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science for a changing world

Continuous water-quality information anywhere and at anytime! How do we get there?

Panelists:

Andy Ziegler (USGS)–Director, Kansas Water Science Center
Overview of continuous real-time water quality and networks, goals, and impediments.

Monty Porter, (OWRB) Technical and Quality Manager, Water Quality Division, Oklahoma Water Resources Board,
Regulatory Applications of Continuous Water Quality Data in Oklahoma

Chuck Dvorsky (TCEQ)— Continuous Water Quality Monitoring Coordinator, Texas Commission on Environmental Quality,
Guidance and protocols-- Why these are necessary in regulatory applications.

Stewart Rounds (USGS)—WQ Specialist, Oregon Water Science Center
Quantifying uncertainty for time series water quality data.

Brian Pellerin (USGS)– Research Chemist, Sacramento, CA
Applications of optical sensors in rivers and streams.

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

and YOU!

Ninth National Monitoring Conference
Working Together for Clean Water
Cincinnati, Ohio April 29, 2014

Opening Panel goals:

- Overview of continuous monitoring, surrogates, networks, regulatory applications, uncertainty, new …..
- Spur discussions and move this science tool forward
- Encourage MORE SITES and networks implemented to answer the needs of society and the environment- strive for *Regulatory* acceptance!
- Offer thoughts on how we can arrive at Water Quality anywhere AND at anytime….
- Encourage everyone to TRY IT! Or REALLY JUST DO IT!

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Why measure water quality?

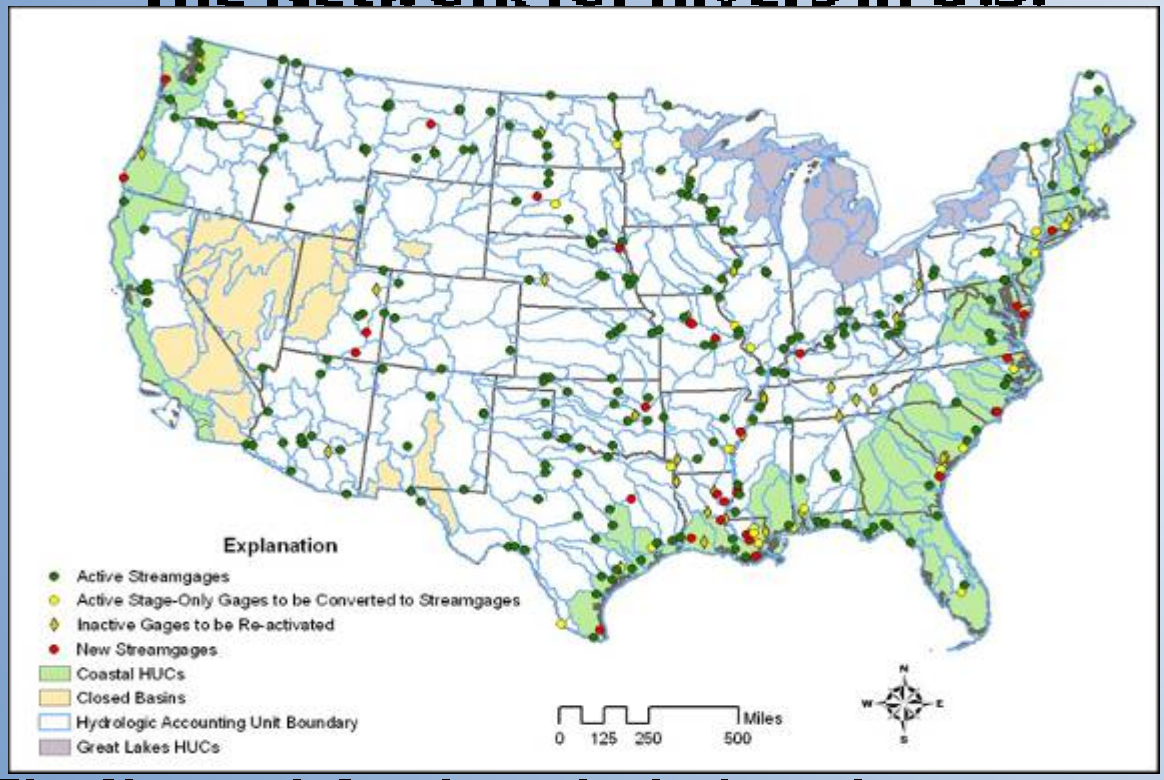
Many impairments can EASILY be measured or computed continuously

EPA top 15:

1. Pathogens
2. Mercury
3. Metals
4. Nutrients
5. Sediment
6. Organics/DO
7. pH
8. unknown biota
9. PCBs
10. Turbidity
11. Temperature
12. Pesticides
13. salinity/tds
14. Unknown
15. Aquatic plants

http://www.epa.gov/owow/tmdl/results/pdf/aug_7_introduction_to_clean.pdf

The Network for Rivers in U.S.



The Network for rivers is designed to assess:

- streamflow, contaminant loads, biological conditions at the outlet of each Hydrologic Accounting Unit at HUC6
- streamflow and constituent loads from coastal rivers.

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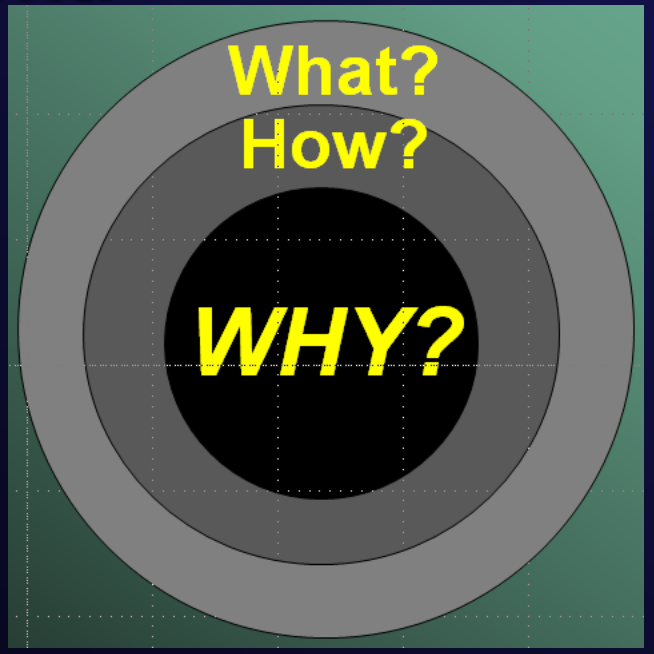
http://acwi.gov/monitoring/network/

Why Continuous data?

Time-dense continuous water quantity and quality data (in real-time) improves our understanding of hydrology and water quality that are used by management agencies to improve the quality of human life and that of the environment.

