

# **Total Maximum Daily Load for Fecal Pathogens in Buffalo Bayou and Whiteoak Bayou**

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# TMDL Equation

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$$\text{TMDL} = \Sigma \text{WLA} + \Sigma \text{LA} + \text{MOS}$$

**WLA – wasteload allocation; all controllable sources**

**LA – load allocation; non-controllable sources**

**MOS – margin of safety; 5% in this study**

# WWTP Discharges

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## 1. Normal WWTPs Discharge

- a) Dry weather flow is average of self-reported monthly flows between 4/1/99 and 10/1/2003
- b) Bacteria concentration in dry weather
  - i. Sampled: < 1 and 14,812 MPN/dL
  - ii. Nonsampled: 3.5 MPN/dL for Buffalo and 2 MPN/dL for Whiteoak

## 2. Wet WWTPs

- a) Rainfall of 0.25 inches used to predict flow
- b) Wet weather concentrations same as dry

## 3. Biosolid

- 1. Rainfall of 0.5 inches used to predict flow
- 2. Biosolid concentration of 2,612 MPN/dL

# Dry weather storm sewer discharges (DWSS)

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1. DWSS discharges located with GIS
2. Flow range between  $3.42\text{E-}5$  to 0.21 MGD
3. Concentrations range between 11 and  $> 241,920$  MPN/dL
4. Discharges only applied to dry weather and median flow conditions

# Wet Weather MS4 Discharge Loads

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1. 2002 Land Use Land Cover from HGAC
2. EMCs between 10,000 to 500,000 MPN/dL from MS4 Permit and Galveston Bay Estuary Program Study
3. Runoff determined using curve number approach
4. Estimated made for typical rainfall event of 0.8 inches
5. Representative of peak flow conditions

# Sanitary sewer overflow (SSO) discharges

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1. SSOs estimated based upon either
  - a. Known values from COH database
  - b. Outside COH, number of SSOs from housing ages
2. Flows reported by EPA range from 500 – 14,000 gallons/event
3. Dry weather concentration measured in WWTP influent from watershed of  $4.9E+06$  MPN/dL
4. Wet weather concentration of  $3.5E+06$  MPN/dL
5. Dry weather SSOs occur only during dry and median flow; Wet weather SSOs occur only during wet weather
6. 72% Delivery rate

# On-site sewage facility (OSSF) discharges

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1. 0 to 184 per subbasin determined based distribution on a zip-code basis
2. Harris county septic density extended to neighboring counties (Ft. Bend and Waller) that did not have data
3. Failing septic systems load =  $4.9\text{E}+06$  MPN/dL
4. Failing septic system flow = 193 gallons/septic/day

# OSSF Discharges

Assumption	Value
Number Individ. per Household	2.8
Failure Rate	25%
Wastewater Production (per person per day)	69
Deliver Rate	100%
Fecal coliform concentration in Wastewater (cfu/dL)	4.9E+06

**Load:**

**$2.3 \times 10^8$  MPN/day/  
septic system**

**Flow:**

**$1.9 \times 10^{-5}$  MGD/septic  
system**



# Bed sediment resuspension

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1. Stream width is 10 ft for upper Buffalo and Whiteoak Bayou, 20 ft for lower Buffalo
2. Stream lengths range from 792 to 40,656 ft
3. Resuspension rate of 2,740,000 cfu/ft<sup>2</sup>/hr
4. Shear occurs along entire reach
5. Concrete lined portions of Whiteoak Bayou do not have resuspension

