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

Robstown, Texas

Meeting #5
July 20, 2005

THE Louis Berger Group, INC.

Outline

- TMDL Process - What is? Why? Which segment? How?
- Presented and reviewed 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

TMDL Segment and Process

Why Develop TMDLs?

Requirements of 1972 Clean Water Act:

- States are required to identify impaired waters
- Section 303(d) of the Clean Water Act:
  - Requires states to periodically list impaired waters
  - Requires development of TMDLs for impaired waters

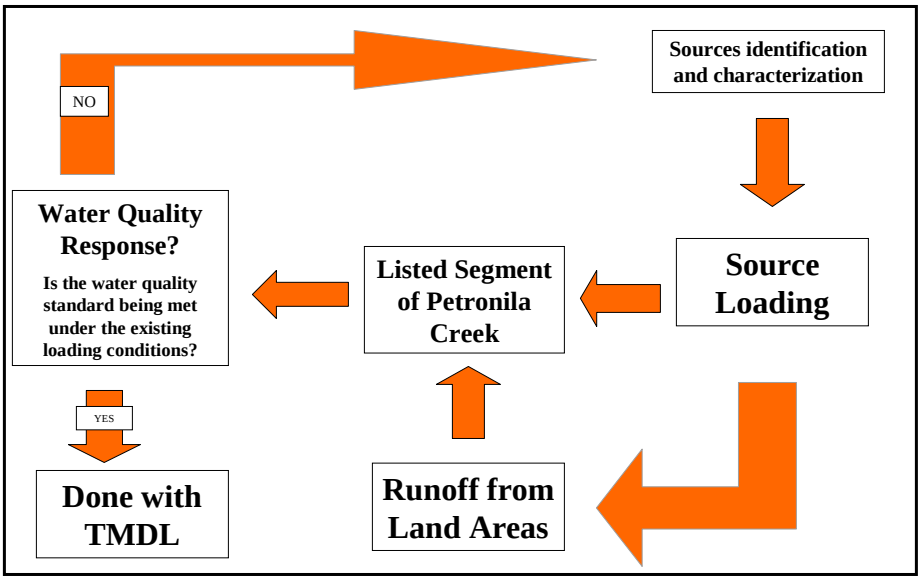
EPA in litigation for failure to promulgate Section 303(d) of the Clean Water Act.

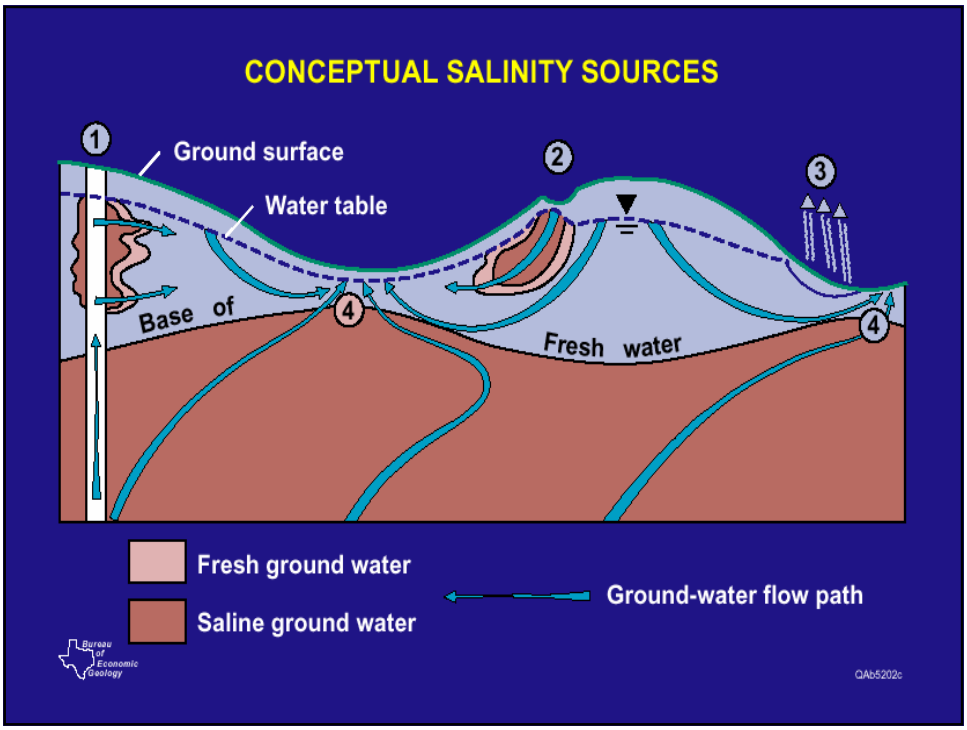
Petronila Creek Listed Segment

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

TMDL Process





Salinity Sources

Sources of salinity may be originating from:

- Human Sources:
  - Permitted Facilities
  - Brine Pits and Injections
  - Leaking Wells
- Natural Sources:
  - Geologic Formations - Salt Deposits
  - Saltwater Intrusion

