



# Groundwater Monitoring in Texas

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**ACWI SOGW Meeting**  
**May 21, 2007**

Mary Ambrose  
Texas Commission on Environmental Quality

# Groundwater in Texas

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- ✿ Groundwater supplied 57 percent of the 16.2 million acre-feet of water used in the State in 2003
- ✿ 80 percent of the groundwater used in 2000 was for irrigation
- ✿ Remainder used for municipal supplies, rural and municipal domestic consumption, rural livestock, electric utility, and industry
- ✿ Approximately 33 percent of municipal water is obtained from groundwater sources
- ✿ Groundwater provides a significant amount of the base flow for the state's rivers and streams, and is important to the maintenance of the state's environment and economy

# Mapped Aquifers

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## ✿ Nine Major Aquifers

Defined as producing large quantities of water in a comparatively large area of the state

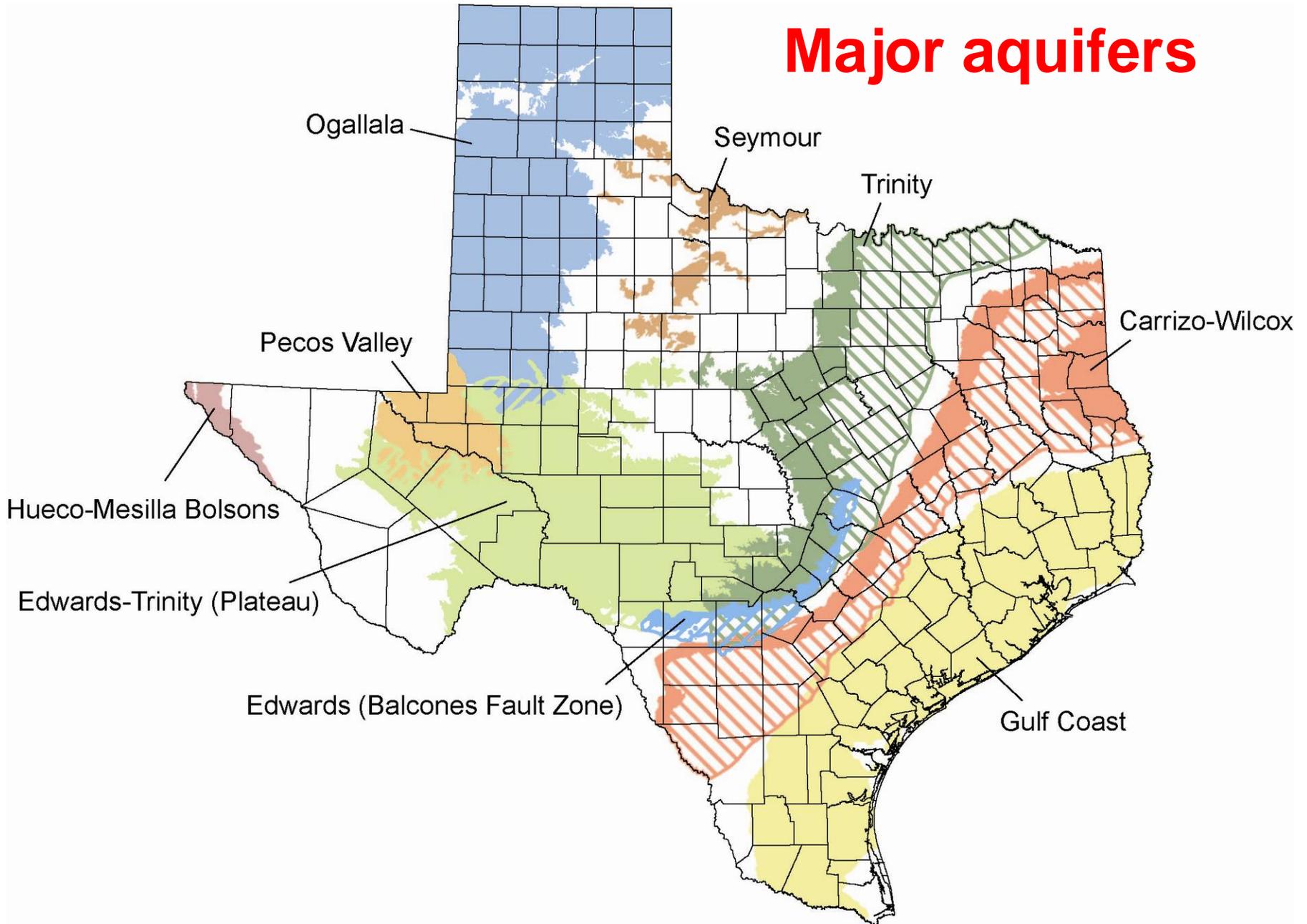
## ✿ Twenty-one Minor Aquifers

Defined as produce significant quantities of water within smaller geographic areas or small quantities in large geographic areas

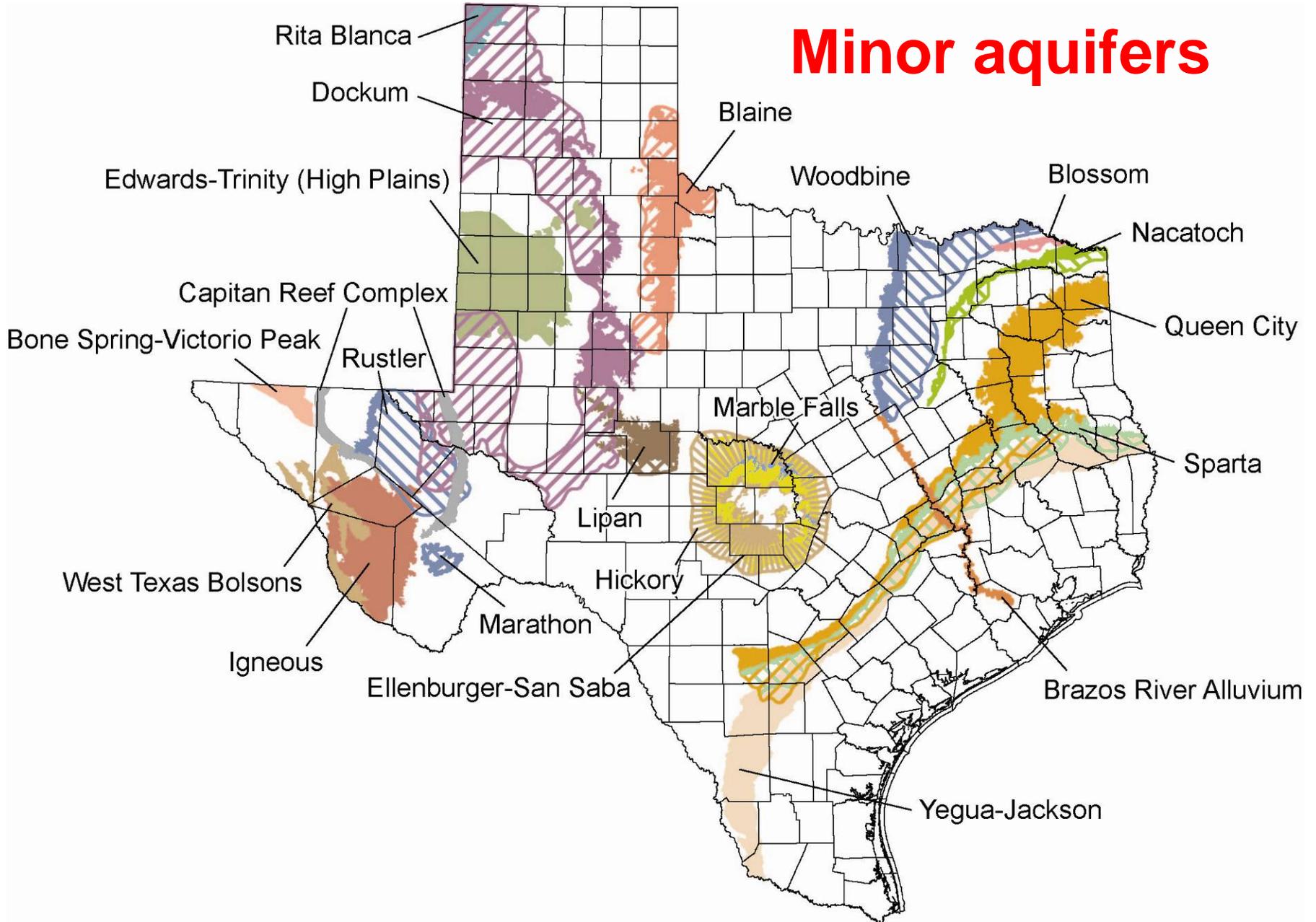
✿ The major and minor aquifers are composed of many rock types, including limestones, dolomites, sandstones, gypsum, alluvial gravels, and in some parts of the state, igneous rocks

