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# Computation of Time-Series Suspended-Sediment Concentrations and Loads Using In-Stream Turbidity and Streamflow

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**National Water Quality Monitoring Conference**
**May 19-22, 2008**
**Atlantic City, New Jersey**

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

# Turbidity-SSC Guidelines

- First deviation from USGS techniques using streamflow to compute fluvial-sediment discharge by Porterfield since 1972…
- Time-series suspended-sediment concentration computed from turbidity
- Published USGS Techniques and Methods (2009)

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# Contributing Authors

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# Three steps to computing SSC

- Compile model calibration data set
- Develop a site-specific single or multiple linear regression model
- Compute a time series of suspended-sediment concentration and load

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# Step 1 – Model calibration data set

- Calibration data set
  - Turbidity time-series record
    - Fixed in-stream sensor  (Wagner and others, 2006)
    - Turbidity cross-section measurements
    - Turbidity includes-
      - Nephelometry
      - Optical Backscatterance
  - SSC of samples
    - Depth integrated, EDI or EWI (Nolan and other, 2005; Edwards and Glysson,1999)
    - Sample full range of hydrologic conditions
  - Streamflow time-series record

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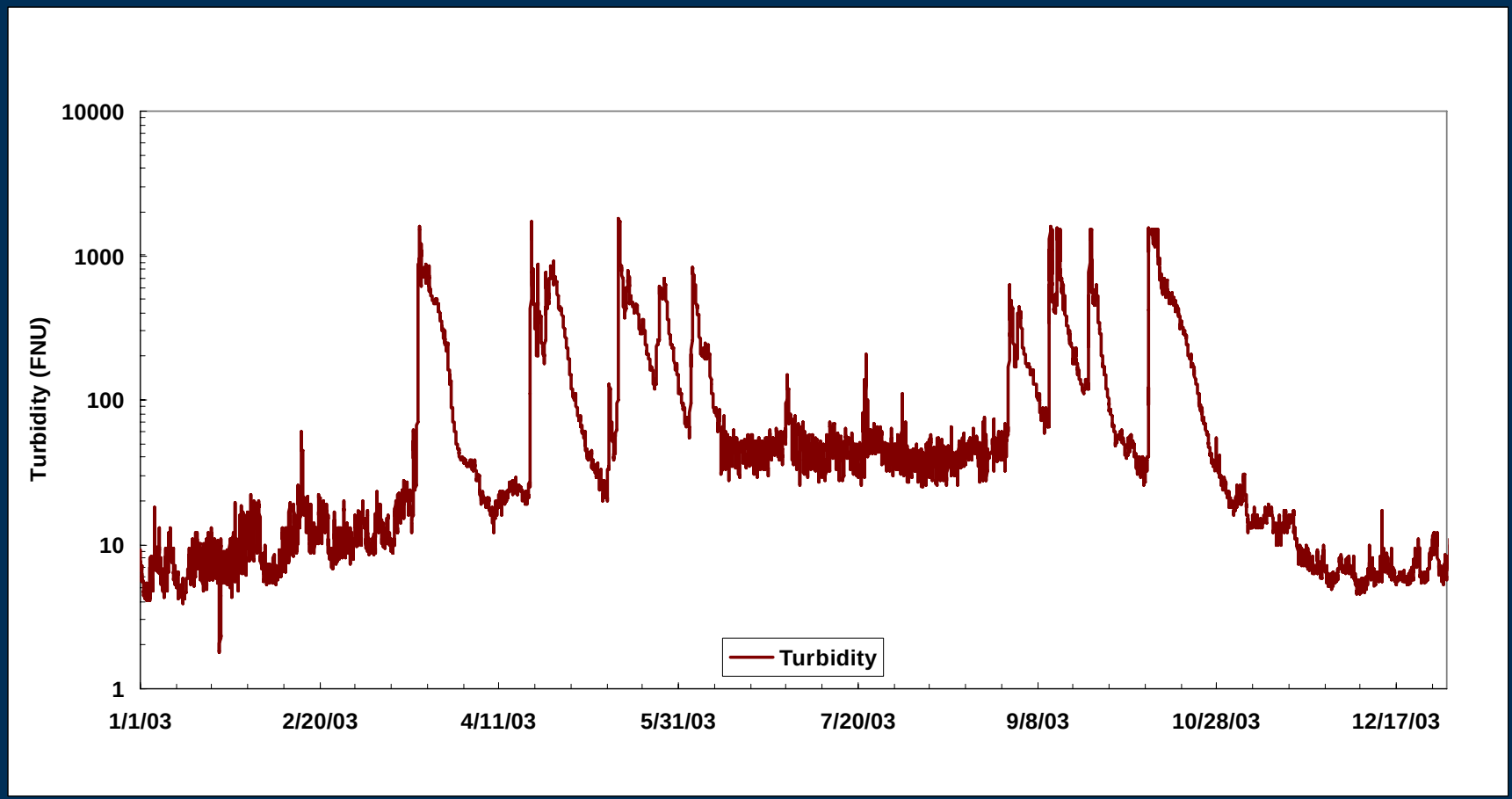
# Step 1 – Model calibration data set