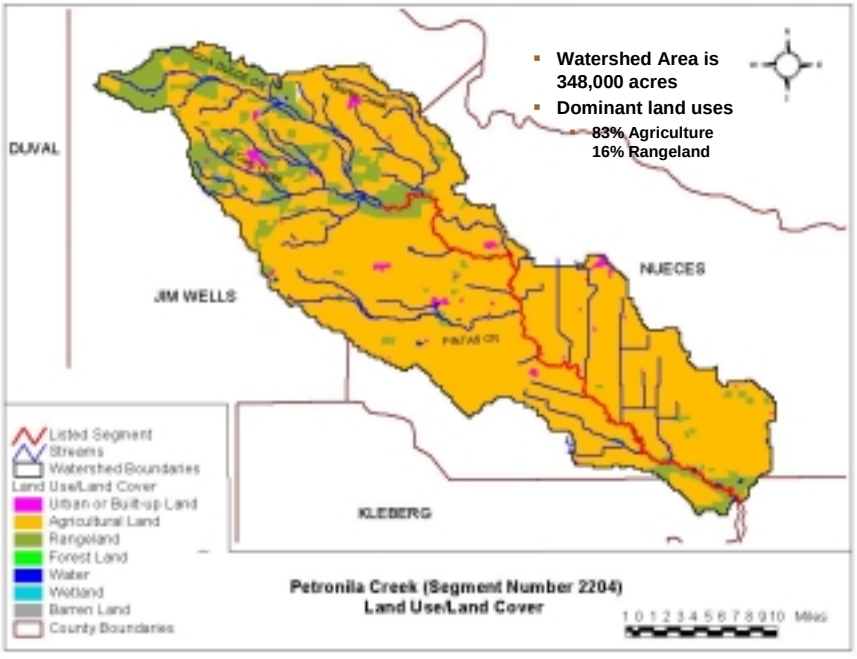
Watershed Characterization

Data Inventory

Data Category	Description	Potential Source(s)
Watershed physiographic data	Watershed boundary	USGS, TCEQ
	Land use/land cover	BASINS, MRLC, NLCD, TCEQ
	Soil data (SSURGO, STATSGO)	USDA, NRCS
	Topographic data (USGS-30 meter DEM, USGS Quads)	USGS, TCEQ
Hydrographic data	1. Stream network and reaches (RF3)	BASINS, TCEQ, Field determination
	2. Stream channel morphology	
Weather data	Hourly meteorological conditions	NOAA NCDC, Earth Info, local airports, weather stations, and colleges and universities
Watershed activities/ uses data and information related to pollutant Production	Compile information, data, reports, and maps that can be used to support CL, TDS and Sulfate source identification and loading. Address the following issues:	TCEQ,River Authorities, TSSWCB, RRC, and other State, County and Local agencies
	▪ Leaking oil wells	
	▪ Brine Pits	
	▪ Brine injection	
	▪ Phreatophytic Brush	
	▪ Salt deposits (geological source)	
Point sources and direct discharge data and information	Permitted facilities locations and discharge monitoring reports (DMR)	US EPA Permit Compliance System (PCS), TCEQ
Environmental monitoring data	Station locations and ambient instream monitoring data	TCEQ, Monitoring Plan, River Authorities
Stream flow data	Gaging station location and continuous flow data	USGS, TCEQ, River Authorities

Segment 2204 Land Use Data

Land Use		Acres	Percent	Total Percent
Urban	RESIDENTIAL	2,094	0.5	1.2
	COMMERCIAL AND SERVICES	614	0.2	
	INDUSTRIAL	734	0.2	
	TRANS, COMM, UTIL	663	0.2	
	MXD URBAN OR BUILT-UP	540	0.1	
	OTHER URBAN OR BUILT-UP	64	0.0	
Agricultural	CROPLAND AND PASTURE	329,048	83.0	83.1
	CONFINED FEEDING OPS	45	0.0	
	OTHER AGRICULTURAL LAND	503	0.1	
Rangeland	HERBACEOUS RANGELAND	13,704	3.5	15.4
	SHRUB & BRUSH RANGELAND	31,338	7.9	
	MIXED RANGELAND	16,100	4.1	
Forest	DECIDUOUS FOREST LAND	111	0.03	0.03
	EVERGREEN FOREST LAND	1	0.00	
Water	LAKES	19	0.00	0.0
	RESERVOIRS	22	0.01	
Wetland	NONFORESTED WETLAND	52	0.01	0.01
Barren	STRIP MINES	768	0.2	0.2
	Total	396,419	100.0	100

