

**Segment 1426 of the Colorado River  
Chloride and Total Dissolved Solids  
Total Maximum Daily Load Development**

**Ballinger, Texas**

Meeting #4  
October 13, 2005



## Recap from Meeting 3

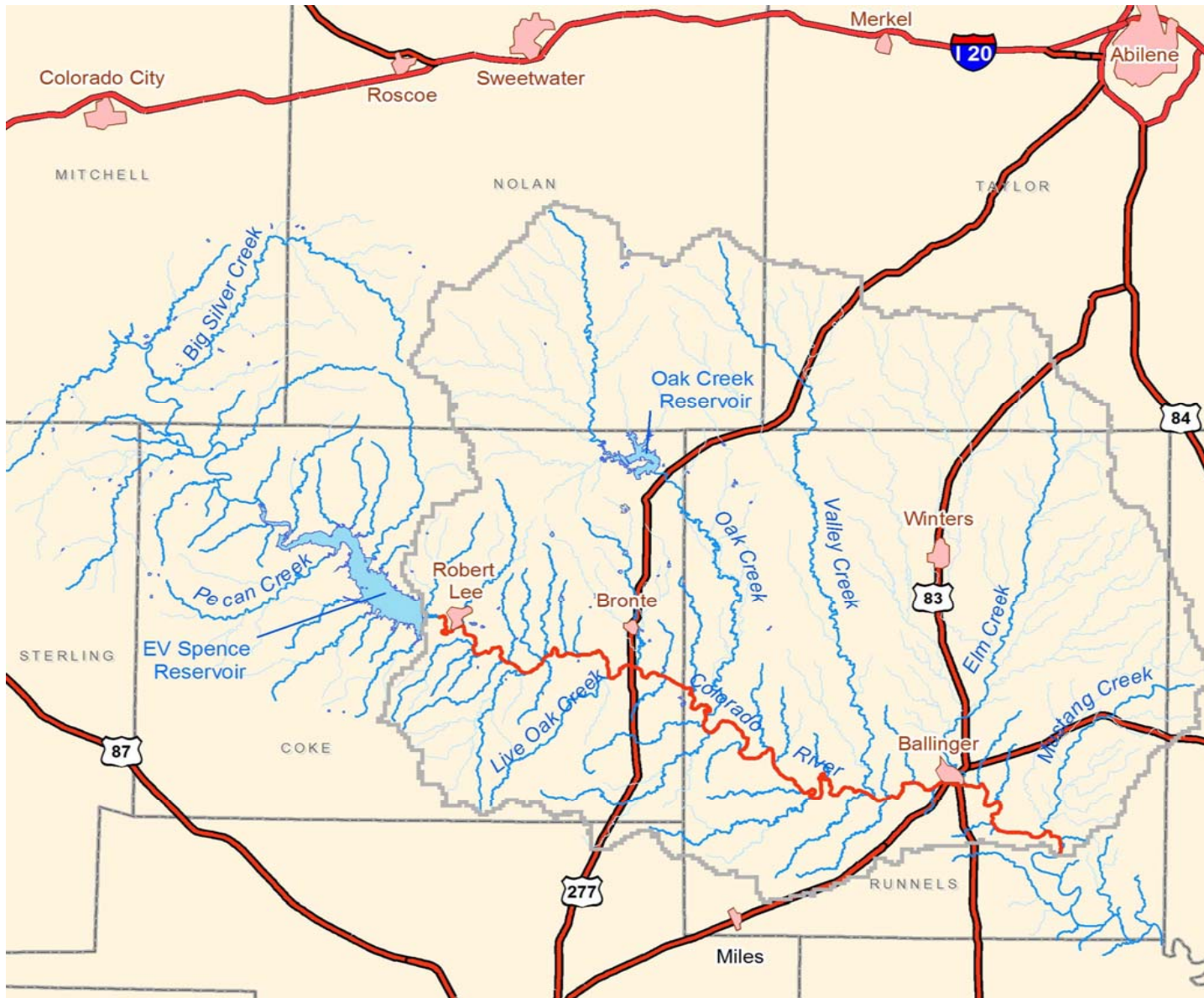
- Explained the TMDLs: What is? Why? Which segment? How?
- Presented and reviewed the steps and the data needed in the development of the TMDL for the listed segment 1426 of the Colorado River
- Reviewed environmental monitoring data
- Discussed the potential causes of impairment
- Presented preliminary model results

# Colorado River Listed Segment

Based on the 2000 303(d) List

- **Upstream Limit:**
  - Robert Lee Dam
- **Downstream Limit:**
  - A point 2.3 miles below Mustang Creek Confluence
- **Segment Length:**
  - 66 miles
- **Water Quality Standards:**
  - Chloride = 610 mg/L
  - Sulfate = 980 mg/L
  - Total Dissolved Solids = 2,000 mg/L

# Colorado River-Segment 1426



## Legend

- Urban Areas
- Counties
- Waterbodies
- Project Watershed
- Listed segment
- Highways



## MAP INDEX

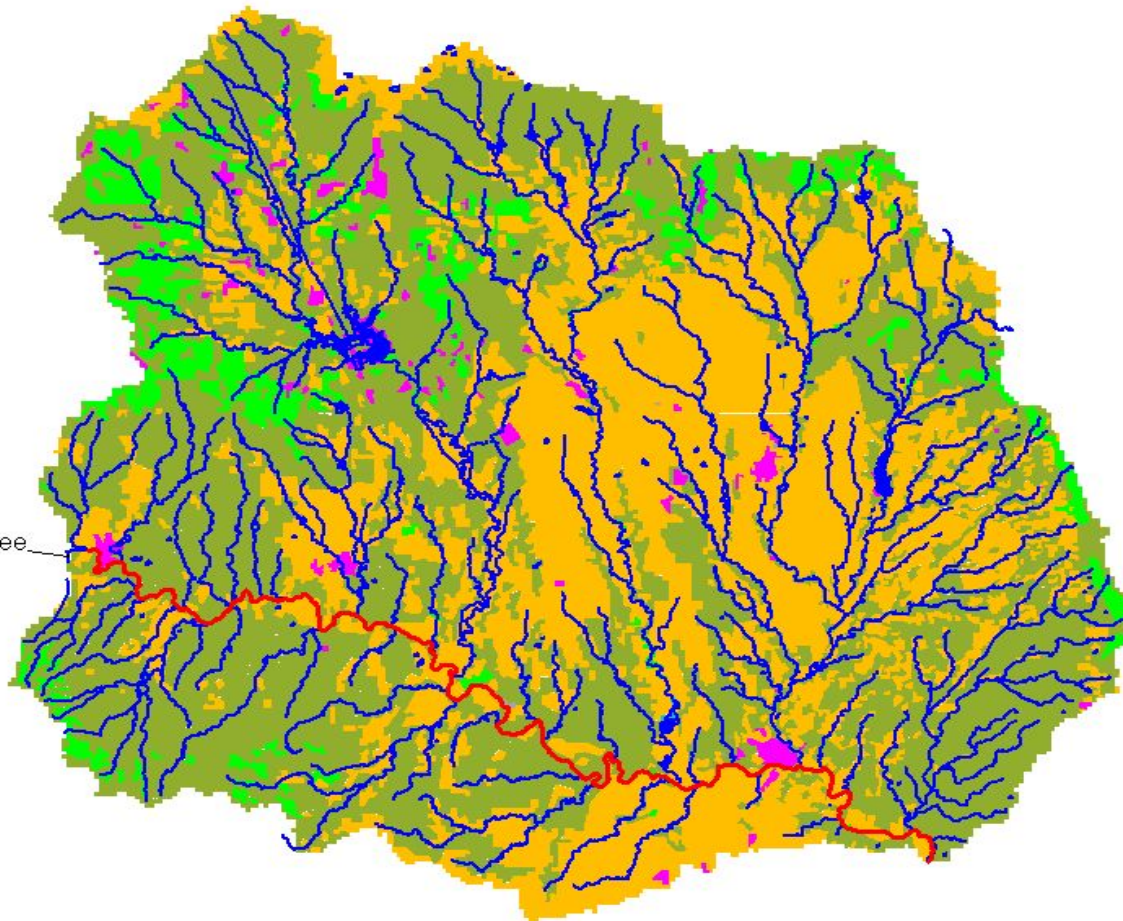


0 250 500 1,000 Miles

# Colorado River-Segment 1426 Land Use

- **Watershed Area is 1,100,000 acres**
- **Dominant land uses**
  - **53% Rangeland**
  - **39% Agriculture**

