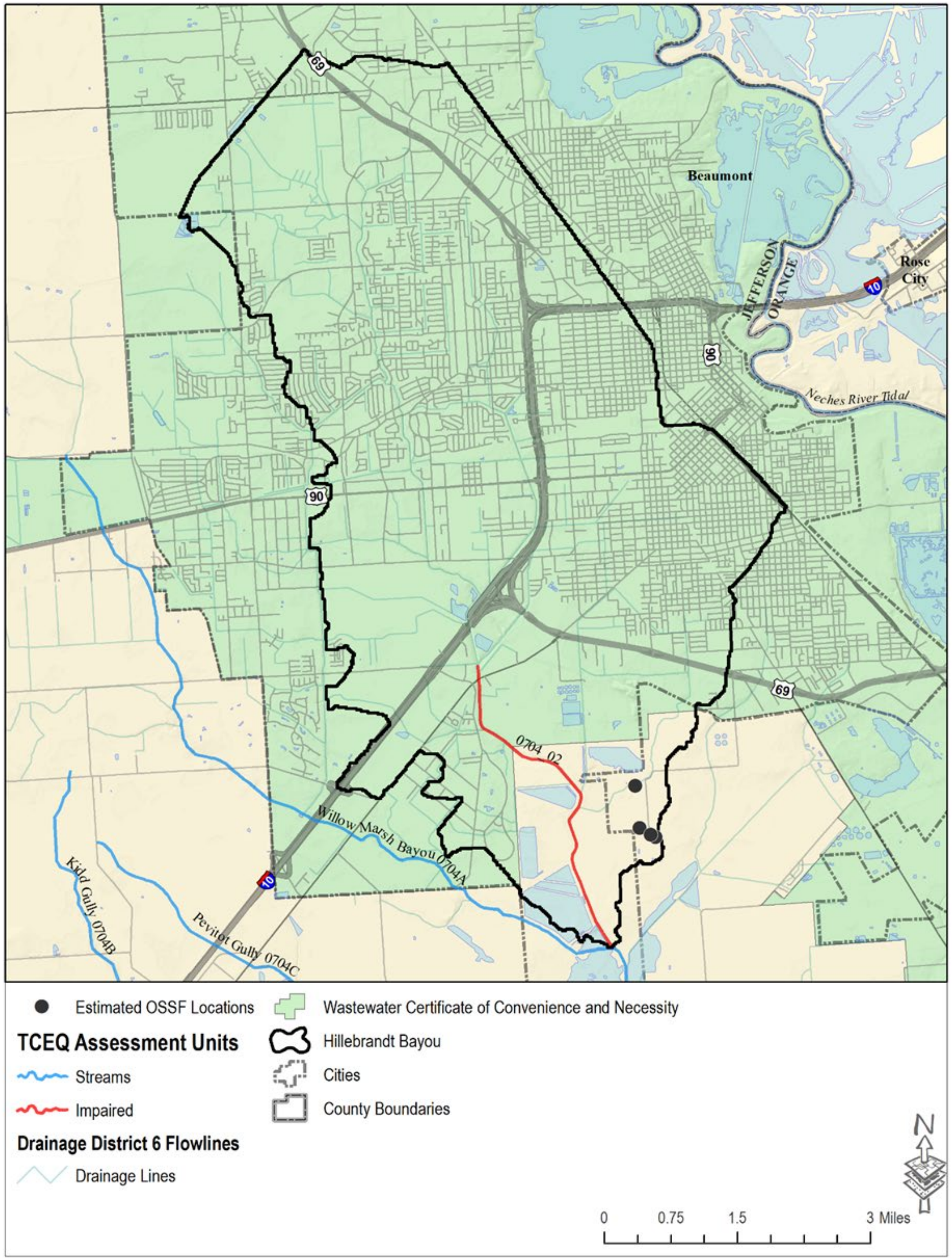
Hillebrandt Bayou

Area of Regulated Stormwater



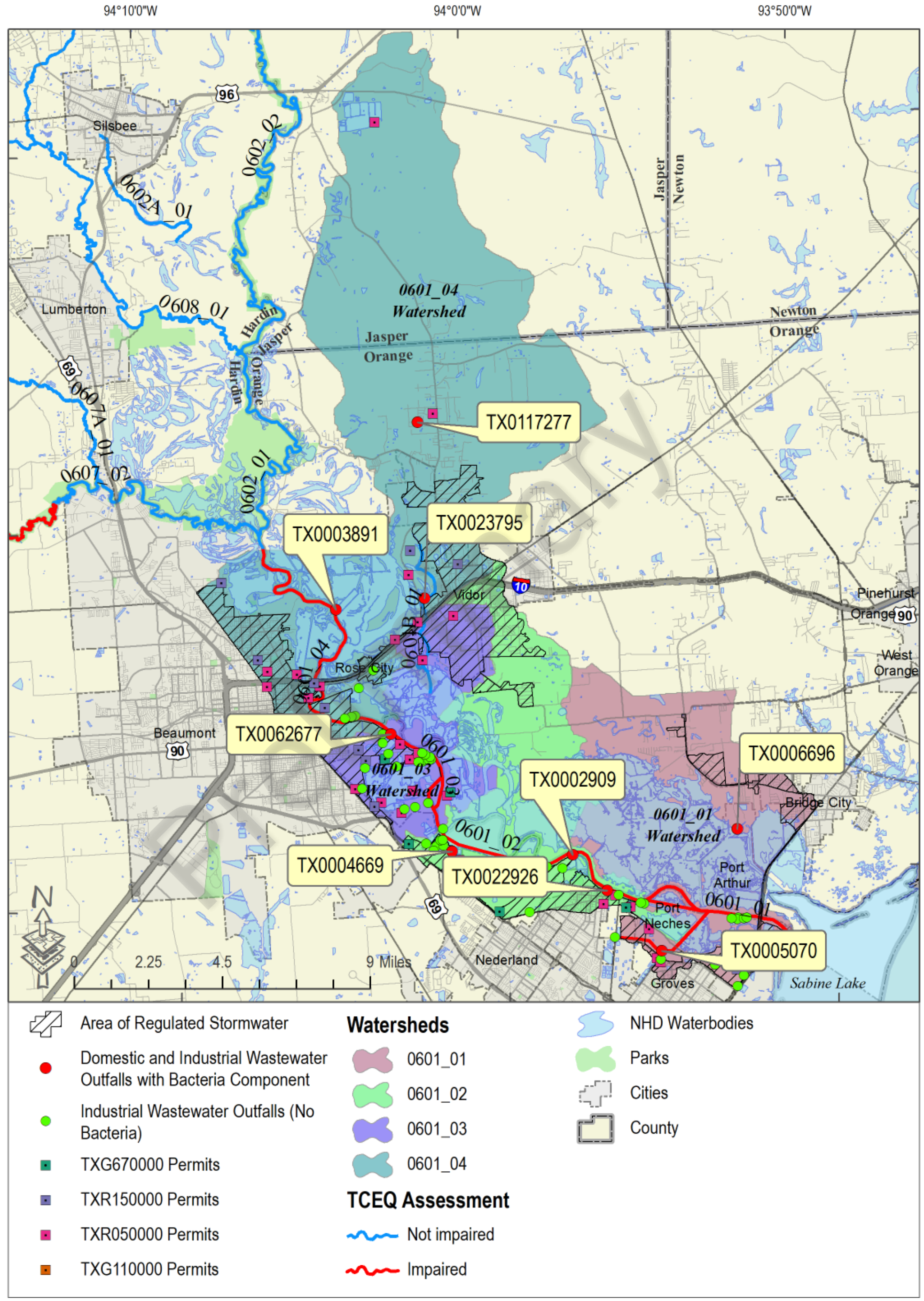
Hillebrandt Bayou

Estimated OSSF Locations



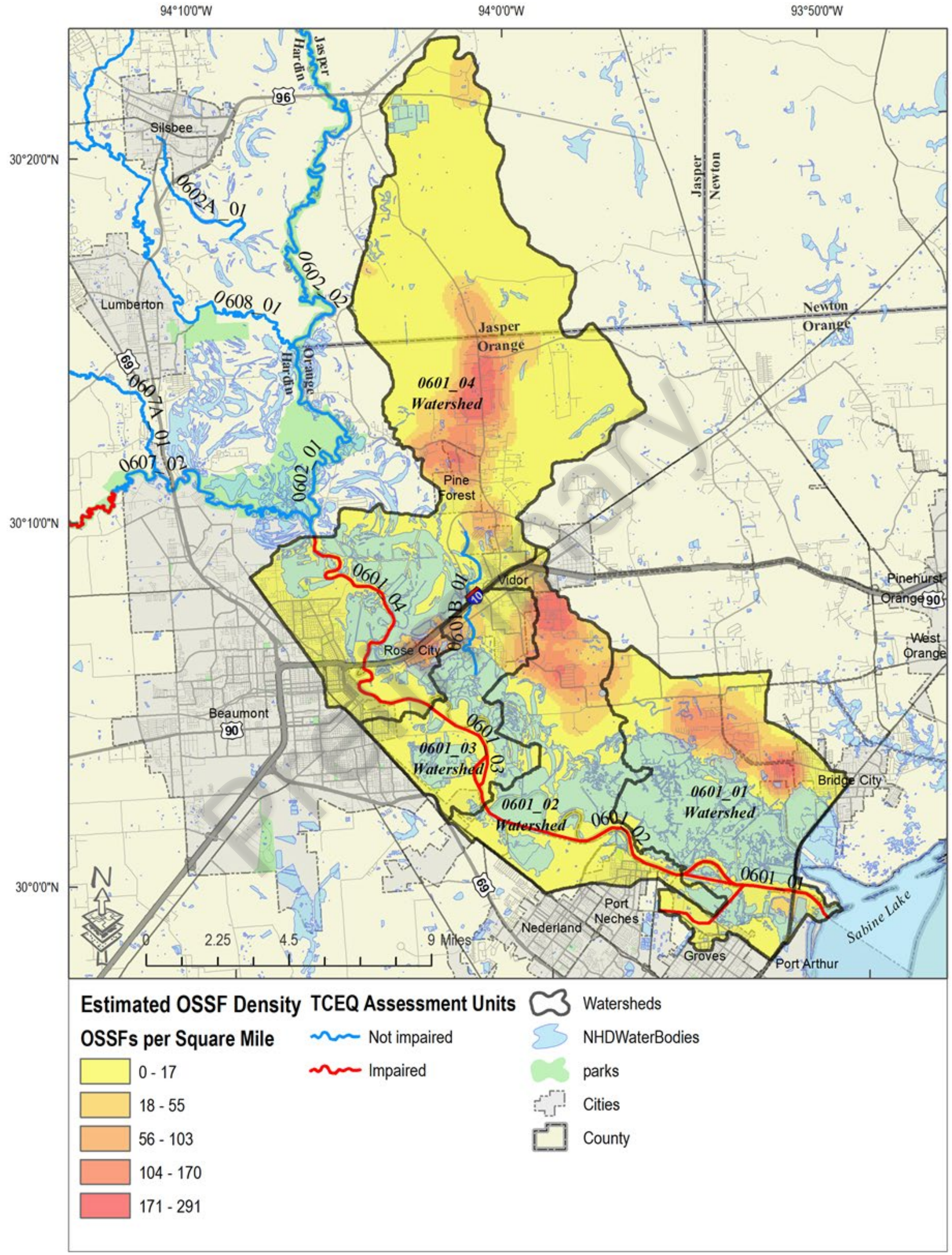
