2018 Annual Groundwater Report

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General Manager

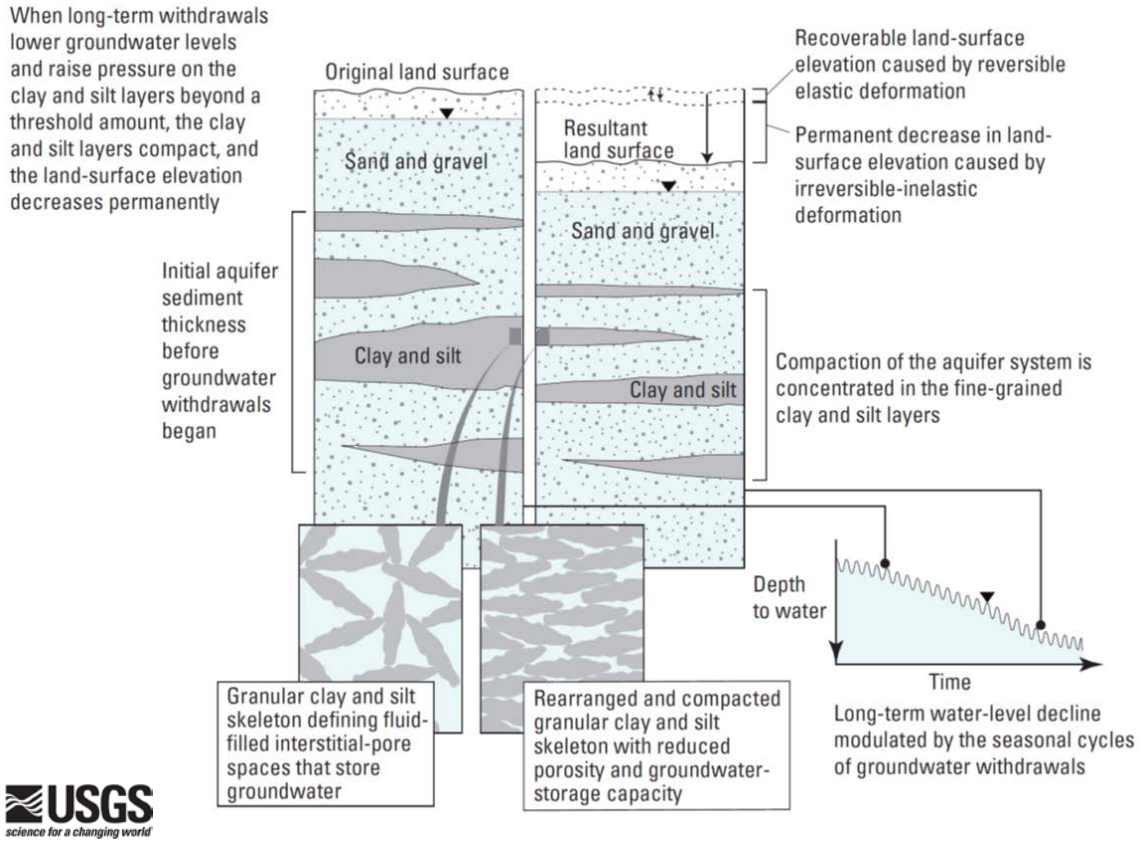
Harris-Galveston Subsidence District

GMA 14

June 26, 2019

SUBSIDENCE

- Subsidence is the lowering of the elevation of land surface over time.
- Subsidence can have a wide range of consequences depending on the location of the occurrence and its proximity to surface drainage and coastal zones
- In the Gulf Coast, aquifer clay and silt compaction resulting from groundwater withdrawal is the primary cause for land surface subsidence



USGS
science for a changing world

HARRIS-GALVESTON SUBSIDENCE DISTRICT

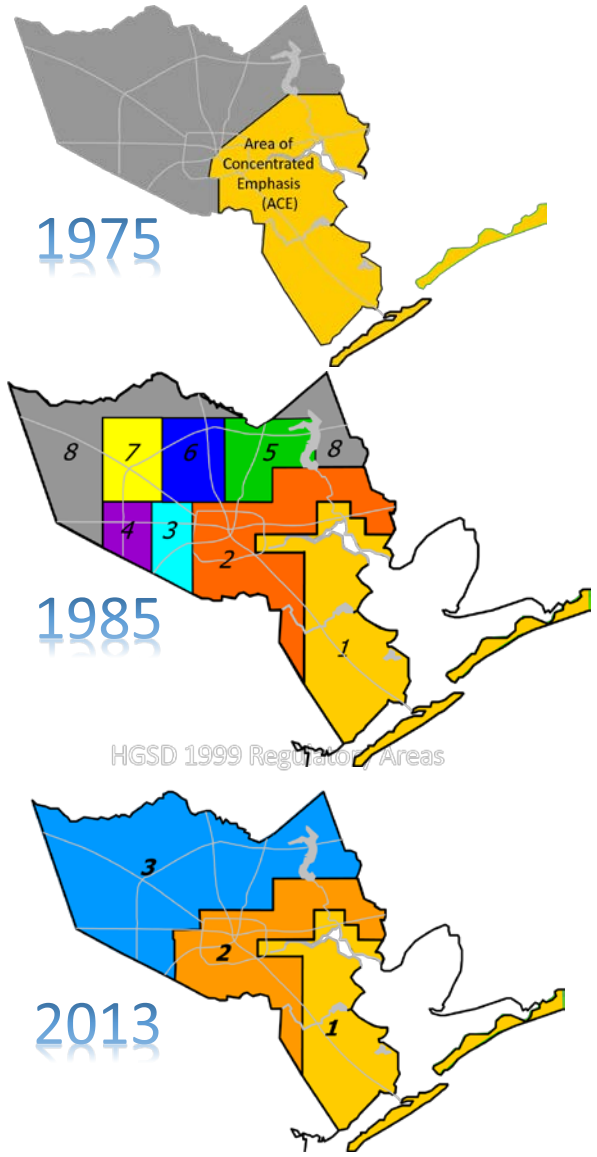
Agenda

1. **Quick overview of current and previous regulatory planning efforts**
2. Annual Groundwater Report
3. Science and Research Program Update
   a) Brackish Groundwater
   b) Aquifer Storage and Recovery
   c) Other ongoing studies
4. Upcoming Activities

