


# SAN BERNARD WATERSHED PROTECTION PLAN:

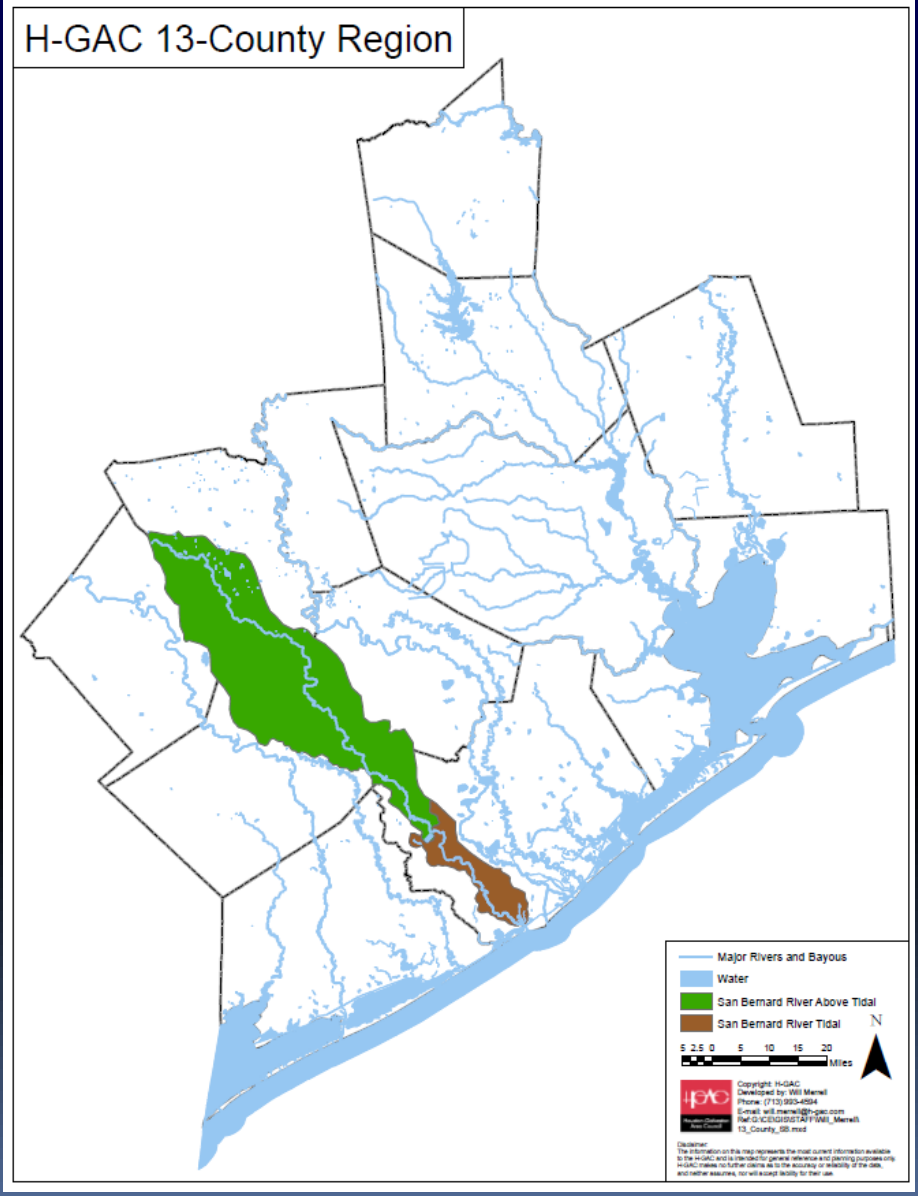
## The Spatially Explicit Enrichment Calculation Tool (SELECT) UPDATE

**Wharton, TX**
**June 16, 2011**

Houston-Galveston Area Council

RECOVERY.GOV

# STUDY AREA



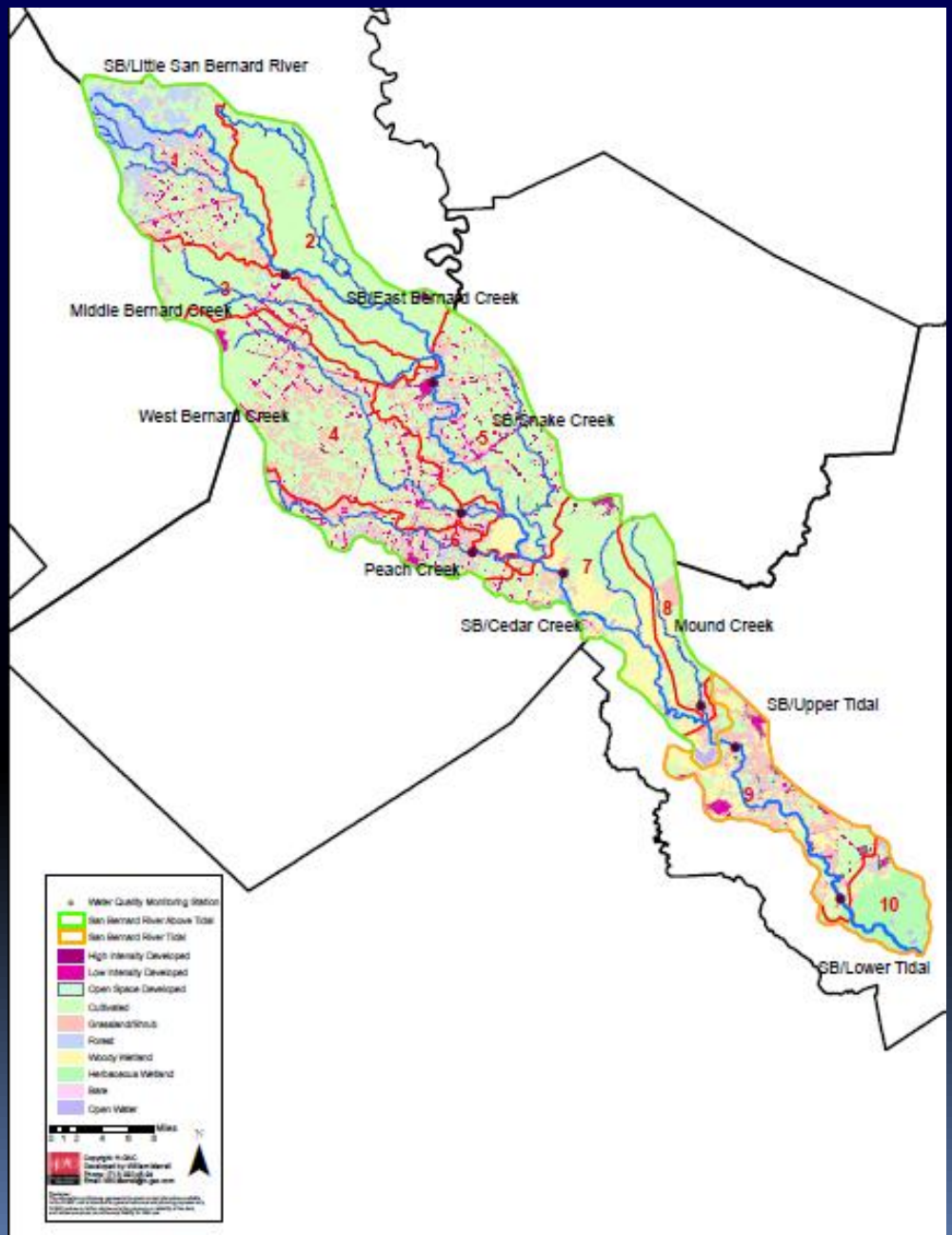

- Area of approximately 900 $mi^2$
- San Bernard River has a length of 125 mi and flows through Austin, Colorado, Wharton, Fort Bend and Brazoria counties
- Approximately, 15% of the stream is tidally influenced
- The watershed receives around 52in of rainfall at year
- The watershed is mainly undeveloped

# SELECT MODEL

- SELECT (Spatially Explicit Load Enrichment Calculation Tool) is an analytical approach for developing an inventory of potential bacteria loads based on land use and geographical location.
- It evaluates each pollutant source and identifies subwatersheds with the greatest contamination potential.
- It was successfully used to evaluate bacteria loads in Plum Creek and Bastrop Bayou watersheds
- Limitations:
  - The model overestimates potential sources because it does not account for mitigation processes within the watershed.

