Oklahoma's TMDL Program

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Mountain Fork River

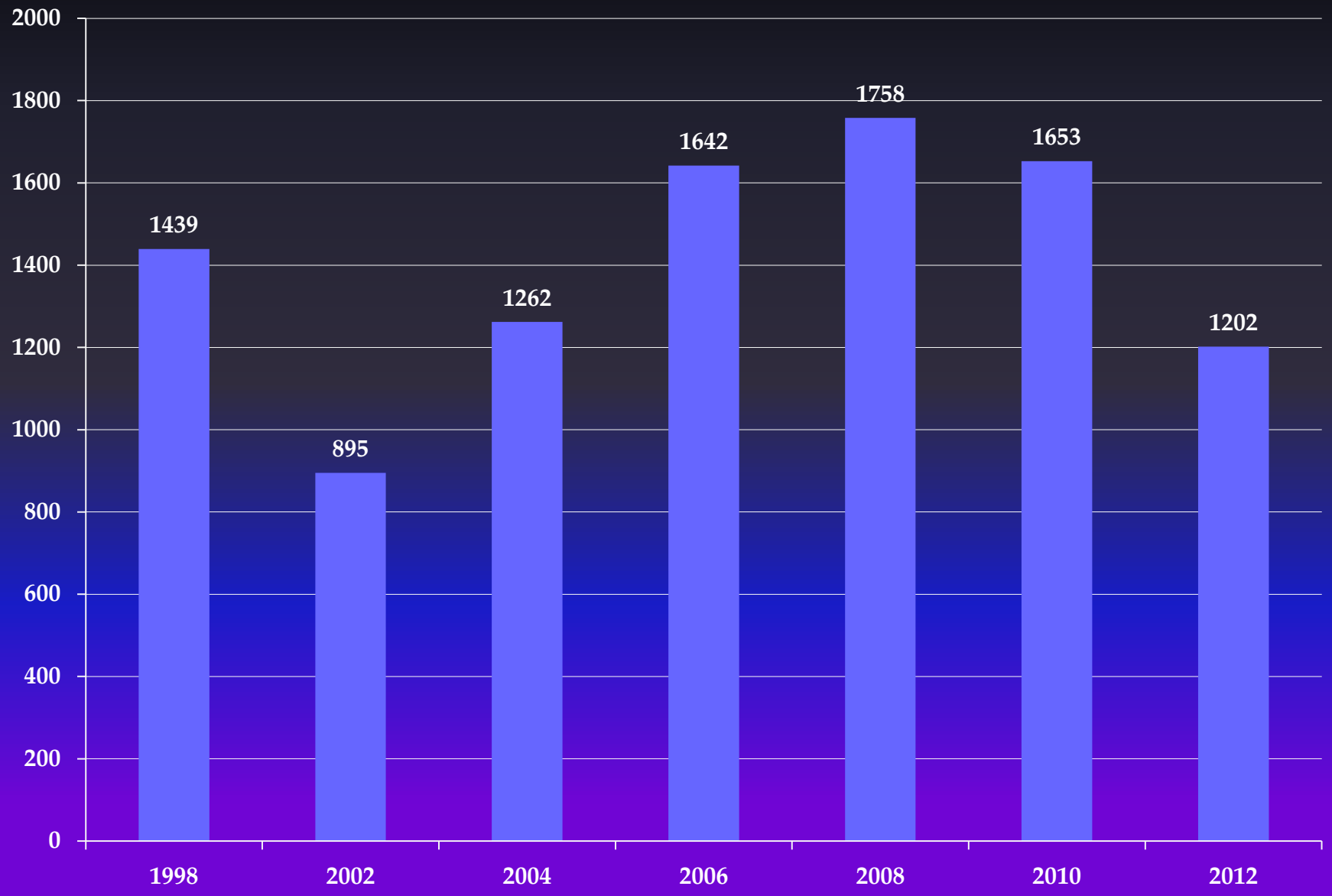
TMDL Litigation

- About 45 legal actions in 34 States, as of August, 1999
- OK suit filed in 1998

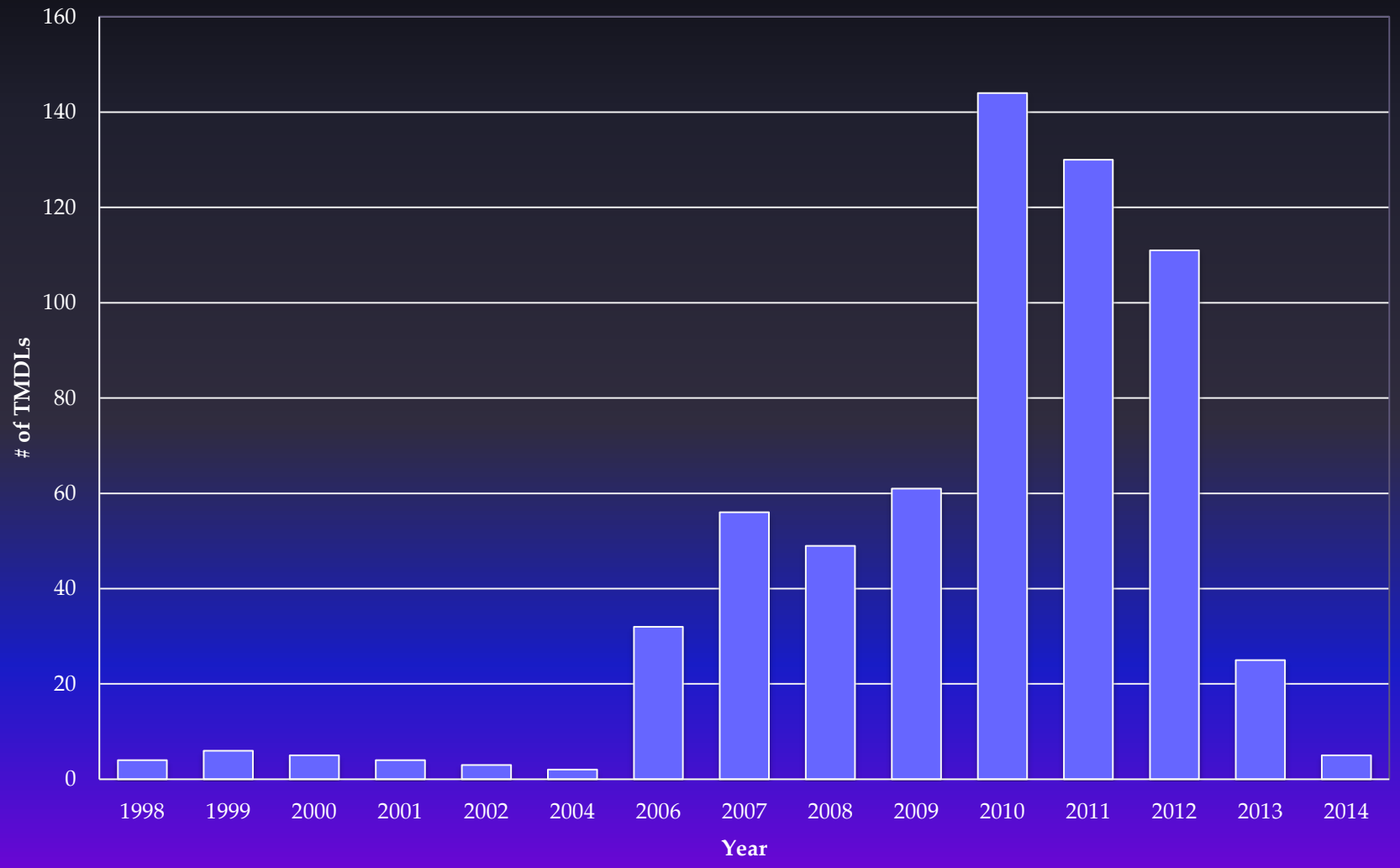
TMDL Litigation

- EPA placed under court order/consent decree to ensure TMDLs established in many States
- 3 cases dismissed since 1993
- But in Oklahoma

