Water-Level Altitudes and Changes in the Chicot, Evangeline, and Jasper Aquifers, Houston-Galveston Region, Texas, 2017

The Scientific Story of Water-Levels, Long-term Changes, and Compaction

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U.S. Department of the Interior
U.S. Geological Survey

Introduction to U.S. Geological Survey

- Department of Interior - Founded in 1879
- Six Science Mission Areas
  - Water Resources
  - Ecosystems
  - Energy, Minerals, and Environmental Health
  - Core Science Systems
  - Climate and Land-Use Change
  - Natural Hazards
- 8,300 employees nationwide
- Conduct interdisciplinary scientific monitoring, assessment, and research… distribute that information to the public

- **Scientific Mission**
- **Non-Regulatory**

USGS

Overview

- Gulf Coast Aquifer System

USGS

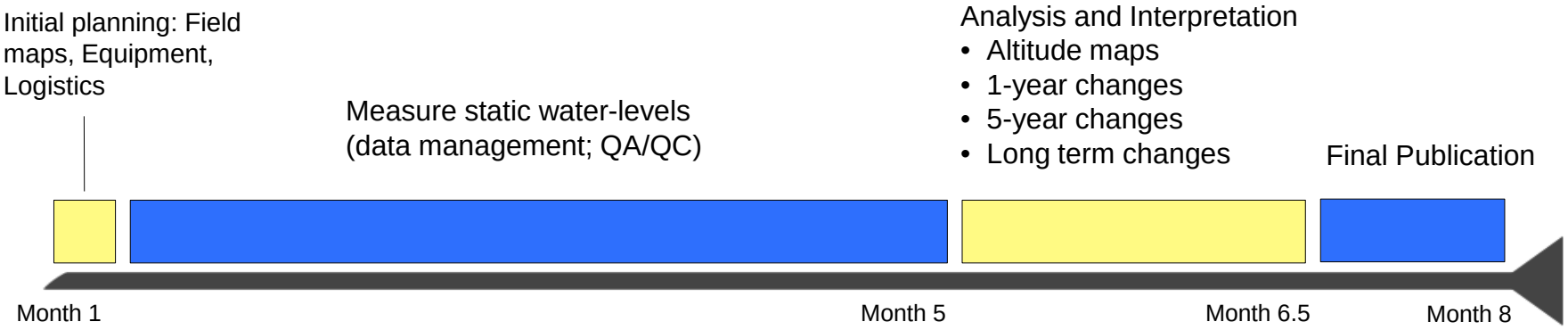
Overview

- Approach and Methodology
  - Order of Operations
  - Monitoring Network

Overview

- **Aquifer Map Interpretations**
  - Annual water-level altitude
  - 1-year water-level change
  - Long-term water-level change
  - Measured cumulative compaction

Approach and Methodology



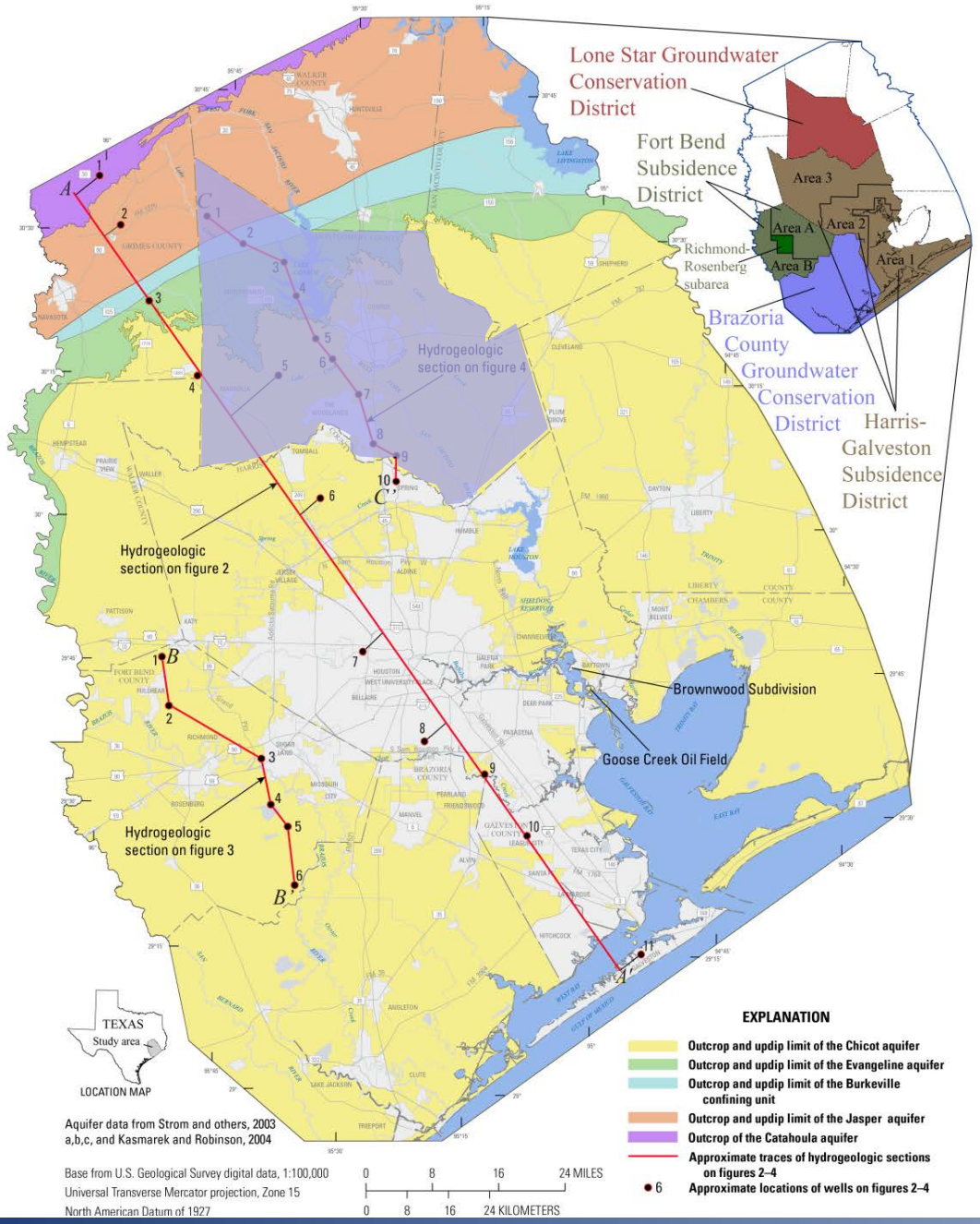
Approximately 700 wells measured between December and March in accordance with approved and documented USGS field procedures:

- public supply
- Irrigation
- industrial wells

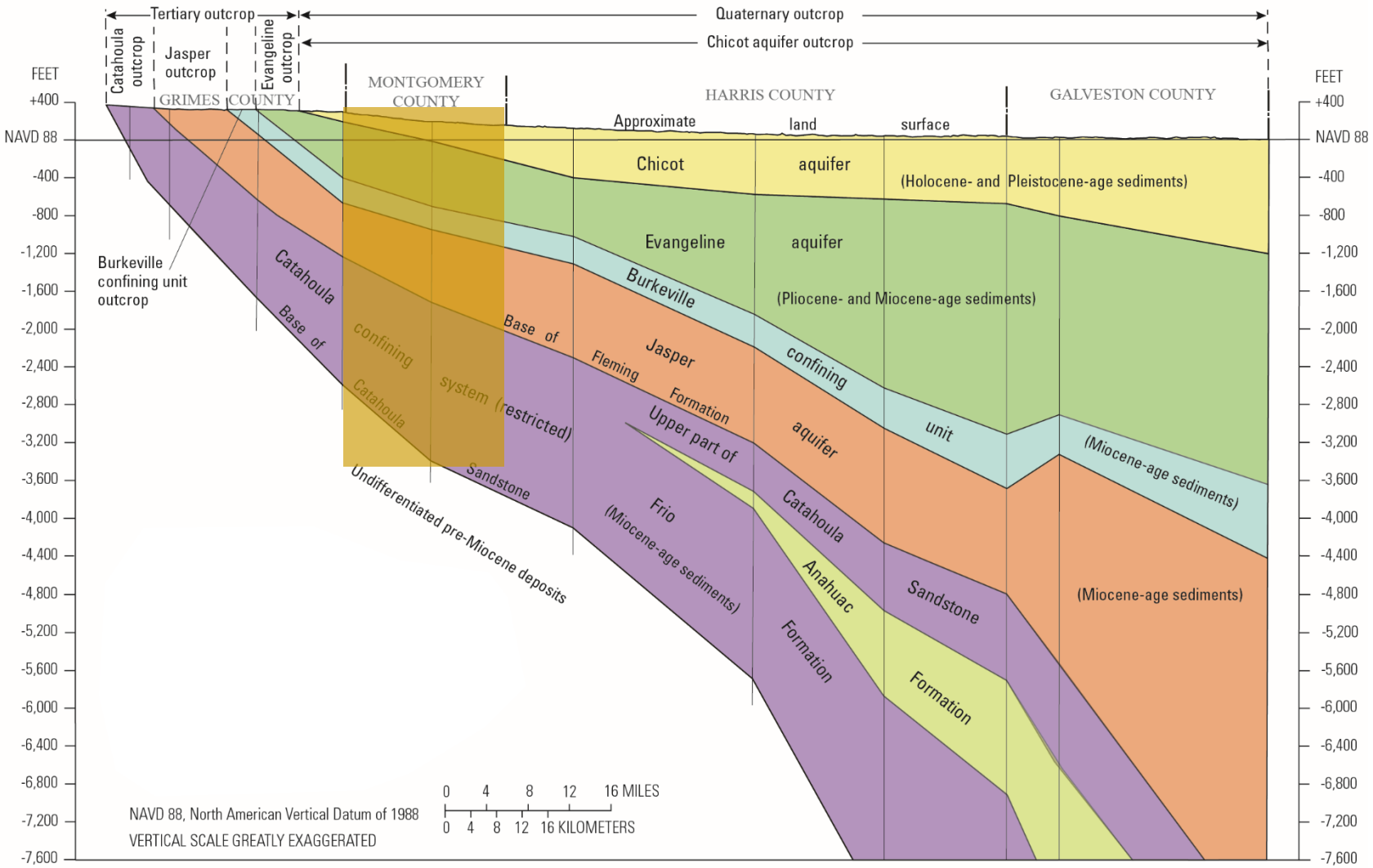
Peer reviewed by USGS prior to data delivery and presentation.

