Restoring Water Quality In An Urban/Urbanizing Watershed

The Lake Thunderbird TMDL

Oklahoma Clean Lakes & Watersheds Association
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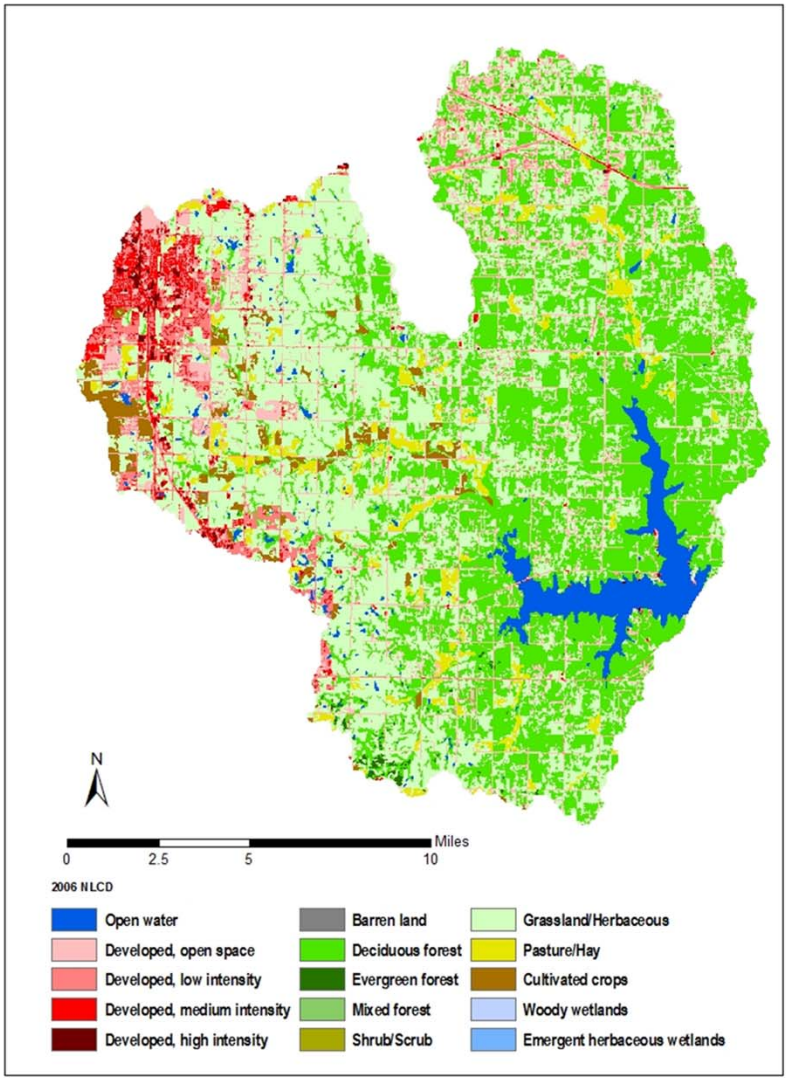
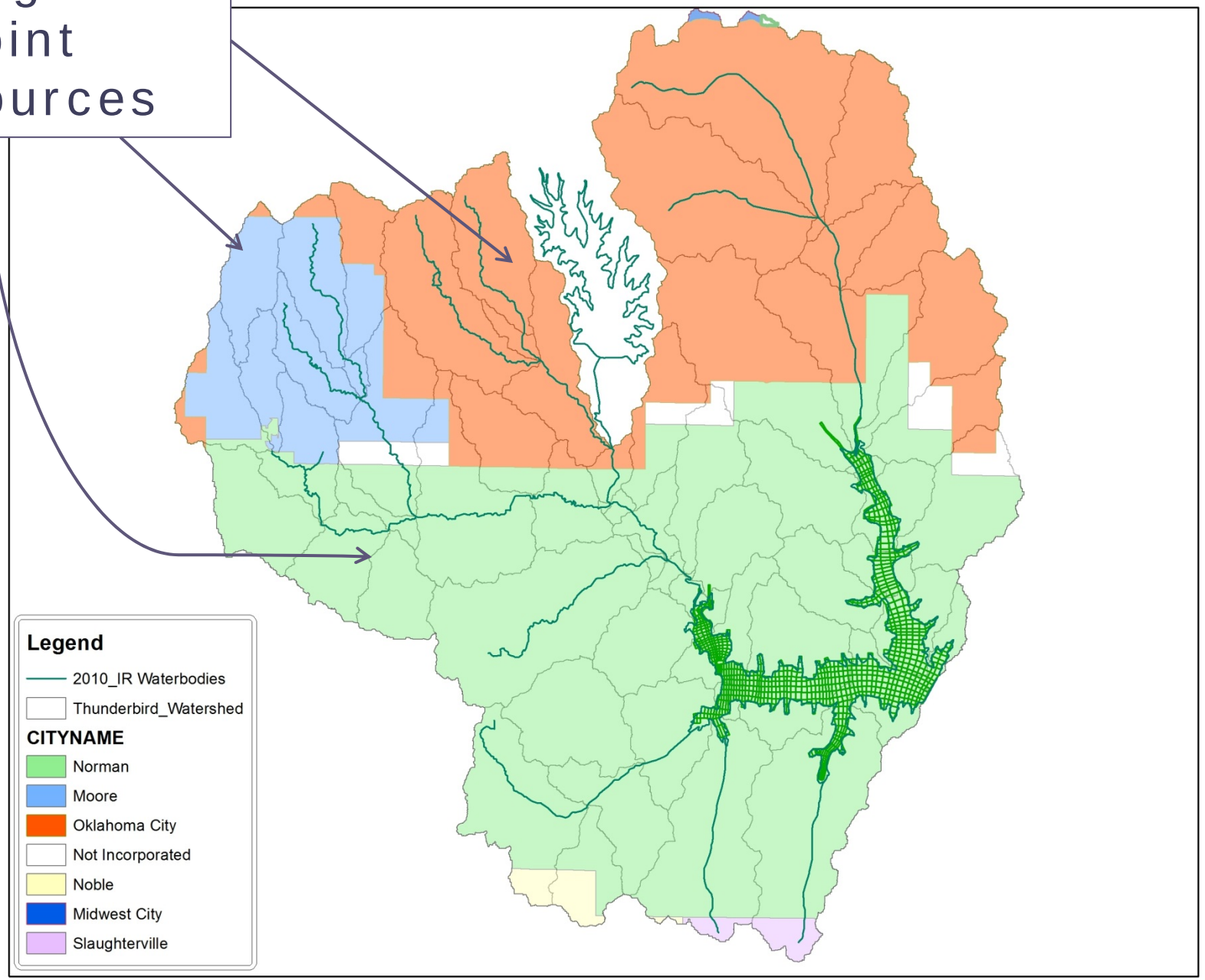
Lake Thunderbird

