Real-Time Water-Quality Monitoring to Continuously Estimate Constituent Concentrations and Loads in Kansas Streams

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Problems with Conventional Water-Quality Monitoring

- **Limited number of samples are collected annually**
  - **Annual load estimates are based on a finite number of samples**
  - **Seasonal, diurnal, and event driven fluctuations are missed**
  - **Frequency not sufficient**
  - **Costs of manual sampling**

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Objectives

- **Continuously measure water-quality parameters**
- **Optimize timing of sample collection**
- **Estimate selected constituent concentrations and loads**
- **Provide information to water users**

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Approach

1. **Upgrade selected USGS stream gages**
2. **Collect periodic manual samples**
3. **Develop regression equations**
4. **Estimate concentrations and loads based on surrogate relations**

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Real-time, Continuous Water-Quality Monitoring

- **pH**
- **Water Temperature**
- **Dissolved Oxygen**
- **Specific Conductance**
- **Turbidity**
- **ORP**
- **Total Chlorophyll**

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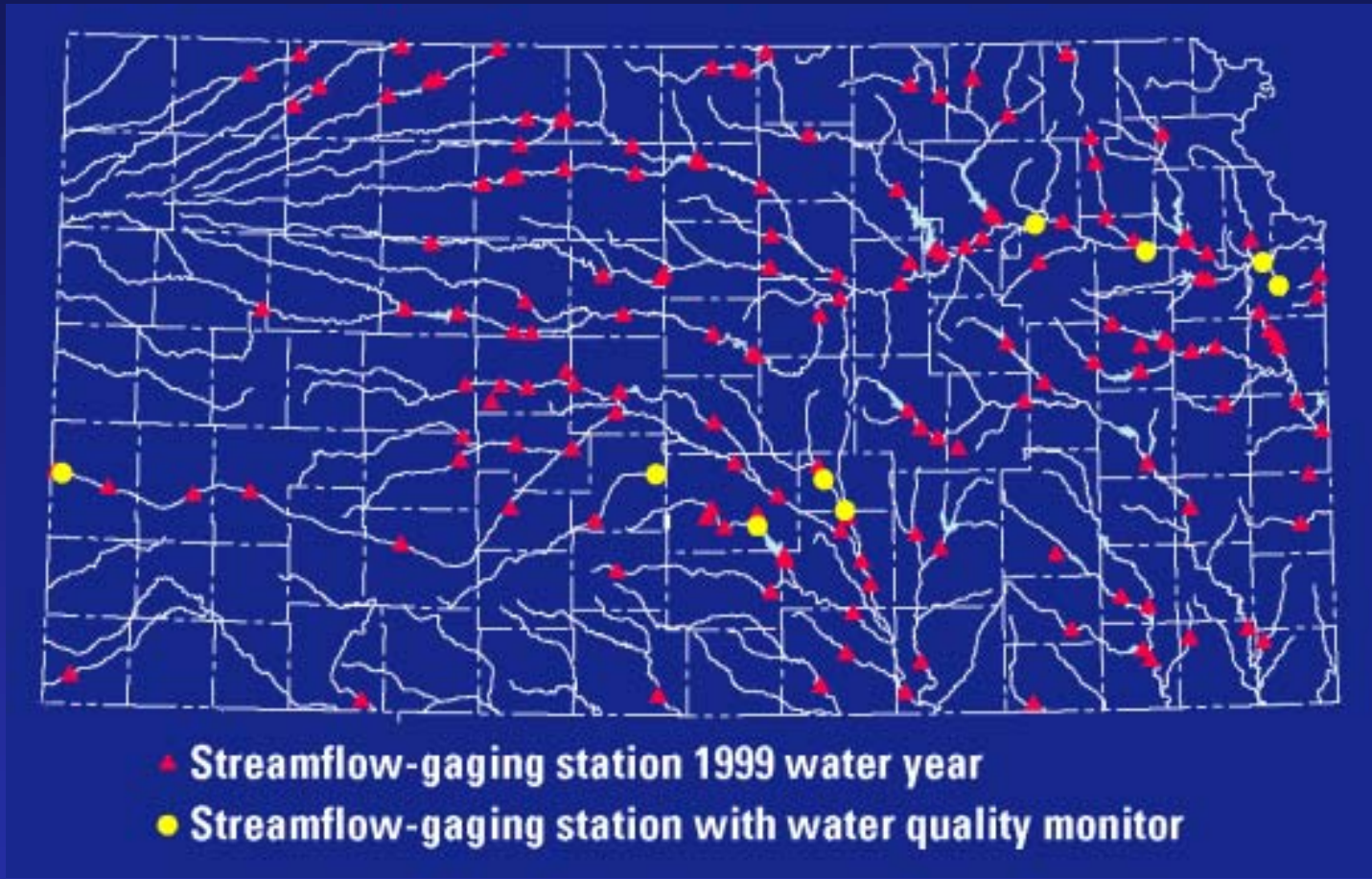
Current Streamflow-Gaging Locations in Kansas



