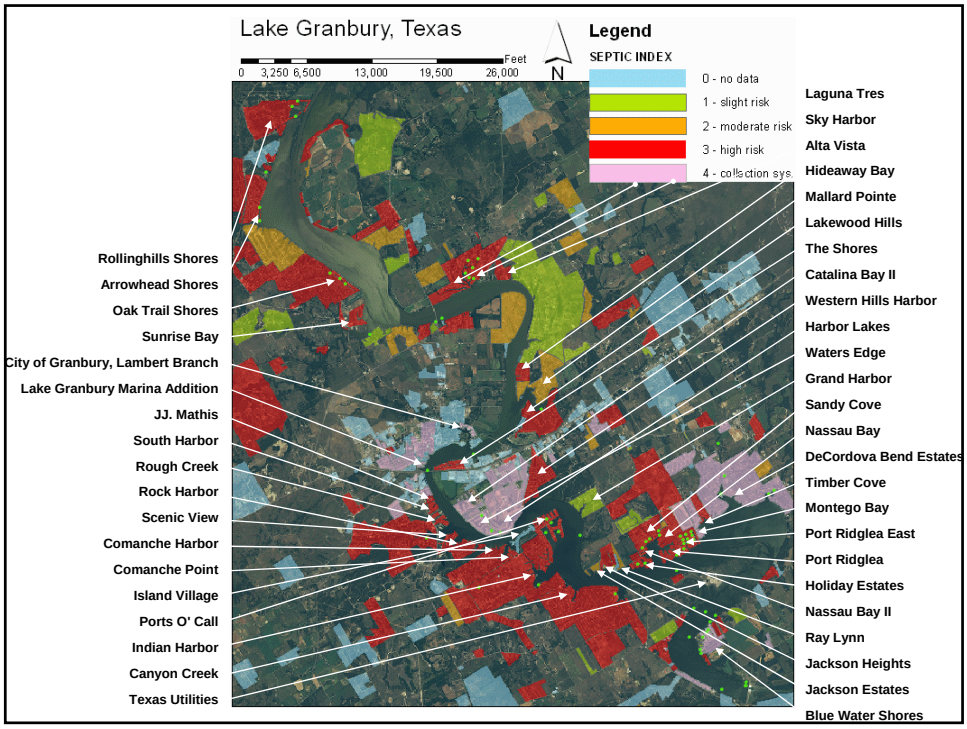
Water Quality Modeling Update

Espey Consultants, Inc.

October 2, 2007

Presentation Outline

- Summary of Phase 1
- Discussion of water quality modeling (watershed versus canal)
- Preliminary water quality modeling, highlight Oak Trail Shores
- Future modeling activities
- Blue Water Shores dye investigation



Summary of Phase 1 Data Evaluation Conclusions

- Septic Index used to identify areas with greatest potential for septic failure
- Bacteria
  - Problems in some canals, not in main body
  - Data does not indicate a relationship between bacteria concentration and rainfall or river flow
- Other Water Quality Constituents
  - Dissolved Oxygen, algae and clarity show trends
  - Similar in main body and canals
  - Nutrient concentrations are generally below analytical detection limits; however, events of high nitrogen and phosphorus concentrations are more frequent in recent years
- Define lake-to-canal water exchange

Summary of Phase 1 Data Evaluation Conclusions

- Data available for modeling effort is extensive, but has limits
- Monitoring data
  - Monthly cove data set on Lake Granbury is one of the most complete and extensive lake data sets in the state
  - Even so, water quality changes faster than once per month; interpretation and modeling is important
- Source of bacteria not known
- Bacteria production and decay rates not known; use of literature values is possible
- Exchange of water between lake and coves not known
- Rainfall and runoff; precipitation varies across region

Summary of Phase 1 Additional Information Needed

- Septic tracer studies
  - To aid in understanding movement of bacteria into coves
- Lake-to-canal water exchange
  - Dye-tracer with atmospheric and water quality measurements to aid in understanding movement and interaction of water from main body to canals
  - Collect low-level phosphorus in main body and canals to aid in tracing movement and connectivity
  - Evaluate differences between coves and lake
- Bacterial Source Tracking
  - To verify potential sources and assist in allocating loading