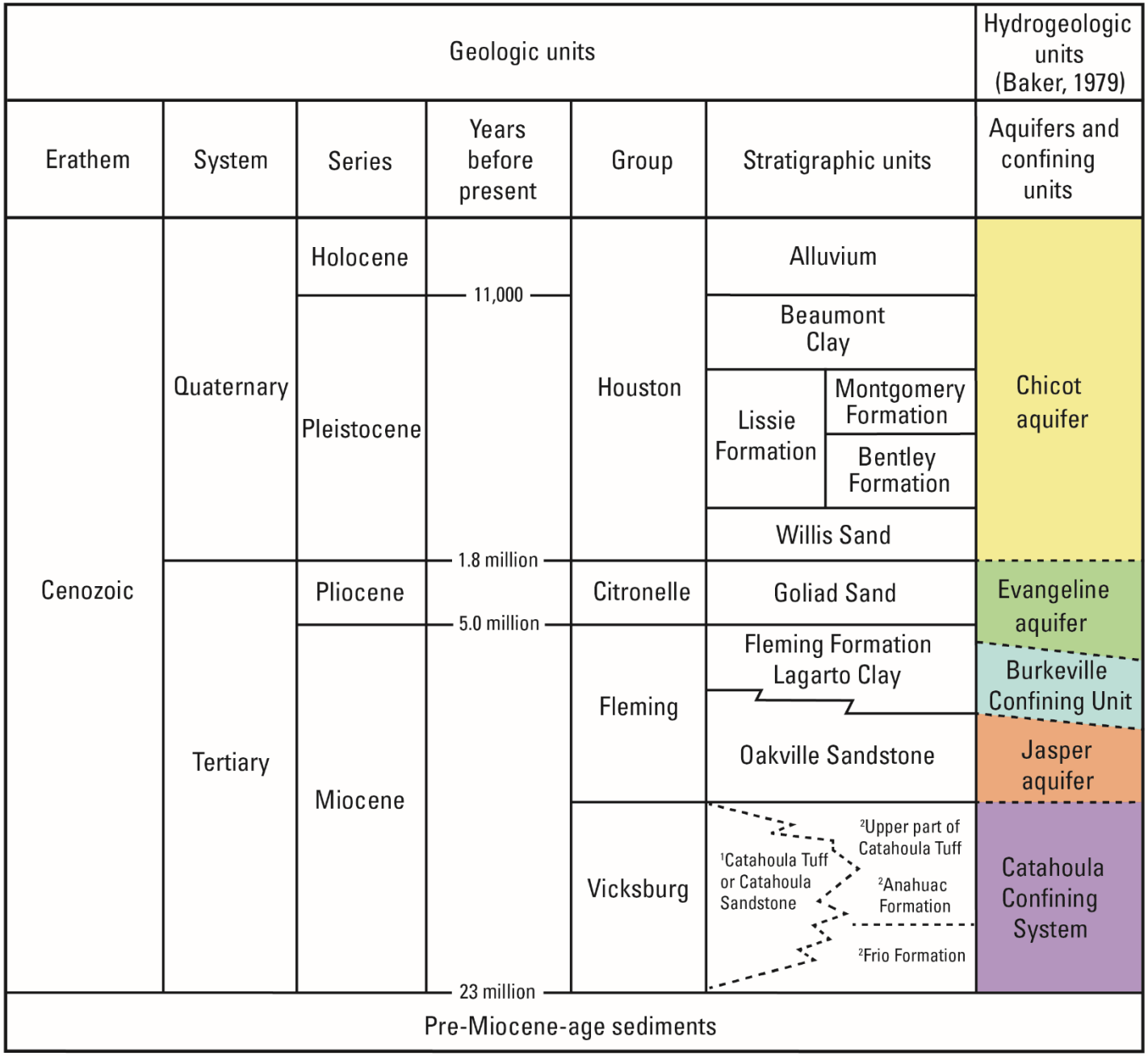
All data, interpretations, depictions, and documents are:

1. Archived
2. Published
3. made available to the public.


Lone Star Groundwater Conservation District
Fort Bend Subsidence District
Area 3
Area A
Area 2
Area B
Area 1
Richmond-Rosenberg subarea
Brazoria County Groundwater Conservation District
Harris-Galveston Subsidence District
Hydrogeologic section on figure 4
Hydrogeologic section on figure 2
Hydrogeologic section on figure 3
Brownwood Subdivision
Goose Creek Oil Field
TEXAS
Study area
LOCATION MAP
EXPLANATION
Outcrop and updip limit of the Chicot aquifer
Outcrop and updip limit of the Evangeline aquifer
Outcrop and updip limit of the Burkeville confining unit
Outcrop and updip limit of the Jasper aquifer
Outcrop of the Catahoula aquifer
Approximate traces of hydrogeologic sections on figures 2–4
6 Approximate locations of wells on figures 2–4
Aquifer data from Strom and others, 2003 a,b,c, and Kasmarek and Robinson, 2004
Base from U.S. Geological Survey digital data, 1:100,000
Universal Transverse Mercator projection, Zone 15
North American Datum of 1927
0 8 16 24 MILES
0 8 16 24 KILOMETERS

Hydrogeologic Section of the Gulf Coast Aquifer System




Geologic units
Hydrogeologic units (Baker, 1979)
Erathem
System
Series
Years before present
Group
Stratigraphic units
Aquifers and confining units
Cenozoic
Quaternary
Holocene
11,000
Pleistocene
Houston
Alluvium
Beaumont Clay
Lissie Formation
Montgomery Formation
Bentley Formation
Willis Sand
Chicot aquifer
1.8 million
Tertiary
Pliocene
5.0 million
Citronelle
Goliad Sand
Evangeline aquifer
Miocene
Fleming
Fleming Formation
Lagarto Clay
Burkeville Confining Unit
Oakville Sandstone
Jasper aquifer
Vicksburg
[1]Catahoula Tuff or Catahoula Sandstone
[2]Upper part of Catahoula Tuff
[2]Anahuac Formation
[2]Frio Formation
Catahoula Confining System
23 million
Pre-Miocene-age sediments

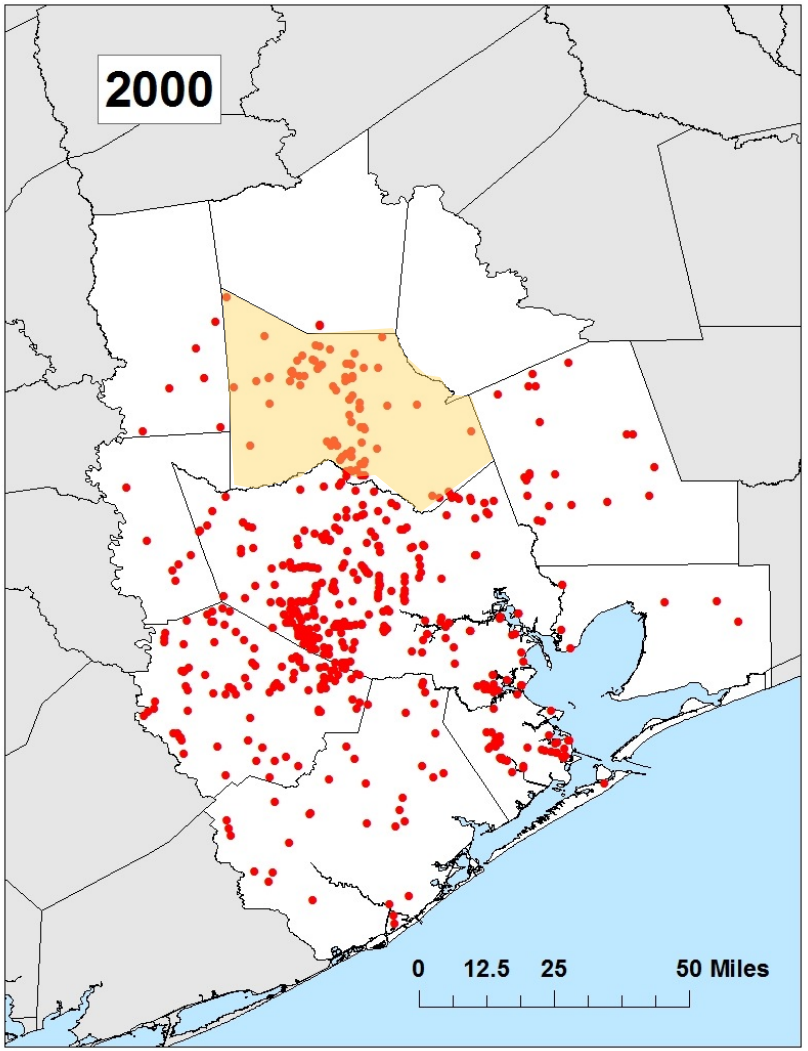
Monitoring Network

- Collaboration with local well owners, municipalities, MUDs, PUDs, SUDs, and other entities.
- Chicot and Evangeline aquifers are hydraulically connected: *Withdrawals from one aquifer can affect water-levels in the other.*
- USGS measuring water-level information in the Catahoula aquifer.
- Number of wells used for constructing 2017 maps:
  - Chicot (164)
  - Evangeline (307)
  - Jasper (102)

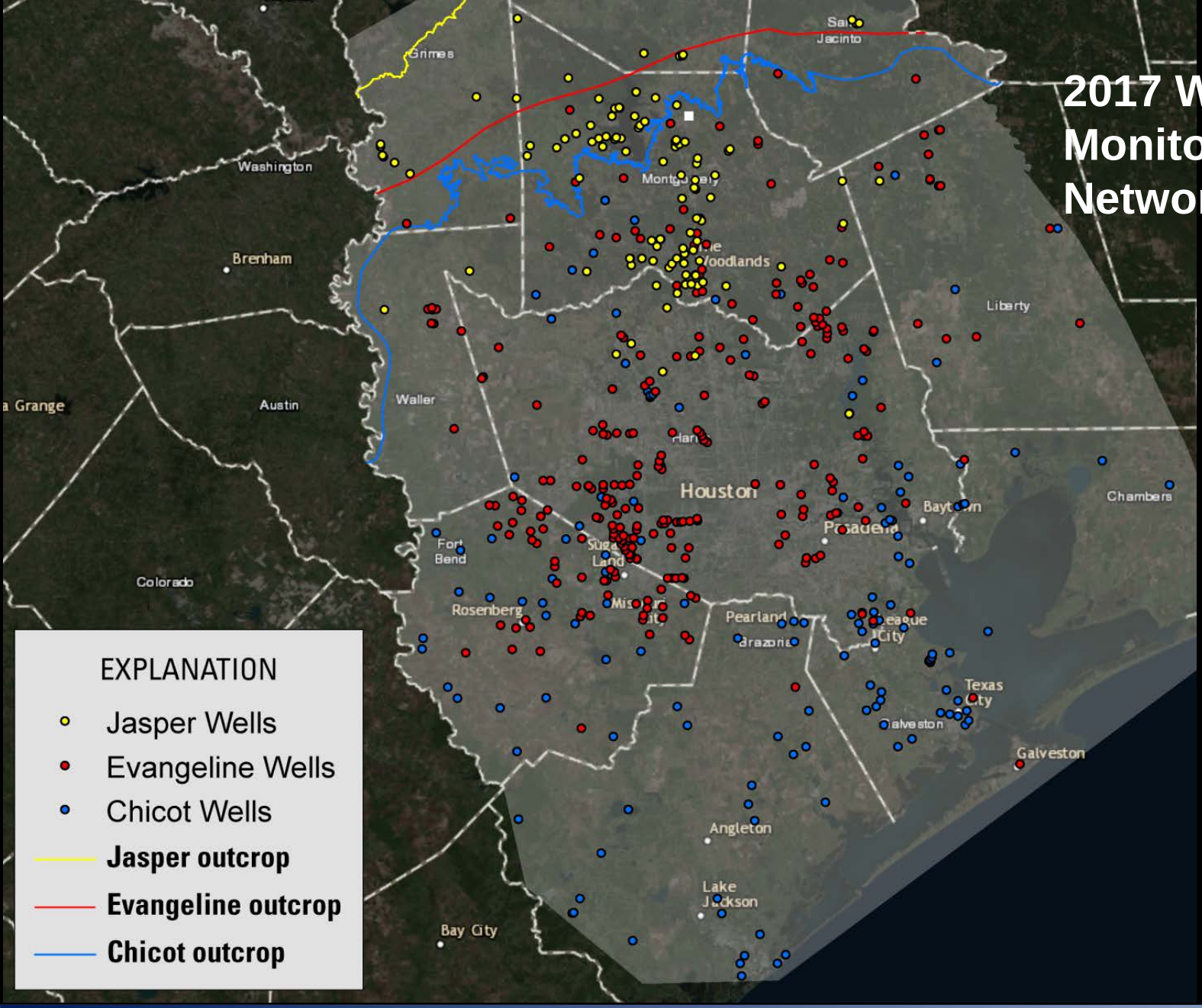
Field Data Collection

- Network in Montgomery County has grown over time
- Currently measuring data at approximately 700 wells