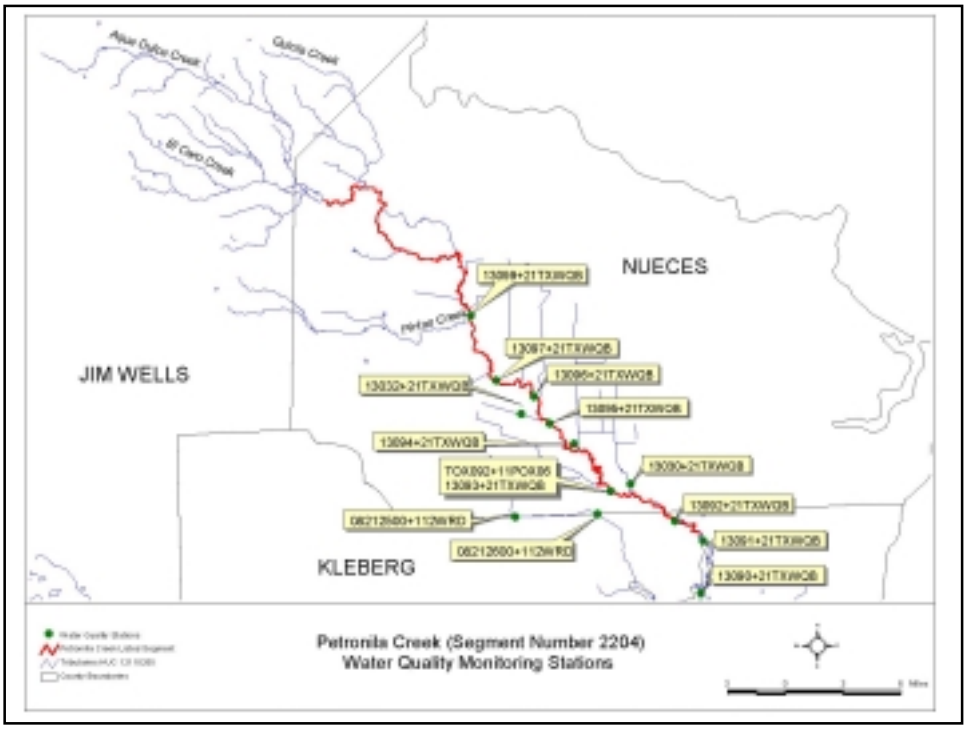


Permitted Facilities

Permit #	Name of Facility	Design Flow (MGD)	Permit Date	Latitude	Longitude
WQ0010140-001	City of Agua Dulce	0.16	12/12/00 - 06/01/05	274700	975346
WQ0010592-001	City of Orange Grove	0.2	04/12/01 - 06/01/05	275629	975607
WQ0011541-001	Driscoll Plant, City of Driscoll	0.1	10/02/01 - 06/01/05	274052	974419
WQ0011583-001	Banquete Plant, Nueces CO WCID 5	0.1	02/09/01 - 06/01/05	274815	974652
WQ0011689-001	City of Coastal Bend Youth City	0.015	04/04/01 - 06/01/05	274124	974438
WQ0011754-001	Petronila Elementary	0.008	06/01/00 - 02/01/02	274020	973813

MGD: Million gallons per day

Environmental Monitoring


Petronila Creek
Quinta Creek
El Cano Creek
NUECES
JIM WELLS
KLEBERG
13089+21TXWQB
13087+21TXWQB
13095+21TXWQB
13096+21TXWQB
13094+21TXWQB
13090+21TXWQB
13092+21TXWQB
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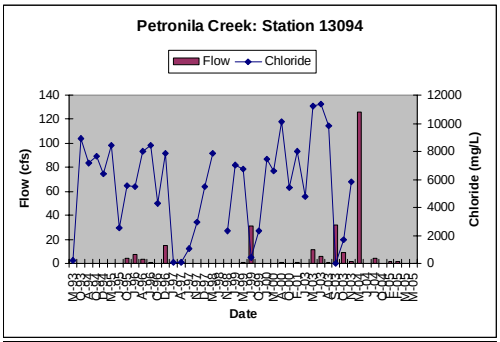
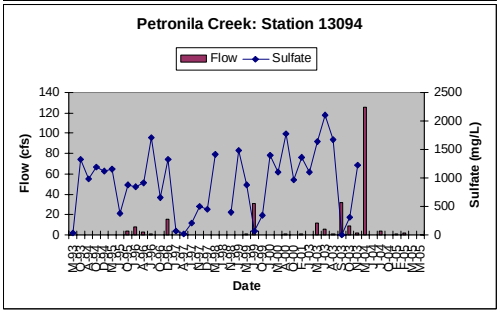
Petronila Creek (Segment Number 2204)
Water Quality Monitoring Stations


Petronila Creek: Station 13094
Flow
Chloride
Flow (cfs)
Chloride (mg/L)
Date


Petronila Creek: Station 13094
Flow
Sulfate
Flow (cfs)
Sulfate (mg/L)
Date

Summary of Water Quality Conditions: Chloride

Station	Period of record	# of Samples	# of Violations	% Time Standard exceeded
13094	May 95 - Jun 05	42	33	78.6
13032	Jan 03 - Jun 05	12	9	75.0
13093	Jan 03 - Jun 05	16	11	68.8
13096	Oct 95 - Jun 05	21	13	61.9
13095	Jan 03 - Jun 05	15	9	60.0
13030	Jan 03 - Jun 05	17	10	58.8
13098	May 03 - Jun 05	14	1	7.1
13099	Jan 03 - Jun 05	9	0	0.0
14944	Oct 95 - Jun 96	4	0	0.0
17658	Aug 03	2	0	0.0
17659	Aug 03	2	0	0.0
17660	Aug 03	2	0	0.0

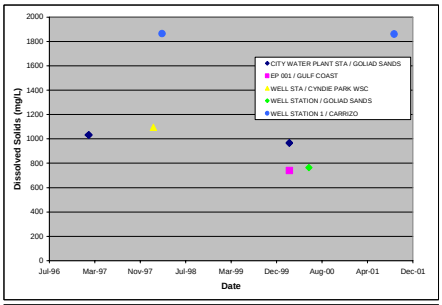
Summary of Water Quality Conditions: Sulfate

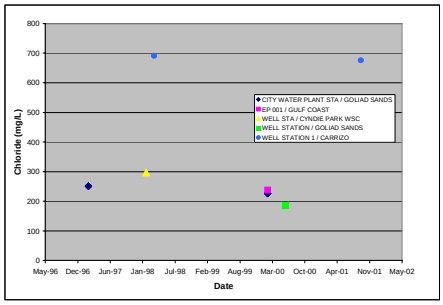
Station	Period of record	# of Samples	# of Violations	% Time Standard exceeded
13032	Jan 03 - Jun 05	12	9	75.0
13093	Jan 03 - Jun 05	17	11	64.7
13030	Jan 03 - Jun 05	17	10	58.8
13095	Jan 03 - Jun 05	16	9	56.3
13096	Oct 95 - Jun 05	21	11	52.4
13094	May 95 - Jun 05	42	20	47.6
13098	May 03 - Jun 05	14	0	0.0
13099	Jan 03 - Jun 05	9	0	0.0
14944	Oct 95 - Jun 96	4	0	0.0
17658	Aug 03	2	0	0.0
17659	Aug 03	2	0	0.0
17660	Aug 03	2	0	0.0

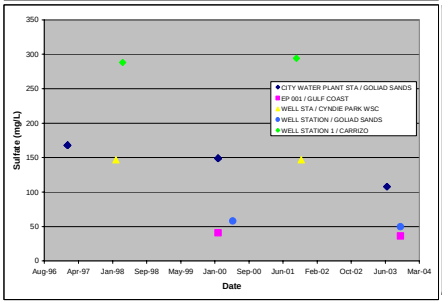
Summary of Water Quality Conditions: TDS