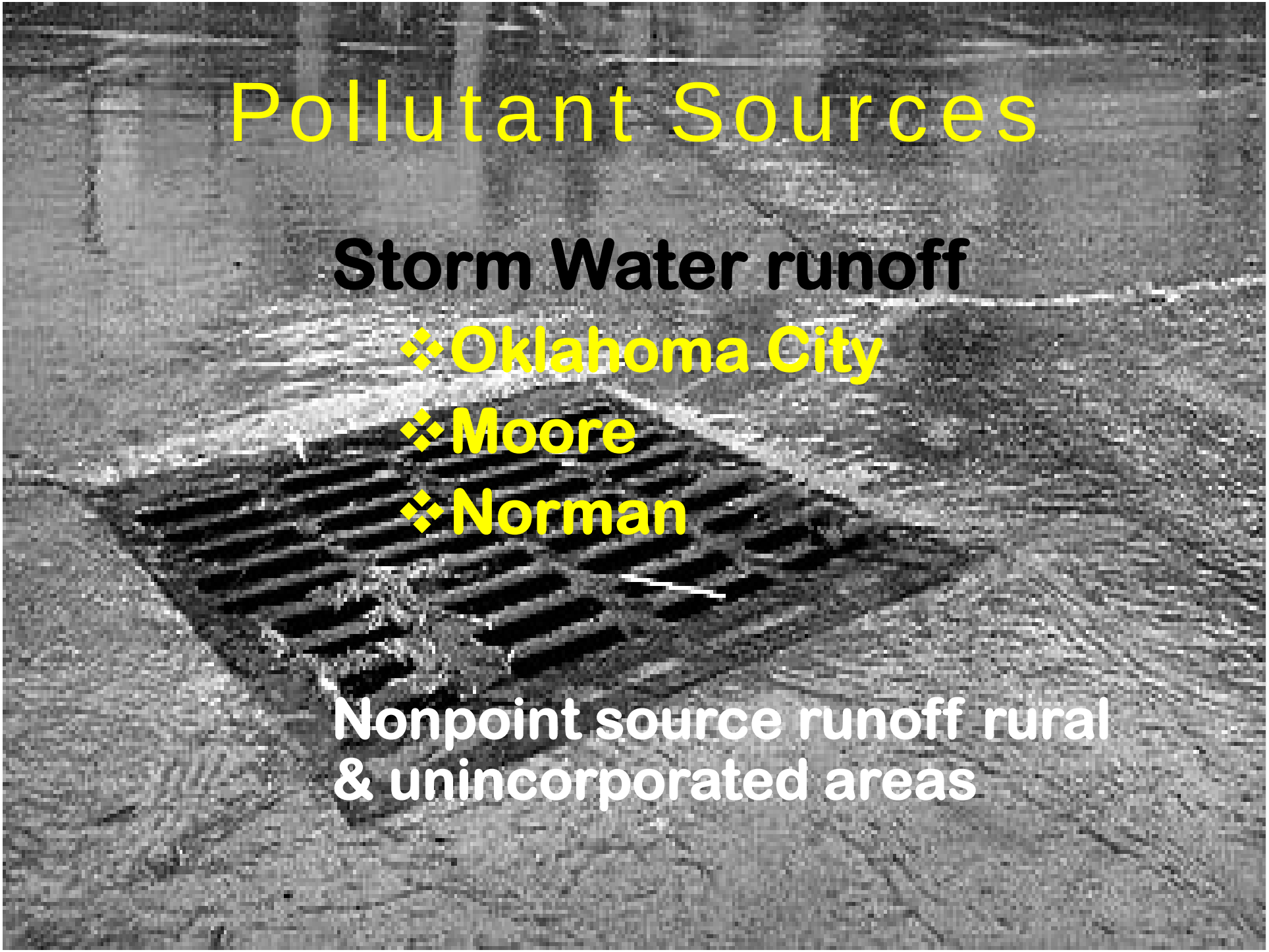
- 6,070 acre reservoir
- Cleveland County
- Upper Little R (256 mi^2)
- 99,600 pop (2010)
- Public water supply for Norman, Midwest City & Del City

Watershed Land Use



Regulated Point Sources




Pollutant Sources
Storm Water runoff
Oklahoma City
Moore
Norman
Nonpoint source runoff rural
& unincorporated areas

