Segment 2204 of the Petronila Creek
Chloride, Sulfate, Total Dissolved Solids
Total Maximum Daily Load Development

Robstown, Texas

Meeting #5
October 14, 2005

THE Louis Berger Group, INC.

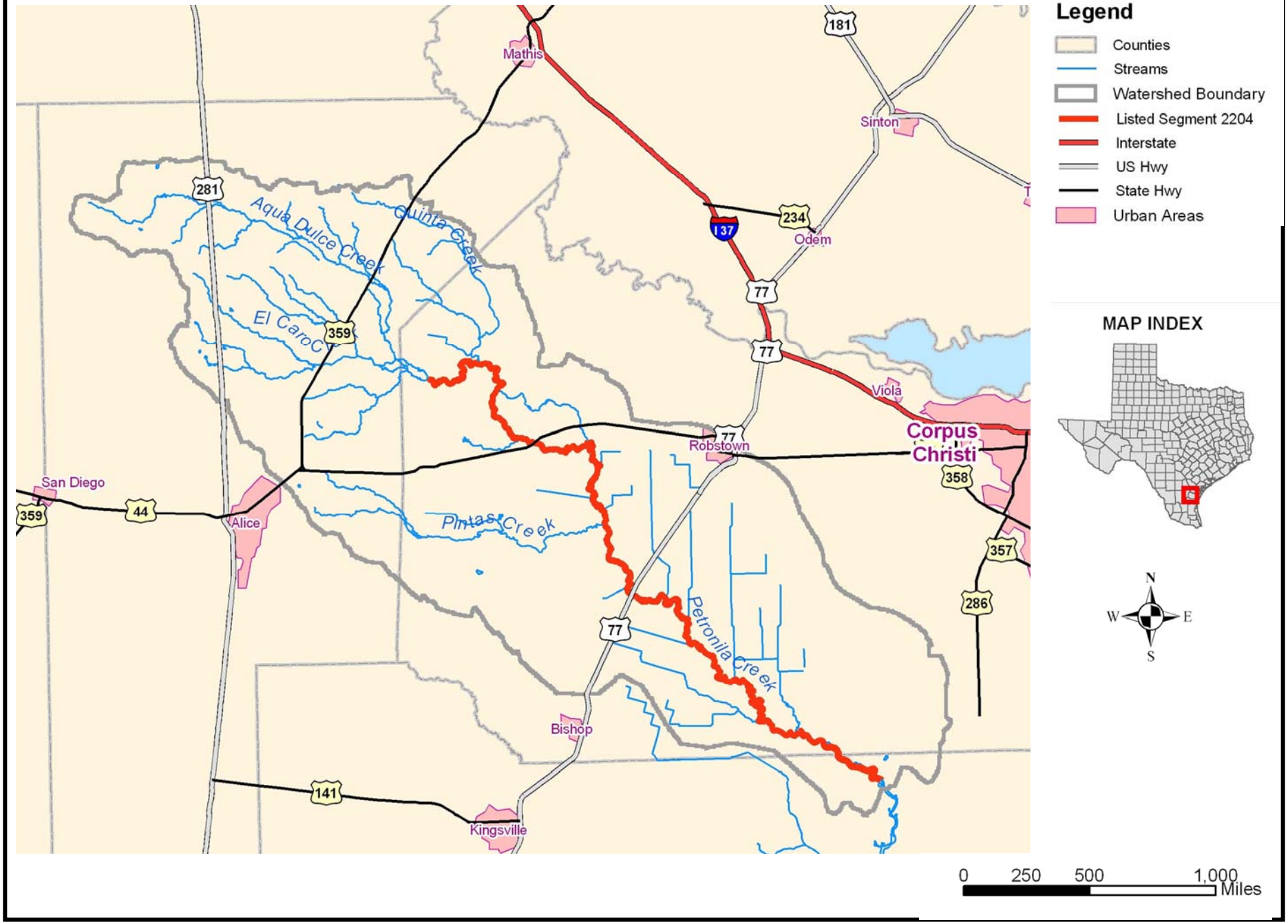
Recap from Meeting #4

- TMDL Process - What is? Why? Which segment? How?
- The steps and the data needed in the development of the TMDL for listed segment 2204 of Petronila Creek
- Watershed Characterization
- Water Quality Characterization
- Model set up, Calibration and Validation
- Sources Assessment
- Draft TMDL for Chloride, Sulfate, and Total Dissolved Solids