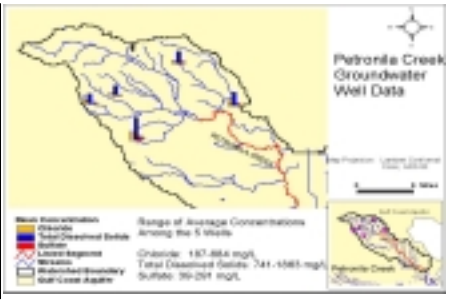
Station	Period of record	# of Samples	# of Violations	% Time Standard exceeded
13094	May 95 - Jun 05	45	34	75.6
13032	Jan 03 - Jun 05	12	9	75.0
13093	Jan 03 - Jun 05	17	12	70.6
13096	Oct 95 - Jun 05	20	13	65.0
13095	Jan 03 - Jun 05	15	9	60.0
13030	Jan 03 - Jun 05	17	10	58.8
13098	May 03 - Jun 05	14	0	0.0
13099	Jan 03 - Jun 05	12	0	0.0
17658	Aug 03	2	0	0.0
17659	Aug 03	2	0	0.0
17660	Aug 03	2	0	0.0

Groundwater Concentrations



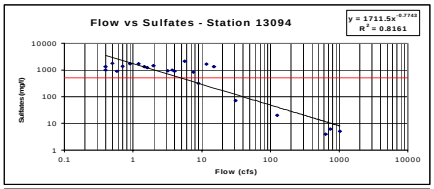


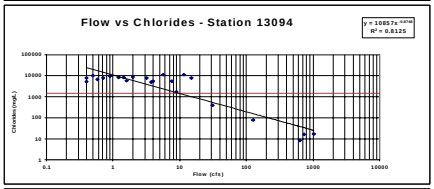


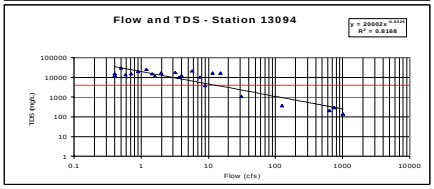


WQ Regressions at Station 13094

- Water quality standards were violated under both dry and wet weather flows
- Strong correlation exists between flow and concentration
- Concentrations increased with decreasing flow
- Regressions developed for all monitoring stations

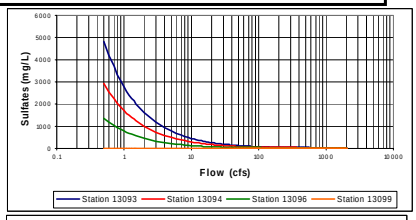


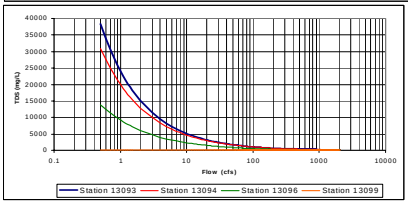


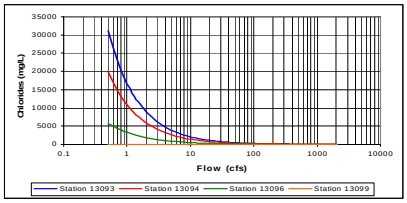


Summary of Regressions

- Concentrations increased with decreasing flow
- Strong spatial variability in observed data
- For the same flow, concentrations increased in a downstream fashion

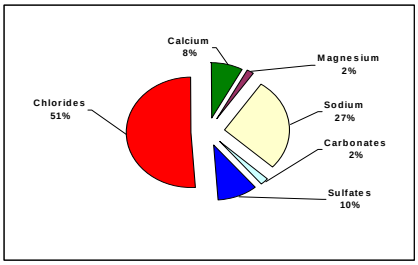


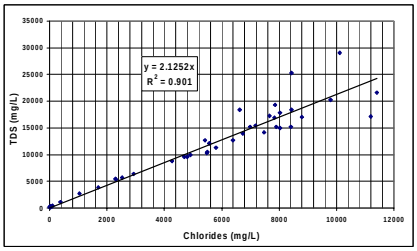




Chloride and TDS in Petronila Creek

- 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





Environmental Data Summary

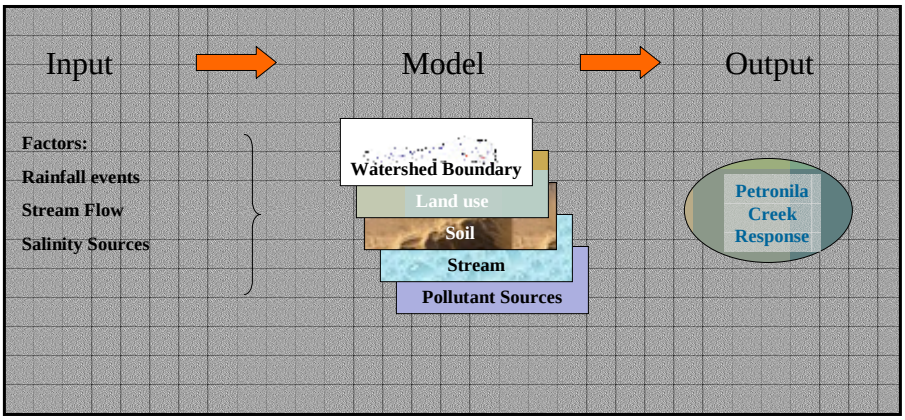
- Water quality standards are regularly exceeded under both wet and dry weather conditions
- Sources of chloride and sulfate include sources that contribute to wet weather flows
- Strong spatial variation in environmental data

➔ A detailed model is required to determine the pollutant loads from different types of nonpoint sources and their transport mechanisms.

