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Water-quality surrogates, Little Arkansas River, Kansas, 1999–2011

A template for USGS surrogate model approval

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NWQMC April 29, 2014, Cincinnati

U.S. Department of the Interior
U.S. Geological Survey

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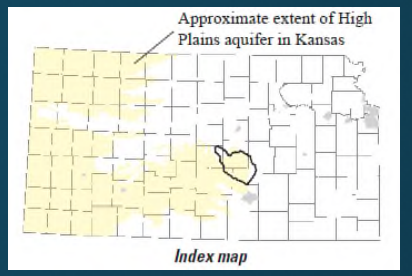
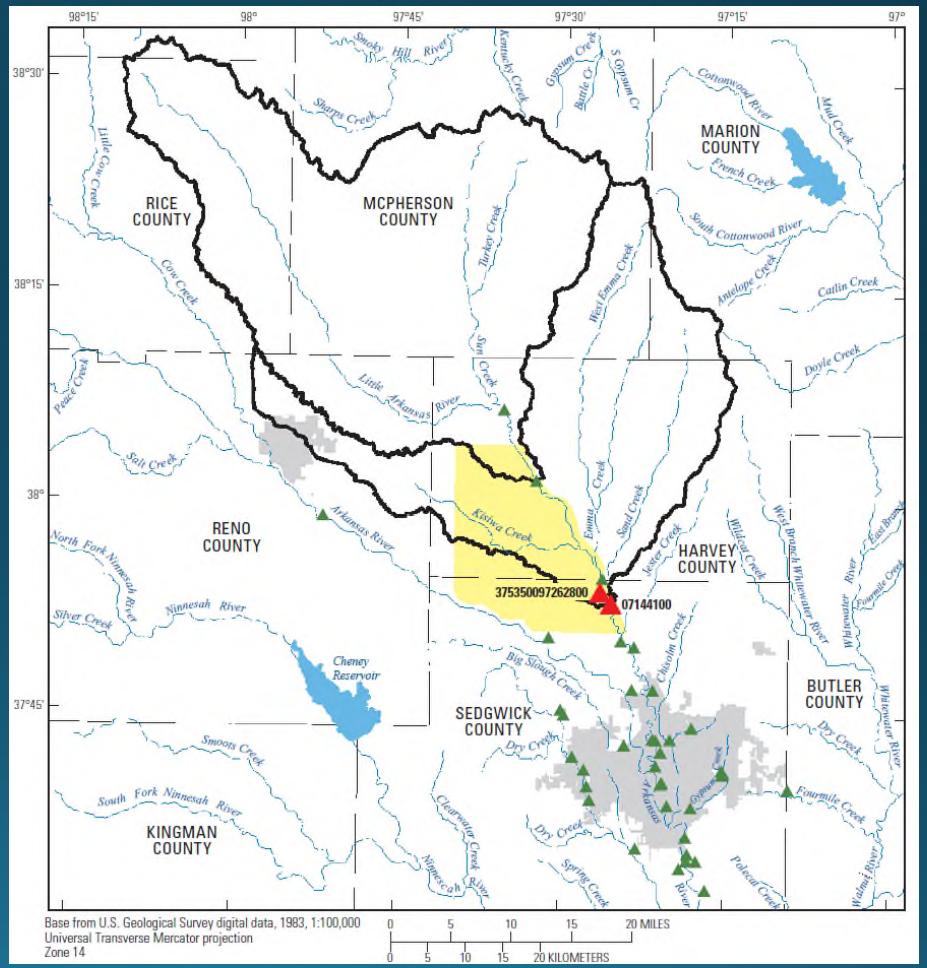
Little Arkansas River



- Just north of Wichita
- Water supply
  - To WTPs for city
  - To Equus aquifer for storage
- ~100 ground water sites
- Annual rainfall 32.6 in, 82.8 cm
- Two stream sites
  - Halstead – 759 m^2 (1,966 km^2)
  - Sedgwick – 1,239 m^2 (3210 km^2)



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WQ monitoring

- 5,000+ samples since 1995
- WQ monitor at each site since 1999
  - Temperature, SC, pH, DO, Turb
  - Nitrate, CDOM, chlorophyll
- Surrogates
  - 17 concentration models
  - Real-time concentrations used to manage artificial recharge