Petronila Creek Listed Segment

Based on the 2000 Section 303(d) List

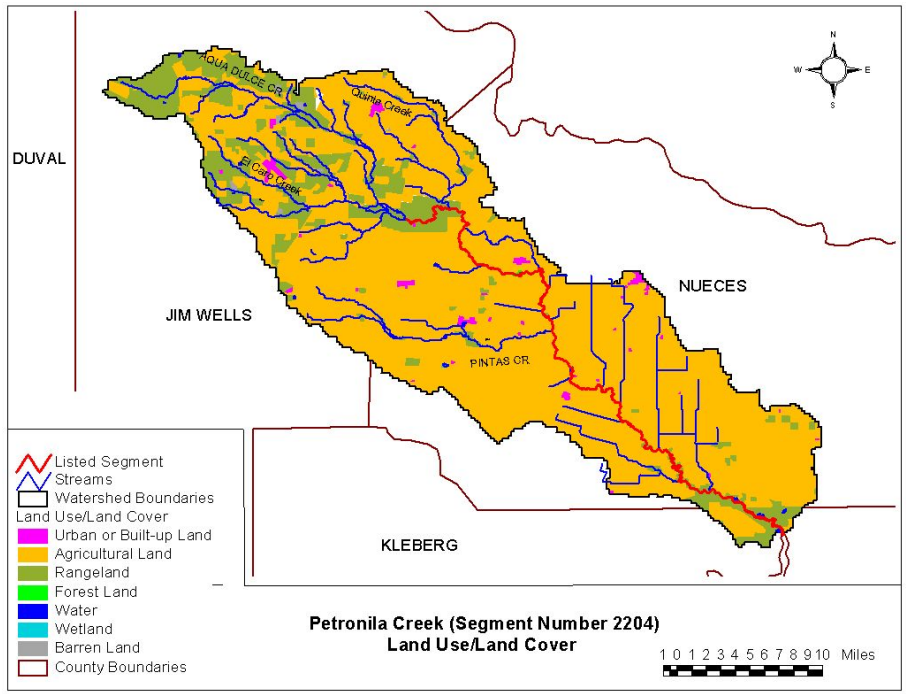
- Upstream Limit:
  - Confluence of Aqua Dulce Creek and Banquete Creek.
- Downstream Limit:
  - A point 0.6 miles upstream of private road crossing near the Laureles Ranch in Kleberg County.
- Segment Length:
  - 44 miles
- Water Quality Standards:
  - Chloride = 1,500 mg/L
  - Sulfate = 500 mg/L
  - Total Dissolved Solids = 4,000 mg/L


Legend
Counties
Streams
Watershed Boundary
Listed Segment 2204
Interstate
US Hwy
State Hwy
Urban Areas
MAP INDEX
N
W
E
S
0 250 500 1,000 Miles
Mathis
Sinton
Odem
Viola
Corpus Christi
Robstown
San Diego
Alice
Bishop
Kingsville
Aqua Dulce Creek
Quinta Creek
El Carro Creek
Pintas Creek
Petronila Creek
281
359
44
77
37
234
181
358
357
286
141

Watershed Characterization

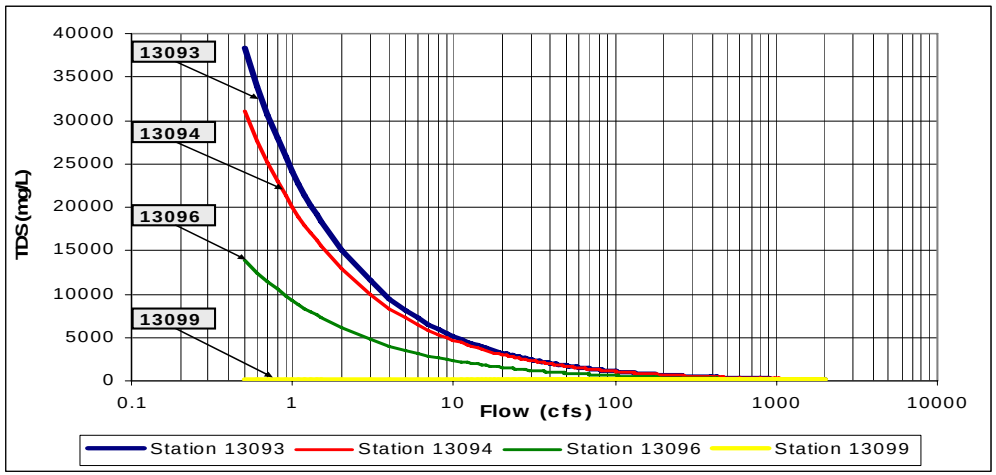
Watershed Characterization

- Watershed is 348,000 acres with the dominant land uses:
  - Agricultural 83%
  - Range land 16%
- Six permitted point sources dischargers are located in the watershed