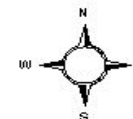
Robert Lee Dam



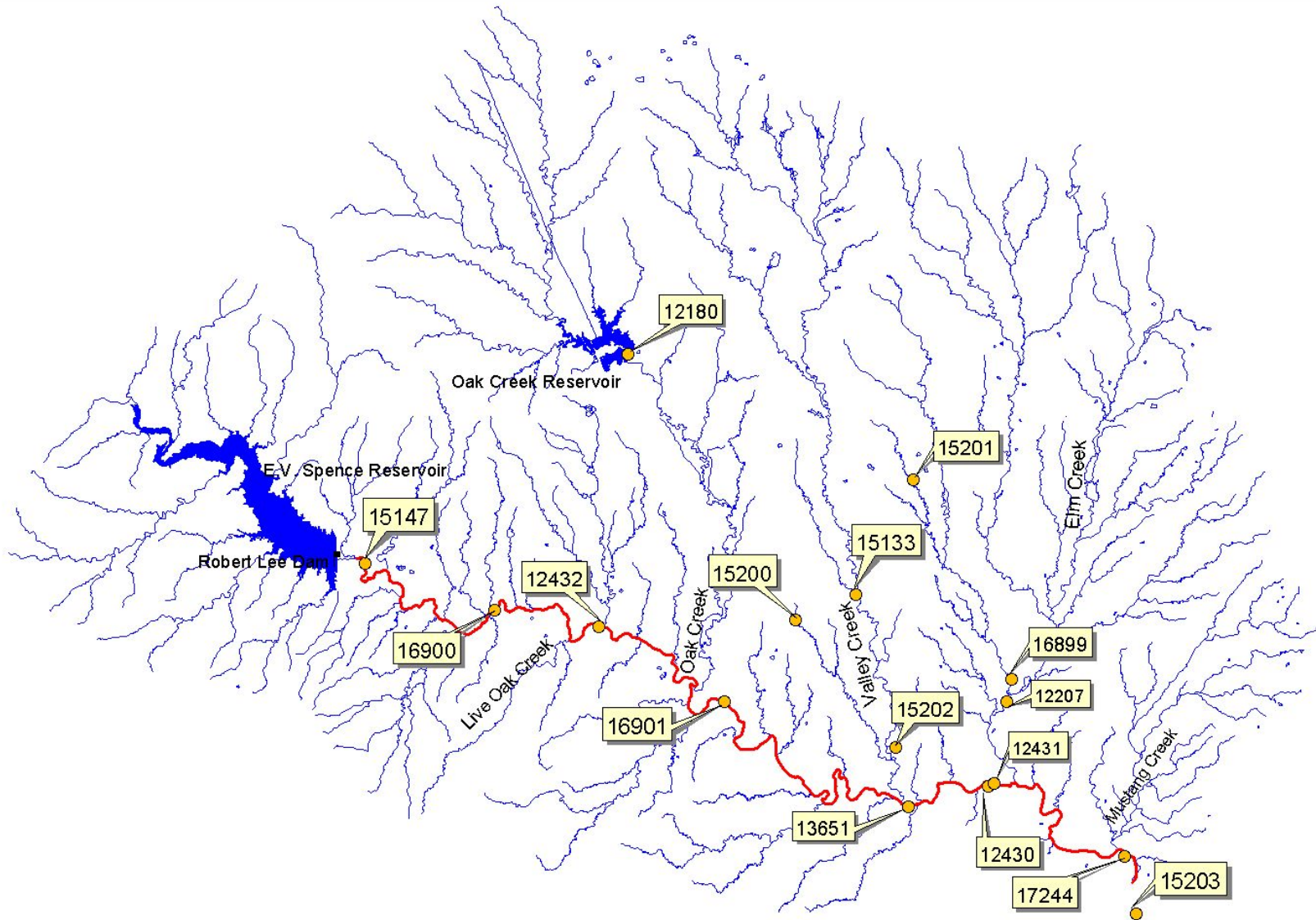
1 0 1 2 3 4 5 6 7 8 9 10 Miles



**Colorado River (Segment Number 1426)  
Land Use/Land Cover**

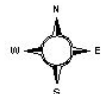


# Environmental Monitoring



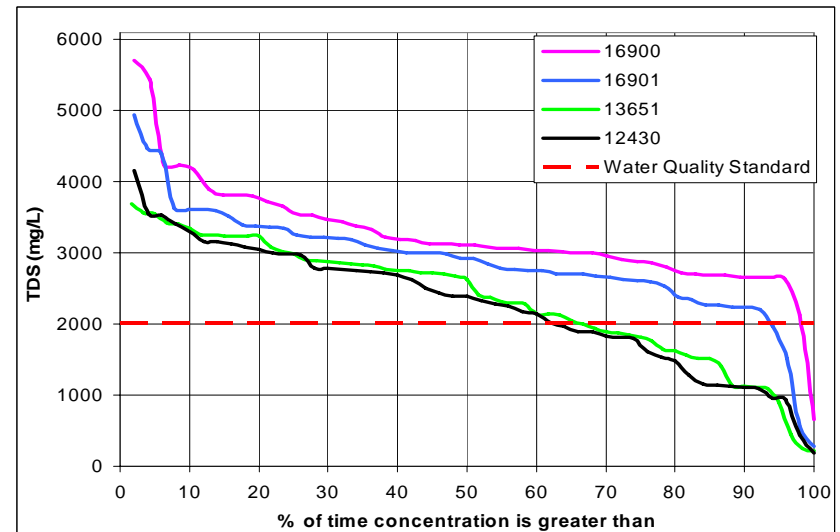
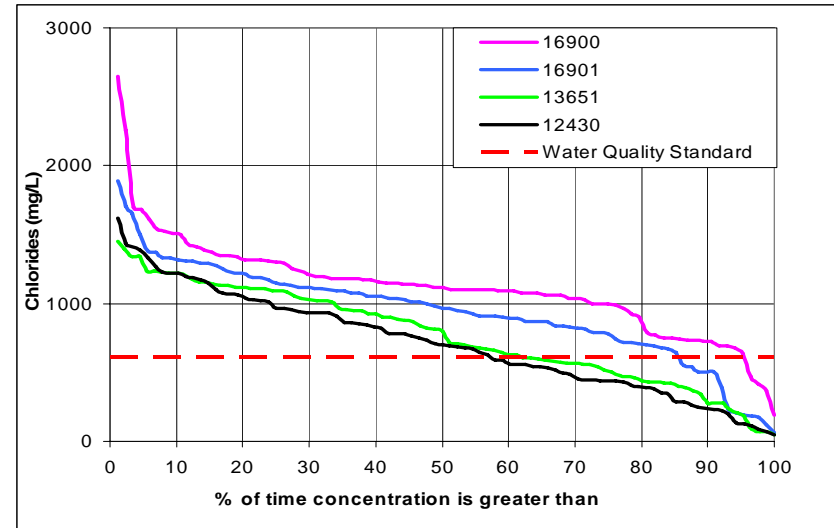
- ▬ Dam
- Monitoring Stations
- Listed Segment #1426
- ~ Streams