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Real-Time Surrogate Studies in Kansas

- **Quivira National Wildlife Refuge**
- **New Lake Olathe**
- **Kansas River Real-Time Alert Network**
- **Equus Beds Ground-Water Recharge Project**

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Kansas River Alert Network

- Kansas Dept of Health and Environment (KDHE)
- Optimize sample collection frequency
- Fecal Coliform vs. E. Coli
- Monitor TMDLs
- Alert downstream water suppliers

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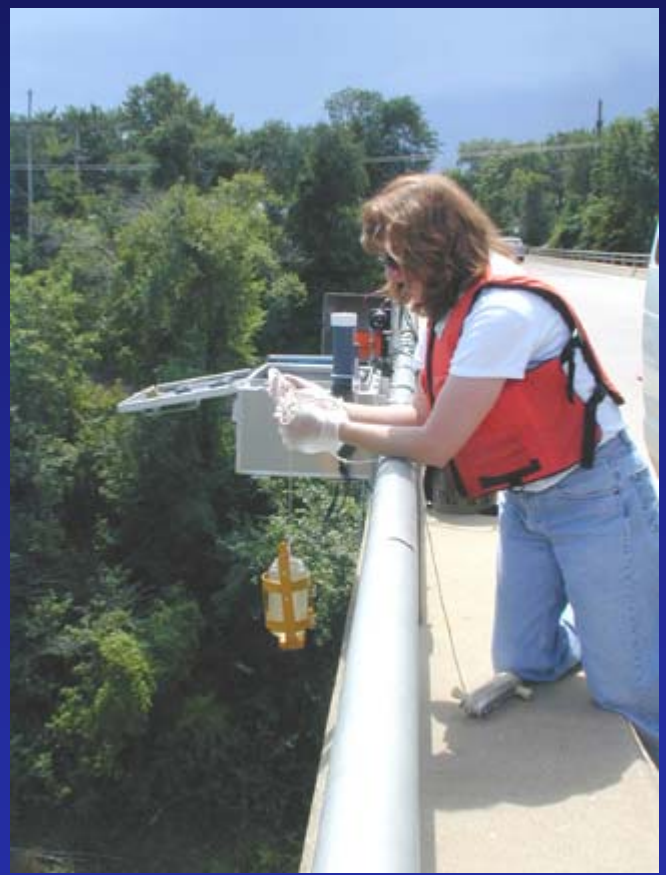
Collection of Manual Samples

- **Collected during all hydrologic conditions**
- **Analyzed for nutrients, major ions, bacteria, and other selected constituents**
- **Historical data may also be used**