✿ The major and minor aquifers underlie approximately 76 percent of the state's surface area

# Major aquifers



# Minor aquifers



# The TGPC

T E X A S  
**GROUNDWATER  
PROTECTION**  
C O M M I T T E E

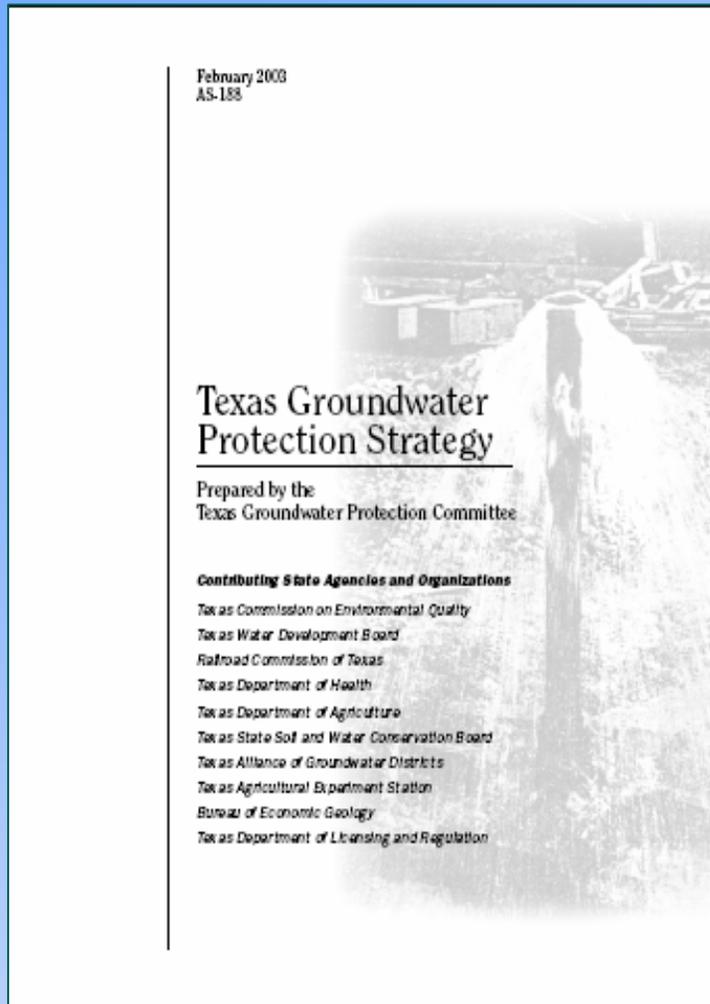


#### MEMBER AGENCIES

Texas Commission on Environmental Quality  
Texas Water Development Board  
Railroad Commission of Texas  
Department of State Health Services  
Texas Department of Agriculture  
Texas State Soil and Water Conservation Board  
Texas Alliance of Groundwater Districts  
Texas Agricultural Experiment Station  
University of Texas Bureau of Economic Geology  
Texas Department of Licensing and Regulation

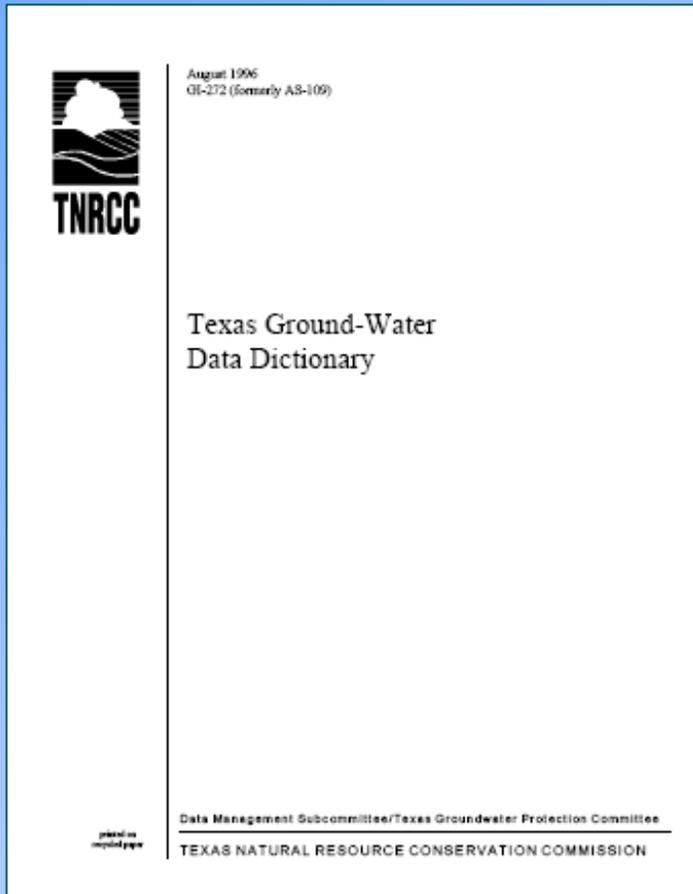
- ✿ Created 1989 by Legislation
- ✿ Implements State's Groundwater Protection Strategy
- ✿ Publishes Joint Groundwater Monitoring and Contamination Report
- ✿ Facilitates the Coordination of Member Agencies

# Data Management Subcommittee



- ☀ Data Management Coordination
- ☀ Joint Groundwater Monitoring and Contamination Report
- ☀ Groundwater portion of the 305(b)
- ☀ Statewide Groundwater Monitoring Design

# Data Dictionary - 1996



- ✿ Standardized framework for collecting and storing information on ground water
- ✿ 135 data elements
- ✿ Core set specified to meet the requirements of the Minimum Set of Data Elements for Ground Water Quality (MSDE)
- ✿ Reviewed 2006

[http://www.tceq.state.tx.us/files/gi-27.pdf\\_4009807.pdf](http://www.tceq.state.tx.us/files/gi-27.pdf_4009807.pdf)

# Joint Groundwater Monitoring and Contamination Report—2006

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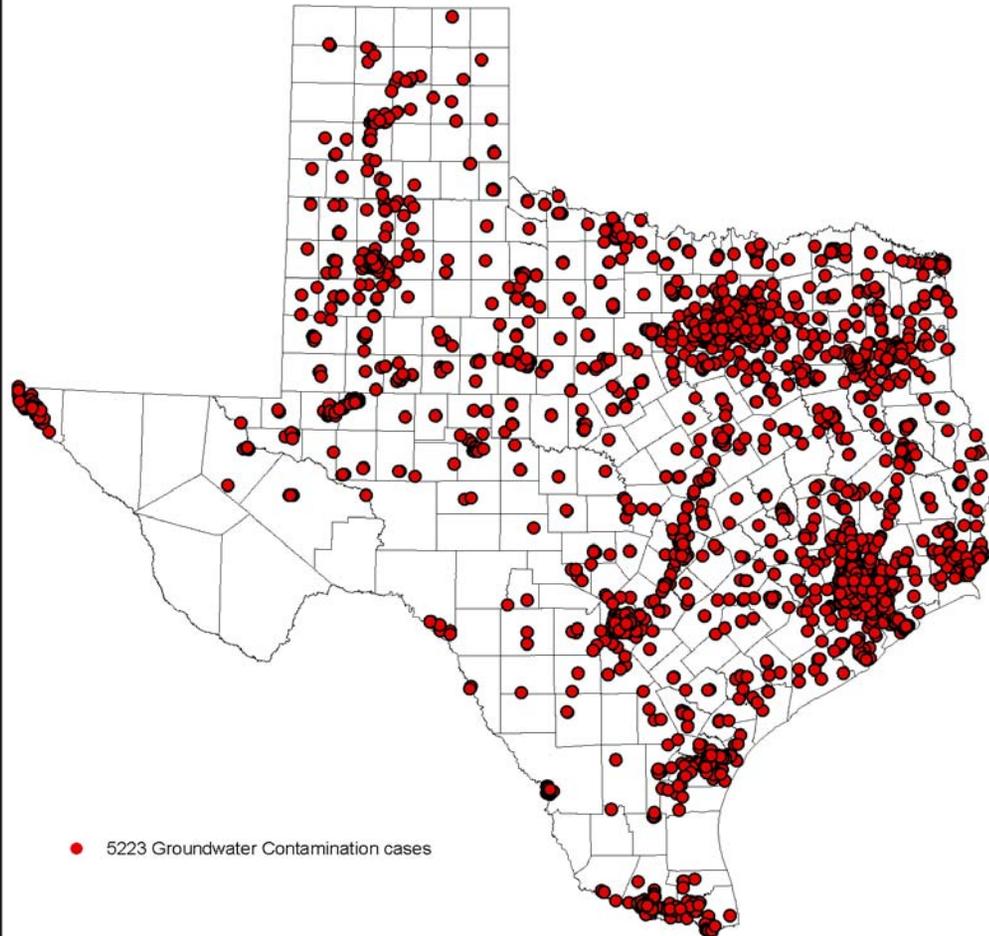
- ✿ Annual report
- ✿ Describes the current status of groundwater monitoring programs for all Agencies
- ✿ Describes 5,576 groundwater contamination cases documented or under enforcement during the 2006 calendar year

