Water Quality Modeling Lake Granbury

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Presentation Outline

- Model Inputs
  - Bacteria concentration study
  - Field circulation study
  - Field septic study
- Watershed modeling

Lake Modeling Resolutions

- Ratio of E. Coli to Fecal Coliform 0.7:1
- Raw sewage E. Coli count 6.68 million MPN/100mL
- Fecal coliform count in runoff 16,048 MPN/100mL
- Residential wastewater generation 200 gpd/house
- Site-specific dispersion values 0.02 to 0.18 m/s2
- Bacteria decay rate 0.2/day at 15`C
  - Medium summer temperature 28`C
  - Temperature correction, K = K1* Θ ^ (T – T1)
    - Θ = 1.07 (Thomann and Mueller 1987) (decay rate = 0.5 @ 28`C)

Bacteria Concentration Study

Bacteria in Raw Sewage

- Two WWTPs – DeCordova Bend & Blue Water Shores
- 9 sampling visits to each WWTP
- 20 analyses for each visit at each plant
- Average (arithmetic mean) of E. Coli concentration in raw sewage samples: 6,688,176 MPN per 100 ml

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Circulation Study

Circulation Study

- Purpose: Calculating dispersion coefficient needed in canal modeling
- Released 20% solution of Rhodamine WT dye in canal systems on Lake Granbury
- Each canal system was revisited multiple times to measure the concentration of the dye
- Dispersion coefficient was calculated according to contours of dye concentration measured, time of travel and distances from releasing point in the canal system

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Indian Harbor

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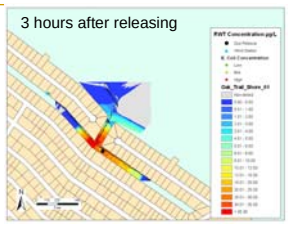
Concentration Contours

Oak Trail Shores

Dye released on 02/19/2008

3 hours after releasing



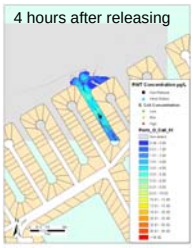
27 hours after releasing

72 hours after releasing

Concentration Contours

Ports O' Call
Dye released on 02/21/2008
8.5' deep canal

4 hours after releasing



23 hours after releasing

28 hours after releasing

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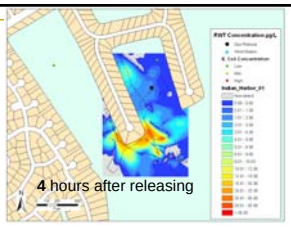
Concentration Contours

Indian Harbor
Dye released on 02/21/2008

- 4-6' deep canal
- Dye plume center moved
- Adjacent cove was affected



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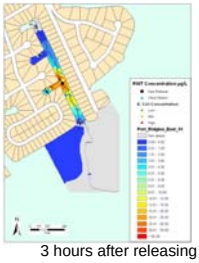
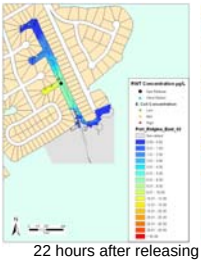
Concentration Contours

Port Ridglea East
Dye released on 02/21/2008


3 hours after releasing


22 hours after releasing


30 hours after releasing

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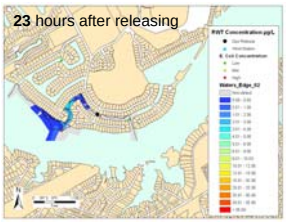
Concentration Contours

Waters Edge

Dye released on 02/21/2008
8' – 10' deep


4 hours after releasing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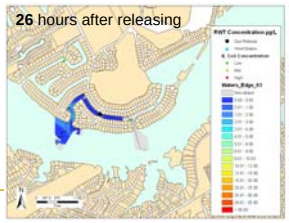
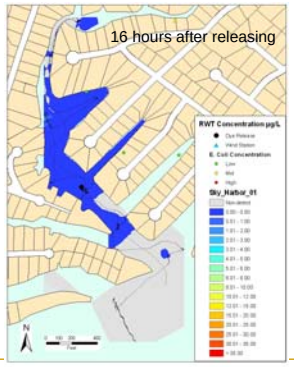