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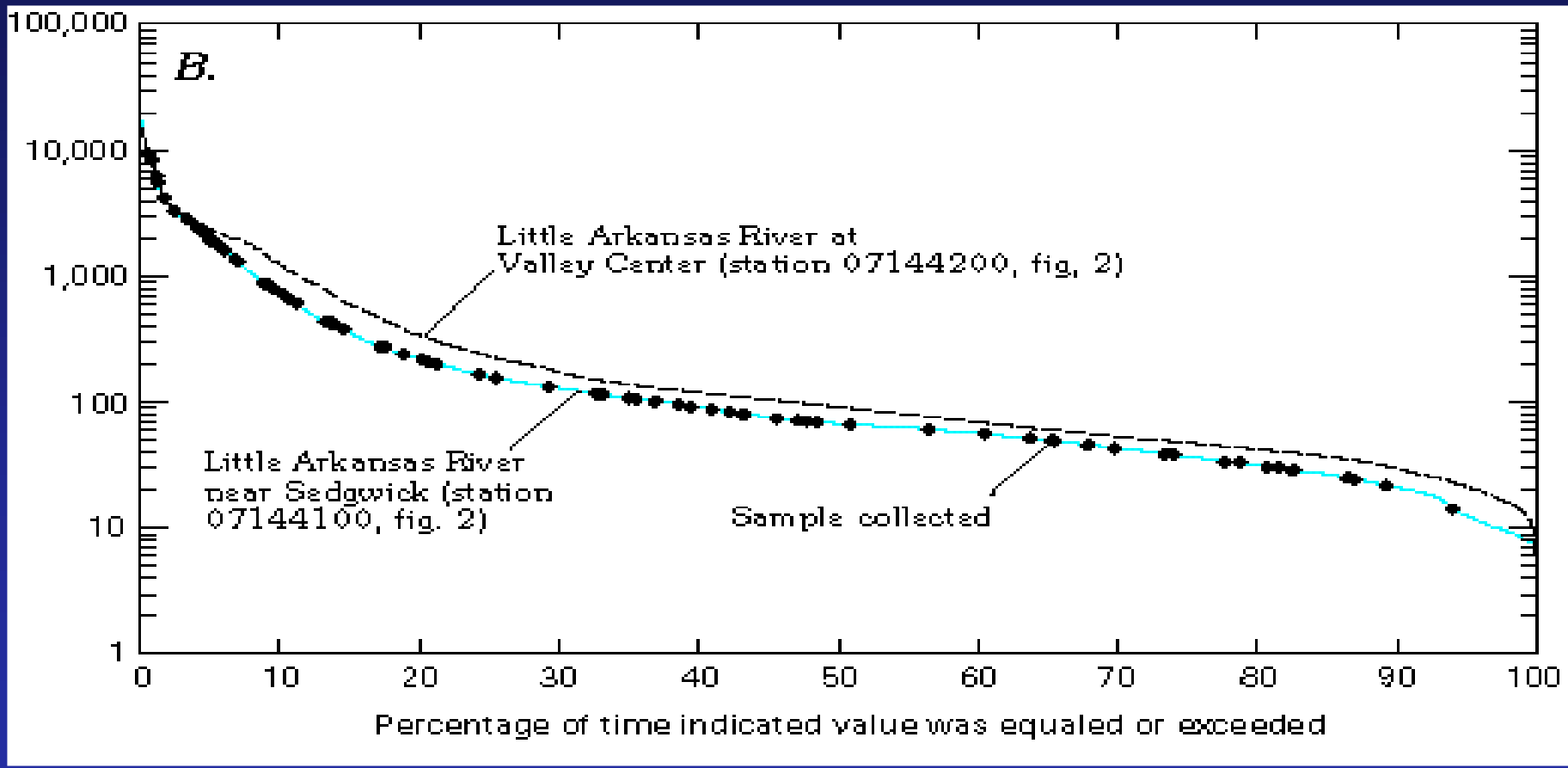
Samples collected over 95 percent of flow conditions



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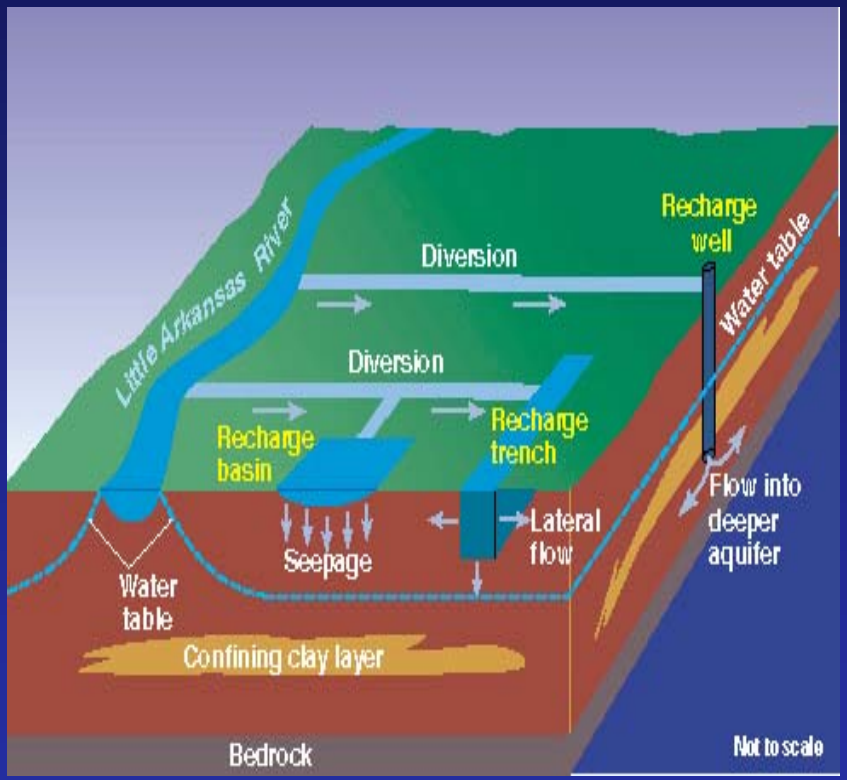
Equus Beds Ground Water Recharge Project—Little Arkansas River