How leaders inspire action..
Start with Why…
Simon Sinek;
http://www.youtube.com/watch?v=qp0HIF3SfI4



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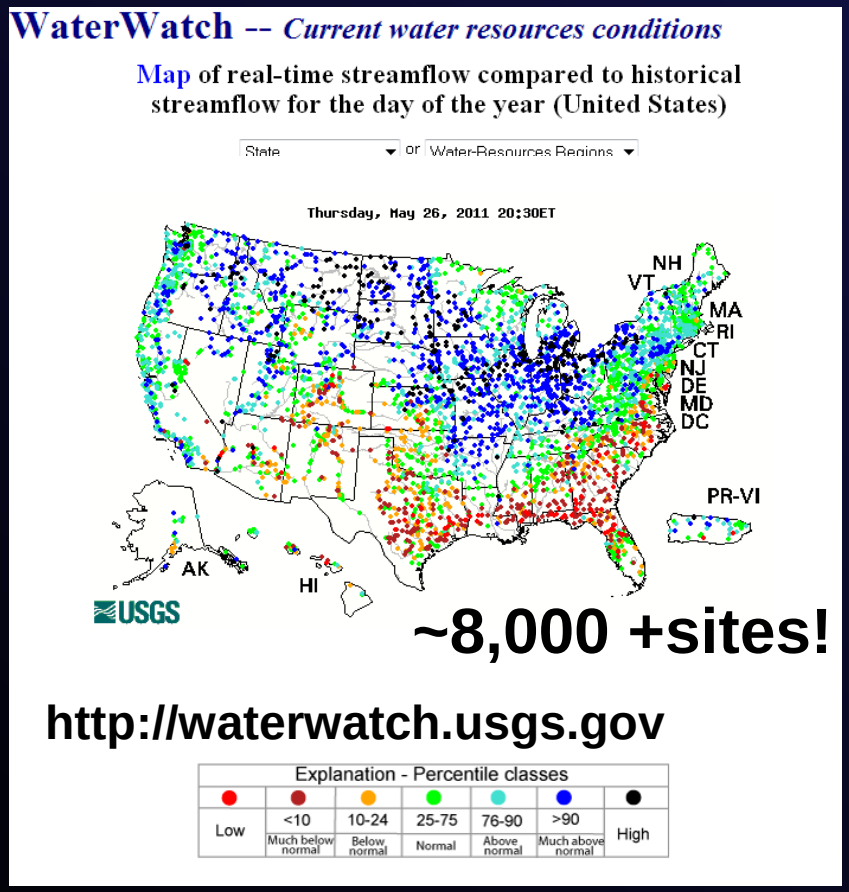
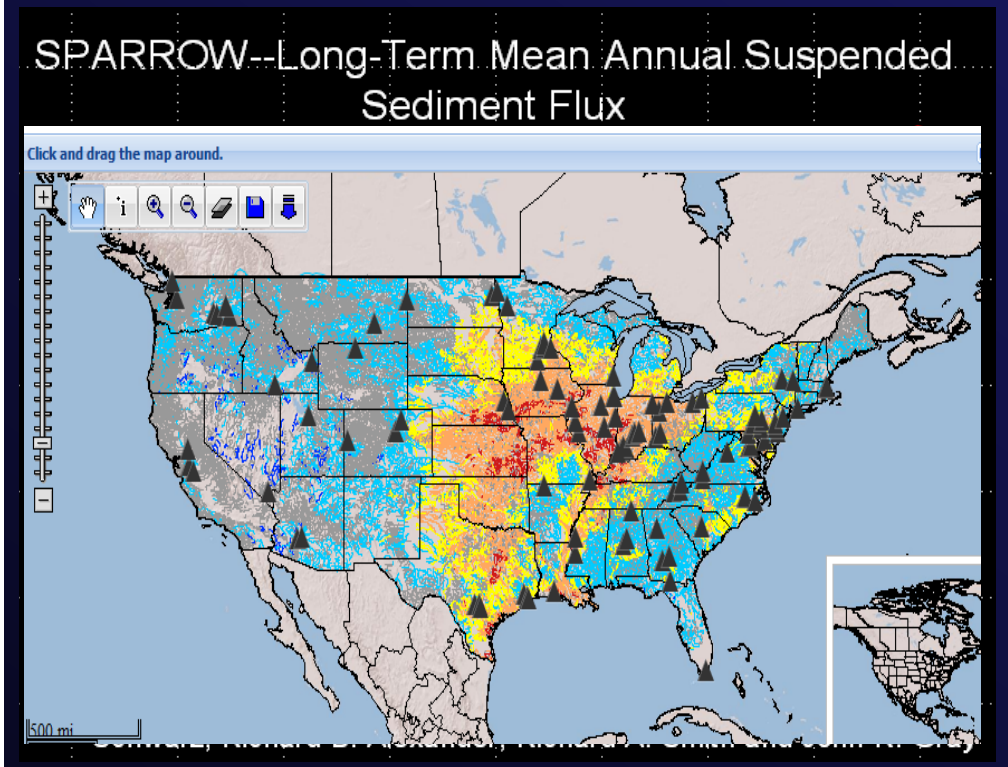
Vision: Water-quality information, anywhere (and) at anytime (Thank you, Bob Hirsch!)





WARP http://infotrek.er.usgs.gov/warp/

Our goal *is* to provide nationally consistent water-quality concentrations and loads with associated uncertainty on all time and spatial scales with a historical perspective … (and maybe even forecasting!)

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Spatially continuous data and information--Satellite information to interpolate between measurement points– all on a near real-time basis

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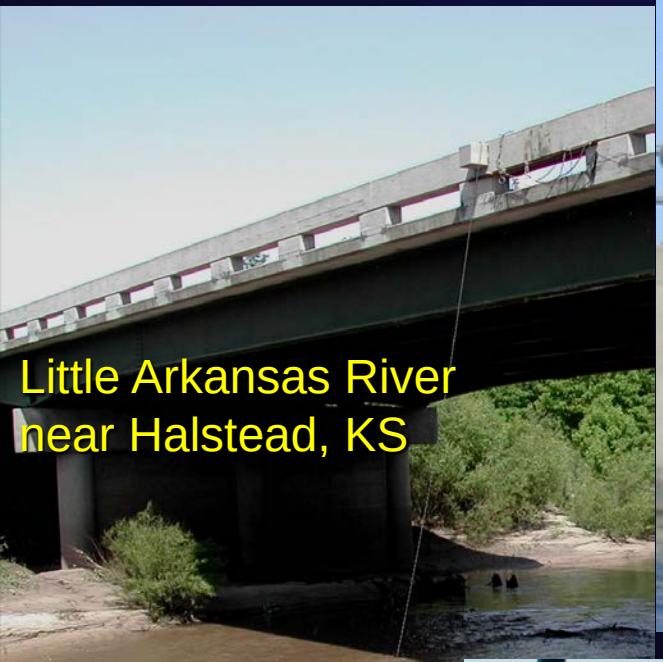
Examples of Surface Water Installations