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Water quality monitoring

- Turbidity
  - 1998 – 04 YSI model 6026
  - 2004 – now YSI model 6136
  - 2011 – now HACH Solitax
- DO
  - 1998 – 2007 YSI Clark cell
  - 2007 – now YSI 6150 ROX

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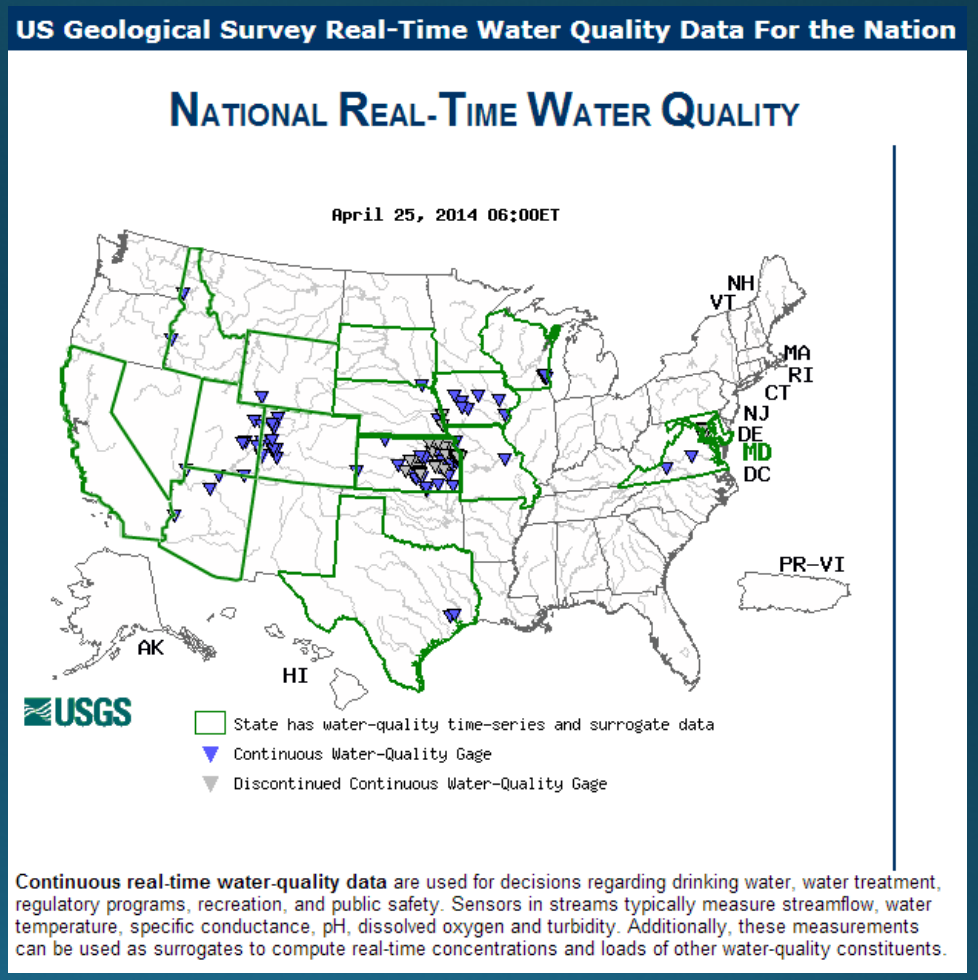
Surrogates

- National real-time water quality (NRTWQ)
  - Developed in 2000
  - Supported by OWQ
  - Displays surrogates from 15 states
- Little Ark
  - 2000, 2003, 2010
    - 15 models per site
    - Started NRTWQ
  - 2001-12
    - Various updates
    - Bacteria, sediment, pesticides



http://nrtwq.usgs.gov

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Recent surrogates

- Data from 2000 through 2012
- 17 models at each site
  - Major ion vs SC
  - Sediment, ECB, FCB vs turbidity
  - Nutrients
  - Atrazine and triazine