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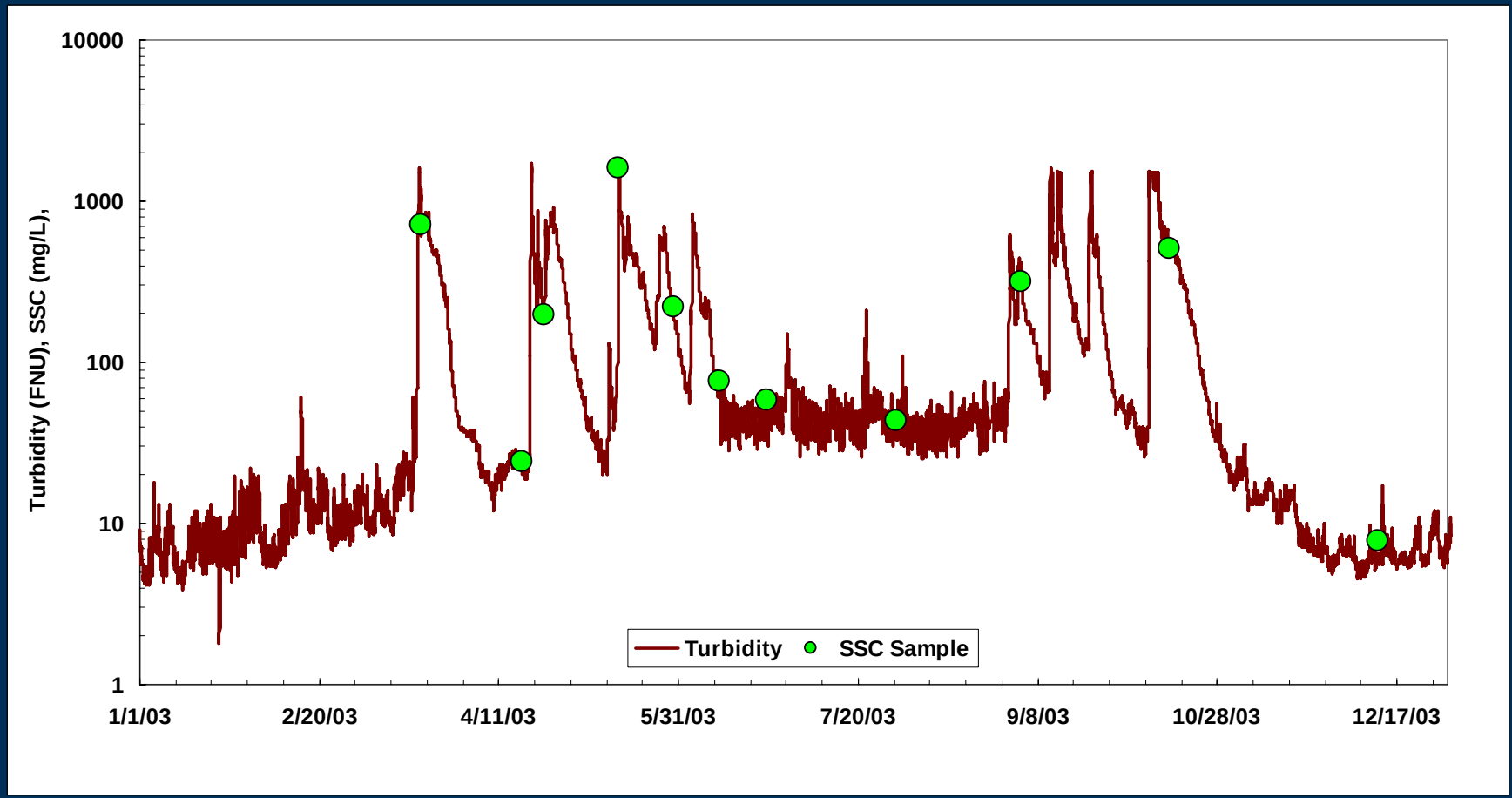