Neches River Tidal

Permitted sources



Neches River Tidal

Estimated OSSF Density



Drainage Area Ratio

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

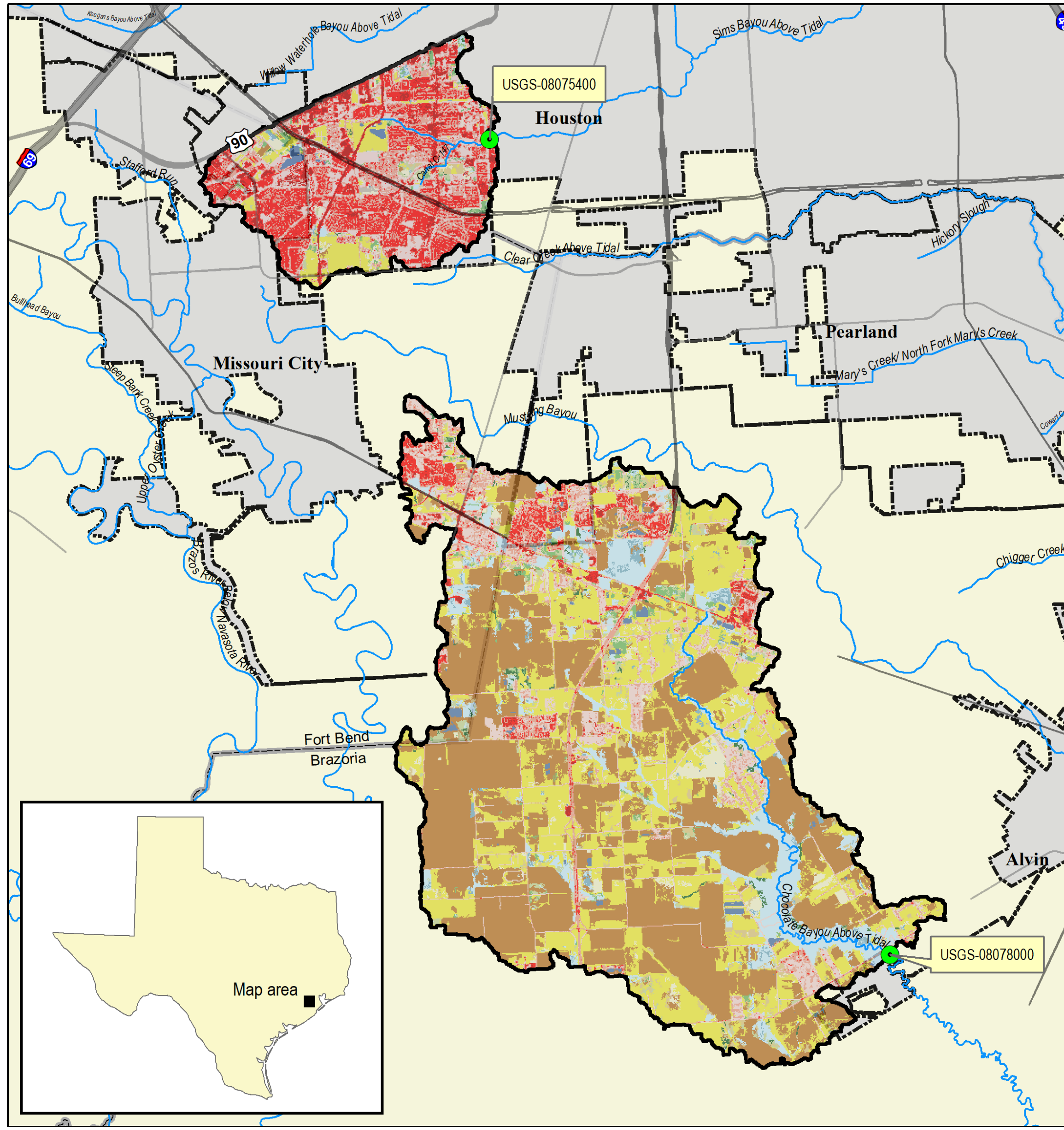
- Y = streamflow for the ungaged location,
- X = streamflow for the gaged location,
- A_y = drainage area for the ungaged location,
- A_x = drainage area for the gaged location,
- D_y = developed area for the ungaged location,
- D_x = developed area for the gaged location,
- W_y = wetland area for the 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).

Watersheds used to develop DAR parameters

Sims Bayou (USGS 08075400)