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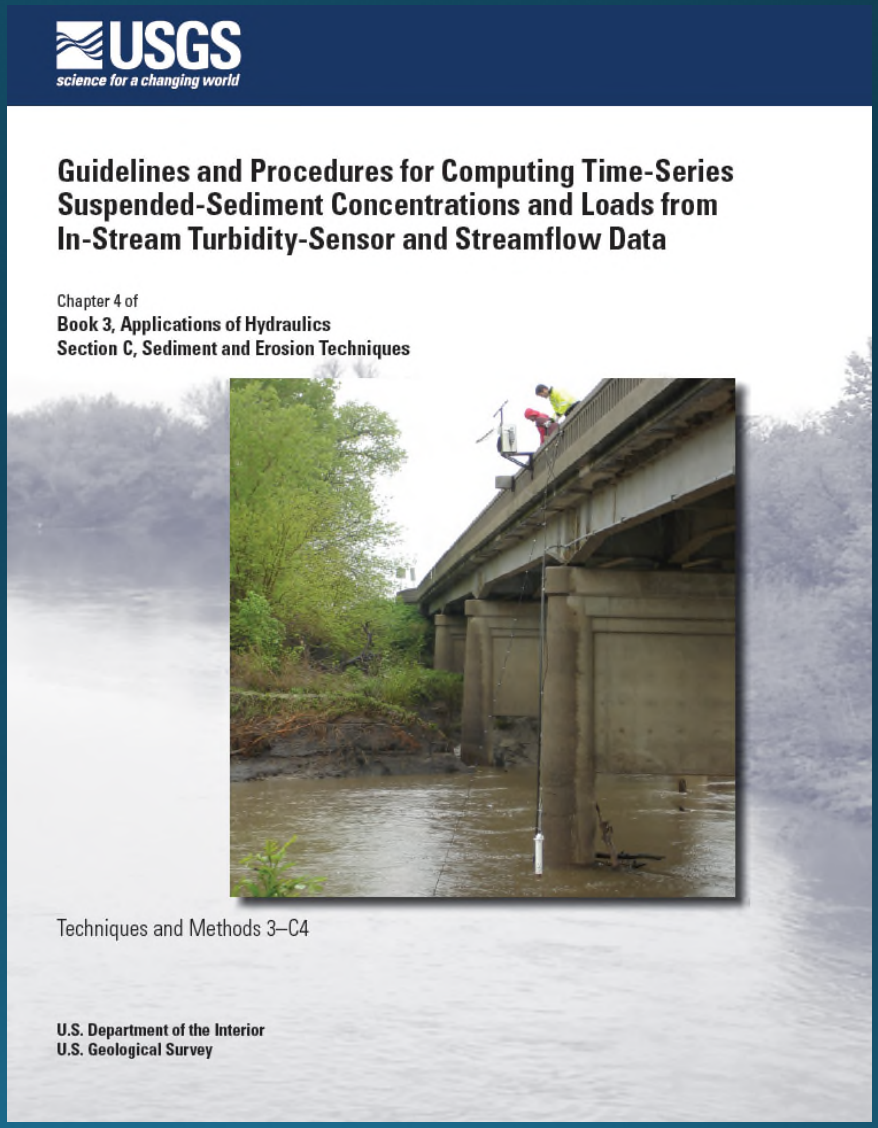
Surrogate methods

- Simple-linear and multiple linear regression
  - Tobit (MLE) for censored data
  - Standard error, PRESS, and C_p
- Model development
  - Assemble model calibration data set
  - Find correlated variables
  - Identify outliers
  - Apply data transformations
  - Add variables
  - Repeat