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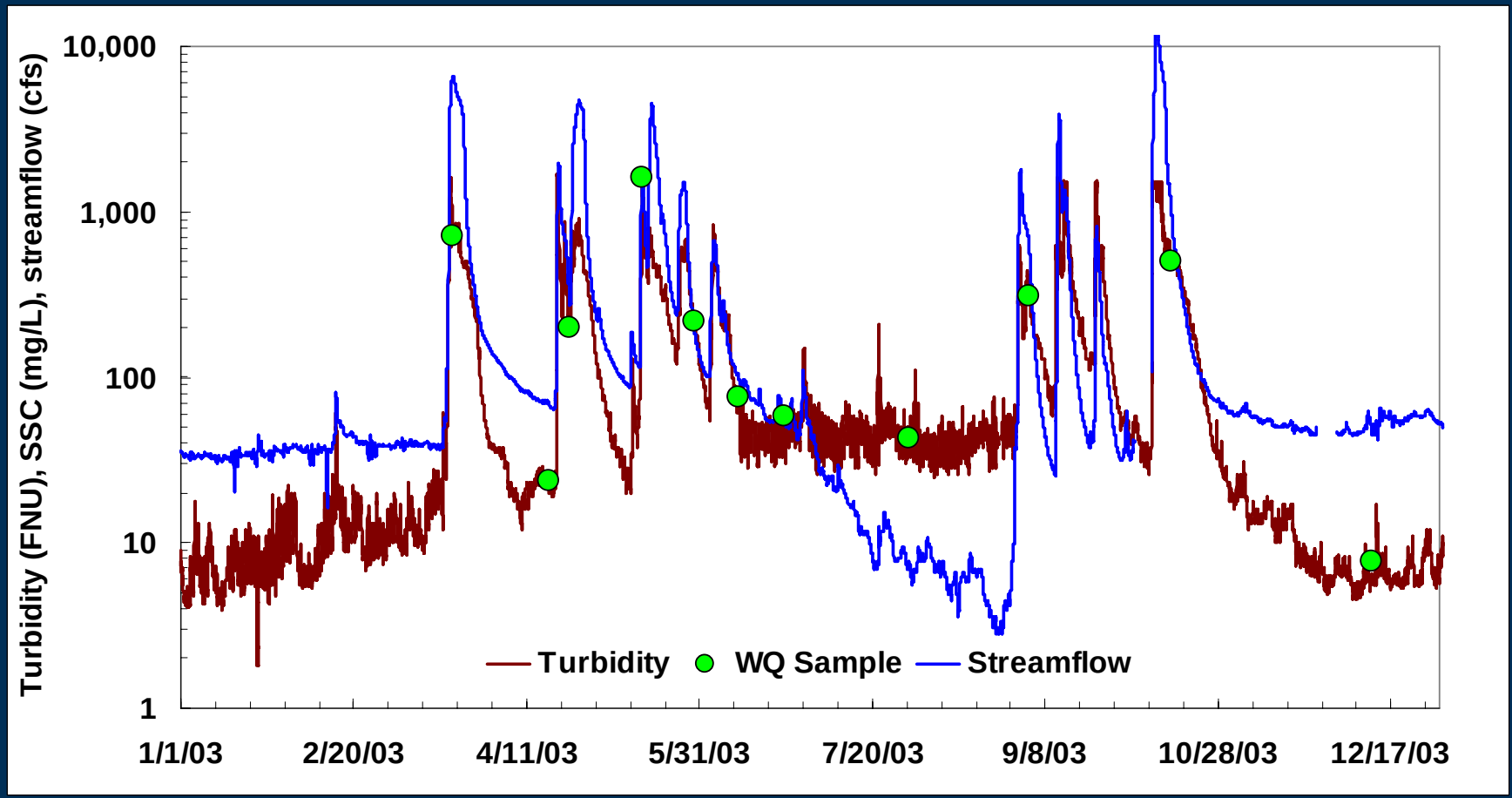


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# Step 2 – Develop regression model

- Simple linear regression (SLR)
  - Plot data
    - Turbidity is explanatory variable
    - SSC is response variable
  - $\log_{10}$ transformation
    - Symmetry, linear, constant variance
    - Must apply bias correction factor
  - Regression provides expressions of uncertainty
  - Plot data
- Other regression techniques

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# Step 2 – Develop regression model

- Other regression techniques
  - Plot data
    - Streamflow vs. SLR residuals
    - Time vs. SLR residuals
  - Multiple linear regression (MLR)
    - If SLR $R^2 < 0.85$ or sand is > 20 % of SSC
    - Turbidity and streamflow are explanatory variables
    - Use MLR?
      - Significant p-value (>0.05) for streamflow,
      - > 10 % decrease in MLR RMSE, and
      - t-stat > 2

