

# **Total Maximum Daily Loads (TMDLs) for Indicator Bacteria in the Armand Bayou Watershed**

Hanadi S. Rifai and Rose Sobel  
Civil and Environmental Engineering  
University of Houston

Tina Petersen  
CDM Smith

**Armand Bayou I-Plan Meeting  
August 13, 2013**

# Project Objectives

- Develop technical support document (TSD) and TMDLs for Assessment Units:
  - 1113\_02 – Armand Bayou Tidal
  - 1113A\_01 – Armand Bayou Above Tidal (*unclassified water body*)
  - 1113B\_01 – Horsepen Bayou Tidal (*unclassified water body*)
  - 1113C\_01 – Unnamed Tributary to Horsepen Bayou (*unclassified water body*)
  - 1113D\_01 – Willow Springs Bayou (*unclassified water body*)
  - 1113E\_01 – Big Island Slough (*unclassified water body*)
- Support Public Participation

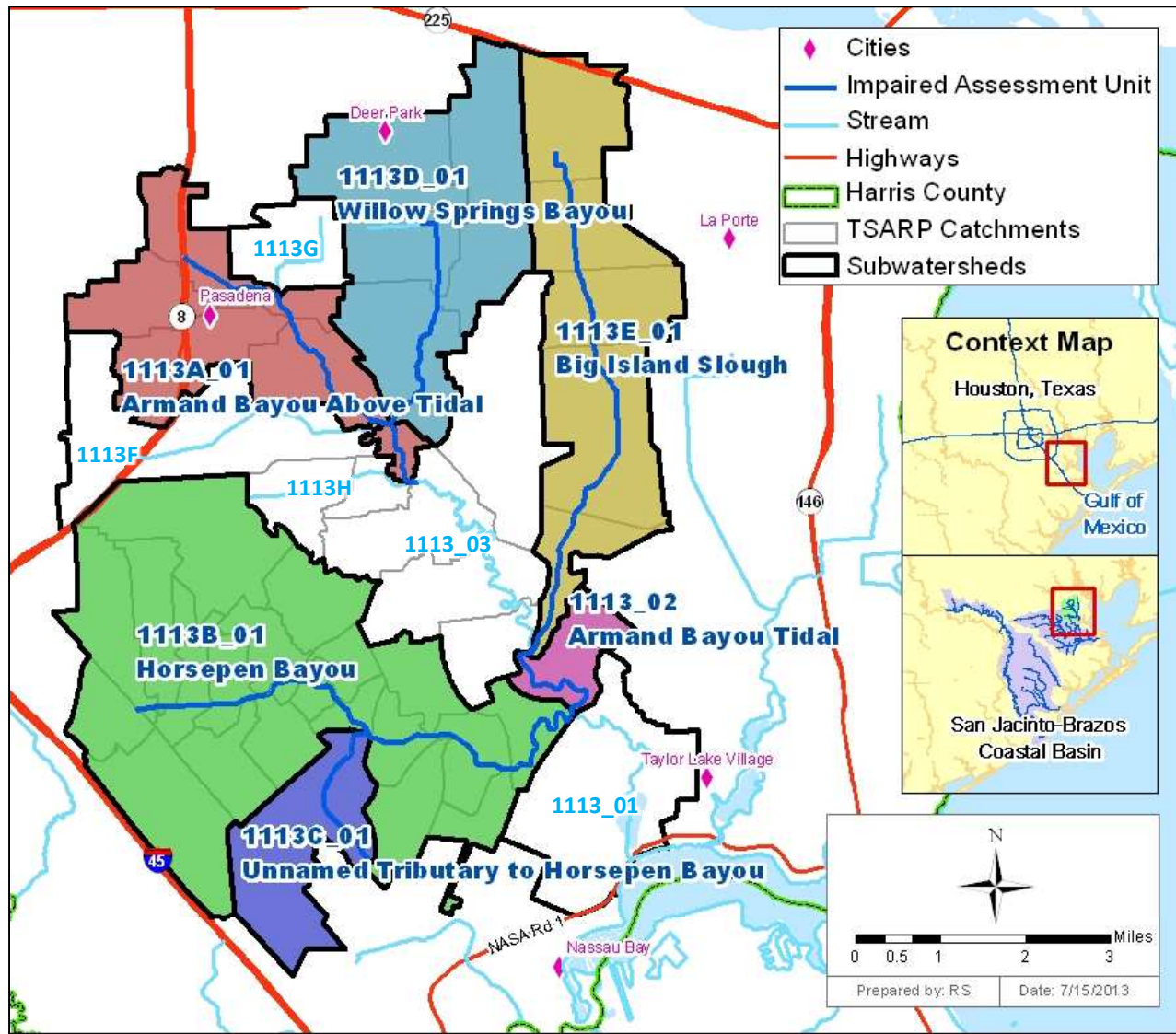
# Key Steps in TSD and TMDLs

- Data Compilation and Analysis
- Pollution Source Assessment
- Development of Flow Duration Curves (FDCs) and Load Duration Curves (LDCs) (non-tidal)
- Tidal Prism mass balance (tidal)