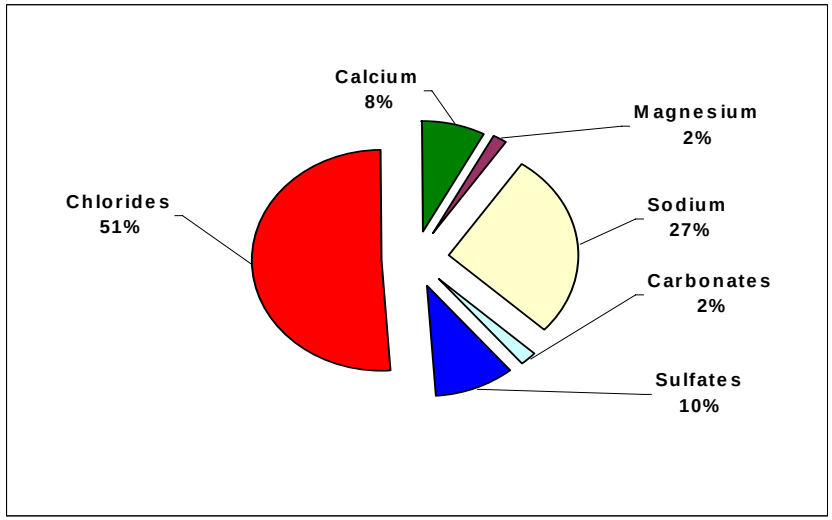
Summary of Environmental Data

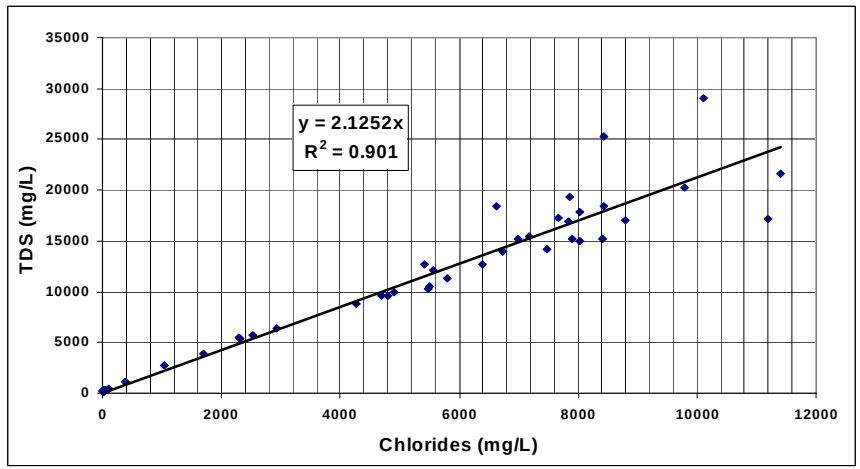
- Water quality standards were exceeded under both dry and wet weather flows
- Strong correlation exists between flow and concentration
- Concentrations increase with decreasing flow
- Regressions developed for all monitoring stations
  - Concentrations increased with decreasing flow
  - Strong spatial variability in observed data
  - For the same flow, concentrations increased in a downstream fashion



Chloride and TDS in Petronila Creek

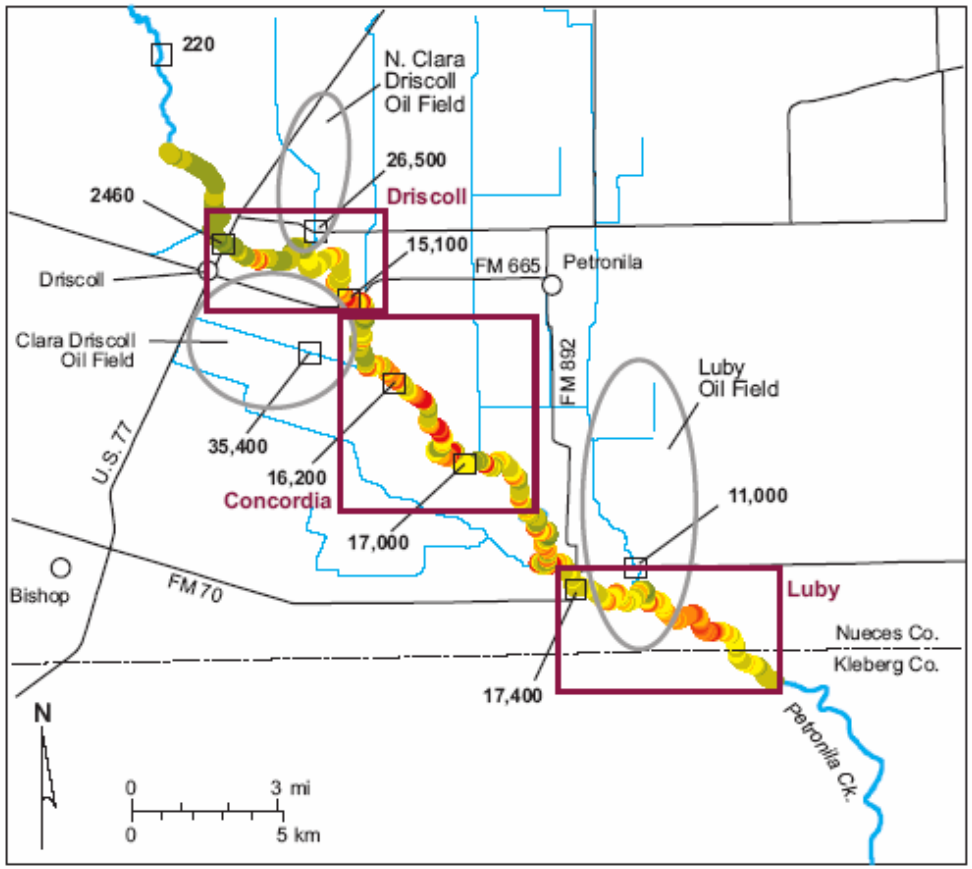
- Chloride is the dominant species in the Total Dissolved Solids
- Strong relationship exists between Total Dissolved Solids and Chloride
- Chloride used as a surrogate to simulate Total Dissolved Solids





BEG Study Results

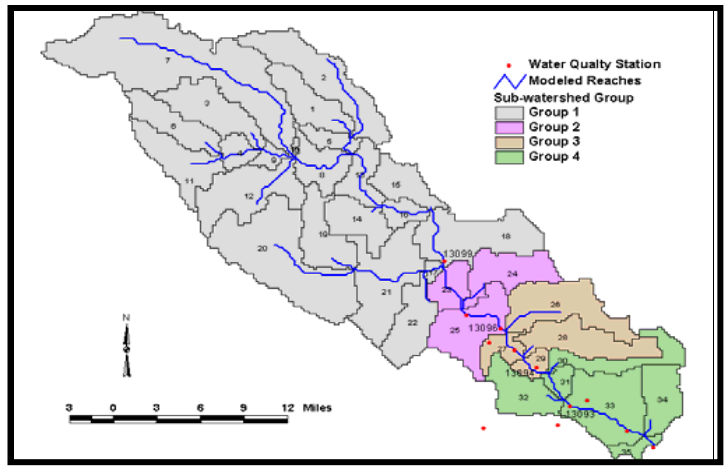
- The airborne geophysical survey delineated three problem areas in the Petronila Creek watershed. These include:
  - Driscoll Area
  - Concordia Area
  - Luby Area