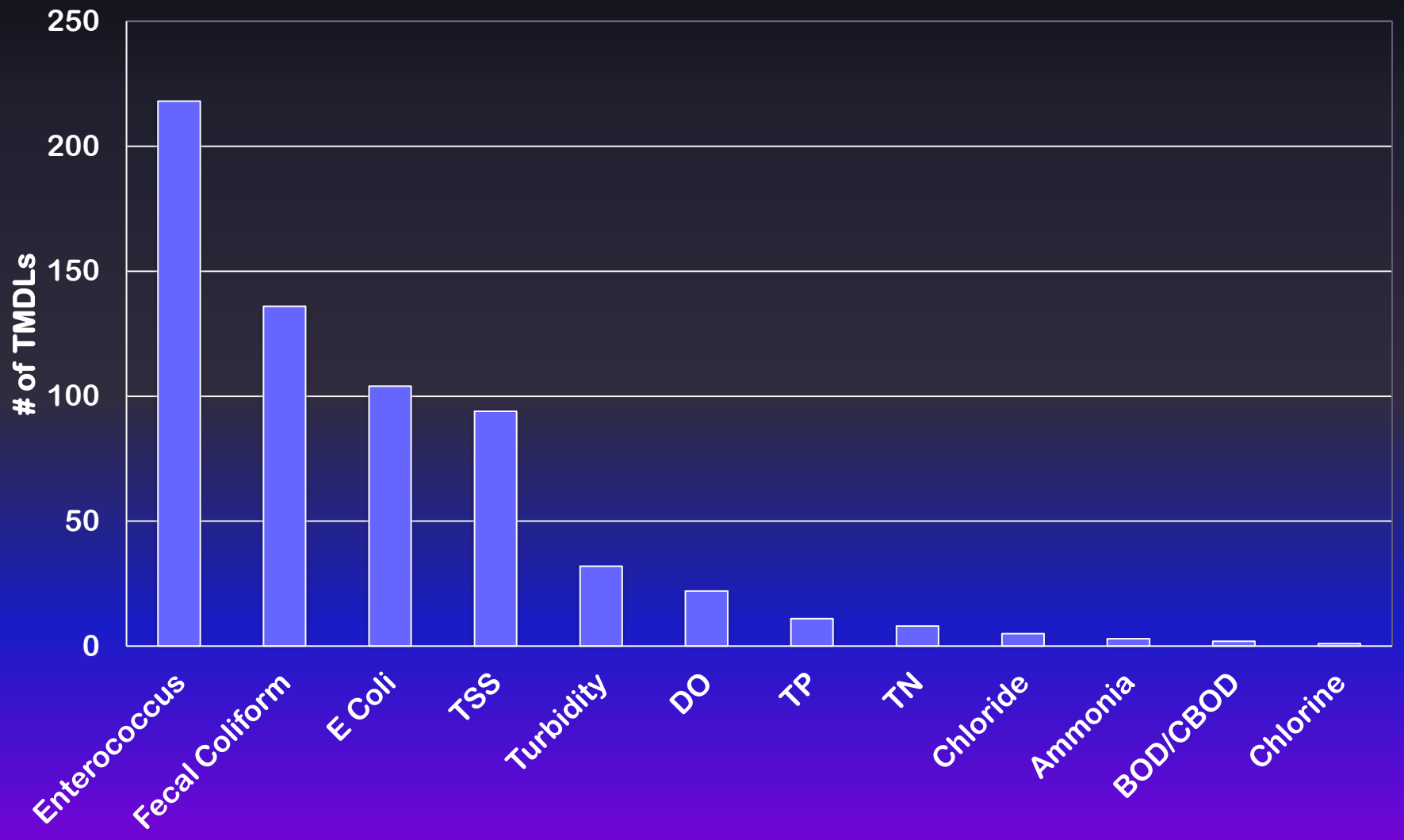
TMDLs Needed



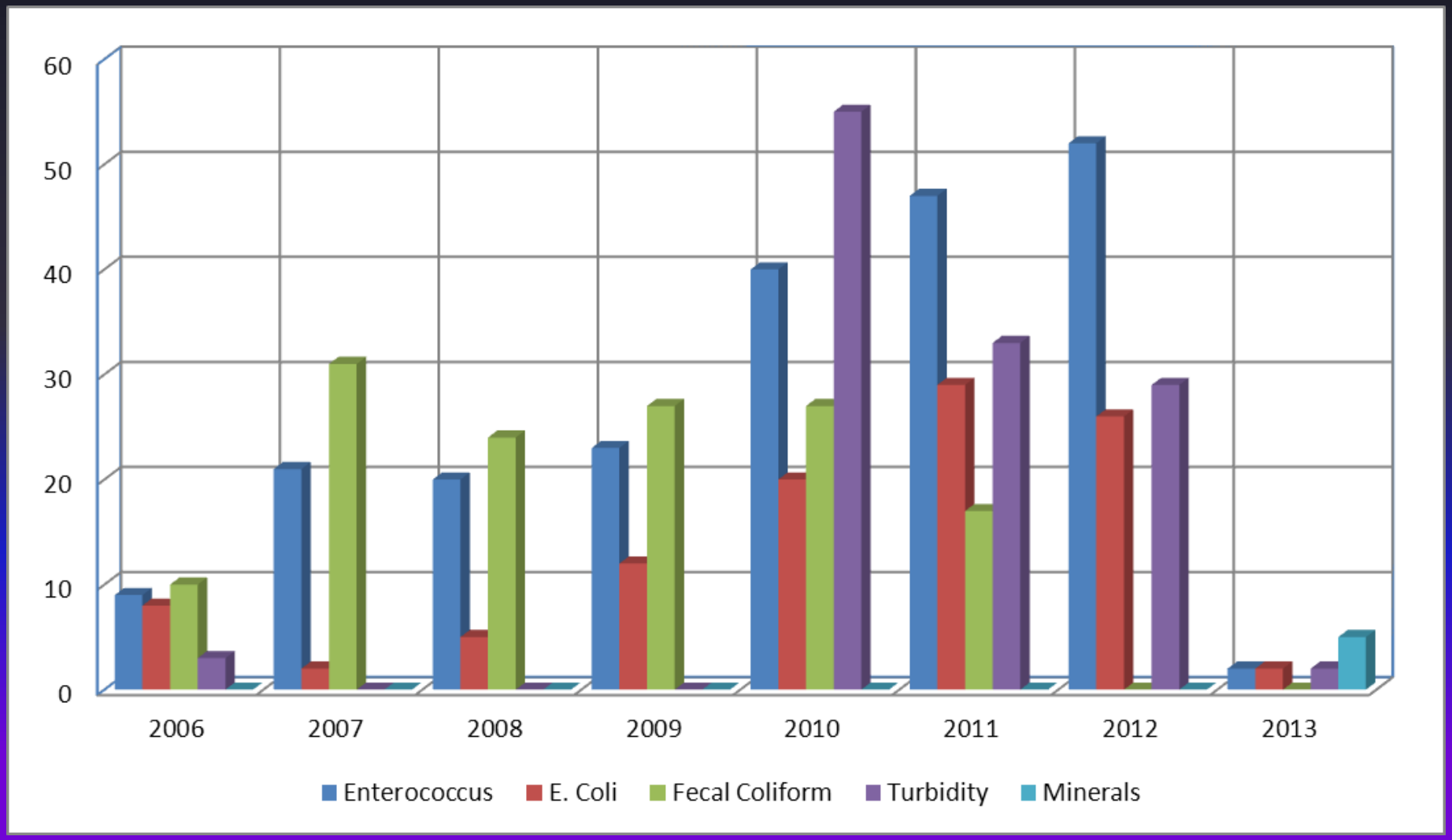
TMDLs Completed



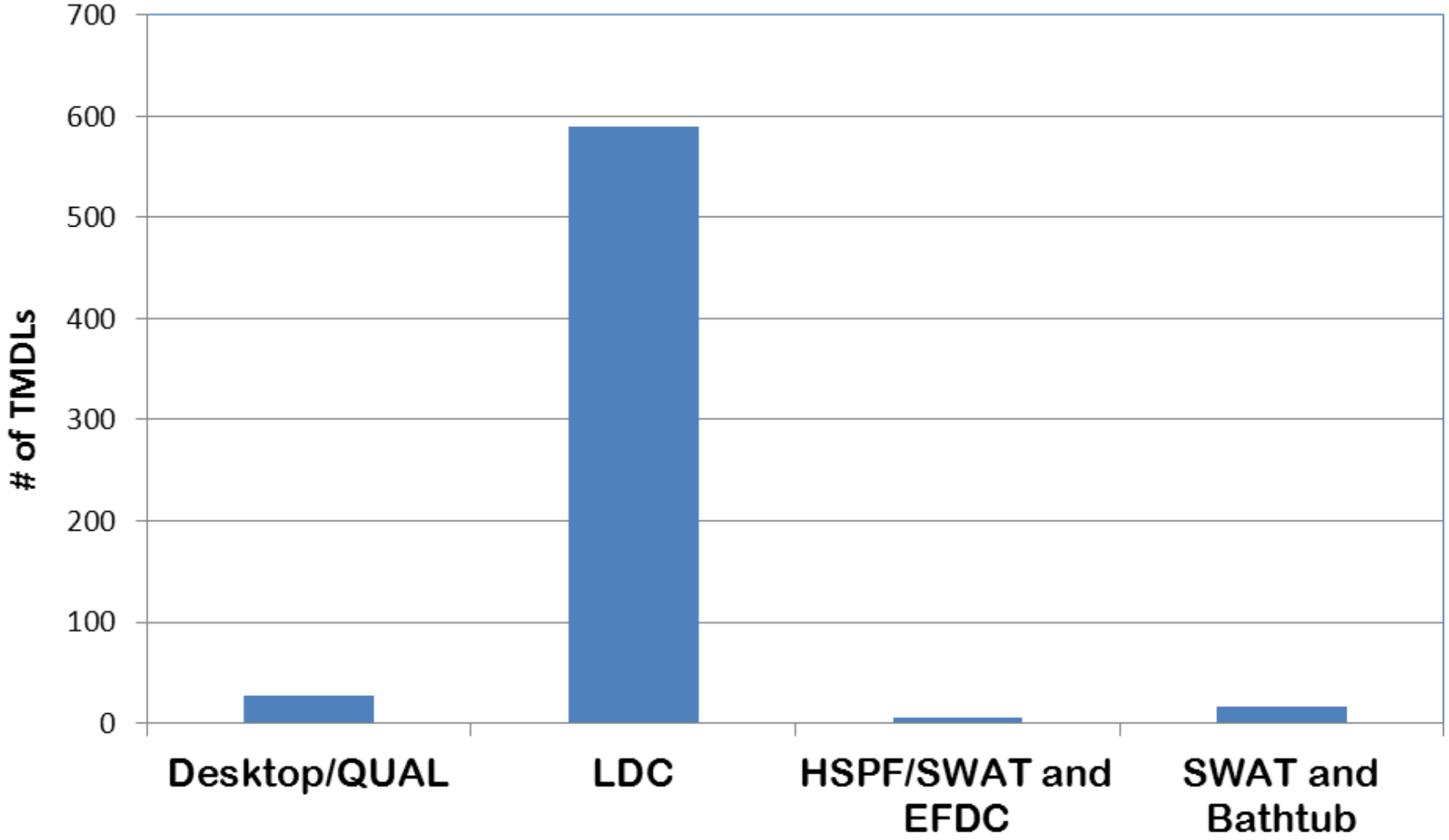
TMDLs - Pollutant Addressed



TMDLs – Pollutant Addressed Over Time



TMDLs – Model Utilized



Problem

Turbidity Impairments

SOLUTION

DURATION CURVES !

- Quick and “Easy”
- Amenable To Standardization
- Considers All Flows
- Graphical Presentation

TMDLs Using Duration Curves

1. Develop Flow Duration Curves
2. Calculate Load Duration Curves And Current Loading
3. Account For Margin Of Safety
4. Calculate WLA For Wastewater Discharges
5. Calculate LA And WLA For Stormwater Discharges
6. Estimate Overall Percent Reduction Goal

Turbidity TMDLs

- **Load Duration Curve Based**
  - **Flow exceedance frequency - % of flow observations exceed a given flow**
  - **Water quality standard - 50 NTU <u>base-flow</u>**
- **Turbidity translated into TSS using regression (line of organic correlation – LOC)**

Line of Organic Correlation

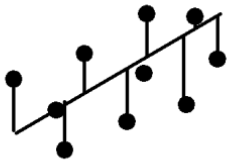
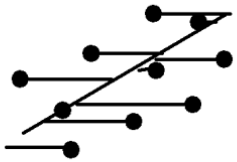
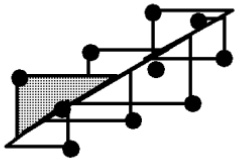
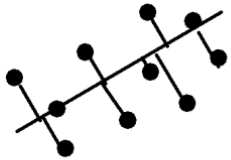
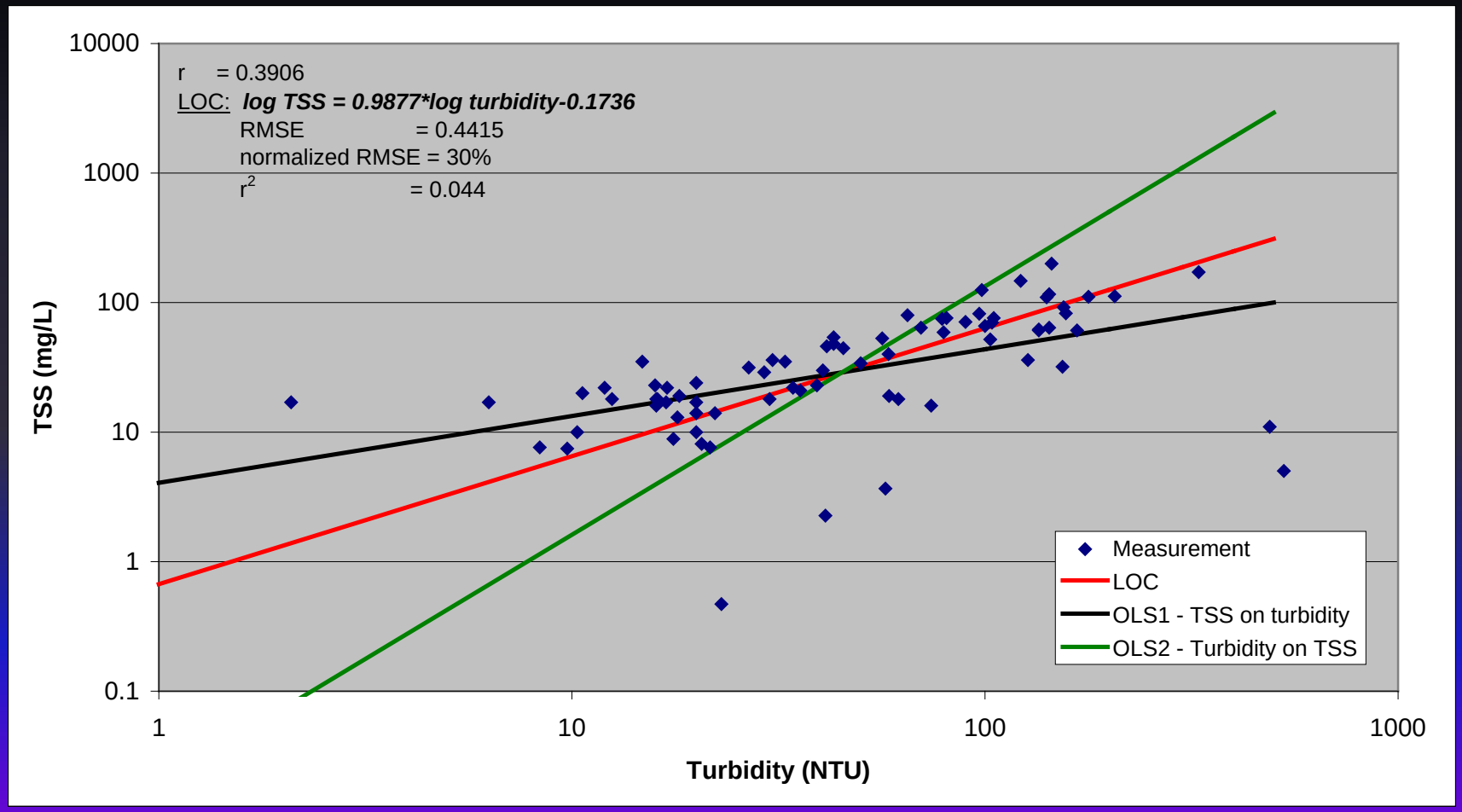
Method	Minimizes:	Slope	Scale Change	Rotation
OLS Y on X		$b_1 = r\frac{s_y}{s_x}$	invariant	changes
OLS X on Y		$b_1' = \frac{1}{r}\frac{s_y}{s_x}$	invariant	changes
LOC		$b_1'' = \text{sign}[r]\frac{s_y}{s_x}$	invariant	changes
LNS		$b = -A + \frac{\sqrt{r^2 + A^2}}{r}$ where $A = 0.5\left(\frac{s_x}{s_y} - \frac{s_y}{s_x}\right)$	changes	invariant

Figure 10.8 Characteristics of four parametric methods to fit straight lines to data