Lake Thunderbird Impairments

Aquatic Life

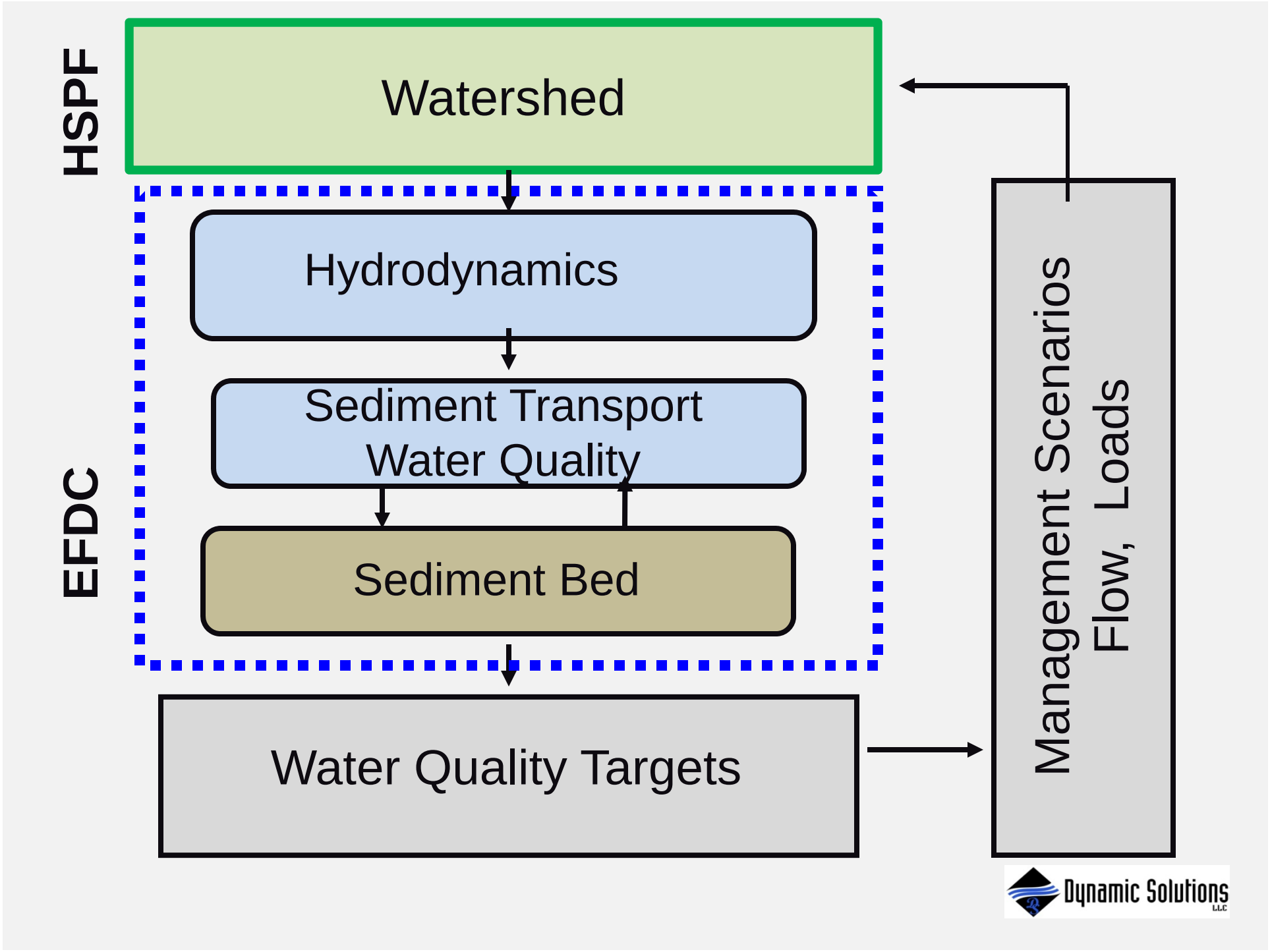
- High Turbidity
  - Target
    - < 10% exceeds 25 NTU
- Low Dissolved Oxygen
  - Targets
    - When stratified
      - 5 mg/L at surface
      - < 50% Lake volume below 2 mg/L
    - When NOT stratified
      - 5 mg/L for the entire water column

Lake Thunderbird Impairments

Drinking Water

- High Chlorophyll a
  - Target
    - Average < 10ug/L


Lake Thunderbird
Watershed-Lake Models
Dynamic Solutions, LLC
Knoxville, TN
Dynamic Solutions
LLC

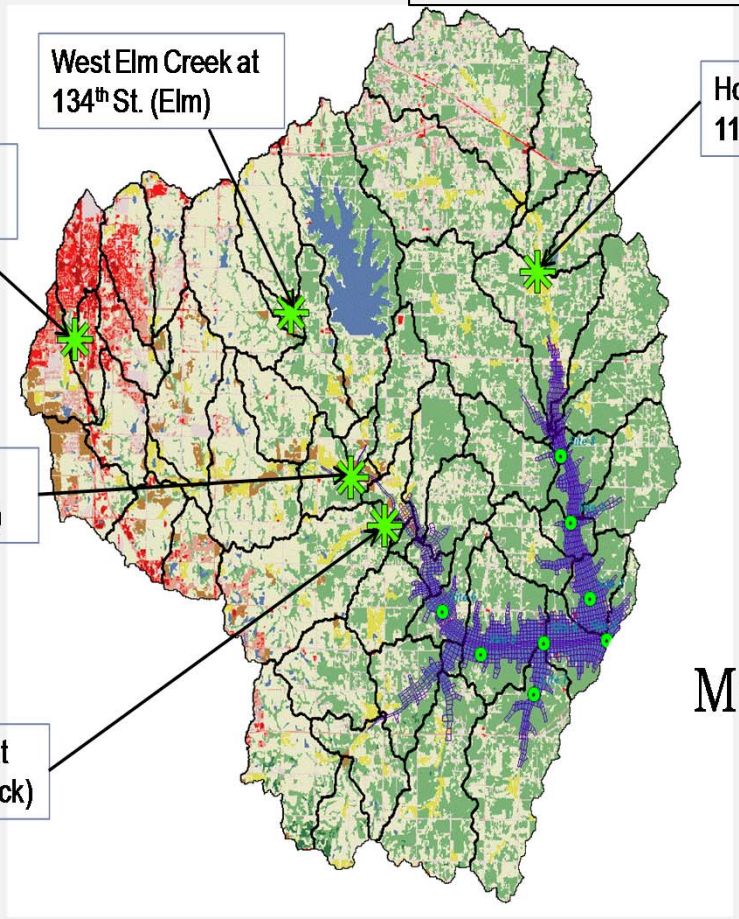

HSPF
Watershed
EFDC
Hydrodynamics
Sediment Transport
Water Quality
Sediment Bed
Water Quality Targets
Management Scenarios
Flow, Loads
Dynamic Solutions LLC

HSPF Watershed Model

- Rain/meteorology
- Topography
- Land uses/soils
- Stream channels
- Overland flow
- Infiltration
- Groundwater
- Sub-watersheds
- Flow & Pollutant loads (TN,TP,BOD,TSS)