Summary of Phase 1 Recommendations for Watershed Modeling

- Utilize a simple watershed modeling approach (rainfall-runoff method)
- Reasons for choosing this model:
  - Small (or no) drainage areas for many canals
  - Limited data on runoff volume
  - Limited data on runoff water quality
  - Limited time series data
    - Monthly data points, 2002-2007
    - Continuous (hourly or daily) data needed for more complex modeling

Summary of Phase 1 Recommendations for Canal Modeling

- Use segmented well-mixed mass balance model
  - Spreadsheet mass-balance model
- Reasons for choosing this model:
  - Shallow depths in coves
  - Limited hydrodynamic data
  - Limited data on biologic kinetics
  - Limited time series data
    - Monthly data points, 2002-2007
    - Continuous (hourly or daily) data needed for more complex modeling

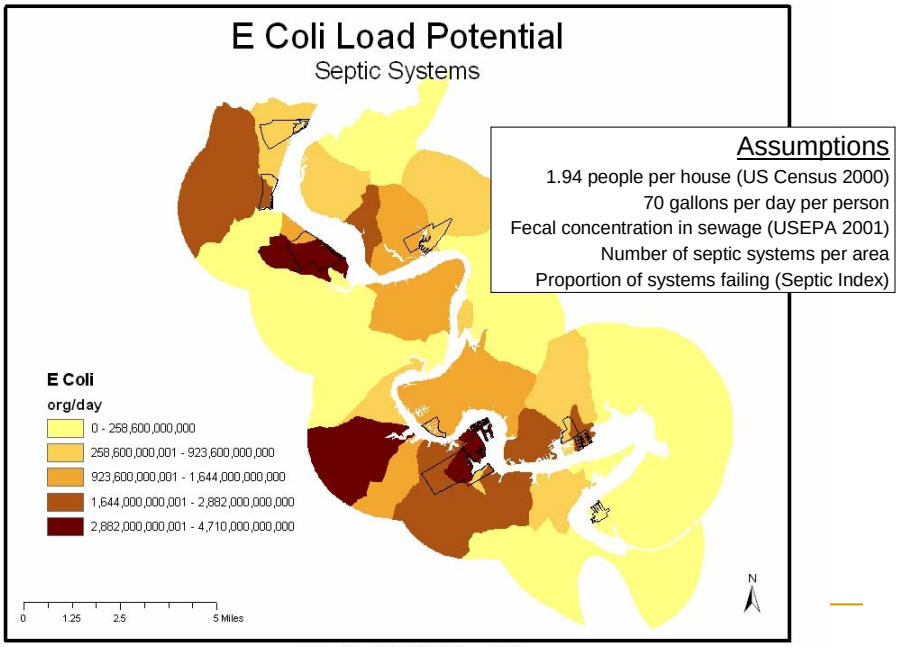
Watershed Modeling

Watershed Modeling Considerations