HARRIS-GALVESTON SUBSIDENCE DISTRICT

Regulating Groundwater to Stop Subsidence

- Following the creation of the District, groundwater regulation began nearest the coast in the area of concentrated emphasis (ACE)
- As population spread to the north and west and water use increased numerous regulatory plans were developed and implemented
- The 1999 Regulatory Plan designated the 3 Regulatory Areas that exist today
- Both the HGSD and FBSD Regulatory Plans were updated in 2013.
  - GW reduced to 40% of Total Water Demand by 2025
  - GW reduced to 20% of Total Water Demand by 2035



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Alternative Water Conversion

- Alternative water supply infrastructure is under construction for Area 3
  - Luce Bayou Interbasin Transfer Project – Raw water supply transfer from the Trinity River Basin to the San Jacinto River Basin increasing the raw water supply to Lake Houston
  - Northeast Water Purification Plant (NEWPP) Expansion is underway that provides increases capacity of surface water treatment plant capacity from 80 to 400 MGD
  - Water Distribution and Transmission Systems that will convey treated water from NEWPP throughout Northern Harris County, Western Harris County and Northern Fort Bend County

Luce Bayou Canal near Grand Parkway

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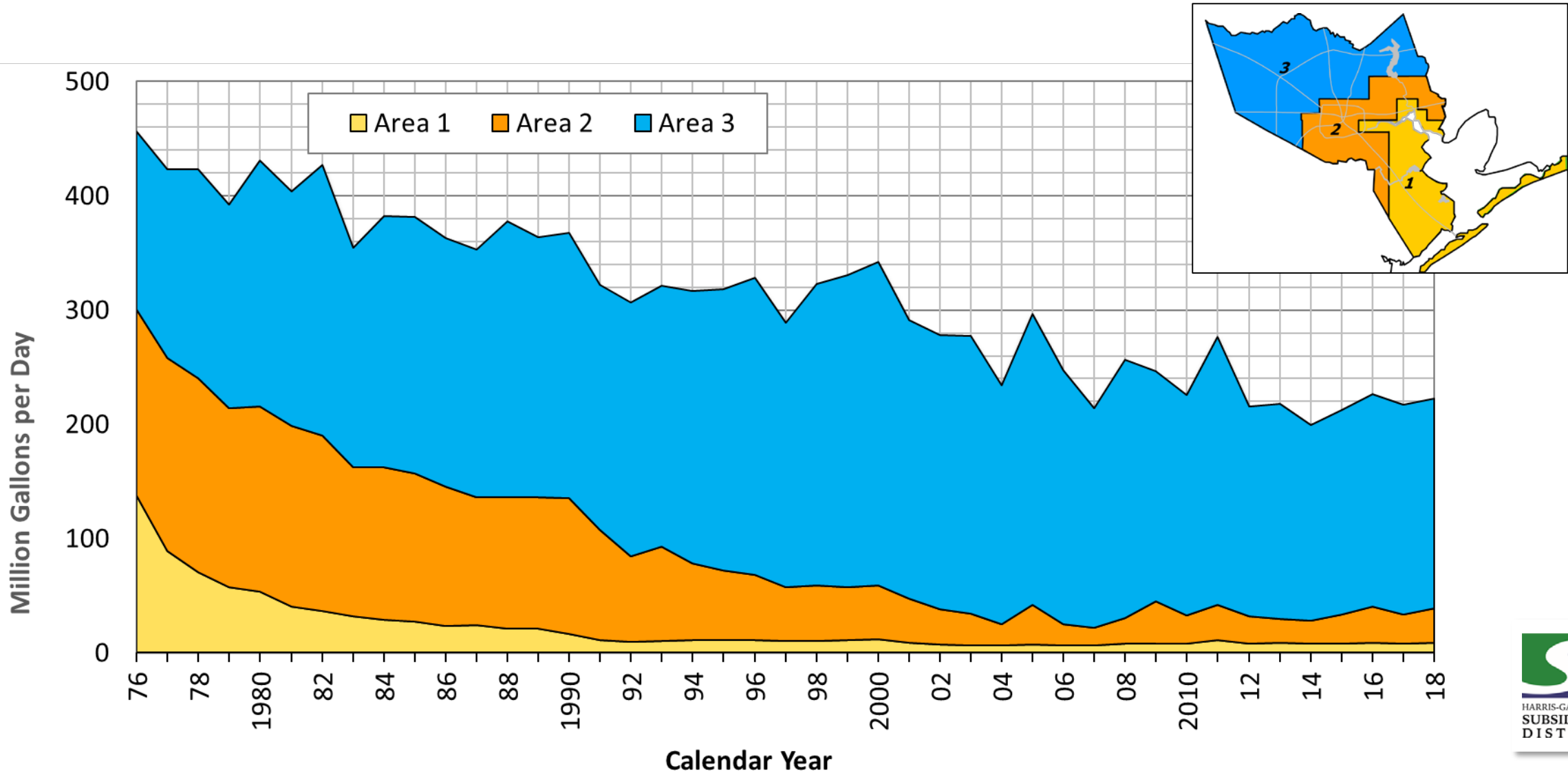
HARRIS-GALVESTON SUBSIDENCE DISTRICT