http://pubs.usgs.gov/tm/tm3c4/

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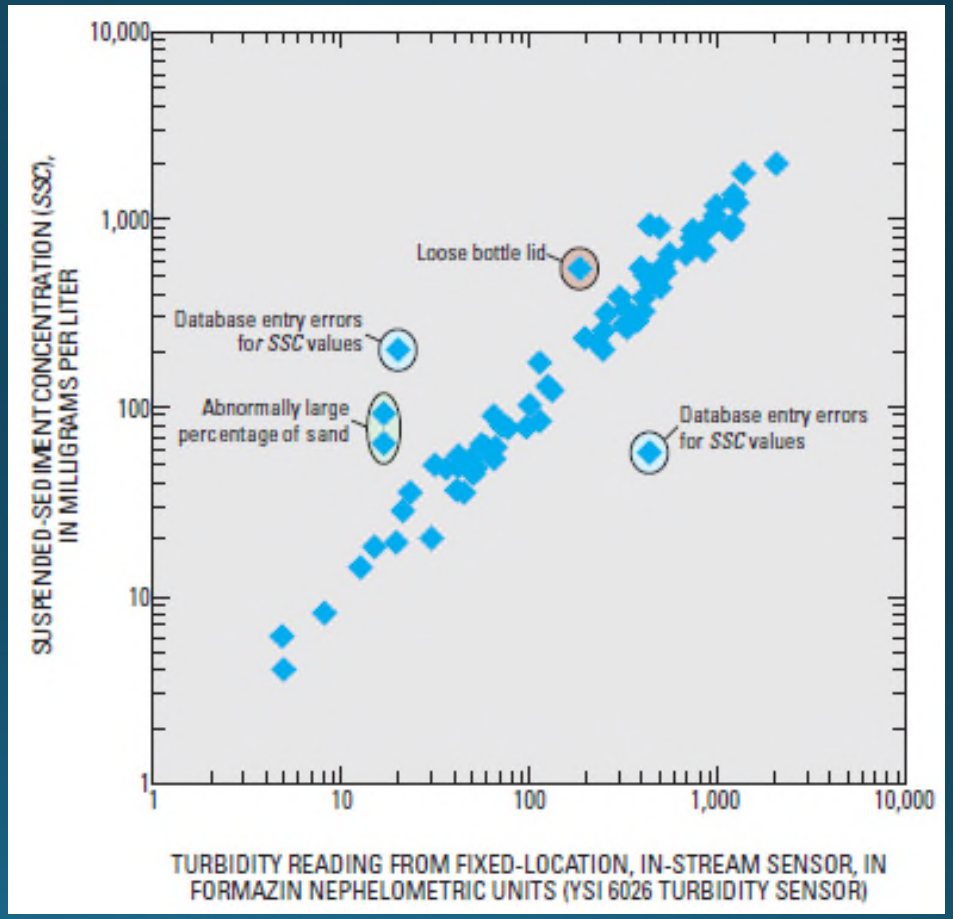
Surrogate methods

- Model development
  - 60-150 samples per model calibration data set
  - Used approved instantaneous values measured during sample collection
  - A few outliers
  - Mostly log transformations
  - Mostly SLR (5 MLRs)