Colorado River Segment #1426  
 Water Quality Monitoring Stations

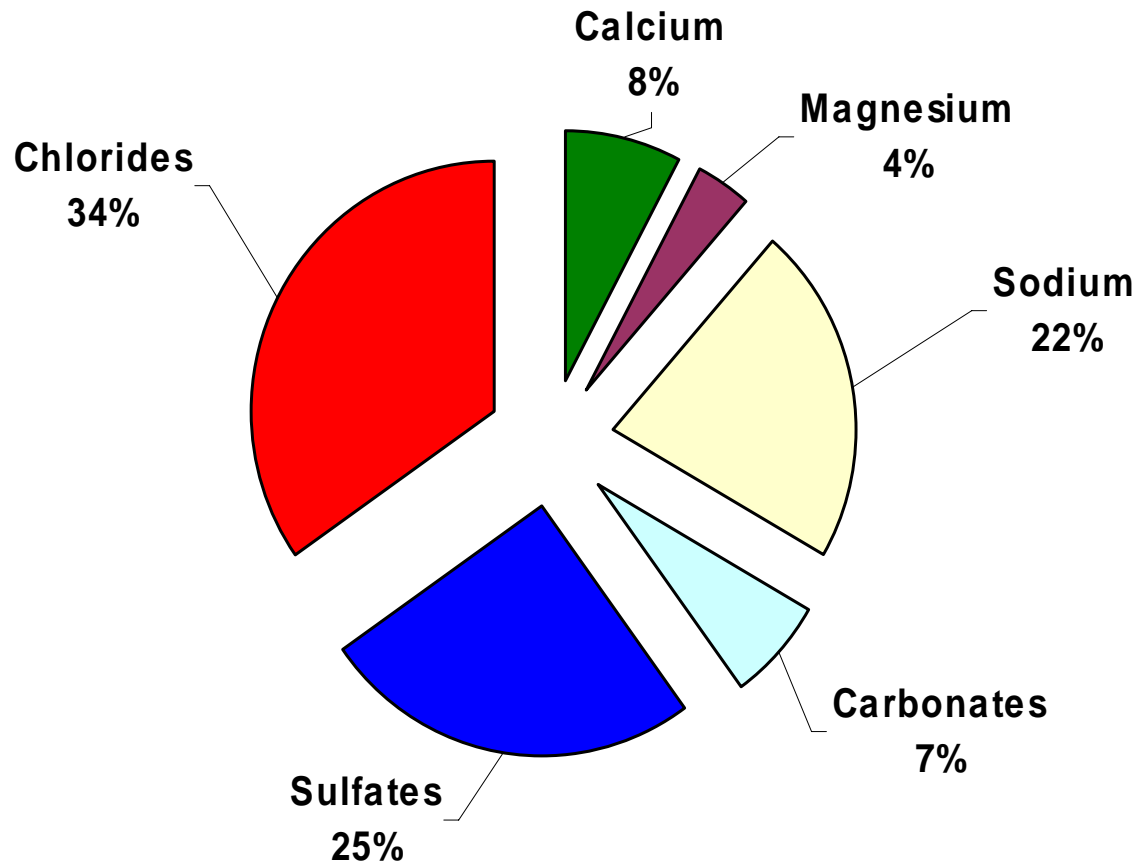


# Water Quality Concentrations

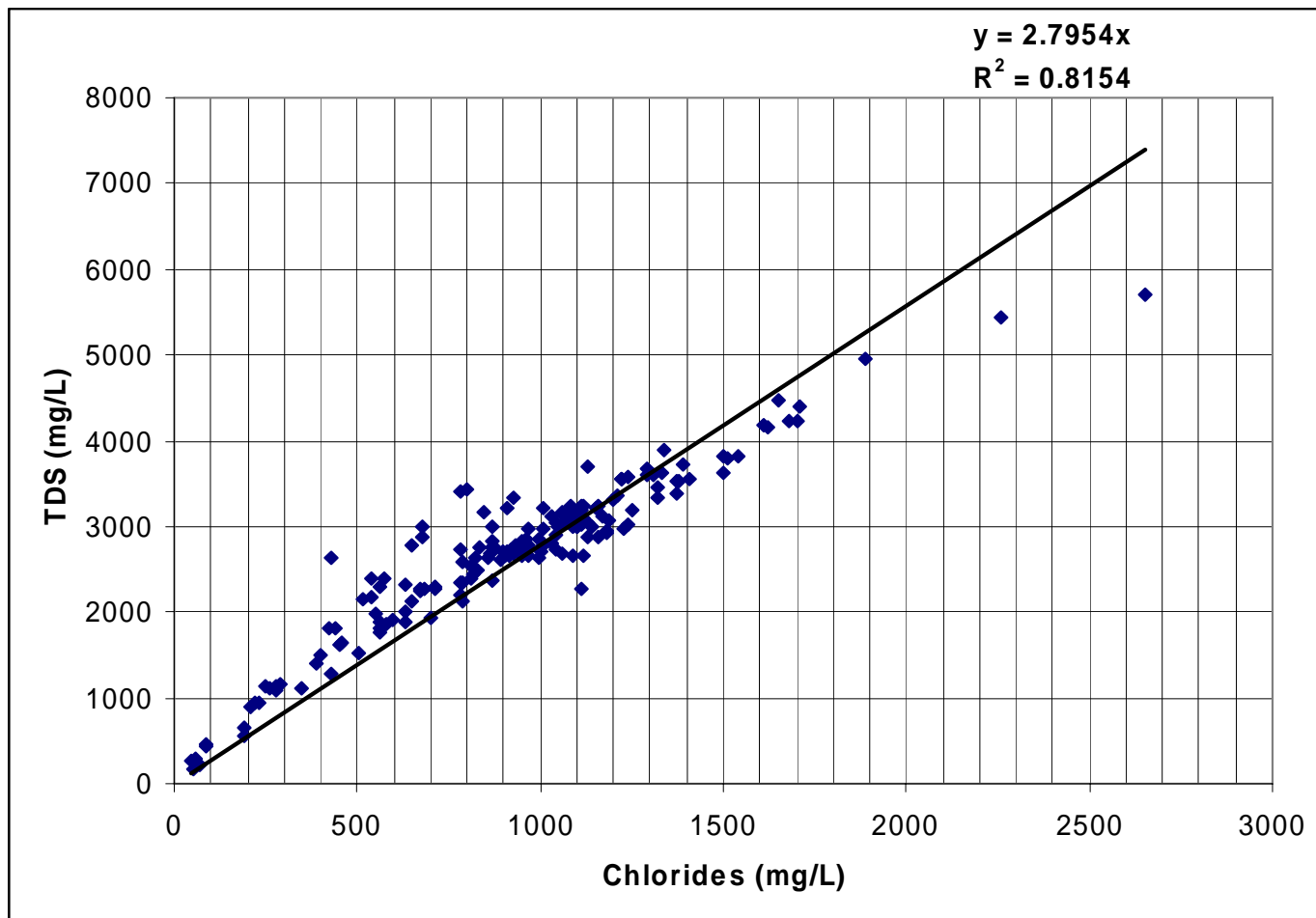
- At each station, constituent concentrations (TDS and chlorides) were plotted with their frequency distributions
- All the stations showed similar frequency distribution trends for chlorides and TDS
- Chloride and TDS concentrations decrease downstream indicating that the E.V. Spence Reservoir is the major source of chloride and dilution is taking place