26 hours after releasing

Concentration Contours

Sky Harbor

Dye released on 02/19/2008
5' in finger canals
10'-15' in tributary area


16 hours after releasing

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Dispersion Calculation

- Graphical method (Ward 1985)
- Dispersion Coefficients Calculated

Subdivision	Dispersion Coefficients (m2/s)
Indian Harbor	0.02
Oak Trail Shores	0.1
Port Ridglea East	0.125
Ports O' Call	0.09
Sky Harbor	0.18
Waters Edge	0.08

Dispersion Coefficients in untested canals were used the same as the one in canals with similar condition

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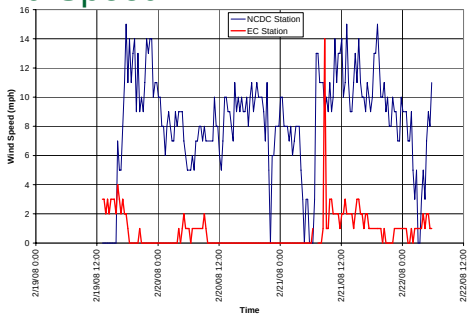
Wind Speed



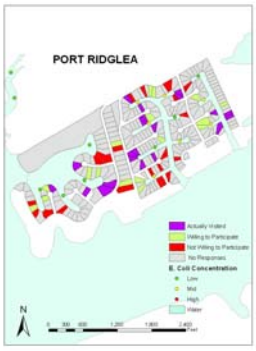
- Wind speed in the canal system is lower than NCDC Granbury airport data (measured at 30')
- Canal system is more restrained and disperse slowly
- Thus calculated dispersion coefficients are relatively low compared with literature values (~0.5 m/s2)

Circulation Study

- E.Coli Concentration on 02/20/2008

Subdivision	E. Coli Conc. (MPN/100mL)
Oak Trail Shores	41
Port Ridglea	PRW 14/ PWE 39
Sky Harbor	35
Indian Harbor	9
Ports O' Call	NA
Waters Edge	NA

Septic Study



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Breakdown of contacts

Subdivision	Letters
Oak Trail Shores	161
Rolling Hills Shores	78
Port Ridglea	238
Sky Harbor	313
Total	790

Subdivision	Phone Calls
Oak Trail Shores	85
Rolling Hills Shores	52
Port Ridglea	167
Sky Harbor	237
Total	541

Subdivision	Responses		Actually Visited
	Yes	No	
Oak Trail Shores	5	14	3
Rolling Hills Shores	1	6	0
Port Ridglea	35	24	PRE 18/ PRW 8
Sky Harbor	34	16	15
Total	75	60	44
	135		

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Septic Study

- Leakage found in two systems
  - Main-line blockage with minor leak
  - Pooling on ground following laundry loads
- Despite rainfall (0.72") on evening after leakage (4/8/2008), no dye found in canals
- E.Coli Concentration on 04/10/2008

Subdivision	E. Coli Conc. (MPN/100mL)
Oak Trail Shores	>2000
Rolling Hills Shores	>1635
Port Ridglea	PRE 416/ PRW 297
Sky Harbor	>1875

- Of 44 systems thought to be properly functioning, two exhibited imperfect function. On both:
  - Full-time residents
  - Some repairs had been made within last 2 years

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Septic Study – The Participants

- Participants were all concerned about water quality in the lake and cited a range of reasons:
  - Property values
  - Swimming
  - Fishing
  - Aesthetics
- 16% did not know when septic system was last serviced
- 30% of systems had not been serviced within last 5 years
- 11% were new systems less than 5 years old

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Watershed Modeling

Potential Bacteria Loading -Methodology

- SELECT – Spatially Explicit Load Enrichment Calculation Tool
  - TAMU BAE department
  - Kendra Riebschleager and R. Karthikeyan
- Determine Potential Waste Load
  - Spatially distribute source populations based on land use
  - Apply fecal production rate
  - Aggregate to level of interest
- Develop a Qualitative Assessment of Pollutant Connectivity
  - Pollution Indicator
  - Run-off Indicator
  - Distance Indicator
  - PCF - Pollutant Connectivity Factor

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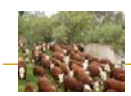
Potential Sources

- Livestock
  - **Cattle**
  - *Other (Sheep, Goats, Swine, Horses)*
- Wildlife
  - **Deer**
  - *Feral Hogs*
  - *Other (Raccoons, Birds, Rodents)*
- Domestic
  - **Septic Systems**
  - **Pets**
- WWTPs