Technical Approch

HSPF Model

Linking Sources to Water Quality



Sources

Salinity Sources

Sources of salinity may be originating from:

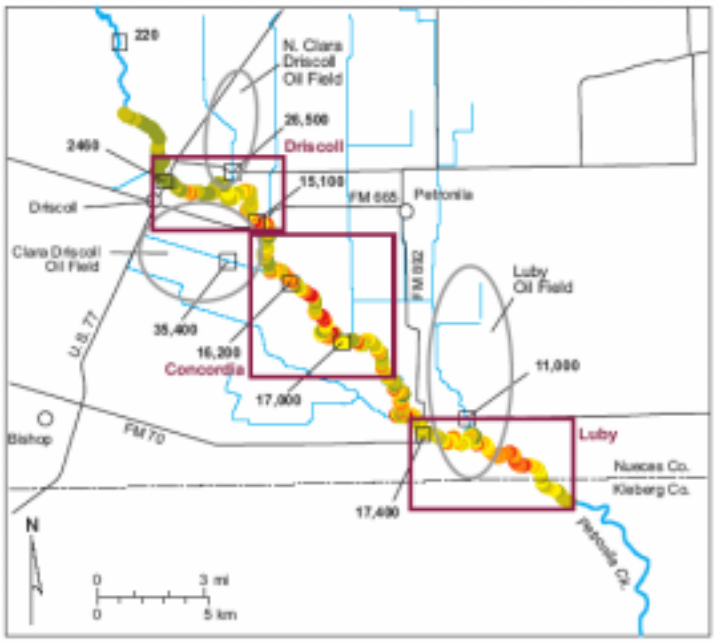
- Human Sources
  - Permitted Facilities
  - Brine Pits and Injections
  - Leaking Wells
- Natural Sources:
  - Geologic Formations - Salt Deposits
  - Saltwater Intrusion

Source Contributions

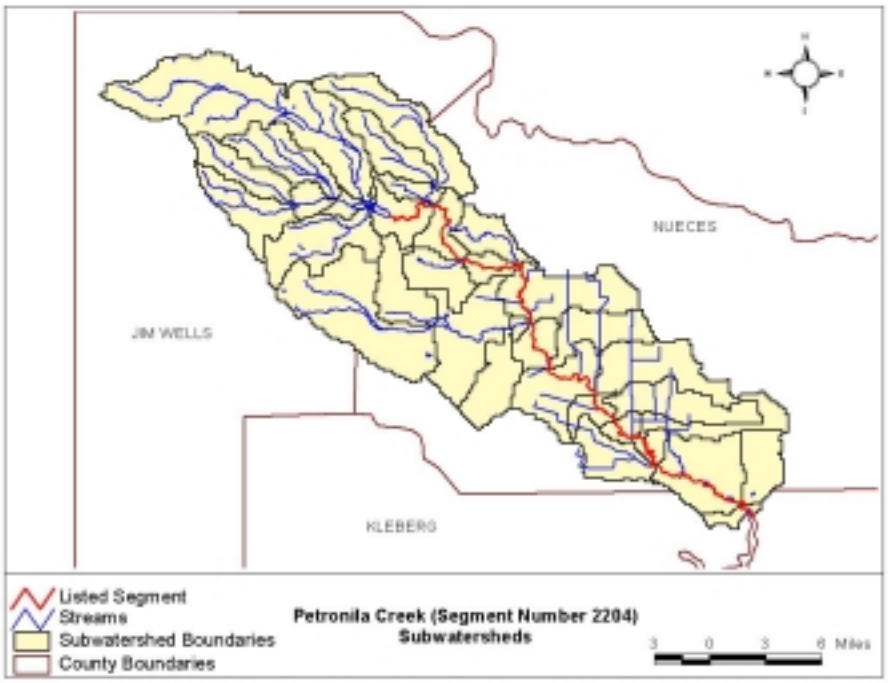
- Increased salinity may occur from the dissolution of geologic formations
- Oil-related activities may contribute to increased salinity, including brine pits and injection, and leaking oil wells
- Ground water may contribute to increased salinity
- Six permitted facilities located in Petronila Creek watershed