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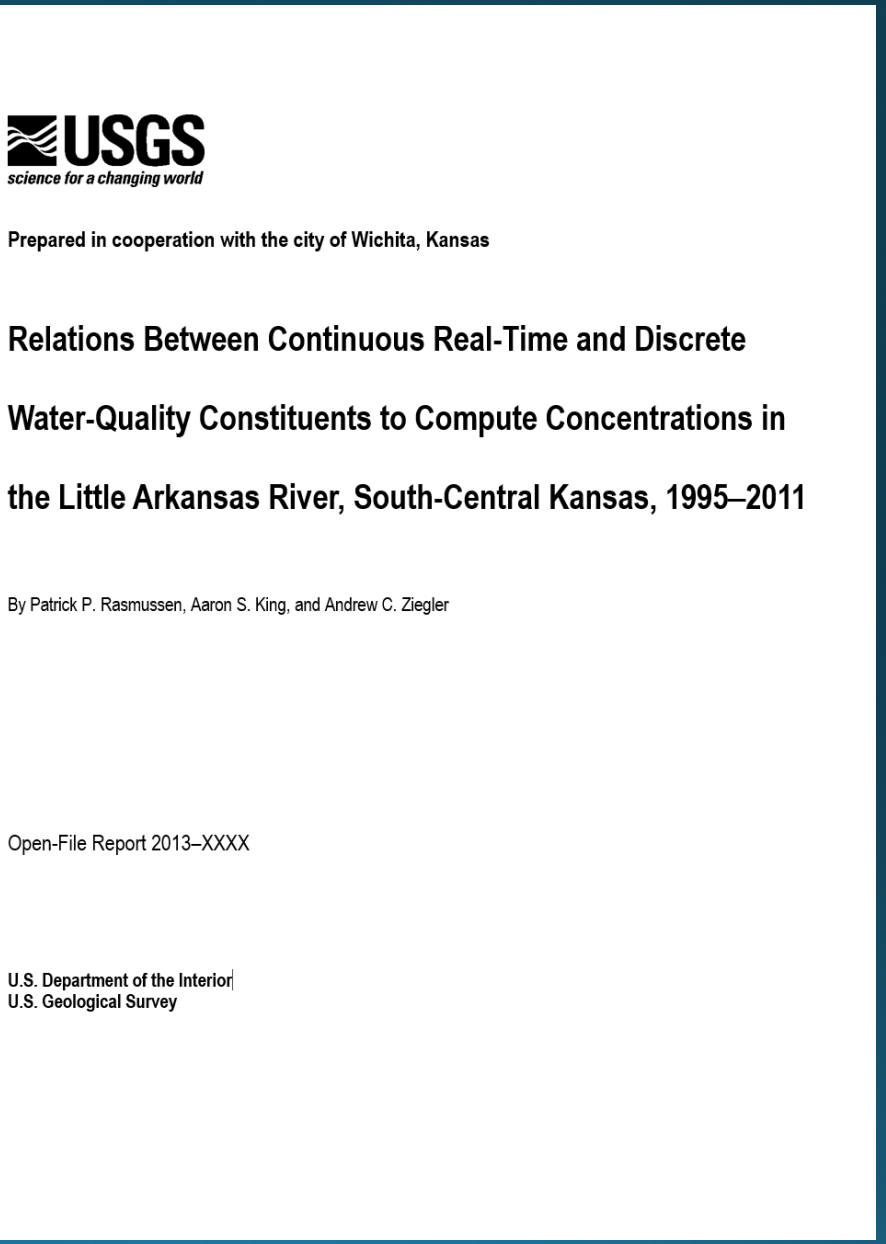
Surrogate publication

Open-file report (OFR)

- Peer reviewed
- Bureau approving official
- Model approval package
  - Model analysis
  - Model
  - Statistics, metrics, and measures
  - Residual plots
  - Model calibration data set



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Prepared in cooperation with the city of Wichita, Kansas

Relations Between Continuous Real-Time and Discrete Water-Quality Constituents to Compute Concentrations in the Little Arkansas River, South-Central Kansas, 1995–2011

By Patrick P. Rasmussen, Aaron S. King, and Andrew C. Ziegler

Open-File Report 2013–XXXX

U.S. Department of the Interior
U.S. Geological Survey

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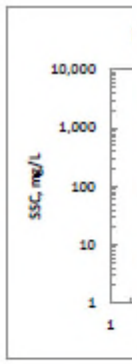