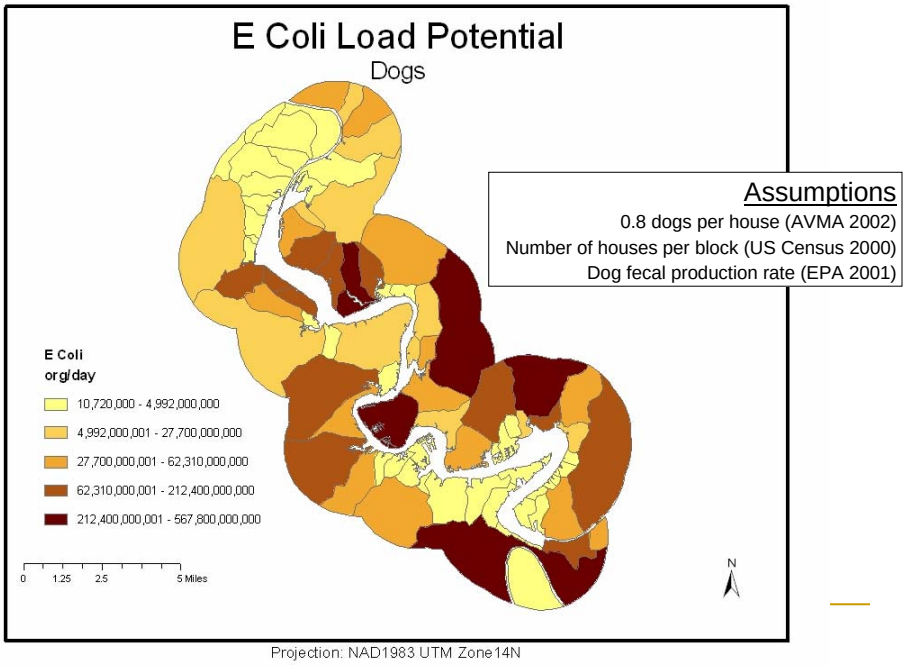
- Identify potential sources using land use
- Estimate concentration of sources in each watershed
- Apply potential loading based on concentration of sources in a watershed
- Utilize results of Bacteria Source Tracking to verify assumptions

Literature values for bacteria sources

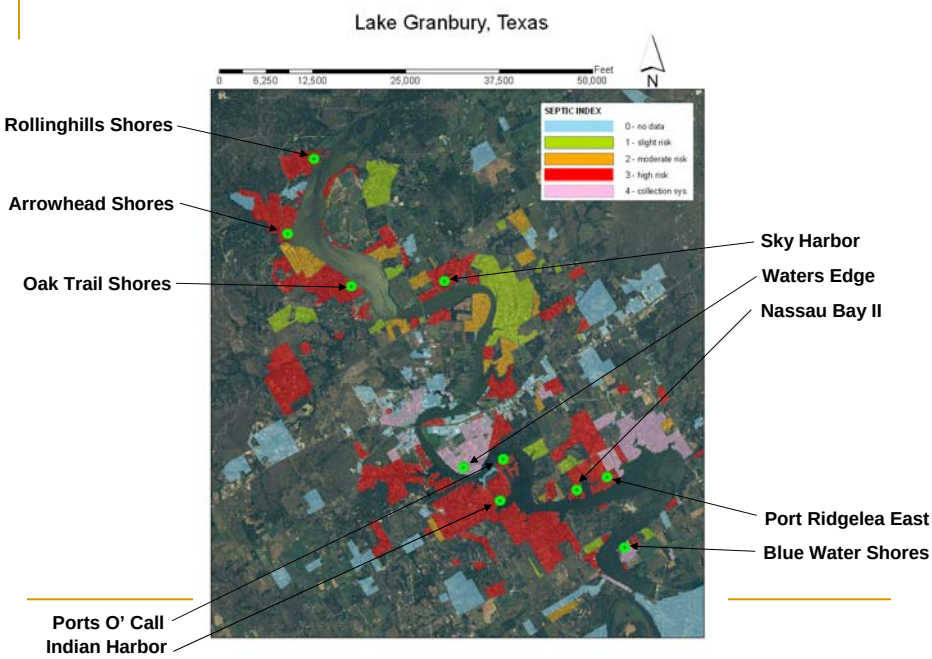
Indicator	Concentration (mpn/100 ml)	Source	Reference
Fecal Coliforms (FC)	8,400	Urban Runoff (Texas)	Environmental Criteria Manual, 2007
FC	19,743	Urban Runoff (Texas)	CCBNEP, 1996
FC	20,000	Urban Runoff (Texas)	CRWR Report, 1996
FC	960 - 430,000	Urban Runoff	USEPA, 2001 (referred to Doran et al., 1981)
FC	1,000,000 - 10,000,000	Raw Sewage	USEPA, 2001 (referred to Metcalf and Eddy, 1991)
FC	6,300,000	Raw Sewage	USEPA, 2001 (referred to Overcash and Davidson, 1980)
FC	550,000	Raw Sewage (Georgia)	Kuntz, 2003
FC	125,000	Raw Sewage	Lisle, 2004
E. Coli	50,000	Raw Sewage	Lisle, 2004