BEG Study Results

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

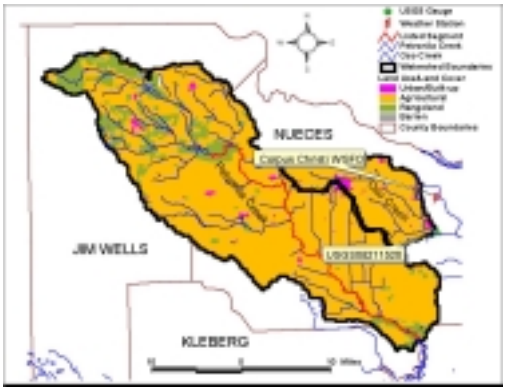


Modeling/Simulation

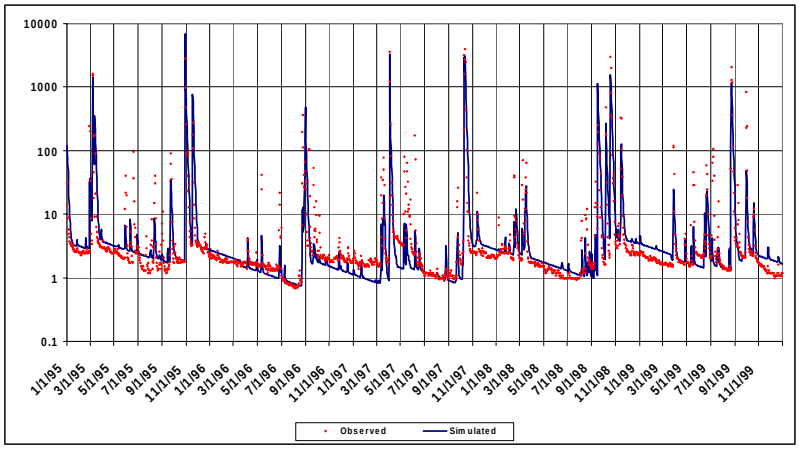


Stream Flow and Weather Data

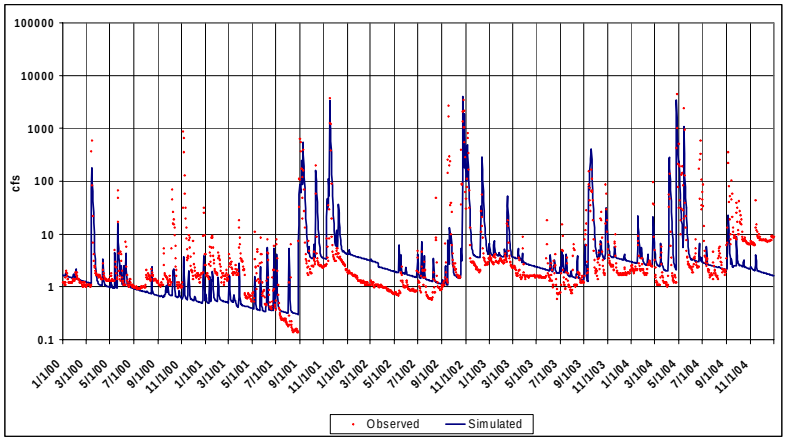
- Weather data:
  - Corpus Christi airport
  - Located approx. 13 miles NE of watershed
- Stream Flow:
  - Paired-watershed approach
  - Oso Creek



HSPF Hydrology Calibration



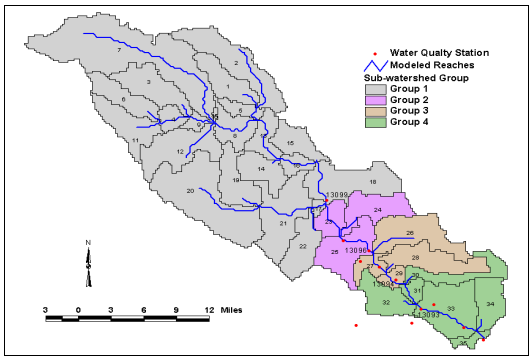
HSPF Hydrology Validation

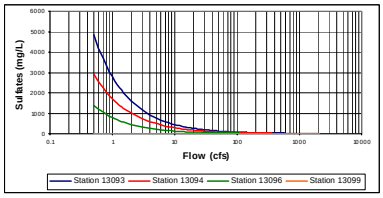


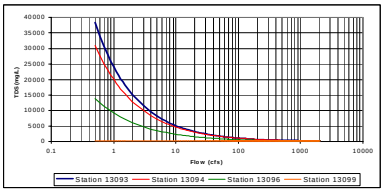
Hydrologic Calibration Results

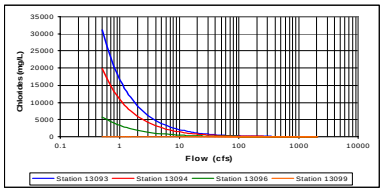
Category	Simulated	Observed	Ratio Simulated/ Observed
Total simulated in-stream flow (cfs)	51,700	53,575	0.96
Total of highest 10% flows, in inches	20.16	22.23	0.91
Total of lowest 50% flows, in inches	0.559	0.638	0.88
Summer flow volume, in inches	3.41	4.10	0.83
Winter flow volume, in inches	2.12	2.51	0.84