Measured 143 wells in Montgomery County in 2017

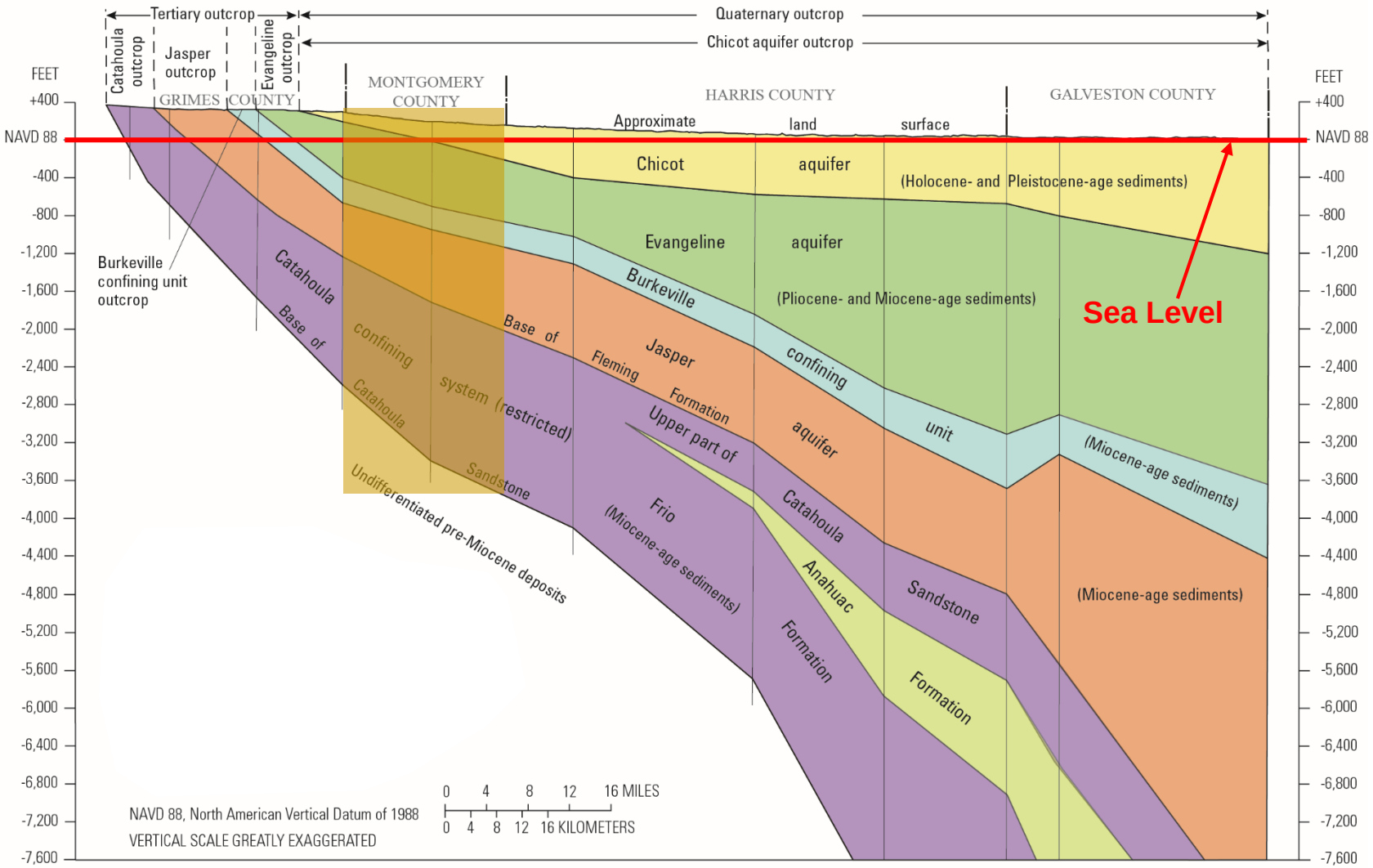


2017 Water-Level Monitoring Network



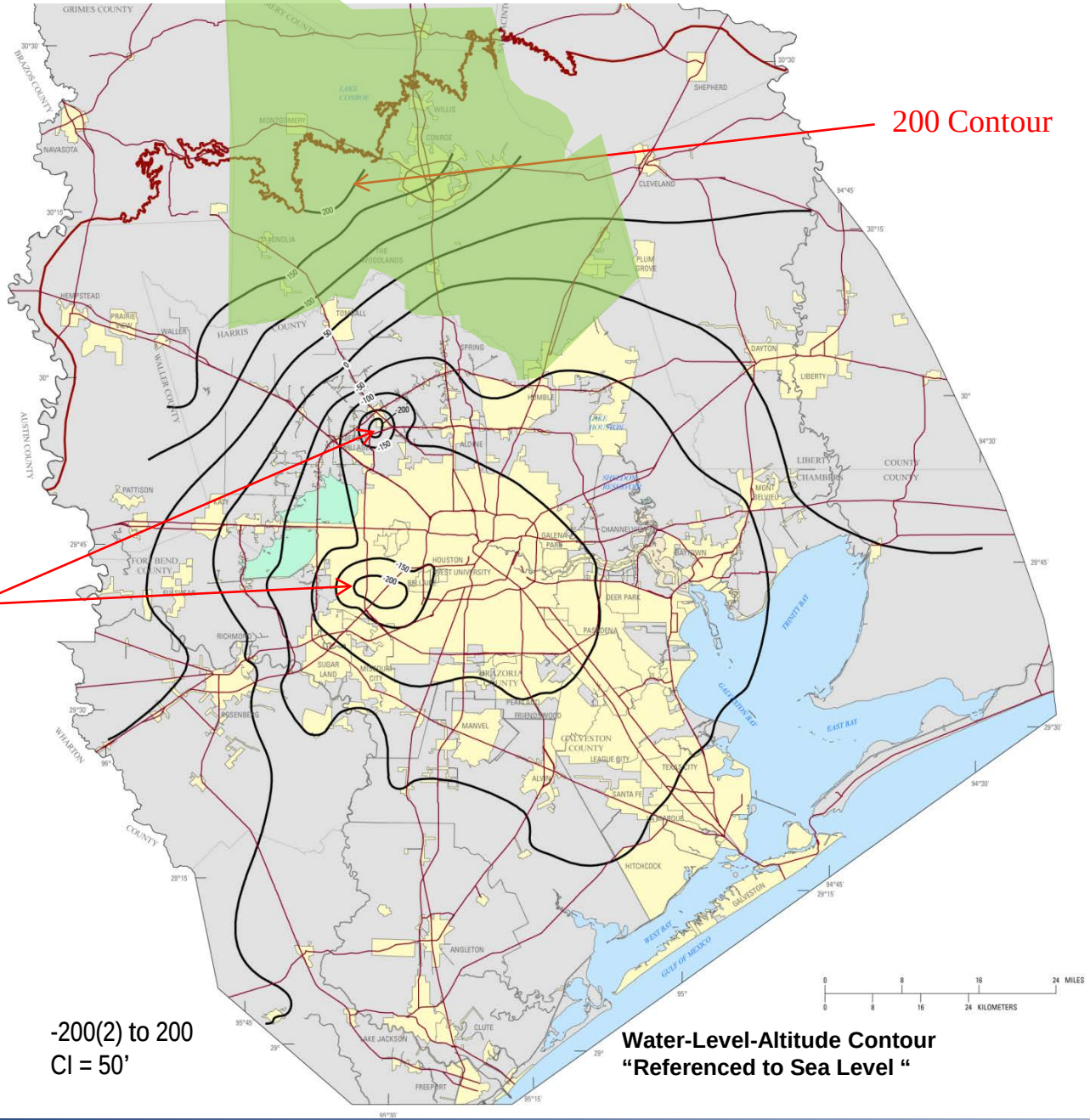
USGS

Hydrogeologic Section of the Gulf Coast Aquifer System

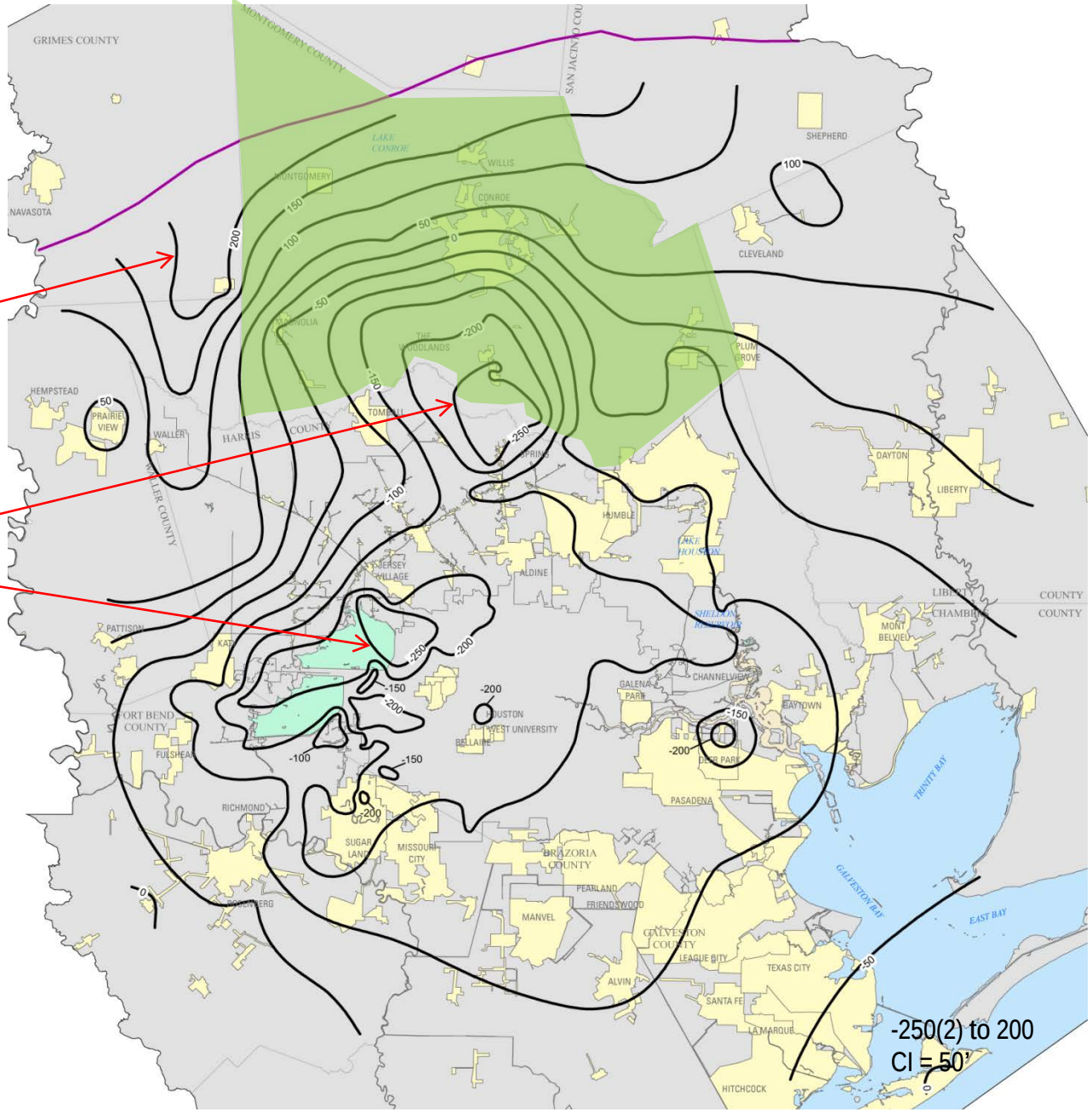


USGS

2017 Water-Level Altitude: Chicot Aquifer