# METHODOLOGY

1. SPATIAL SUBDIVISON OF THE WATERSHED:
- Based on HUC-12 subdivision
- Major tributaries
- Location of WQMS



# METHODOLOGY

## 2. LAND COVER CLASSIFICATION

Land use distribution per subwatershed/ County Details Analysis
2006 NLCD was used

## 3. IDENTIFICATION OF SOURCES

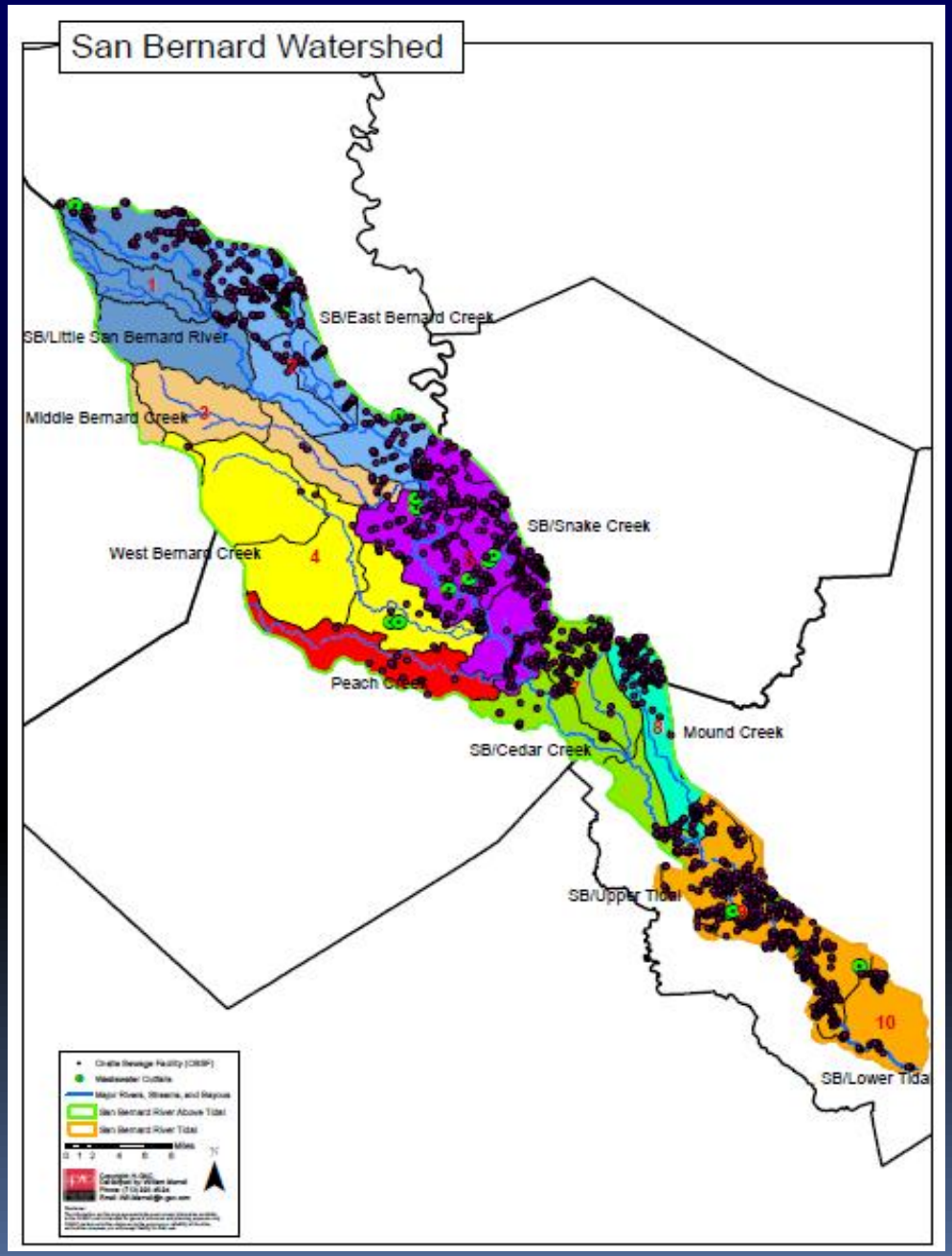
### Non-Point Sources of Bacteria

- On-site sanitary system facilities - H-GAC
- Pets (Dogs) - AVMA
- Wildlife (Deer, Geese, and Feral Hogs) - TWPD
- Urban Runoff
- Livestock (Census of Agriculture 2007)

### Point Sources of Bacteria

WWTPs – Loads and Self-reported Flows
SSOs - TCEQ

Calculation of Loads



# ASSUMPTIONS OF THE MODEL

1. OSSFs loadings were recalculated based on the Households forecast instead of OSSFs database.
   - Increase on number of OSSFs proportional to households (HH) growth in rural areas
   - Non regulated (previous 1989) and regulated OSSFs systems presented a failure rate of 50% and 12% respectively (Reed, Stowe, and Yanke, 2001)

2. A buffer zone of 100 m was delimited around streams. It was assumed that 100% of the loadings within the buffer and 25% of the loadings outside the buffer reach the streams.

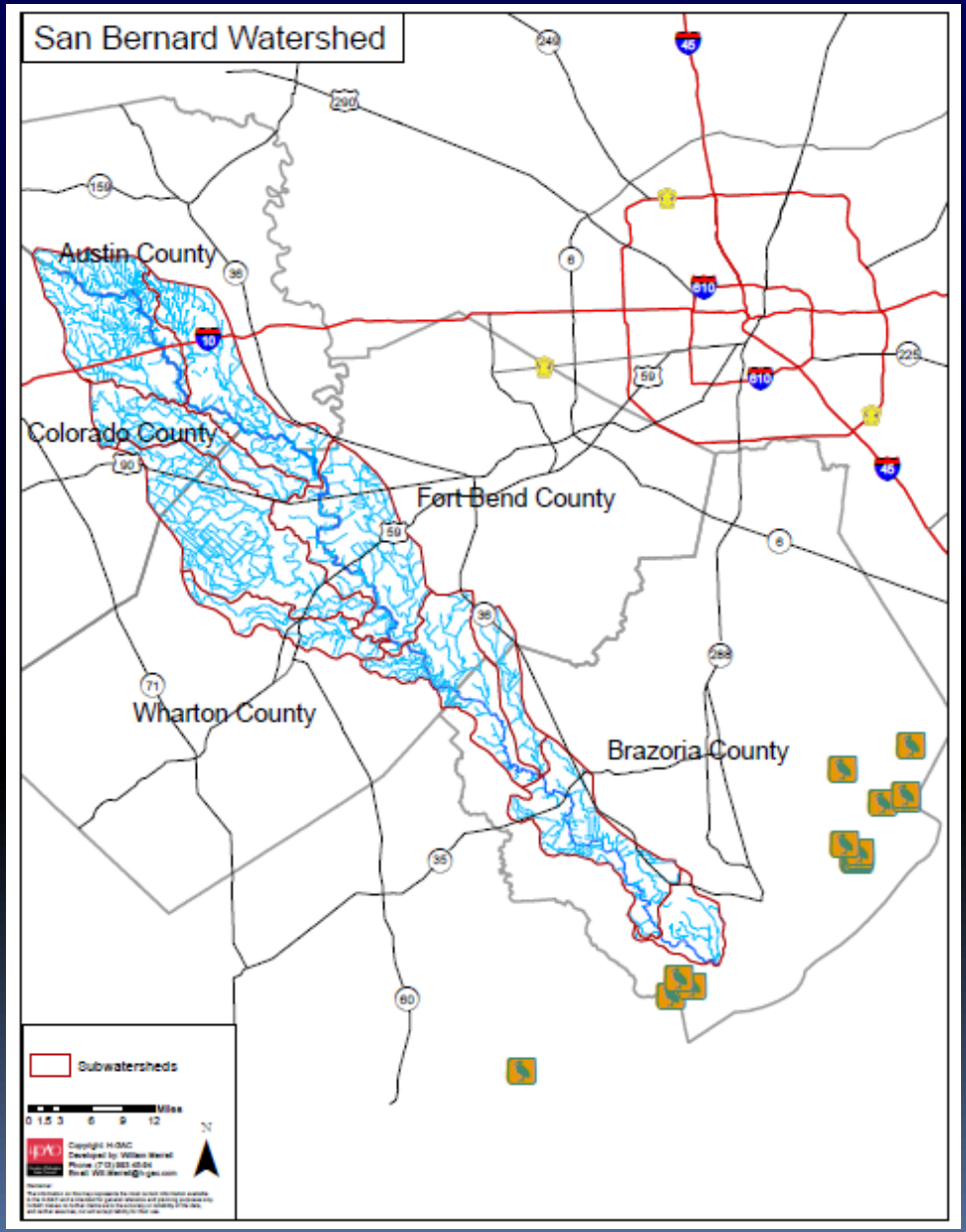
3. Effluent concentrations from WWTPs were assumed to be 126 cfu/dL
   - Increase on WWTPs effluents proportional to population growth in urban areas.