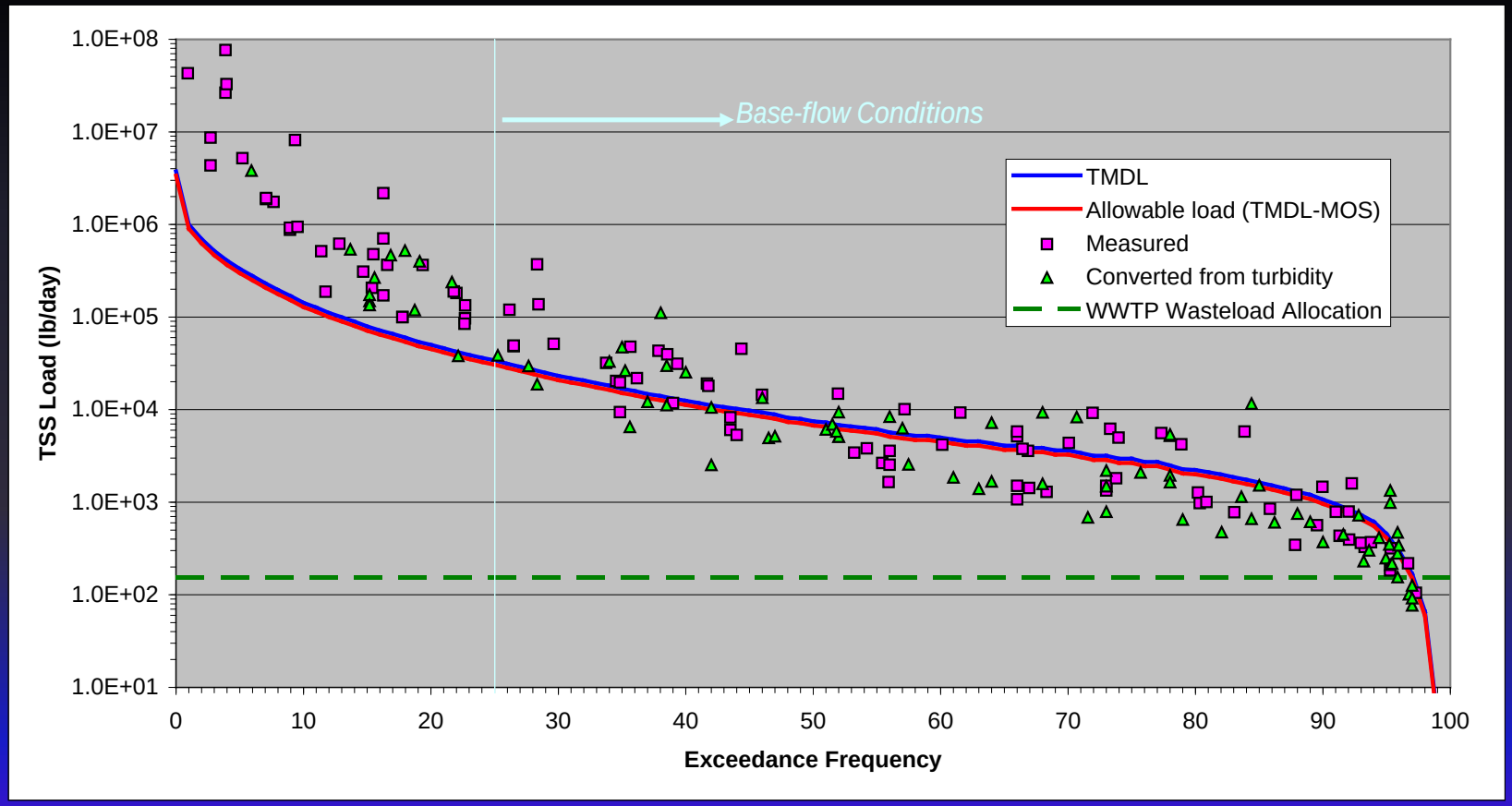
D.R. Helsel and R.M. Hirsch, 2002, *Statistical Methods in Water Resources*, USGS

Line of Organic Correlation



Regression Lines, Black Bear Creek, all base-flow data points

Load Duration Curve



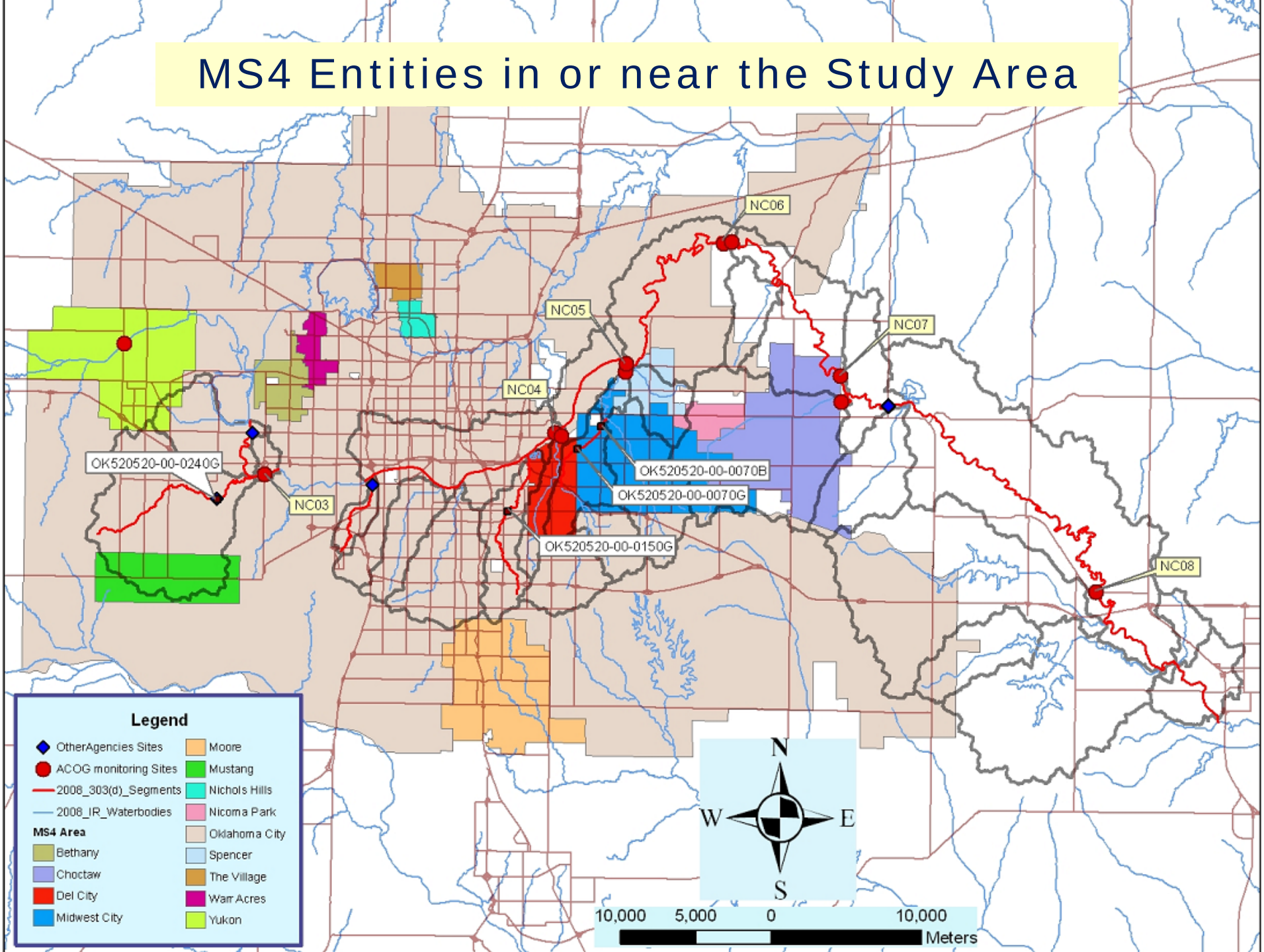
Black Bear Creek

The Oklahoma River Bacteria TMDL

Devon Energy
Devon Explorer

OKLAHOMA RIVER
EXPERIENCE

MS4 Entities in or near the Study Area



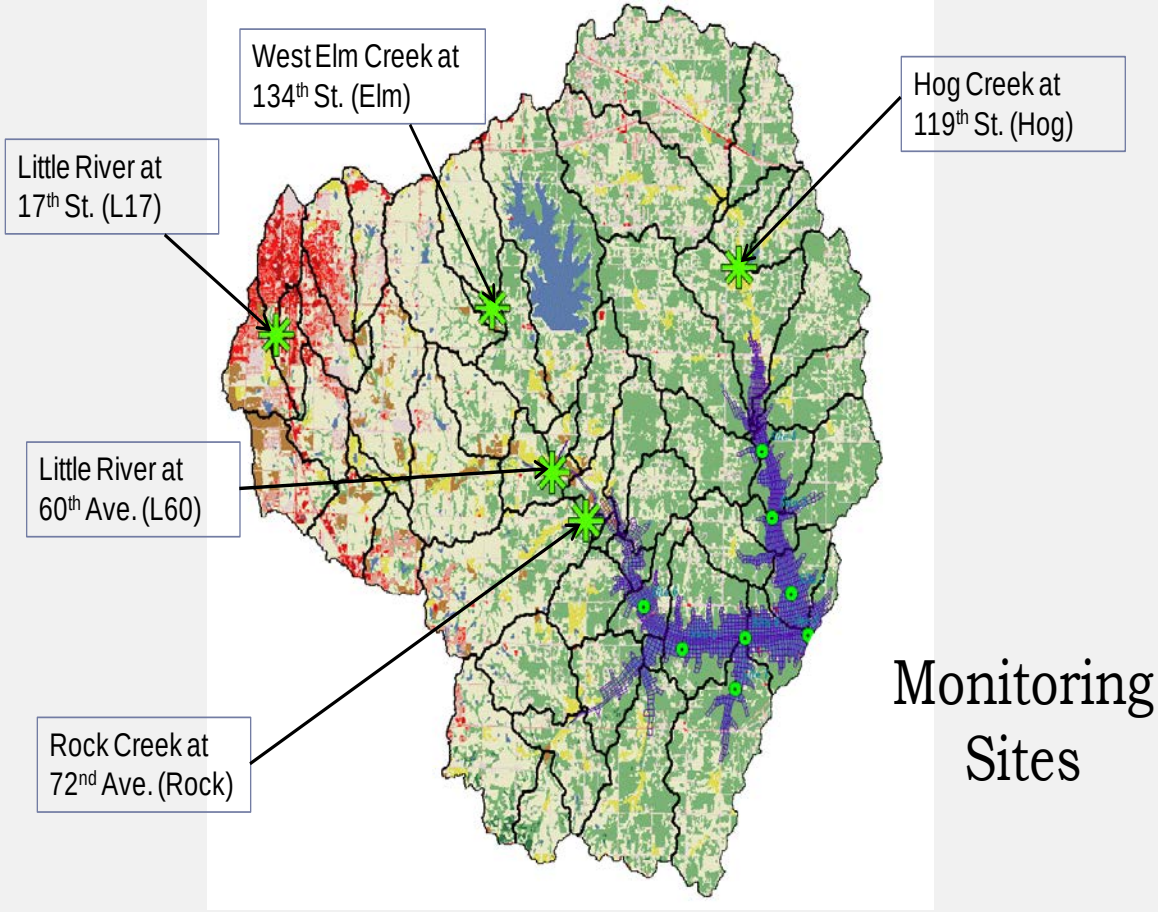
Lake Thunderbird TMDLs

July 23, 2013

OKLAHOMA
DEPARTMENT OF ENVIRONMENTAL QUALITY

HSPF Model Calibration

64 Sub-Watersheds

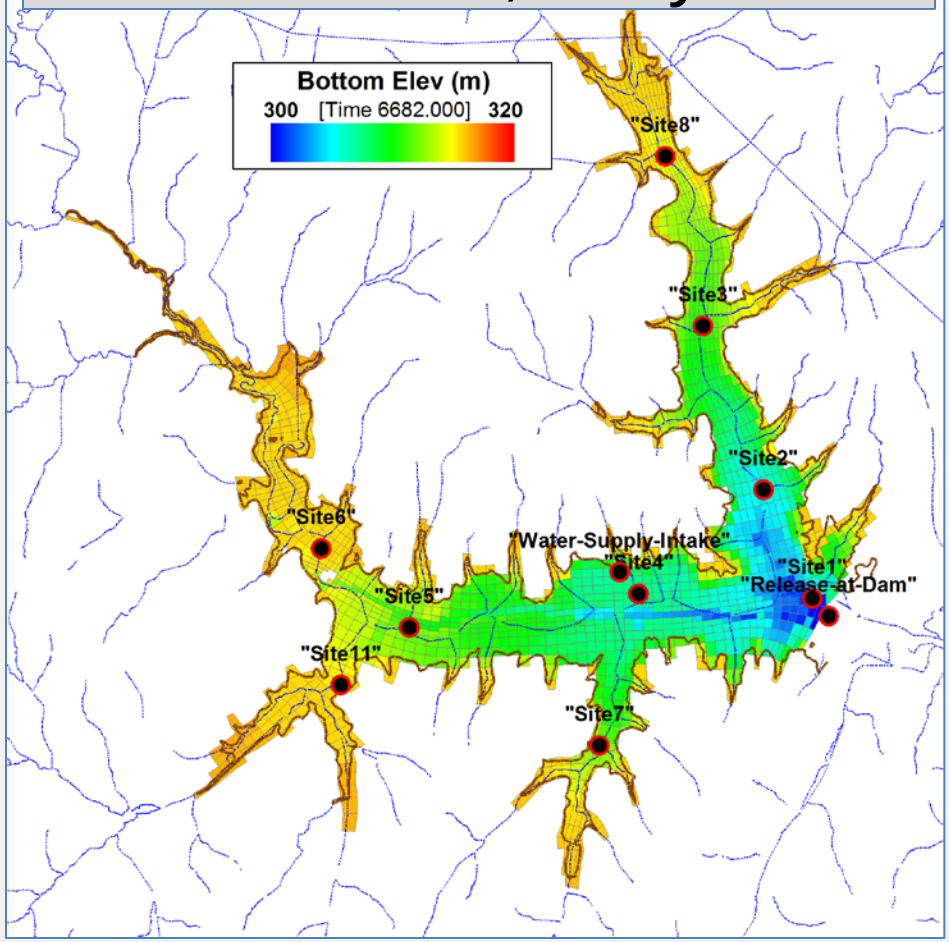


Monitoring Sites

- Model simulation from 4/18/2008 to 4/27/2009
- OCC stream data collected at 5 sites (2008-2009)
- Model results compared to streamflow, TSS, water temperature, oxygen, nutrients