- **City of Wichita**
- **Increase water supply**
- **Prevent salt-water intrusion**
- **High flows / high constituent concentrations**

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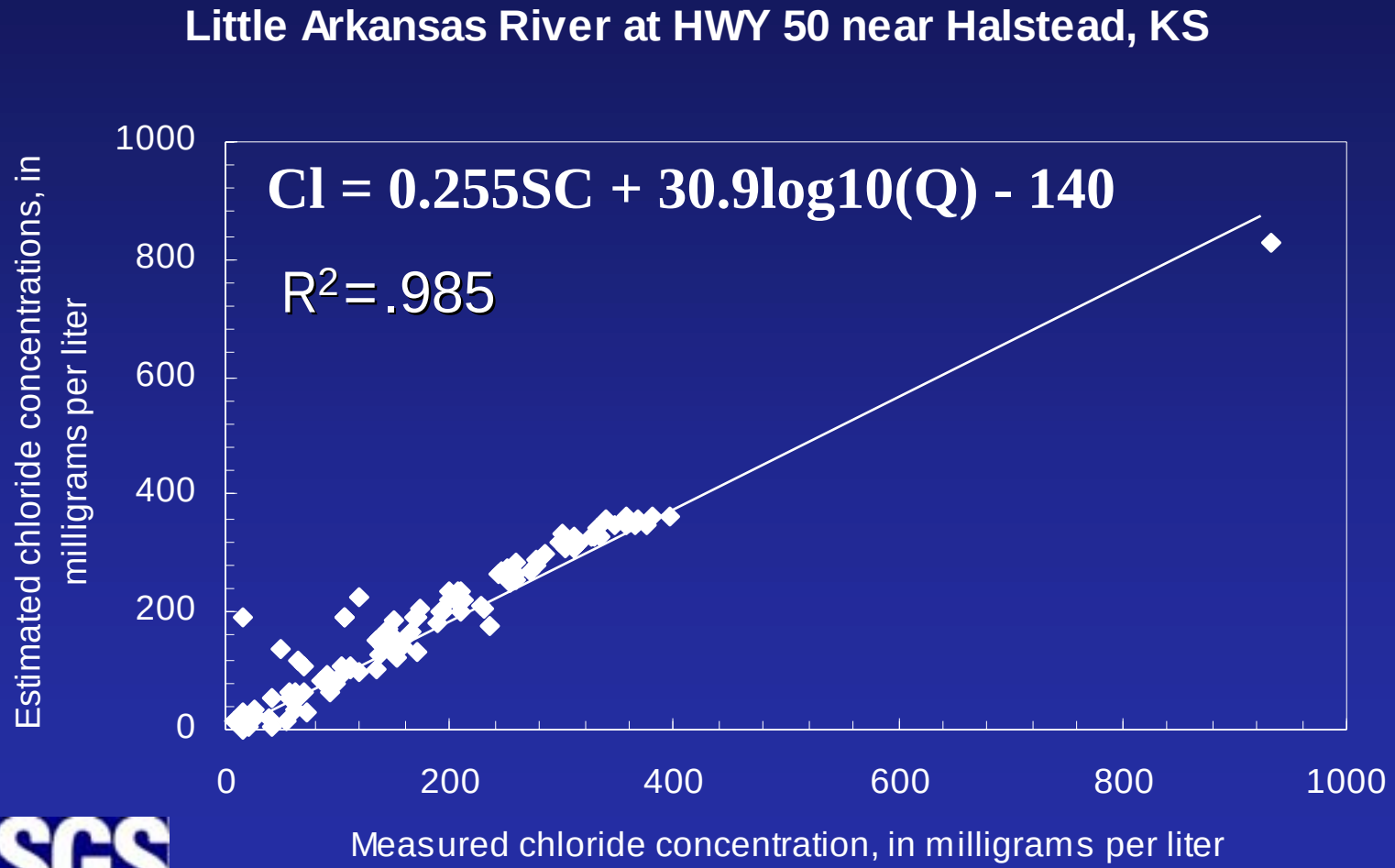
Estimated vs. Measured Chloride Concentrations