SITE NUMBER—07144100

SITE NAME—Little Arkansas River near Sedgwick

DATE CREATED—3/11/2013

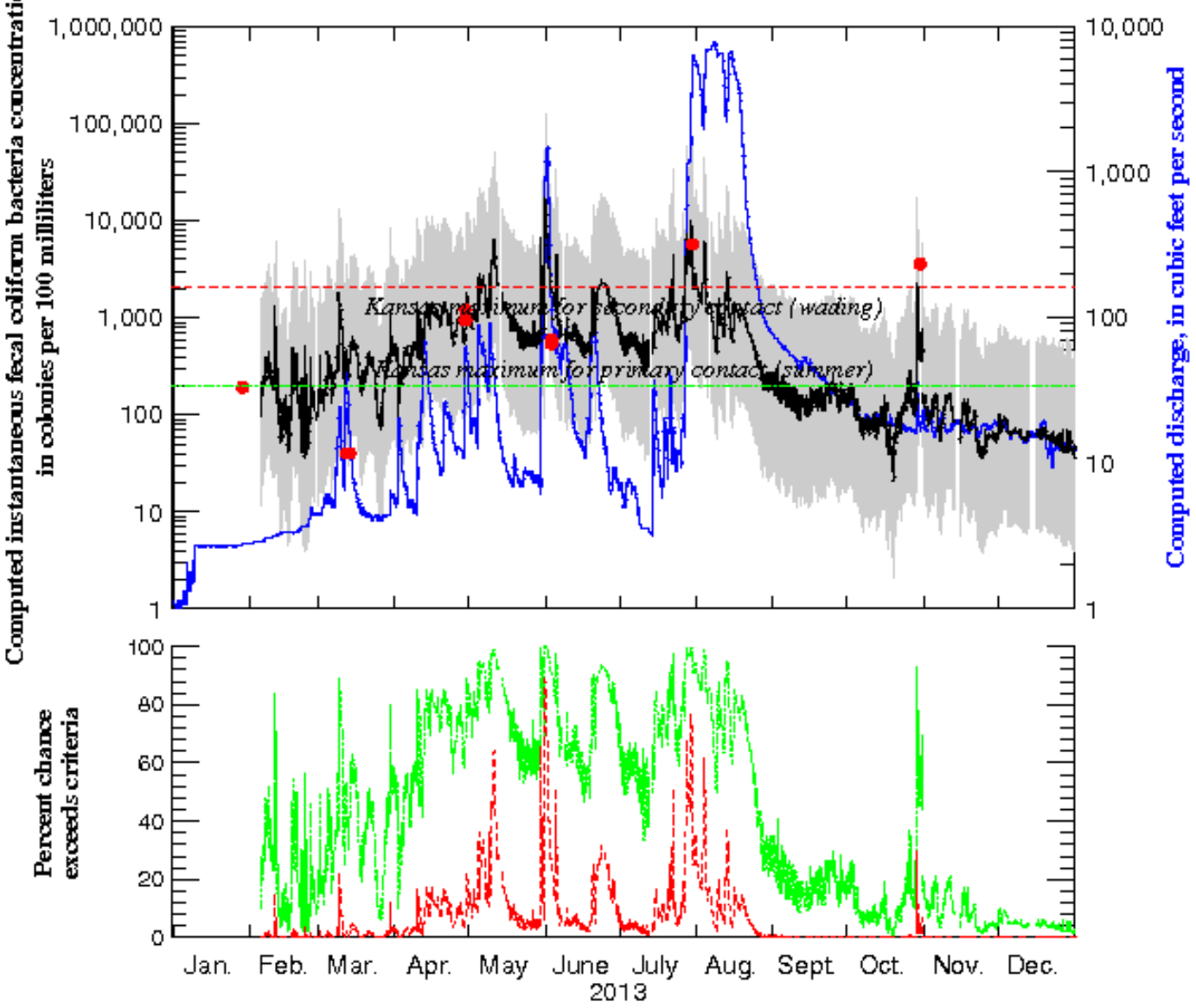
MODEL DEVELOPMENT DATA PERIOD—7/27/2004 – 5/16/2011

MODEL-CALIBRATION DATASET—All data were collected using U.S. Geological Survey (USGS) protocols and are stored in National Water Information System (NWIS) database. The regression model is based on 67 concurrent measurements of suspended sediment concentration, streamflow, and turbidity samples collected from 07-27-2004 through 05-16-2011. Samples were collected throughout the range of continuously observed hydrologic and turbidity conditions. Summary statistics and complete model-calibration dataset are provided. Two suspended sediment values were deemed outliers.

Outliers removed from the dataset.

Date	Suspended sediment concentration, in milligrams per liter	Turbidity, in formazin nephelometric units
12/1/2009	85	3.9
12/17/2009	174	1.4

The documentation to review the SSC analysis was unavailable. However, the suspended sediment concentration values were either 10 times more than the maximum or less than the minimum suspended sediment concentration value at similar turbidity values. For this reason, the samples were removed from the dataset.