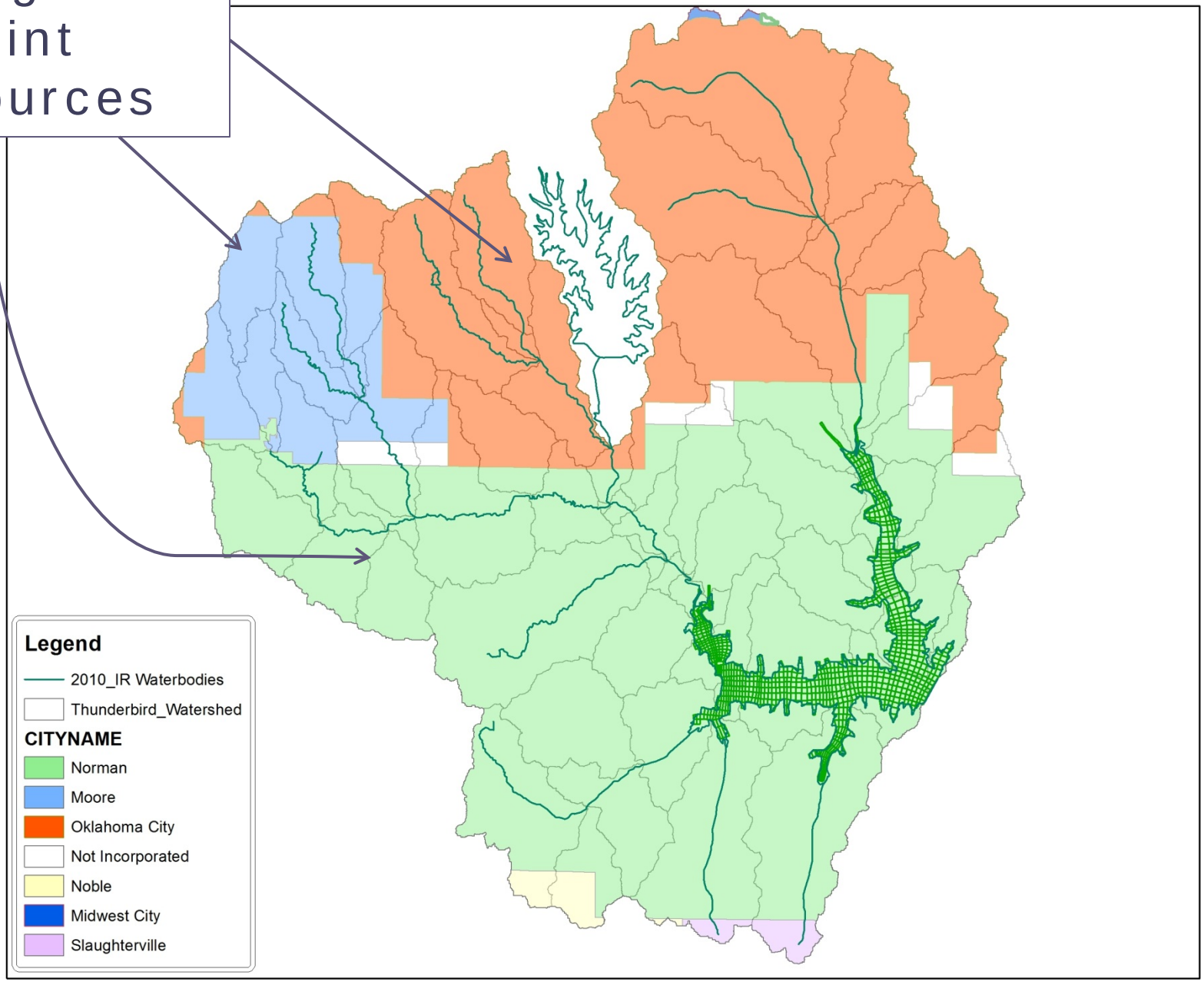
EFDC Lake Model

1660 Cells,6 Layers

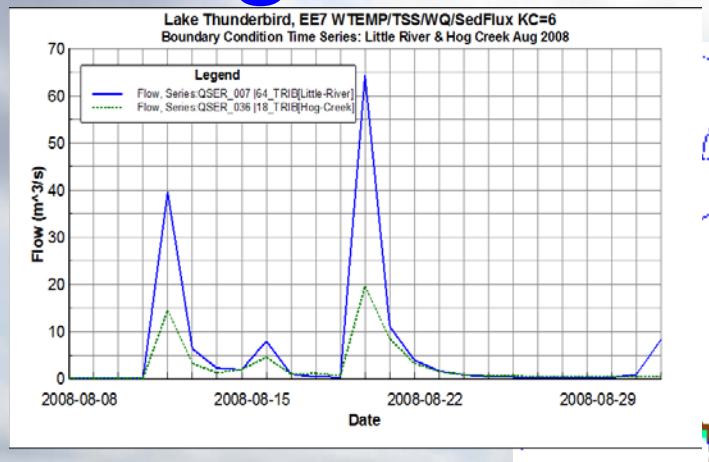


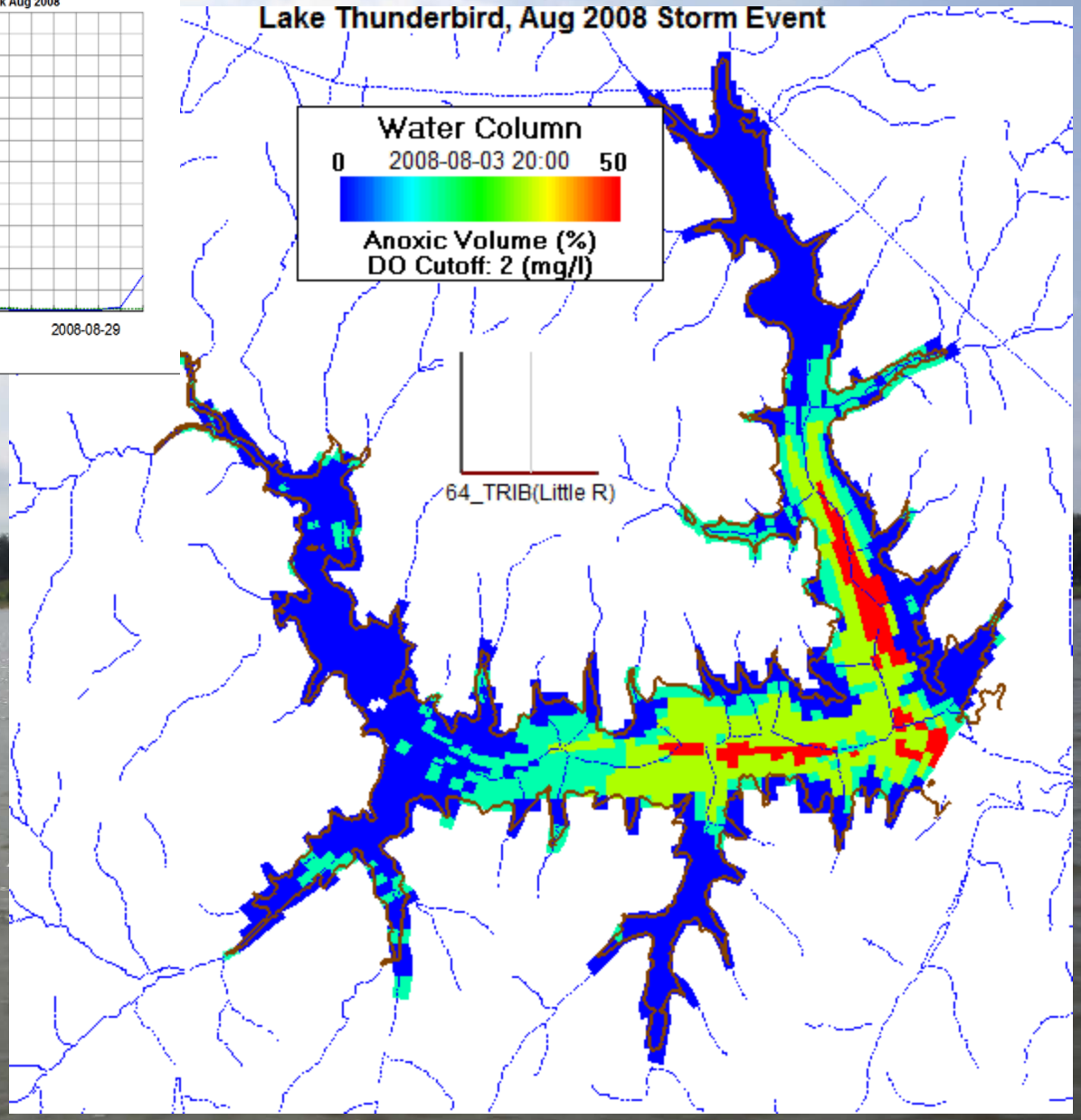
- HSPF Streamflow & Loads (TN,TP,BOD,TSS)
- Atm-Deposition (N,P)
- Internal N,P load (bed)
- Velocity, Water Level
- Water Temperature
- Sediment (TSS)
- Detrital Organic Matter
- Algae
- Dissolved Oxygen
- Nutrients (N,P)