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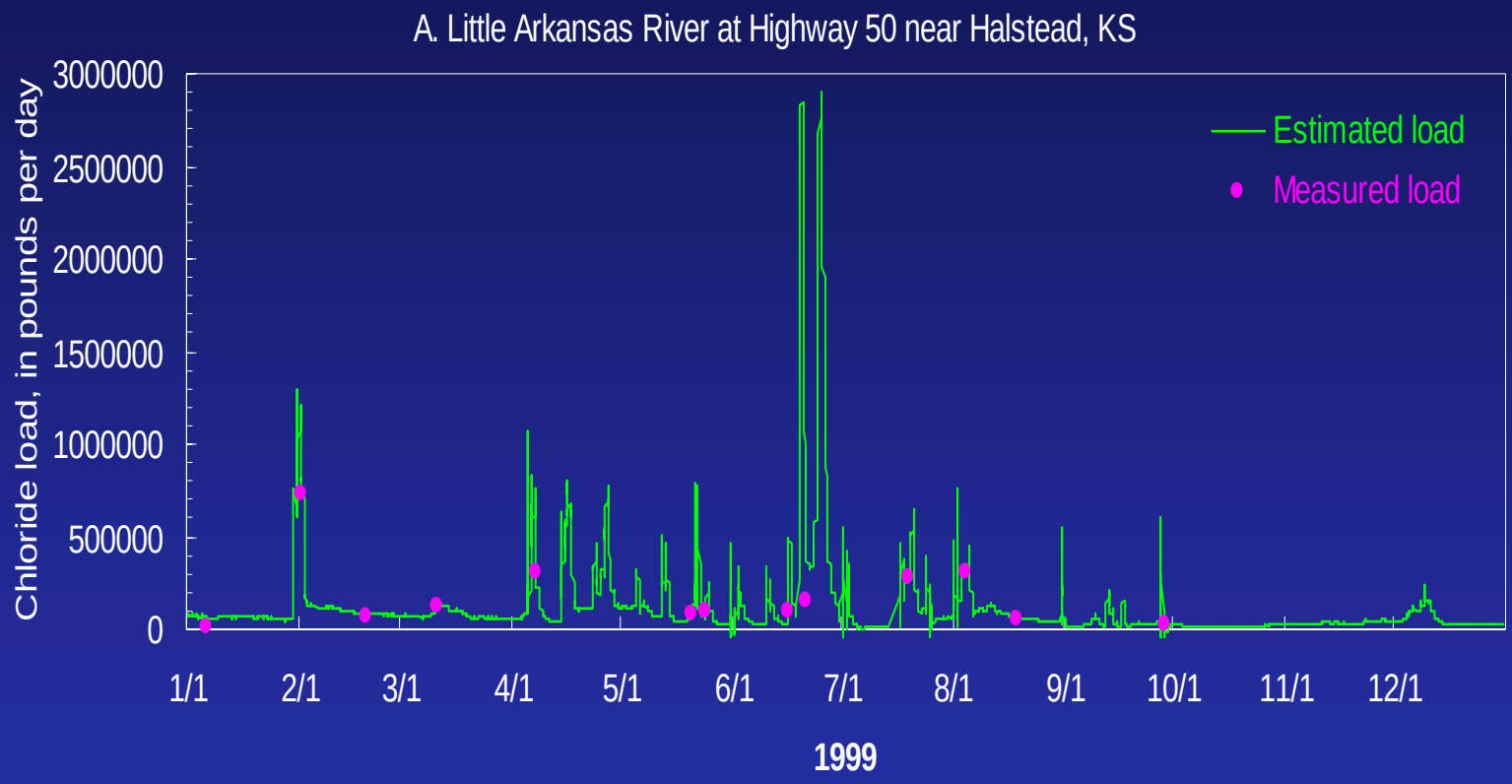
Little Arkansas River near Sedgwick, KS

Year	n	R^2	SSE	% change SSE
1995	20	0.921	22,700	--
1996	38	.950	14,300	-37.0
1997	54	.952	13,800	-3.50
1998	74	.954	13,400	-2.90