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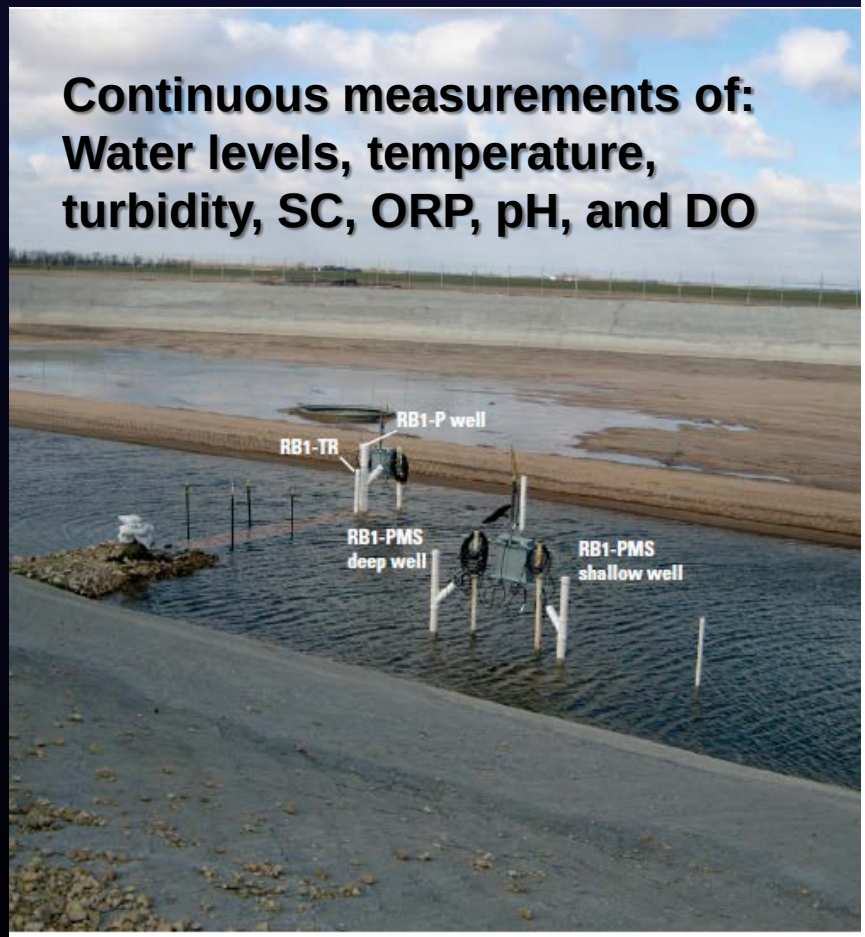
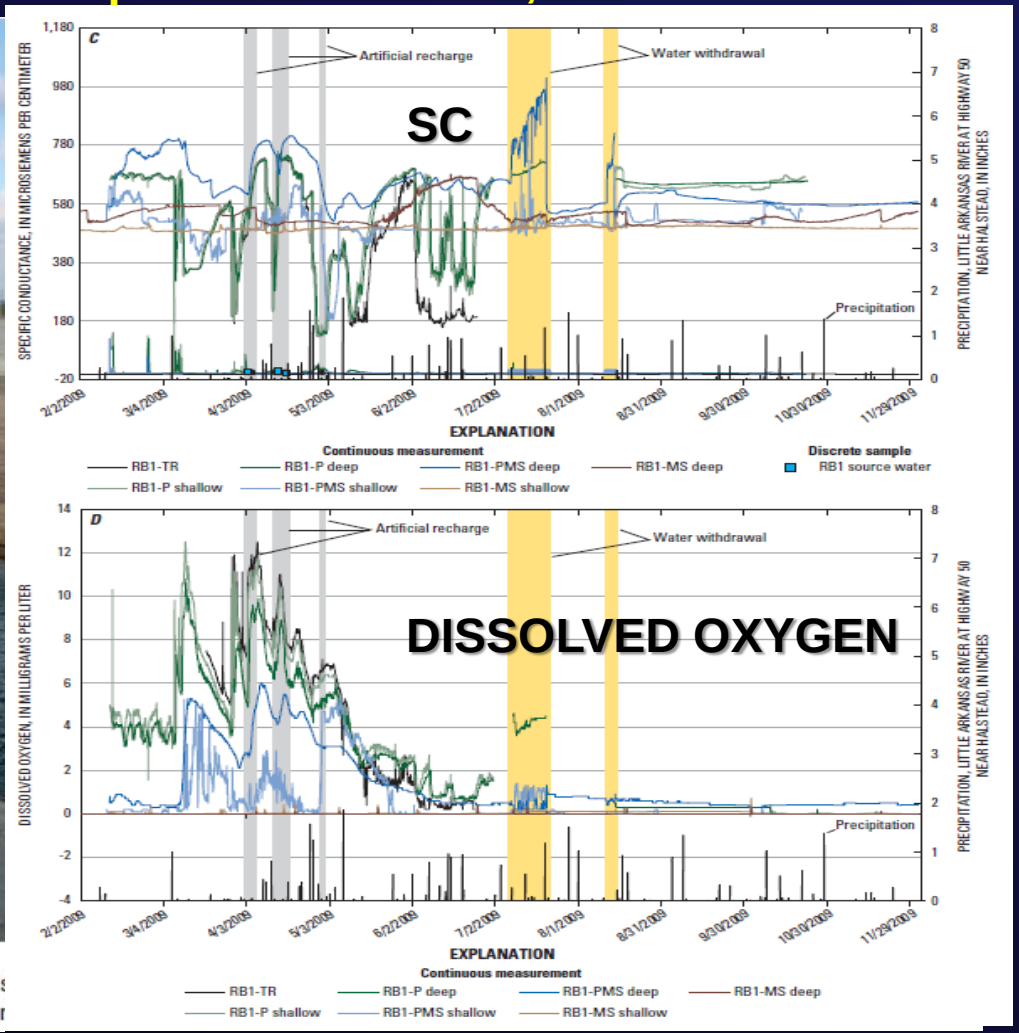
What About Groundwater?– Of Course!

Effects of experimental passive artificial recharge of treated surface water on water quality of the Equus Beds Aquifer near Wichita, KS 2009-2010

Continuous measurements of: Water levels, temperature, turbidity, SC, ORP, pH, and DO

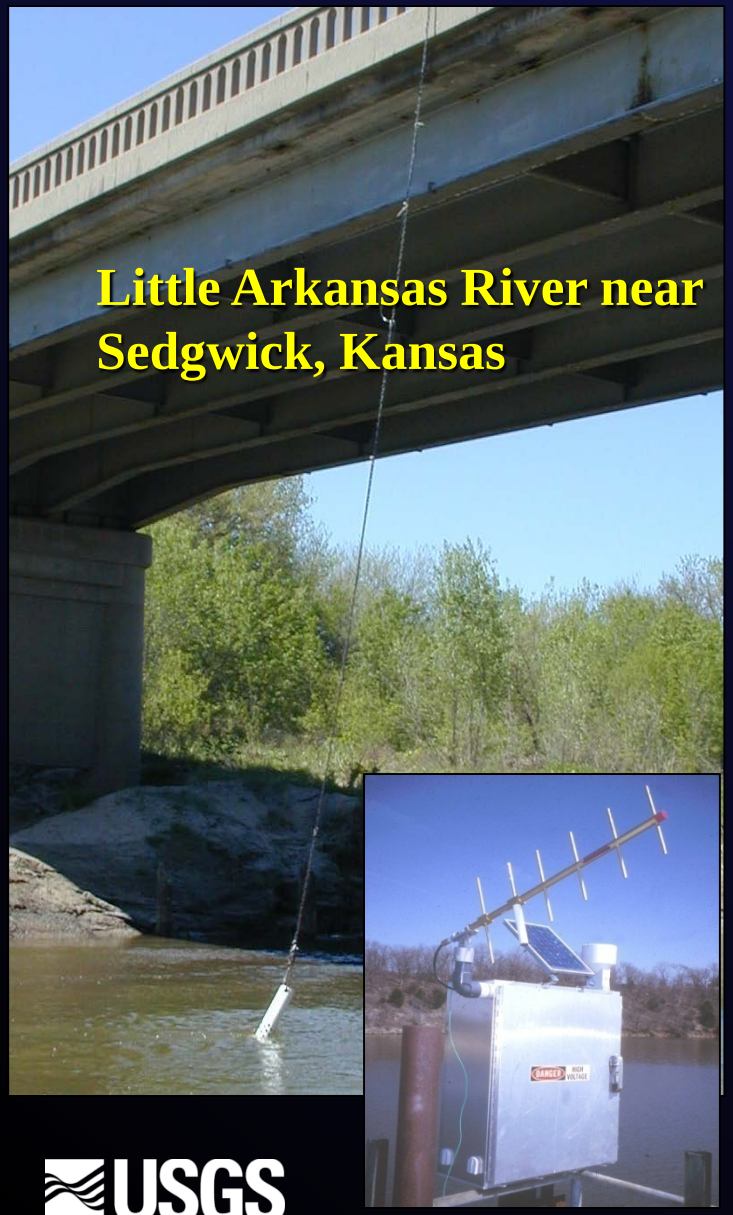


1-TR, RB1-P well, and RB1-PMS wells installed along the eastern edge of the original RB1 bas
te. Photographed from a location northeast of the trench, RB1-P well and RB1-PMS wells dur