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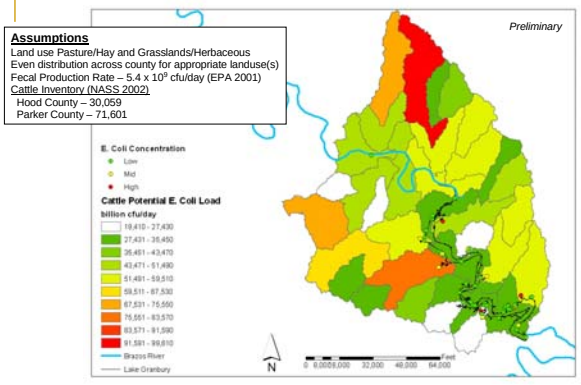

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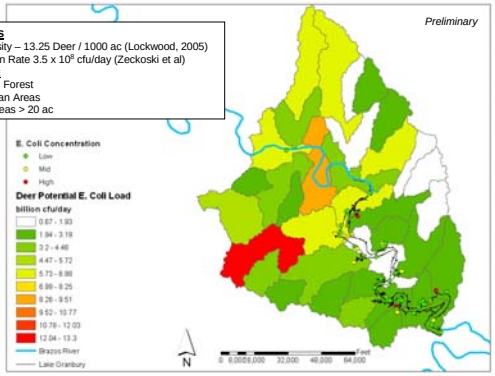
Preliminary

Assumptions
Population density – 13.25 Deer / 1000 ac (Lockwood, 2005)
Fecal Production Rate 3.5 x 10^8 cfu/day (Zeckoski et al)
Suitable Habitat
Grassland and Forest
Not within Urban Areas
Continuous Areas > 20 ac



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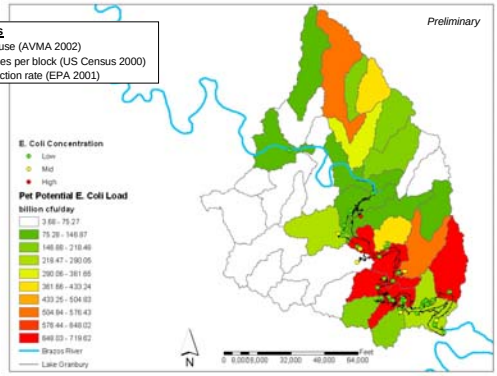
Preliminary

Assumptions
0.8 dogs per house (AVMA 2002)
Number of houses per block (US Census 2000)
Dog fecal production rate (EPA 2001)



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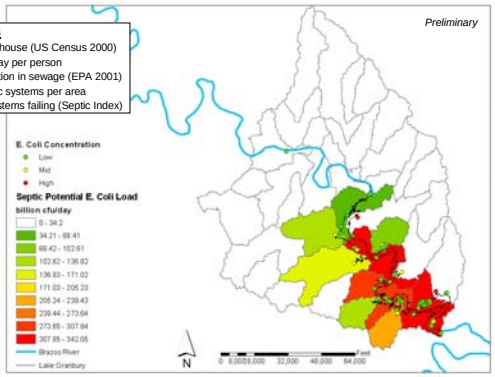
Preliminary

Assumptions
1.94 people per house (US Census 2000)
60 gallons per day per person
Fecal concentration in sewage (EPA 2001)
Number of septic systems per area
Proportion of systems failing (Septic Index)



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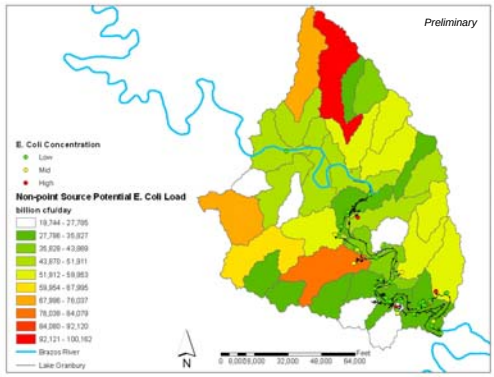