# ASSUMPTIONS OF THE MODEL

4. Livestock were located mainly in grassland areas and wildlife were located in forest and wetland areas (Teague, 2009). Habitats assignation
   - Livestock, deer, and geese population were considered to remain constant at current values during forecast.
5. *Estimates on Feral Hogs densities were reevaluated – Highlights (Burns, 2011)*
   - *A density of 3 to 5 hogs/km$^2$ was used in the model*
   - *Growth of 20% annual on Hogs population*
6. New HH in rural areas were considered to occupy ½ ac per HH and were located in cultivated, grassland, forest and wetlands in proportion (40, 40, 10, and 10%).

7. Birds and Waterfowl population should be considered as a potential source.

- An inventory of rookeries in the coastal area was obtained from FWS
- Not included in the model



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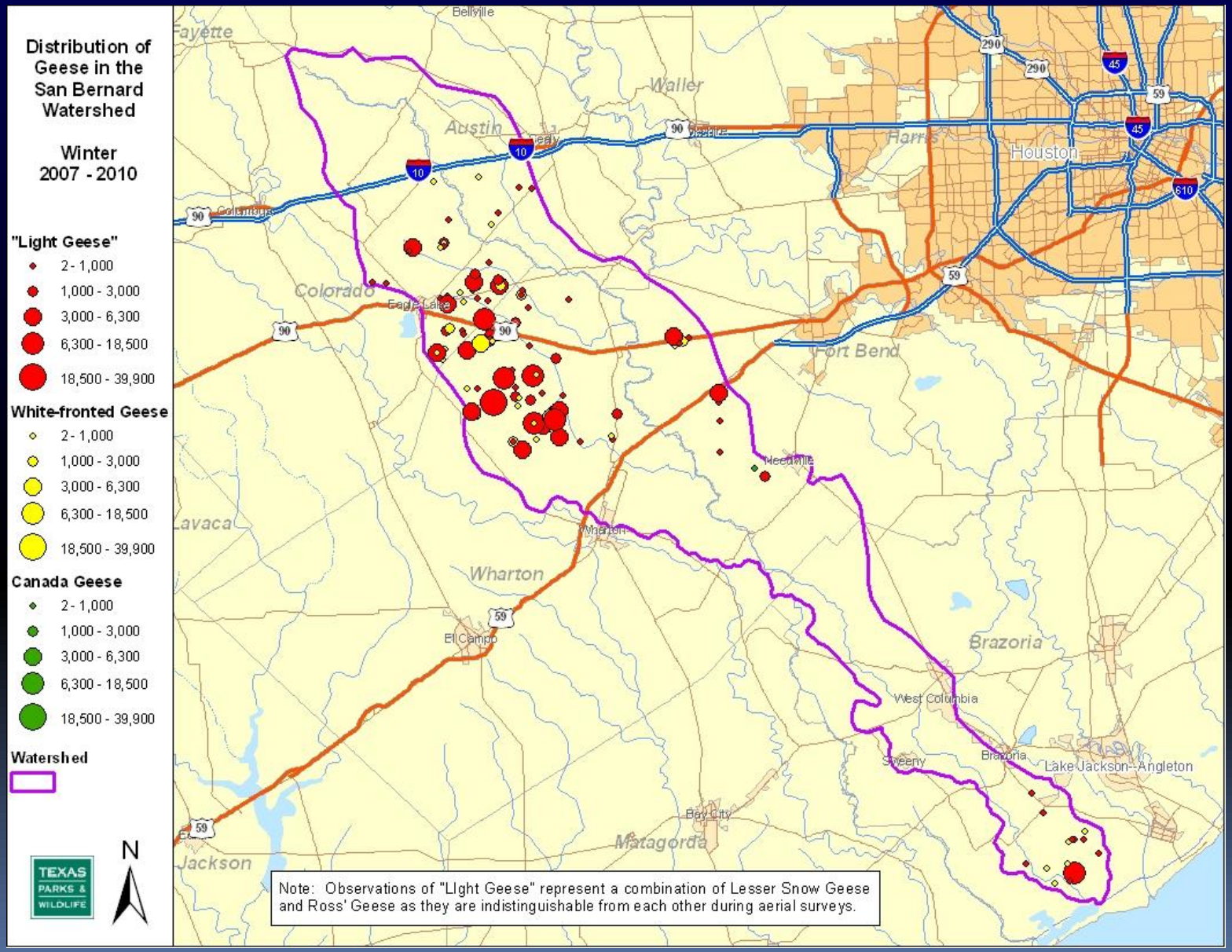


# Sewer System Overflows SSOs

- Data for SSOs were obtained for SB
- Scarce data.  71 events reported (four facilities)  in a 7-year period.
- 92% of the overflows were generated by storm events and reported in Sub watershed 9, at city of Brazoria and city of Sweeny facilities
- This source was not included in the analysis.

| SUBWAT. | EPA Permit | Date | # events | TOTAL DURATION (days) | TOTAL GALLONS | EC CONC. (#cfu/dL) | EC TOTAL LOADING (cfu/day) |
|---|---|---|---|---|---|---|---|
| 1 | TX0114880 | 8/29/2005 | 1 | 0.2083 | 0 | 1.00E+07 | 0.00E+00 |
| 5 | TX0098949 | 5/23/2003 | 1 | 0.2083 | 9000 | 1.00E+07 | 1.18E+13 |
| 9 | TX0024511 | 6/2/2002, 6/16/04 | 2 | 0.0417 | 200000 | 1.00E+07 | 1.31E+15 |
| 9 | TX0025615 | 06/26/06-09/20/10 | 62 | 25.17 | 1418870 | 1.00E+07 | 1.54E+13 |

# RESULTS - LOADINGS BUFFER ZONE

| SOURCES | NO BUFFER | | BUFFER | | % REDUCTION |
|---|---|---|---|---|---|
| OSSFs | 1.4E+13 | 4.2% | 4.8E+12 | 3.3% | 65% |
| WWTPs | 9.8E+09 | 0.0% | 9.8E+09 | 0.0% | 0% |
| Urban Runoff | 1.2E+13 | 3.8% | 1.2E+13 | 8.4% | 0% |
| Dogs | 3.9E+13 | 12.0% | 2.3E+13 | 16.0% | 40% |
| Cattle | 1.8E+14 | 54.8% | 6.9E+13 | 47.5% | 61% |
| Horses | 5.7E+11 | 0.2% | 2.2E+11 | 0.2% | 61% |
| Sheep/Goats | 2.1E+13 | 6.5% | 8.1E+12 | 5.5% | 62% |
| *Livestock* | *2.0E+14* | *61.5%* | *7.8E+13* | *53.2%* | 61% |
| Deer | 2.3E+12 | 0.7% | 9.2E+11 | 0.6% | 60% |
| Feral Hogs | 5.1E+13 | 15.7% | 2.0E+13 | 13.9% | 60% |
| Geese | 6.8E+12 | 2.1% | 6.8E+12 | 4.6% | 0% |
| *Wildlife* | *6.0E+13* | *18.5%* | *2.8E+13* | *19.1%* | 53% |
| TOTAL | 3.3E+14 | 100% | 1.5E+14 | 100% | 56% |