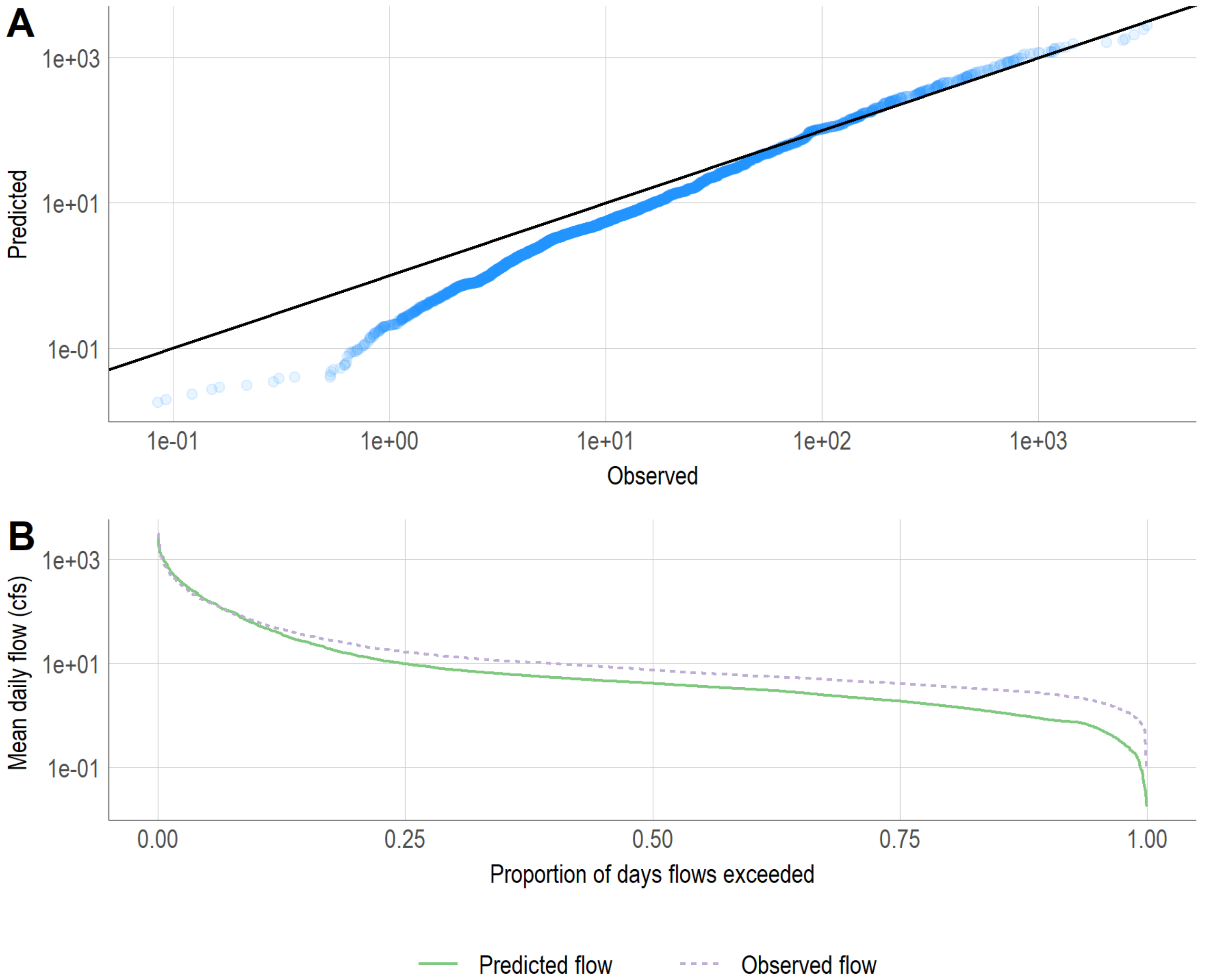
Chocolate Bayou (USGS 0807800)