WQ Calibration Subwatersheds



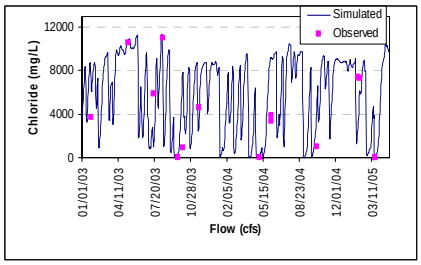


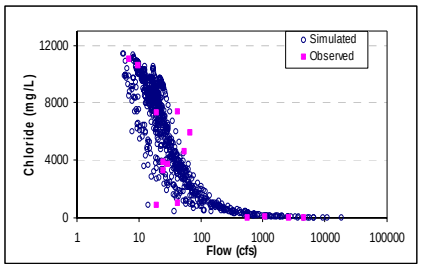




Chloride Water Quality Calibration

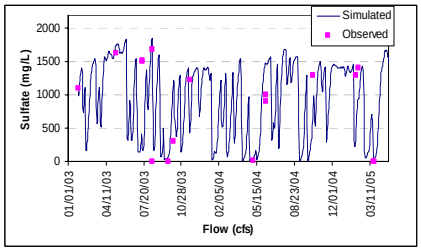
Station 13096

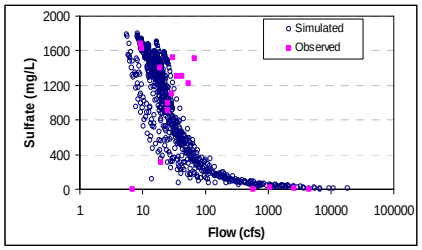




Sulfate Water Quality Calibration

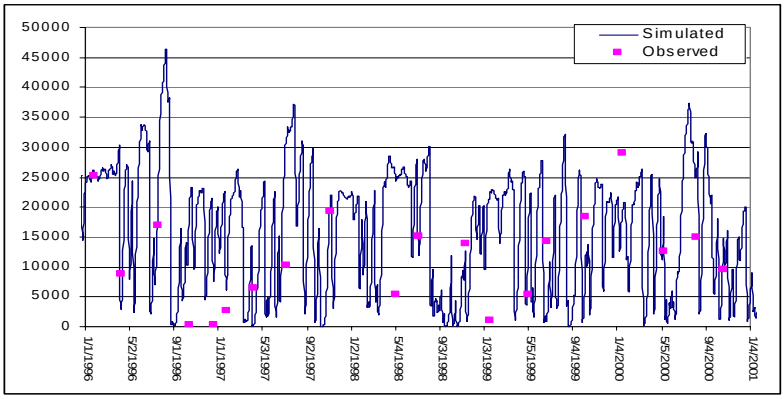
Station 13094





TDS Water Quality Calibration

Station 13093



Source Loads

Sources Loading Estimates

- Determine the daily pollutant production by source
- Estimate the size/number of each source
- Determine whether the source is
  - Direct or Indirect
  - Deep or Shallow
- Calculate the load to each land use based on a monthly schedule and for each source
- The sum of all the individual sources is the total load

Water Quality Model

Assumptions:

1. Deep loads:
   - Leaking oil wells
   - Groundwater
2. Shallow surface loads
   - Brine Pits

Source Loading Estimates

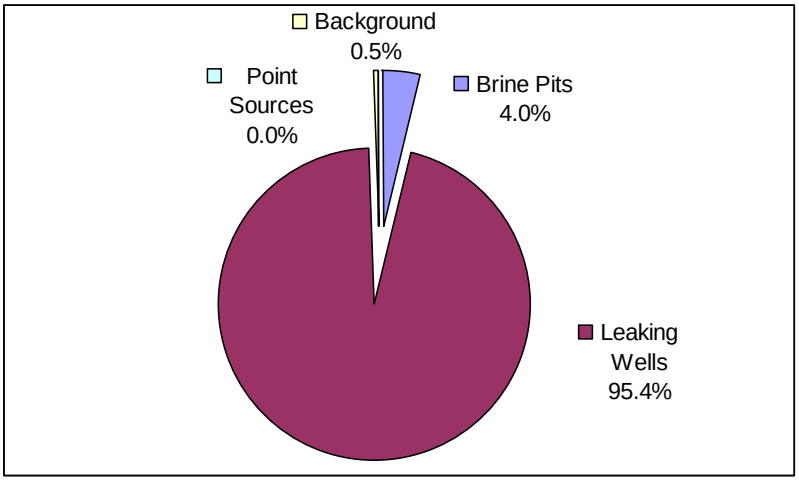
Model Source Representation

- 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 leaking wells was accounted for in groundwater concentrations as an additional load
- Brine pit loading was simulated as a non-point source

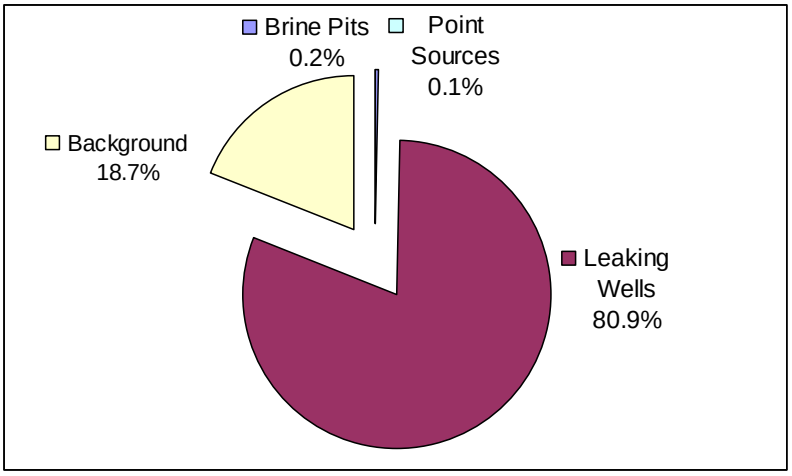
Existing Loads Distribution

Source	Annual Average Loads (Lbs/Year)					
	Sulfate	% Total	Chloride	% Total	TDS	% Total
Brine Pits and Injections	1.08E+05	0.2%	1.18E+07	4.0%	2.51E+07	4.0%
Leaking Wells	3.75E+07	80.9%	2.82E+08	95.4%	5.99E+08	95.4%
Background	8.67E+06	18.7%	1.59E+06	0.5%	3.38E+06	0.5%
Point Sources	5.33E+04	0.1%	8.88E+04	0.0%	1.89E+05	0.0%
Total	**4.63E+07**	**100.0%**	**2.95E+08**	**100.0%**	**6.28E+08**	**100.0%**