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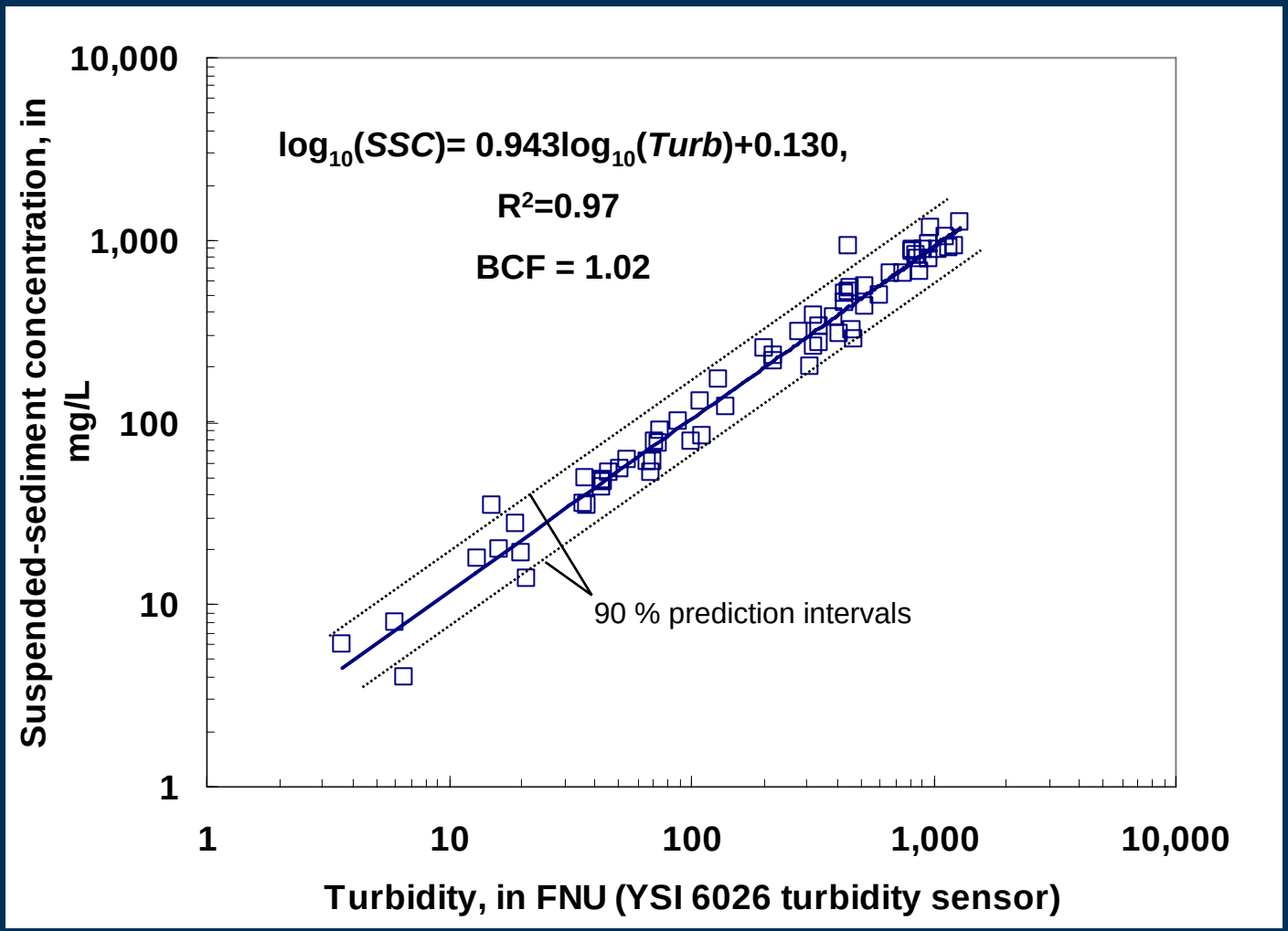
# Step 2 – Develop regression model

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# Step 3 – Compute SSC and SSL

- Apply regression model to continuous turbidity (and streamflow)
  - Compute time-series SSC
    - SSC time interval same as turbidity
    - Multiply retransformed SSC by BCF
    - Missing and truncated turbidity values
  - Compute time-series SSL
    - Multiply SSC by Q and conversion factor
    - Missing streamflow