USGS SIR 2011-5070; Garinger, King, and Ziegler

Three elements needed to execute Vision of "Water Quality-Anywhere and at Anytime"



1. Data and databases = national consistency
   - National *COLLABORATIVE* Network, centralized database, objective and consistent protocols and QA, automated records, improved sensors, data uncertainty, satellite data to interpolate between sites, furnished data.
2. Statistics and models = national consistency
   - Calibrated sensors, defined uncertainty simple is better, protocols, add spatial modeling, interpolation between sites, prediction of future quality….
3. Information products = national consistency
   - "Watches", nrtwq, data grapher, data access portals… information products…Tools available and used by everyone

Surrogates for sediment:
Rasmussen, Gray, Glysson, and Ziegler, 2009,
http://pubs.usgs.gov/tm/tm3c4/

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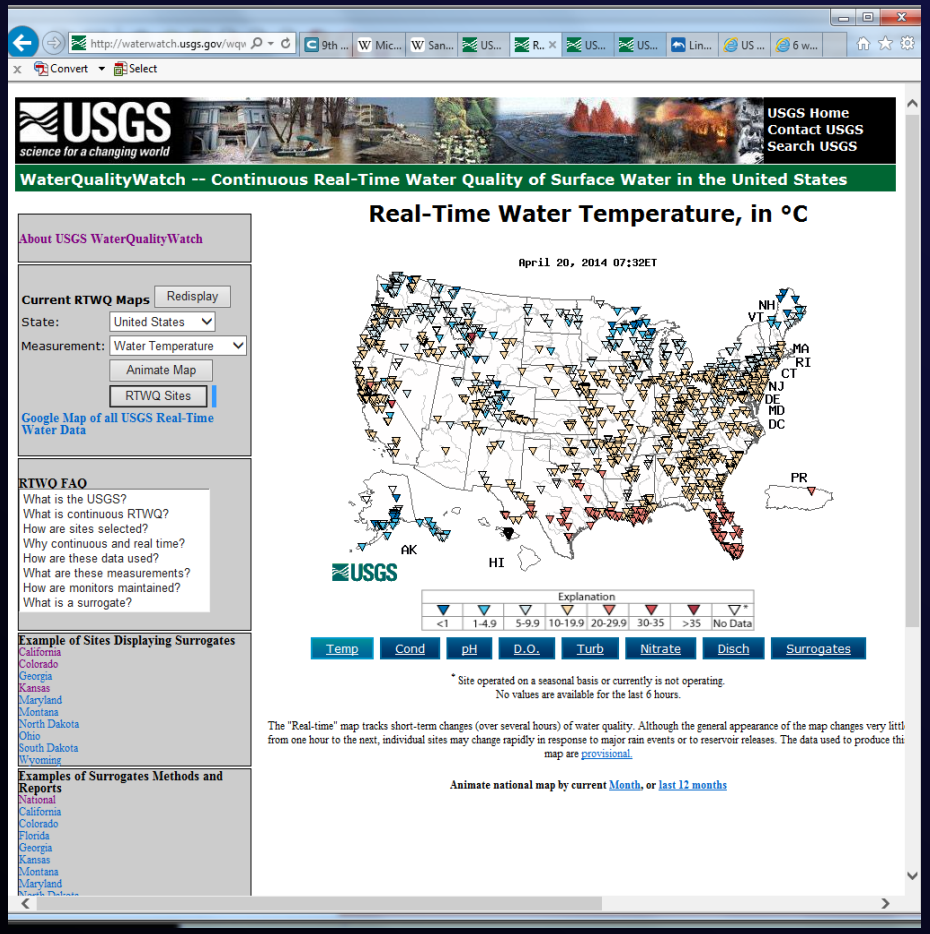
WaterQualityWatch
http://waterwatch.usgs.gov/wqwatch/



- The collaborative national **surface water quality** network is a synthesis of short and long-term sites.
- Substantial increase in the number of sites since 2001

Measurement	2001	April 2014
Discharge	7,245	7,994
Water Temperature	850	1,699
Specific Conductance	531	871
Dissolved Oxygen	251	470
Turbidity	90	372
Nitrate	2	57

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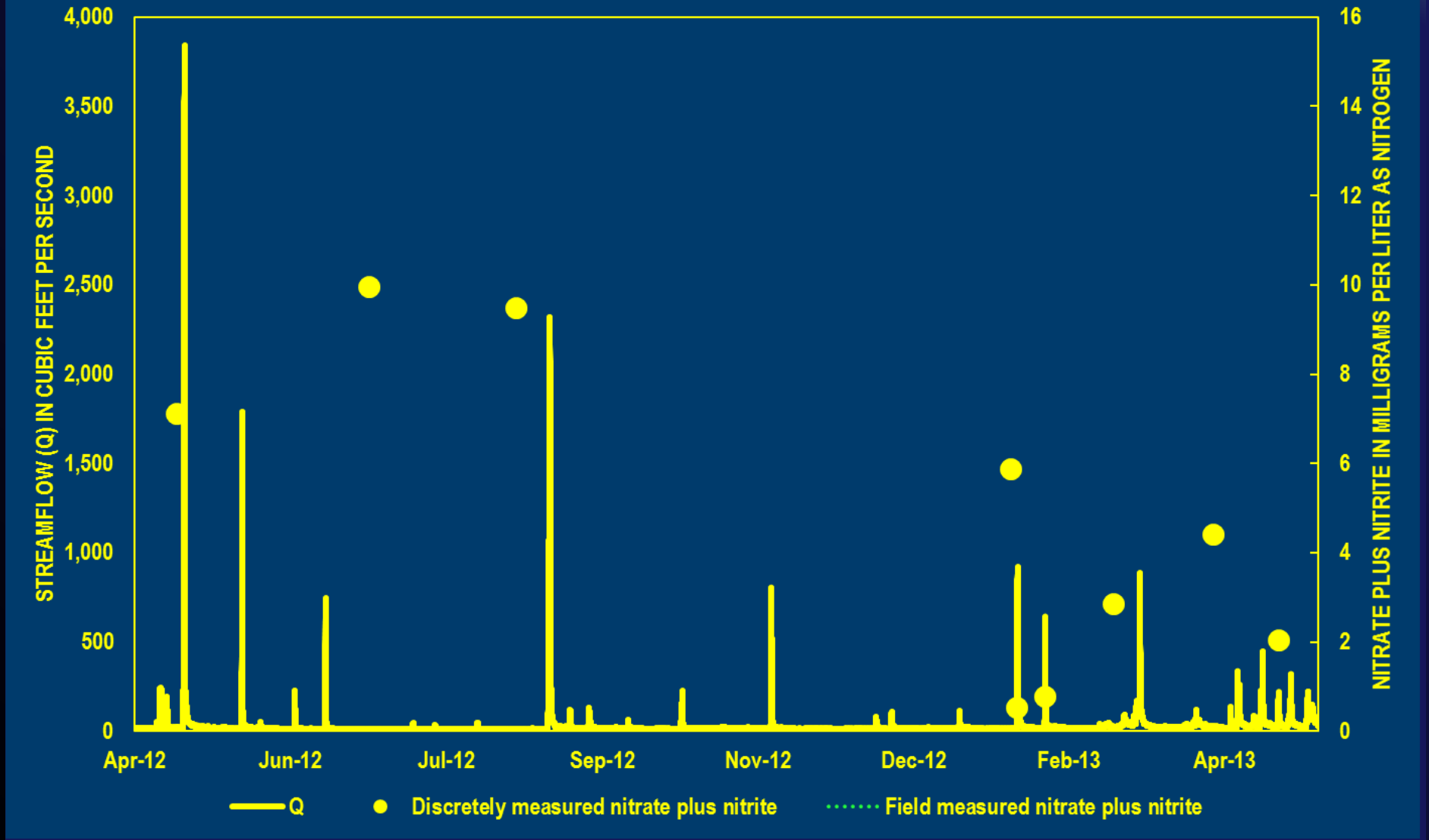
Nitratax Sensor Performance: Discrete & Field-Measured Data
Indian Creek at College, Overland Park, Kansas, April 2012–June 2013