Real-Time Loads



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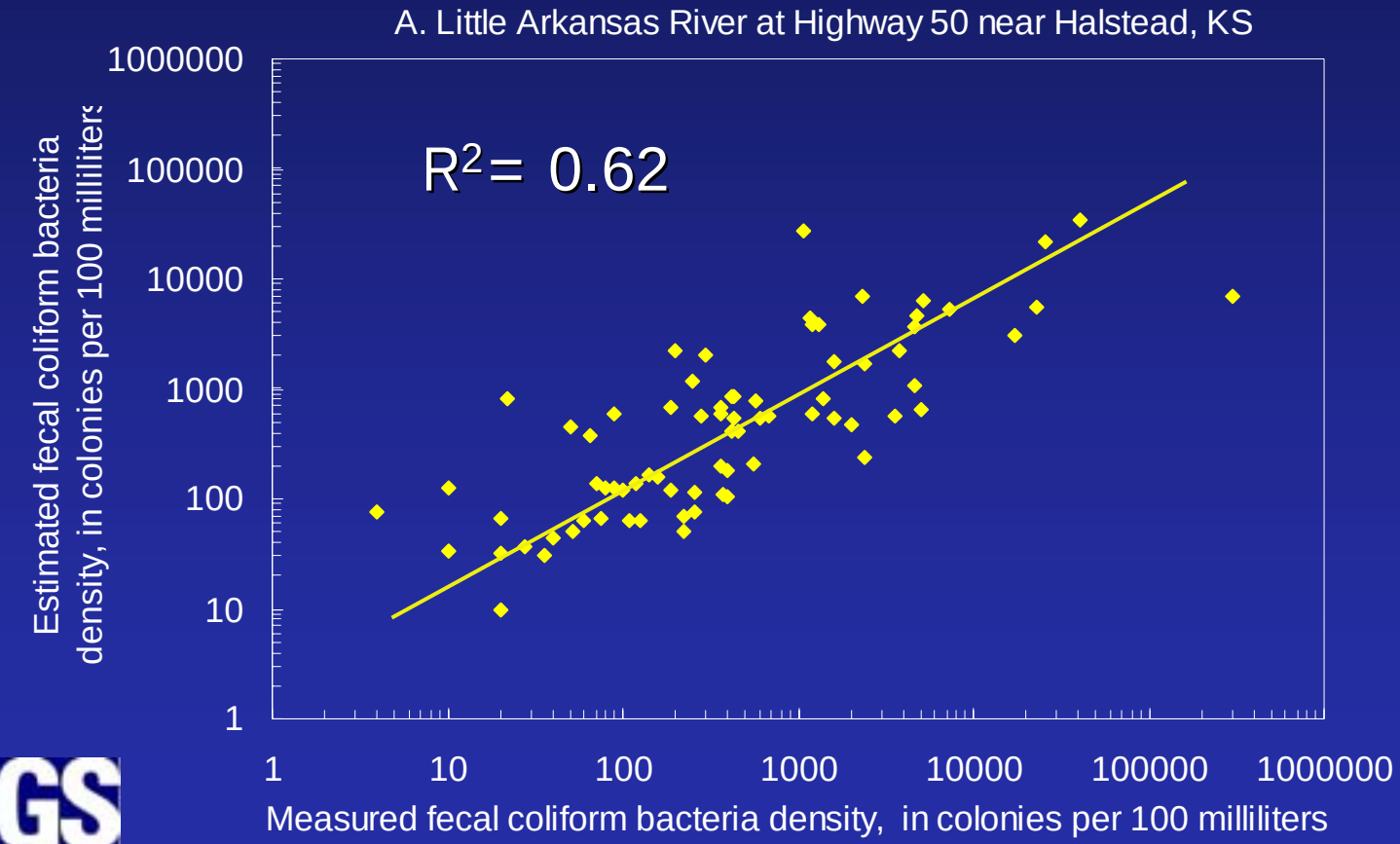
Estimated vs. Measured Bacteria Densities

$$\log_{10}(Bact) = (0.490)\cos(2\pi(\frac{month + 2.06}{8.76})) + 0.00106Turb + 0.417\log 10(Turb) + 1.65$$