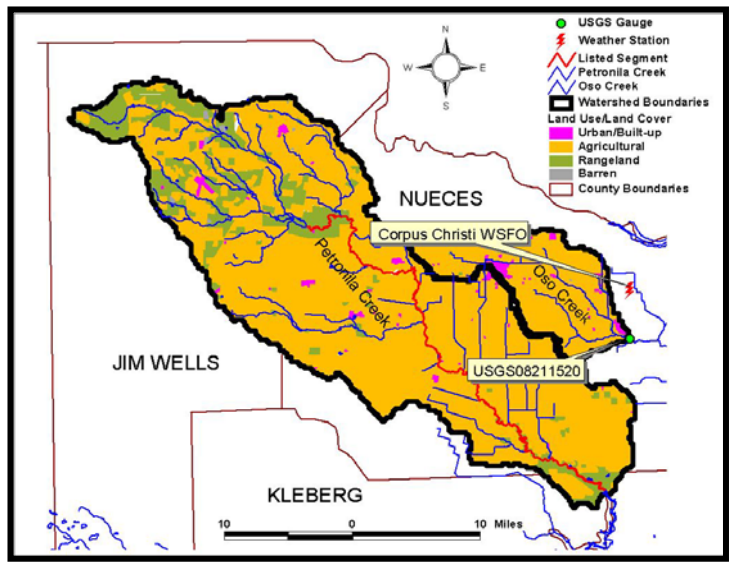


Technical Approch

Technical Approach Summary

- HSPF Model
- Weather Data:
  - Corpus Christi airport
- No Stream Flow exists
  - Paired-watershed approach using Oso Creek



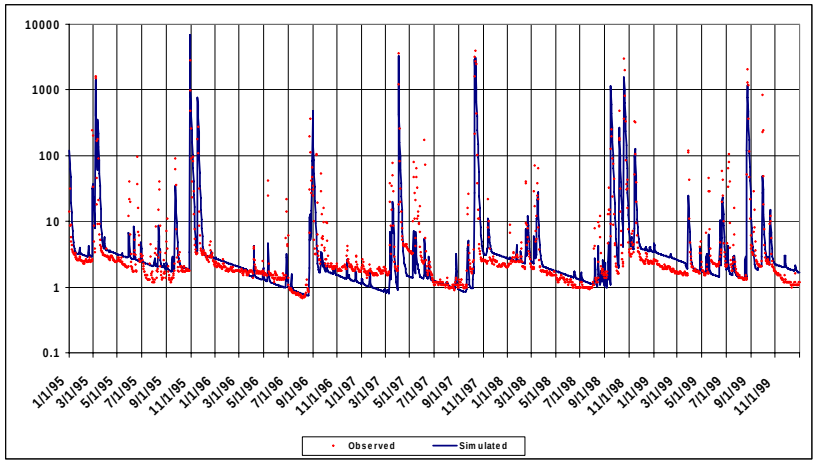


Salinity Sources

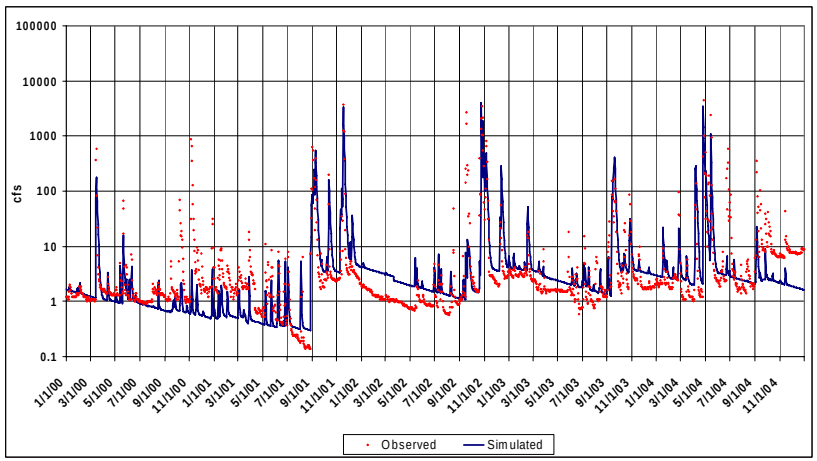
Sources of salinity may be originating from:

- Human Sources:
  - Permitted Facilities
  - Produced Water
  - Abandoned Brine Pits and Injections
- Natural Sources:
  - Geologic Formations - Salt Deposits
  - Phreatophytic Brush
  - Saltwater Intrusion