HSPF Model Calibration

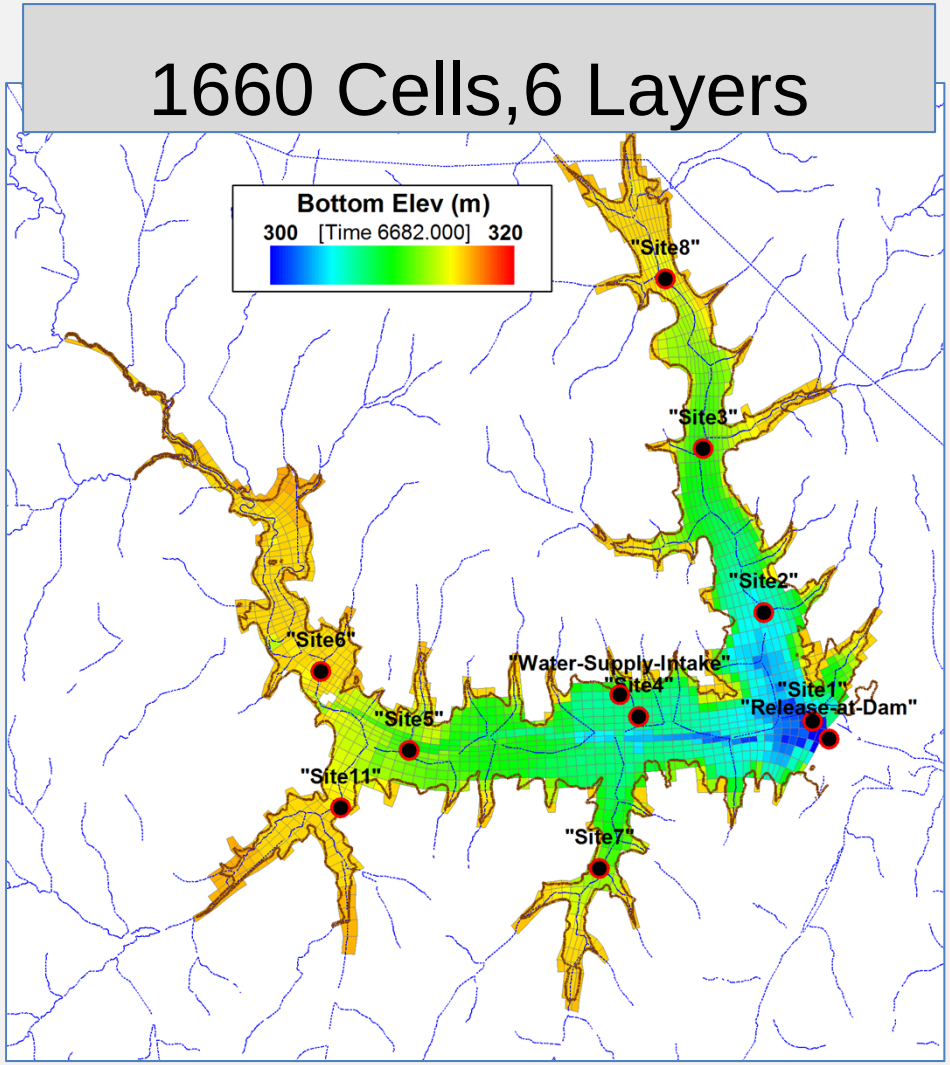
64 Sub-Watersheds



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



- 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)

Lake Model Calibration

- EFDC model simulation period from 4/18/2008 through 4/27/2009
- OWRB monitoring data collected at 8 sites in 2008-2009
- EFDC model results compared to water level, water temperature, suspended solids, dissolved oxygen, algae chlorophyll, water clarity (secchi depth), nutrients and sediment flux

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Lake Model Calibration

- Model generated seasonal stratification with good match to water temperature and dissolved oxygen; Aug-2008 storm event reproduced.
- Model matched seasonal trends of water temperature, dissolved oxygen, water clarity (secchi depth), nutrients and chlorophyll
- Model results used to compute anoxic volume of lake as percentage
- Sediment flux model accounted for internal loads of N, P

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Model Projections

- **Reduction needed to meet Water Quality Standards**
- **35% reduction for all loadings of nitrogen, phosphorus and TSS from watershed was identified for Lake Thunderbird TMDL**
- **No reduction needed for organic matter/BOD**