2018 Annual Groundwater Report

- Public Hearing held every year to fulfill the requirements of the District's enabling legislation, which requires that the Board of Directors shall hold a public hearing to take testimony concerning the effects of groundwater withdrawals on the subsidence of land within the District during the preceding year.
- This year's 43rd Annual Report includes information on:
  - Groundwater Withdrawals and Total Water Demand
  - Groundwater levels in Chicot, Evangeline and Jasper Aquifers
  - Compaction measurements and GPS monitoring network

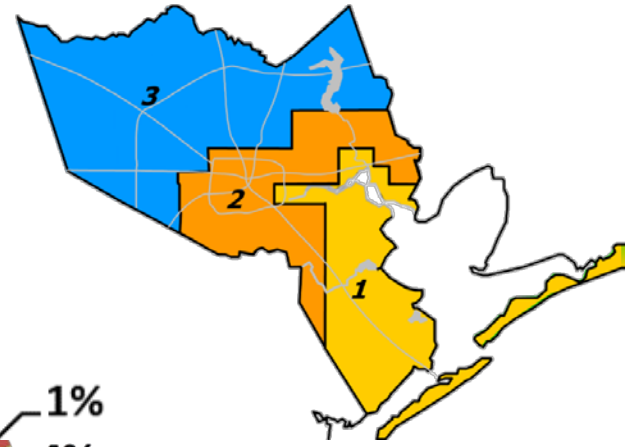
HARRIS-GALVESTON SUBSIDENCE DISTRICT