# RESULTS - Contribution of potential E. *coli* sources

| NLDC 2006 COMPOSITION PER SOURCE (%) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBW. | SUBWATERSHED | OSSFs | WWTP | Urban Runoff | Dogs | Cattle | Horses | Sheep/ Goats | Deer | Geese | Hogs | TOTAL LOADING |
| SW1 | SW1- SB/Little San Bernard River | 8 | 0 | 11 | 2 | 23 | 17 | 11 | 28 | 0 | 16 | 16 |
| SW2 | SW2- SB/East Bernard Creek | 8 | 8 | 12 | 8 | 21 | 24 | 18 | 18 | 1 | 13 | 17 |
| SW3 | SW3- Middle Bernard Creek | 2 | 0 | 6 | 1 | 10 | 5 | 5 | 7 | 10 | 8 | 6 |
| SW4 | SW4- West Bernard Creek | 8 | 2 | 19 | 12 | 15 | 10 | 20 | 11 | 74 | 18 | 11 |
| SW5 | SW5- SB/Snake Creek | 16 | 21 | 15 | 11 | 7 | 13 | 8 | 9 | 6 | 15 | 15 |
| SW6 | SW6- Peach Creek | 5 | 0 | 8 | 7 | 6 | 4 | 8 | 5 | 0 | 5 | 4 |
| SW7 | SW7- SB/Cedar Creek | 9 | 9 | 7 | 9 | 6 | 8 | 8 | 7 | 1 | 10 | 7 |
| SW8 | SW8- Mound Creek | 5 | 0 | 3 | 2 | 3 | 6 | 5 | 3 | 0 | 4 | 5 |
| SW9 | SW9- SB/Upper Tidal | 34 | 60 | 18 | 45 | 6 | 13 | 16 | 11 | 0 | 9 | 11 |
| SW10 | SW10- SB/Lower Tidal | 4 | 0 | 2 | 4 | 1 | 1 | 1 | 1 | 8 | 1 | 1 |

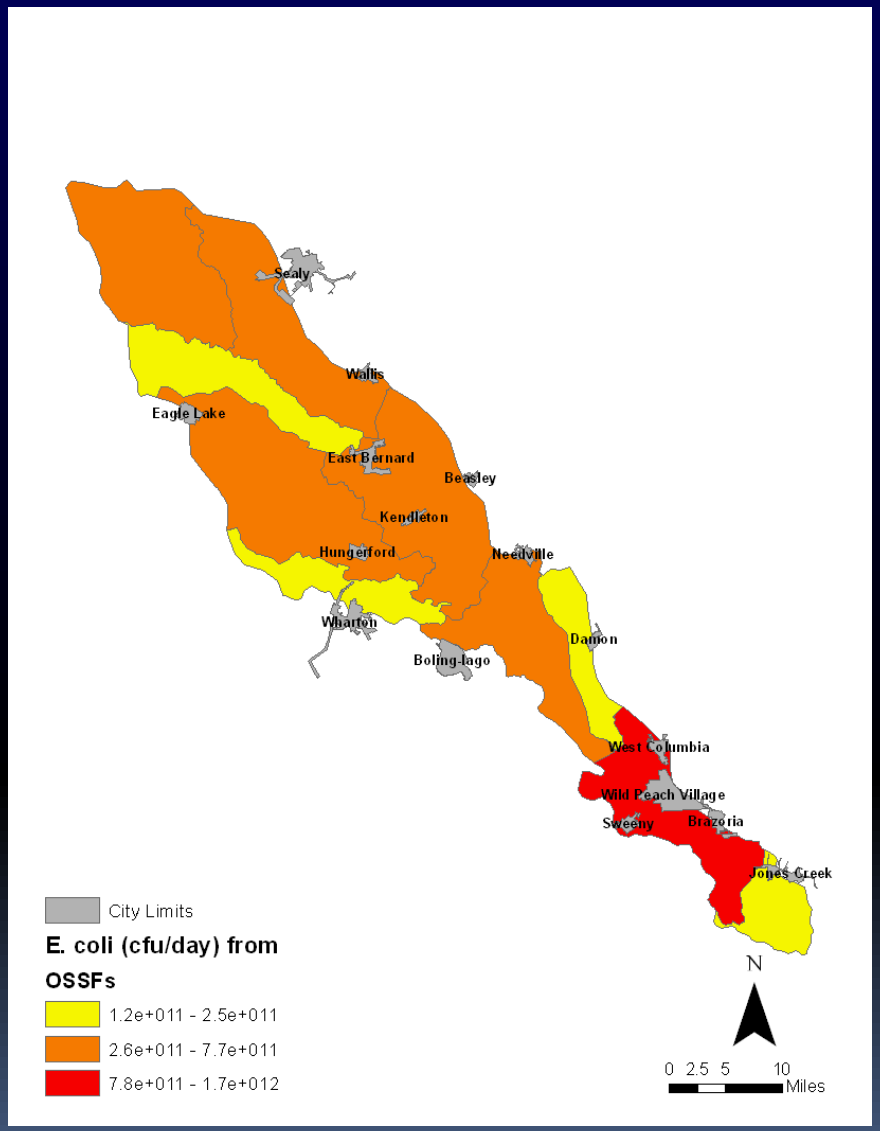
| NLDC 2006 COMPOSITION PER SUBWATERHSED (%) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SUBW. | SUBWATERSHED | OSSFs | WWTP | Urban Runoff | Dogs | Cattle | Horses | Sheep/ Goats | Deer | Geese | Hogs |
| SW1 | SW1- SB/Little San Bernard River | 2 | 0 | 6 | 2 | 71 | 0 | 4 | 1 | 0 | 14 |
| SW2 | SW2- SB/East Bernard Creek | 2 | 0 | 7 | 8 | 65 | 0 | 6 | 1 | 0 | 11 |
| SW3 | SW3- Middle Bernard Creek | 1 | 0 | 6 | 1 | 65 | 0 | 4 | 1 | 6 | 16 |
| SW4 | SW4- West Bernard Creek | 1 | 0 | 9 | 11 | 40 | 0 | 6 | 0 | 19 | 14 |
| SW5 | SW5- SB/Snake Creek | 5 | 0 | 13 | 18 | 35 | 0 | 5 | 1 | 3 | 21 |
| SW6 | SW6- Peach Creek | 3 | 0 | 11 | 19 | 47 | 0 | 7 | 1 | 0 | 12 |
| SW7 | SW7- SB/Cedar Creek | 4 | 0 | 8 | 20 | 41 | 0 | 6 | 1 | 1 | 19 |
| SW8 | SW8- Mound Creek | 6 | 0 | 8 | 8 | 50 | 0 | 9 | 1 | 0 | 18 |
| SW9 | SW9- SB/Upper Tidal | 7 | 0 | 10 | 47 | 20 | 0 | 6 | 0 | 0 | 8 |
| SW10 | SW10- SB/Lower Tidal | 7 | 0 | 8 | 35 | 16 | 0 | 4 | 0 | 21 | 9 |