Regulated Point Sources

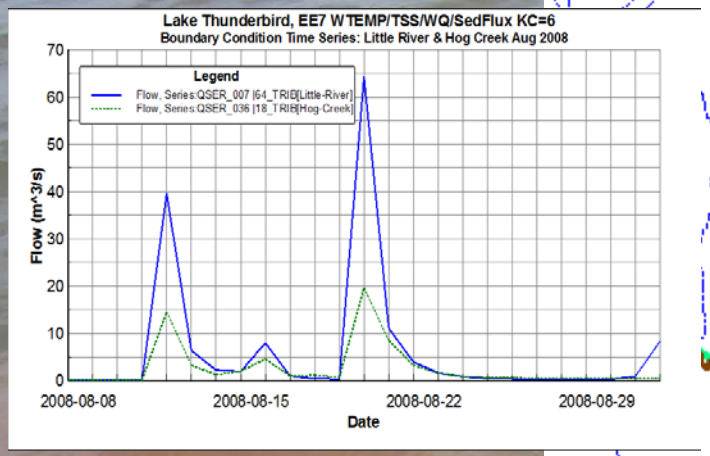


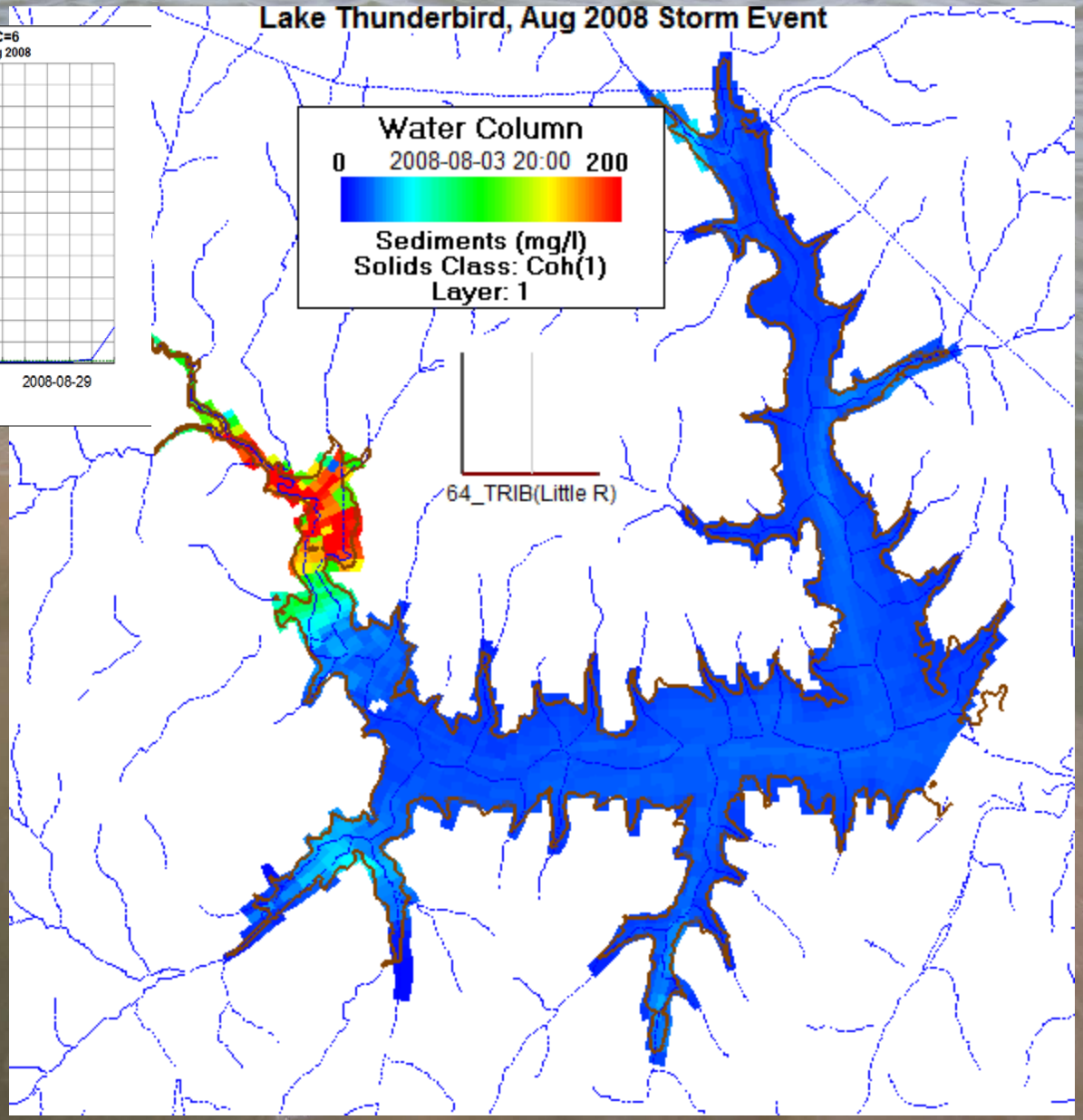
Aug-2008 Storm, Anoxic Volume





Aug-2008 Storm, Sediment





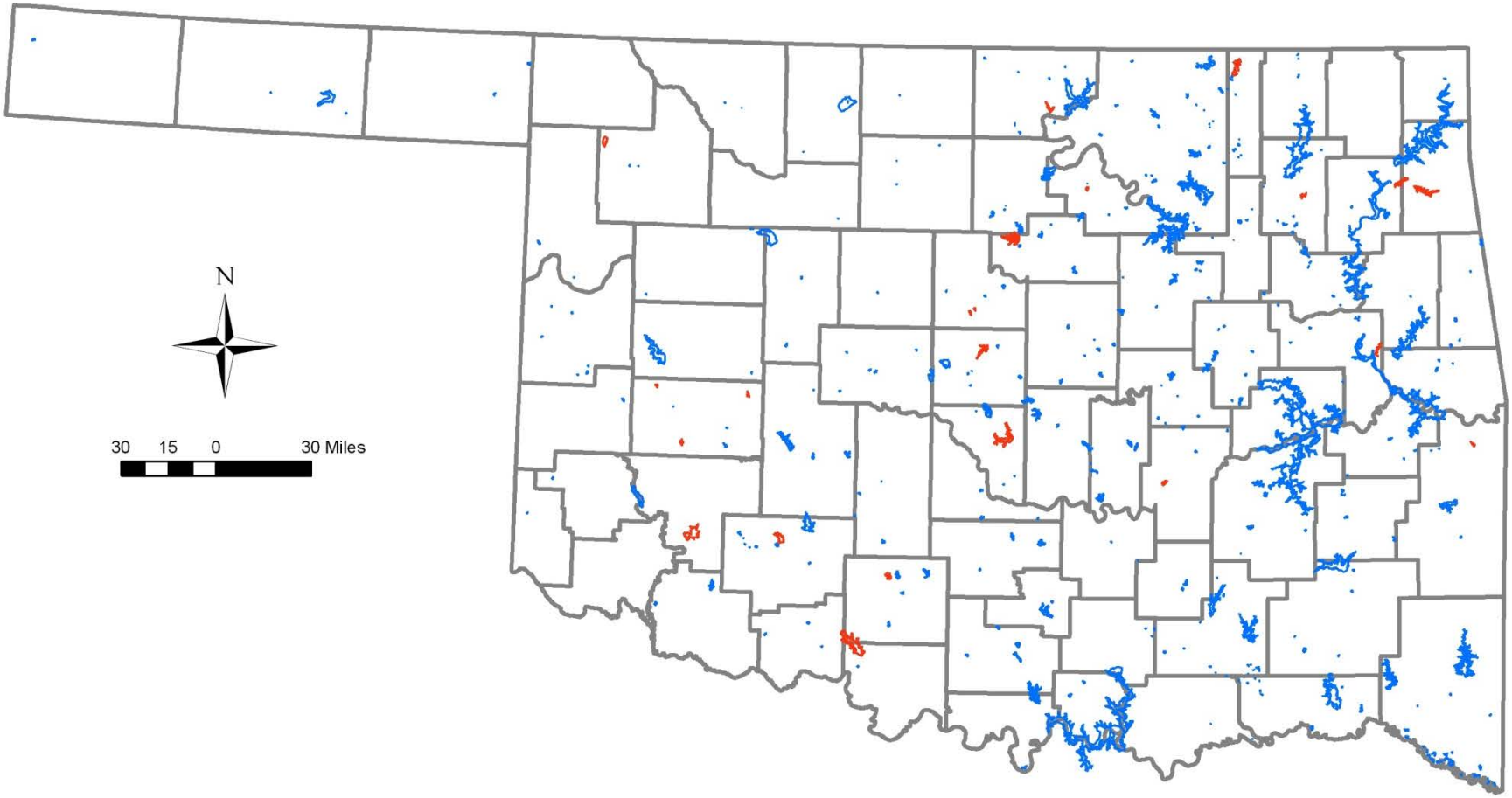
Nutrient TMDLs for Sensitive Water Supply Lakes

Andrew Fang, Mark Derichsweiler

Jim Patek, Monica Suarez

9th Annual OWRRI Water Research Symposium
Norman, OK
October 18-19, 2011

Chl-*a* Impaired SWS Lakes

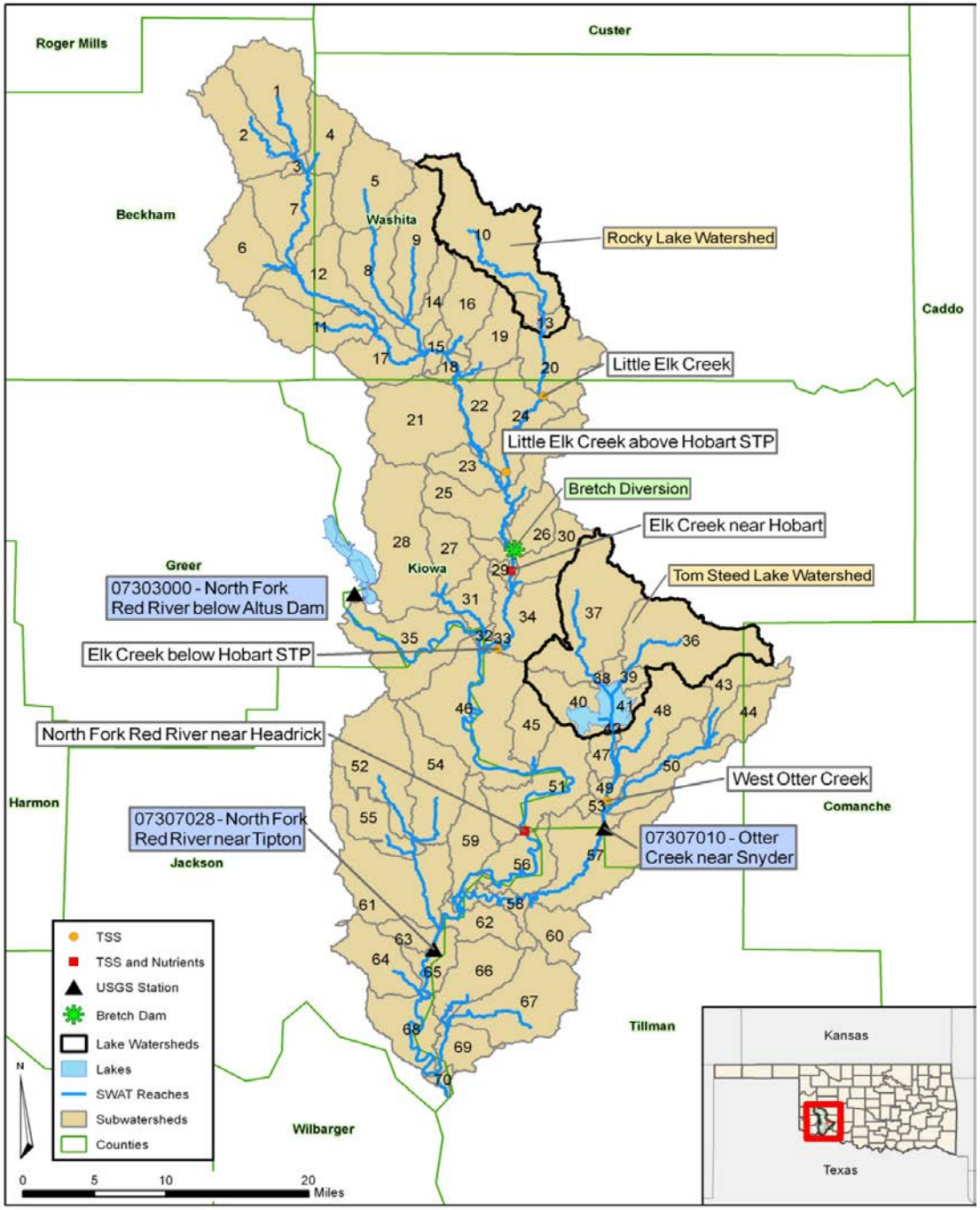


Watershed Monitoring

<u>2 USGS gage stations:</u>
1998/2000-2008

<u>6 TSS stations:</u>
18-22 samples in 2 years

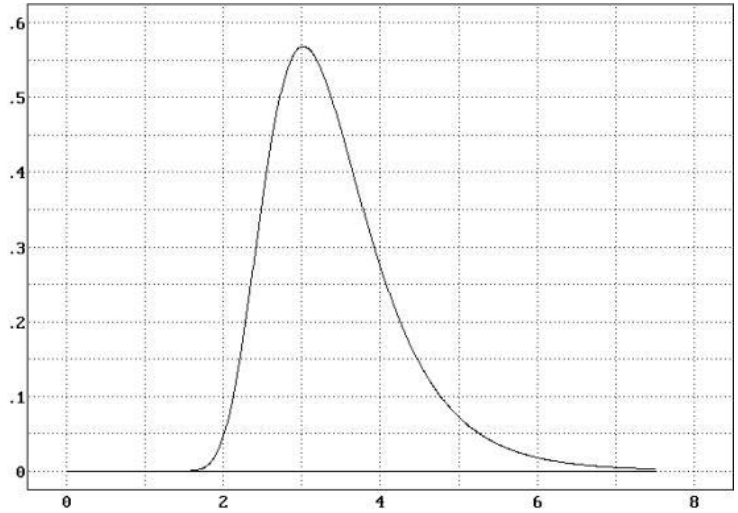
<u>2 nutrients stations:</u>
38 samples in 4 years



Monte Carlo Simulation

- The process is repeated hundreds or thousands of times, each time using different combination of randomly-selected values

- These results represent the range and frequency of possible model output



Monte Carlo Uncertainty Analysis for BATHTUB

Calibrate Model

↓

Choose most sensitive parameters

↓

Determine parameter distributions

↓

Given a TP load reduction, run BATHTUB many times with parameter values <u>randomly</u> sampled from the distributions