# Direct deposition

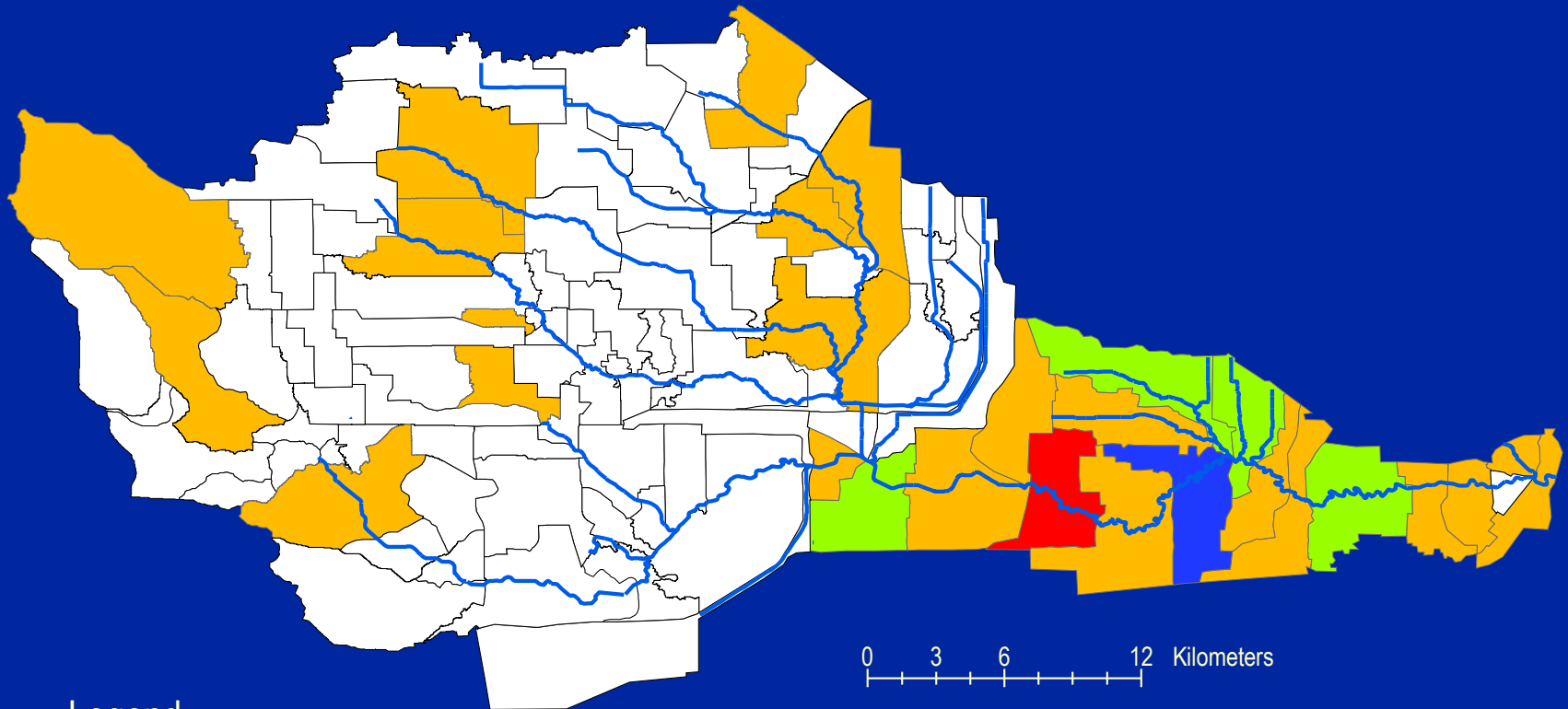
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- 1. Animal densities in buffer along stream:**
  - a. Waterfowl populations:  $6 \times 10^{-3}$  birds/acre**
  - b. Dogs: 0.12 dogs/acre**
  - c. Other animals, such as bats, raccoon, deer, rats: 8/acre**
- 2. Stream buffer of 10 ft conducive to direct deposition**
- 3. Bacteria loading:**
  - a. Waterfowl populations:  $1 \times 10^8$  cfu/animal/day**
  - b. Dogs:  $2 \times 10^9$  cfu/animal/day**
  - c. Other animals:  $8.6 \times 10^8$  cfu/animal/day**
- 4. Assumed to occur during both wet and dry weather**

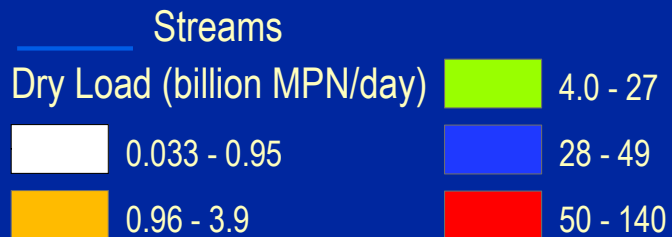
# Largest Source of *E. coli*

	Low	Median	High
Watersheds Draining to 1014	OSSF	Wet weather MS4 Runoff	Wet weather MS4 Runoff
Mouth of Segment 1014	DWSS	Wet weather MS4 Runoff	Wet weather MS4 Runoff
Mouth of Segment 1013	Direct Deposition	Wet weather MS4 Runoff	Wet weather MS4 Runoff
Mouth of Segment 1017	OSSF	Wet weather MS4 Runoff	Wet weather MS4 Runoff