2017 Water-Level Altitude: Evangeline Aquifer



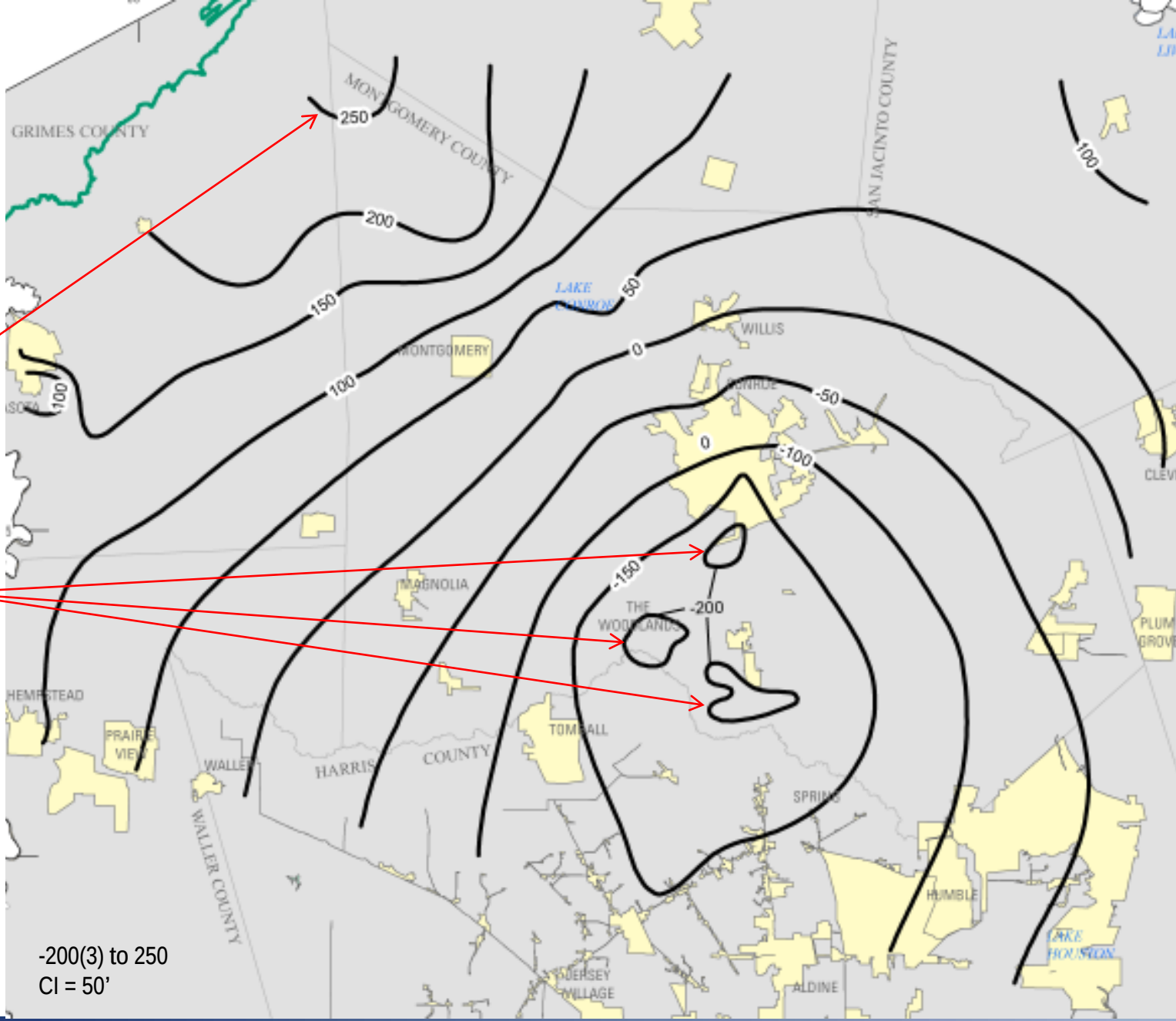
Water-Level-Altitude Contour "Referenced to Sea Level "

USGS

2017 Water-Level Altitude: Jasper Aquifer

250 contour

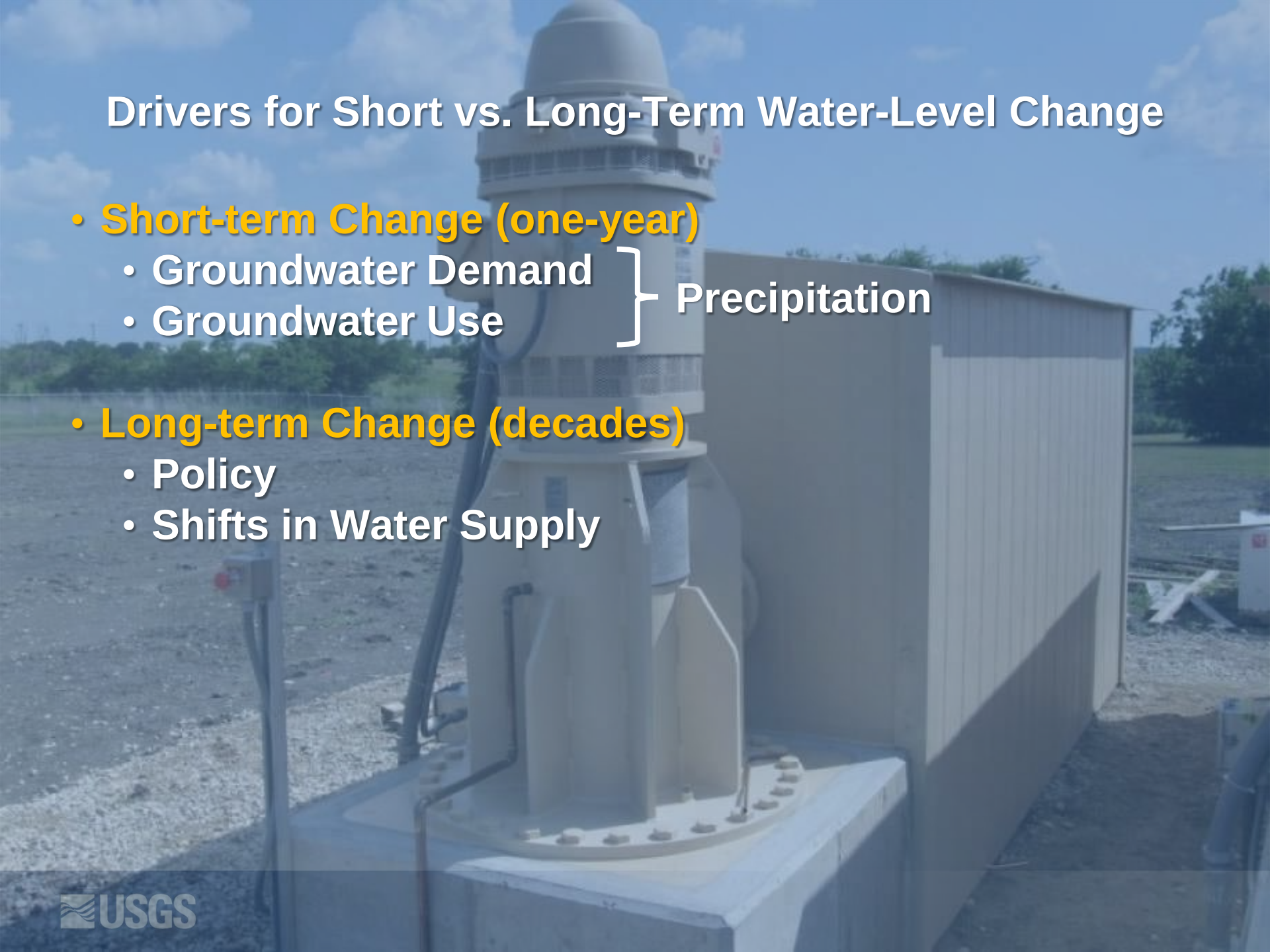
-200 contour



Water-Level-Altitude Contour "Referenced to Sea Level "

-200(3) to 250
CI = 50'