Projection: NAD 1983 Zone 14N



Canal Modeling



Data for Canal Modeling

- Existing data
  - Canal depth
  - Sample data
  - Canal width and mouth opening
  - Wind data
  - Precipitation data
- Additional data needed for modeling (already budgeted)
  - Circulation patterns
  - Additional sampling
  - Biologic kinetics (respiration, growth rate, decay, settling, etc.) – literature values

Canal Water Quality Modeling - Assumptions

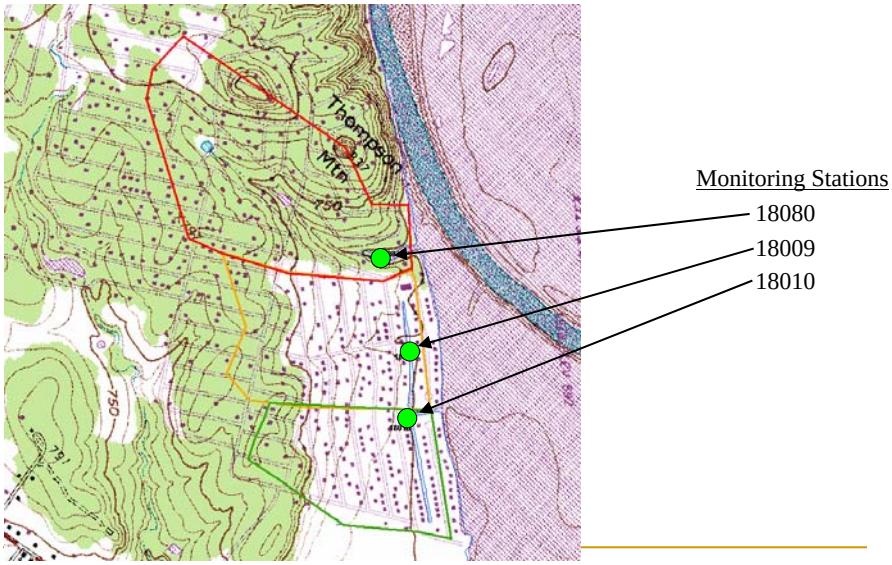
- Mass-balance water quality model with well-mixed segments
- Two modeling scenarios (nonpoint and point source)
- 550,000 MPN per 100 ml in raw sewage
  (200 gallons/day from one source)
- Dispersion and diffusion transport
- Advection transport
- Bacteria decay rate 0.5 per day

Oak Trail Shores - Modeling

Monitoring Stations
18080
18009
18010

Segment	1	2	3	4	5
Depth (ft)	3.40	3.40	3.70	3.70	4.50
Volume (L)	1,561,495.89	1,590,958.46	1,919,740.74	2,030,261.22	1,353,988.66