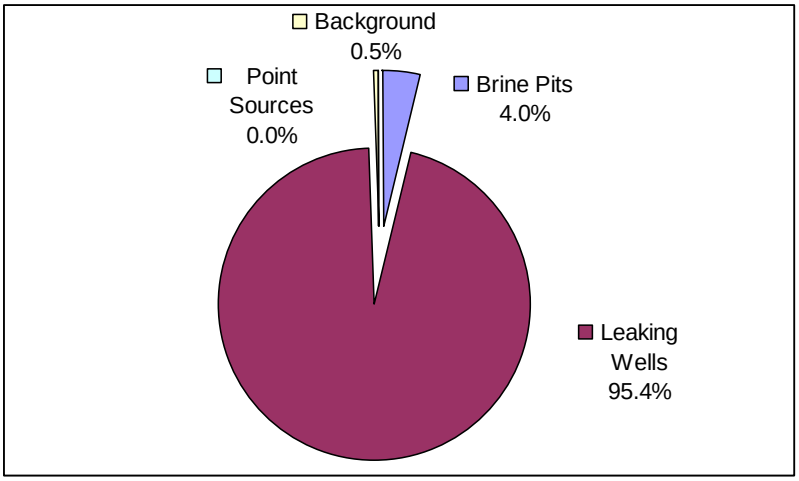
Model Source Loading: Chloride



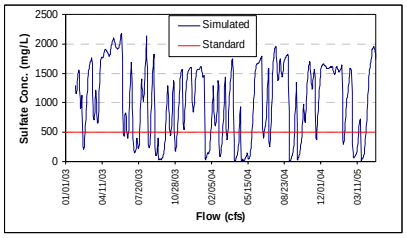
Model Source Loading: Sulfate

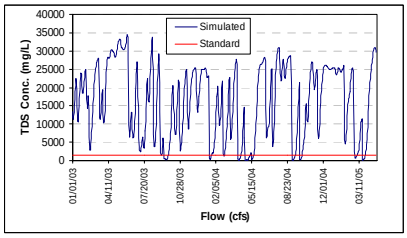


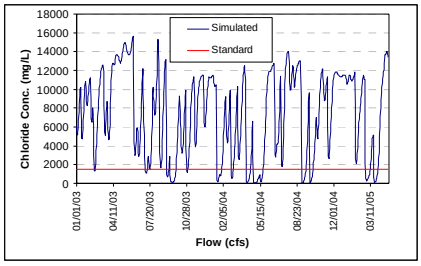
Model Source Loading: TDS



Existing Conditions Loading







Allocation Scenarios Framework

- Existing conditions
- Need to address the loads from the following:
  - Brine pits
  - Leaking wells

Allocation Scenarios Framework: Chloride and TDS

- Scenario 0 represents the existing loading, which is no reduction of any of the sources;
- Scenarios 1 through 4 represent gradual reductions in loadings from brine pits. The intent is to assess the resulting effect of controlling solely the brine pit sources of pollutants.
- Scenarios 5 through 7 represent gradual reduction in loadings from leaking wells and groundwater in addition to a complete reduction in loadings from brine pits.

Scenario	Chloride and TDS Reduction in Loadings from Existing Conditions (%)		
	Brine Pits	Leaking Wells	Ground Water
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	95	0

Allocation Scenarios Framework: Sulfate

- Scenario 0 represents the existing loading, no reduction of any of the sources;
- Scenarios 8 and 9 represent gradual reductions in loadings from brine pits (50 and 100 percent reductions, respectively).
- Scenarios 10 - 12 represent gradual reduction in loadings from leaking wells in addition to complete reduction in loadings from brine pits

Scenario	Sulfate Reduction in Loadings from Existing Conditions (%)		
	Brine Pits	Leaking Wells	Groundwater
0	0	0	0
8	50	0	0
9	100	0	0
10	100	25	0
11	100	50	0
12	100	86	0

Allocation Scenarios Framework

Scenario Number	Reduction in Loadings from Existing Conditions (%)			Percent of Time the Standard is Violated		
	Brine Pits	Leaking wells	Groundwater	Chloride	Sulfate	TDS
0	0	0	0	84	74	82
1	25	25	0	81		79
2	50	50	0	76		72
3	75	75	0	63		55
4	100	0	0	84		82
5	100	50	0	75		71
6	100	75	0	58		51
7	100	96	0	0		0
8	50	0	0		74	
9	100	0	0		74	
10	100	25	0		68	
11	100	50	0		57	
12	100	86	0		0	

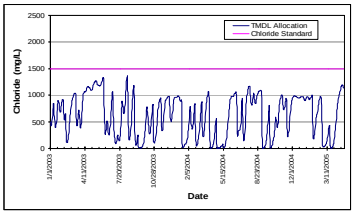
Allocated Loads Distribution

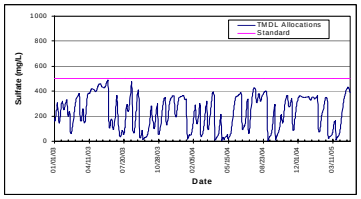
Source	Annual Average Loads (lbs/Year)					
	Sulfate	% Total	Chloride	% Total	TDS	% Total
Brine Pits and Injections	0	0.0%	0	0.0%	0	0.0%
Leaking Wells	5.25E+06	34%	1.40E07	77.3%	2.98E07	77.3%
Background	8.67E+06	56%	1.59E06	8.8%	3.38E06	8.8%
Point Sources	1.52E+06	10%	2.53E06	14.0%	5.39E06	14.0%
Total	1.55E+07	100%	1.81E07	100%	3.86E07	100%

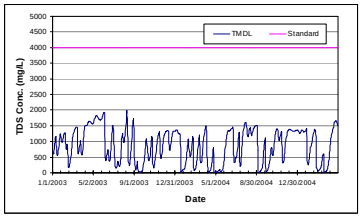
Allocated Loads

The elimination of water quality standard violations requires the following reductions from non-point sources:

- 92 percent reduction in chloride loading
- 70 percent reduction in sulfate loading
- 92 percent reduction in TDS loading







TMDL Expressions

Chloride TMDL

TMDL (lbs/year)	WLA (lbs/year)	LA (lbs/year)	MOS (lbs/year)
1.90E+07	2.53E+06	1.56E+07	9.5E+05

Sulfate TMDL

TMDL (lbs/year)	WLA (lbs/year)	LA (lbs/year)	MOS (lbs/year)
1.63E+07	1.52E+06	1.39E+07	7.75E+05

Total Dissolved Solids TMDL

TMDL (lbs/year)	WLA (lbs/year)	LA (lbs/year)	MOS (lbs/year)
4.05E+07	5.39E+06	3.32E+07	1.93E+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
www.TCEQ.state.tx.us

The Louis Berger Group, Inc.
Raed EL-Farhan – 202 912-0307
relfarhan@louisberger.com