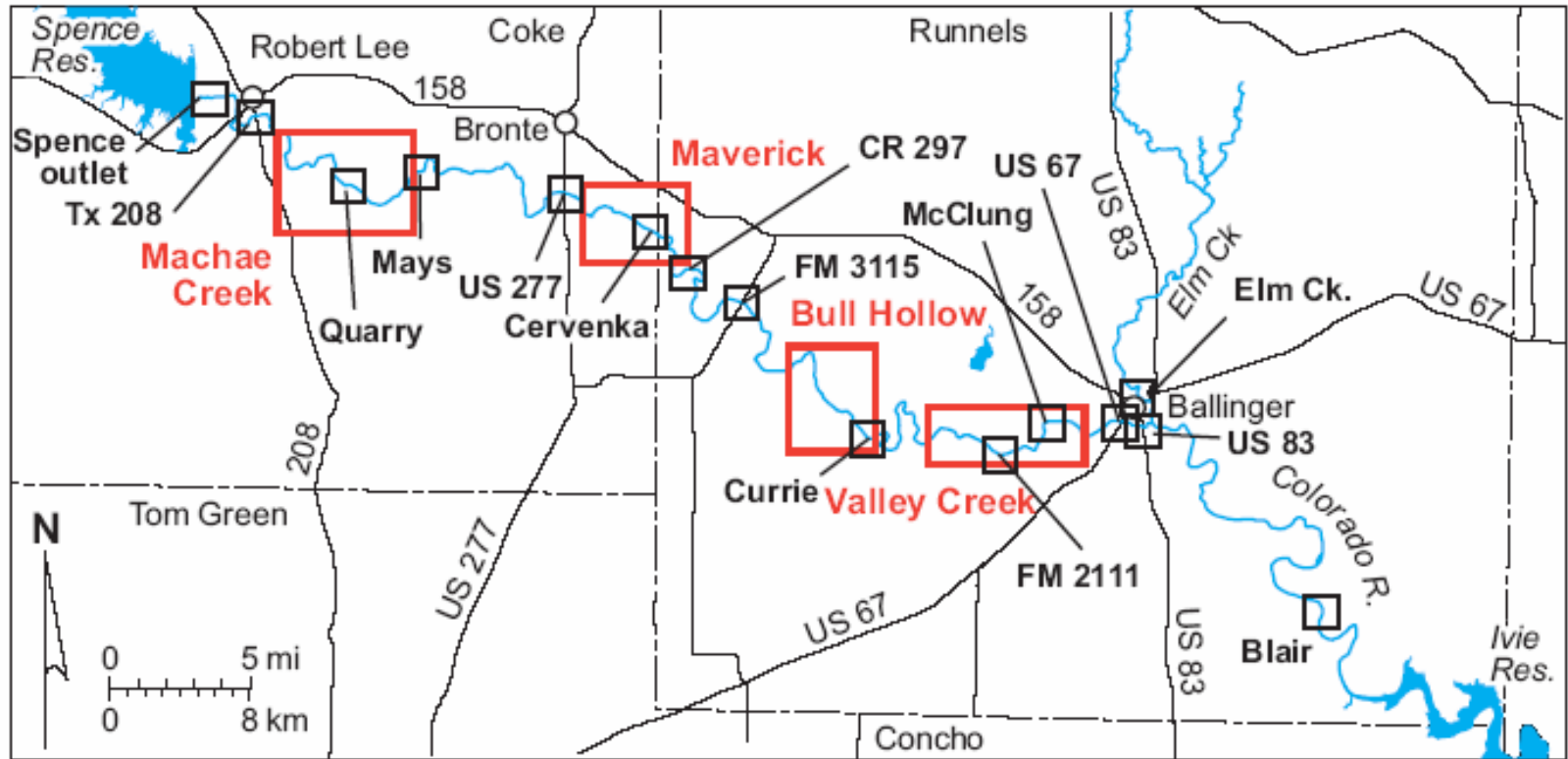
# TDS Composition



# Correlation between TDS and Chlorides



# Airborne Geophysical Survey



□ Water measurement locations

The study delineated four problem areas in the watershed

- Machae Creek Area - Oilfield brine is primary contributor of increases salinity, rather than groundwater
- Maverick Area - No evidence of near-surface salinization. Increased salinity occurs mostly from groundwater base-flow contributions (i.e., natural geologic sources)
- Bull Hollow Area - Increase attributed to groundwater base-flow contributions (i.e., natural geologic sources)
- Valley Creek Area - Increase attributed to groundwater base-flow contributions (i.e., natural geologic sources)

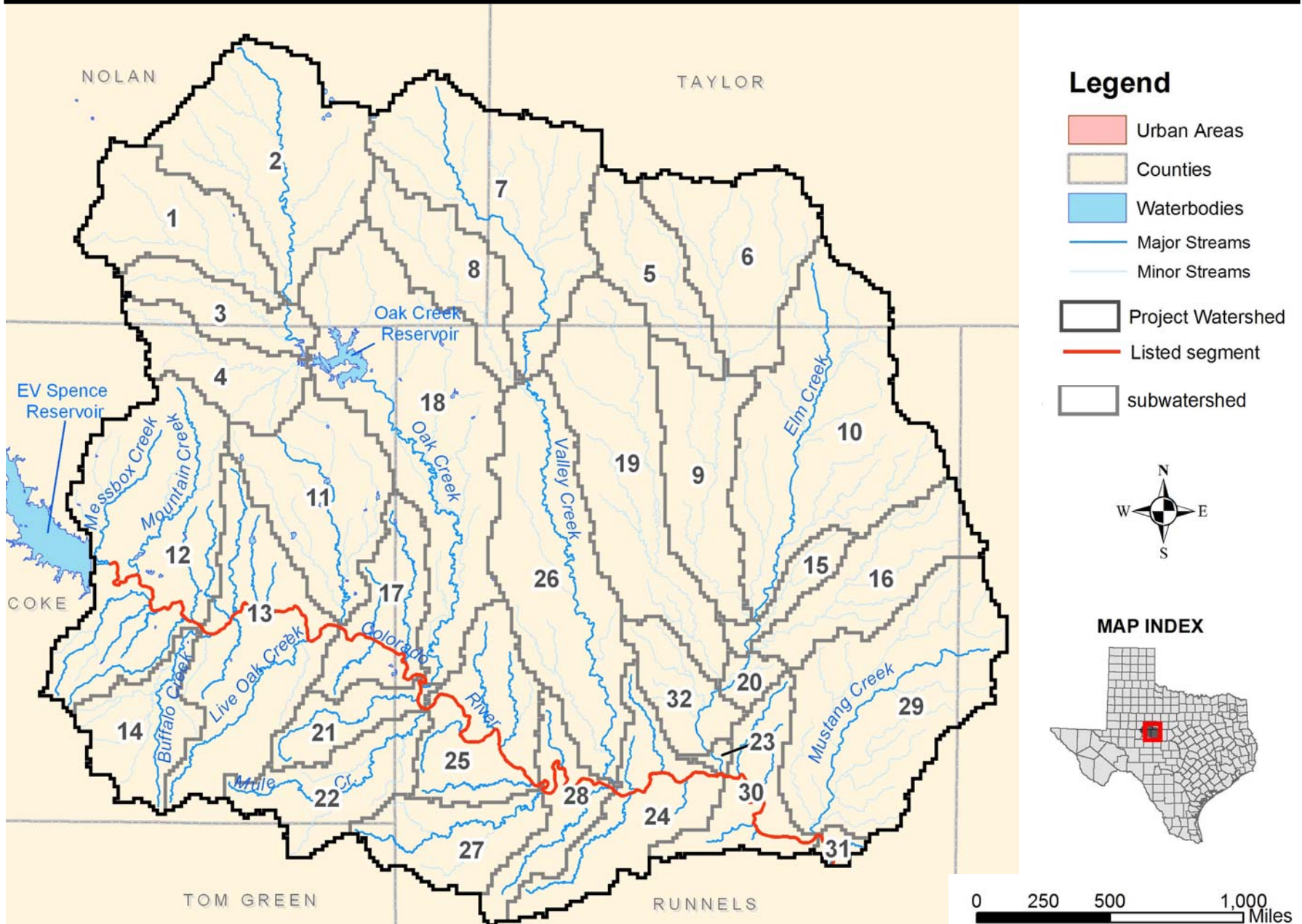
# Modeling/Simulation

# Water Quality Model

## Source Representation:

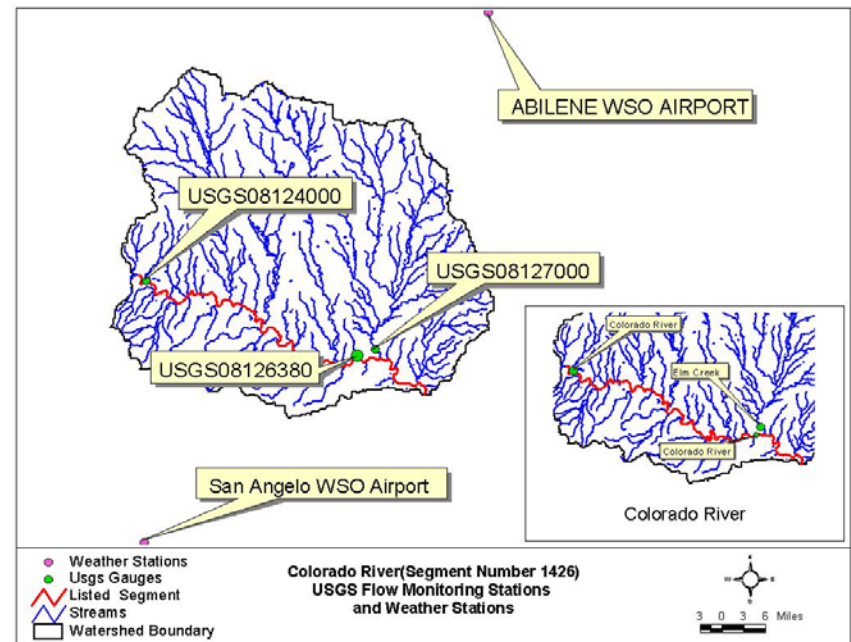
1. Deep loads – Ground water:
  - Produced water
2. Shallow loads – Surface water and interflow
  - Salt Cedar
  - Abandoned brine pits
3. Boundary Condition (EV Spence Reservoir)
  - Chloride concentration
  - Observed flow (release)

# Model Segmentation

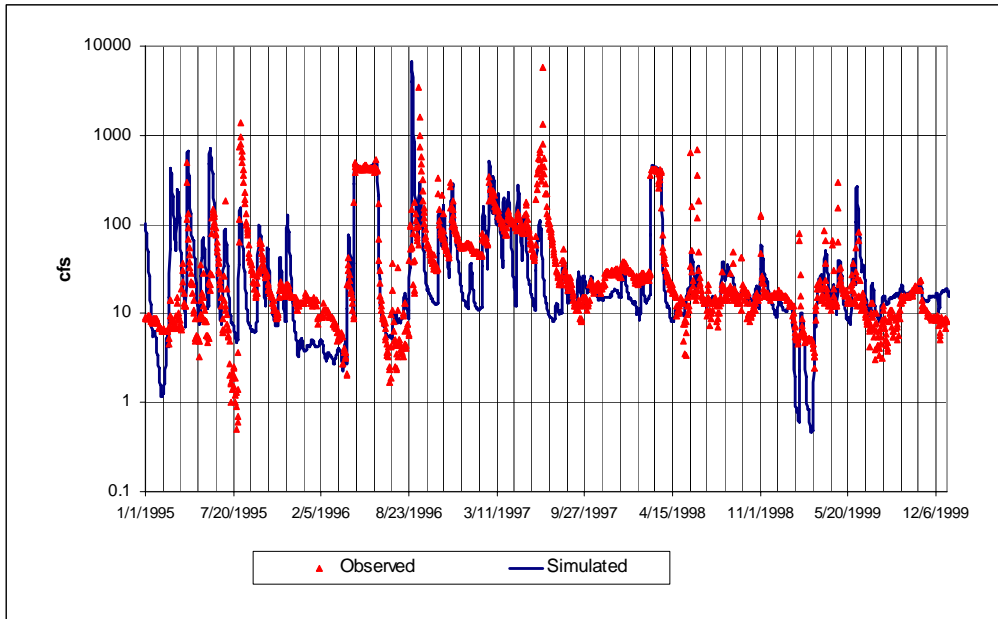


# Stream Flow and Weather Data

- Two weather stations:
  - San Angelo airport
  - Abilene airport
- Three stream flow stations:
  - USGS08124000
  - USGS08126380
  - USGS08127000