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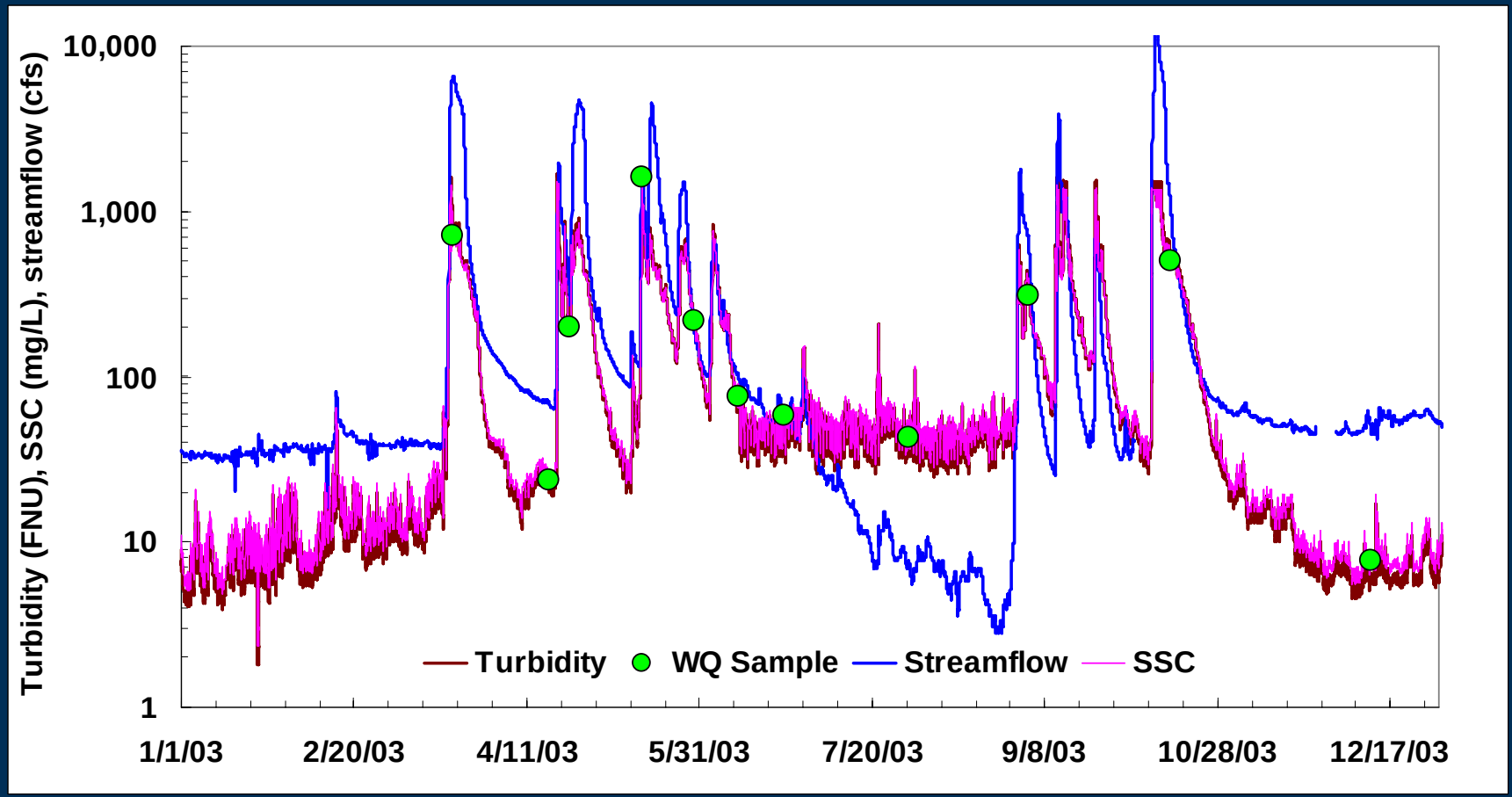
# Step 3 – Compute SSC and SSL

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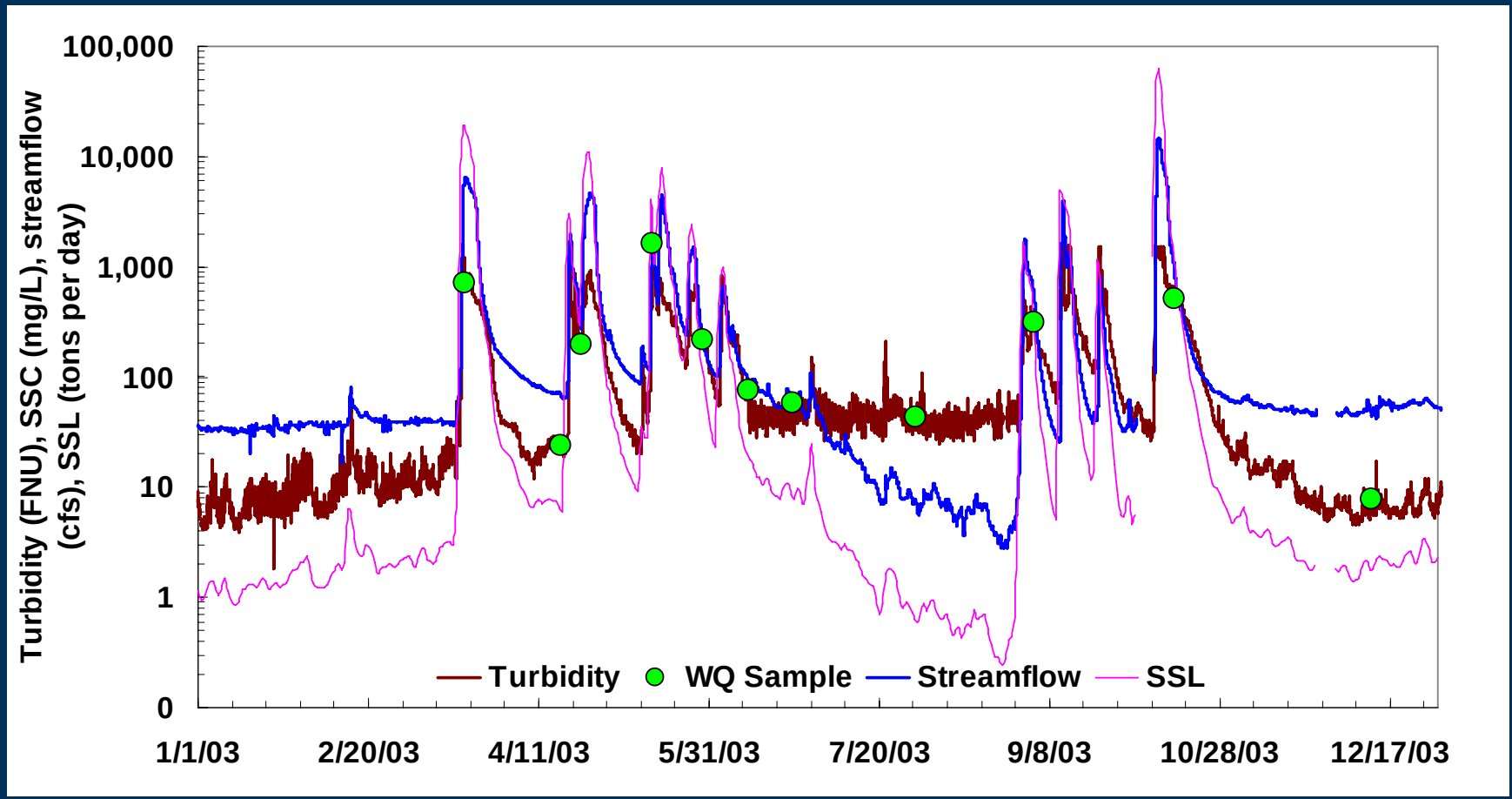
# Step 3 – Compute SSC and SSL