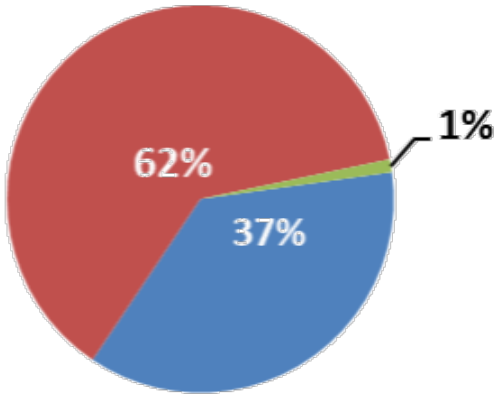
Reported Groundwater Use - By Area



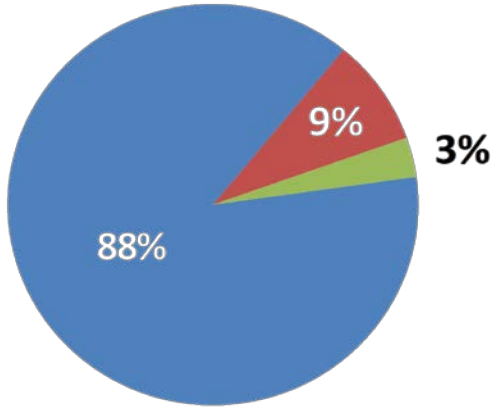
HARRIS-GALVESTON SUBSIDENCE DISTRICT

Reported 2018 Groundwater Use – By Sector

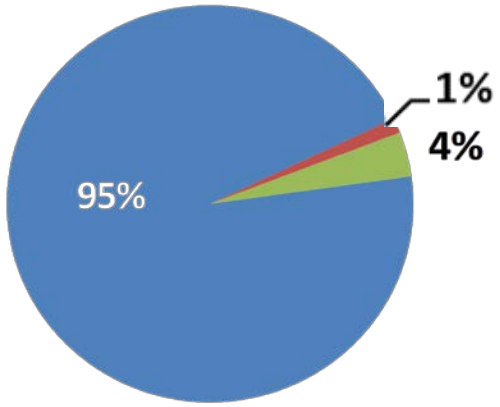




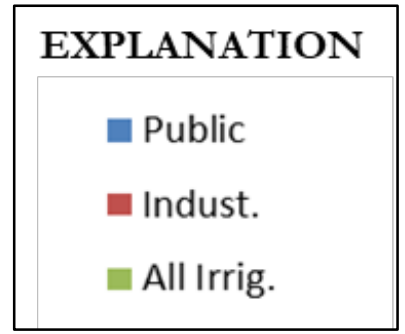
Area 1 - 2018
TGWD = 9.2 MGD



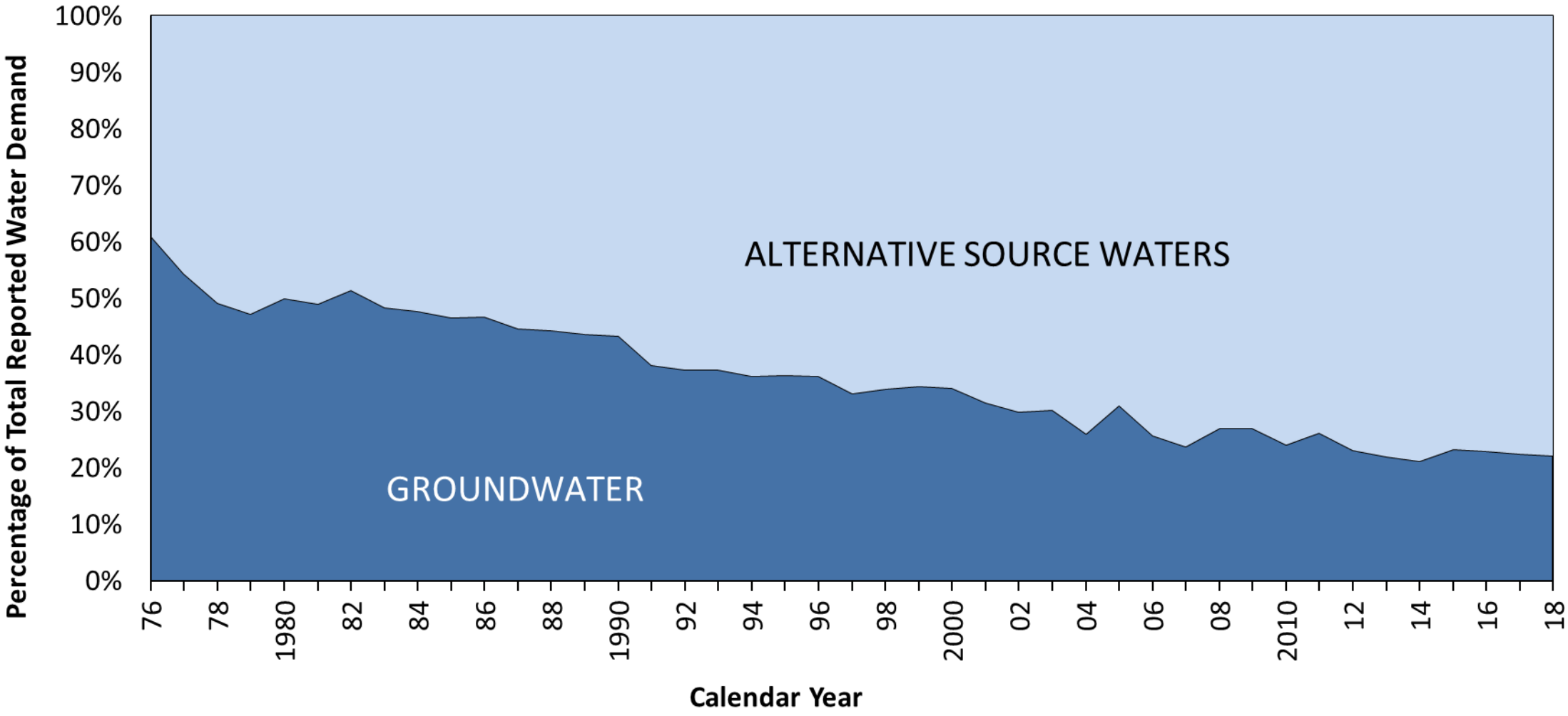
Area 2 - 2018
TGWD = 29.6 MGD



Area 3 - 2018
TGWD = 183.8 MGD

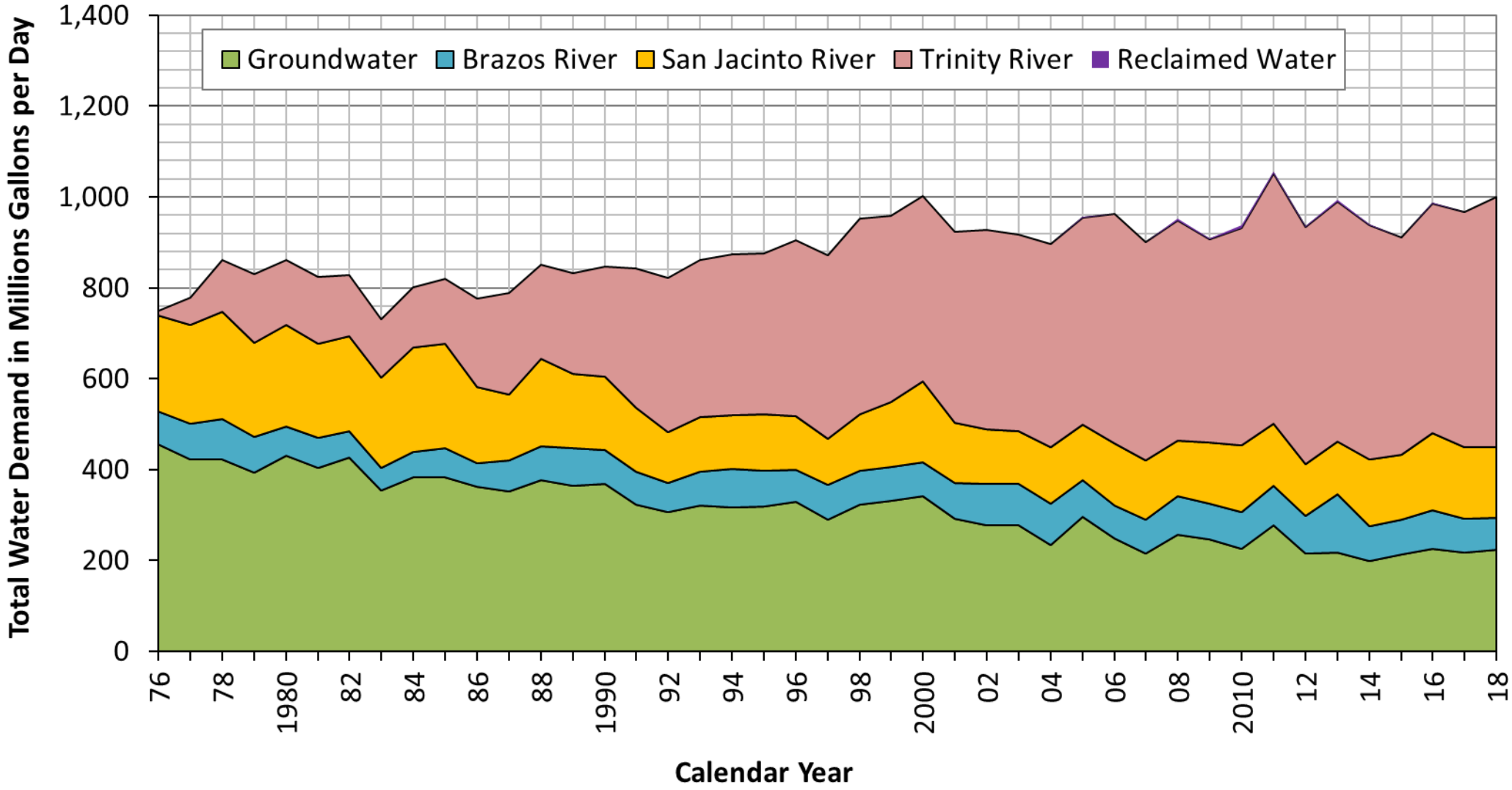


Reported Groundwater Use



HARRIS-GALVESTON SUBSIDENCE DISTRICT

Reported Total Water Demand – By Source



HARRIS-GALVESTON SUBSIDENCE DISTRICT

USGS Water Level Measurements