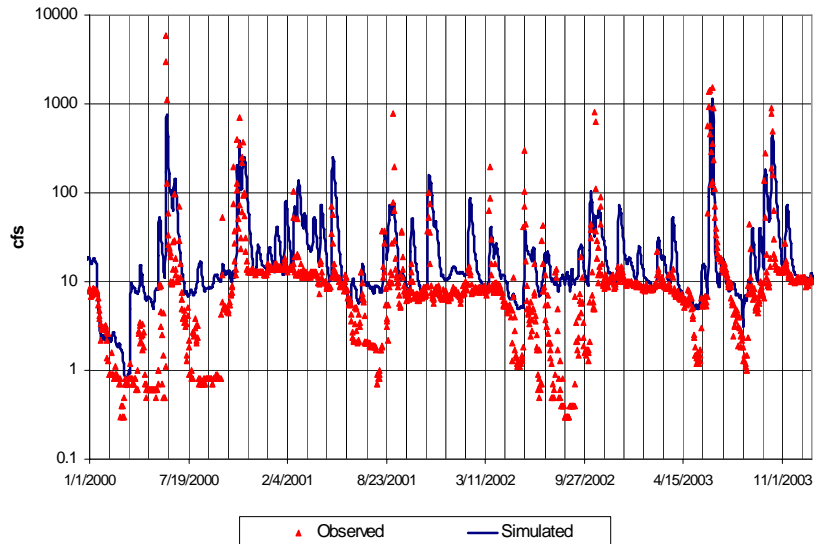


# Hydrology Model Calibration



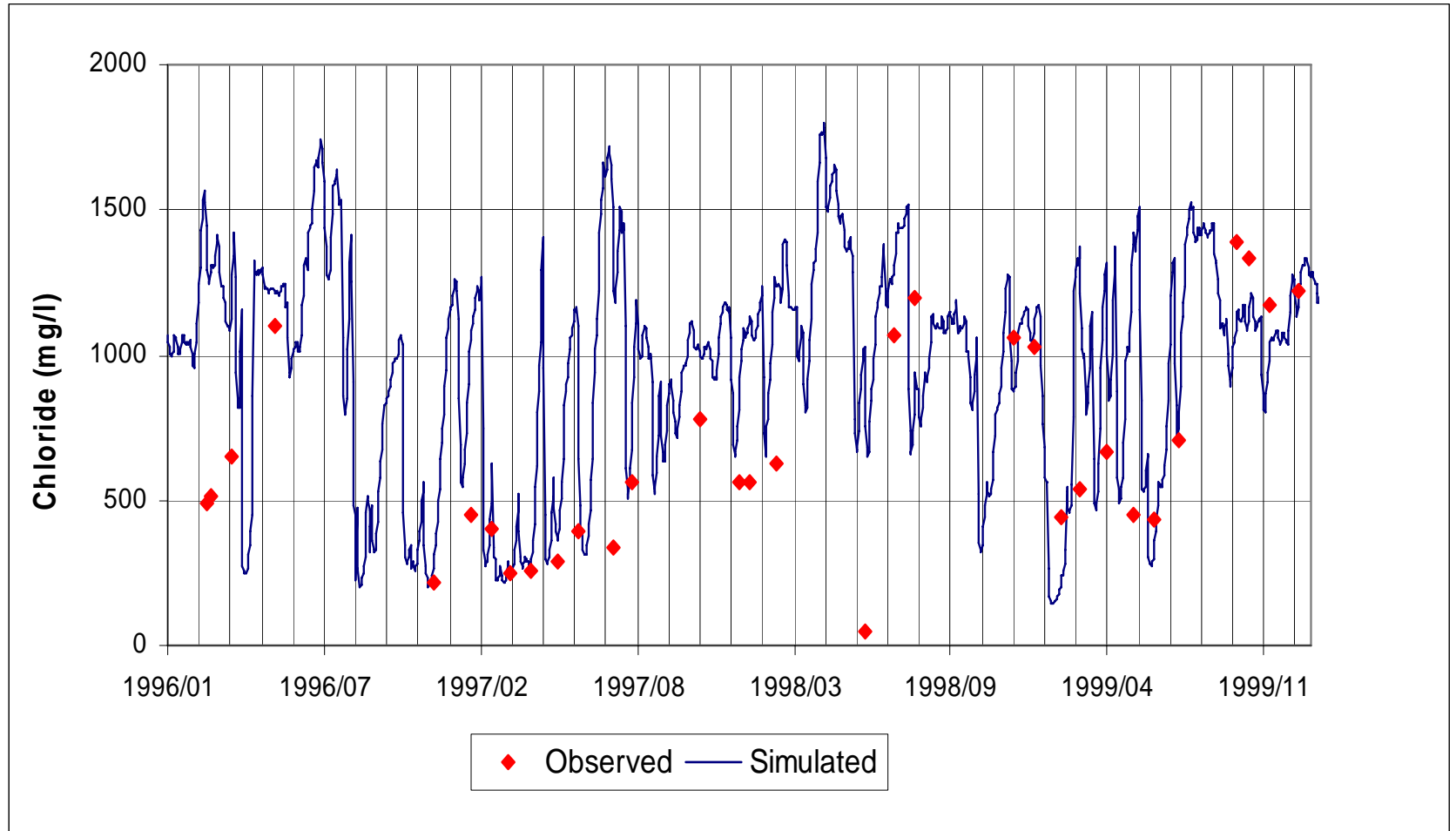
Category	Simulated	Observed
Total simulated in-stream flow (cfs)	120,111	119,081
Total of highest 10% flows (cfs)	71,328	77,310
Total of lowest 50% flows (cfs)	10,636	10,860
Summer flow volume (cfs)	32,888	38,270
Winter flow volume (cfs)	12,596	13,881