HSPF Hydrology Calibration and Validation

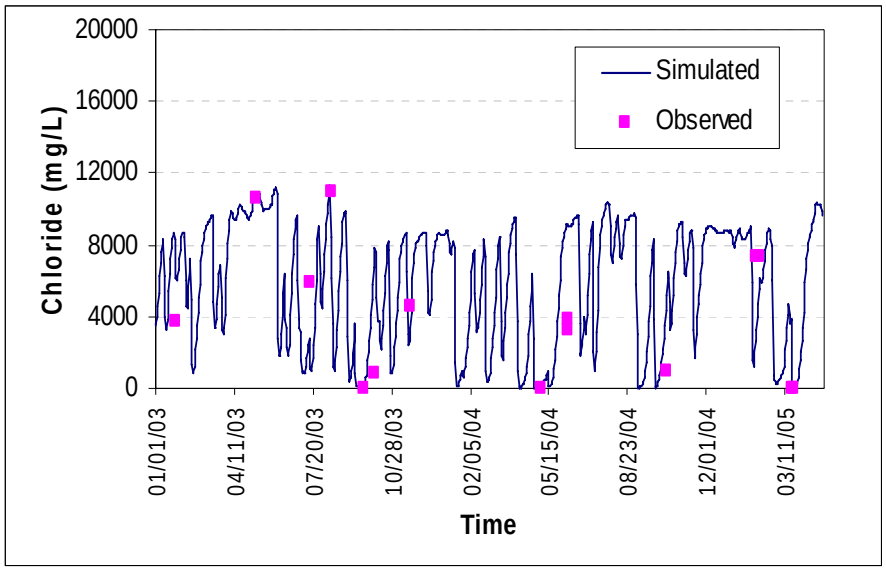


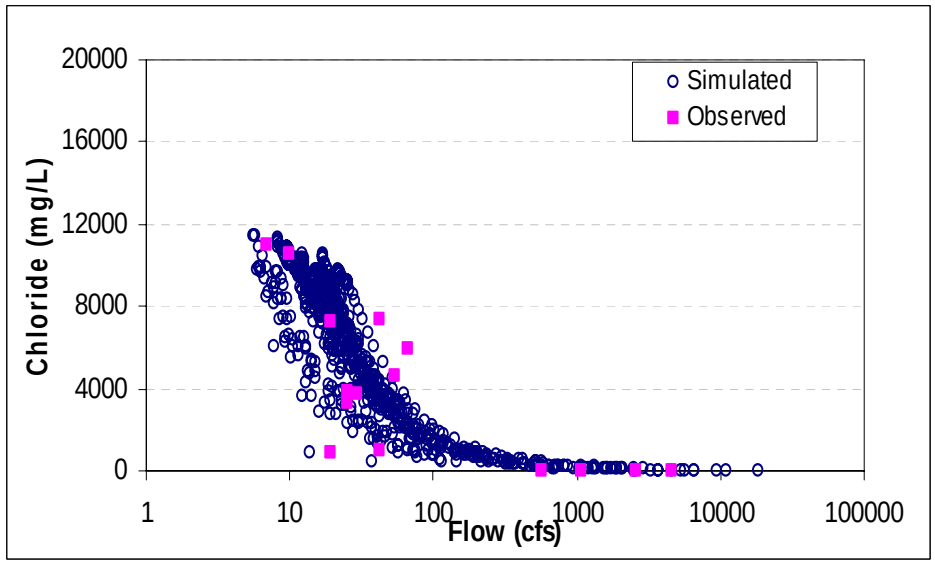
Year	Simulated Ratio Base flow/Total Flow	HYSEP Ratio Base Flow/Total Flow
1995	0.051	0.105
1996	0.296	0.390
1997	0.035	0.153
1998	0.081	0.139
1999	0.169	0.124
Average	**0.126**	**0.182**



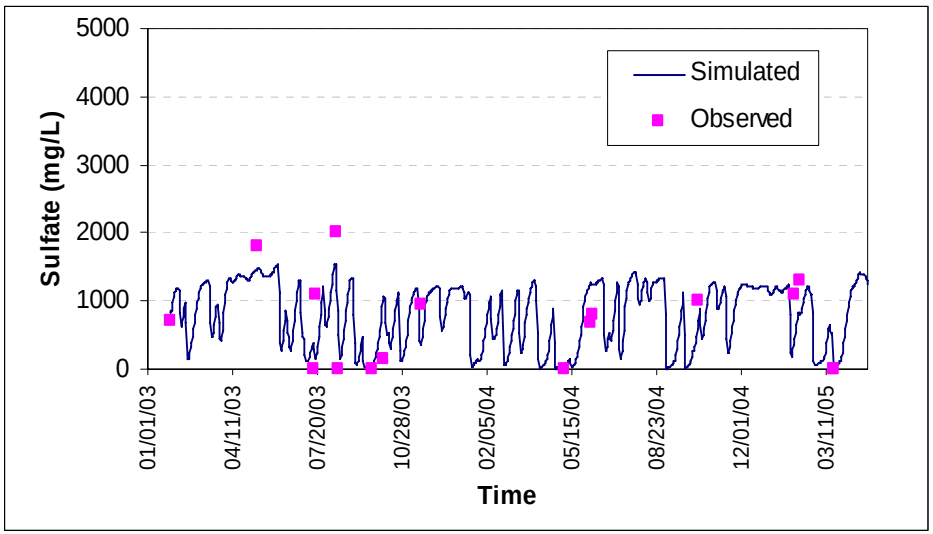
Category	Simulated	Observed	Ratio Simulated/ Observed
Total simulated in-stream flow (cfs)	40,198	54,845	**0.73**
Total of highest 10% flows, in inches	14.68	19.32	**0.76**
Total of lowest 50% flows, in inches	0.46	0.38	**1.20**
Summer flow volume, in inches	2.39	4.85	**0.49**
Winter flow volume, in inches	0.77	0.93	**0.83**

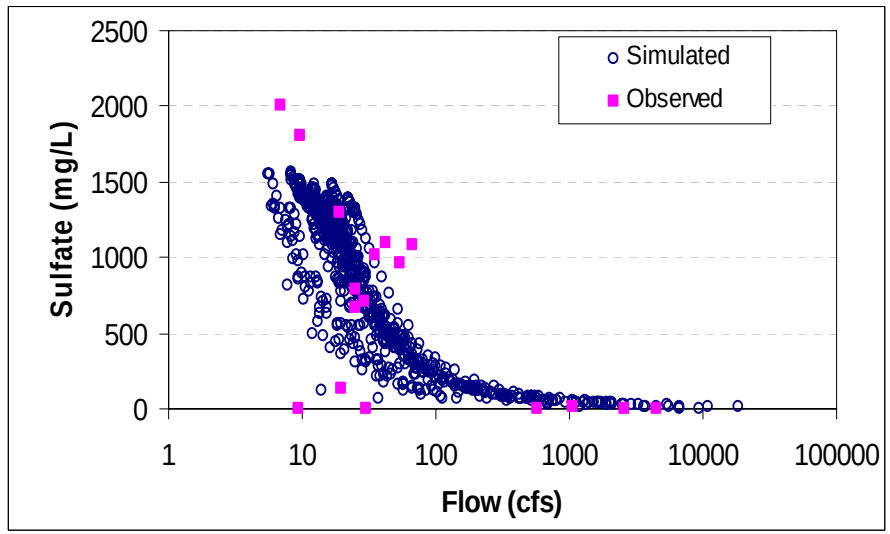
Chloride Water Quality Calibration-Station 13096