Data Compilation and Analysis

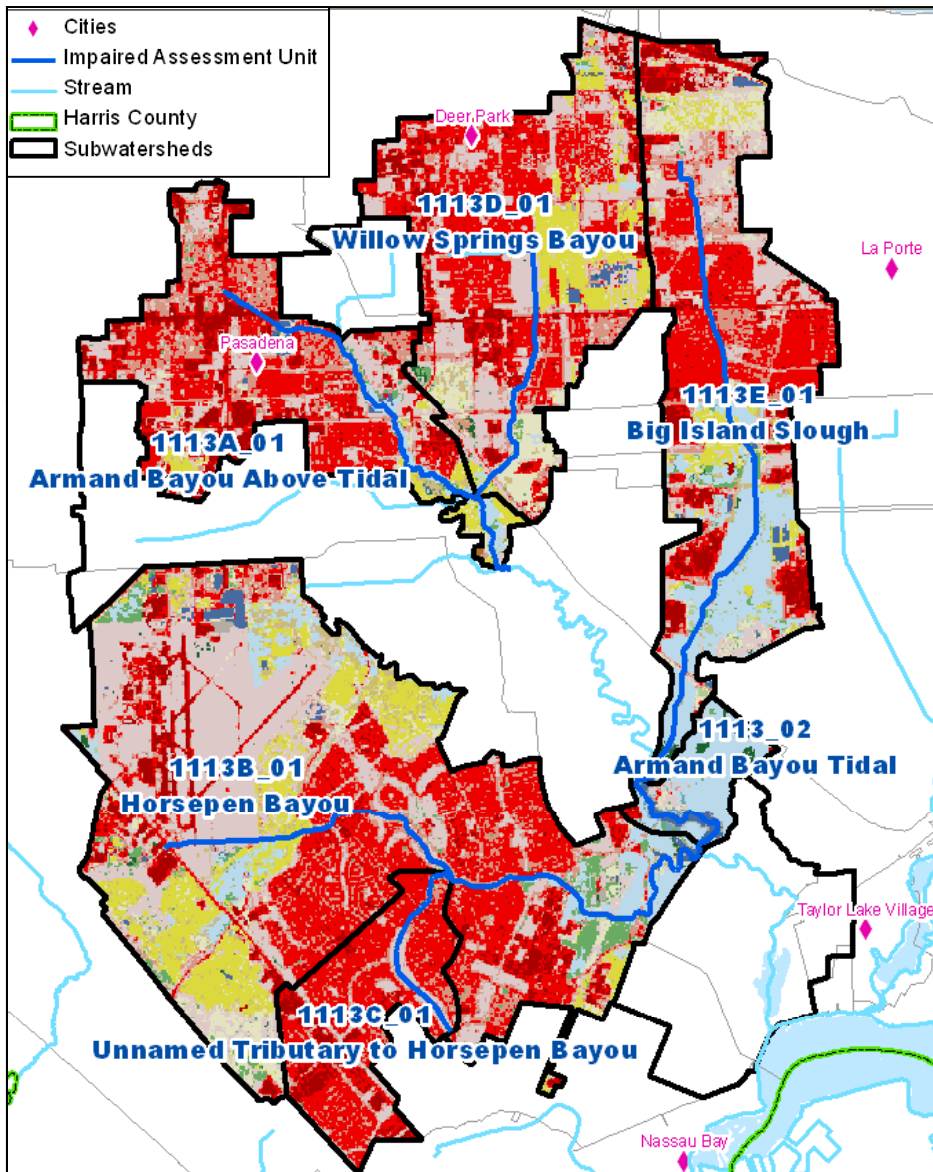
# **WATERSHED CHARACTERISTICS**

# Armand Bayou Watershed



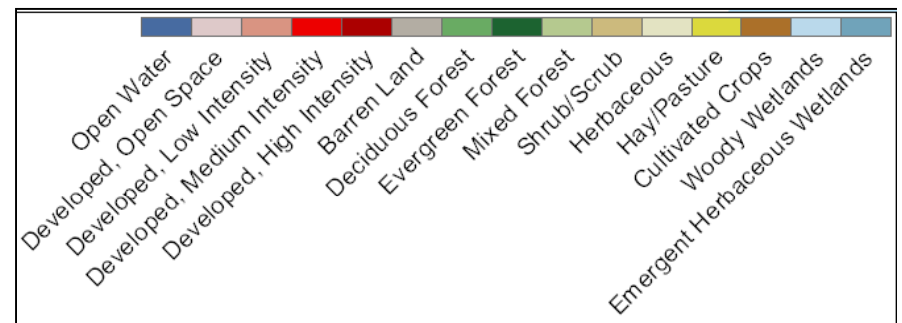
Watershed	Area (acres)
Armand Bayou	37,822
1113_02	673
1113A_01	3688
1113B_01	10,668
1113C_01	1,777
1113D_01	4,871
1113E_01	5,106

# Land cover and Population



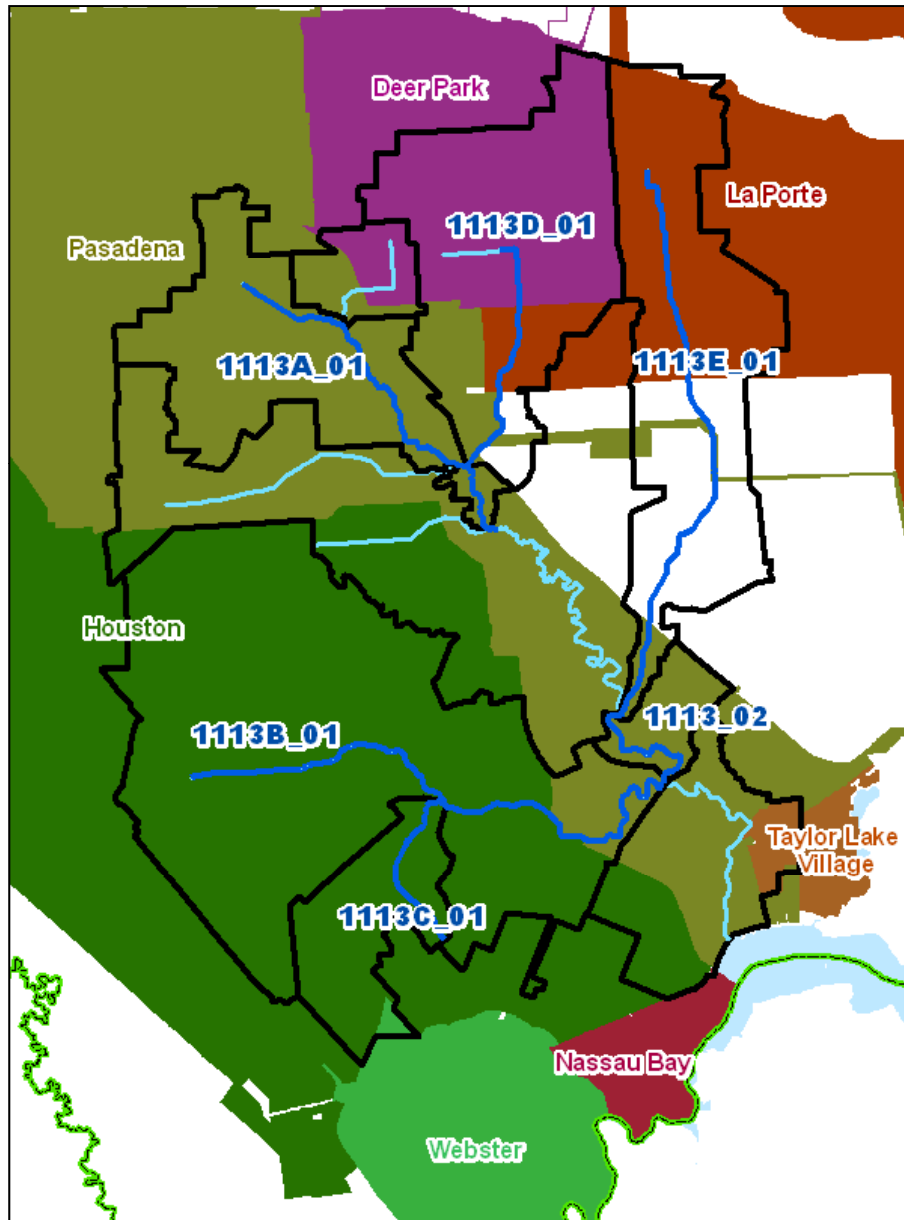
Watershed	Population (2010 Census)
Armand Bayou	125,844
1113_02	294
1113A_01	14,376
1113B_01	27,494
1113C_01	17,680
1113D_01	21,922
1113E_01	14,782