# Groundwater Monitoring Programs

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- ✱ Regulatory agencies require or conduct monitoring to assure compliance with guidelines and regulations for the protection of groundwater from discharges of contaminants
- ✱ Agencies or entities conducting monitoring to assess ambient or existing groundwater quality conditions and to track changes in water quality over time
- ✱ Agencies or entities conducting research activities related to groundwater resources and groundwater conservation

# TCEQ Groundwater Contamination Map

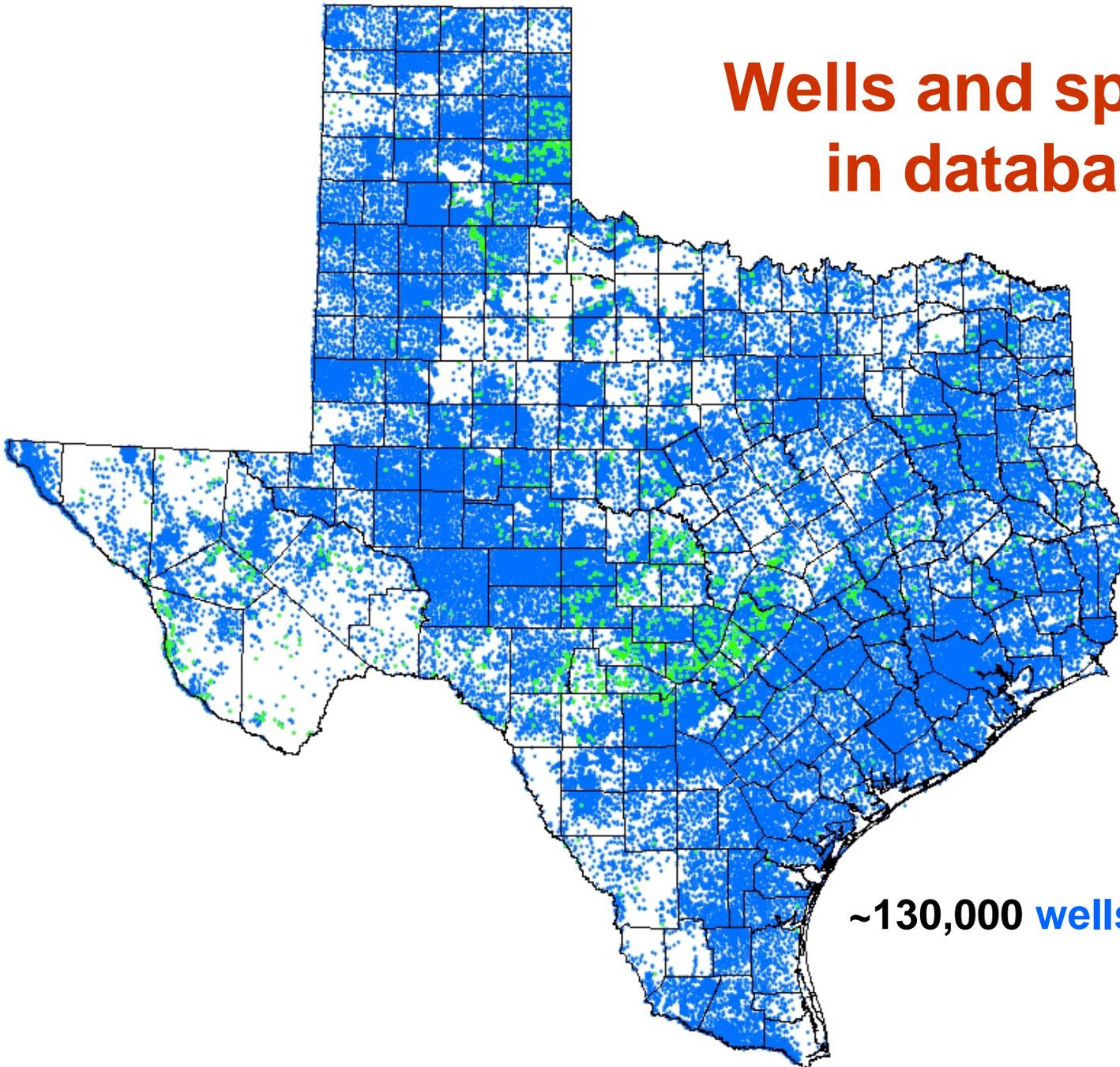


# Texas Water Development Board Water Quality Sampling Program

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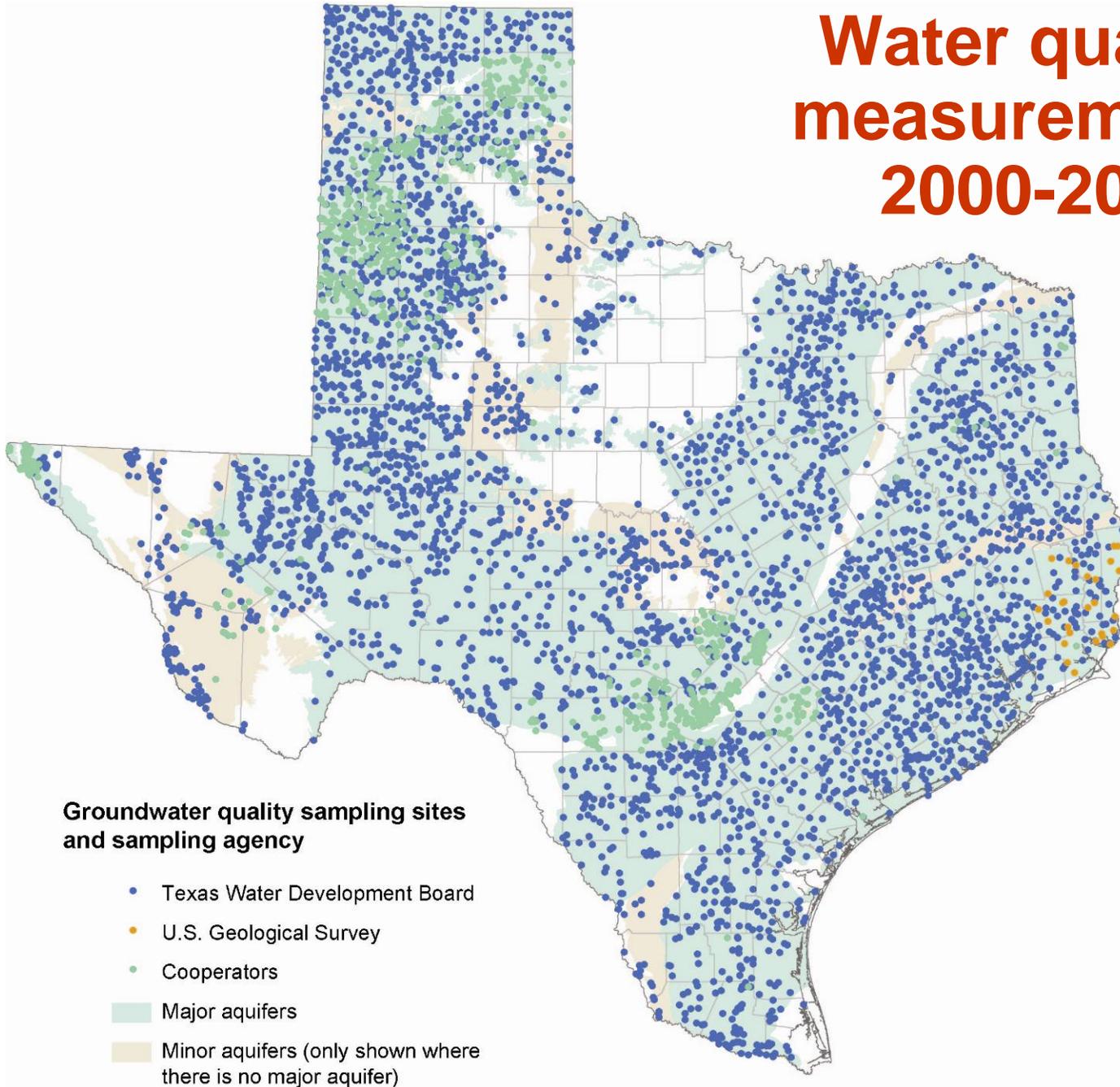
- ✿ Monitor changes in the quality of groundwater over time and to establish natural baseline quality of groundwater in the state's aquifers
- ✿ Collected on a rotating schedule every 4 years
- ✿ Samples collected in accordance with procedures established in the TWDB's Field Manual for Ground-Water Sampling
- ✿ Results from analyses and results sampled by other entities are also entered in the TWDB's groundwater database