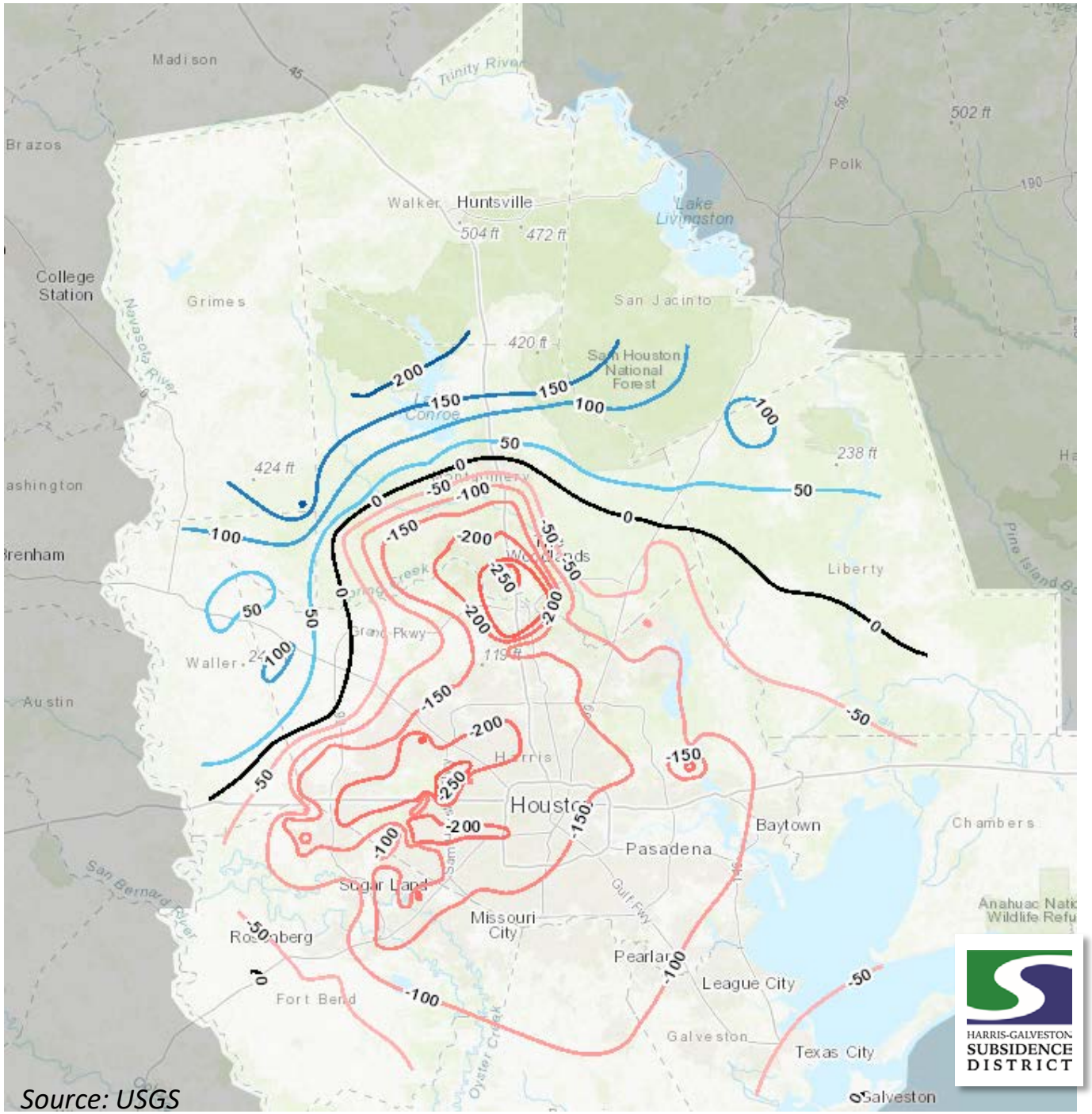
- United States Geological Survey (USGS) monitors 636 public supply, irrigation, industrial, and observation wells in 11-county Houston-Galveston Region
  - Strong collaboration with local well owners, municipalities, municipal utility districts, public utility districts, special utility districts
  - Multi-agency effort including the USGS, Subsidence Districts, City of Houston, BCGCD, and LSGCD
  - Wells used to construct 2019 contours:
    - Chicot – ~170
    - Evangeline – ~330
    - Jasper - ~100
- Potentiometric water-level measured by the USGS between December 2018 and March 2019