## Land Cover Classes\*



\*NLCD

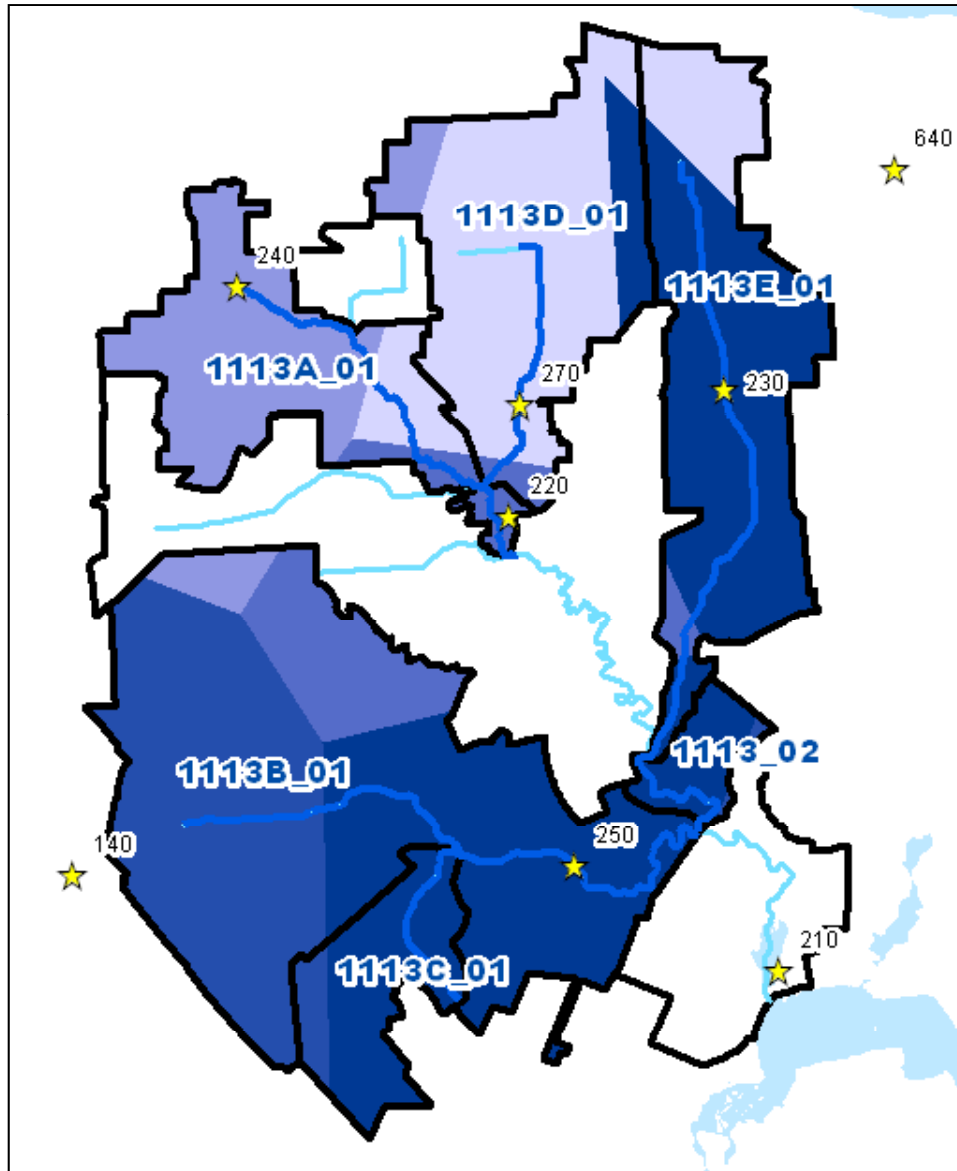
# Municipalities and Population Growth



City	Projected Growth Rate (2030)*	Sub-watershed	Percent City in Sub-watershed
Deer Park	7 %	1113D_01	50 %
Houston	25 %	1113B_01	3 %
		1113C_01	0.5 %
La Porte	20 %	1113D_01	4 %
		1113E_01	22 %
Pasadena	24 %	1113_02	2 %
		1113A_01	13 %
		1113B_01	2 %
		1113D_01	3 %
		1113E_01	1 %
Webster	59 %	1113C_01	2 %

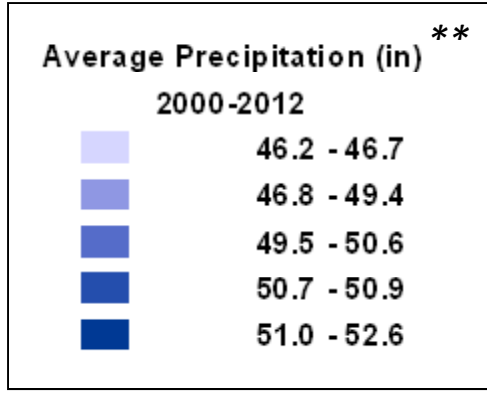
\*TWDB

# Precipitation and Climate



1981-2010 Watershed Average\*:  
 Temperature: 70.3 °F  
 Range: 45.1- 84.6 °F

- ★ Rain gages
- Impaired Assessment Unit
- Stream
- Subwatersheds



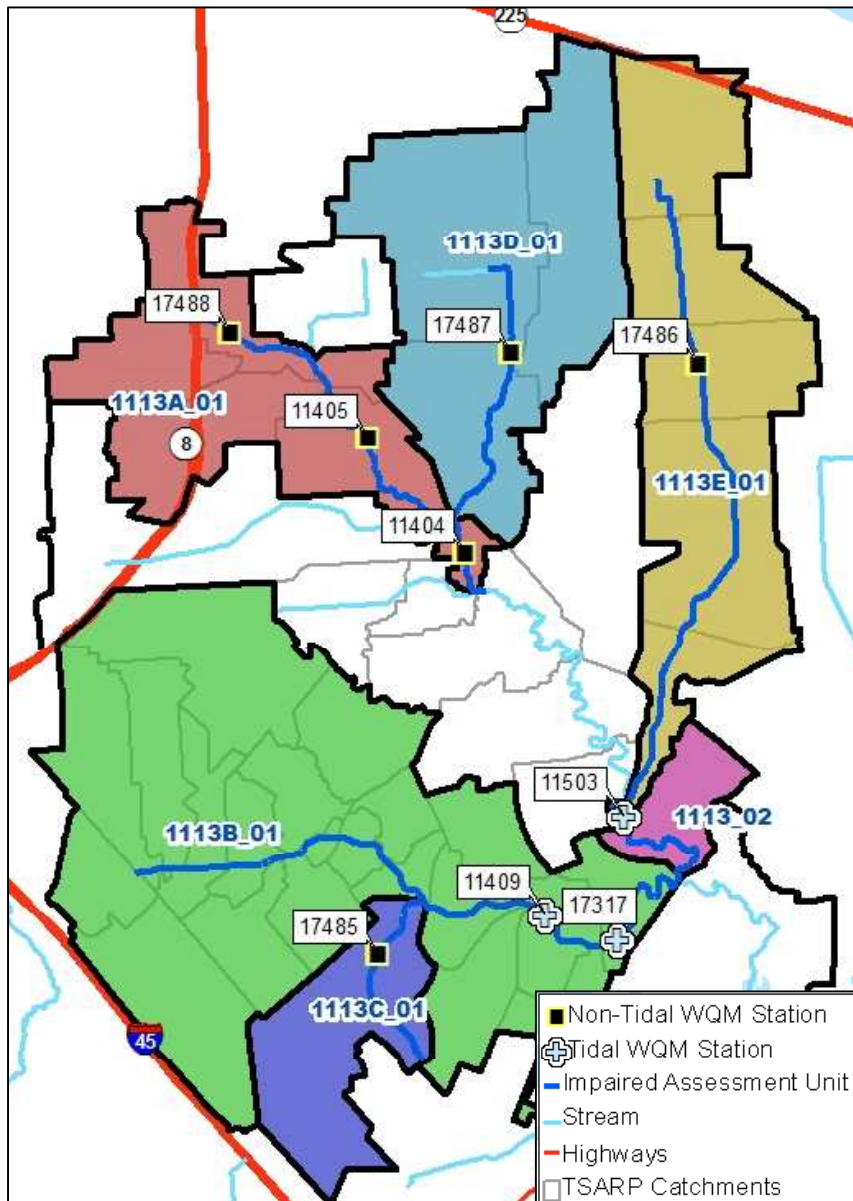
\*NOAA  
 \*\* HCFC



Data Compilation and Analysis

# **INDICATOR BACTERIA**

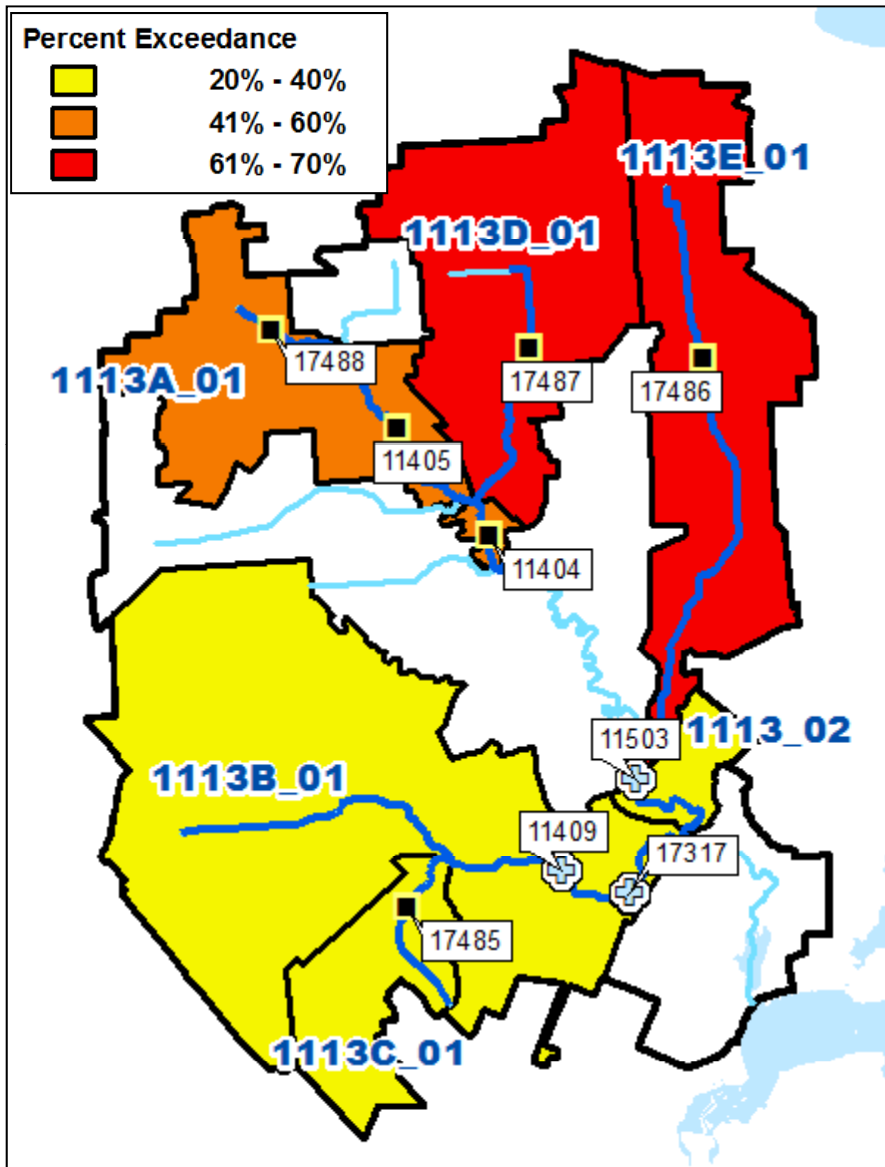
# Station locations and impairment history