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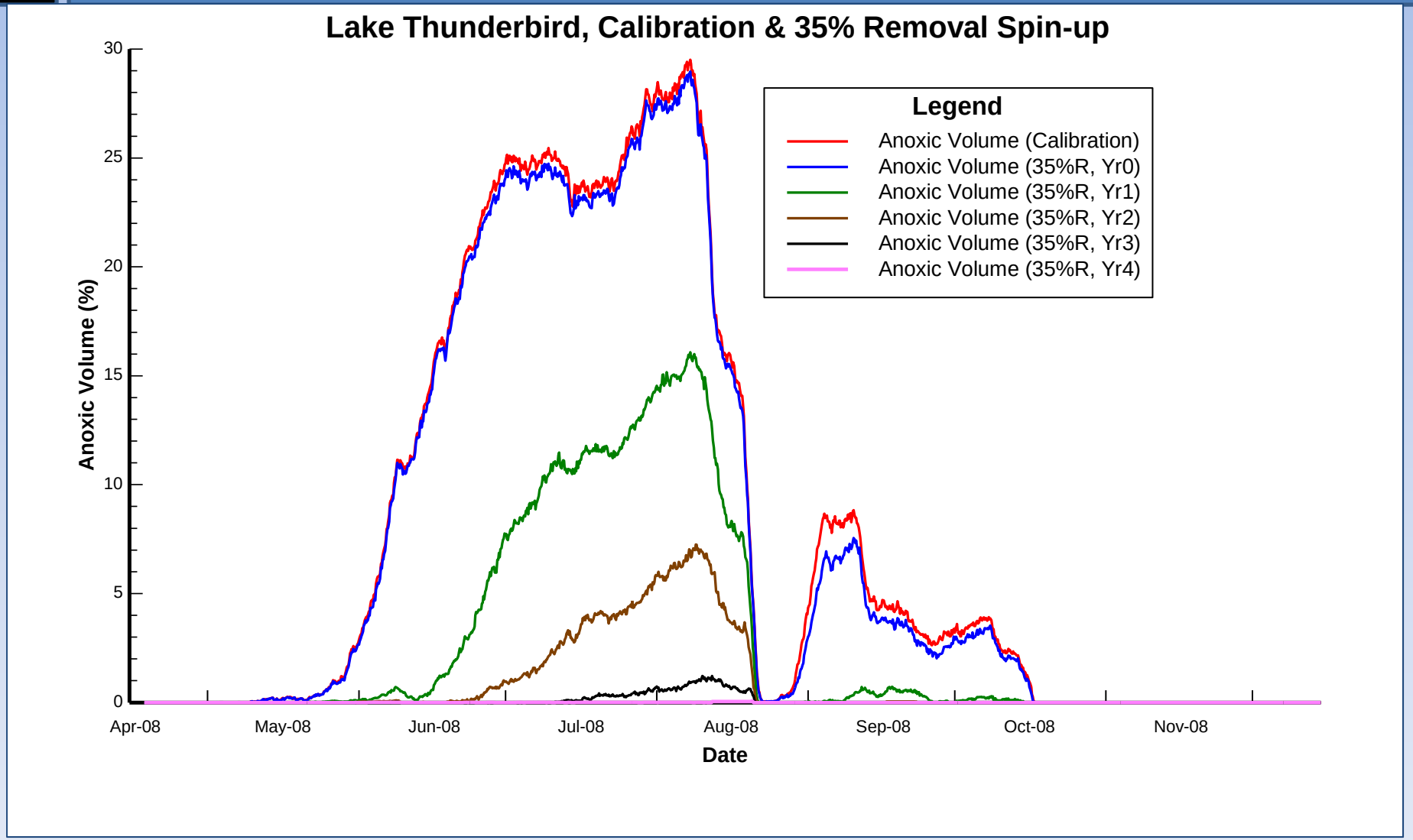
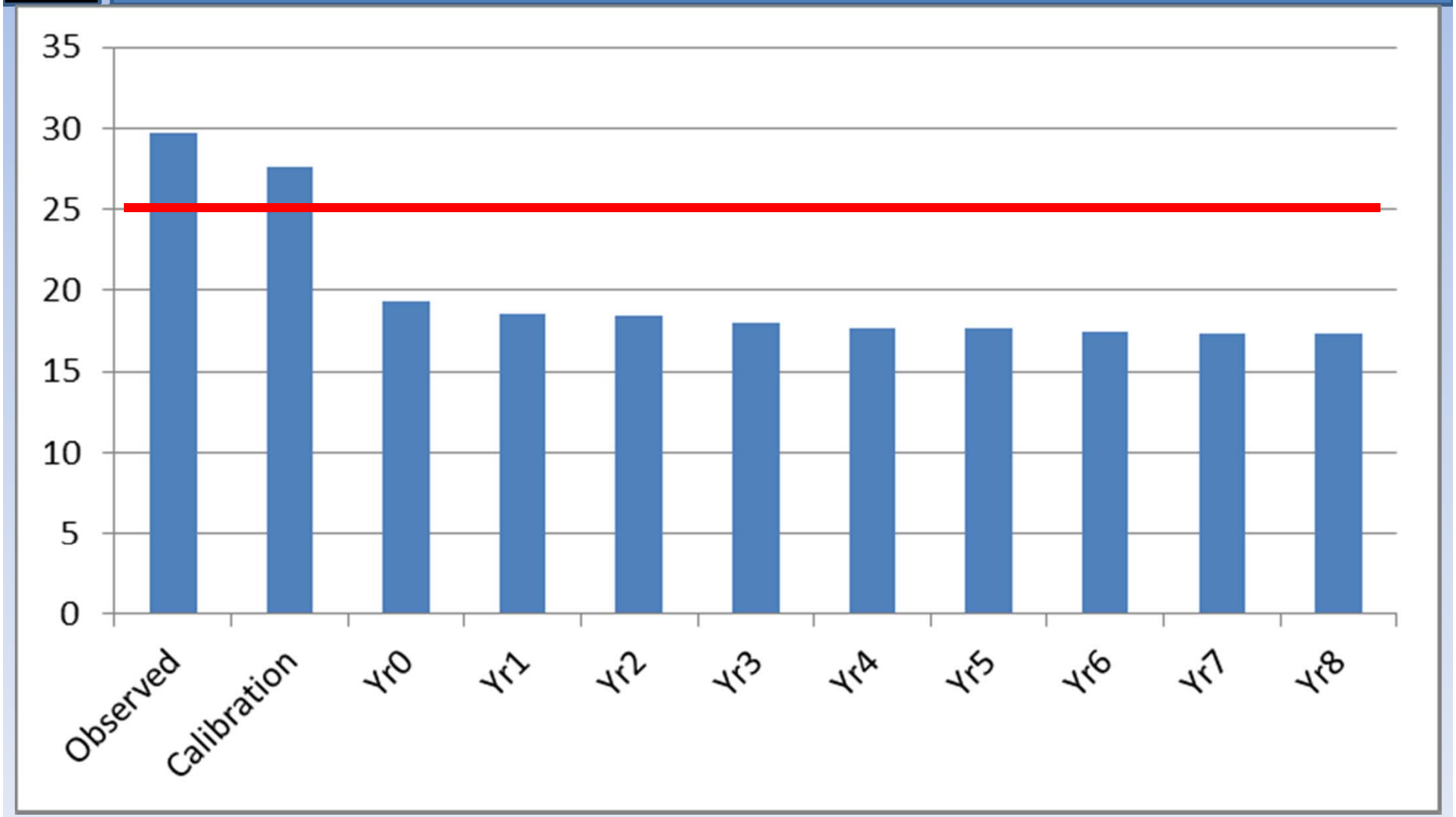
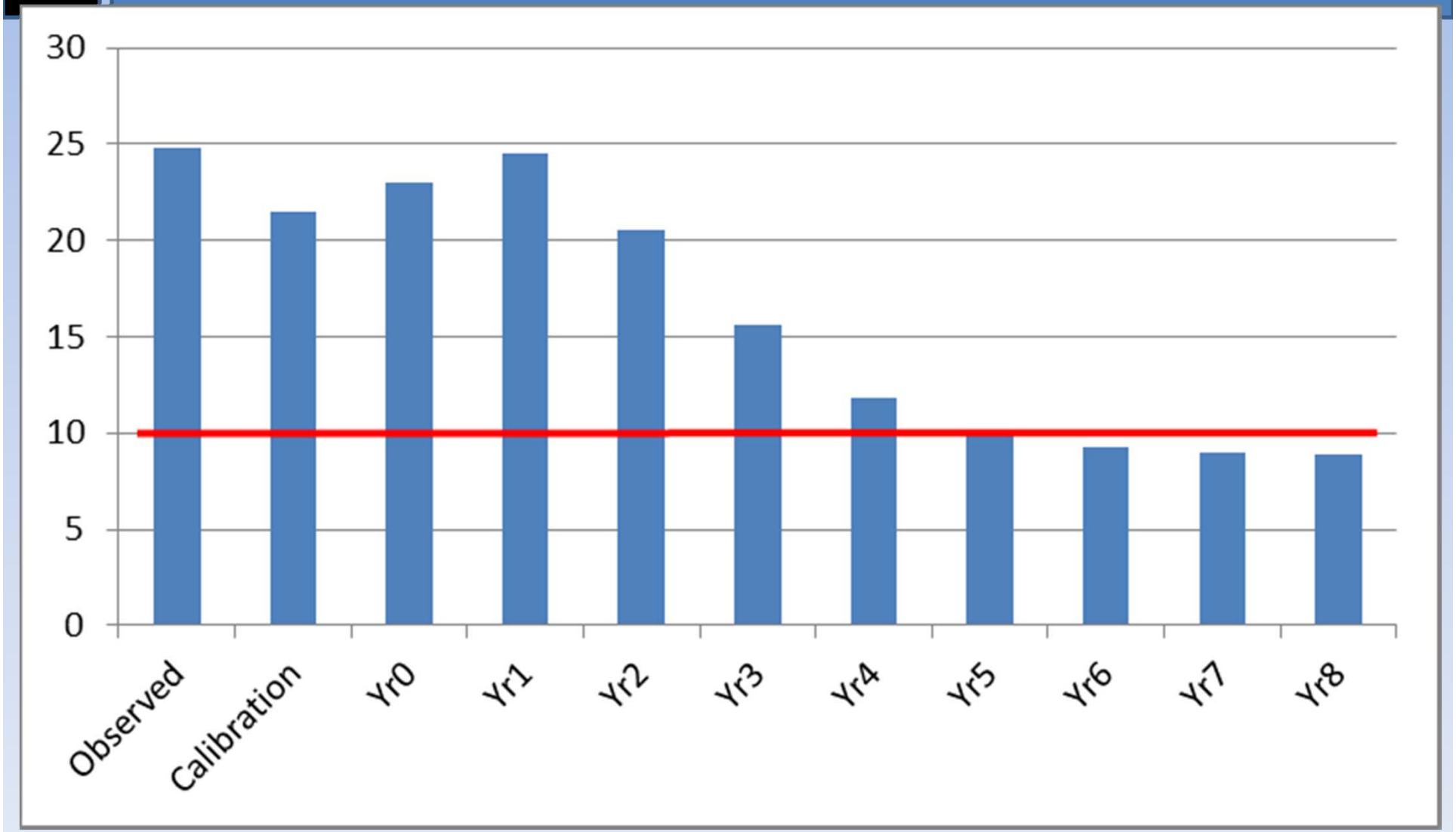
Model Projection (Anoxic Volume %)