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# Maintaining sediment record

- Continue monitoring turbidity
  - Continuously at a single point
  - Periodic cross-sectional measurements
- Continue collecting SSC samples
- Evaluate new turb/SSC pairs with old pairs annually
  - Similar distribution verifies current regression
  - Differences may indicate a change in sediment transport and a need for new regression

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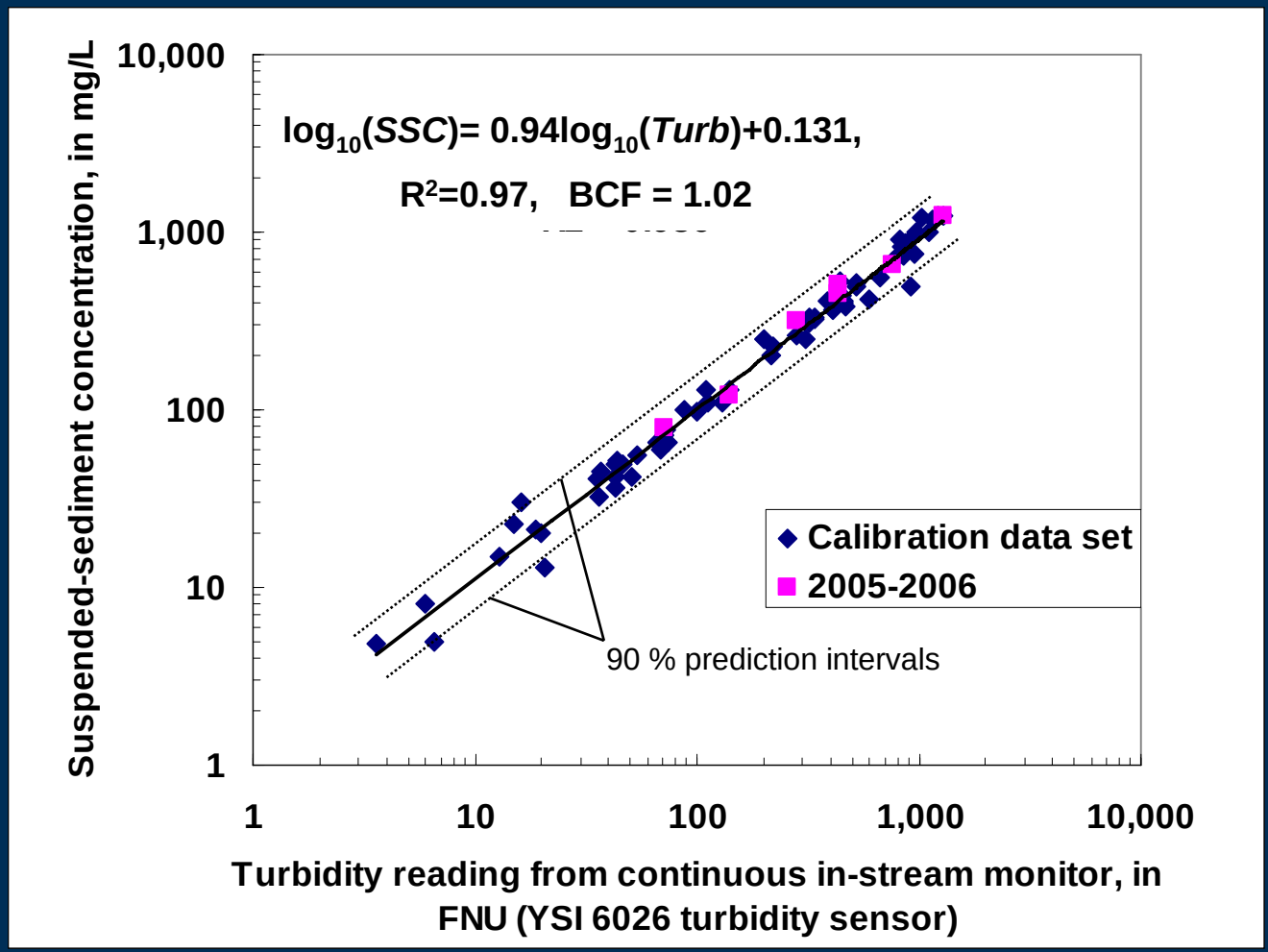
# Maintaining sediment record