# Hydrology Model Validation

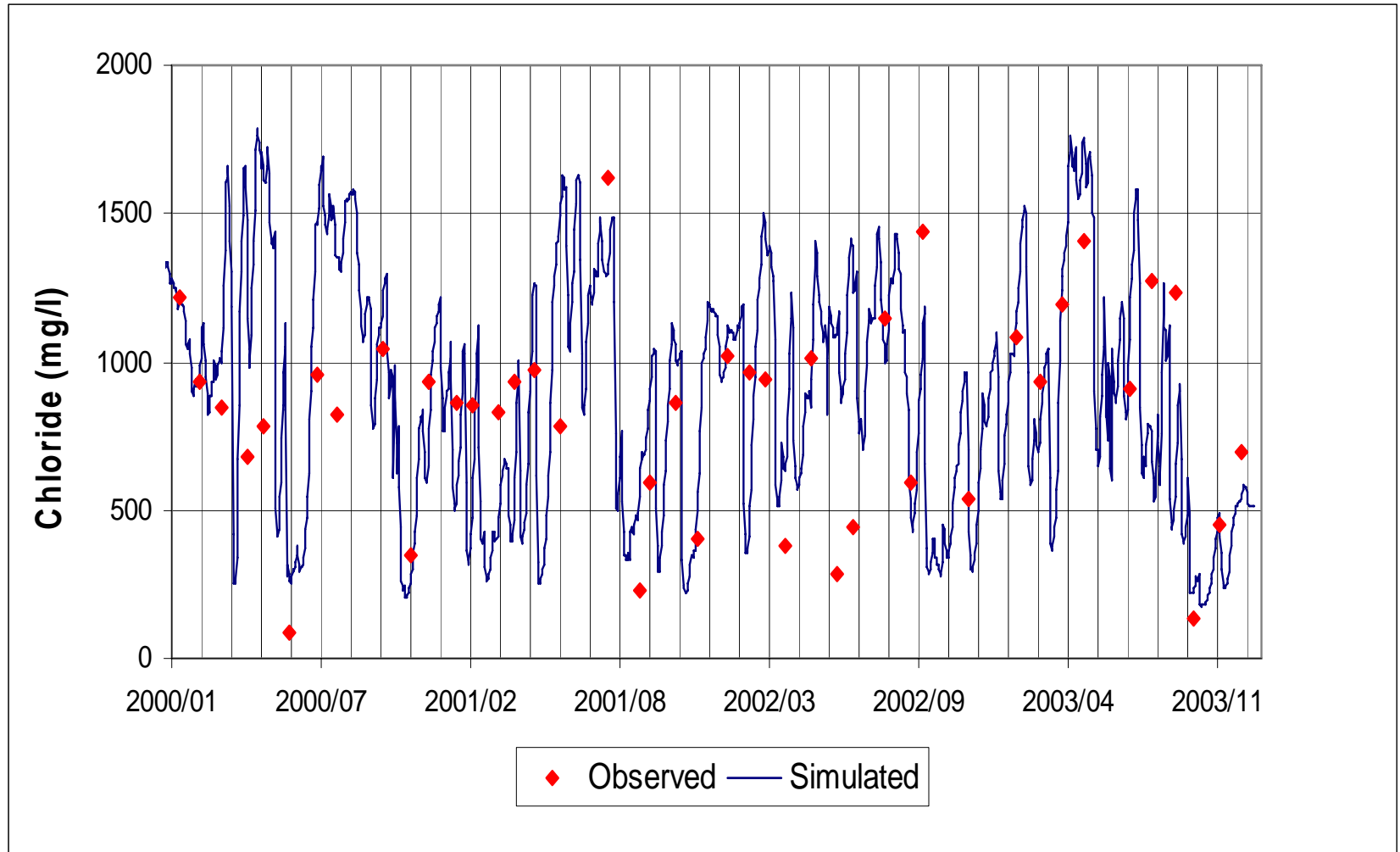


Category	Simulated	Observed
Total simulated in-stream flow, in (cfs)	45,258	41,347
Total of highest 10% flows (cfs)	26,223	32,189
Total of lowest 50% flows (cfs)	6,185	2,650
Summer flow volume (cfs)	11,927	16,282
Winter flow volume (cfs)	7,244	3,527

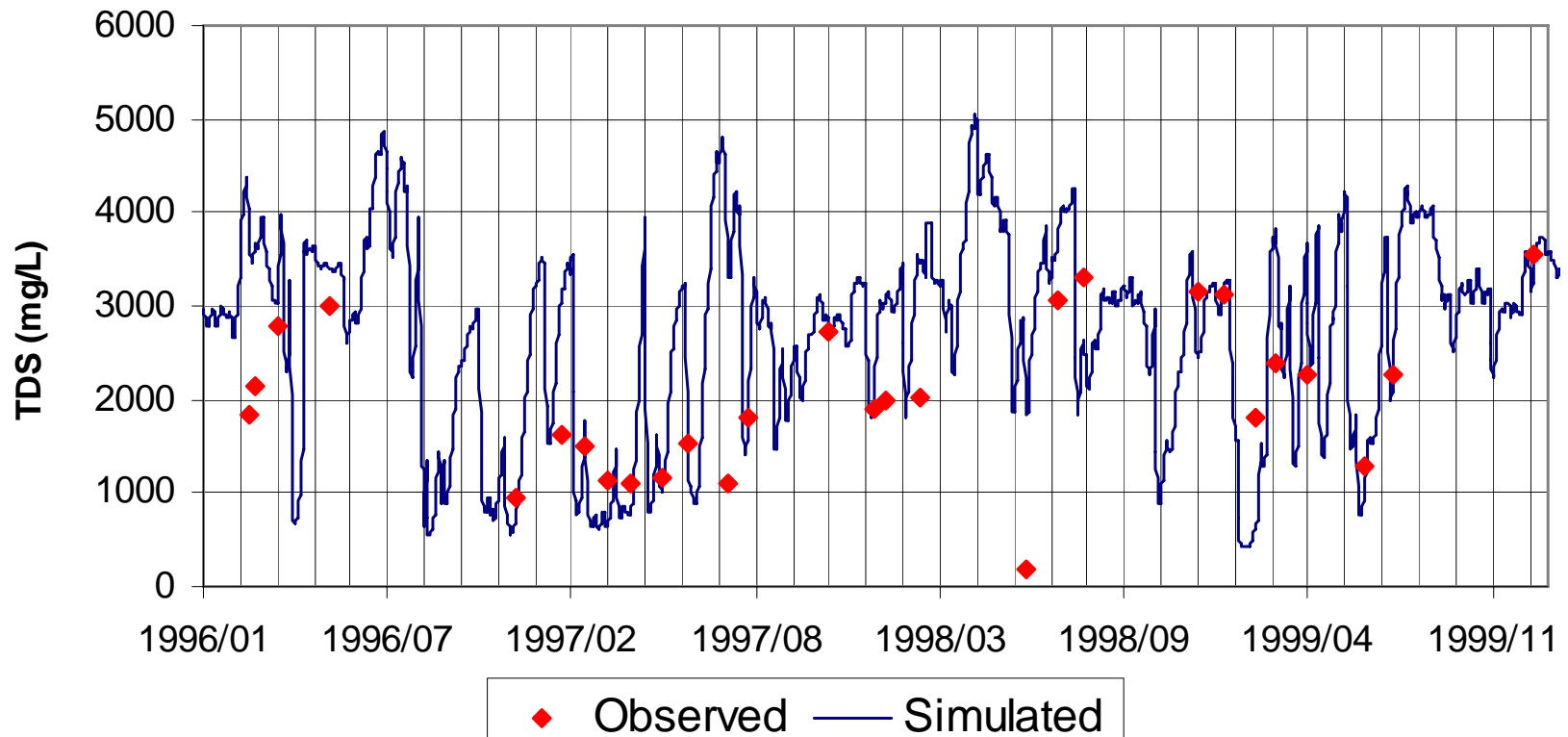
# Model Calibration for Chloride at Station 12430



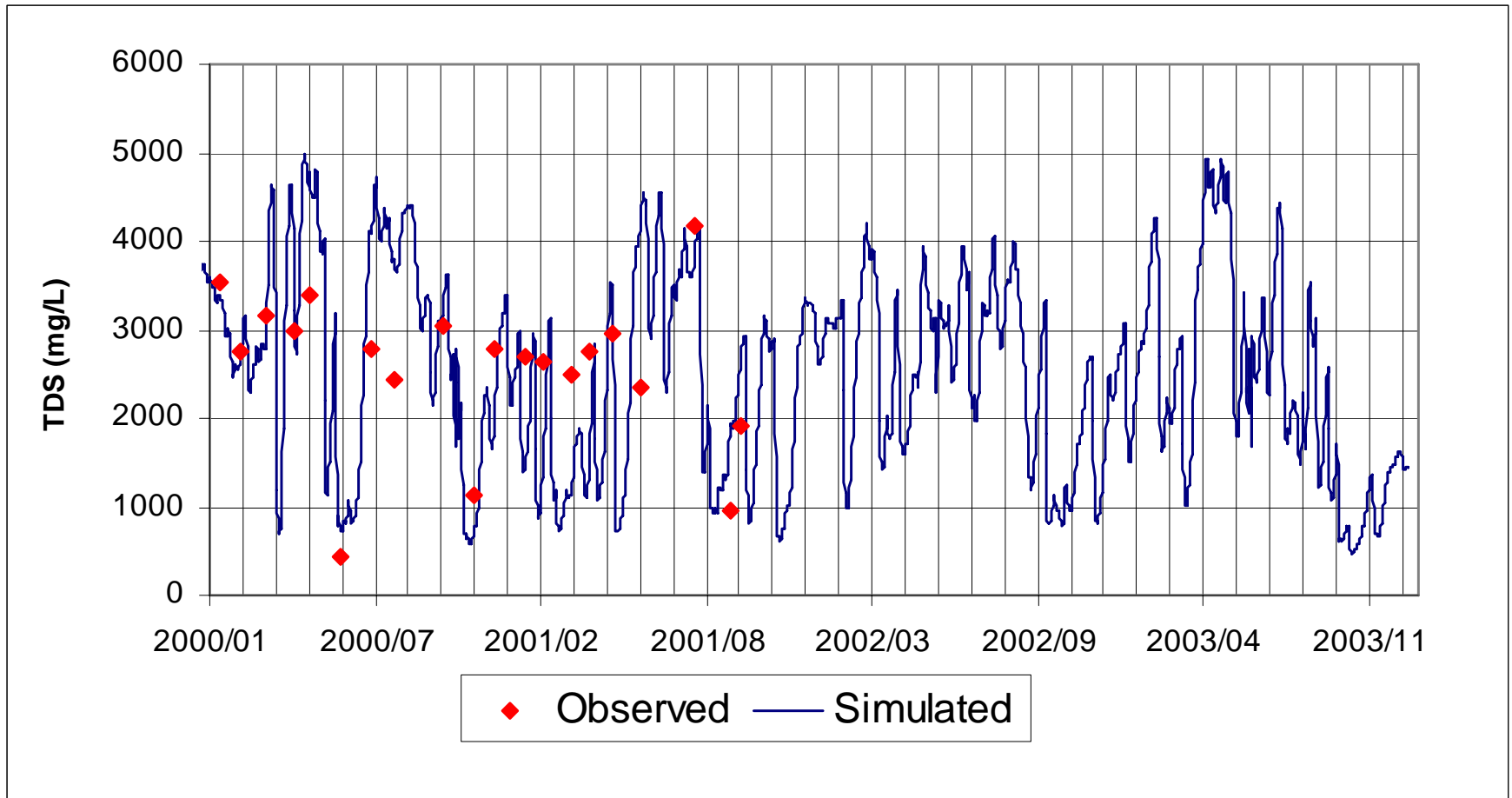
# Model Validation for Chloride at Station 12430