# Wells and springs in database



~130,000 wells and spring

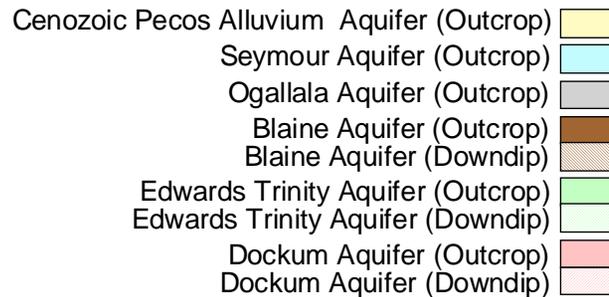
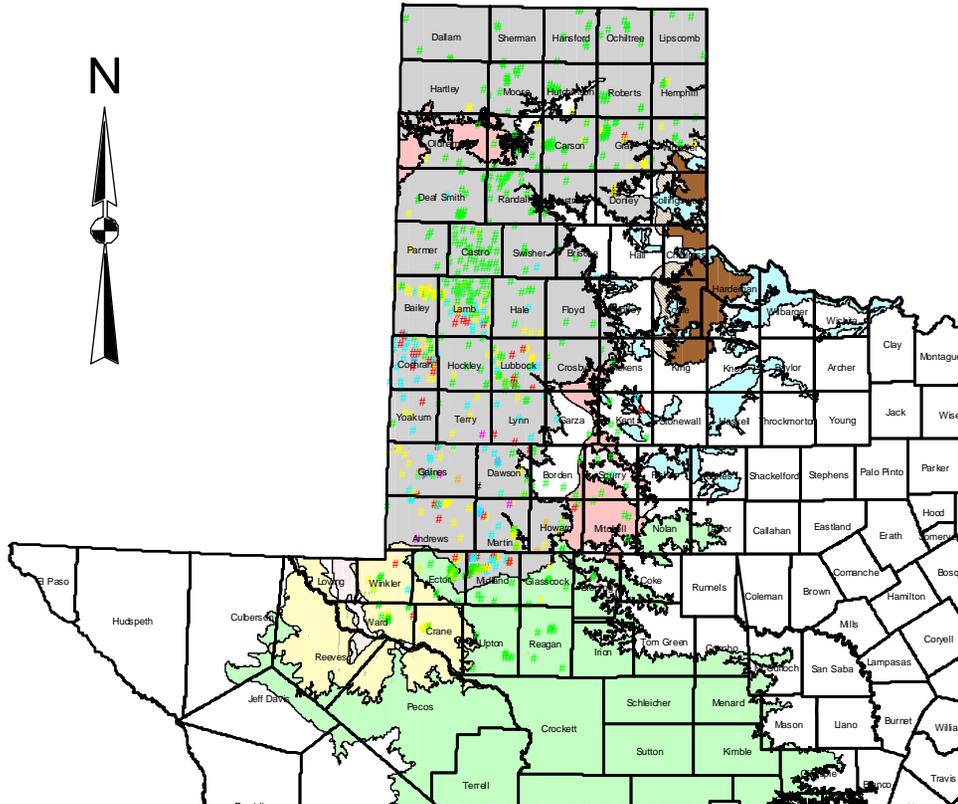
# Water quality measurements 2000-2005



# 305(b) Report

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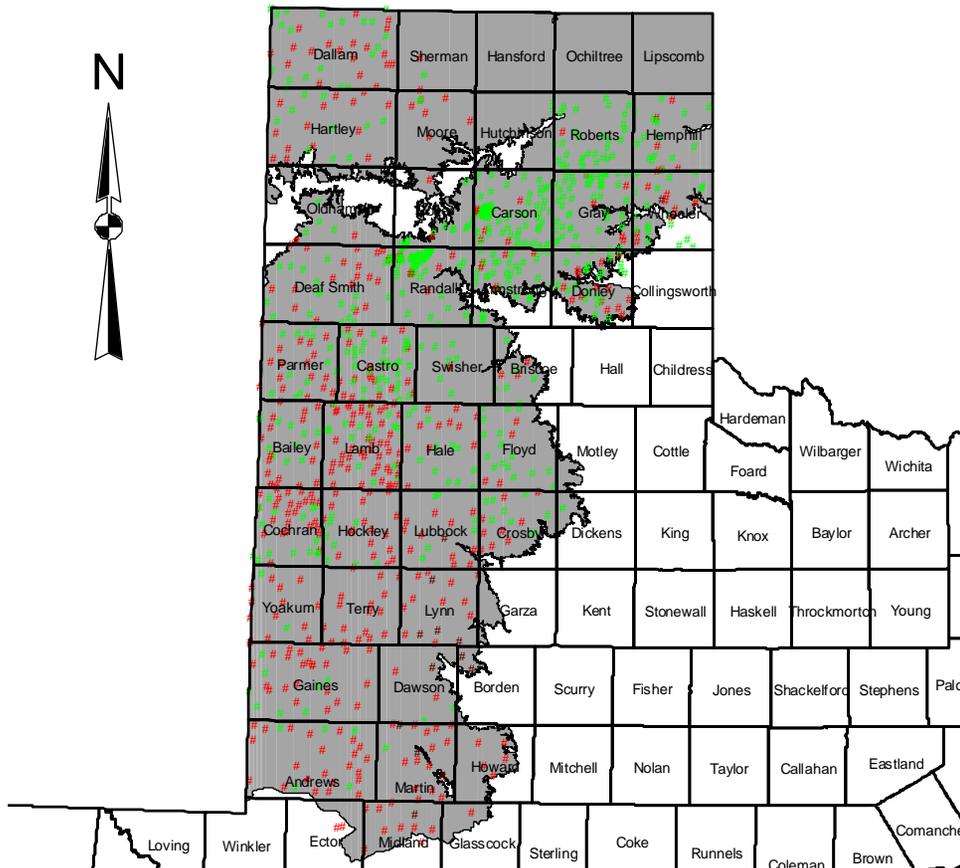
- ✿ Use data from the TWDB's Ambient Groundwater Monitoring program, augmented by data from the TCEQ's database of Public Water Supply analyses, to provide an idea of the extent of undesirable groundwater constituents for certain aquifers
- ✿ Constituents include nitrate, arsenic, fluoride, chloride, sulfate, iron, manganese, perchlorate, and total dissolved solids in aquifers where they pose a particular risk or problem with respect to the use of groundwater



**Perchlorate Concentration**

- # Greater than 51 ug/l
- Greater than 24.5 ug/l, but less than 51 ug/l
- Greater than 17 ug/l, but less than 24.5 ug/l
- Greater than 6 ug/l, but less than 17ug/l
- Greater than 4 ug/l , but less than 6 ug/l
- Greater than 1 ug/l, but less than 4 ug/l
- Less than 1 ug/l