AU ID	Segment Name	Designated Use*	Year 1 <sup>st</sup> on 303(d) list	Stream Length (miles)
		Contact Recreation		
1113_02	Armand Bayou Tidal	NS	2006	1.8
1113A	Armand Bayou Above Tidal	NS	1998	4.6
1113B	Horsepen Bayou Tidal	NS	2006	6.7
1113C	Unnamed Tributary to Horsepen Bayou	NS	2010	2
1113D	Willow Springs Bayou	NS	2010	2.9
1113E	Big Island Slough	NS	2012	6.5
<b>NS = Not Supporting; FS = Fully Supporting</b>				

\*TCEQ

# Indicator Bacteria data summary



Indicator	Single sample criterion	Geomean criterion
<i>E. coli</i>	399	126
Enterococcus	104	35

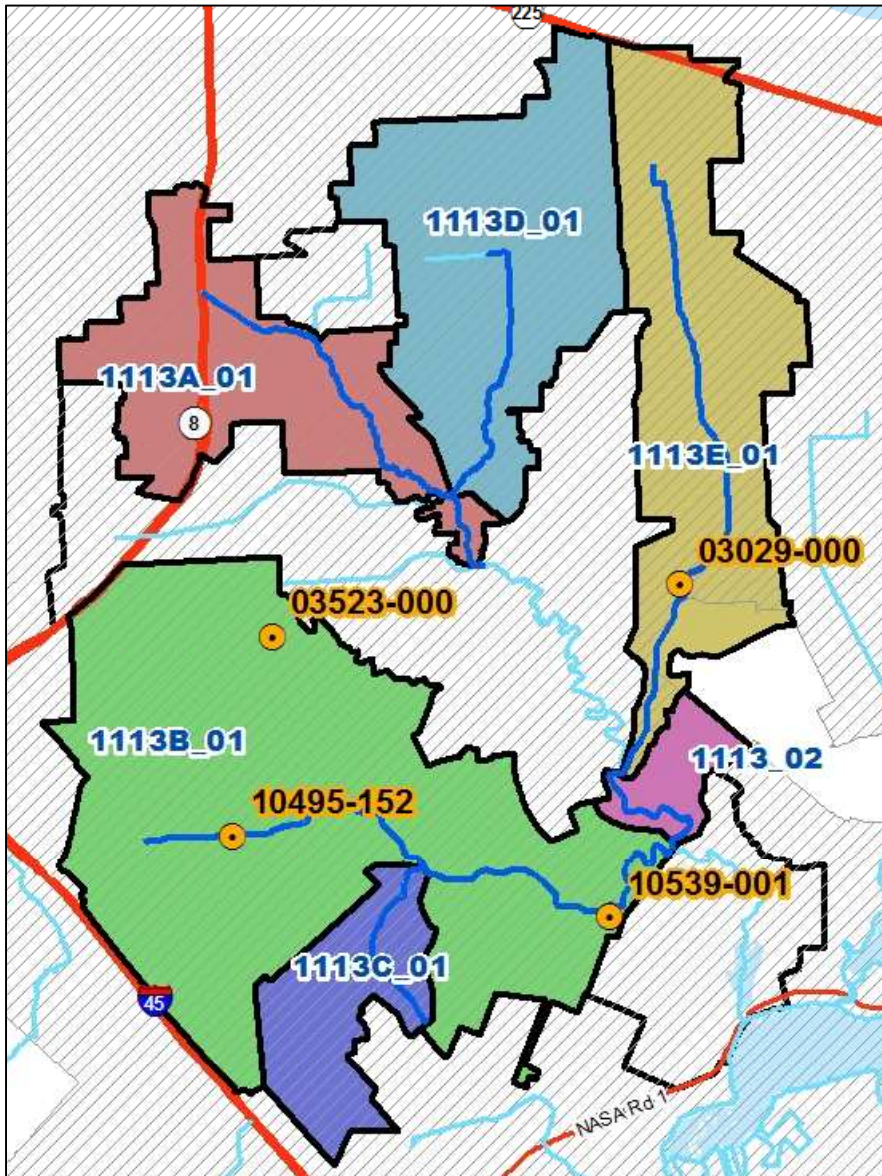
AU ID	Indicator Bacteria	n	% Exceedance	Geo-mean
1113_02	ENT	80	26.3%	38.9
1113A	EC	136	47.1%	419.9
1113B	ENT	103	28.2%	58.9
1113C	EC	69	30.4%	192.2
1113D	EC	70	67.1%	628.3
1113E	EC	67	65.7%	646.4

All values in CFU/100 mL

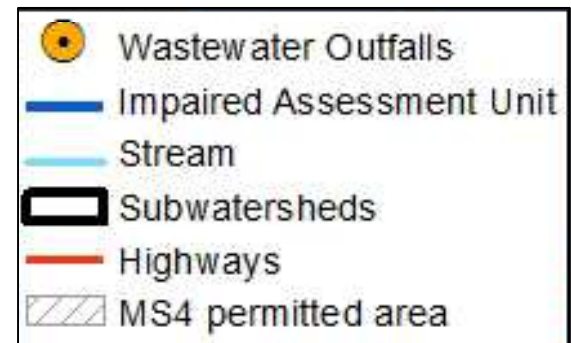
Pollution source assessment

# **PERMITTED AND NON-PERMITTED SOURCES**

# Permitted Sources



AU ID	Receiving Stream	% Watershed under MS4 Jurisdiction
1113_02	Armand Bayou Tidal	100%
1113A	Armand Bayou Above Tidal	100%
1113B	Horsepen Bayou	100%
1113C	Unnamed Tributary to Horsepen Bayou	100%
1113D	Willow Springs Bayou	100%
1113E	Big Island Slough	93%



# Permitted Sources

AU ID	Receiving Water	TPDES Number	NPDES Number	Facility Name	Facility Type	Date Range	Permitted Flow (MGD)	Average Monthly Flow (MGD)
1113B	Horsepen Bayou Tidal	10495-152	TX0069736	Metro Central WWTP	Sewerage Systems	11/30/03 -5/31/13	5	1.44
		10539-001	TX0022543	Robert T Savely Water Reclamation Facility	Sewerage Systems	12/31/04 -5/31/13	10	5.58
		03523-000	TXL005000	City of Houston Sludge Plant	Water Supply	n/a	n/a	n/a
1113E	Big Island Slough	03029-000	TX0103900	Equistar Chemicals Bayport Complex	Industrial Stormwater	n/a	n/a	n/a