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Graham and others, 2014, in review

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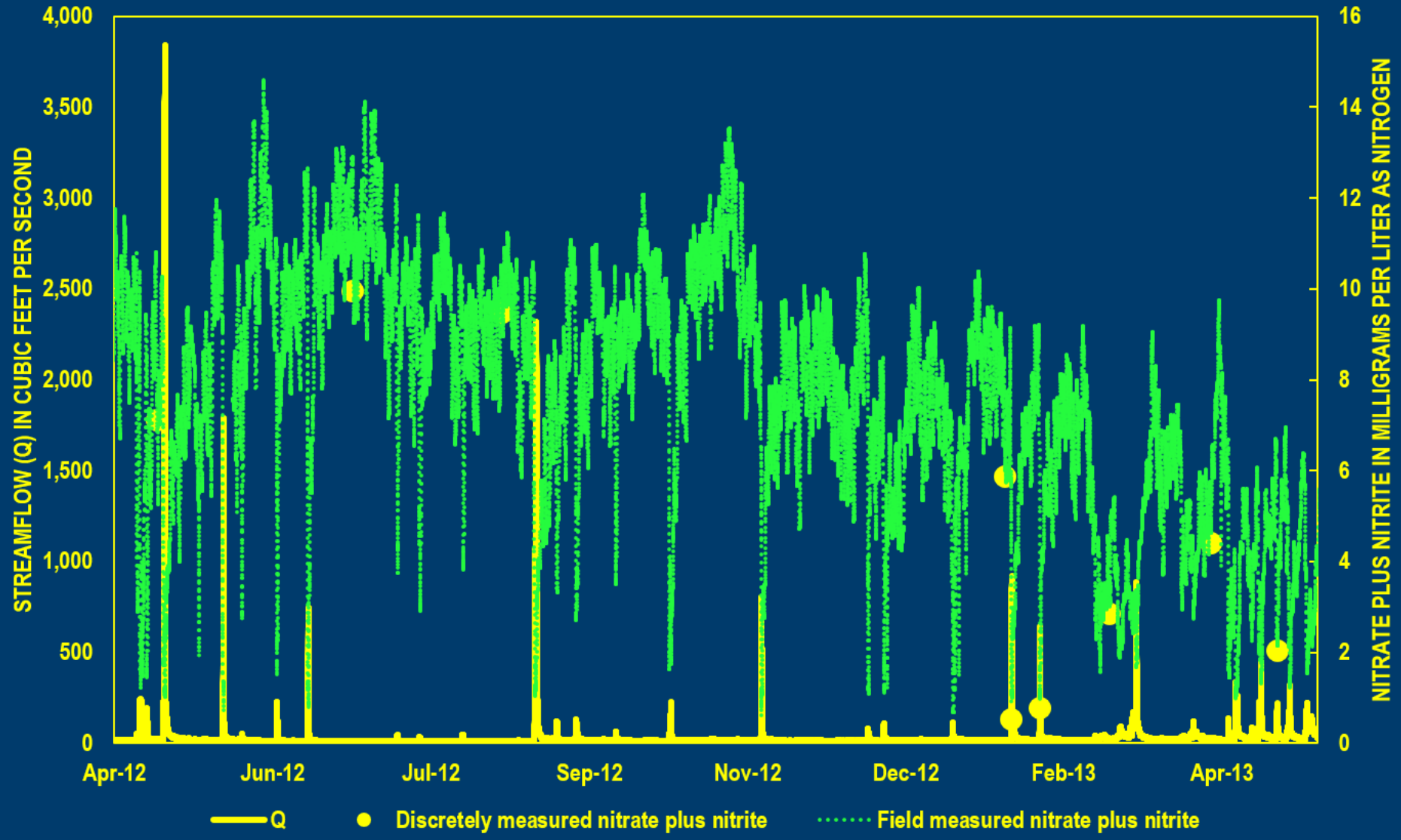

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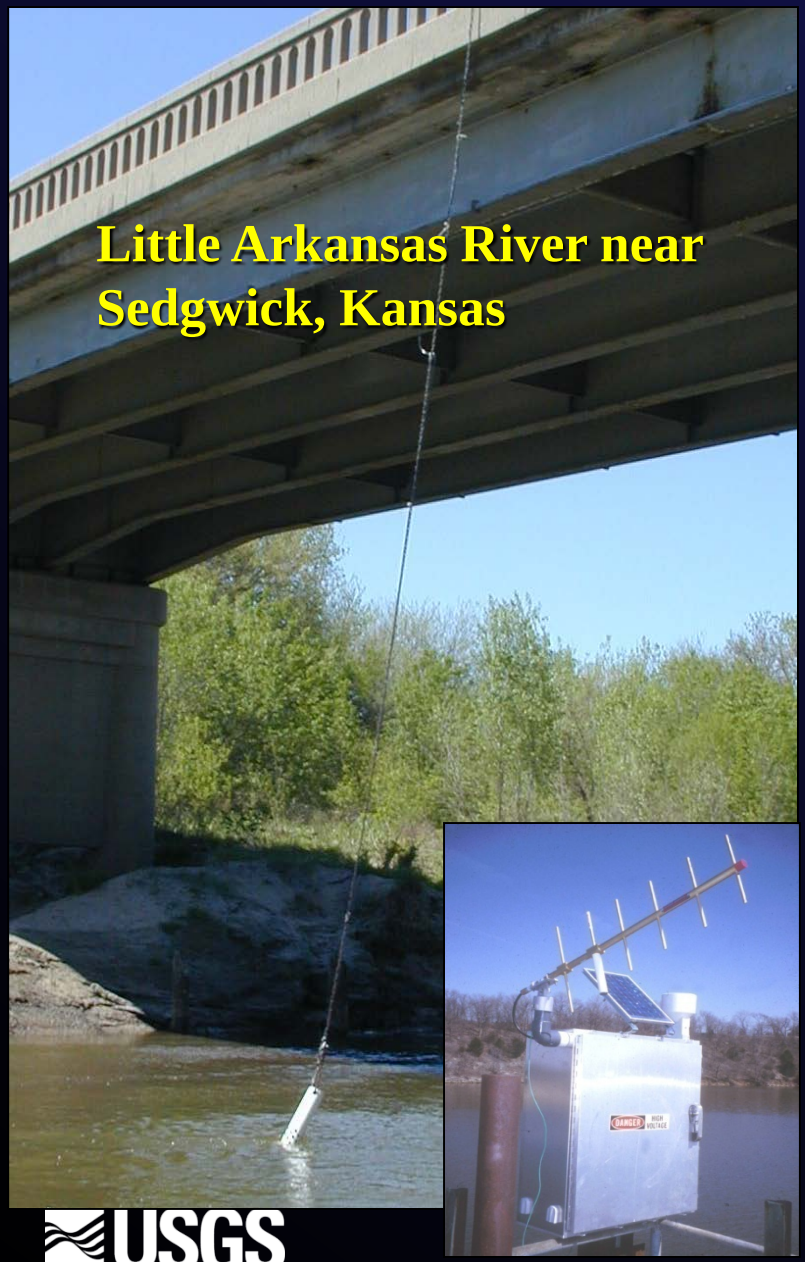
Graham and others, 2014, in review