# Distribution of perchlorate concentrations in the High Plains region of Texas



### Nitrate Concentration

- # Less than 10 mg/l
- # 10 mg/l or greater, but less than 100 mg/l
- # 100 mg/l or greater

■ Outcrop of the Ogallala Aquifer

# Distribution of Nitrate in the Ogallala Aquifer

# Draft Texas Groundwater Monitoring Strategy

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- ✿ Establish a baseline set of data regarding number of wells, well distribution, constituents of concern, land-use (hydro-geographical)
- ✿ Evaluate trends in water quality
- ✿ Analyze land-use effects on water quality
- ✿ Evaluate recharge and recharge variability in all aquifers
- ✿ Determine constituents of concern and methods for early detection
- ✿ Determine aquifer water levels according to regional priority
- ✿ Evaluate cycles (seasonal changes) in water quality according to regional priority

# Three Draft Network Types

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- ✿ Basic – Aquifer-wide – ambient conditions
- ✿ Reference – Selected – undisturbed/least disturbed settings (as aquifer changes, point of reference for comparison)
- ✿ Targeted – Local – water quality issues (water use, land use)

# Draft Well Selection Guidelines

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- ✱ Wells should provide a statewide overview of ground water quality
- ✱ Wells should be selected to include all major and minor aquifers
- ✱ Well network should be integrated with existing water resources data networks
- ✱ Network should provide data on water quality for studies of regional significance
- ✱ Wells should represent both horizontal and vertical distributions
- ✱ Wells should represent both domestic and public supplies

# Draft Well Selection Guidelines

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For Basic and Reference wells:

- ✿ Wells should be systematically distributed with respect to regional flow
- ✿ Wells should be selected so that analytical data will refine the definition of baseline quality
- ✿ Wells should be part of a present water resource data base
- ✿ Wells should be frequently used, to assure samples are representative

# Draft Well Selection Guidelines

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For Targeted wells:

- ✱ Wells should be selected within cones of depression in major metropolitan area pumping centers
- ✱ Wells should be selected from areas where many wells of a single type, such as irrigation wells, are concentrated
- ✱ Wells should be selected from hydrogeologically sensitive areas

# Draft Well Selection Guidelines

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For all wells:

- ✿ Adequate information must be available to enable field personnel to positively identify the well
- ✿ A geologic log of the well borehole must be available to identify the sequence of geologic materials penetrated by the well
- ✿ Well construction information must be provided, including depth drilled, depth of casing, casing material and diameter, length of open hole or type and length of screen

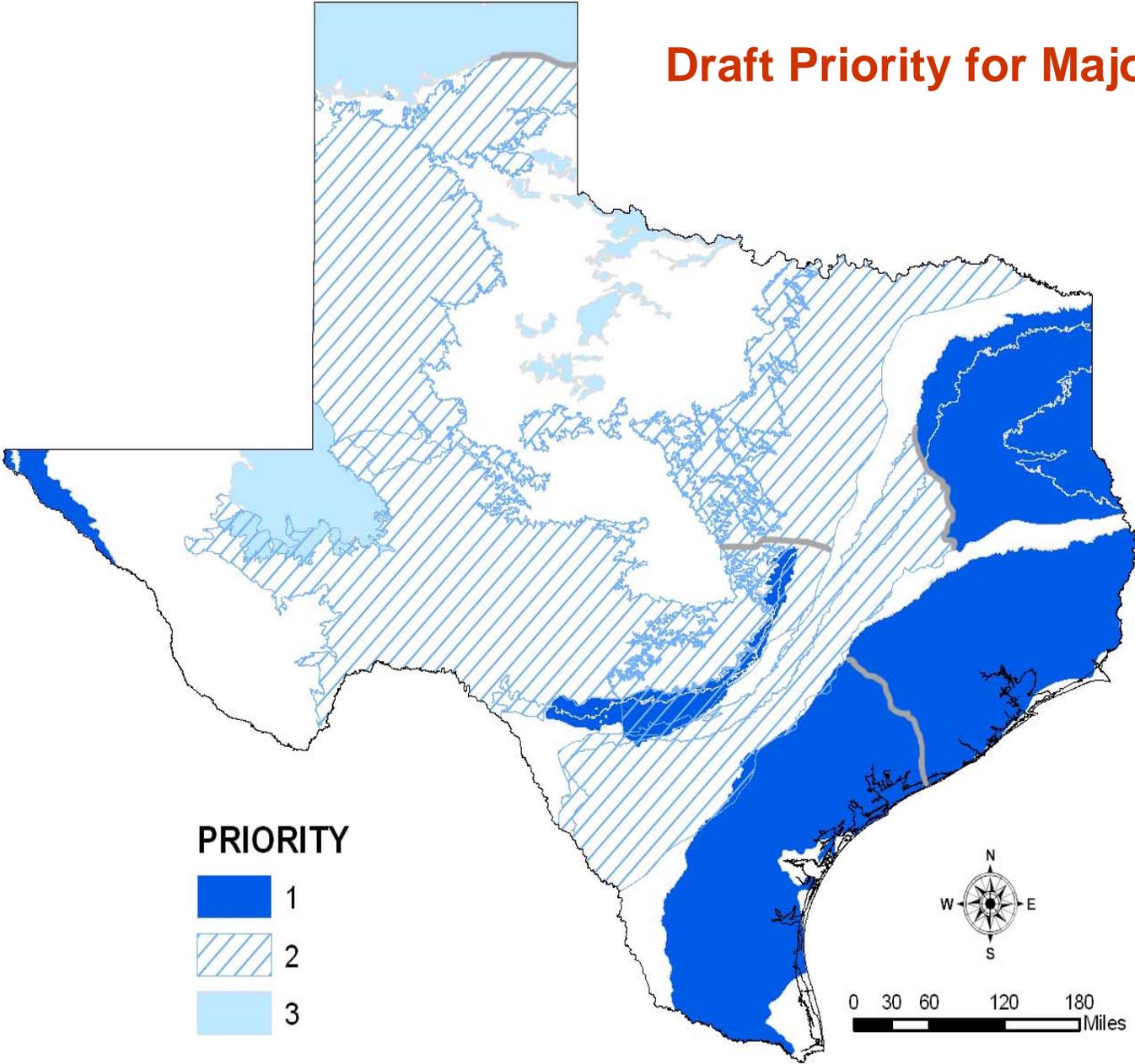
# Draft Monitoring by Well Type

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Constituents are Monitored according to Network Type and Aquifer Priority Levels

- ✱ Basic and Reference wells will be monitored for all compounds of interest based upon aquifer priority
- ✱ Targeted wells will be monitored for specific compounds of interest, based on the constituent(s)

# Draft Priority for Major Aquifers



# Draft Constituent Groups Proposed For Monitoring

Group	Constituents
Field parameters	Water level, pH, dissolved oxygen, specific conductance, temperature, alkalinity (bicarbonate, carbonate)
Inorganics (Major ions)	Dissolved solids, calcium, magnesium, potassium, sodium, chloride, sulfate, bromide, fluoride, silica, sulfide, and others
Trace elements	Aluminum, arsenic, chromium, copper, iron, lead, manganese, nickel
Trace elements (Targeted)	Antimony, barium, beryllium, boron, cadmium, cobalt, iodide, lithium, mercury, molybdenum, selenium, silver, strontium, vanadium, zinc
Nutrients	Nitrate, nitrite, ammonia, organic nitrogen, phosphate, phosphorus
Organics (Organic compounds)	Organic carbon, volatile organic compounds, semivolatile organic compounds, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, phenols, and others
Pesticides (Pesticide compounds)	Herbicides, insecticides, fungicides, rodenticides (organochlorines, organophosphates, carbamates, triazines, amides, pyrethroids, breakdown products, and others)
Microbiology	Coliform, streptococci, protozoans, and others
Radionuclides (Radioactivity)	Gross alpha and gross beta radiation, radium, uranium, radon
Gases	Argon, carbon dioxide, nitrogen, methane, and others
Emerging Contaminants (Wastewater analytes; pharmaceuticals, personal care products)	Human and veterinary pharmaceuticals, wastewater analytes (for example: caffeine, surfactants), coliphage, viruses, perchlorate and others