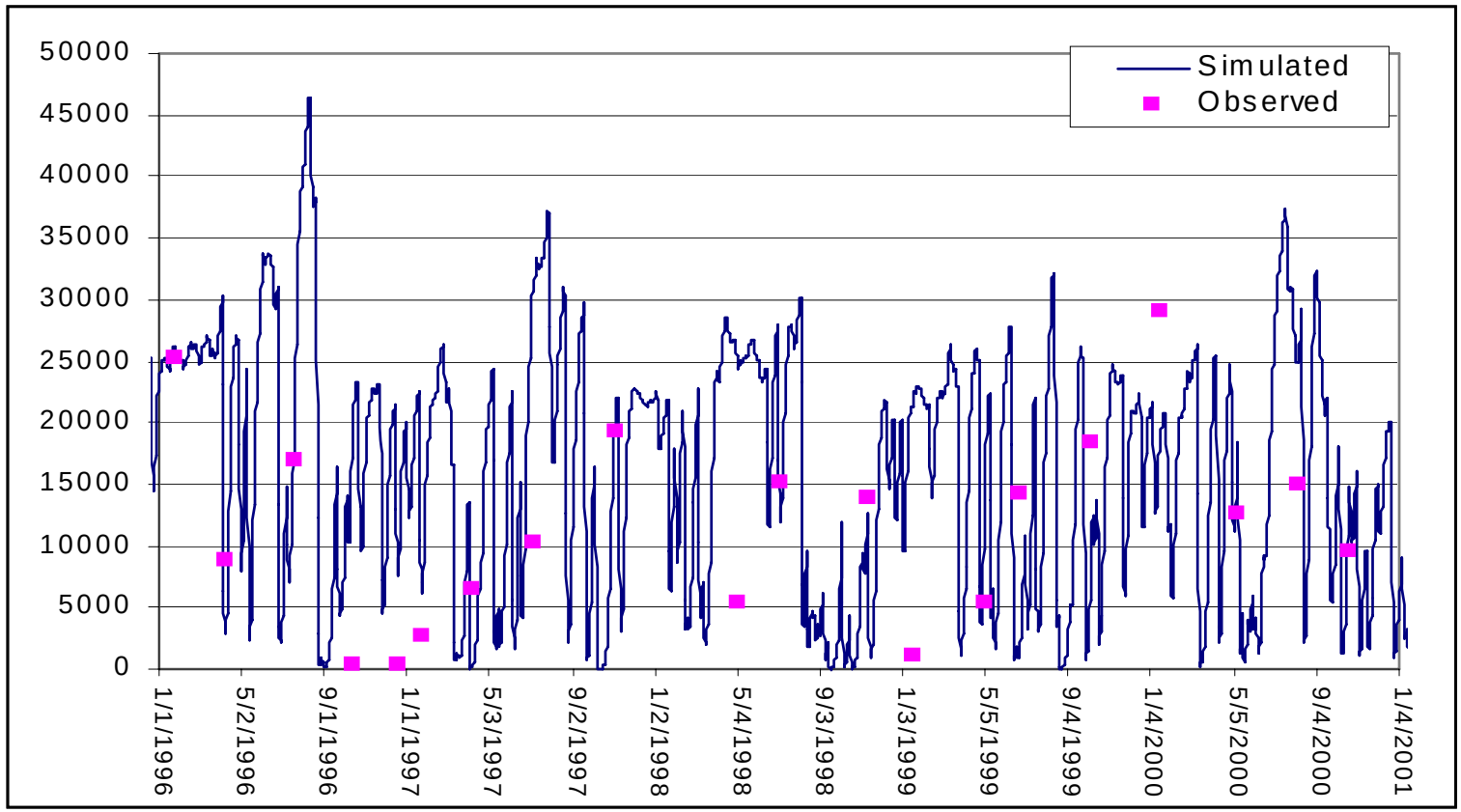


Sulfate Water Quality Calibration-Station 13094





TDS Water Quality Calibration-Station 13094



Source Loading Estimates

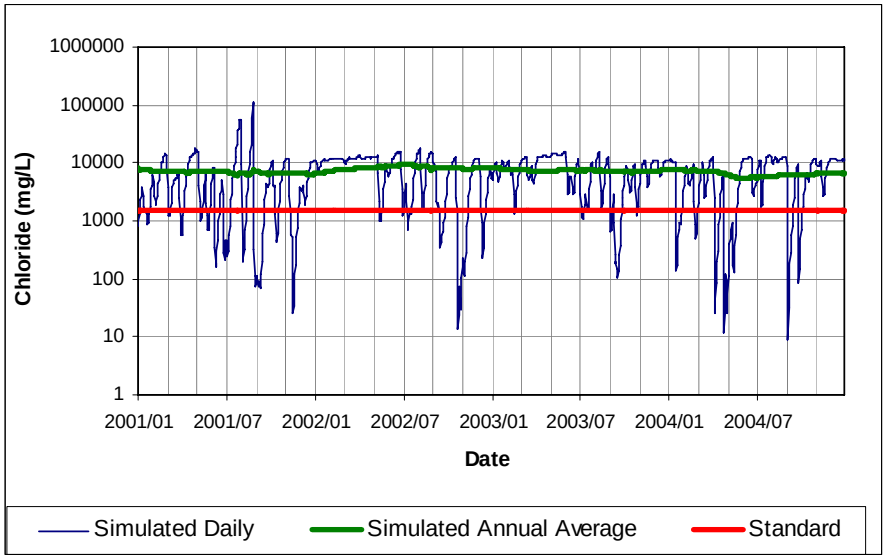
Model Source Representation

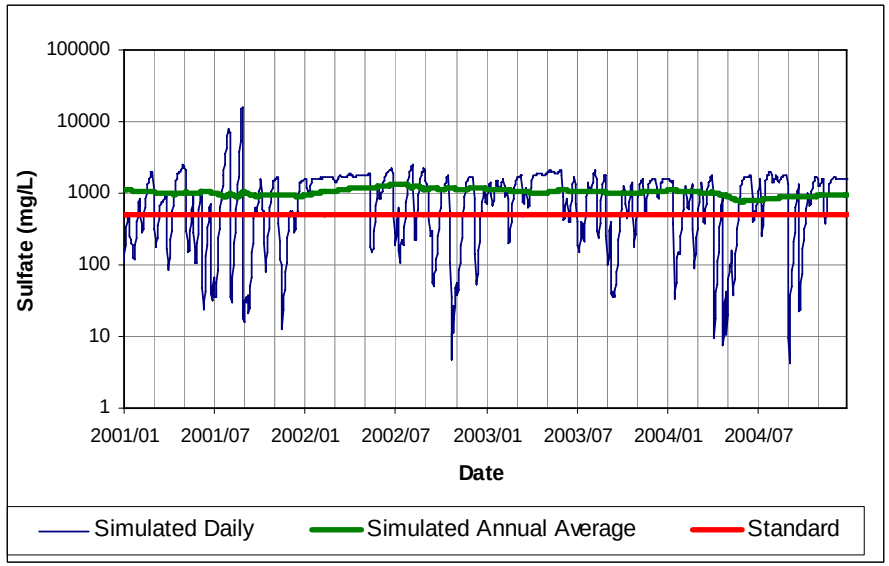
- Observed spatial variations in the loads from groundwater
- Groundwater average concentrations were used to model chloride and sulfate and to develop the background loads
- Loading from produced water was accounted for in groundwater concentrations as an additional load
- Abandoned brine pit loading was simulated as a non-point source

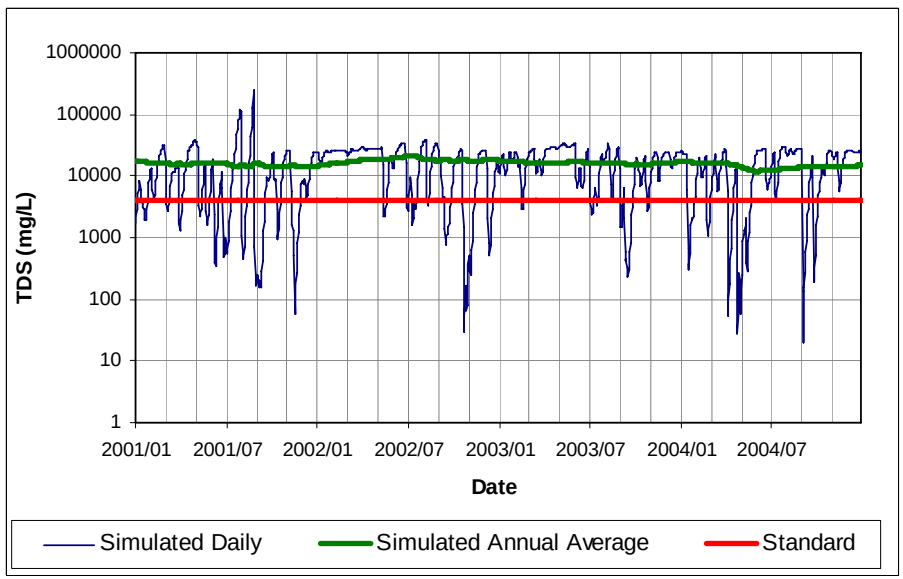
Existing Loads Distribution

Source	Annual Average Loads (lbs/Year)					
	Chlorides	**% Total**	**Sulfates**	**% Total**	**TDS**	**% Total**
Abandoned Brine Pits	2.83E+04	0.4%	1.04E+05	0%	6.02E+04	0.4%
Produced Water	3.15E+08	99.3%	4.09E+07	81%	6.69E+08	99.3%
Groundwater	4.30E+05	0.1%	3.90E+06	8%	9.15E+05	0.1%
Other Background Sources	1.36E+06	0.1%	5.63E+06	11%	2.90E+06	0.1%
Point Sources	8.88E+04	0.1%	5.33E+04	0%	1.89E+05	0.1%
Total	3.17E+08	100%	5.05E+07	100%	6.73E+08	100%

Existing Conditions Loading







Allocation Scenarios Framework: Chloride, Sulfate, and TDS

- Scenario 0 represents the existing loading, which is no reduction of any of the sources;
- Scenarios 1 through 3 represent incremental reductions in loadings from abandoned brine pits and produced water. The intent is to assess the effect of controlling both the abandoned brine pit and produced water sources of pollutants.
- Scenario 4 represents a complete reduction in loadings from the abandoned brine pits.
- Scenarios 5 through 8 represent an incremental reduction in loadings from the produced water in addition to a complete reduction in loadings from the abandoned brine pits.