2019 Evangeline Water Level Altitude

EXPLANATION

-400 ft +275 ft

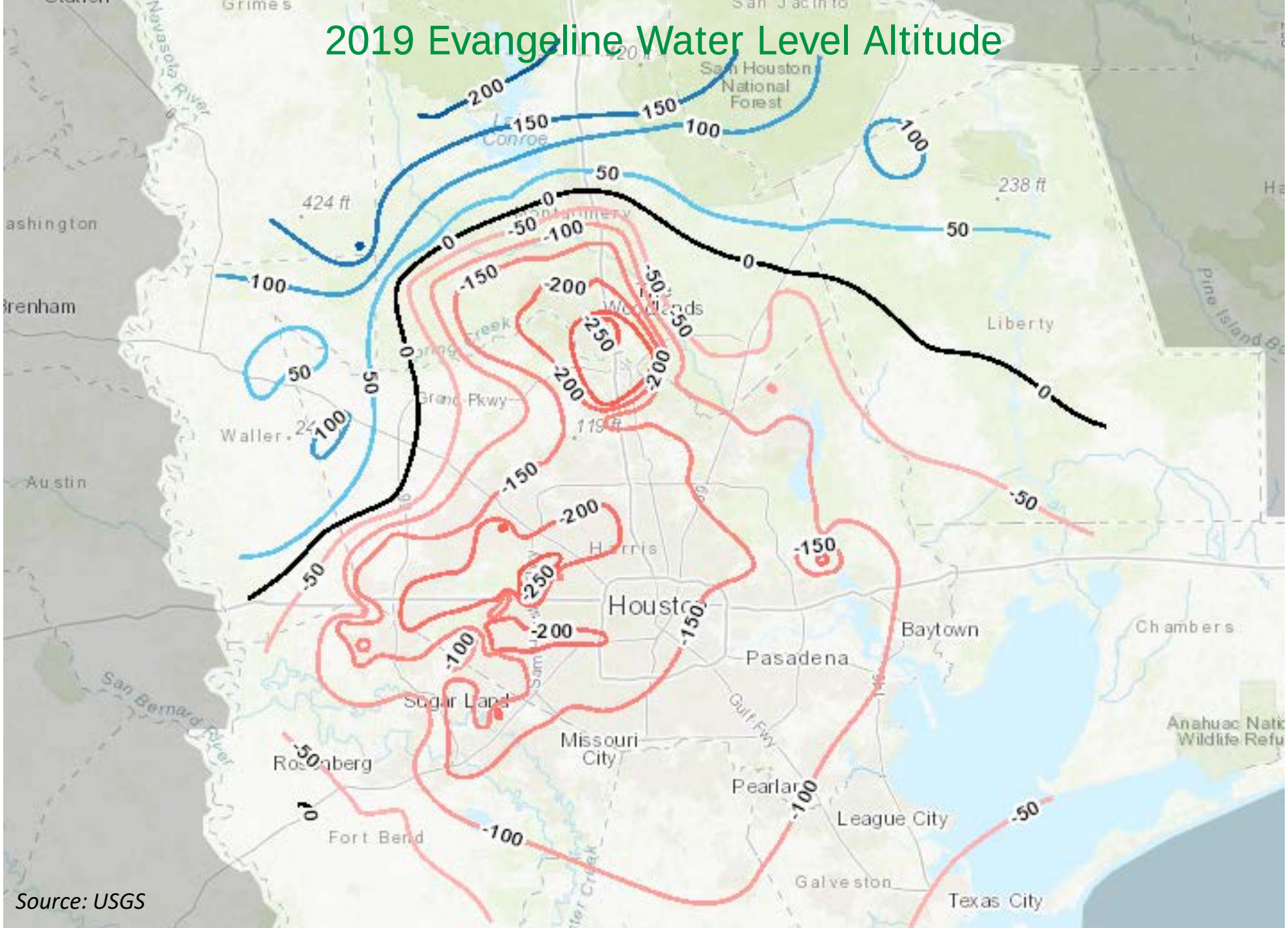
- Potentiometric water-level at wells screened only in the Evangeline aquifer during the winter of 2018-2019
  - Contour interval – 50 ft
  - Range 200 to -300 ft
- Water-levels measured in ~330 wells