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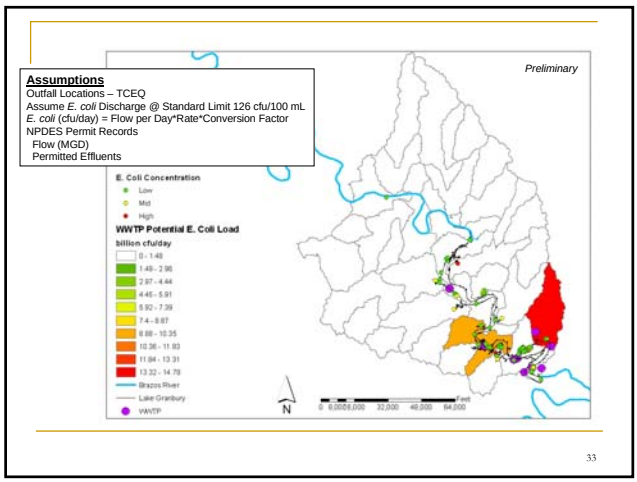

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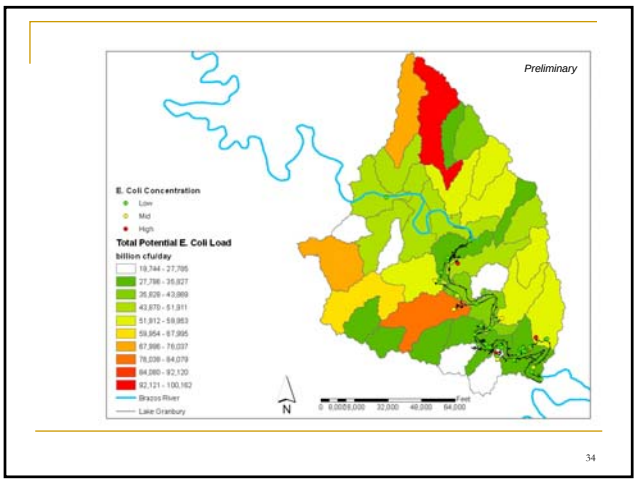

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Pollutant Connectivity Factor

- Contribution of Contaminant based on
  - Total pollutant loading
  - Fate and Transport driven by
    - runoff
    - travel distance
  - Growth and decay
- Estimate influence of driving forces using weighted overlay

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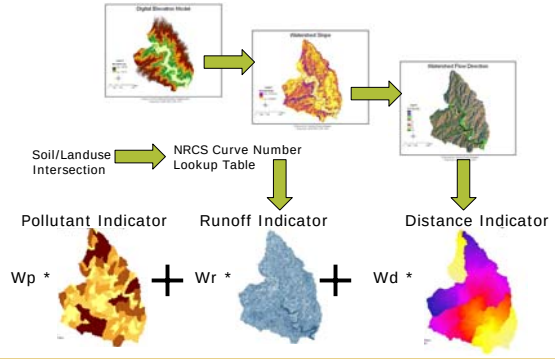
Pollutant Connectivity Factor



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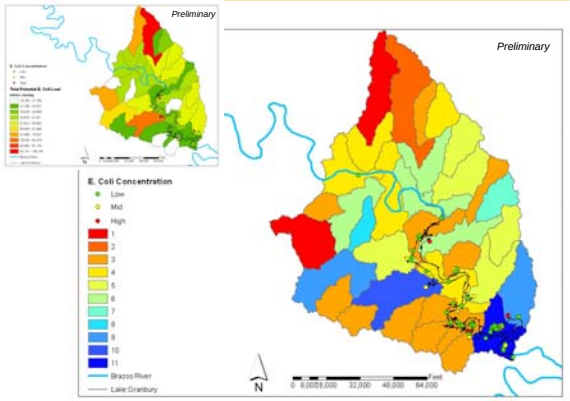

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Microwatershed Load for modeled canals

- Distant watersheds may have small effects on Lake Granbury
- Potential loads for small watersheds near the lake are under investigation
- Pollutant Connectivity Factor (PCF) study for different sources is still in progress

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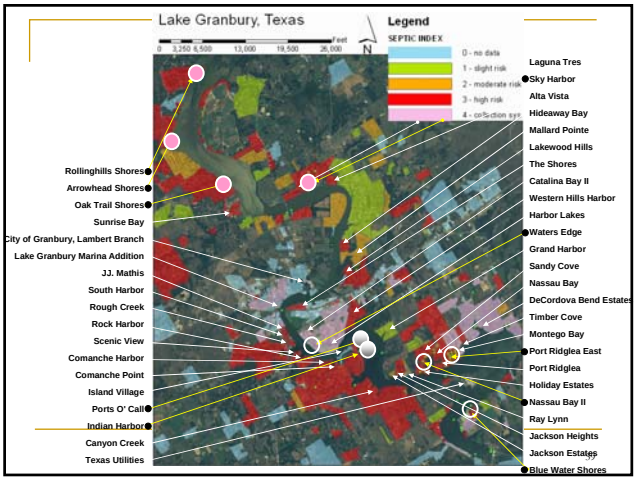