Computed instantaneous fecal coliform bacteria concentration in Little Arkansas River at Highway 50 near Halstead, KS

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Upcoming USGS policy

- Approval process for suspended sediment and perhaps SC vs TDS
  - Model approval package
  - Reviewed by experienced hydrographers
  - Approved by WSC Director
  - Disseminated on NRTWQ
- Other models
  - Model approval package
  - Published in a peer reviewed report (Little Arkansas River OFR)
  - Requires BAO approval
  - Disseminated on NRTWQ

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Questions

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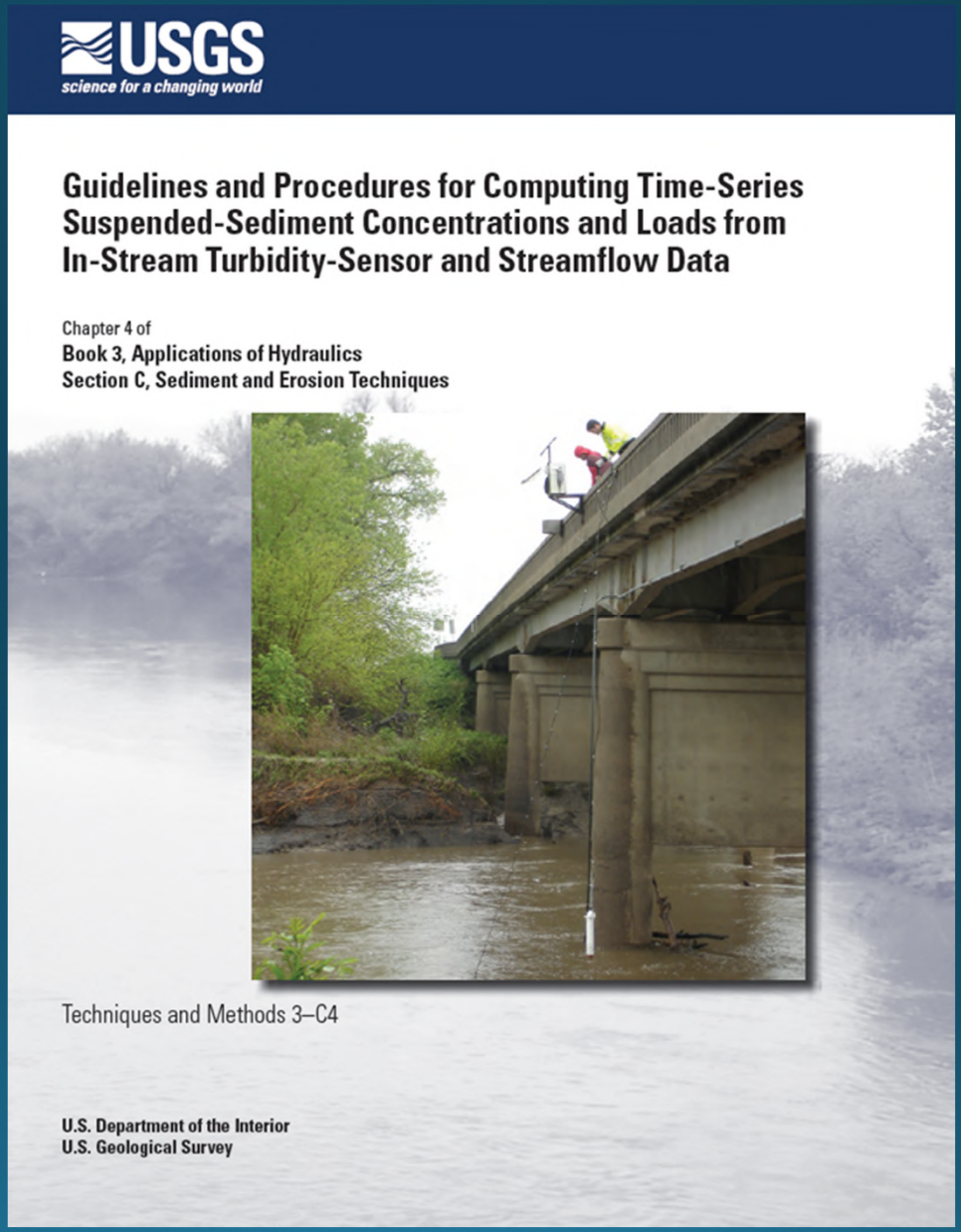

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