Source: USGS

HARRIS-GALVESTON SUBSIDENCE DISTRICT

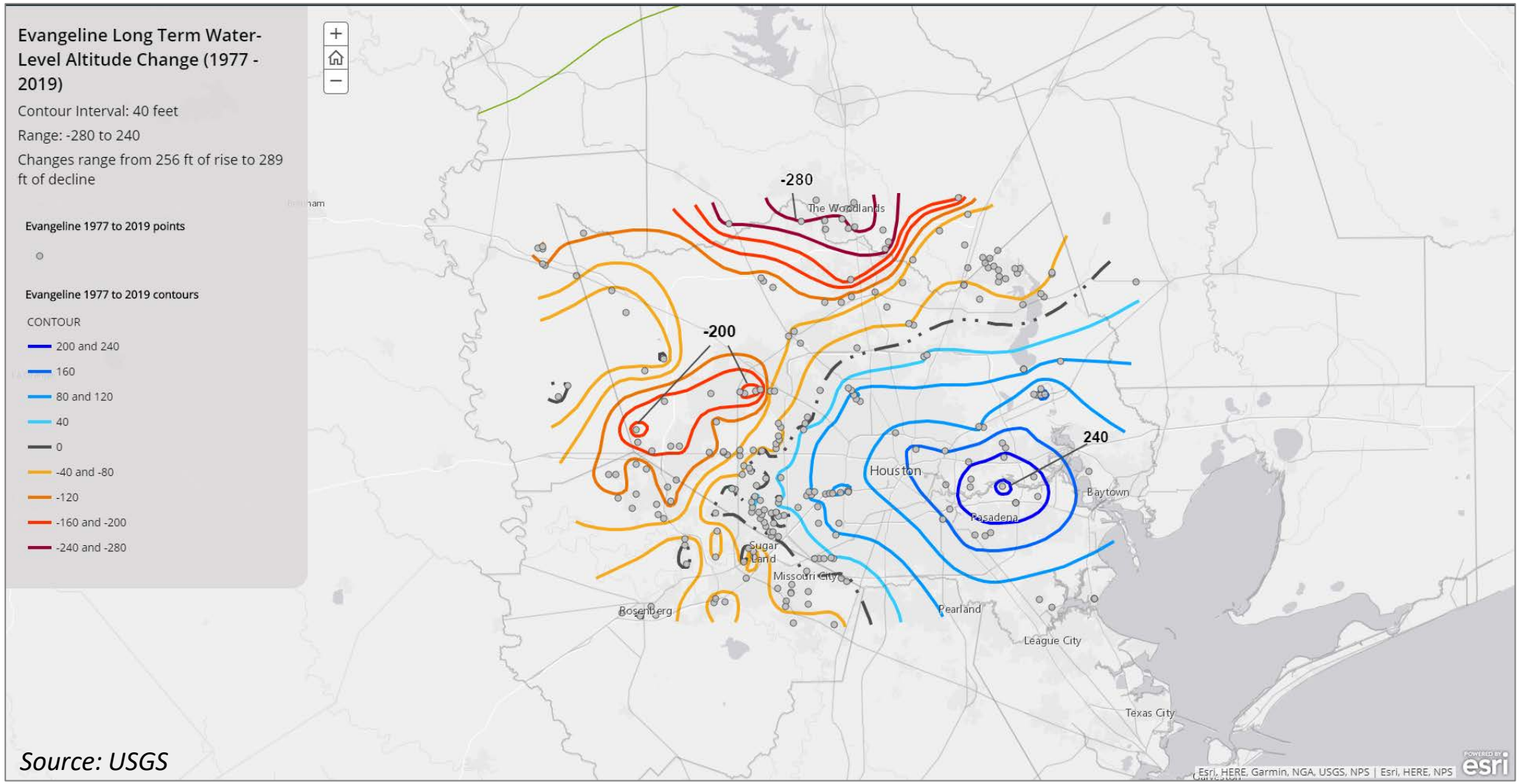
2019 Evangeline Water Level Altitude



Source: USGS

HARRIS-GALVESTON SUBSIDENCE DISTRICT

1977 – 2019 Evangeline Long-Term Water Level Altitude Change



Source: USGS

HARRIS-GALVESTON SUBSIDENCE DISTRICT

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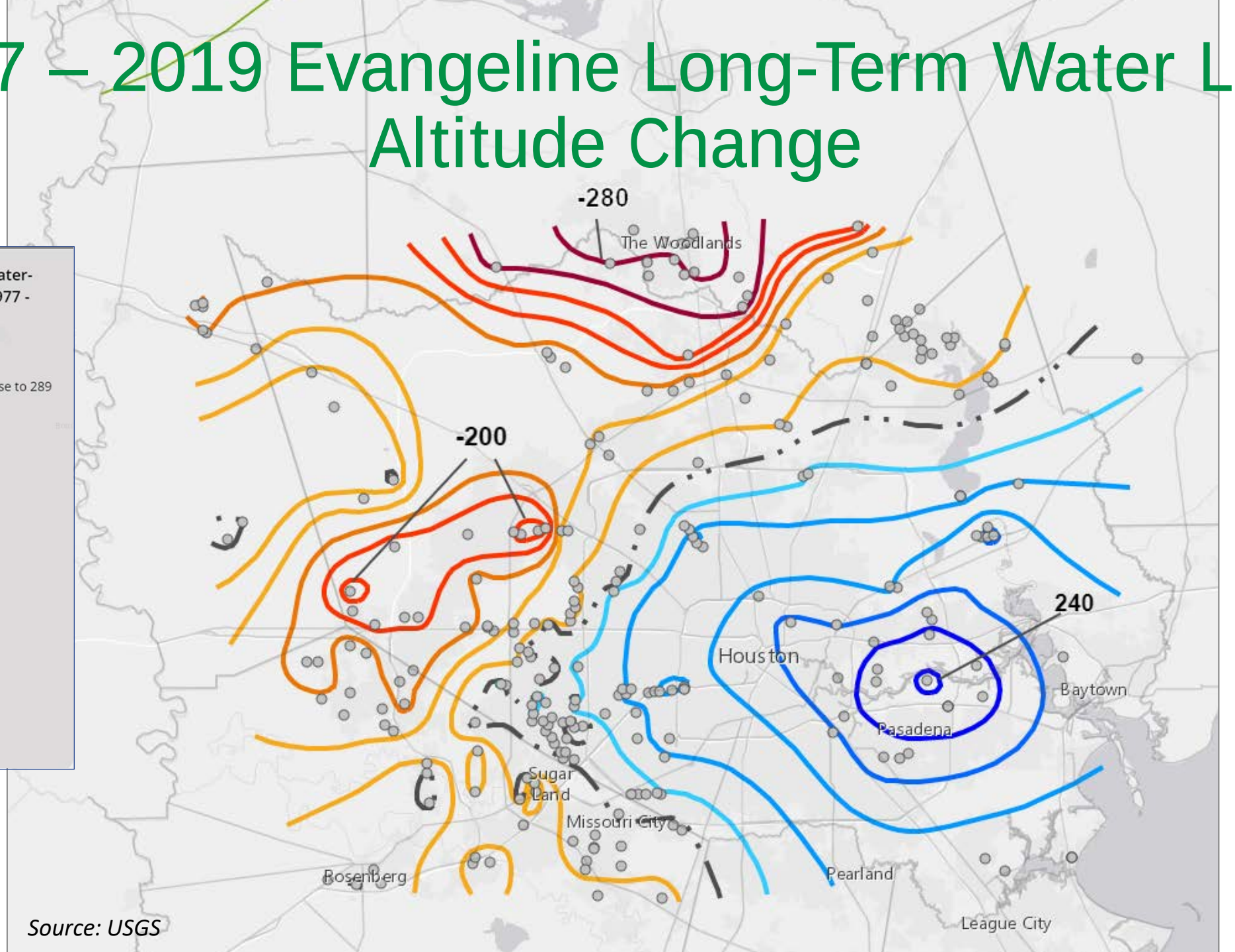