Model Projection (Turbidity)



Model Projection (Chlorophyll-*a*)



35% Load Reduction & TMDL

- 35% load reduction expected to attain compliance with water quality targets
- TMDL computed from Long Term Average (LTA) load based on 35% reduction of existing loads
- Pollutant flow & loads are described by log-normal distribution
- Probability-based statistics of log-normal distribution of watershed loading data used to compute TMDLs

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Total Maximum Daily Loads (kg/day)

	Total-N	Total-P	BOD	Sediment
Existing, 2008-2009	322	63	647	31,487
Load Removal	35%	35%	0%	35%
Long-Term Average Load	209	41	647	20,466
Coeff_Var (CV)	4.25	4.40	4.77	5.82
TMDL	808	158	2,481	76,951

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How were WLAs assigned?

WLA %	Moore	Norman	OKC
Total Nitrogen (TN)	**26.1%**	**40.6%**	**33.3%**
Total Phosphorus (TP)	**28.9%**	**39.0%**	**32.1%**
CBOD	**32.2%**	**39.4%**	**28.3%**
Suspended Solids (TSS)	**21.7%**	**42.2%**	**36.1%**

WLAs were assigned based on the percentage of existing loadings

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Total Maximum Daily Loads (kg/day)

$$TMDL = \Sigma WLA + LA + MOS$$

WQ	TMDL	LA	WLA	WLA	WLA	MOS
			Moore	Norman	OKC	
Total-N	808	21	205	319	262	Implicit
Total-P	158	4	45	60	49	Implicit
BOD	2,481	57	781	956	687	Implicit
TSS	76,951	2,069	16,236	31,596	27,050	Implicit

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How were WLAs assigned?