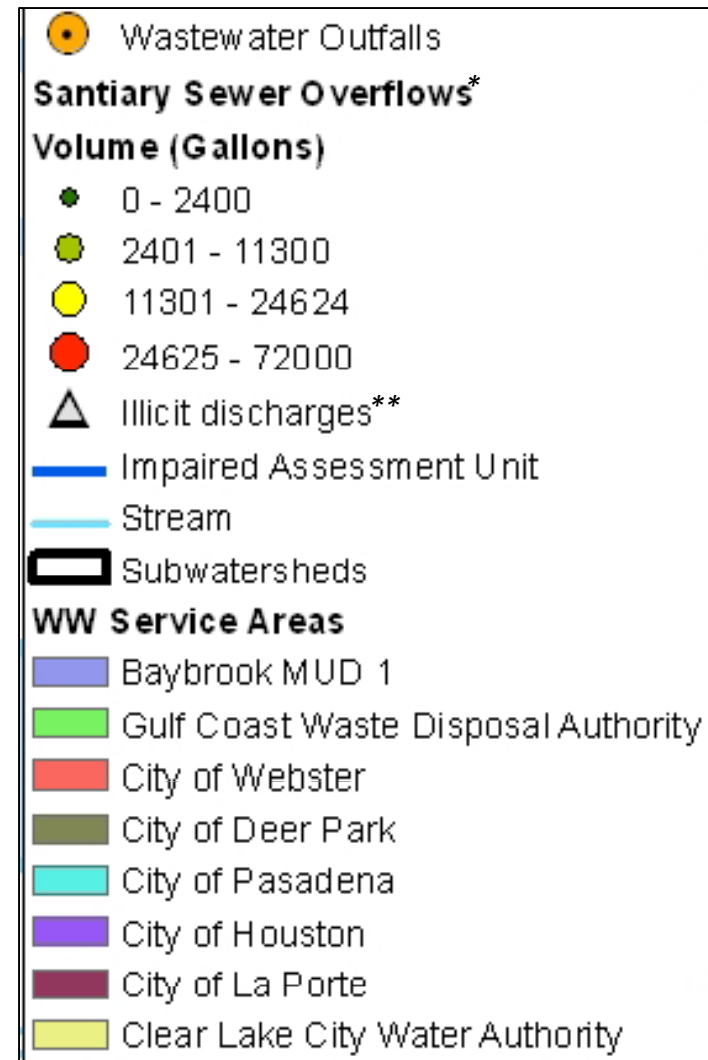
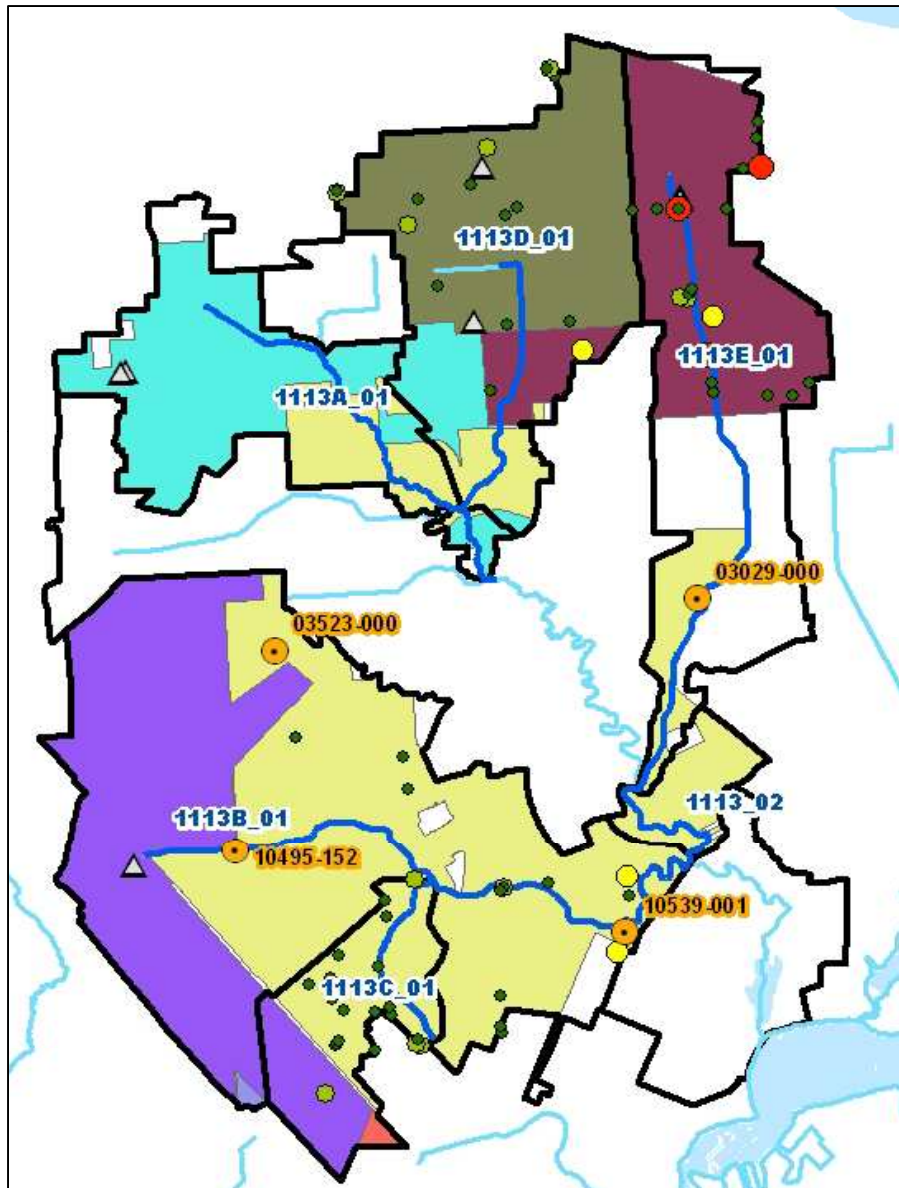
MGD = Millions of Gallons per Day; n/a = Not Applicable

TPDES Number	Facility Name	Enterococci Daily Load 2009-2013			
		# of MCMX Exceedances	% of MCMX Exceedances	# of MCAV Exceedances	% of MCAV Exceedances
10495-152	Metro Central WWTP	n/a	n/a	n/a	n/a
10539-001	Robert T Savely Water Reclamation Facility	4	9.5 %	0	n/a