Nitratax Sensor Performance: Concentration Summary Statistics
Indian Creek at College, Overland Park, Kansas, April 2012–June 2013

	Discretely Collected NO_3NO_2 in mg/L as Nitrogen	Continuously Measured NO_3NO_2 in mg/L as Nitrogen
n	11	42,890
% Complete record	--	98
Minimum	0.5	0.5
Maximum	10	15
Mean	4.1	7.5
Median	2.8	7.7
Standard deviation	3.5	2.7
Standard Error	1.0	0.01

USGS **How much does it cost to be right? Or wrong?**

USGS Continuous Water Quality "Surrogate" Approach:



- Add water-quality monitors at streamgages and transmit data "real" time
- Collect water samples over the range of hydrologic and chemical conditions
- Develop site-specific regression models using samples and sensor values
- Compute concentrations and loads
- Publish regression models
- Display computations, uncertainty, and probability on the Web
- Continued sampling to verify models

Christensen, Jian, Ziegler, 2000……

Rasmussen, Gray, Glysson, and Ziegler, 2009, http://pubs.usgs.gov/tm/tm3c4/

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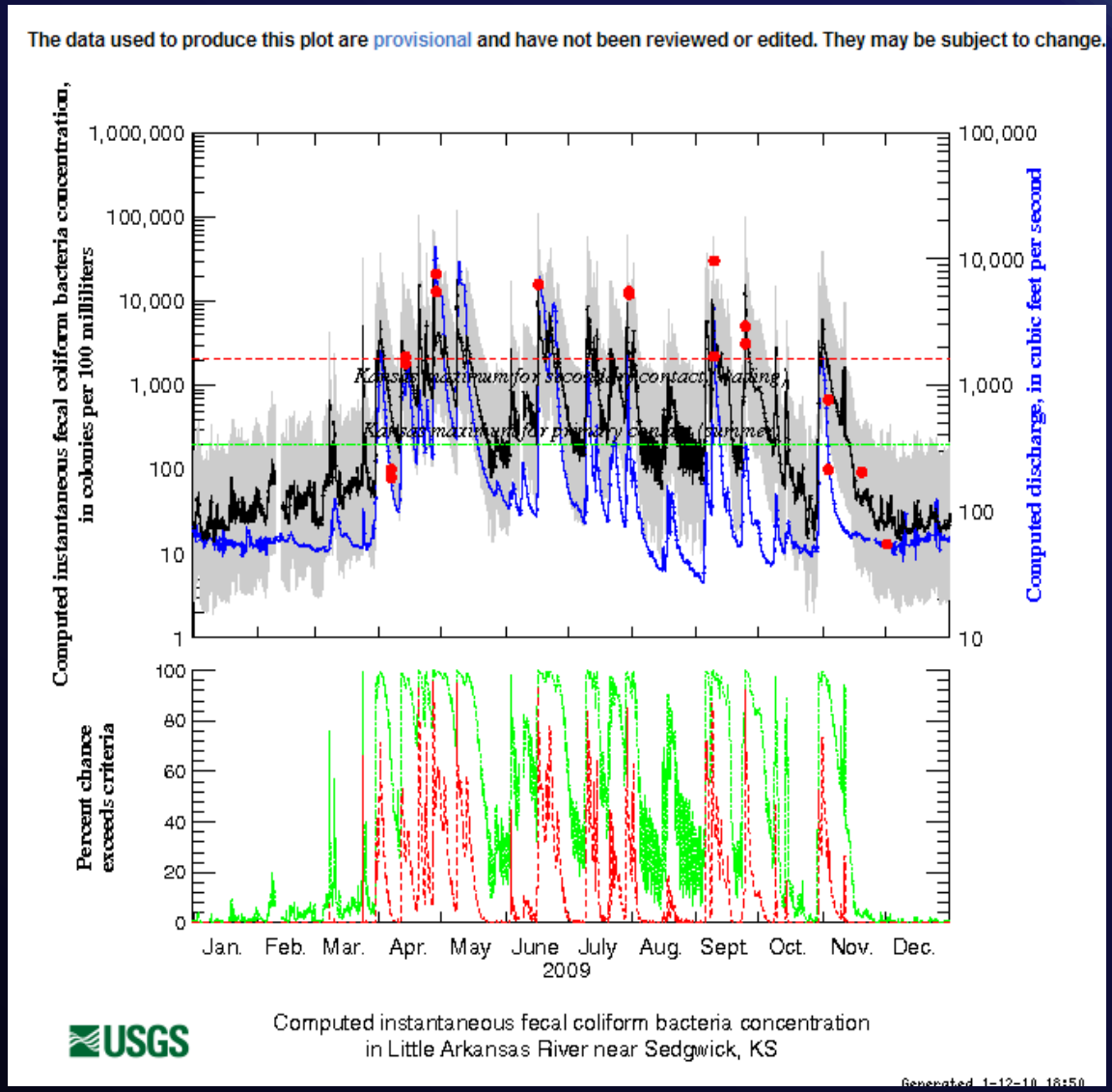
Bacteria frequently exceed water-quality standards

Real-time computed concentrations of bacteria, uncertainty, and probability of exceeding WQ criteria

(look at the sample data….)

Aren't continuous surrogates better?