# Draft “Monitoring Matrix”

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- ✿ Axes contain the different network types, aquifer priority levels and constituent/parameter groups
- ✿ The field of the matrix is populated by sampling regimes; note that frequency of sampling is denoted in the matrix for frequency in years
- ✿ Targeted wells, the constituent(s) for which the well was targeted would be the only constituent(s) sampled at the suggested frequency rate

# Draft Monitoring Matrix

		Constituents									
Monitoring Network Matrix		For Sampling Frequency: Number indicates frequency in years									
Network	Aquifer Level	Field Parameters	Inorganics	Trace Elements	Trace Elements (Targeted)	Nutrients	Organics	Pesticides	Microbiology	Radio-nuclides	Emerging Contaminants
Basic & Reference	Priority I	4	4	4	4	4	4	3	4	6	4
	Priority II	4	4	4	4	4	6	3	6	6	4
	Priority III	6	6	6	6	6	6	4	6	6	6
Targeted	Priority I	1	4	1	1	1	1	1	3	5	1
	Priority II	1	4	4	1	1	1	1	5	5	3
	Priority III	1	5	4	1	4	1	1	5	5	3

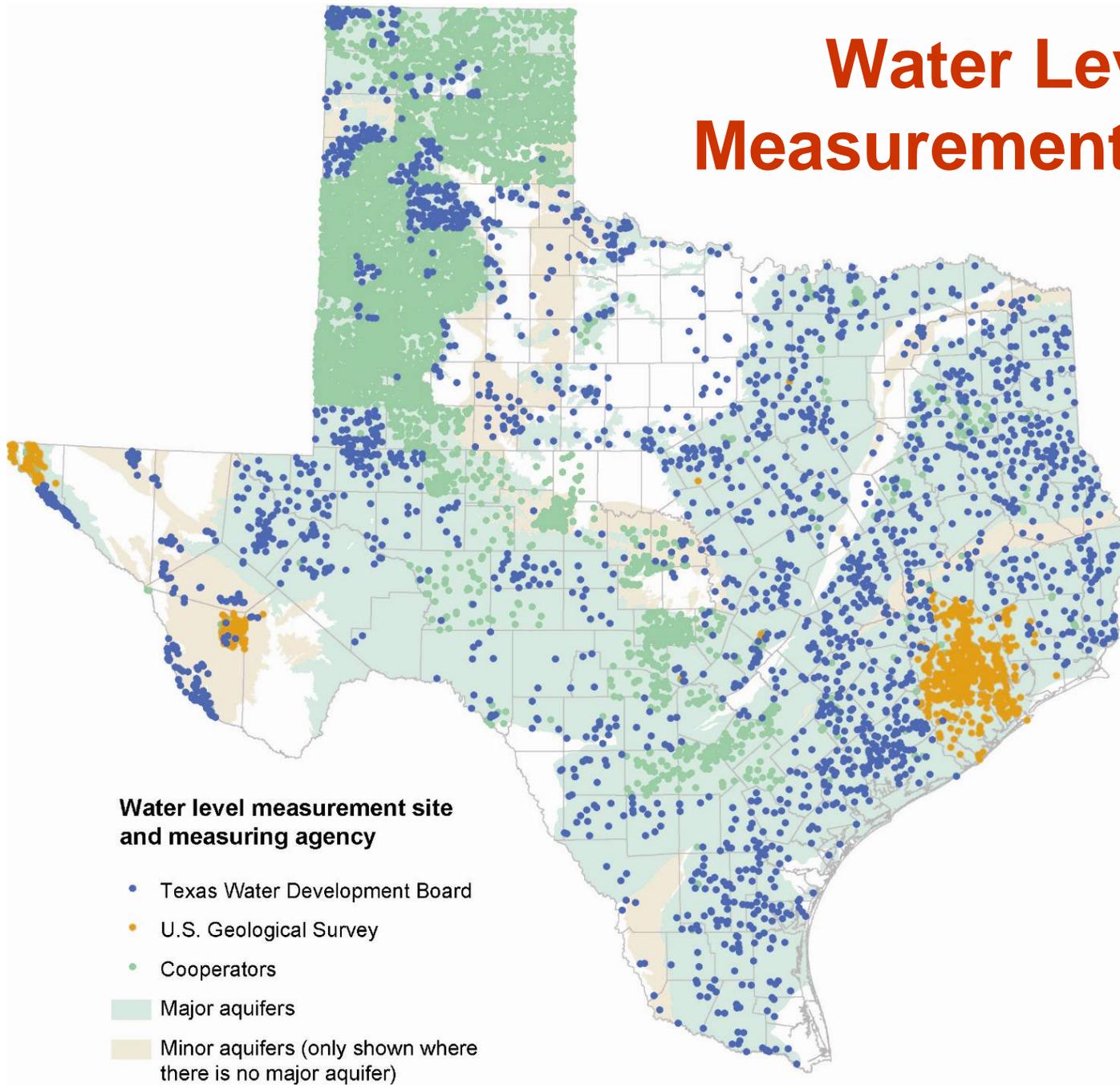
# Texas Water Development Board

## Groundwater Level Measuring Program

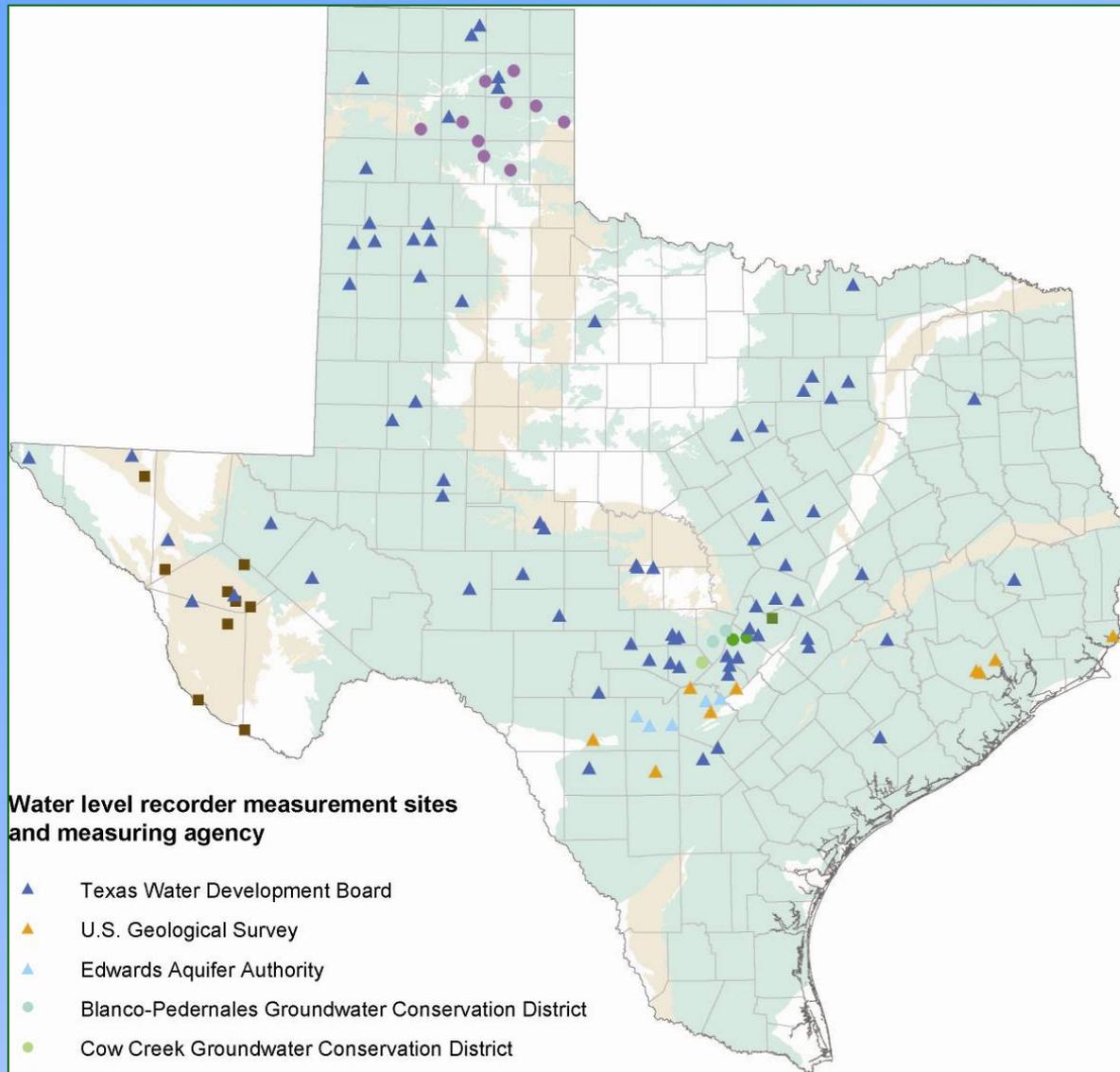
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- ✿ Measures groundwater levels annually in 2500 - 2900 wells completed in the 30 major and minor aquifers and located throughout the state
- ✿ Measure depths to water in accordance with procedures outlined in the TWDB Water-Level Measuring Manual
- ✿ Cooperators from groundwater conservation districts, a few cities, and the USGS provide an additional 6,000 measurements annually
- ✿ Information entered in the TWDB groundwater database