MCMX = Measurement: Concentration Maximum,

MCAV = Measurement: Concentration Average; n/a = Not Available

# SSOs and Illicit Discharges



\*TCEQ  
\*\*HCFC



# SSOs and Illicit Discharges

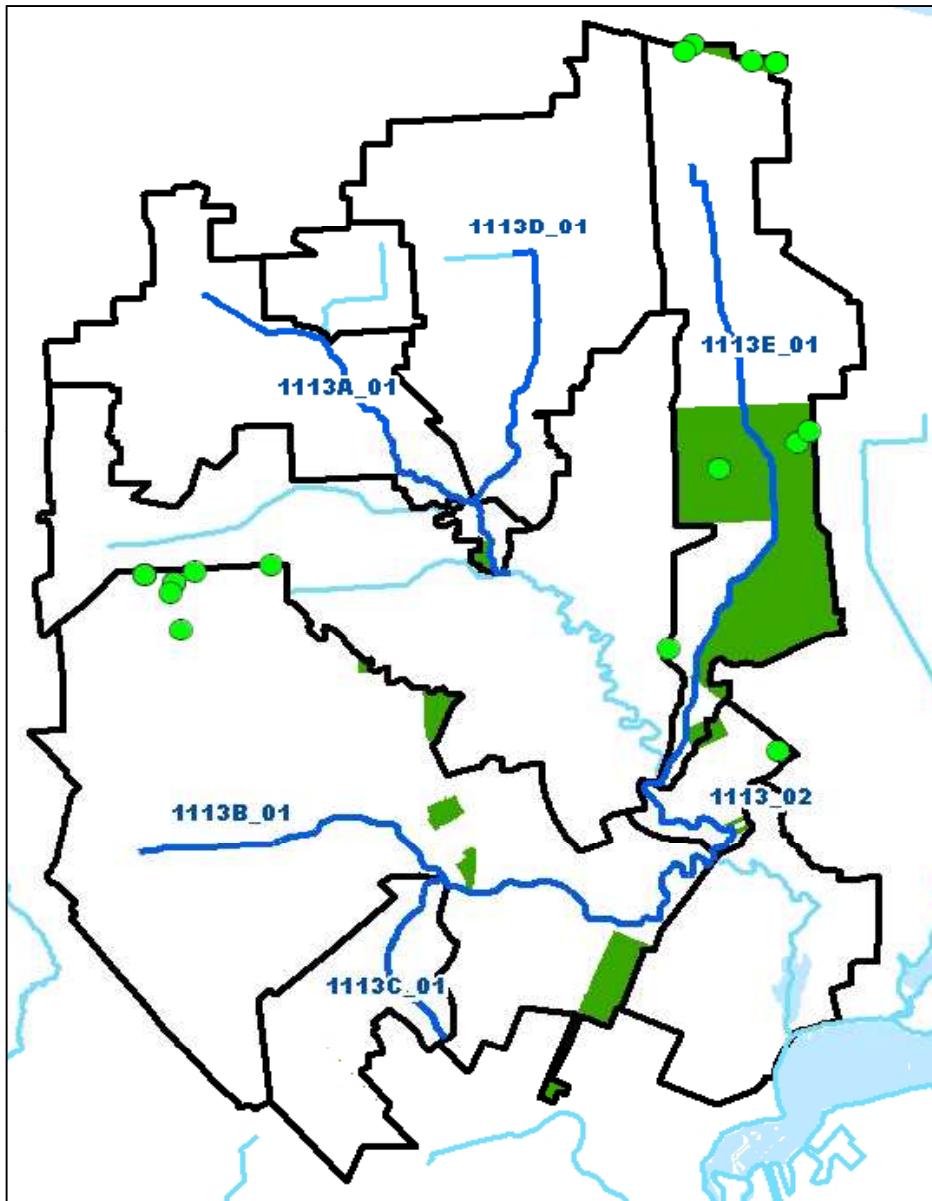


Facility Name	Permittee	NPDES Permit No.	Facility ID	Number of Events	Date Range		Amount (Gallons)	
					From	To	Min	Max
<b>Robert T. Savely WWTF</b>	Clear Lake City Water Authority	0022543	10539-001	51	8/22/03	5/14/13	0	19,200
<b>Metro Cental WWTF</b>	City of Houston	0069736	10495-152	2	4/18/12	5/12/12	200	1000
<b>City of Deer Park WWTF</b>	City of Deer Park	0025321	10519-002	21	9/26/03	6/26/13	0	10,000
<b>Little Cedar Bayou WWTF</b>	City of La Porte	0022799	10206-001	23	6/11/06	4/27/13	0	72,000

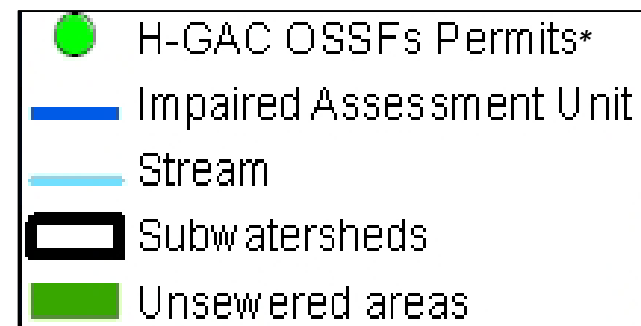
\*TCEQ  
\*\*HCFC



# Non-permitted sources: OSSFs



Segment	On-Site Sewage Facilities (OSSFs)
1113_02	1
1113A	0
1113B	9
1113C	0
1113D	0
1113E	10



\*H-GAC

# Non-permitted sources: Animals

Segment	Dogs	Cats
1113_02	120	137
1113A	3,061	3,483
1113B	6,424	7,310
1113C	4,664	5,307
1113D	4,735	5,388
1113E	3,003	3,417

Animal Type	Number of Animal Units					
	1113_02	1113A	1113B	1113C	1113D	1113E
Cattle and Calves	0	32.8	232.8	0	104	55.2
Layers	0	0.2	1.42	0	0.63	0.33
Other Poultry	0	0.04	0.26	0	0.12	0.068
Horses	0	8	53	0	24	13
Swine	0	0.25	1.5	0	0.50	0.25
Sheep/Lamb/Goat	0	0.4	2.7	0	1.3	0.6
Turkeys	0	0	0.02	0	0.01	0.01
Ducks	0	0	0.04	0	0.02	0.01
Geese	0	0	0.03	0	0.01	0.00
Deer	0	0.18	1.25	0	0.54	0.36
Donkey	0	0.45	1.8	0	0.9	0.45
Rabbits	0	0	0.02	0	0.01	0
Llamas	0	0	0.4	0	0.2	0
<b>Total:</b>	<b>0</b>	<b>32.8</b>	<b>232.8</b>	<b>0</b>	<b>104</b>	<b>55.2</b>