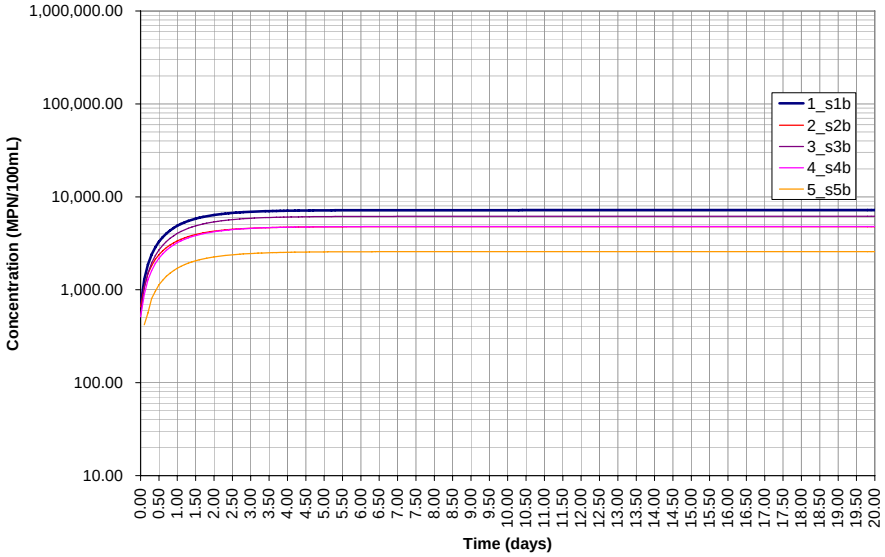
Oak Trail Shores – Drainage Areas



Non-Point Source Loading Assumptions

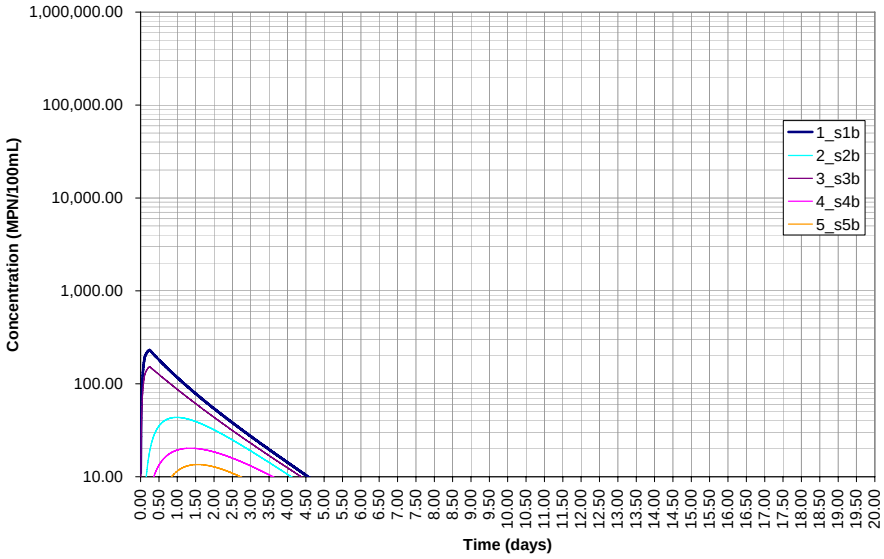
- Rainfall runoff model (NRCS curve number)
- Based on a 1 inch rain for 6 hour duration
- 16,000 MPN per 100 ml runoff (residential area)
- Distribution into segments associated with drainage

Oak Trail Shores – assumed Point Source scenario



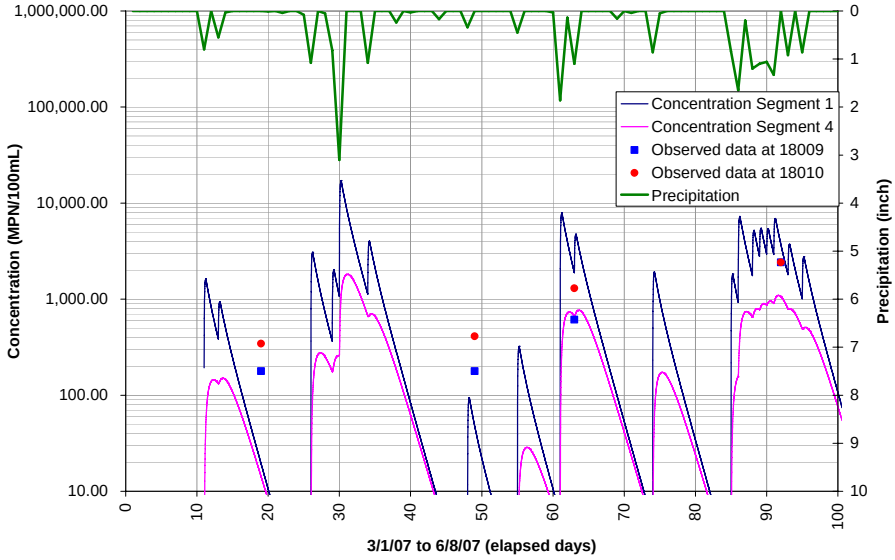
Bacteria concentration with continuous sewage discharge (1 residence)