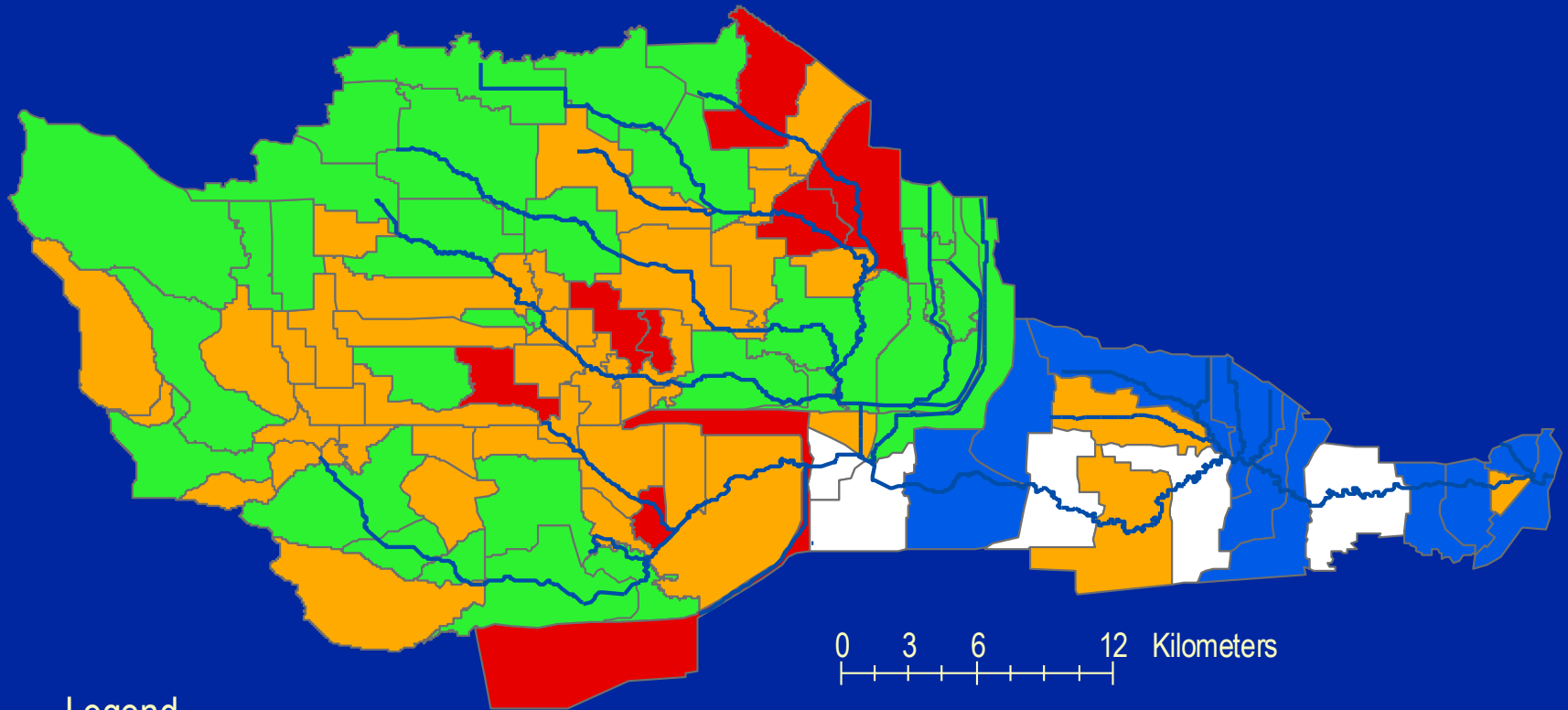
# Subbasin Evaluation of Low Flow Loads



## Legend



# Primary Source of Loads at Low Flow



Legend

Streams

Primary Loading Source



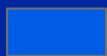
DWSS



DirectDeposition



OSSF

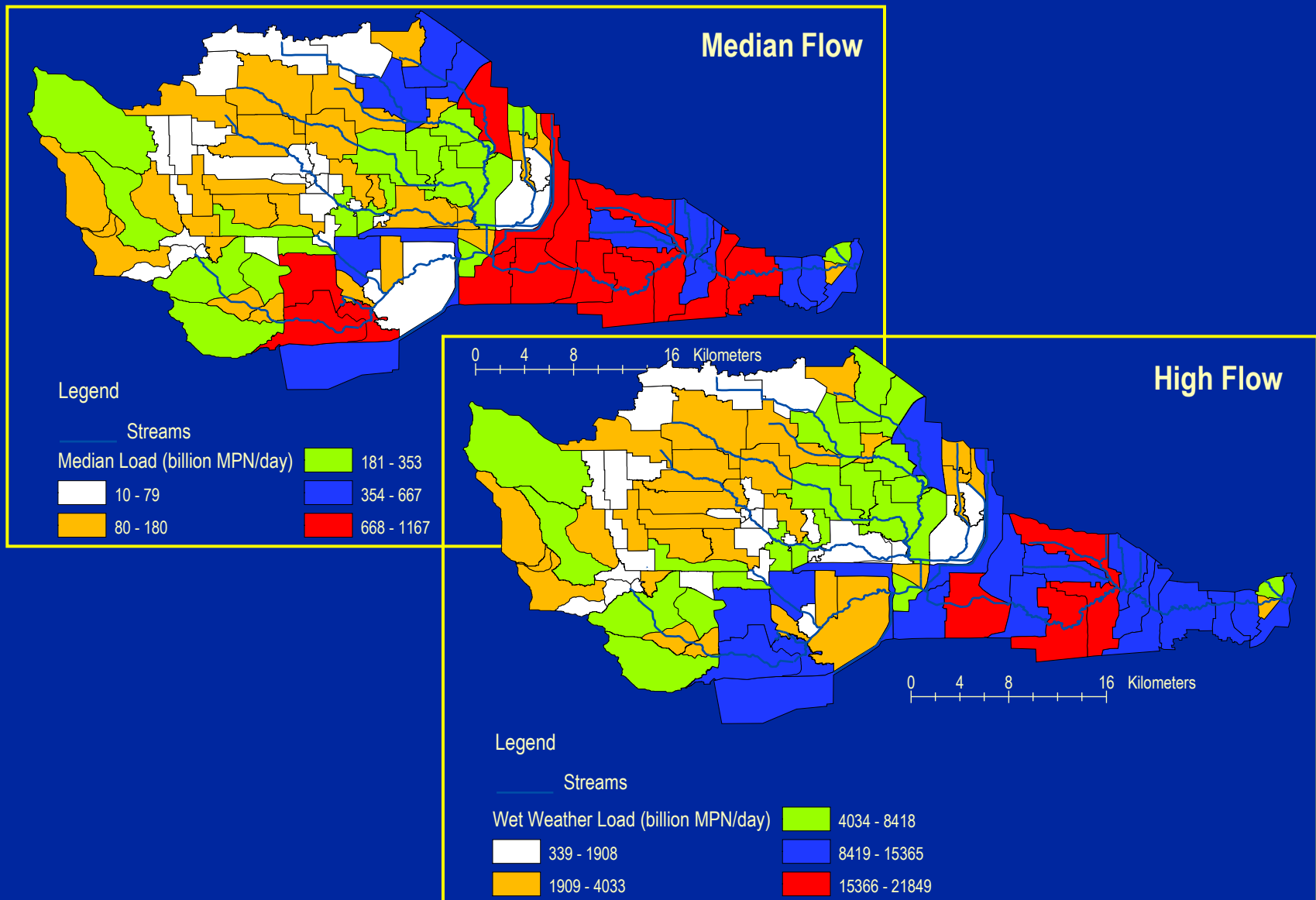


SSO



WWTP Dry

# Evaluation of Median & High Flow Load



# Source Elimination in Load Reduction Evaluation

Type of Reduction	Low Flow	Median Flow	High Flow
Flow and Load Eliminated	<ul style="list-style-type: none"> <li>• Dry SSOs</li> <li>• DWSS Discharges</li> </ul>	<ul style="list-style-type: none"> <li>• Dry SSOs</li> <li>• DWSS Discharges</li> </ul>	<ul style="list-style-type: none"> <li>• Dry SSOs</li> <li>• Dry DWSS Discharges</li> <li>• Wet Weather SSO</li> </ul>
Only Load Eliminated	<ul style="list-style-type: none"> <li>• Septic Systems</li> <li>• WWTP Dry Load</li> </ul>	<ul style="list-style-type: none"> <li>• Septic Systems</li> <li>• Portion of MS4 Runoff during Wet Weather</li> <li>• WWTP Dry</li> <li>• WWTP Wet Load</li> </ul>	<ul style="list-style-type: none"> <li>• Septic Systems</li> <li>• MS4 Runoff during wet weather</li> <li>• WWTP Dry Load</li> <li>• WWTP Wet Load</li> <li>• Biosolid discharges</li> </ul>

Yellow indicates sources where flow and load eliminated

Blue indicates sources where only load was eliminated