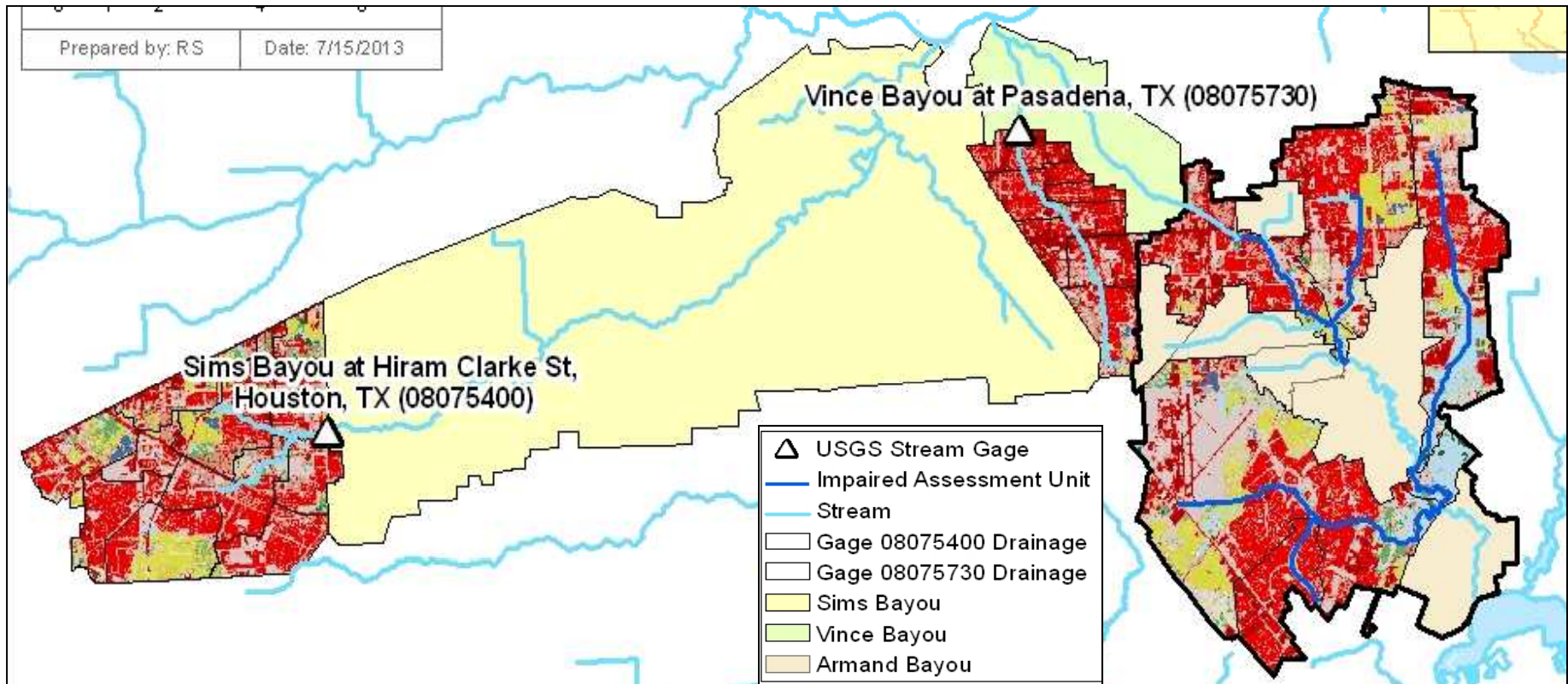


Armand Bayou Nature Center

Non-tidal segments

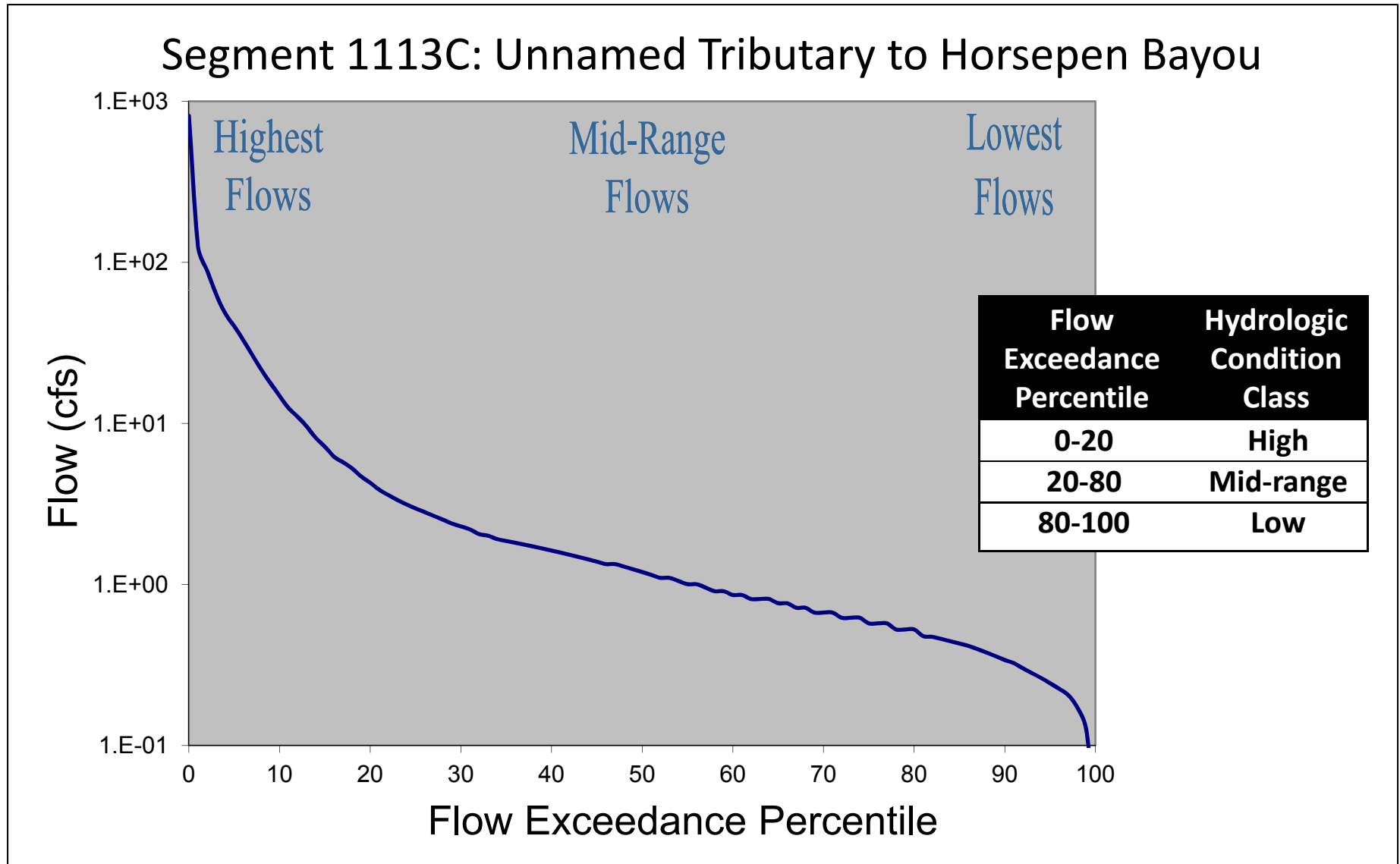
# **DEVELOPMENT OF FDC AND LDC**

# USGS Gages for Flow Projection

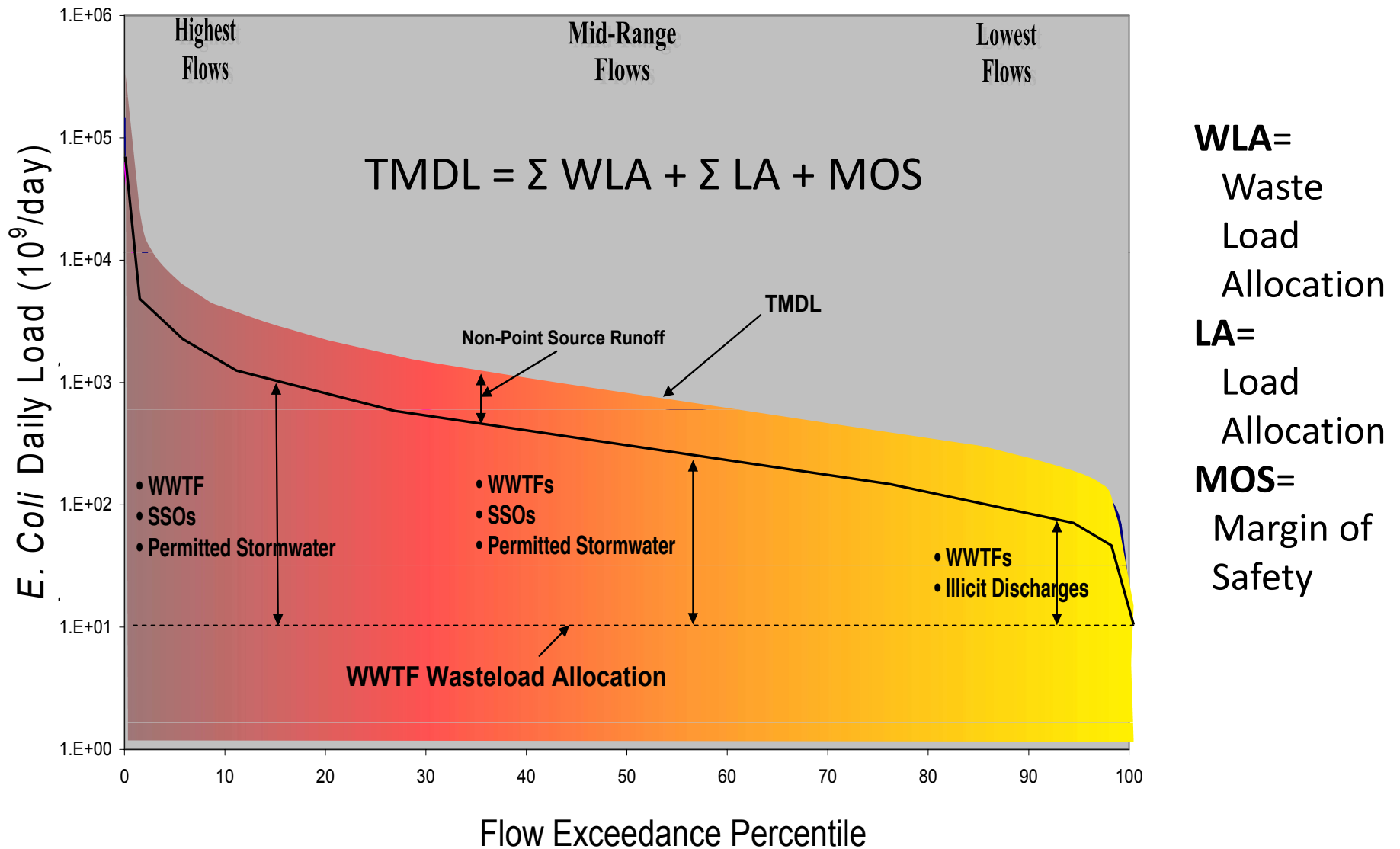


Gage Number	Name	Drainage Area (Acres)	Percent Developed Land	Percent Forest/Wetland	Annual Average Precipitation (in.)	Mean Flow (cfs)	Number of Continuous Data Points
08075730	Vince Bayou at Pasadena	4863	98 %	1 %	53.1	17.3	4018
08075400	Sims Bayou at Hiram Clarke St	13279	78 %	7 %	50.3	38.8	4018