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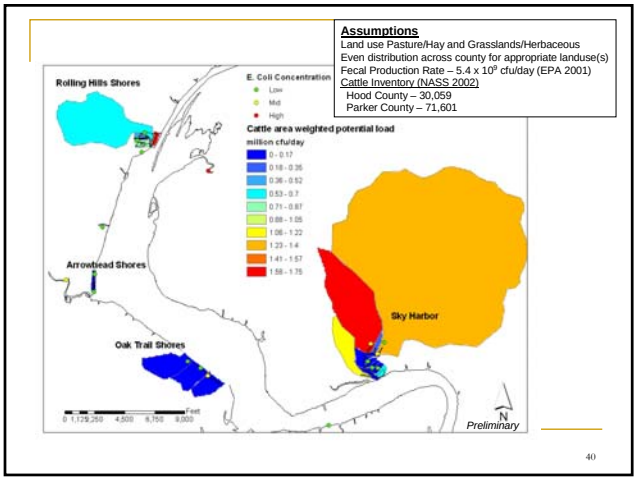

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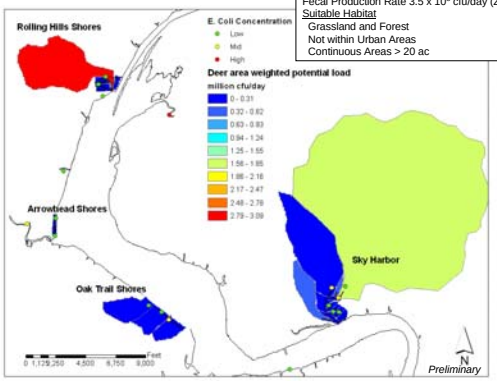

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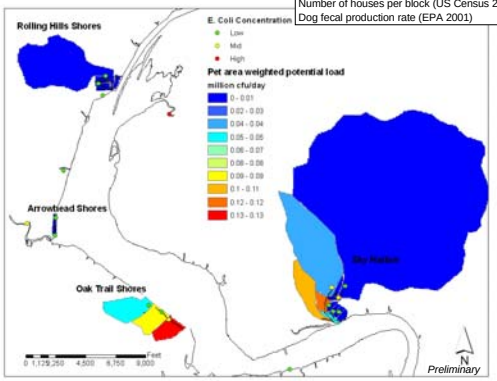

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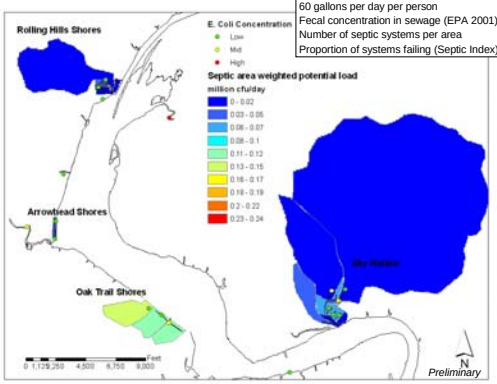

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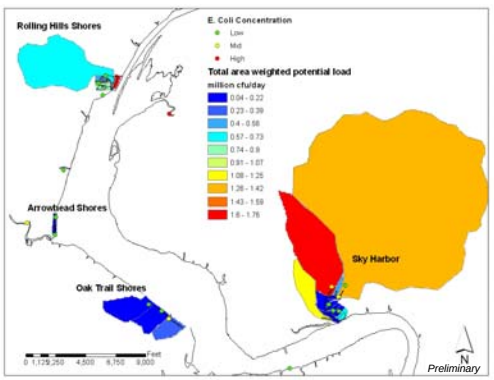

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Next Steps

- Complete Potential Loading Analysis
  - Overall watershed
  - Microwatersheds
- Lake Modeling
- BMP and alternatives analysis

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Questions or Comments?

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