DAR Parameters

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

RMSE: 29.53cfs
NSE: 0.96



Modified Load Duration Curve

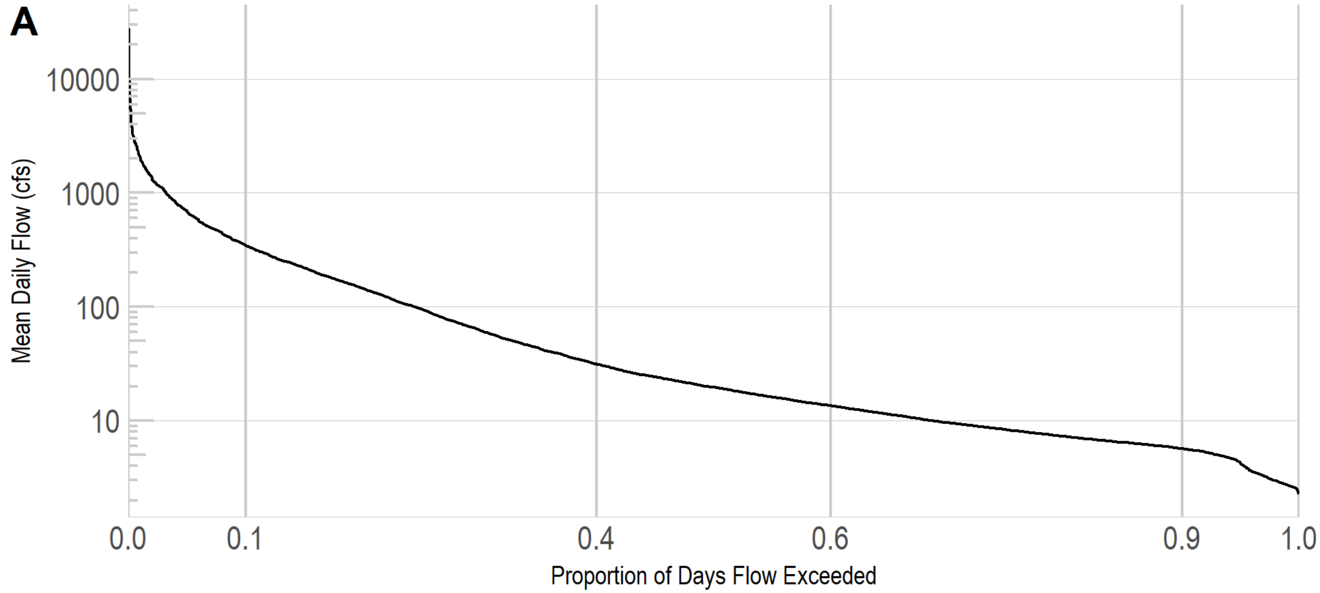
1. Develop salinity to streamflow regression equations at each monitoring station to so we can estimate salinity at mean daily flow values.
2. Use a mass-balance equation to estimate the amount of seawater required to achieve the regression estimated salinity values.

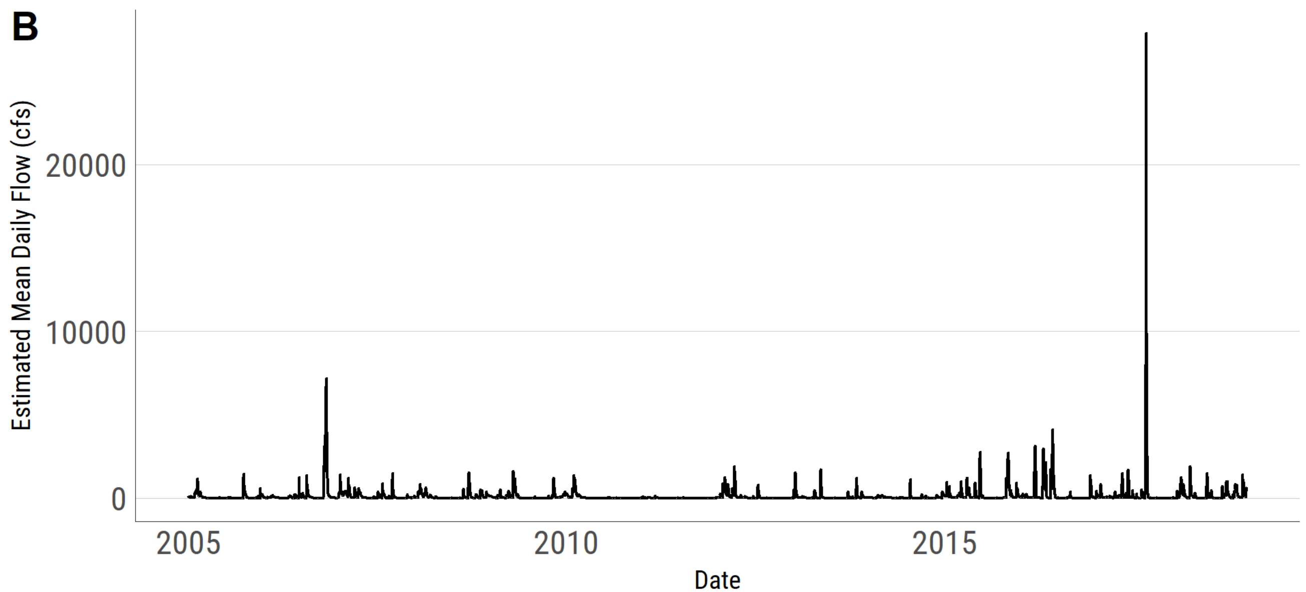
$$V_s = V_r/(S_s/S_t - 1) \text{ For } S_t > \text{ than background salinity, otherwise } V_s = 0$$

$$V_S + V_F = V_T$$

Hillebrandt Bayou

FDC &
Estimated Daily
Streamflow





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