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# Advantages of turbidity/SSC

- Technique works best when:
  - SSC is mostly < 63 μm
  - SSC source is homogeneous
- No hysteresis in turb/SSC
- Relations are generally defined by a single slope
- Uncertainty is easily defined
- Comparisons indicate turb/SSC estimates have less uncertainty than Q/SSC estimates

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# Limitations

- Turbidity truncation
- Turbidity values from different sensors are not equivalent
- Each regression model is site specific
- Turb/SSC relation statistically insignificant if:
  - Sand is large % of SSC or varies with SSC
  - SSC source changes frequently
    - Varying grain-size distributions
    - Varying sediment color

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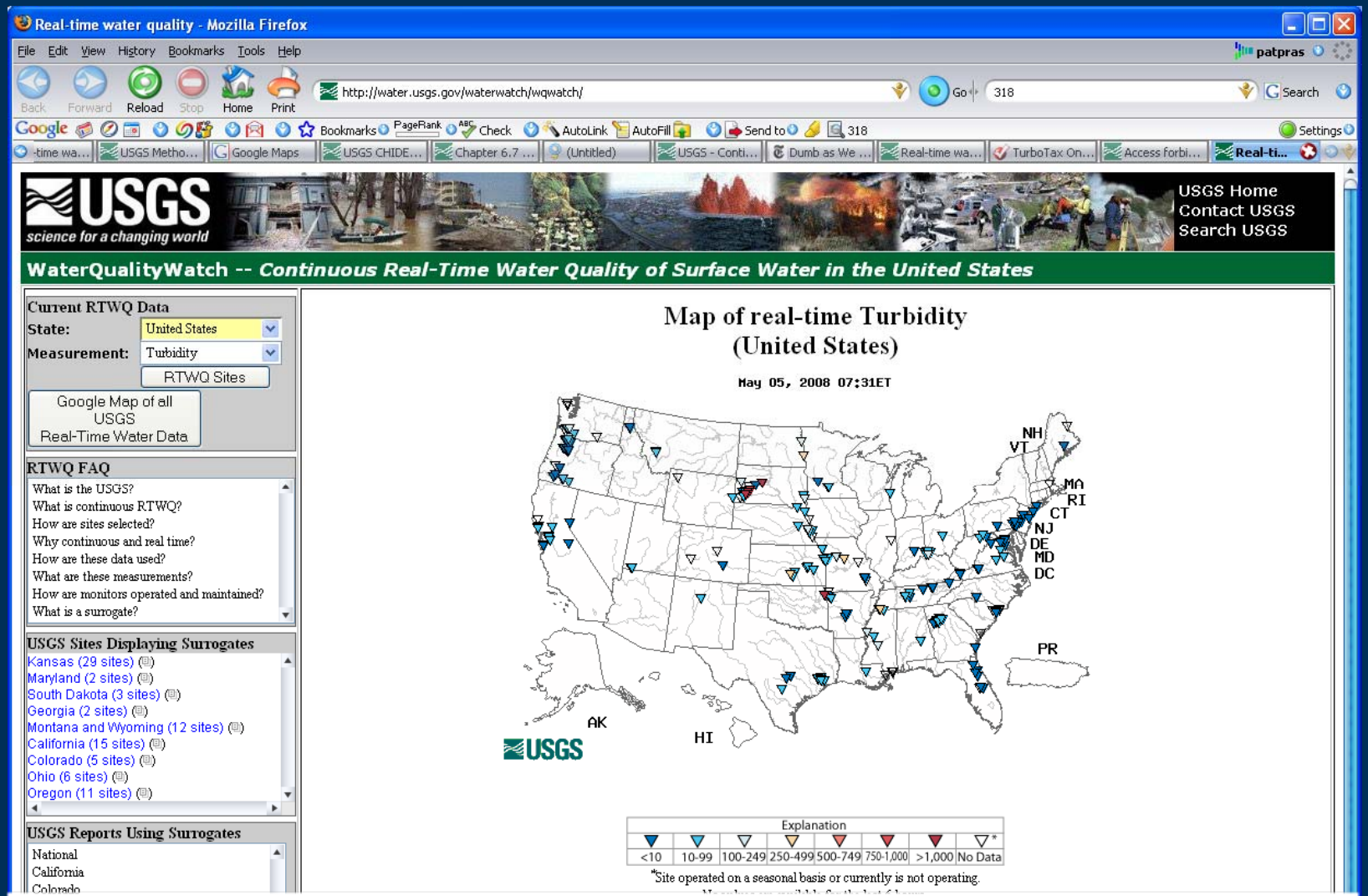