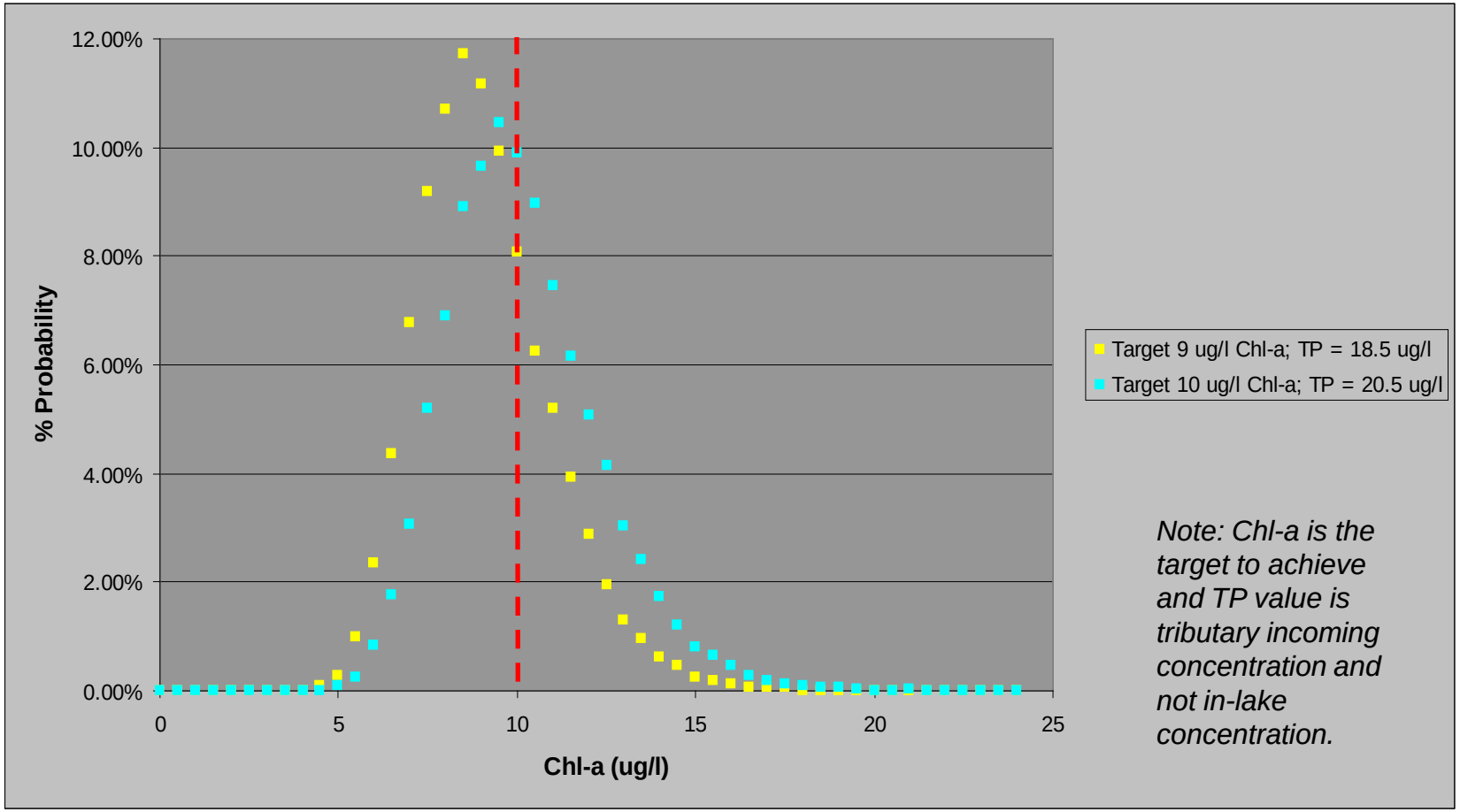
↓

Probability distribution of BATHTUB results

↓

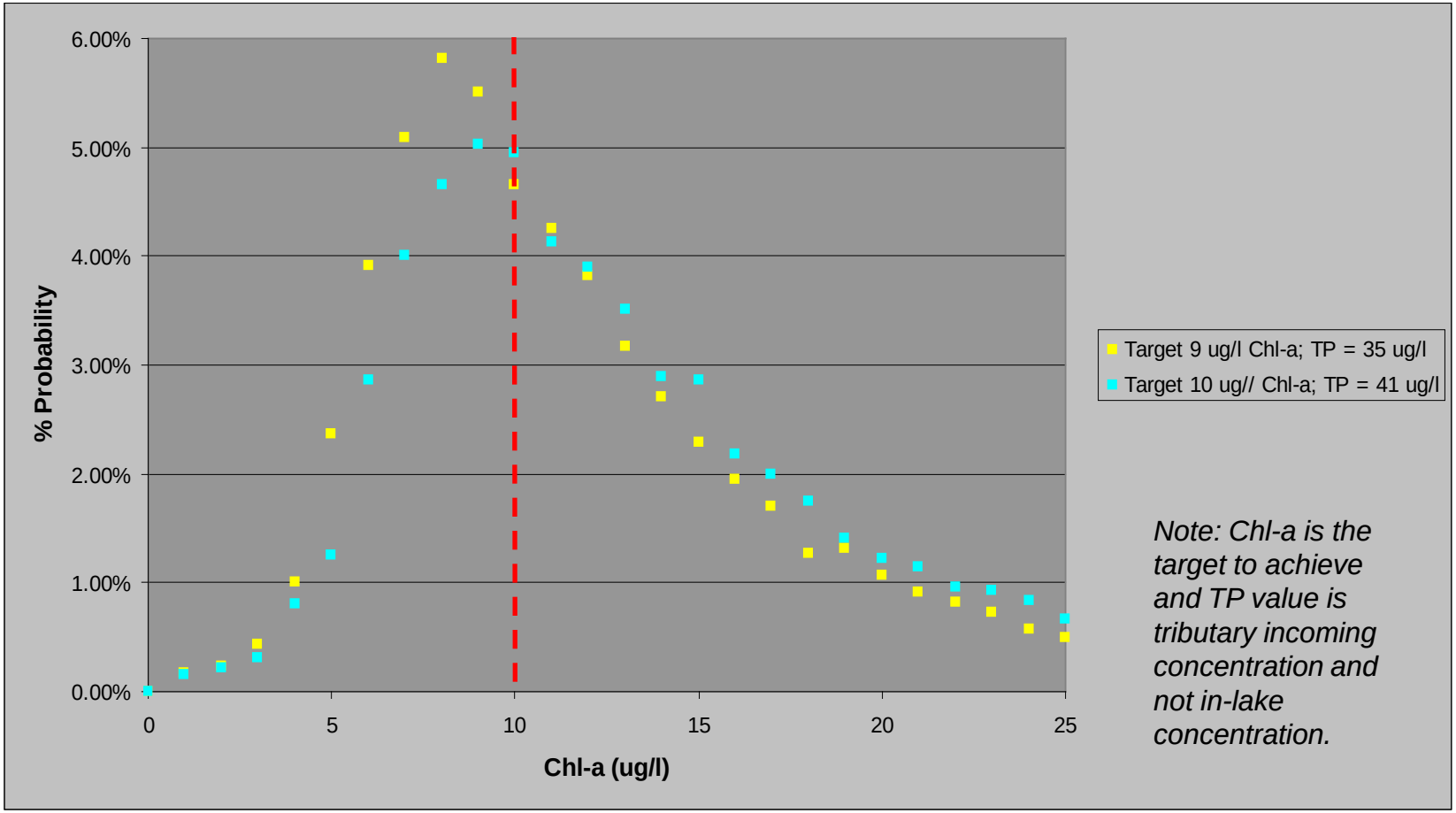
Input to TMDL

Rocky Lake Probability Plot of Chlorophyll-*a* Concentrations Obtained from 20,000 MC Samples



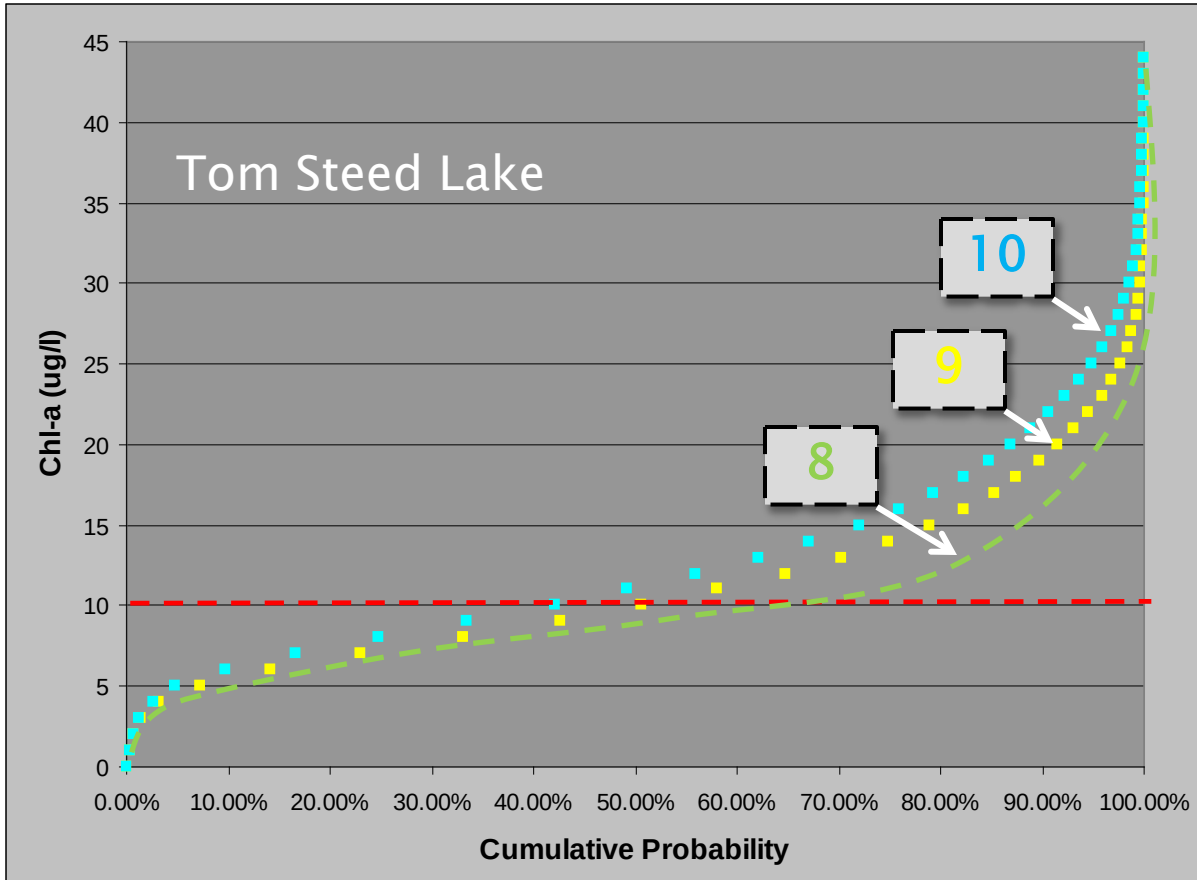
Cumulative probability :
57% for <10 µg/L and 75% if we target 9 µg/L

Lake Tom Steed Probability Plot of Chlorophyll-*a* Concentrations Obtained from 20,000 MC Samples



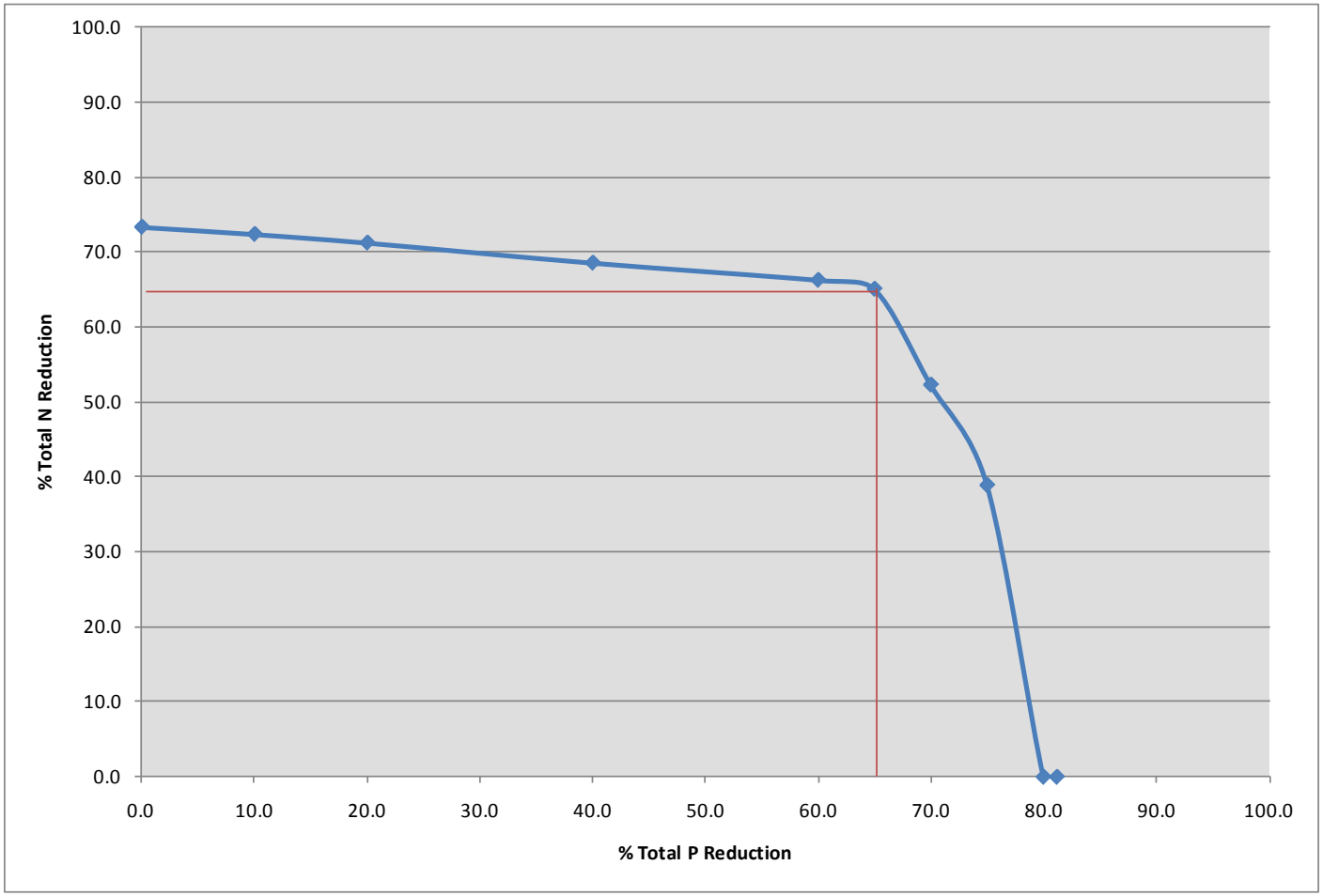
Cumulative probability :
42% for <10 µg/L and 50%, if we target 9 µg/L