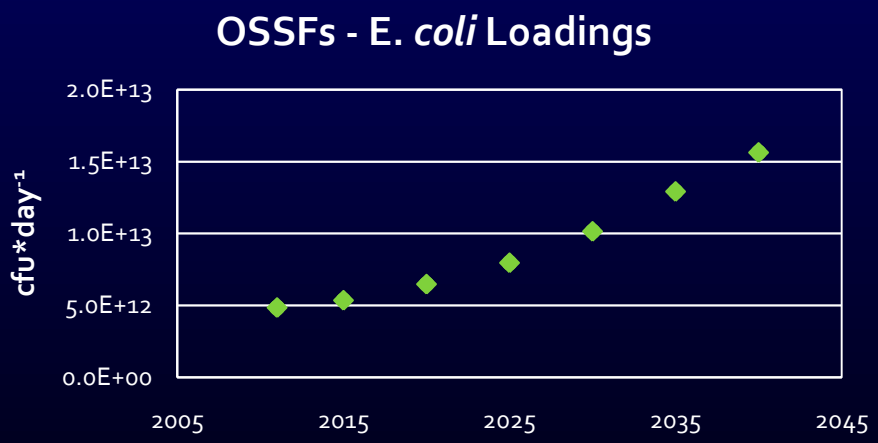
# FORECAST MODELING RESULTS

**2006 NATIONAL LAND COVER DATASET**

| SOURCES | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| OSSFs | 3.3% | 3.2% | 3.1% | 2.7% | 2.2% | 1.6% | 1.1% |
| WWTPs | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Urban Runoff | 8.4% | 7.3% | 5.9% | 4.2% | 2.7% | 1.6% | 0.9% |
| Dogs | 16.0% | 14.5% | 12.3% | 9.6% | 6.9% | 4.6% | 2.8% |
| Cattle | 47.5% | 41.3% | 32.7% | 23.2% | 14.7% | 8.4% | 4.6% |
| Horses | 0.2% | 0.1% | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% |
| Sheep/Goat | 5.5% | 4.8% | 3.8% | 2.7% | 1.7% | 1.0% | 0.5% |
| Livestock | 53.2% | 46.2% | 36.6% | 26.0% | 16.4% | 9.4% | 5.1% |
| Deer | 0.6% | 0.5% | 0.4% | 0.3% | 0.2% | 0.1% | 0.1% |
| Feral Hogs | 13.9% | 24.1% | 38.5% | 54.9% | 70.2% | 81.8% | 89.6% |
| Geese | 4.6% | 4.0% | 3.2% | 2.3% | 1.5% | 0.9% | 0.5% |
| Wildlife | 19.1% | 28.7% | 42.1% | 57.6% | 71.8% | 82.8% | 90.2% |

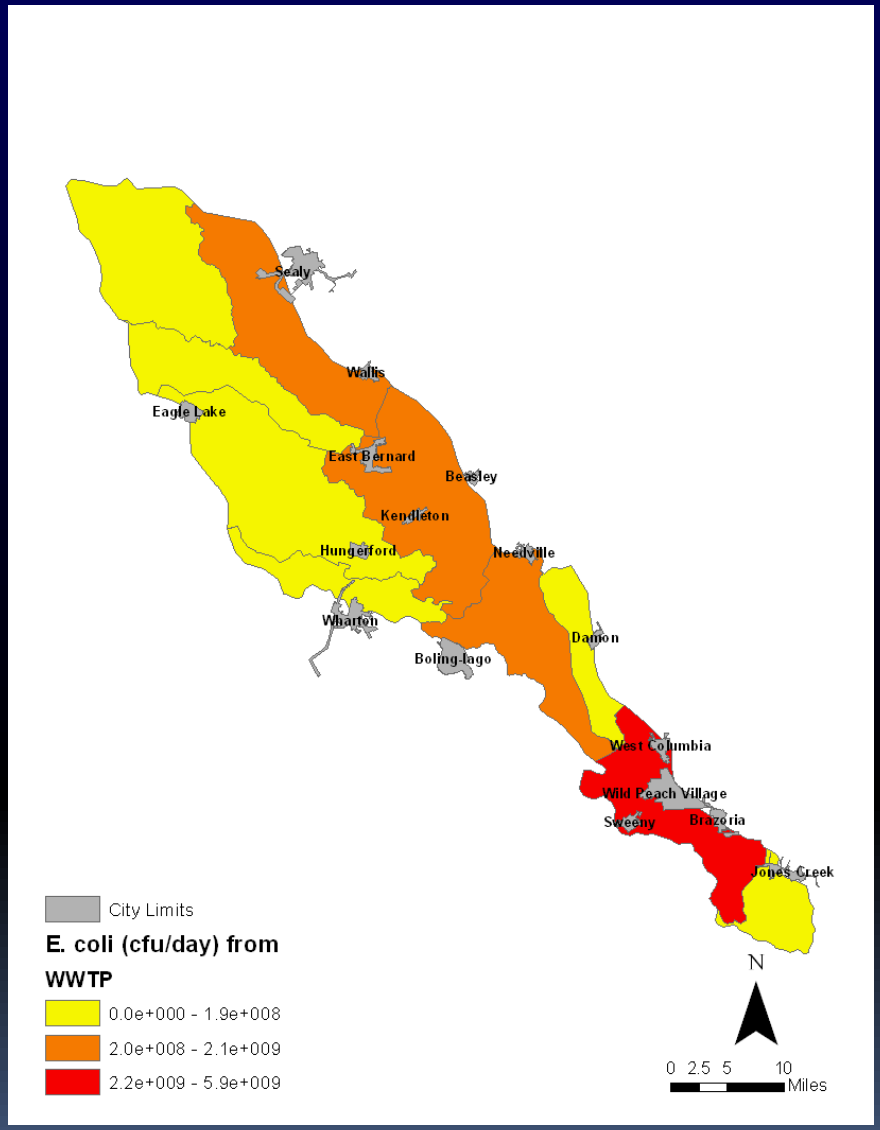
# OSSFs - EC Potential Loadings



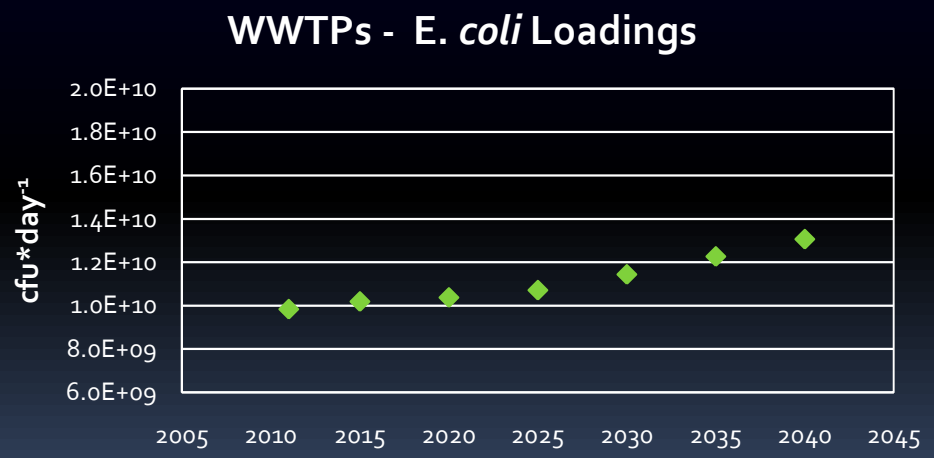




- Highest loadings in subwatershed 9. Highest number of rural households.
- Increasing loading as result of increasing number of households in rural areas