# Water Level Measurements 2006



# Water level recorder sites 2006



## Water level recorder measurement sites and measuring agency

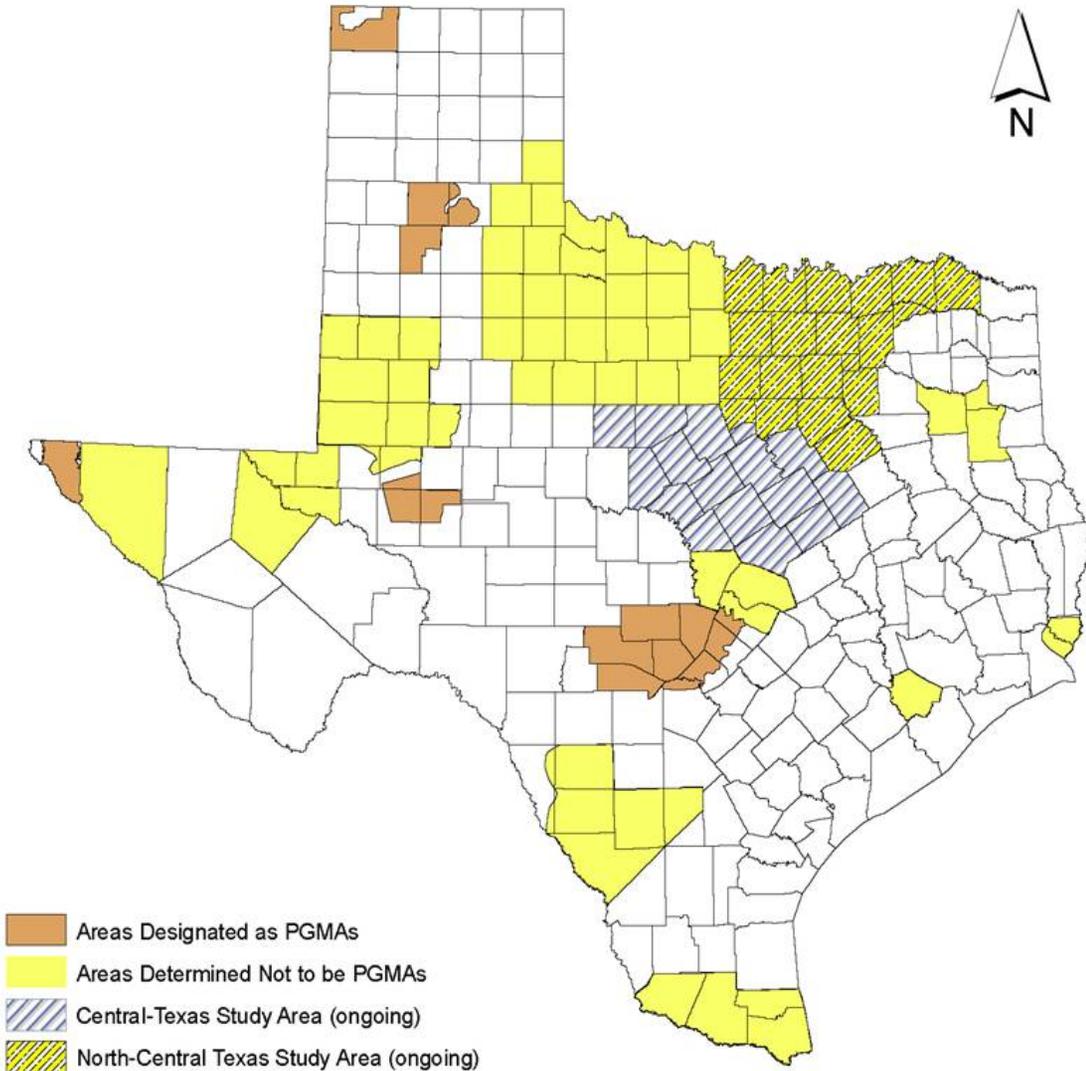
- ▲ Texas Water Development Board
- ▲ U.S. Geological Survey
- ▲ Edwards Aquifer Authority
- Blanco-Pedernales Groundwater Conservation District
- Cow Creek Groundwater Conservation District
- Hays-Trinity Groundwater Conservation District
- Panhandle Groundwater Conservation District
- Austin Community College
- Texas State University and Sul Ross State University
- Major aquifers
- Minor aquifers (only shown where there is no major aquifer)

# Uses of Groundwater Level Measurement Data

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- ✿ Identification of areas that are currently or expected to experience critical groundwater shortages within the next 25 years
- ✿ Background information for the State Water Planning Activities
- ✿ Data for the Groundwater Availability Modeling efforts

# Priority Groundwater Management Area Studies



Texas Commission on Environmental Quality



This map was prepared by the TCEQ for display purposes only. No claims are made to the accuracy or completeness of the information shown here nor is this map suitable for any other use. The scale and location of mapped data are approximate. The groundwater conservation district boundaries are not land survey data and may not accurately depict legal descriptions. For more information about this map, please contact TCEQ Groundwater Planning and Assessment Team.

Map Printed April, 2006

0 85 170 Miles

# 2007 State Water Plan

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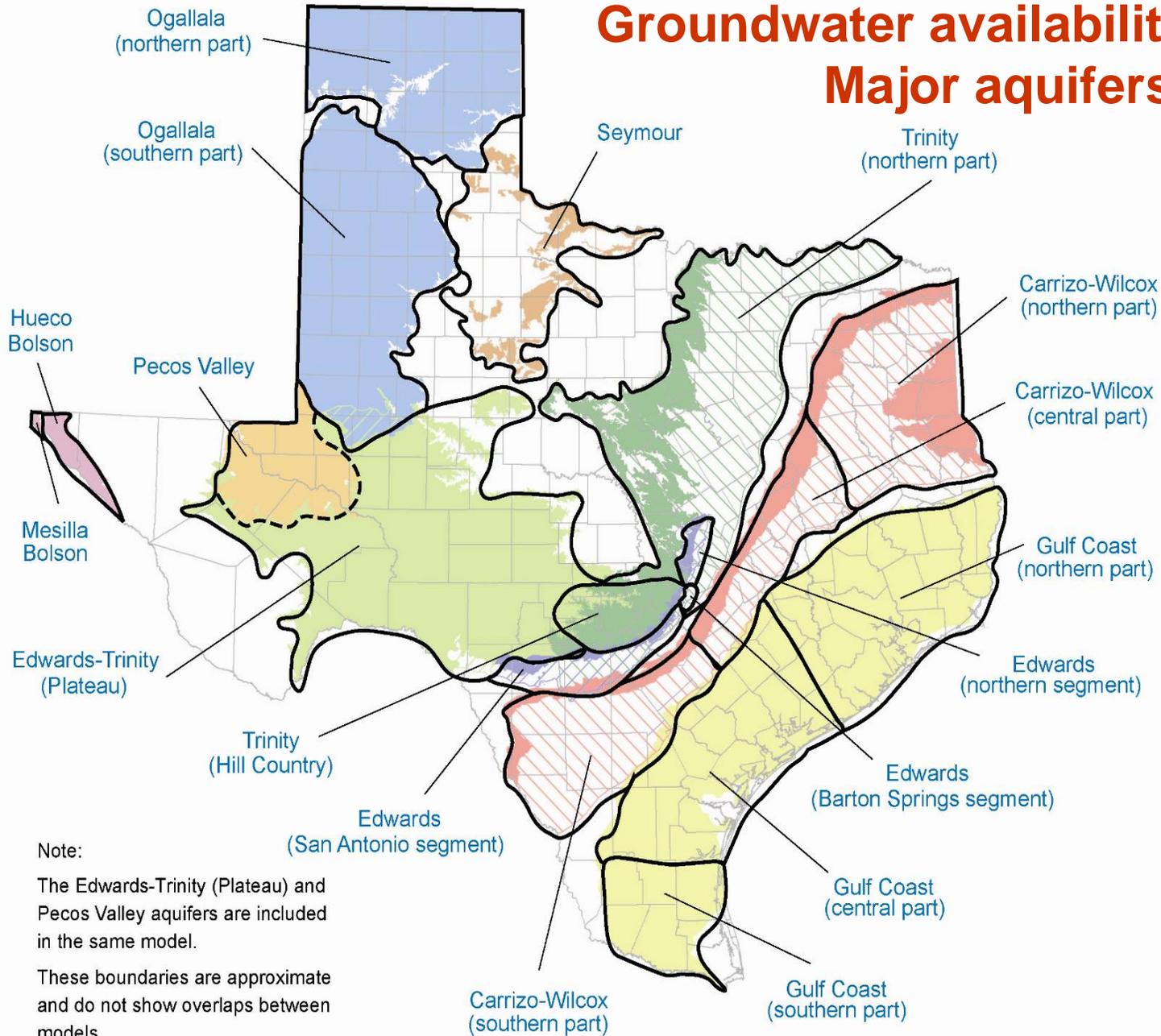
- ✿ TWDB - 50 year Water Planning Document  
Updated Every 5 years
- ✿ Bottom-Up Planning Driven through Regional  
Water Planning Groups
- ✿ The demand for water is expected to increase by 27  
percent, from almost 17 million acre-feet of water  
in 2000 to 21.6 million acre-feet in 2060.
- ✿ Groundwater availability - the amount of water  
from an aquifer that is available for use - is  
projected to decrease 22 percent, from 12.7 million  
acre-feet per year in 2010 to 9.9 million acre-feet  
per year by 2060.