	Comp.	Meas.
n =	8,647 vs.	15
Mean =	780 vs.	5,700
Median =	200 vs.	1,800



Concentration more important than load for health

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http://nrtwq.usgs.gov/explore/plot?site_no=07144100&pcode=31625&period=2009_all&timestep=uv

Ohio Nowcast– Donna Francy--Implementing and monitoring the use of predictive models for beach closure and advisory decisions– Great Lakes collaboration between USGS, EPA, and many state and local agencies
http://www2.epa.gov/exposure-assessment-models/virtual-beach-vb

http://pubs.usgs.gov/sir/2013/5166

http://oh.water.usgs.gov/beach_predictive_models.htm

Output from the model is the probability that *E. coli* will be >235 CFU/100 mL

Threshold probabilities = 20 to 40%

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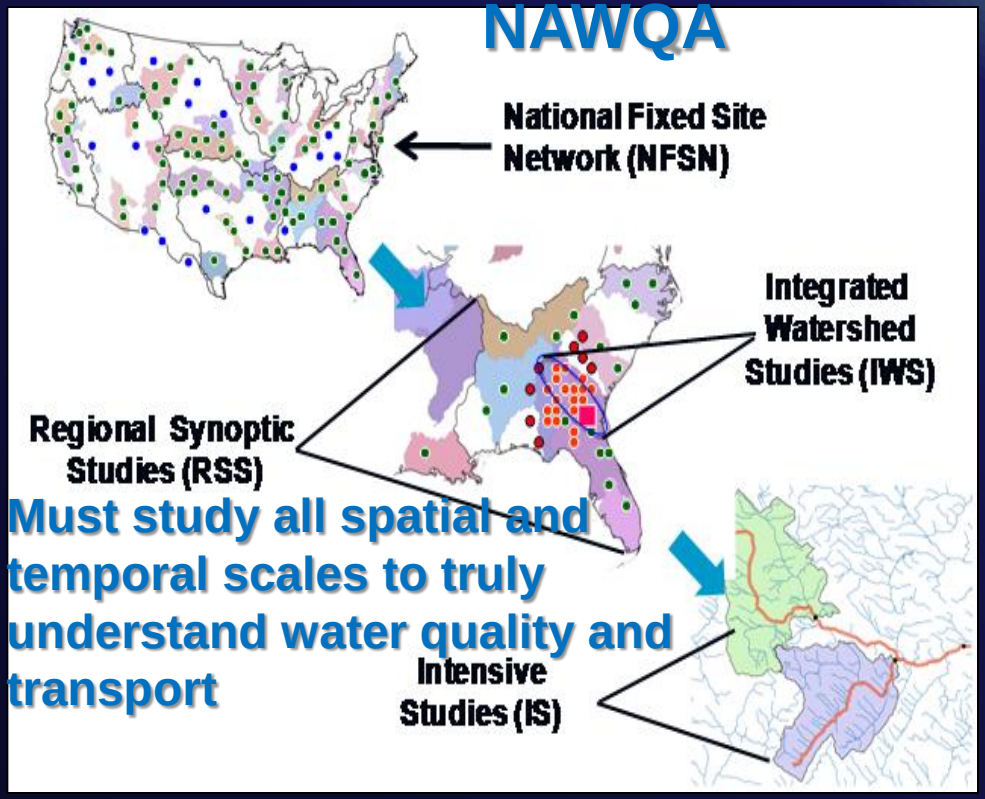
What do we gain from a National Continuous Water-Quality Network?

- Information to assess, describe, and understand water quality for all uses—drinking water, recreation, environment
- Infrastructure that measures water quality in very small to large river and estuaries-MS
- Use of today's technology rather than approaches developed 50 (or more) years ago that are only sufficient for annual loads—at best



- Evaluation of the effectiveness in many and large and expensive programs (AG crop programs, EPA 319, …) designed or thought to improve water quality (but are these measurements made on the time scale that answers these questions?)
  - It takes decades to document measureable change– need the smallest uncertainty possible

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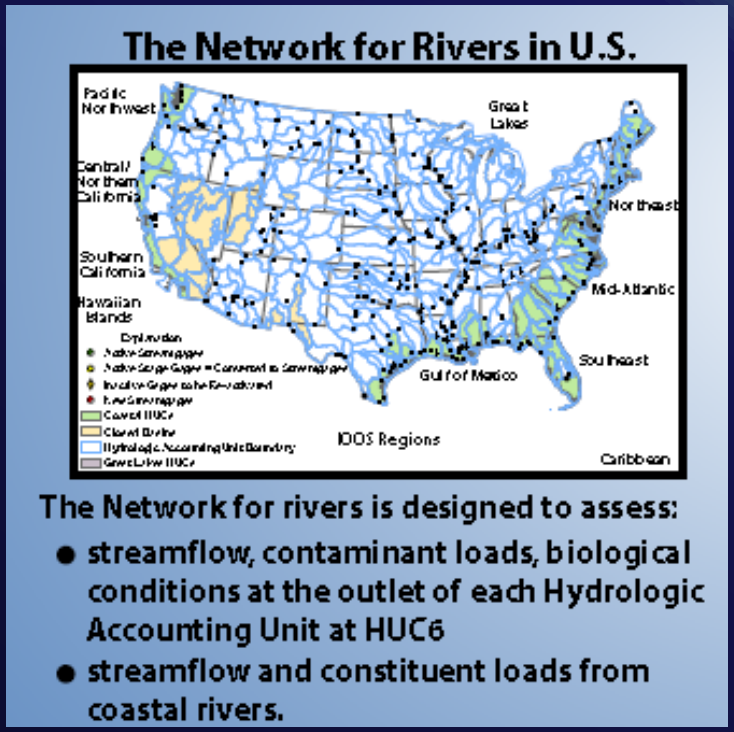
What needs to be measured? Where?

Environmental Issues to be Assessed:

- Nutrient enrichment
- Oxygen depletion
- Sedimentation
- Toxic contamination
- Habitat degradation

Physical , Chemical, & Biological characteristics

- Flow, magnitude and direction;
- Sediments, physical habitat
- Chemical constituents
  - Inorganics - major ions, nutrients, metals, mercury
  - Organics - carbon, pesticides, PCBs, PAHs, emerging contaminants
- Biological
  - Chlorophyll and algae
  - Bacteria and viruses
  - Macroinvertebrates and fish



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http://acwi.gov/monitoring/network/network_features.html

What can (should) be measured ?

- Streamflow (and in Adjacent groundwater)--Continuous monitoring in surface water and adjacent groundwater
- Mature technologies and approaches:
  - Meteorologic parms– wind speed and direction, air temperature, solar radiation, barometric pressure, precipitation,
  - Streamflow,
  - Stream stage/elevation of water surface
  - Velocity,
  - Solar radiation in water,
  - Water temperature,
  - specific conductance,
  - Salinity
  - Sodium adsorption ratio
  - pH,
  - dissolved oxygen, and percent saturation
  - Dissolved gasses
  - turbidity,
  - Nitrate,
  - FDOM/CDOM– organics transport, mercury,….
  - Chlorophyll,
  - phycocyanins
  - surrogates for sediment concentration and load (acoustics and turbidity and sediment ratings)
  - Surrogates for dissolved and total nutrients
  - Surrogates for carbon total and dissolved
  - Surrogates for metals? Arsenic others?
  - Surrogates for biological productivity computations,
  - Surrogates for indicator bacteria,……AND……AND……

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National *Collaborative* Network! WQ anywhere and at anytime! We need to execute….

- What are the top three questions/objectives that we need a nationally consistent water-quality network to answer? EASY!

  sediment/nutrient flux/sources and ecosystem response– C, DO, chloro..

- What are the spatial and measurement gaps in current monitoring networks to answer those questions/objectives?

  Inventory, then fund/fill those gaps

- What water quality and ecological parameters should be measured?