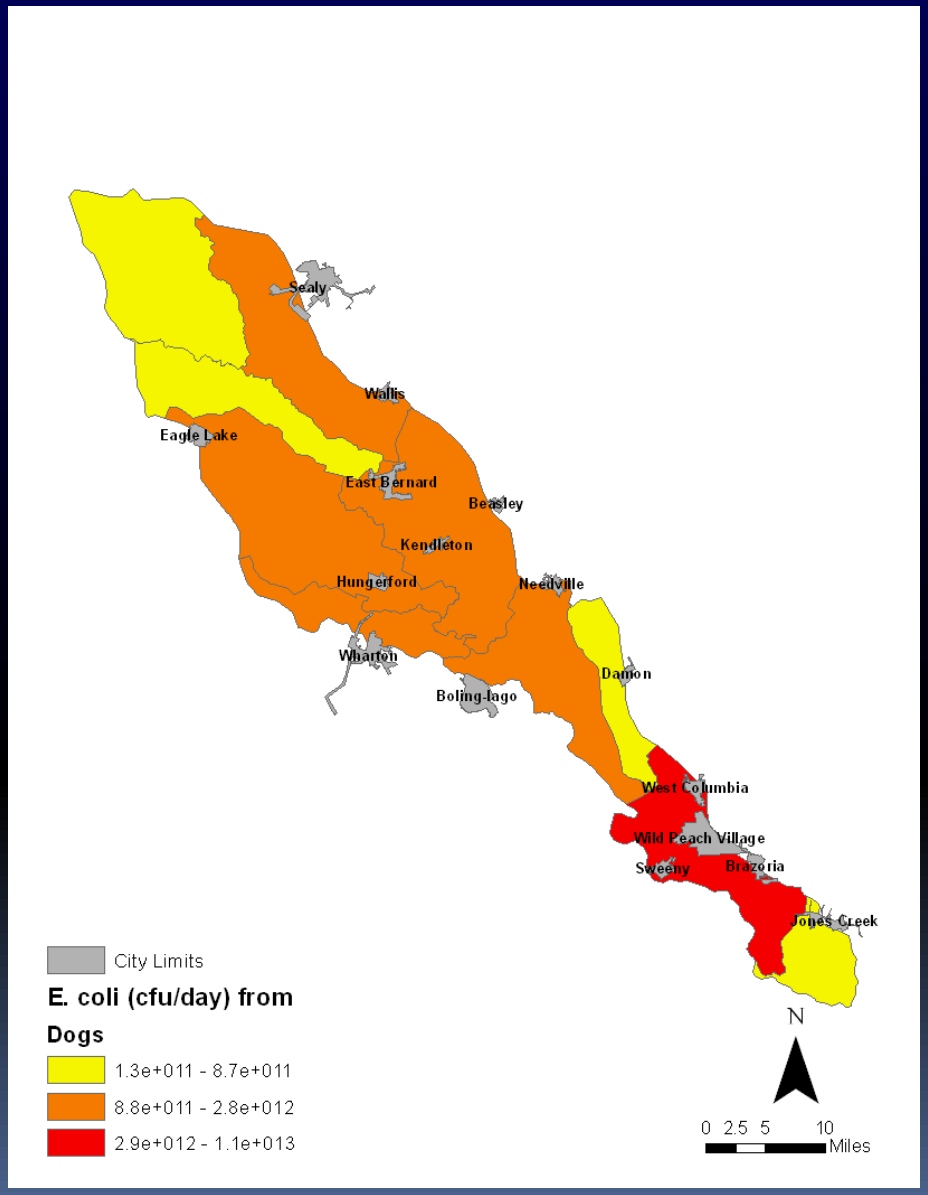
# WWTPs - EC Potential Loadings



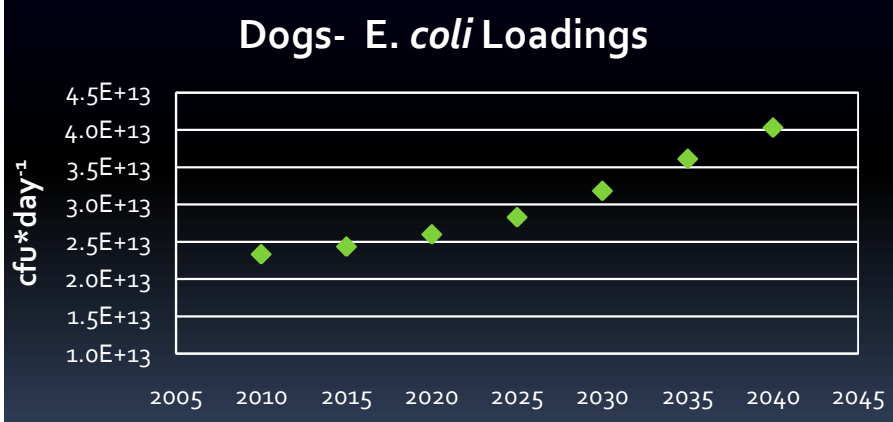

- Highest loadings on the most urbanized subwatersheds
- No significantly contribution of WWTPs to the total EC loading
- Slight increase of loading as population grows in urban areas



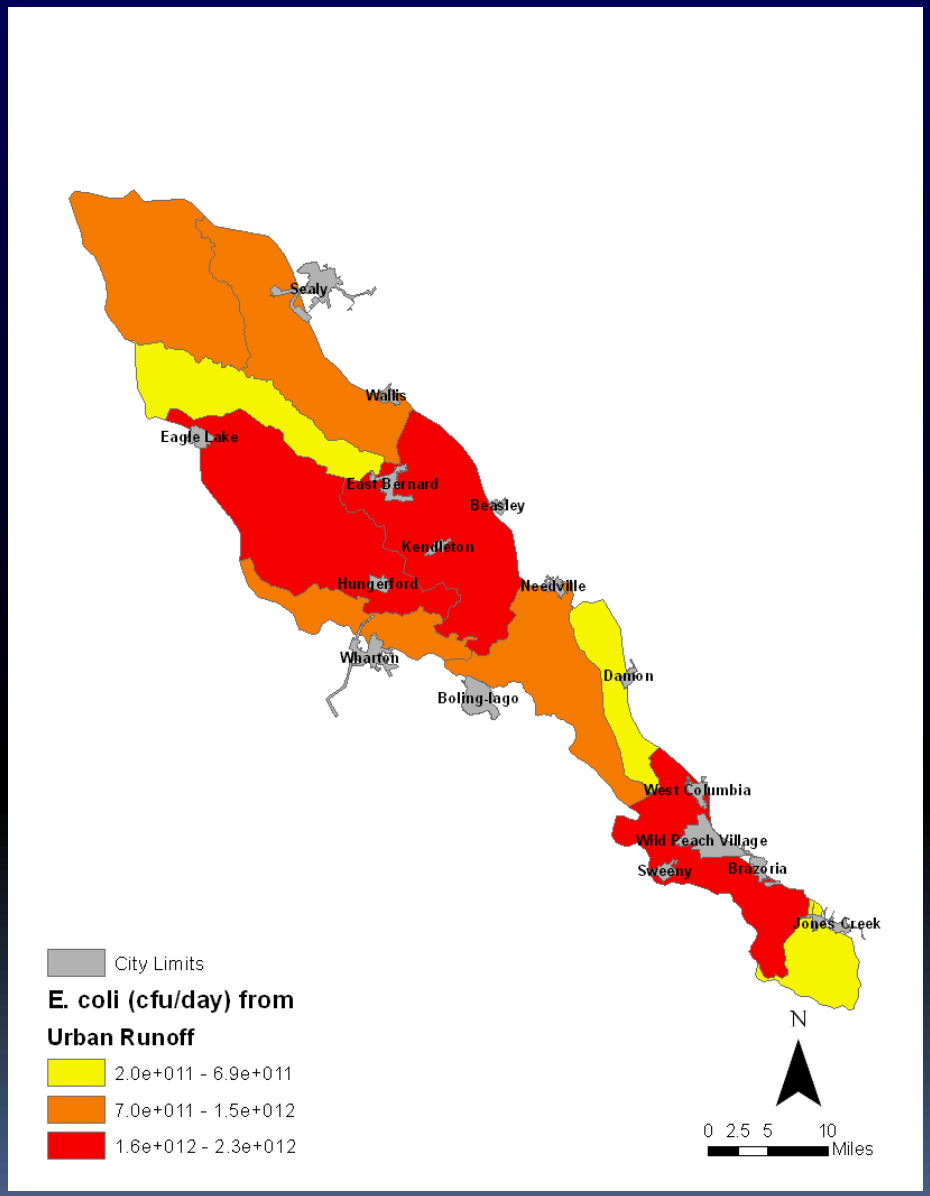
# Dogs - EC Potential Loadings

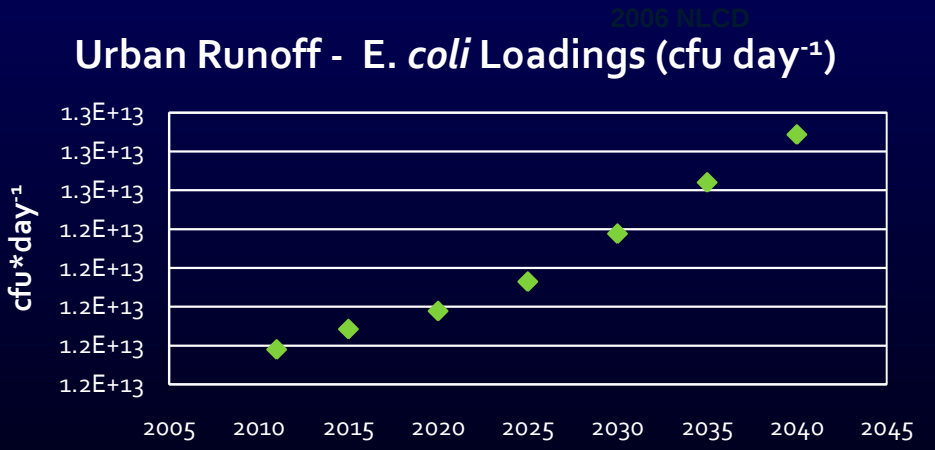



- Potential EC loading associated to number of households
- Increasing trend of potential loadings proportionally to population growth