Oak Trail Shores – assumed Non-Point Source scenario



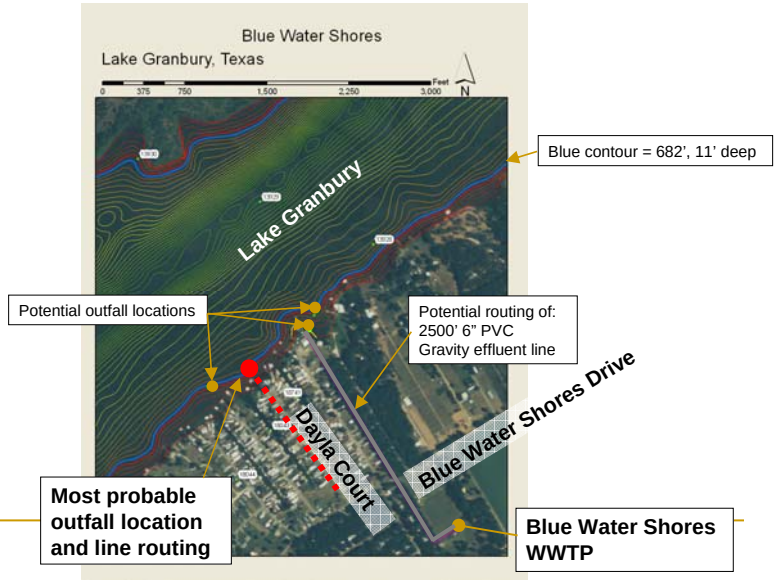
Bacteria concentration with 1” 6 hour rainfall

Oak Trail Shores – assumed Non-Point Source based on observed rainfall

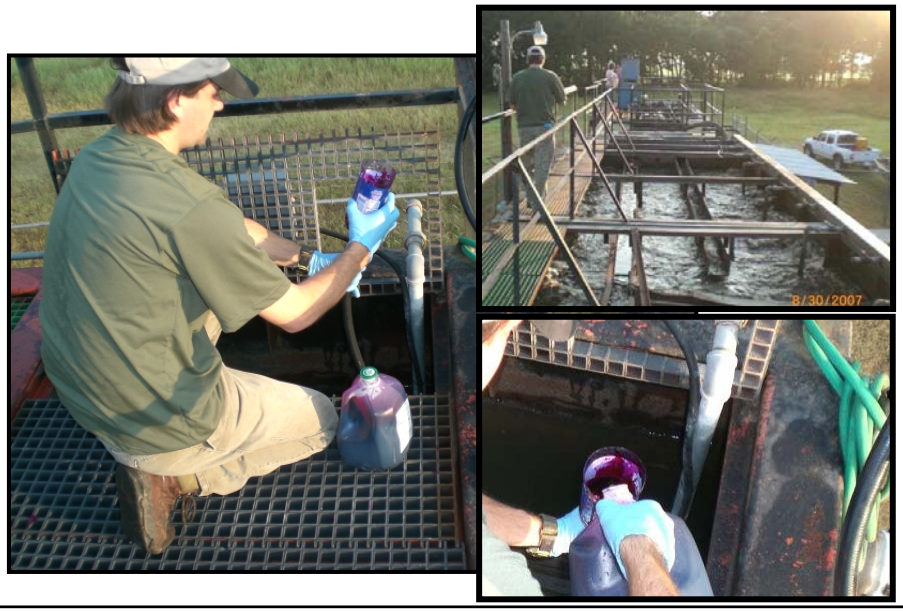


Bacteria concentration from NPS loading, using observed rainfall

Blue Water Shores



Blue Water Shores



Blue Water Shores – Dye Plume

Time elapsed since injection of dye at waste water treatment plant

5 to 6 hours

6.5 to 7.5 hours

Probable routing of discharge line

Blue Water Shores – Dye Plume

Time elapsed since injection of dye at waste water treatment plant

8 hours

Probable routing of discharge line

Questions or Comments?

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