USGS



Drivers for Short vs. Long-Term Water-Level Change

- **Short-term Change (one-year)**
  - Groundwater Demand
  - Groundwater Use

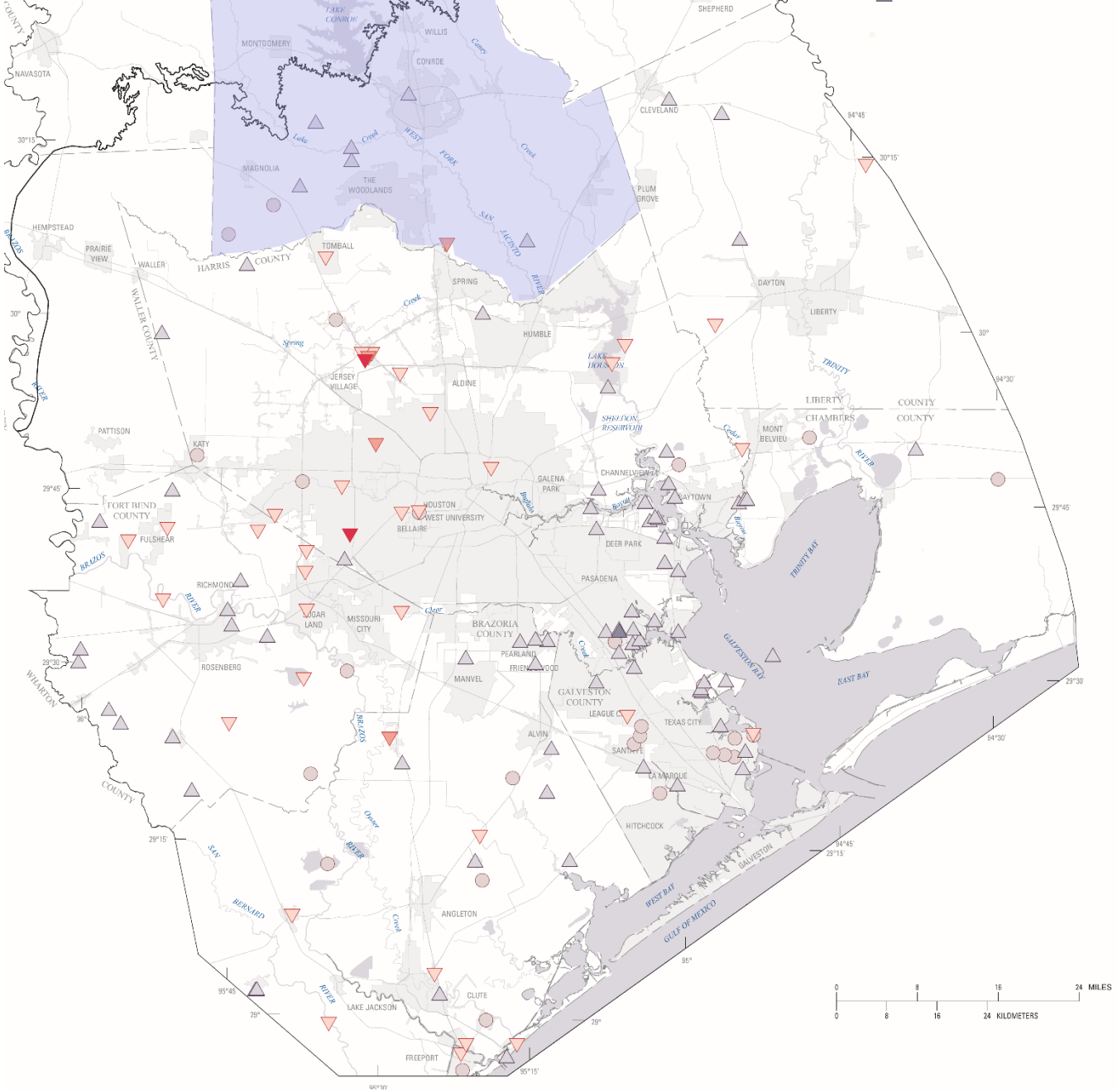
  } Precipitation

- **Long-term Change (decades)**
  - Policy
  - Shifts in Water Supply

USGS

Chicot Aquifer
2016–2017
Water-Level Changes

- ~ 27% Declines
- ~ 19% No change
- ~ 54% Rises

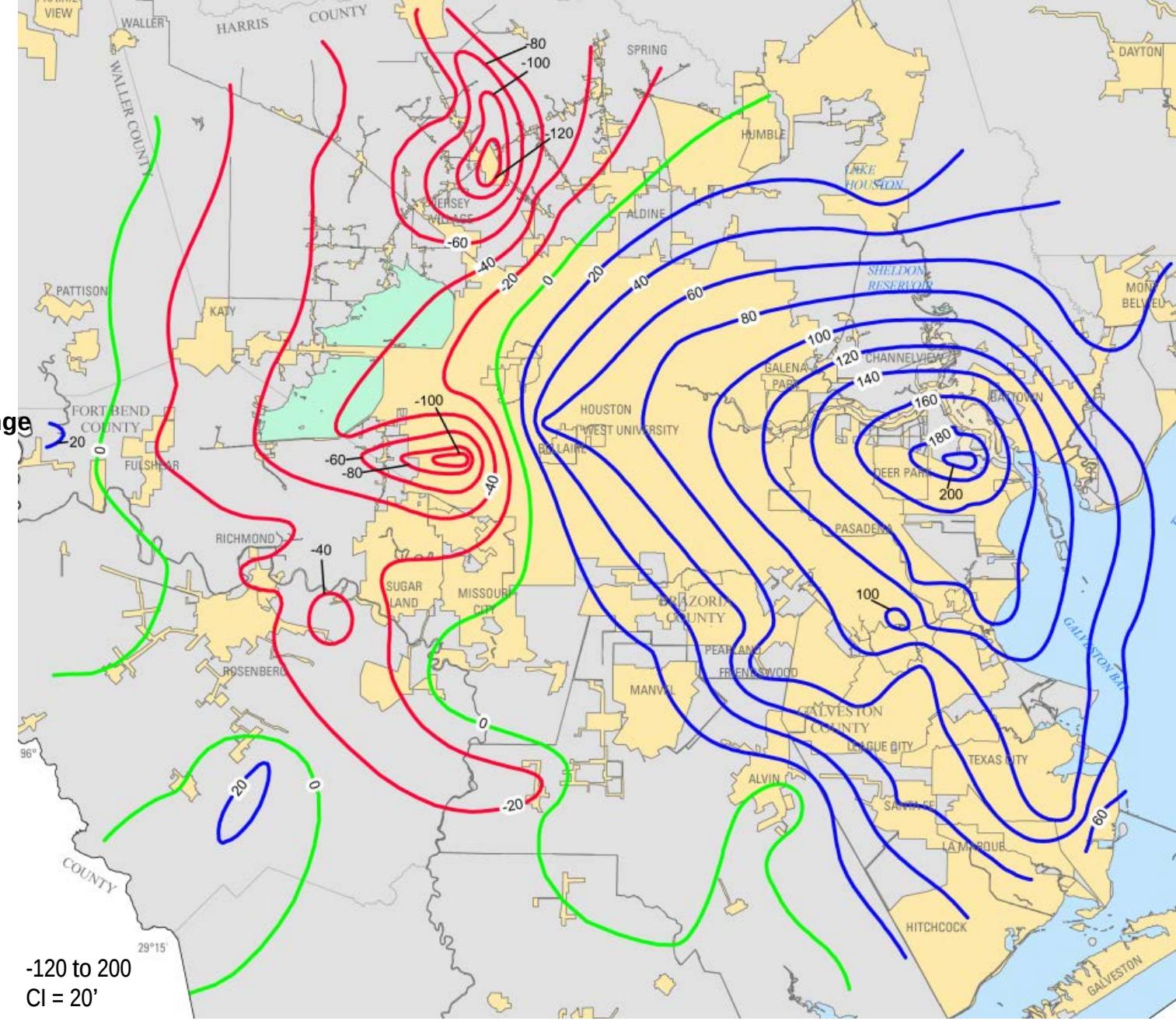


USGS

Chicot Aquifer 1977–2017 Water-Level Change

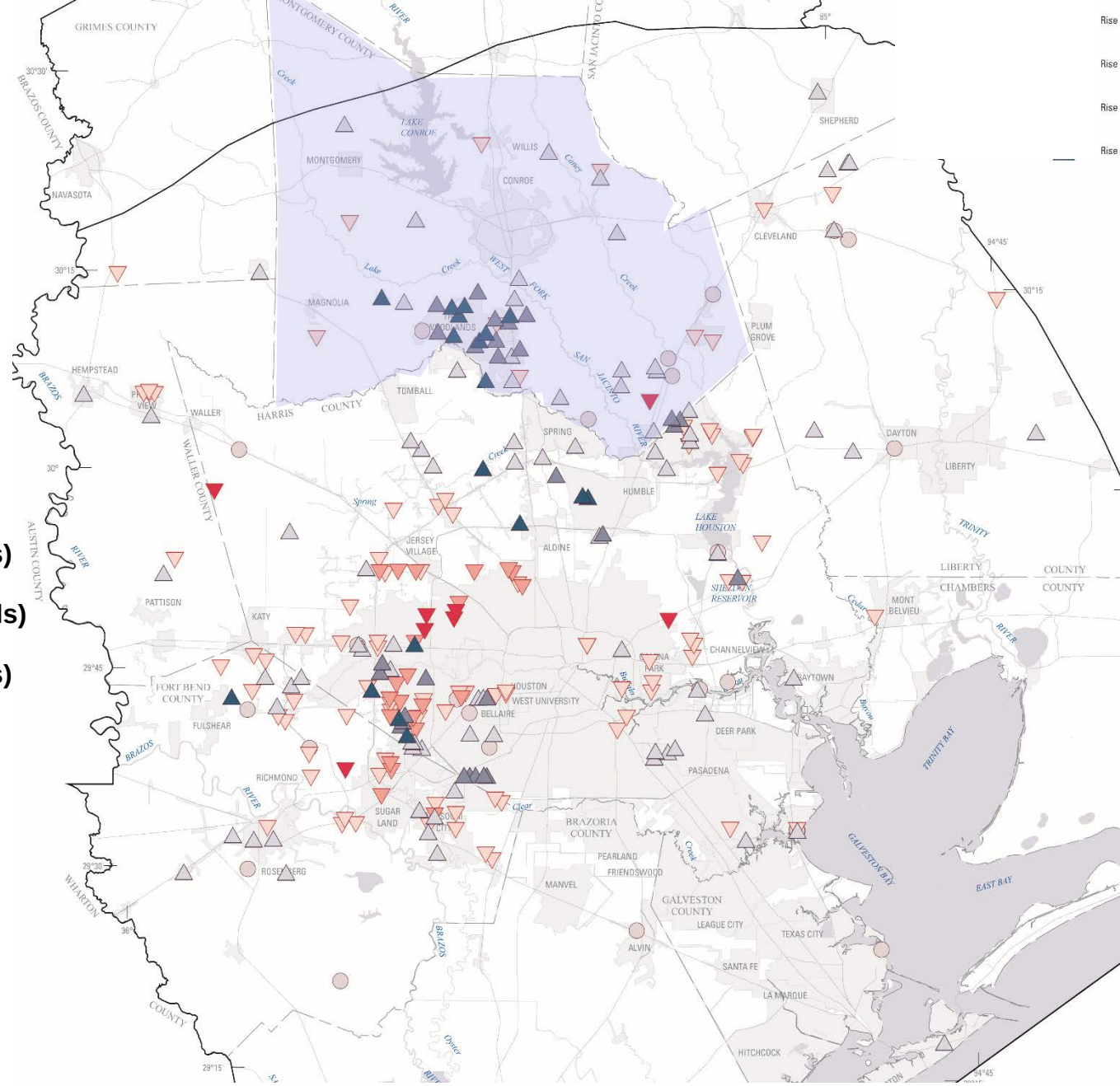
EXPLANATION

- Water-Level Decline