# TWDB Groundwater Availability Modeling

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- ✱ Provide reliable, timely data on groundwater availability to the citizens of Texas to ensure adequacy of supplies or recognition of inadequacy of supplies throughout the 50 year planning horizon
- ✱ GAM will result in publicly available numerical groundwater flow models for the major and minor aquifers of Texas

# Groundwater availability models: Major aquifers

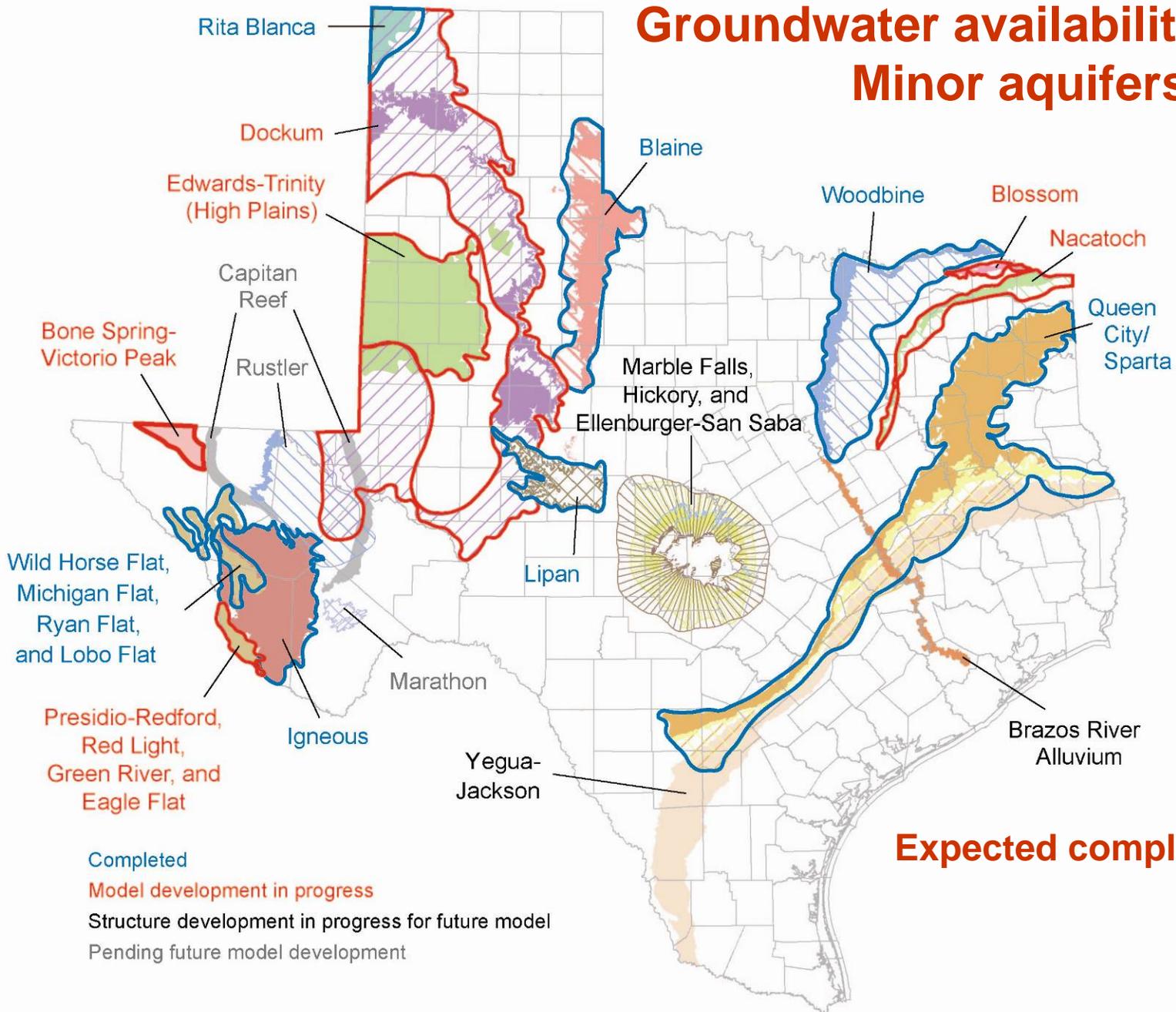


Note:

The Edwards-Trinity (Plateau) and Pecos Valley aquifers are included in the same model.

These boundaries are approximate and do not show overlaps between models.

# Groundwater availability models: Minor aquifers



**Expected completion: 2011**

Completed

Model development in progress

Structure development in progress for future model

Pending future model development

# Online Resources - TWDB

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- ✿ Groundwater resources  
<[www.twdb.state.tx.us/groundwater](http://www.twdb.state.tx.us/groundwater)>
- ✿ Water well database (levels & quality)  
<[wiid.twdb.state.tx.us/](http://wiid.twdb.state.tx.us/)>
- ✿ Daily water levels  
<[www.twdb.state.tx.us/data/waterwells/](http://www.twdb.state.tx.us/data/waterwells/)>
- ✿ GIS coverages  
<[www.twdb.state.tx.us/mapping/gisdata.asp](http://www.twdb.state.tx.us/mapping/gisdata.asp)>
- ✿ State Water Plan /Regional Water Plans  
<[www.twdb.state.tx.us/publications/pub.asp](http://www.twdb.state.tx.us/publications/pub.asp)>

# Other Online Resources

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## **Texas Groundwater Protection Committee**

[<www.tgpc.state.tx.us>](http://www.tgpc.state.tx.us)

Texas Groundwater Protection Strategy

Joint Groundwater Monitoring and Contamination Report

Texas Groundwater Data Dictionary

GW part of 305(b) report

## **TWDB's Field Manual for Ground-Water Sampling**

[<www.twdb.state.tx.us/publications/manuals/UM-51/FieldManual.pdf>](http://www.twdb.state.tx.us/publications/manuals/UM-51/FieldManual.pdf)

## **TWDB Water Level Measuring Manual**

[<www.twdb.state.tx.us/publications/manuals/UM-52/Um-52.pdf>](http://www.twdb.state.tx.us/publications/manuals/UM-52/Um-52.pdf)