# Model Calibration for TDS in Colorado River - Station 12430



# Model Validation for TDS in Colorado River - Station 12430

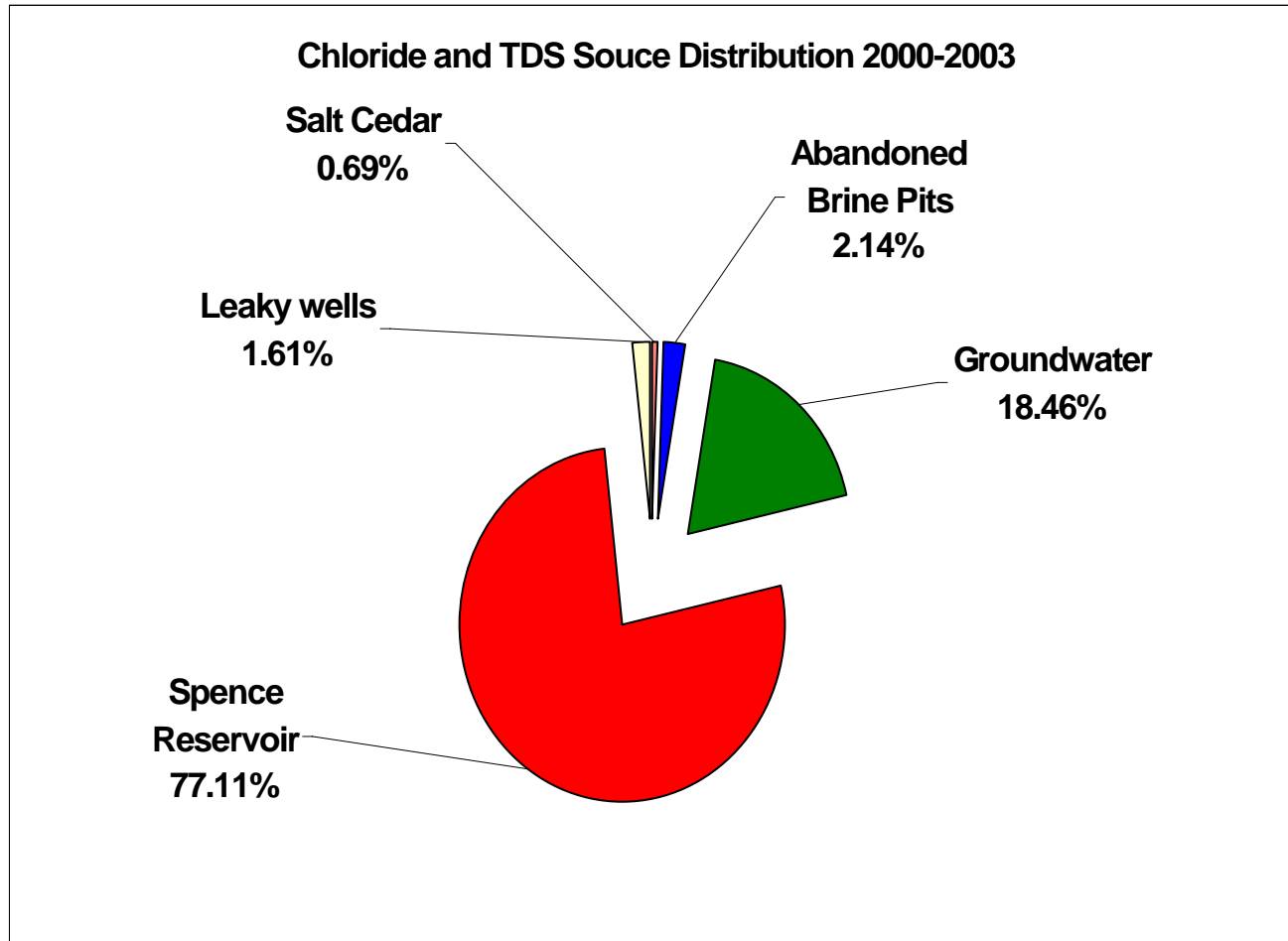


# Source Loading Estimates

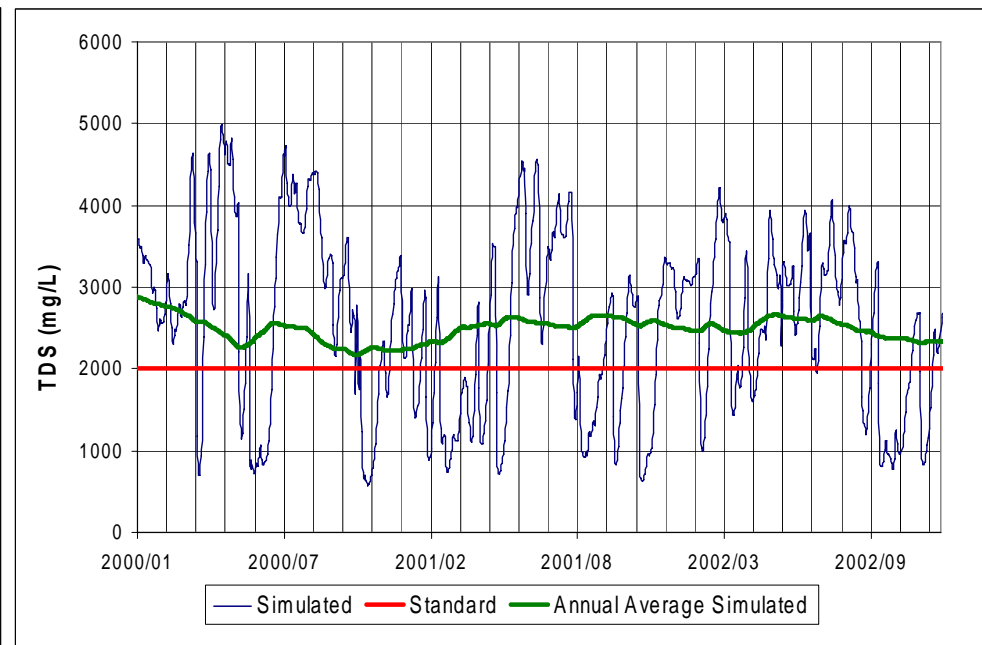
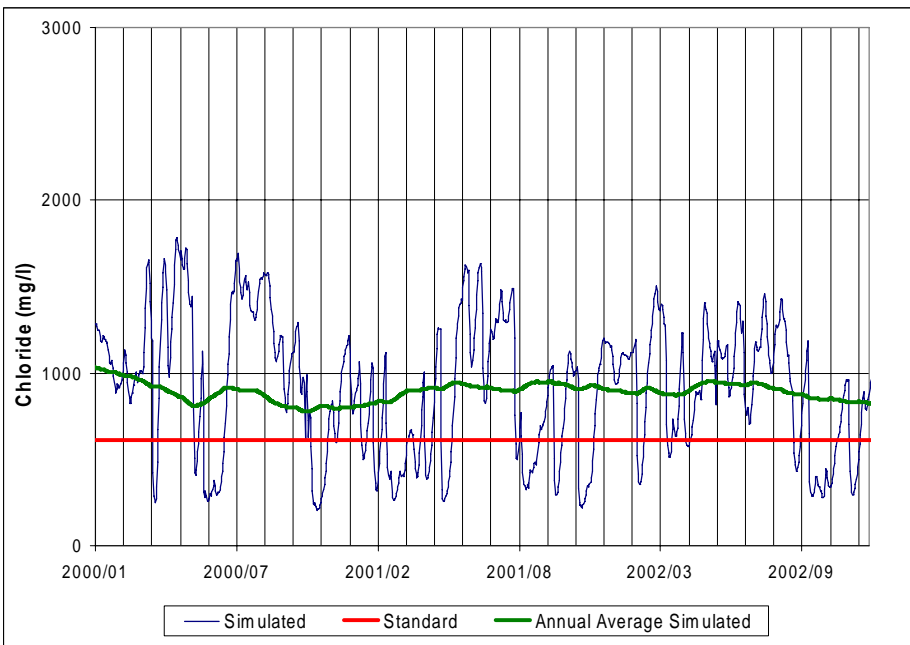
# TDS and Chloride Existing Load Distributions by Source