- **No WLA for Midwest City and Noble**
  - Midwest City – 0.05% of total watershed
  - Noble - 0.26% of total watershed
- **No reductions for unincorporated area**

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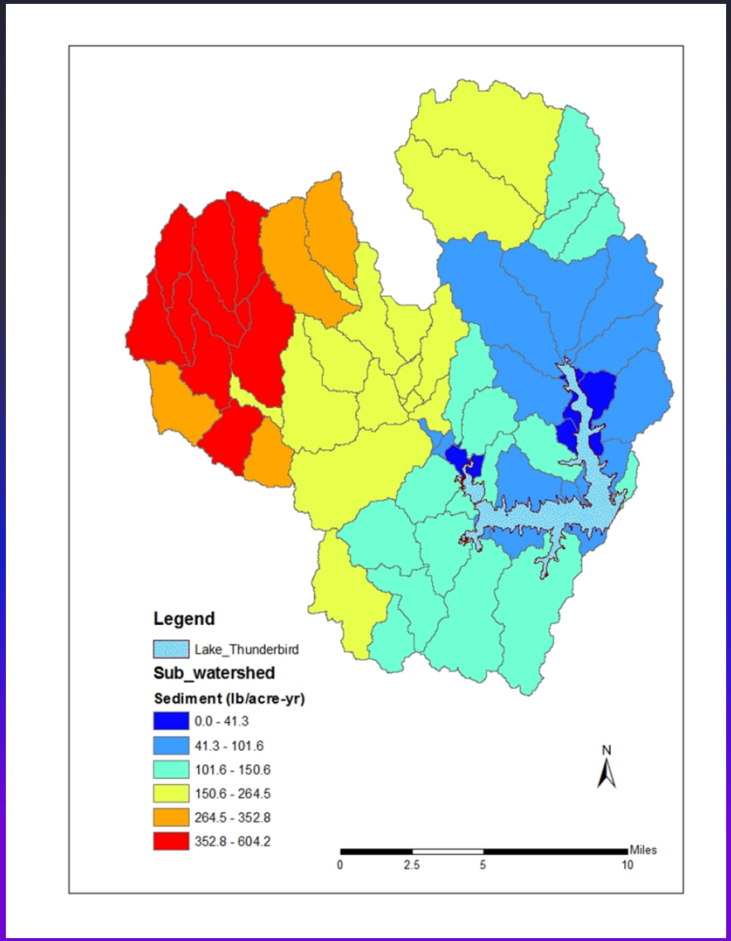
Implementation

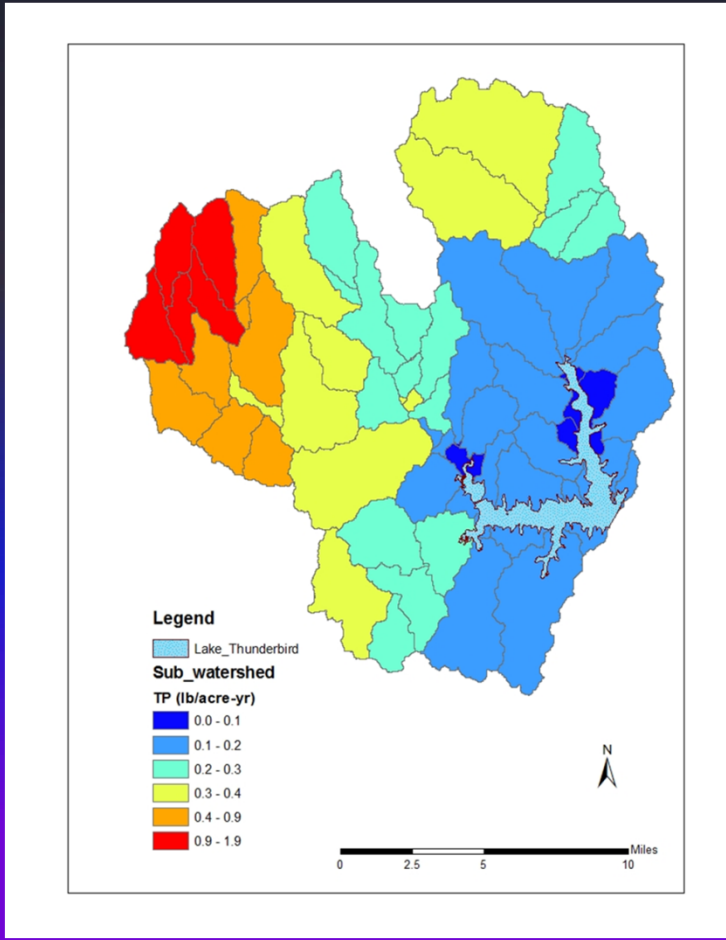
What measures are recommended or required in order to achieve a 35% reduction in pollutant loads?

Sediment Loading

TP loading

(Lb/Ac/Yr)





Lake Management

General Recommendations

- **Continue hypolimnetic oxygen injection project (COMCD)**
- **Continue/expand shoreline re-vegetation establishment (COMCD/OWRB)**
- **Consider establishing treatment wetlands on Little River arm above Twin Bridges**