Explicit MOS



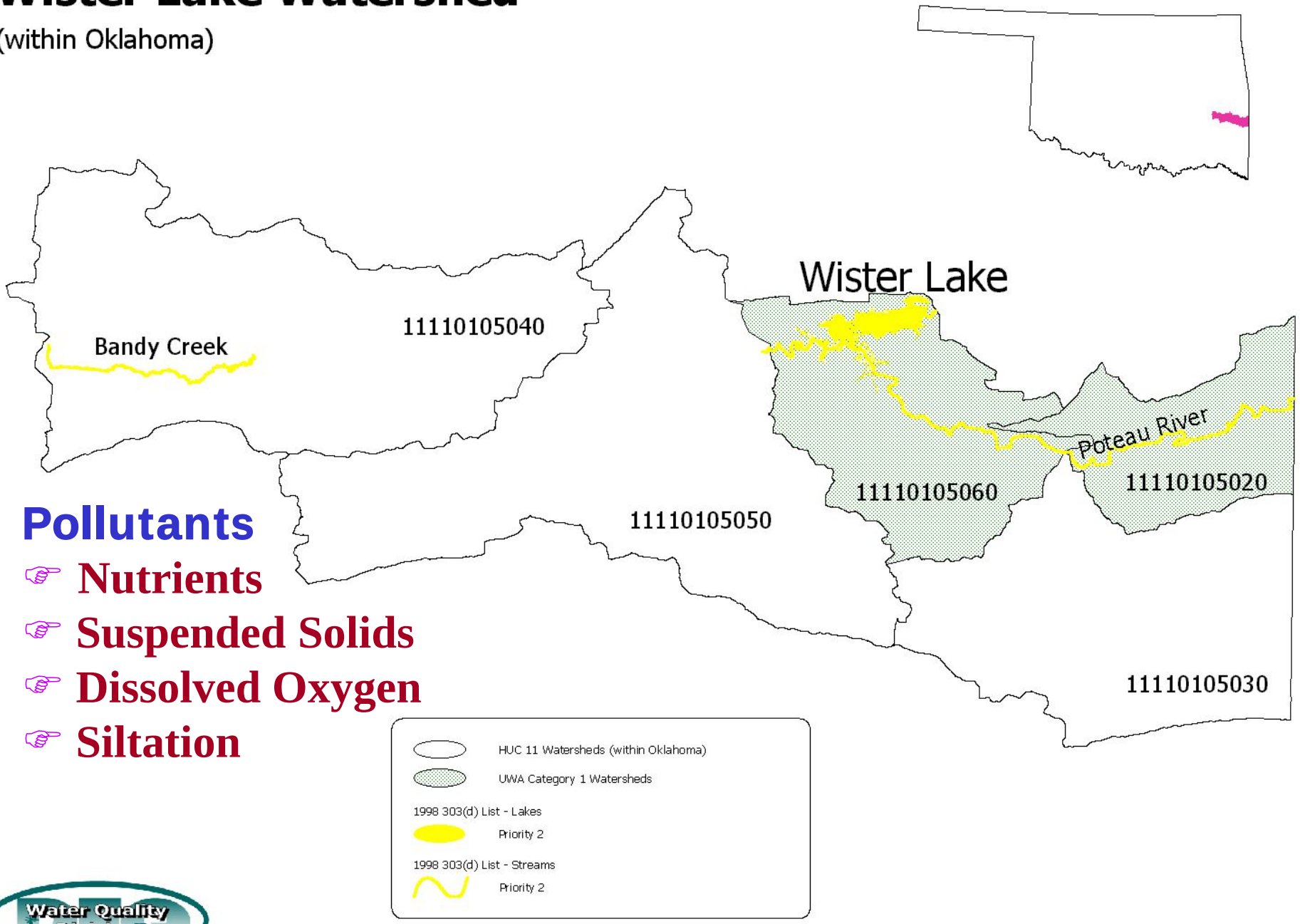
- **10 µg/L** (WQS)
  MOS: 0%
  Prob: 42%
- **9 µg/L**
  MOS: 10%
  Prob: 50%
- *8 µg/L*
  MOS: 20%
  Prob: 70%

Total N and Total P Reduction Combinations Resulting in 10 µg/L Chlorophyll-*a* - Tom Steed Lake



Wister Lake Watershed

(within Oklahoma)

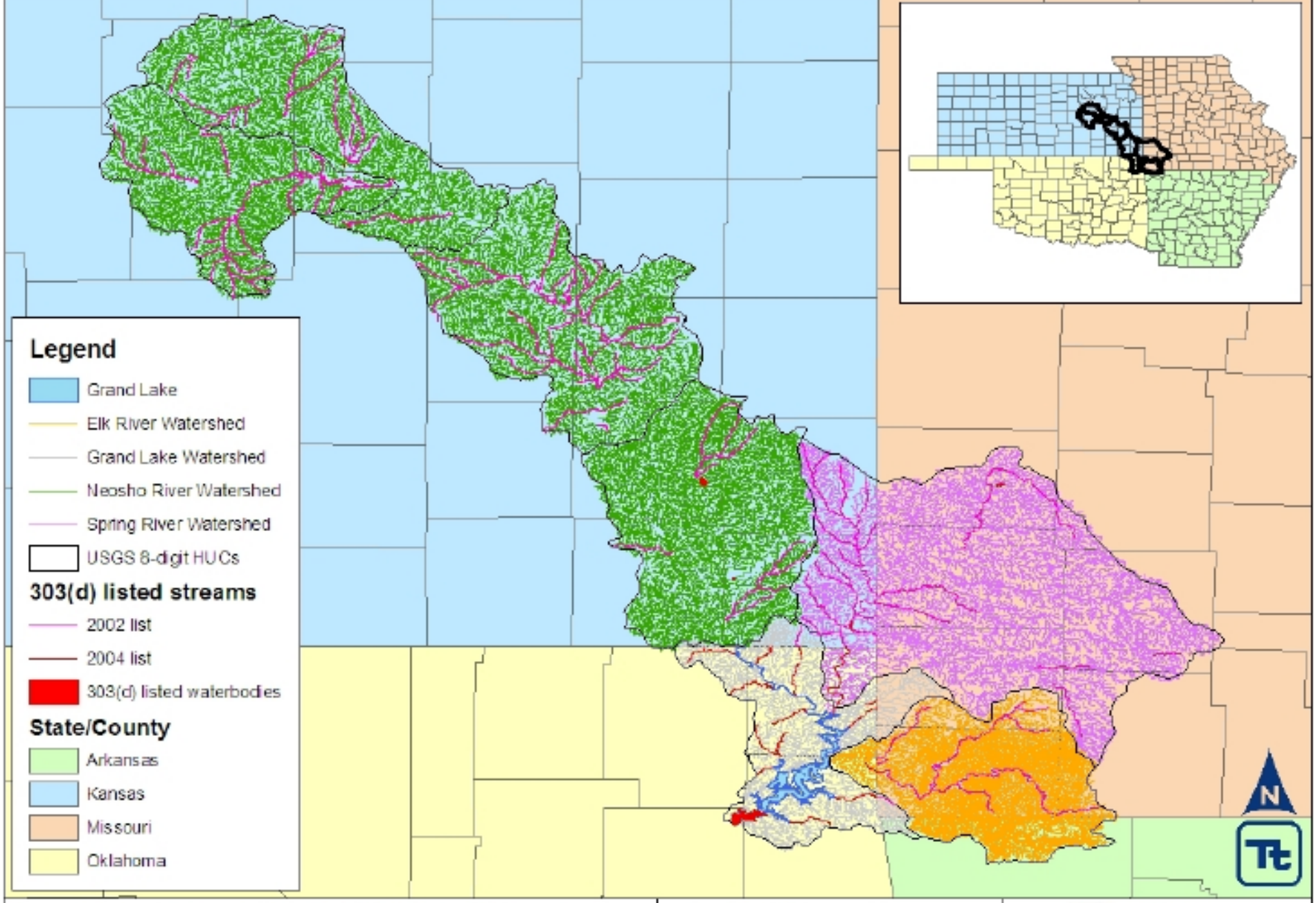


Pollutants

- Nutrients
- Suspended Solids
- Dissolved Oxygen
- Siltation

Water Quality Division
Oklahoma Department of Environmental Quality

6 Oct 1999



Grand Lake Watershed and 303(d) Listed Waterbodies

Sources: NHD (streams, lake), ESRI (counties), USGS (HUCs), EPA (303(d) streams/waterbodies)
Map produced 02-18-2010

0 15 30 60 Kilometers

0 12.5 25 50 Miles

TETRA TECH

complex world | CLEAR SOLUTIONS™

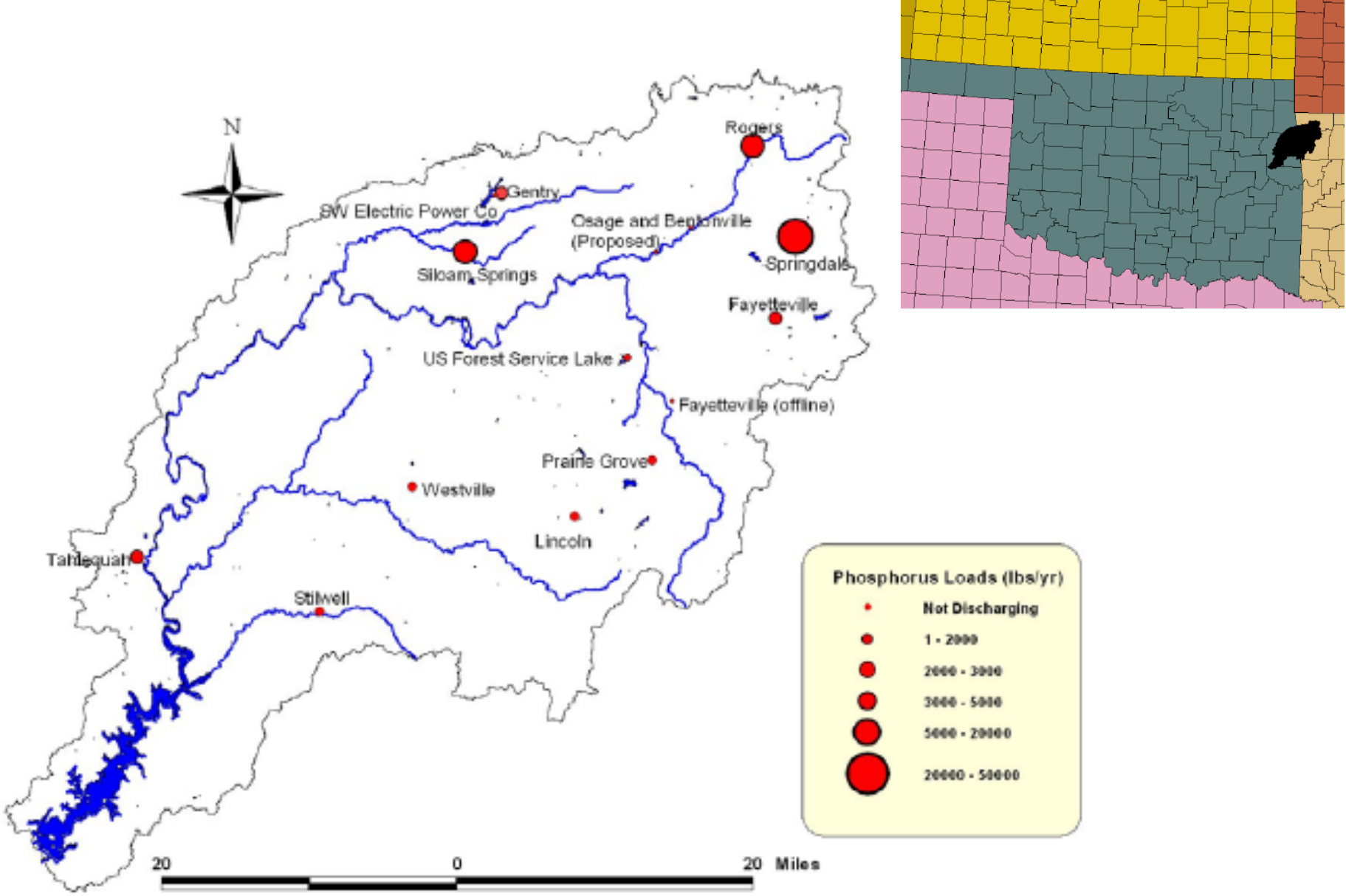


Figure 4.1 Significant urban locations and total phosphorus loads from Waste Water Treatment Plants in the Illinois River basin.