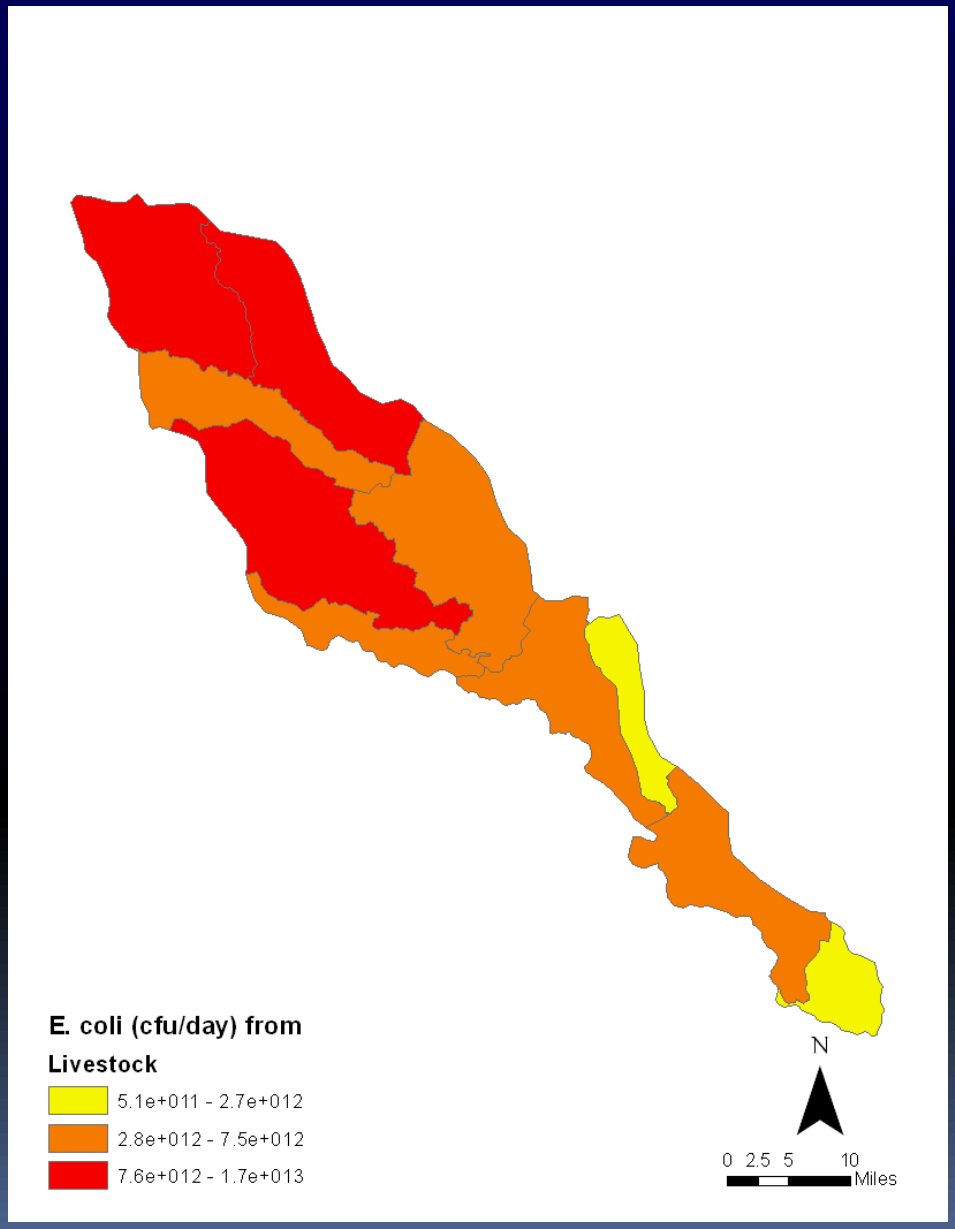
# Urban Runoff - EC Potential Loadings

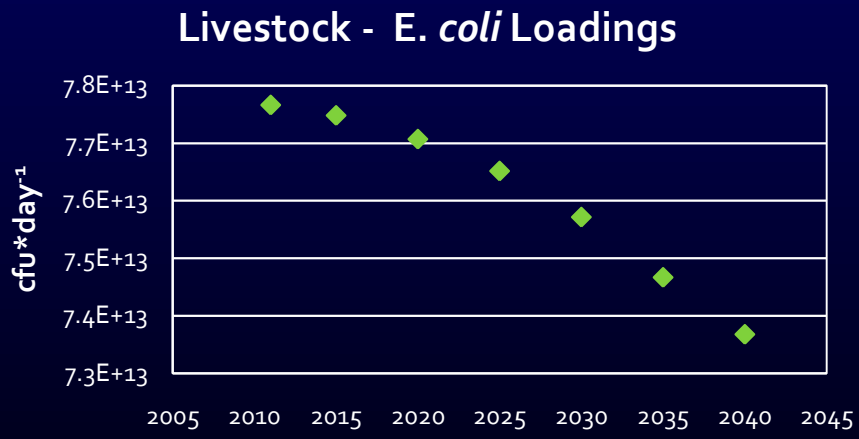



- Same behavior as WWTPs loadings
- Loadings associated to % of impervious areas and event mean concentrations based on empirical relationships
- Slightly increase of loading as population grows in urban areas