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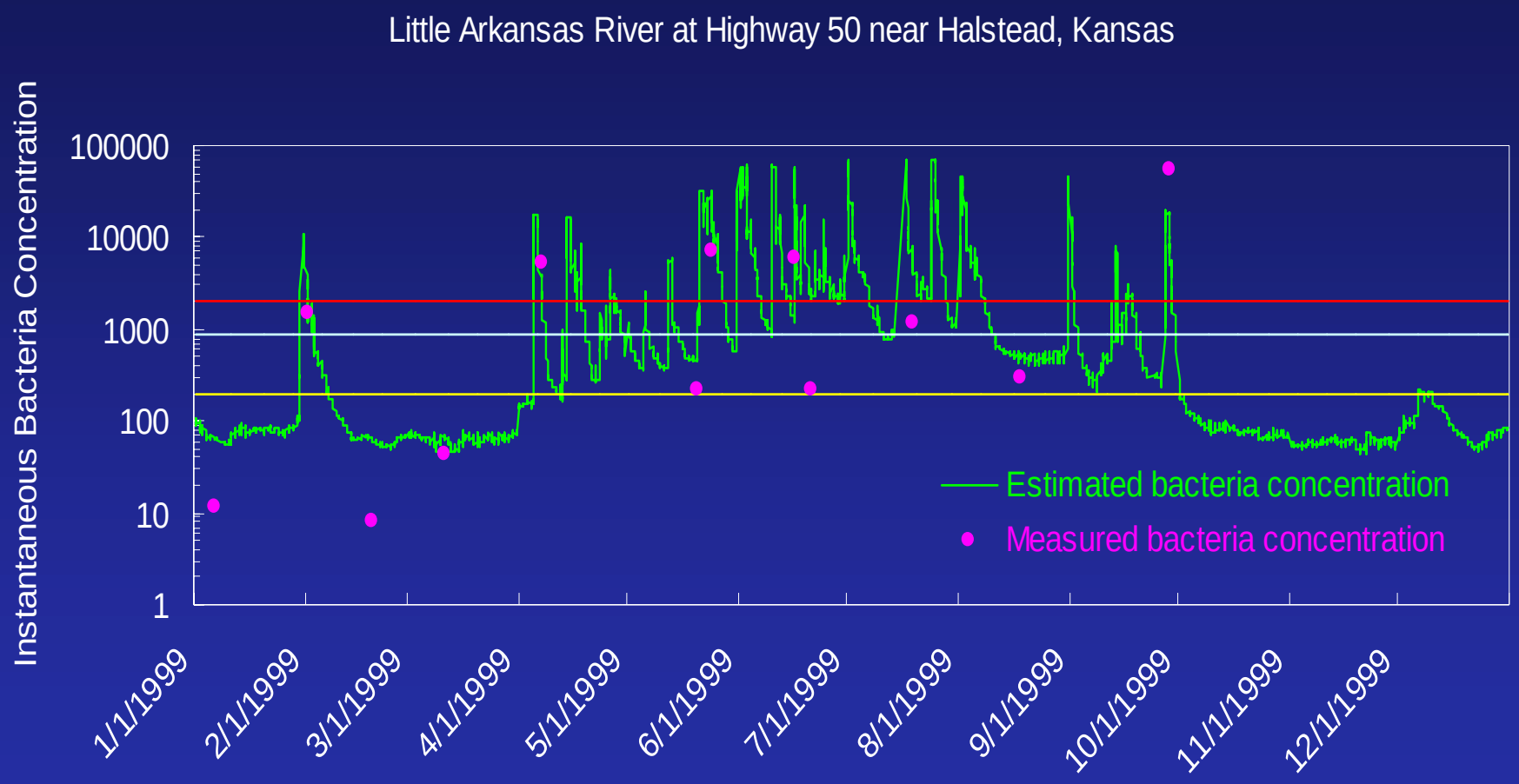
Little Arkansas River at Highway 50 near Halstead, KS

Year	n	R^2	SSE	% change SSE
1995	20	0.574	75.5	--
1996	42	.578	30.1	-60.1
1997	58	.606	28.1	-6.64
1998	75	.620	27.1	-3.56