- No Water Level Change
- Water-Level Rise

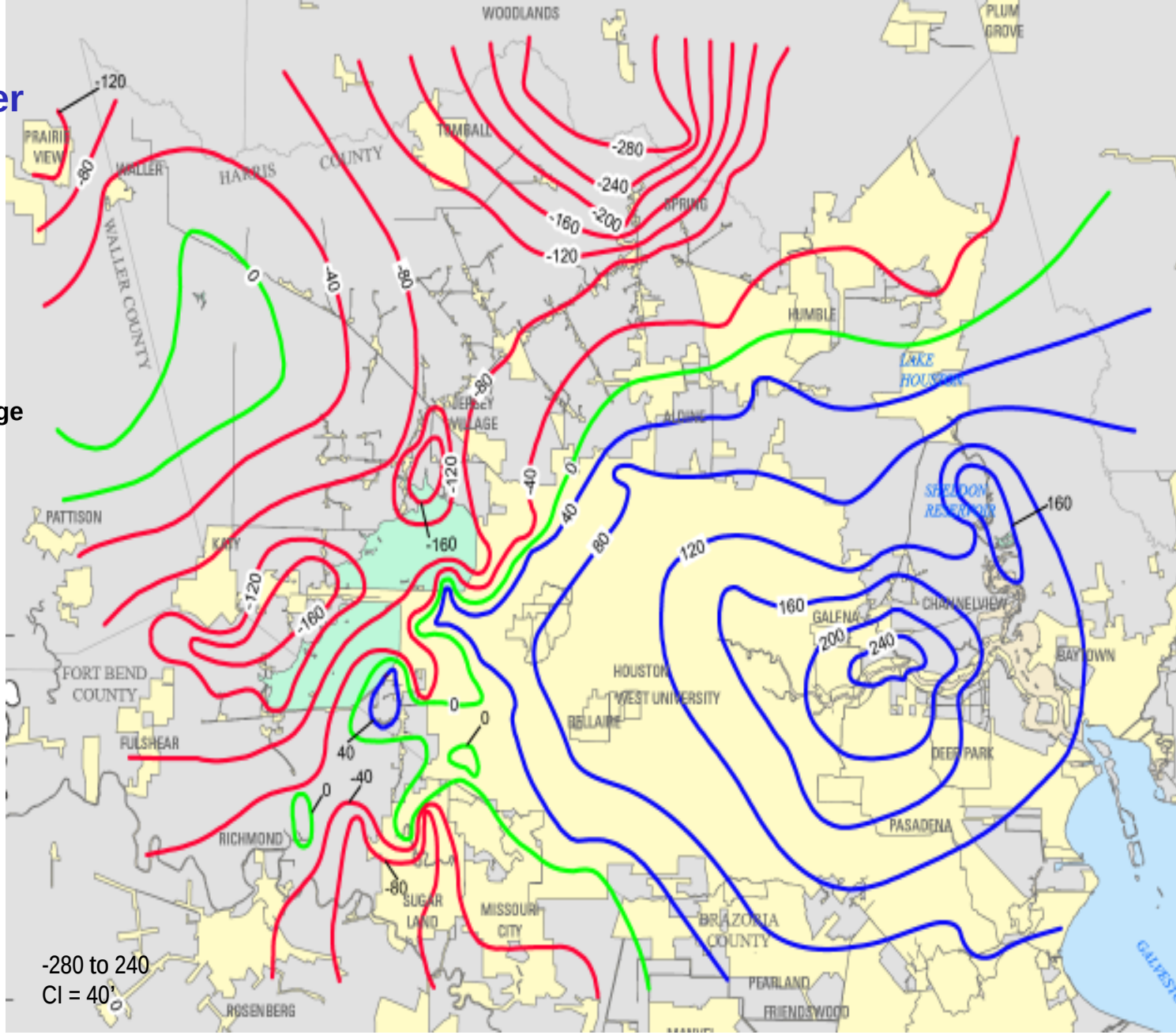


Evangeline Aquifer 2016–2017 Water-Level Changes

- ~ 43% Declines
- ~ 8% No change
- ~ 48% Rises

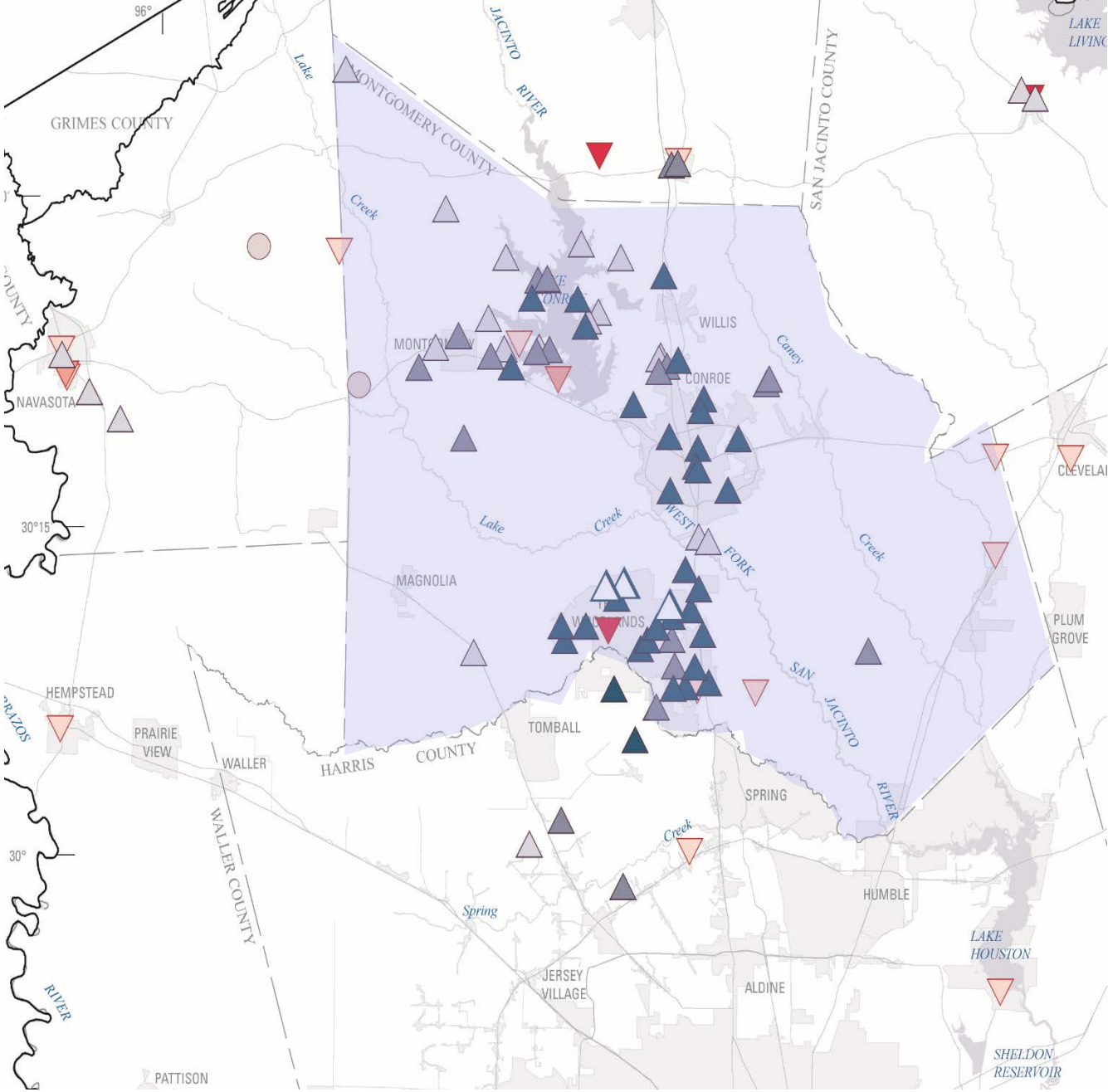


Evangeline Aquifer 1977–2017 Water-Level Change



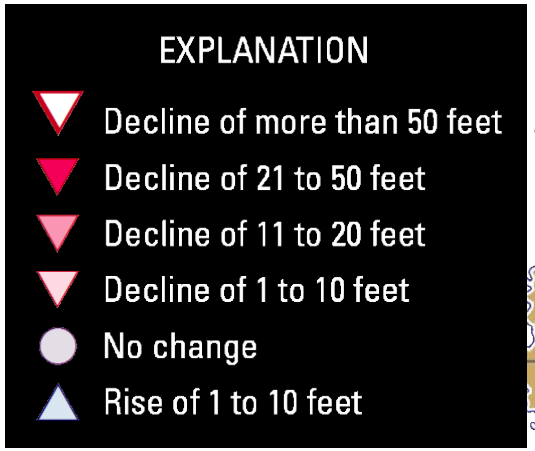
Jasper Aquifer
2016–2017
Water-Level Changes

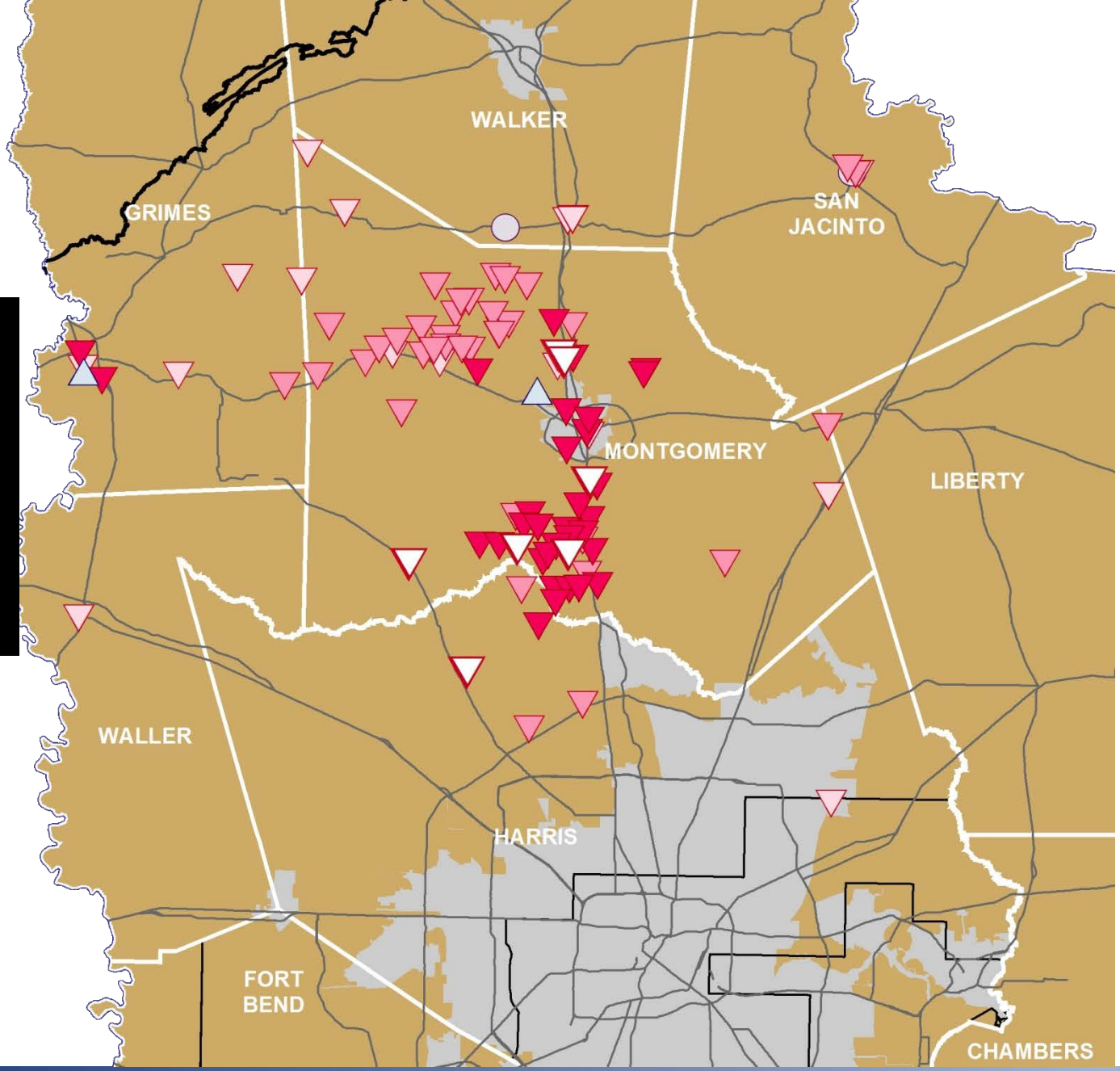
~18% Declines
~2% No change
~80% Rises



USGS

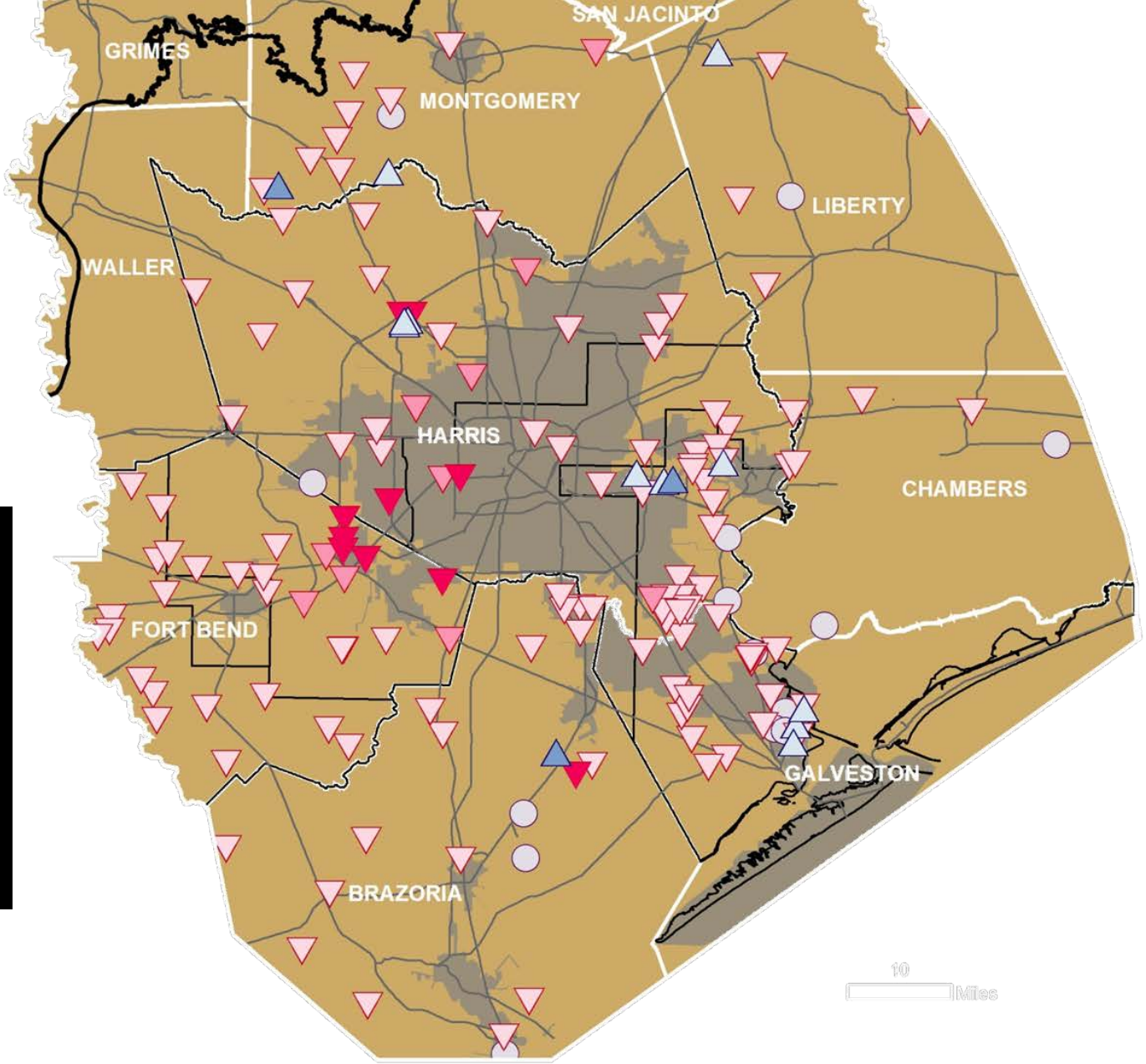
Jasper Aquifer 2011–2012 Water-Level Changes (Drought Year)