Source	Annual Average Loads (Lbs/Year)			
	Chloride	% Total	TDS	% Total
Upstream Boundary	21.28E+6	77.11	59.49E+6	77.11
Produced Water	0.444E+6	1.61	1.842E+6	1.61
Abandoned brine pits	0.589E+6	2.13	1.647E+6	2.13
Groundwater	5.094E+6	18.46	14.24E+6	18.46
Salt Cedar	0.19E+6	0.69	0.531E+6	0.69
<b>Total</b>	<b>2.76E+7</b>	<b>100</b>	<b>7.78E+7</b>	<b>100</b>

# Chloride and TDS Load Distribution under Existing Conditions



# Loading Under Existing Conditions



# Chloride and TDS Load Distributions by Source under the Base Case Conditions

Source	Annual Average Loads (Lbs/Year)			
	Chloride	Total (%)	TDS	Total (%)
Spence Reservoir	1.41E+08	95.6	3.93E+08	95.6
Produced Water	4.44E+05	0.3	1.84E+06	0.3
Abandoned Brine Pits	5.89E+05	0.4	1.65E+06	0.4
Groundwater	5.09E+06	3.5	1.42E+07	3.5
Salt Cedar	1.90E+05	0.1	5.31E+05	0.1
Point Sources	1.79E+05	0.1	3.76E+05	0.1
<b>Total</b>	<b>1.47E+08</b>	<b>100</b>	<b>4.12E+08</b>	<b>100</b>

# Allocation Scenarios Framework: Chloride and TDS

Scenario	Reductions				
	Upstream Boundary	Abandoned Brine Pits	Leaking Wells	Groundwater	Salt Cedar
<b>0 (Existing Conditions)</b>	0	0	0	0	0
<b>1 (Base Conditions)</b>	0	0	0	0	0
<b>2</b>	50	0	0	0	
<b>3</b>	50	100	0	0	0
<b>4</b>	50	0	100	0	0
<b>5</b>	50	0	0	0	100
<b>6</b>	50	100	100	0	100
<b>7</b>	E.V. Spence at Standard	0	0	0	0

# Load Reduction Analyses for Chloride and TDS

Scenario Number	Reduction in Loadings from Existing Conditions (%)					Percent of Time the Annual Average Standard is Violated (%)	
	Upstream Boundary	Abandoned Brine Pits	Leaking wells	Ground water	Salt Cedar	Chloride	TDS
0	0	0	0	0	0	100	100
1	0	0	0	0	0	100	100
2	50	0	0	0	0	100	100
3	50	100	0	0	0	100	100
4	50	0	100	0	0	100	100
5	50	0	0	0	100	100	100
6	50	100	100	0	100	100	100
7	Water Quality Standard Attained	0	0	0	0	0	0

For scenarios 1 to 7 Spence Reservoir flows below 10 cfs are adjusted to the minimum required flow of 10 cfs

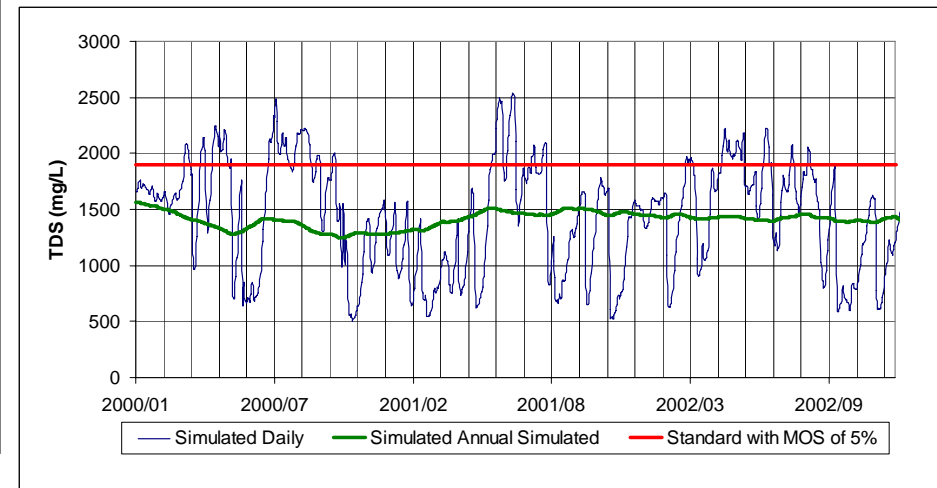
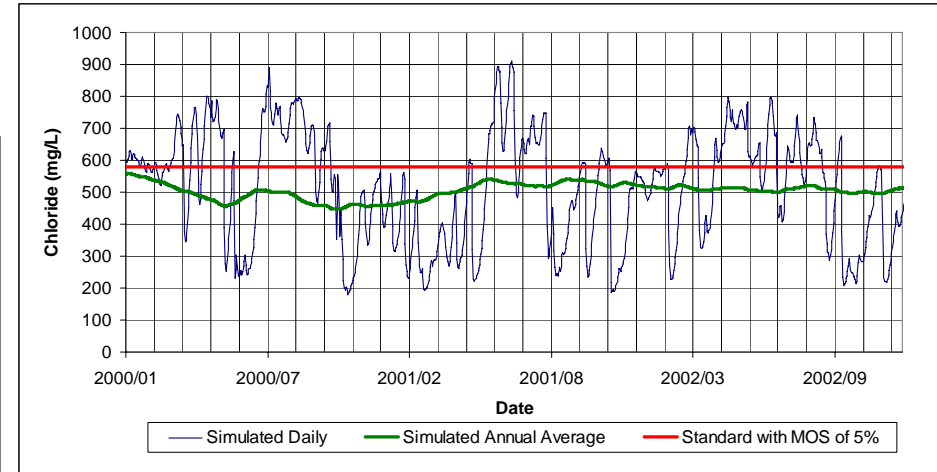
# Allocated Load Distribution

Source	Annual Average Loads (lbs/Year)			
	Chlorides	% Total	TDS	% Total
Spence Reservoir	1.63E+07	66.1	4.56E+07	64.6
Produced Water	4.44E+05	1.8	1.24E+06	2.6
Abandoned Brine Pits	5.89E+05	2.4	1.65E+06	2.3
Groundwater	5.09E+06	20.6	1.42E+07	20.1
Salt Cedar	1.90E+05	0.8	5.31E+05	0.8
Point Sources	2.07E+06	8.4	6.80E+06	9.6
<b>Total</b>	<b>2.47E+07</b>	<b>100.0</b>	<b>7.00E+07</b>	<b>100.0</b>

# Allocated Loads

The elimination of water quality standard violations requires the following:

Spence Reservoir release maintains a minimum of 10 cfs flow and meets 95% of the chloride and TDS water quality standards (579.5 mg/L and 1900 mg/L respectively)



# TMDL Expressions

## Chloride TMDL

TMDL (lbs/year)	WLA (lbs/year)	LA (lbs/year)	MOS (lbs/year)
2.60E+07	2.07E+06	2.26E+07	1.30E+06

## Total Dissolved Solids TMDL

TMDL (lbs/year)	WLA (lbs/year)	LA (lbs/year)	MOS (lbs/year)
7.37E+07	6.80E+06	6.32E+07	3.72E+06

# Next Steps

- Public Comment Period
- Address Comments
- Prepare the Final TMDL Report

# Local TMDL Contacts

## **Texas Commission on Environmental Quality**

**Kerry Niemann – (512) 239 0483**

**[kniemann@TCEQ.state.tx.us](mailto:kniemann@TCEQ.state.tx.us)**

**[www.TCEQ.state.tx.us](http://www.TCEQ.state.tx.us)**

## **The Louis Berger Group, Inc.**

**Raed EL-Farhan – 202 912-0307**

**[relfarhan@louisberger.com](mailto:relfarhan@louisberger.com)**