TMDL Funding Sources

- CWA Programs
  - Section 106
  - Section 104(b)(3)
  - Section 319
  - Clean Lakes
- SDWA Programs
  - Source Water Protection
- State Agency Funds

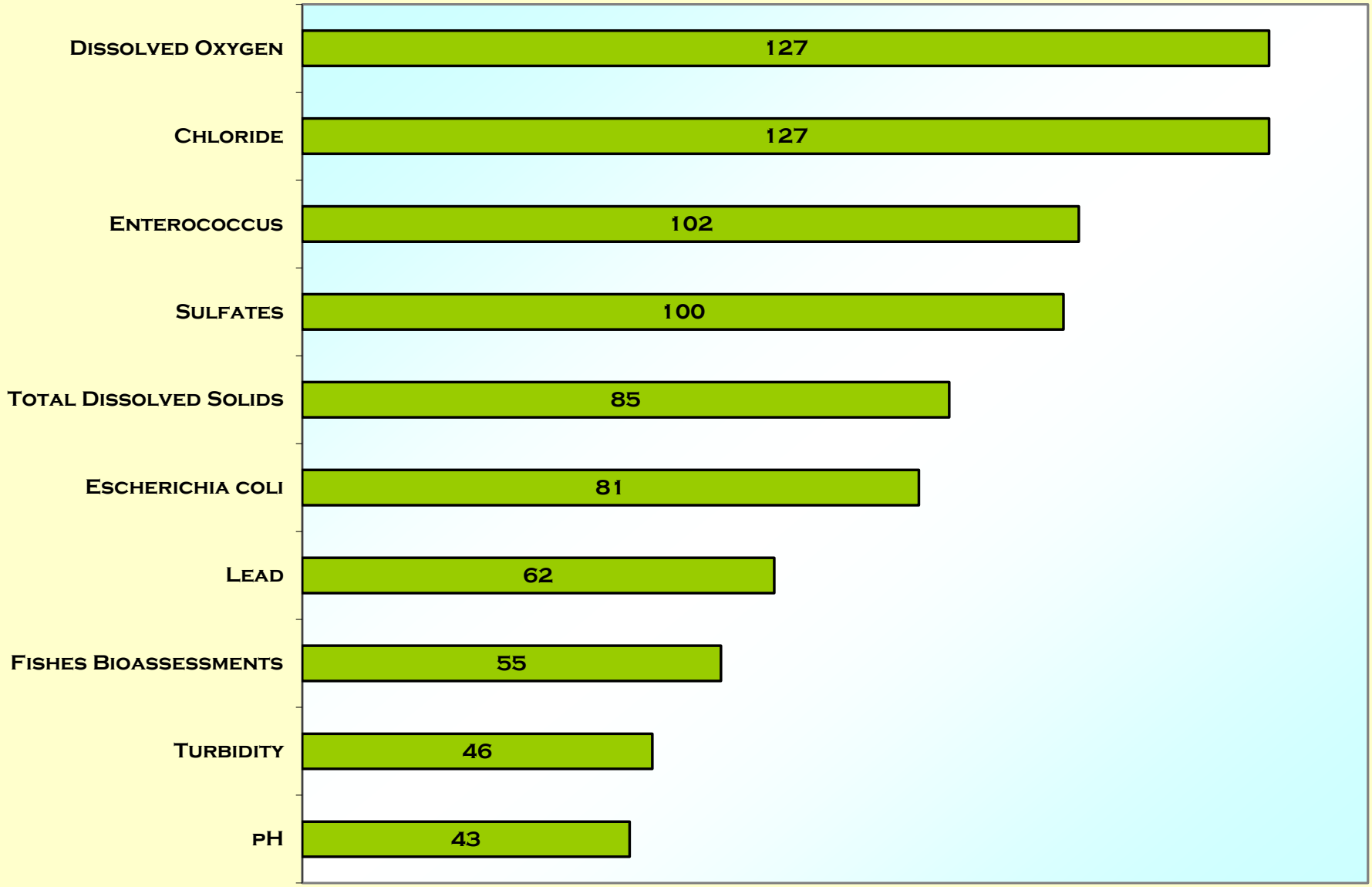
Wewoka Creek

Now What ?

LOST
CONFUSED
UNSURE
UNCLEAR
PERPLEXED
DISORIENTED
BEWILDERED

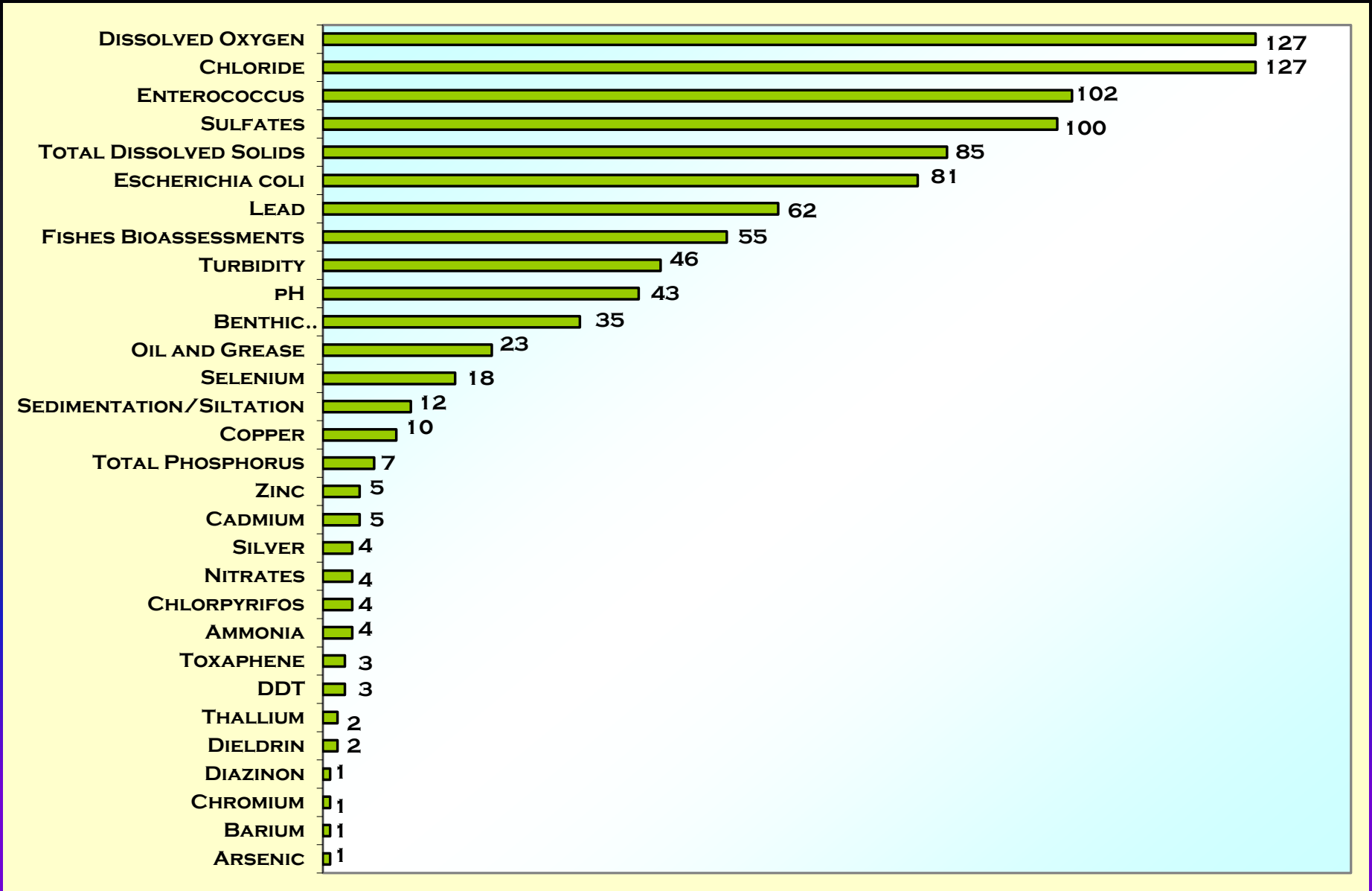
2012 Stream Impairments

Number of Waterbodies Impaired by Pollutant



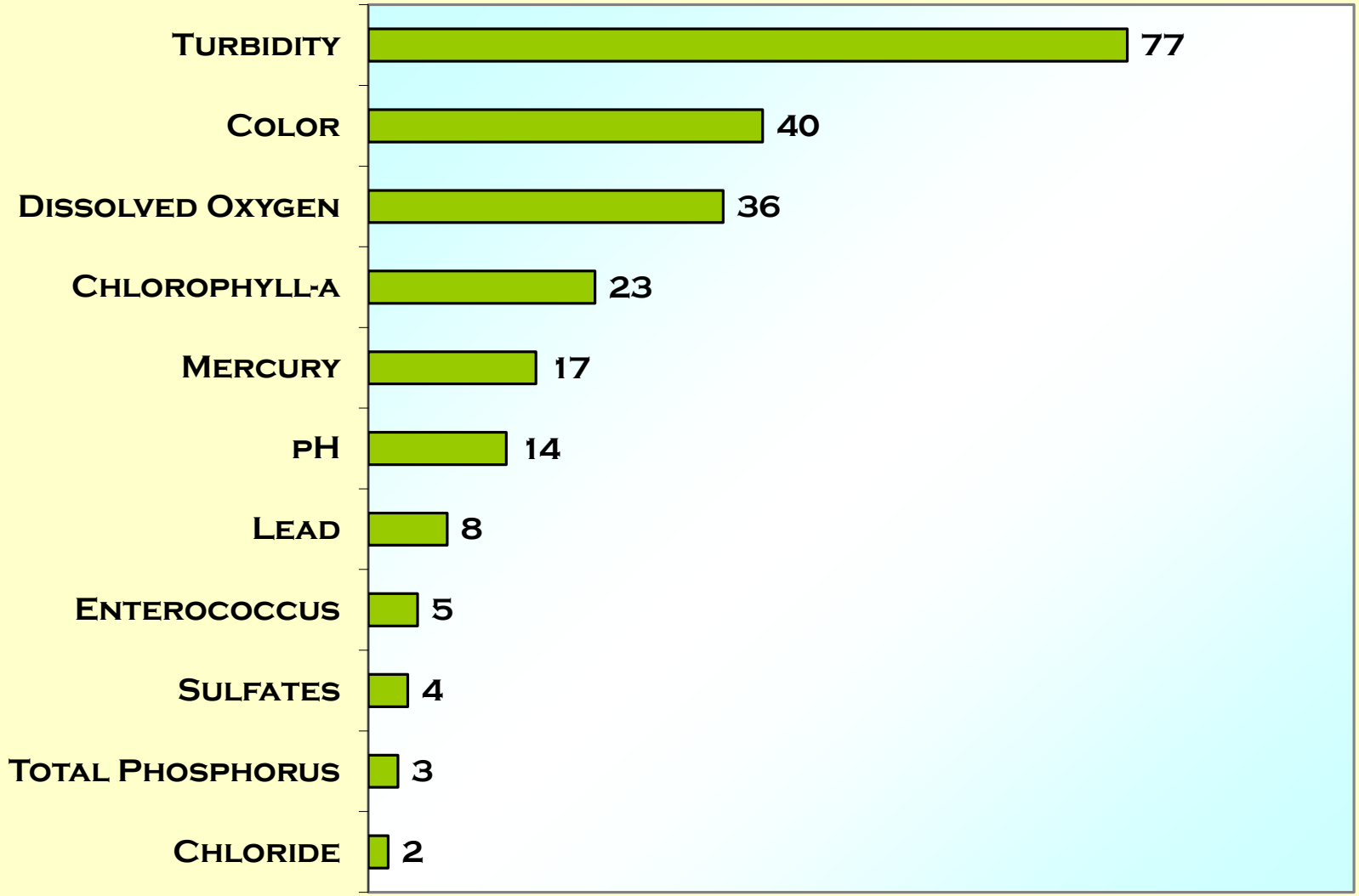
2012 Stream Impairments

Number of Waterbodies Impaired by Pollutant



2012 Lake Impairments

Number of Waterbodies Impaired by Pollutant



Future Trends

- Fewer but more complex projects
- Lack of sufficient data may lead to more detailed monitoring
- Increased focus on implementation

Anybody For
A Swim ??
8. 8. 2000