  Those we are doing now, but with more emphasis on time density to truly assess and understand

- What are the impediments to accepting continuous water quality and surrogates in regulatory applications? (and how can they be overcome…. Quickly!)

  Data protocols, consistency, uncertainty, ….

Each of us individually can work on removing these impediments.

USGS **If we can think of it, we can do it !**

Continuous Water Quality Why? Haiku

Water Quality
Measure Continuously
Help Environment!

Continuous Water Quality Pledge….

Real-time Water Quality REALLY just DO IT!

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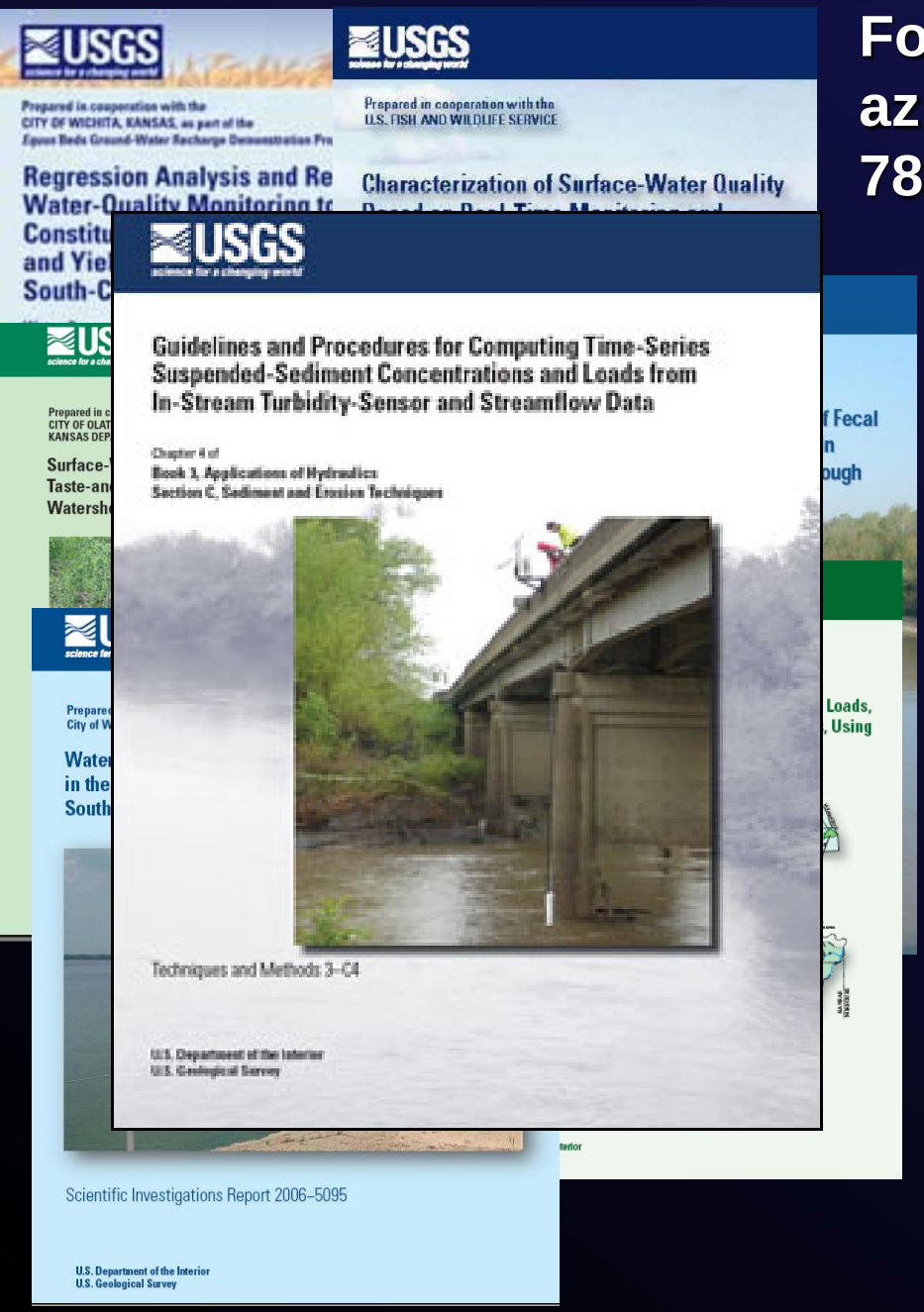
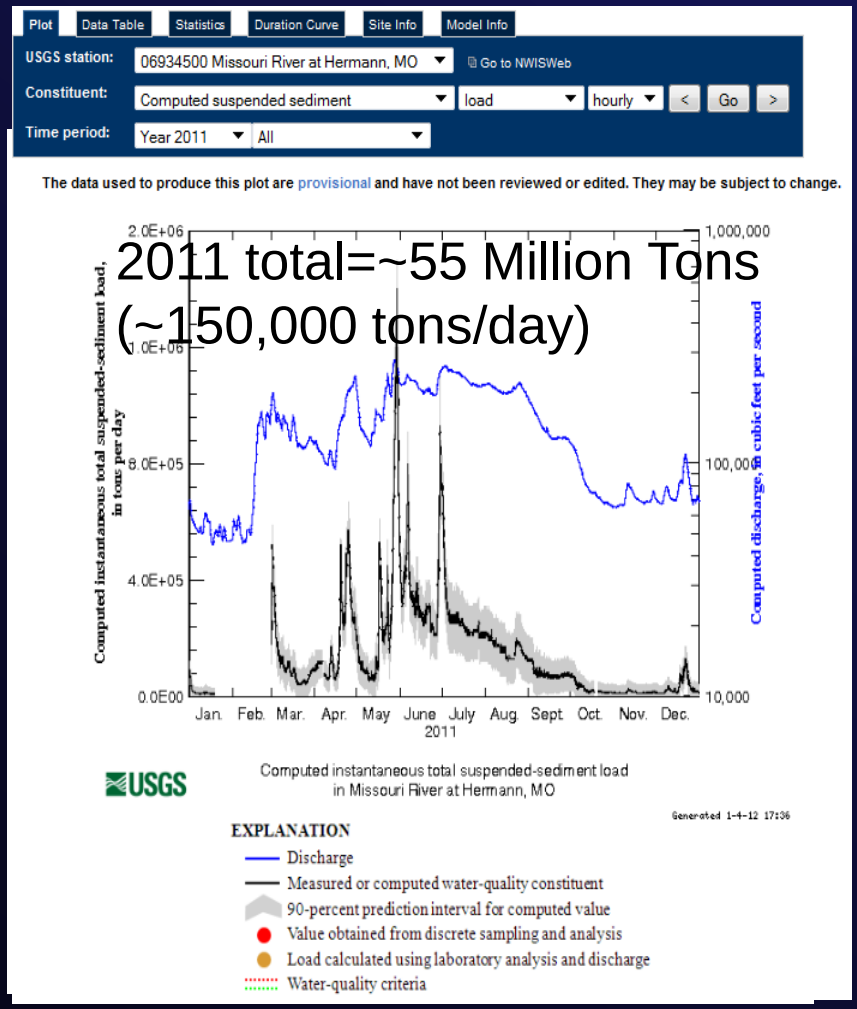
USGS Real-Time Web Page and Reports

For more information: Andy Ziegler
aziegler@usgs.gov
785-832-3539





http:// nrtwq.usgs.gov/