Scenario	Chloride, Sulfate and TDS Reduction in Loadings from Existing Conditions (%)		
	Abandoned Brine Pits	Produced Water	Groundwater
0	0	0	0
1	25	25	0
2	50	50	0
3	75	75	0
4	100	0	0
5	100	50	0
6	100	75	0
7	100	78	0
8	100	88	0

Petronila Creek Load Reduction Analysis

Scenario #	Reduction in Loadings from Existing Conditions (%)			Percent of Time (annual averages) the Standard is Violated		
	Abandoned Brine Pits	Produced Water	Ground water	Chlorides	Sulfates	TDS
0	0	0	0	100	100	100
1	25	25	0	100	100	100
2	50	50	0	100	100	100
3	75	75	0	100	5	98
4	100	0	0	100	100	100
5	100	50	0	100	100	100
6	100	75	0	100	5	98
7	100	78	0	100	0	71
8	100	88	0	0	0	0

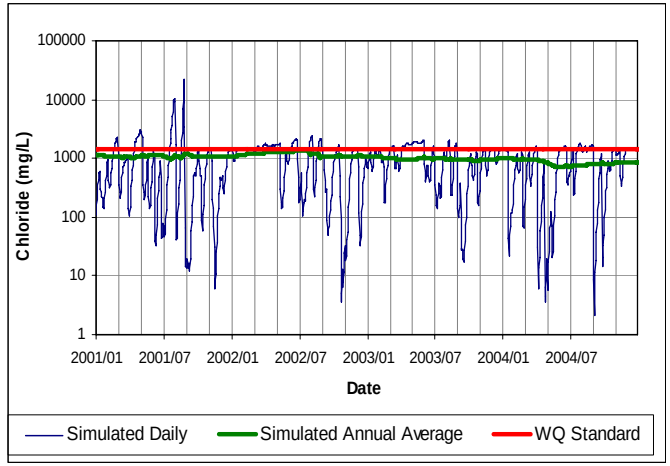
Allocated Load Distribution

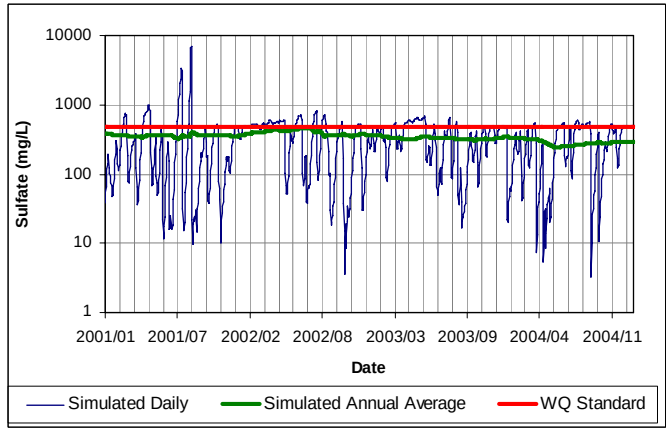
Source	Annual Average Loads (lbs/Year)					
	Chlorides	% Total	Sulfates	% Total	TDS	% Total
Abandoned Brine Pits	0.00E+00	0%	0.00E+00	0%	0.00E+00	0%
Produced Water	3.78E+07	90%	8.98E+06	48%	8.04E+07	95%
Groundwater	5.17E+04	0%	8.56E+05	5%	1.10E+05	0%
Other Background Sources	1.74E+06	4%	8.67E+06	47%	3.70E+06	4%
Point Sources	2.53E+06	6%	2.31E+03	0%	1.85E+04	0%
Total	**4.22E+07**	**100%**	**1.85E+07**	**100%**	**8.42E+07**	**100%**

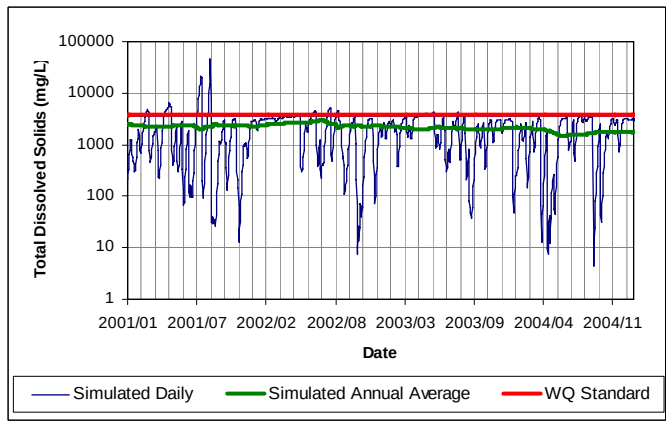
Allocated Loads

Based on the load allocation scenario analysis, a TMDL allocation plan to meet the respective water quality standard goals requires:

- 100 % reduction of loading from abandoned brine pits to meet both Chloride and Sulfate standards
- 88 % reduction of loading from the produced water to meet chloride and TDS standards
- 78 % reduction of the loading from produced water to meet sulfate standards







TMDL Expressions

Chloride TMDL

TMDL (lbs/year)	WLA (lbs/year)	LA (lbs/year)	MOS (lbs/year)
1.95E+07	2.31E+03	1.85E+07	9.74E+05

Sulfate TMDL

TMDL (lbs/year)	WLA (lbs/year)	LA (lbs/year)	MOS (lbs/year)
4.44E+07	2.53E+06	3.96E+07	2.22E+06

Total Dissolved Solids TMDL

TMDL (lbs/year)	WLA (lbs/year)	LA (lbs/year)	MOS (lbs/year)
8.87E+07	1.85E+04	8.42E+07	4.43E+06

Next Steps

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

Local TMDL Contacts

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