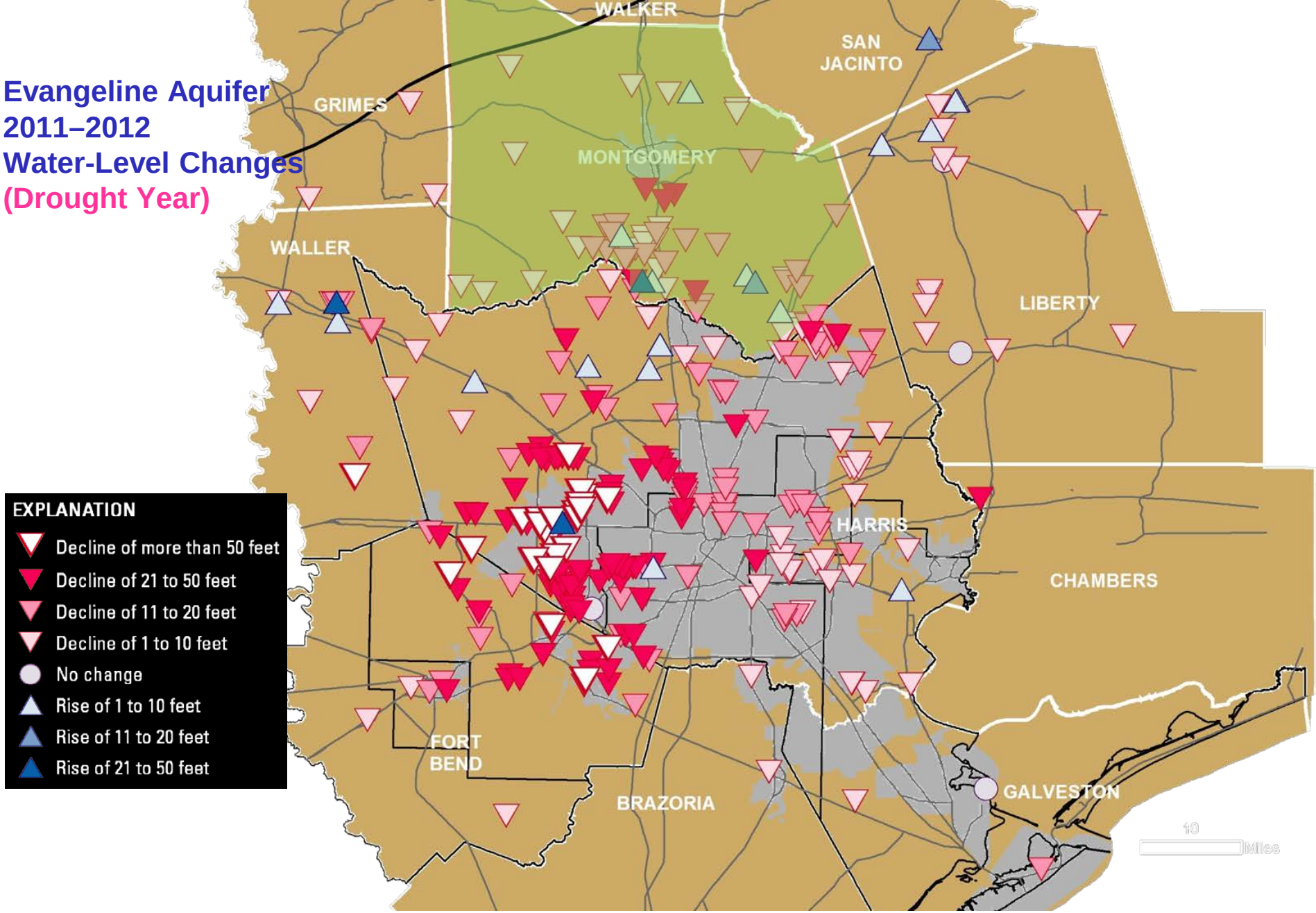


USGS

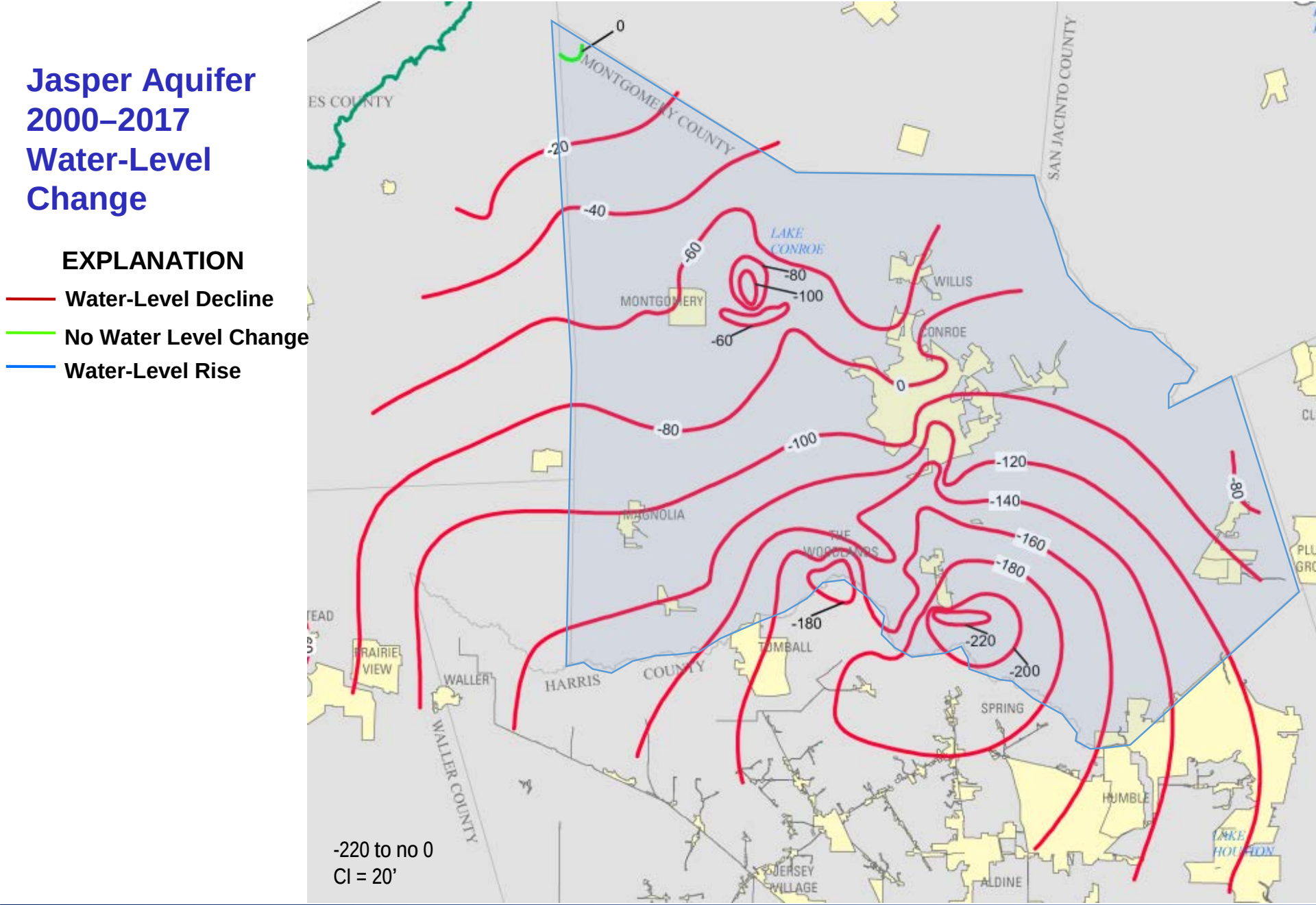
Chicot Aquifer 2011–2012 Water-Level Changes (Drought Year)



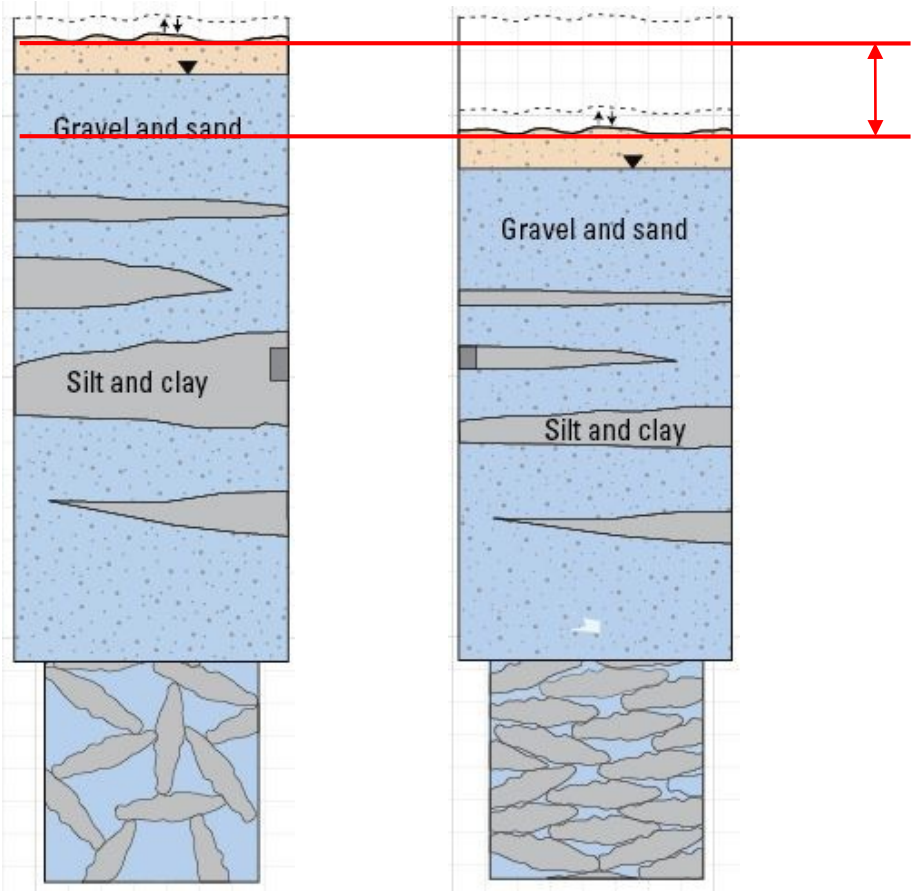
Evangeline Aquifer 2011–2012 Water-Level Changes (Drought Year)