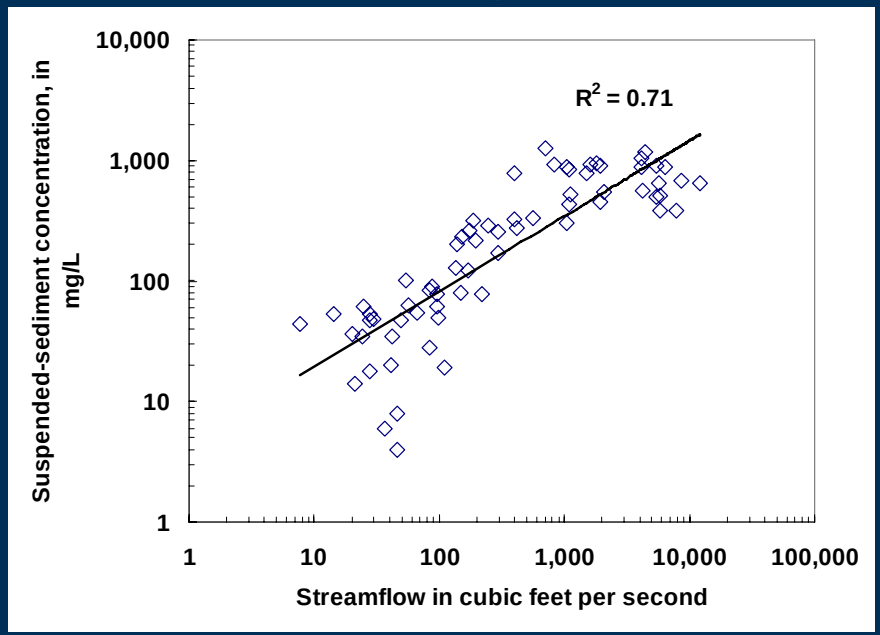
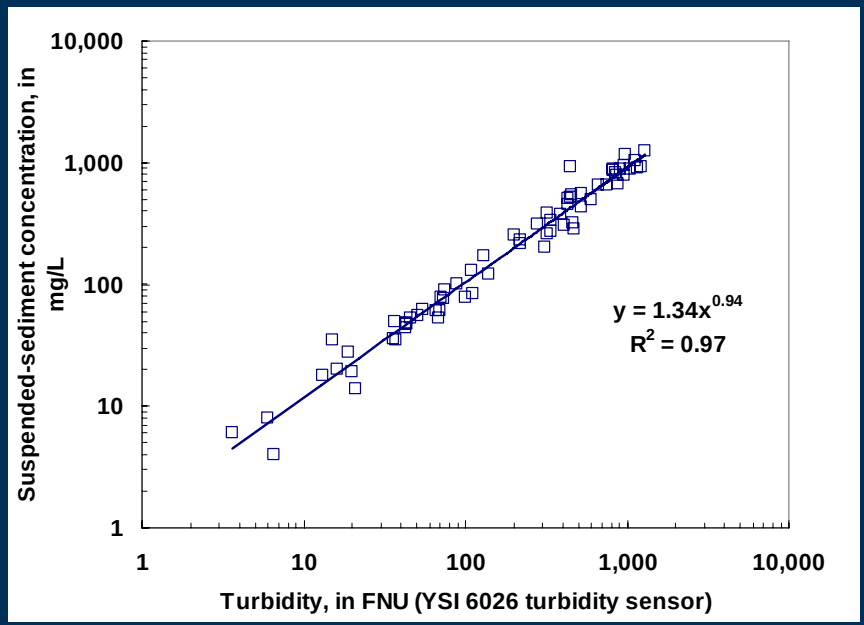
# USGS Water Quality Watch




http://water.usgs.gov/waterwatch/wqwatch/

# Turbidity vs streamflow for computing SSC

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# Questions?

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**http://water.usgs.gov/waterwatch/wqwatch/**
**http://ks.water.usgs.gov/Kansas/rtqw/index.shtml**

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# Tools

- Excel (data management)
- S-Plus (statistics)
- LOADEST (T&M B4 A5) (statistics)
- Graphical Constituent Loading Analysis System (GCLAS; T&M 4-C1) (viewing time-series data)
- KTRLine (T&M 4-A7) (nonparametric linear regression)

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