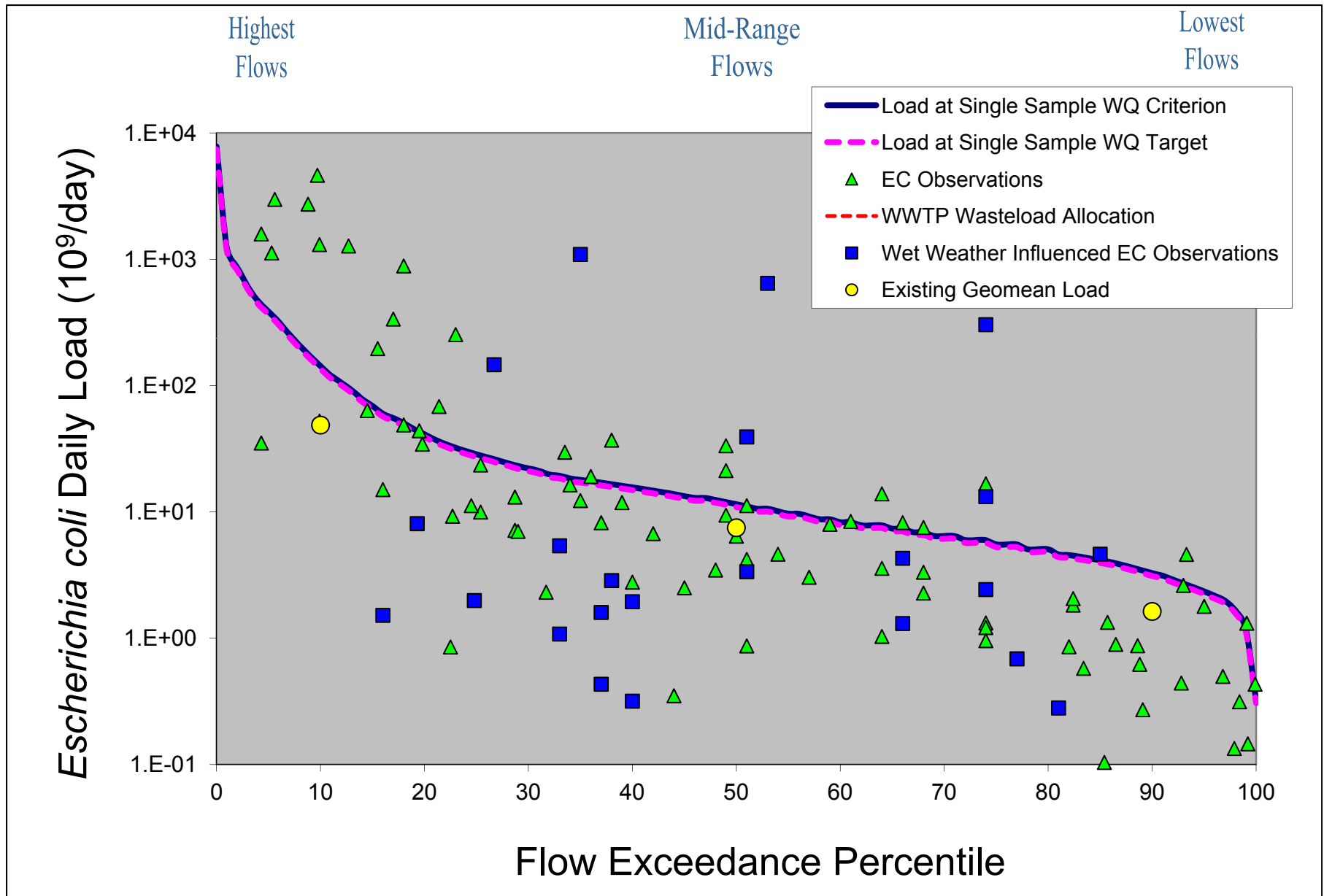
# Flow Duration Curve (FDC)



# Load Duration Curve (LDC)



# LDC for 1113C

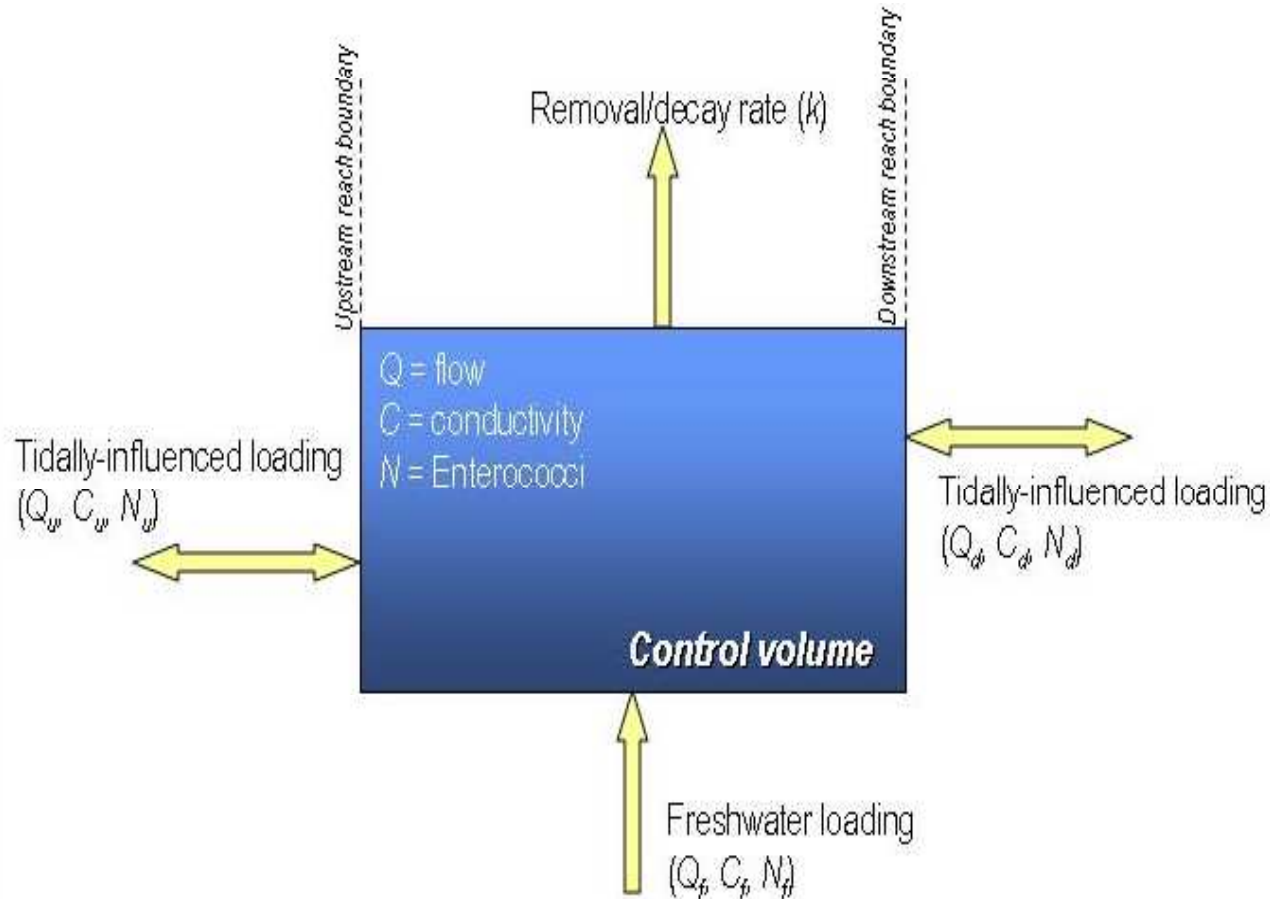


Tidal segments

# **TIDAL PRISM MASS BALANCE**



# Tidal Prism Model



# Next Steps

- Complete FDCs and LDCs
- Complete tidal prism mass balance
- Draft TSD
- Prepare Water Quality Management Plan (WQMP) Update tool
- Status report for FY13
- TSD and WQMP tool FY14