Fecal Coliform Densities



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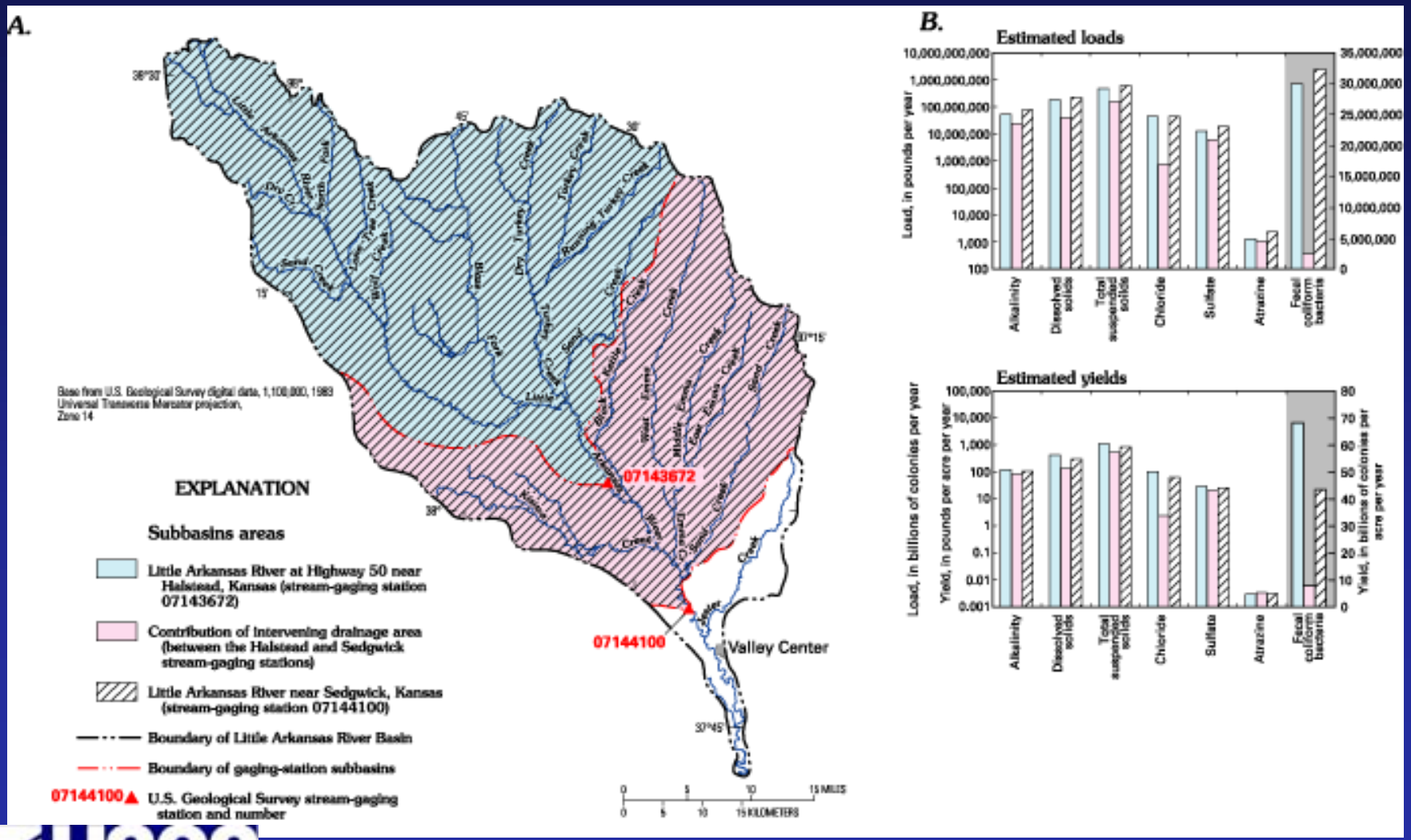
Defining Source Areas



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Errors of Bacterial Analysis

- Applying the Poisson distribution of errors cited in Standard Methods
  - An ideal count of 20 can vary from 11 to 29 or about 50 percent
  - An ideal count of 80 can vary from 29 to 98 or about 25 percent

  These errors account for some of the errors associated with the regression estimates

Surrogate used	to Predict
Specific Conductance	**Chloride, alkalinity, dissolved solids, sulfate, triazine**
Turbidity	**Total suspended solids, fecal coliform, *E. coli*, total nitrogen, total phosphorus**
Chlorophyll	**Taste and odor**

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Summary

- **Provides continuous concentration and load estimates**
- **Identifies source areas and evaluates BMPs**
- **Aquatic and whole-body contact criteria can be examined in real-time**
- **Approach can be used to monitor TMDLs**

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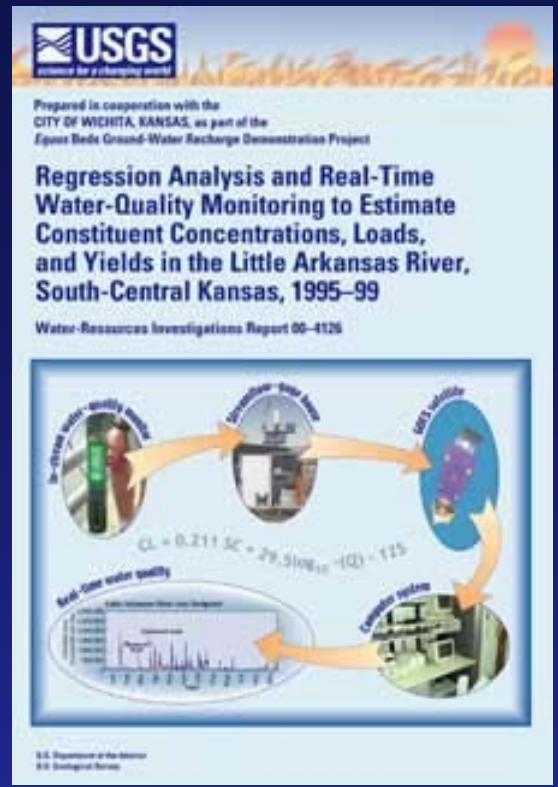
For more information on real-time water quality in Kansas:



http://ks.water.usgs.gov/Kansas/qw/

http://water.usgs.gov/ks/nwis/

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