Jasper Aquifer 2000–2017 Water-Level Change

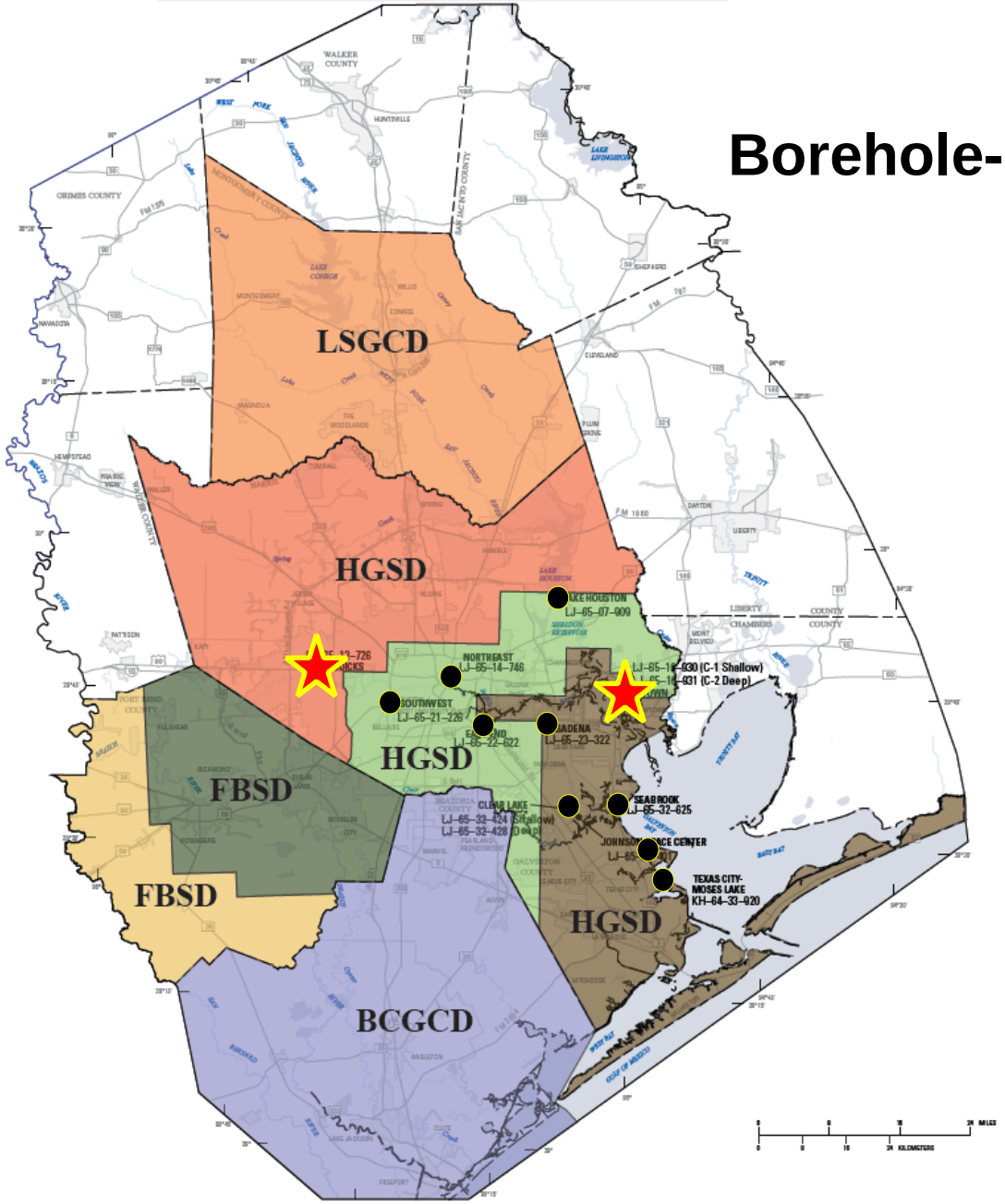


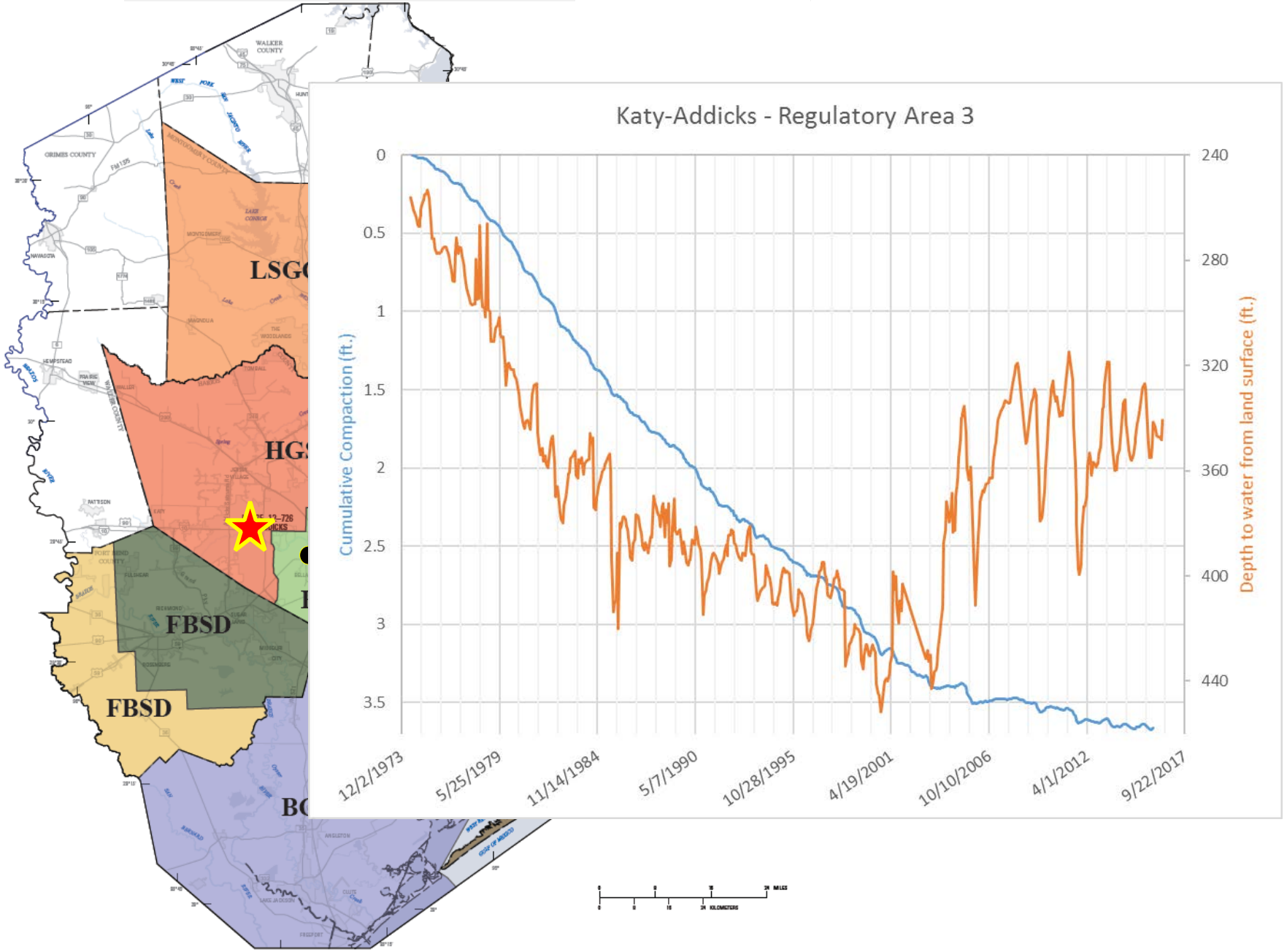
Mechanism of Subsidence



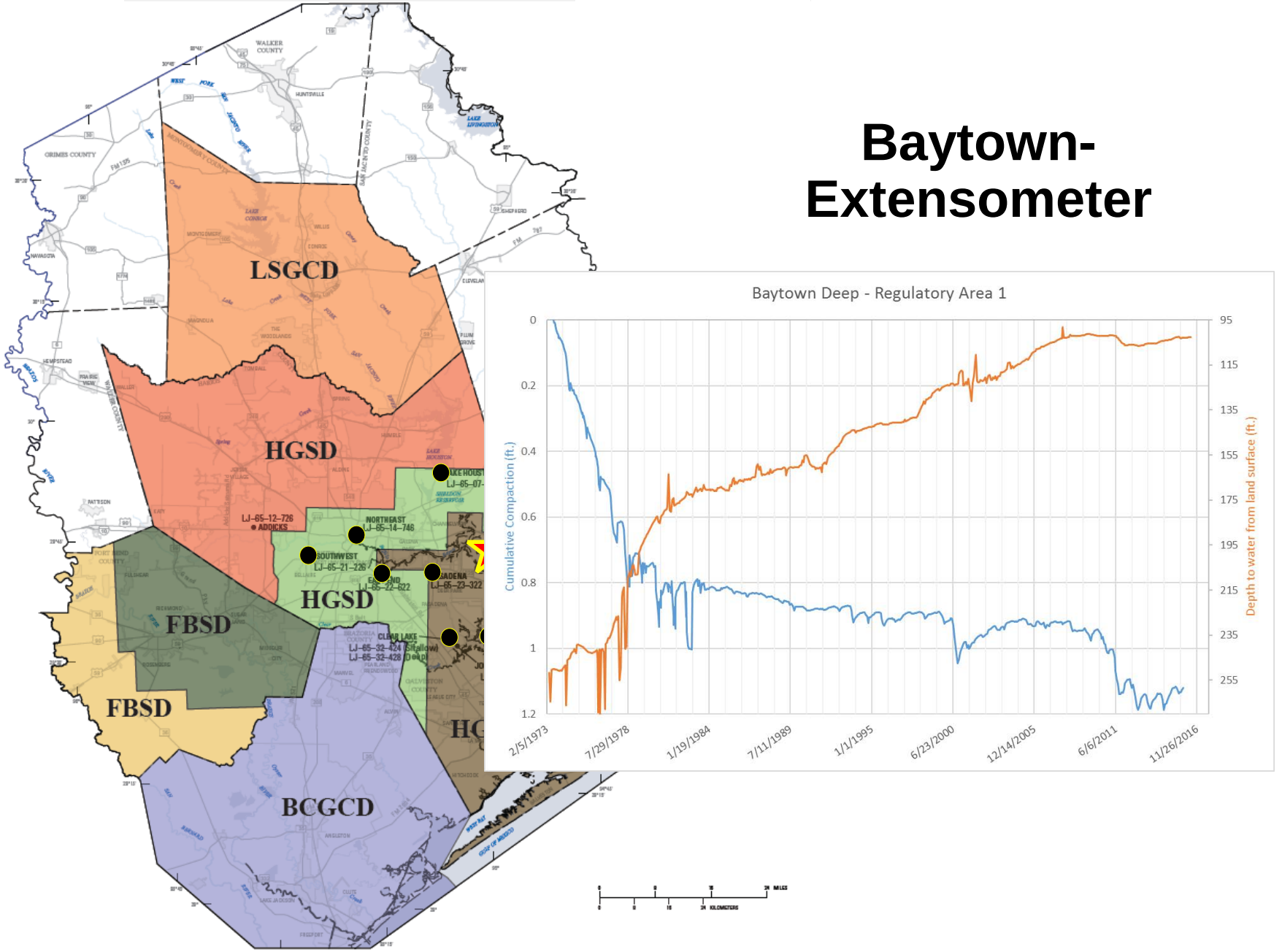
- Withdrawal reduces inter-granular pore fluid pressure
- Supporting matrix collapses and grains re-align
- Reduction in initial volume
- Volume loss becomes significant and lowers land elevation

Borehole-Extensometer Sites




Katy-Addicks - Regulatory Area 3
Cumulative Compaction (ft.)
Depth to water from land surface (ft.)
0
0.5
1
1.5
2
2.5
3
3.5
240
280
320
360
400
440
12/2/1973
5/25/1979
11/14/1984
5/7/1990
10/28/1995
4/19/2001
10/10/2006
4/1/2012
9/22/2017
LSGC
HGS
FBSD
FBSD
BC
WALKER COUNTY
GRIMES COUNTY
MONTGOMERY COUNTY
WALLER COUNTY
FORT BEND COUNTY
HARRIS COUNTY
GALVESTON COUNTY
BRAZORIA COUNTY
KATY
TOMBALL
PATTISON
FULSHEAR
RICHMOND
SUGAR LAND
MISSOURI CITY
ROSENBERG
ANGLETON
FREEPORT
LAKE JACKSON
CLUTE
WEST FORK SAN JACOBO RIVER
SAN JACINTO RIVER
BRAZOS RIVER
BUFFALO BAYOU
CYPRESS CREEK
SPRING CREEK
OYSTER CREEK
CHOCOLATE BAYOU
OLD RIVER
GULF OF MEXICO
726
MILES
KILOMETERS

Baytown-Extensometer



Water-Level Trend Summary in Montgomery County

- Approximately 140 wells measured in 2017
- Well Statistics (2016-2017):
  - Chicot
    - 67% showed rises
    - 11% showed declines
  - Evangeline
    - 74% of wells show rises
    - 17% showed declines
  - Jasper
    - 89% showed rises
    - 9% showed declines
- Long-term trends: (2000-2017)
  - Trends in Jasper aquifer show declines throughout Montgomery County extending into north-central Harris County.

Thank You

U.S. Geological Survey
Gulf Coast Program
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