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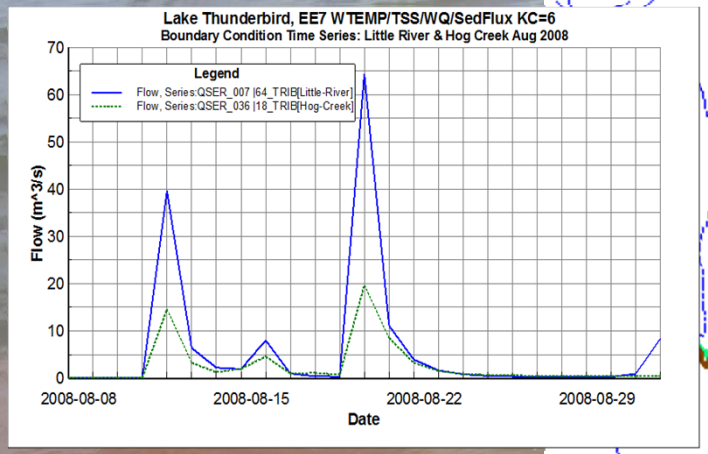
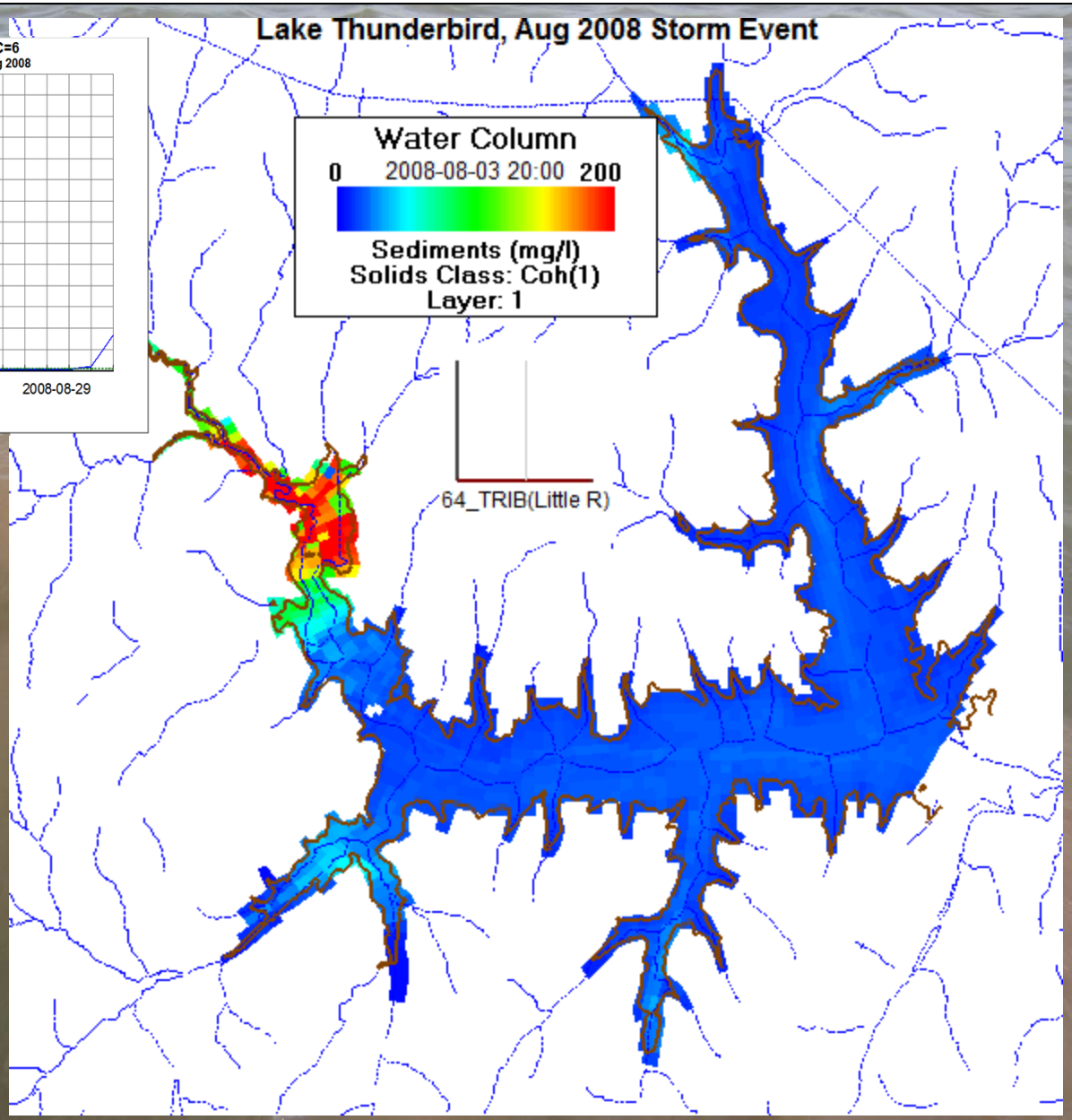
Aug-2008 Storm, Sediment





MS4 Permit Requirements

General Recommendations

- **Improve controls of sewer overflows**
- **Implement enhanced controls for on-site wastewater systems (septic tanks)**
- **Establish a stakeholder/citizen advisory committee**

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MS4 Permit Requirements

MS4s (Moore, Norman, OKC)

- Submit an approvable TMDL compliance Plan within **24 months** of EPA approval
  - Identify potential significant sources
  - Select a General Strategy for meeting the WLAs
  - Implement enhanced or more frequent construction site inspections. Consider enhanced enforcement measures.
  - Determine a schedule for achieving the WLA
  - Track BMP implementation
  - Implement educational programs

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MS4 Permit Requirements

MS4s (Moore, Norman, OKC) - continued

- Submit either a TMDL monitoring plan or a commitment to participate in a coordinated regional monitoring program within **24 months** of EPA approval
- Monitoring program shall be fully implemented within **3 years** of EPA approval
- Utilize the monitoring data to evaluate effectiveness of BMPs and demonstrate progress toward attaining the WLAs
- If progress cannot be shown, revise the compliance plan
- Annual Reporting

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Construction Site Permit Requirements

Stormwater Construction General Permit (OKR10)

- **Meet all conditions in Construction General Permit (OKR10)**
- **Additional general requirements under this TMDL**
  1. **Comply with any additional pollutant prevention or discharge monitoring requirements established by the local MS4 municipalities.**
  2. **Submit to the DEQ all Storm Water Pollution Prevention Plans (SWP3) for sites of five acres or larger**

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Construction Site Permit Requirements

- **Site-specific requirements in all authorizations issued by DEQ in the Lake Thunderbird watershed**
  - **Vegetated buffer: 100 ft minmum for all streams (or equivalent controls)**
  - **Sediment basins for all locations draining 5 acres or more**
  - **Weekly site inspections**
  - **Quicker corrective actions**
  - **Immediate stabilization**
  - **Soil nutrient testing before using fertilizer**

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Industrial Stormwater Permit Requirements

Industrial Stormwater

- **Meet conditions in Multi-Section General Permit (OKR05)**
- **Additional requirements under this TMDL**
  - **Update the SWP3 for additional TSS & nutrient reduction measures within 12 months**
  - **Monthly inspection & maintenance**
  - **Monitoring and reporting once a month if the permit has numeric effluent limits**
  - **Comply with any additional pollutant prevention or discharge monitoring requirements established by the local MS4 municipalities**
- **Applies to – Asphalt Paving, Concrete Products, Sand & Gravel Mining**

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QUESTIONS ?