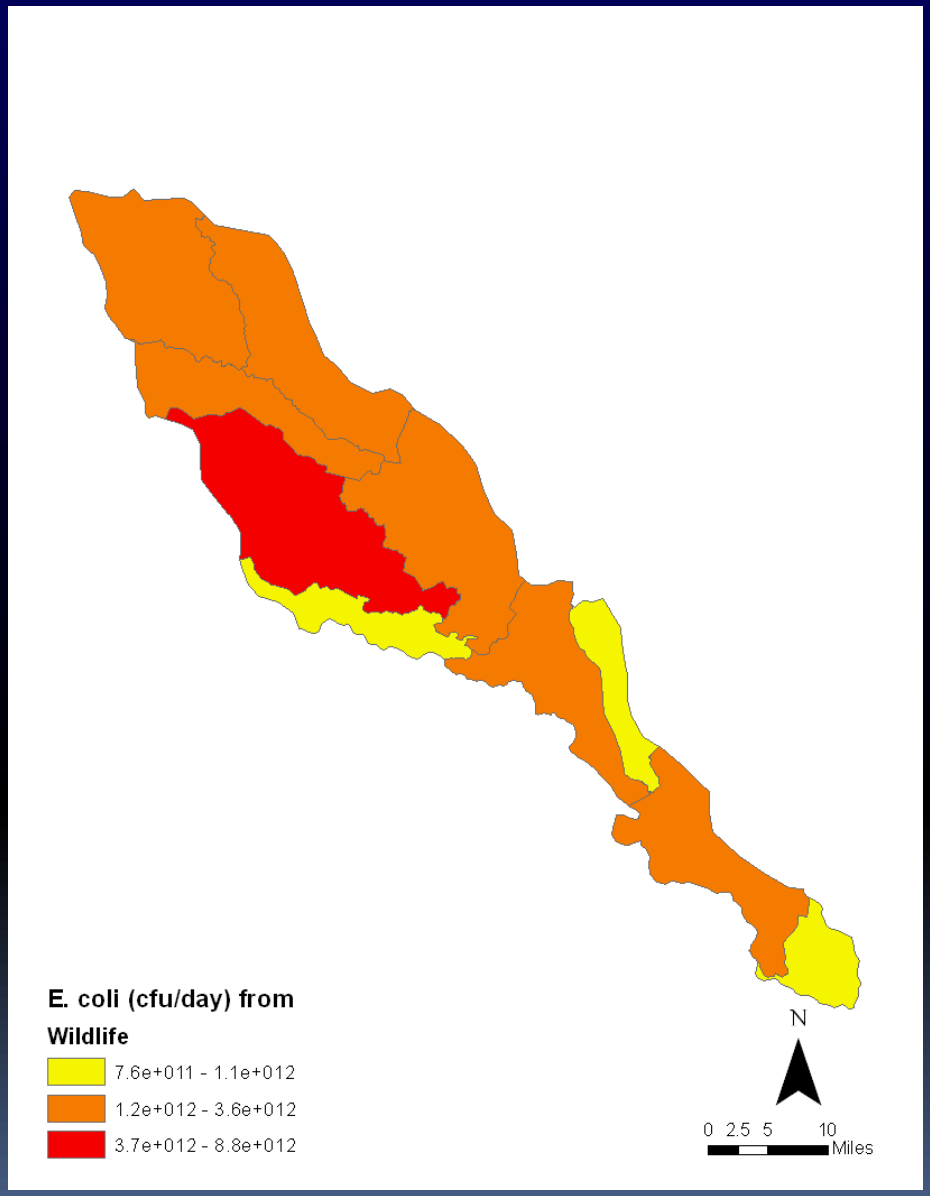
# Livestock EC Potential Loadings

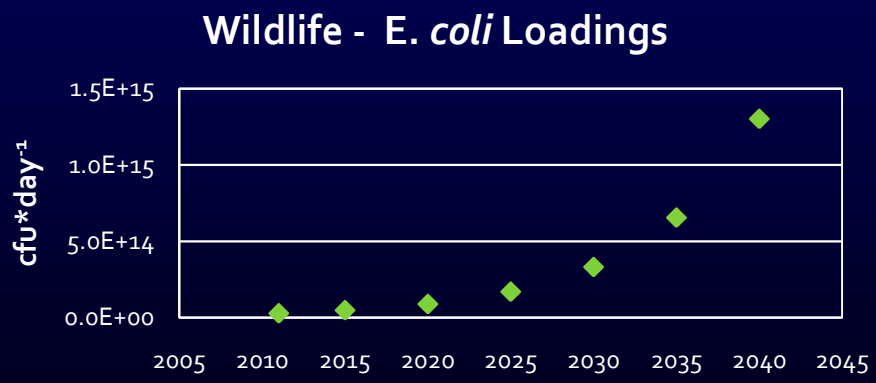



- Distribution of loadings affected by land cover classification and counties livestock numbers
- Constant densities and reduced area for specific habitats lead to decreasing loadings over time

# Wildlife - EC Potential Loadings




- Wildlife (Feral Hogs and Deer) are distributed in the riparian areas around streams, forest and wetlands
- Feral Hogs highest contributor to wildlife loadings
- Increment in wildlife loadings controlled by rapid growth on Feral Hog population

# FINAL COMMENTS

- The inclusion of a buffer zone around the streams showed reduction on rural loadings between 40 to 60%. The distribution on loadings showed a slightly change
- The use of number or rural households instead of OSSFs lead to increments on loadings from this source, but with no drastic changes in the relative contribution.
- The model does not account for mitigation processes such as settling, vegetative filtering , temperature, solar inactivation, or other biological factors that bacteria might undergo before reaching the stream. For this reason, SELECT should be coupled with a watershed model to simulate transport processes.


# Thank you!

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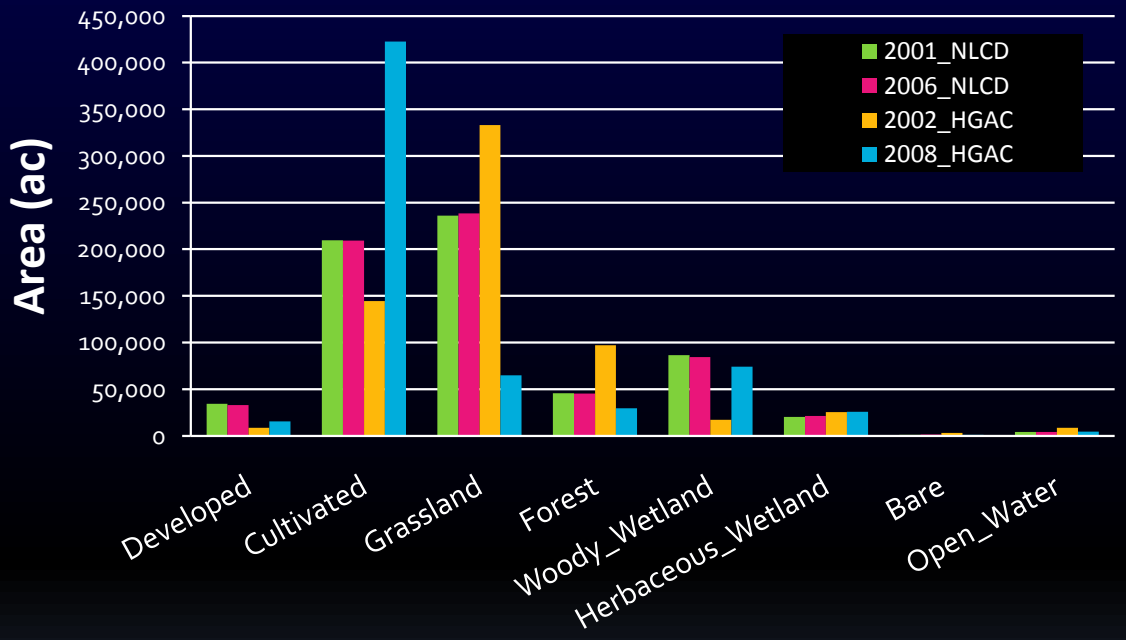
Houston-Galveston Area Council

# LAND COVER DISTRIBUTION

- Originally, 2008 H-GAC Land cover dataset was used. - Overestimation of cultivated areas.
- Comparison different LCDs (2002 H-GAC, 2008 H-GAC, 2001 NLCD, and 2006 NLCD)
- 2006 NLCD was used.




| Land cover Category | 2001_NLCD | 2006_NLCD | 2002_HGAC | 2008_HGAC |
|---|---|---|---|---|
| Developed | 5.4% | 5.2% | 1.4% | 2.4% |
| Cultivated | 32.9% | 32.8% | 22.7% | 66.3% |
| Grassland | 37.0% | 37.4% | 52.2% | 10.2% |
| Forest | 7.1% | 7.1% | 15.2% | 4.6% |
| Woody Wetland | 13.6% | 13.2% | 2.7% | 11.6% |
| Herbaceous Wetland | 3.2% | 3.3% | 4.0% | 4.0% |
| Bare | 0.2% | 0.2% | 0.5% | 0.1% |
| Open_Water | 0.7% | 0.7% | 1.4% | 0.7% |

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# Census of Agriculture

| COUNTY | Cattle | Horses | Sheep/Lambs & Goats |
|---|---|---|---|
| Brazoria | 78560 | 5367 | 5841 |
| Wharton | 76780 | 1942 | 3591 |
| Fort bend | 46206 | 3105 | 1258 |
| Colorado | 98283 | 1897 | 1036 |
| Austin | 70184 | 3491 | 1930 |

Number of animals – Census of Agriculture 2007

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# HABITATS ASSIGNATION

| SOURCE | 2008 H-GAC LD Classification | 2006 NLCD Classification |
|---|---|---|
| **Cattle** | Grassland/Shrub | Herbaceous + 90% of Hay Pasture areas |
| **Horses** | Grassland/Shrub | Herbaceous + 90% of Hay Pasture areas |
| **Sheep&Goats** | Grassland/Shrub | Herbaceous + 90% of Hay Pasture areas |
| **Deer** | Grassland/Shrub and Forest | 90% of Hay Pasture areas+ forest (mixed decidious, and evergreen) |
| **Hogs** | 3hogs/$Km^2$ in bare LC | 3hogs/$Km^2$ in bare LC |
| | 5 hogs/$Km^2$ in all other categories | 5 hogs/$Km^2$ in all other categories |

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# METHODOLOGY

## 3. POTENTIAL E. *coli* LOAD ESTIMATION – According to EPA guidance

| Source | Calculation E. *coli* Loading – EC ($cfu*d^{-1}$) |
|---|---|
| WWTPs | EC = Self reported flow * 126cfu/dL* $10^6$ gal/MGD *3758.2 mL/gal |
| OSSFs | EC = # Failing systems*$510^3$cfu/mL*2.65 $10^5$ mL/MGD * Avg.#persons/household |
| Dogs | EC = # households* 0.8dogs/household * FC loads/day-head * 0.5 |
| Other animals | EC = # animals * FC loads/day-head * 0.5 |

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