Evangeline Long Term Water-Level Altitude Change (1977 - 2019)

Contour Interval: 40 feet

Range: -280 to 240

Changes range from 256 ft of rise to 289 ft of decline

Evangeline 1977 to 2019 points

Evangeline 1977 to 2019 contours

CONTOUR

- 200 and 240
- 160
- 80 and 120
- 40
- 0
- -40 and -80
- -120
- -160 and -200
- -240 and -280

Source: USGS

HARRIS-GALVESTON SUBSIDENCE DISTRICT

Recent Subsidence and Compaction Measurements

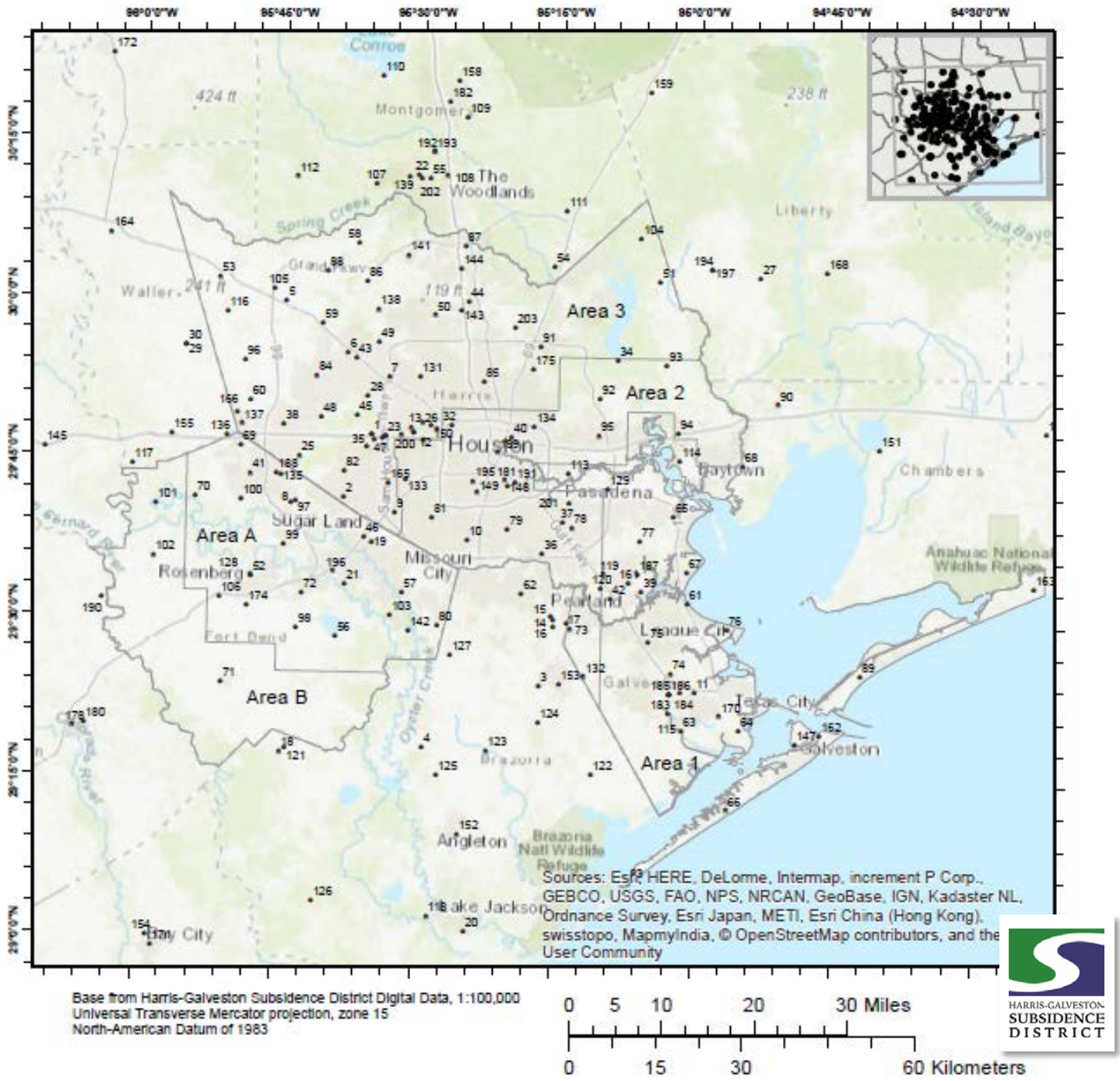
- Since the late 1990s, the District has been utilizing Global Positioning Stations (GPS) to monitor subsidence in the area
- Over 200 HGSD and University of Houston (UH) GPS Subsidence monitoring locations (e.g., PAMs and CORs) operated by multiple agencies:
  - Harris-Galveston Subsidence District
  - Fort Bend Subsidence District
  - University of Houston
  - Lone Star Groundwater Conservation District
  - Brazoria County Groundwater Conservation District
- 11 USGS extensometer locations to measure compaction

HARRIS-GALVESTON SUBSIDENCE DISTRICT

Subsidence Monitoring Network

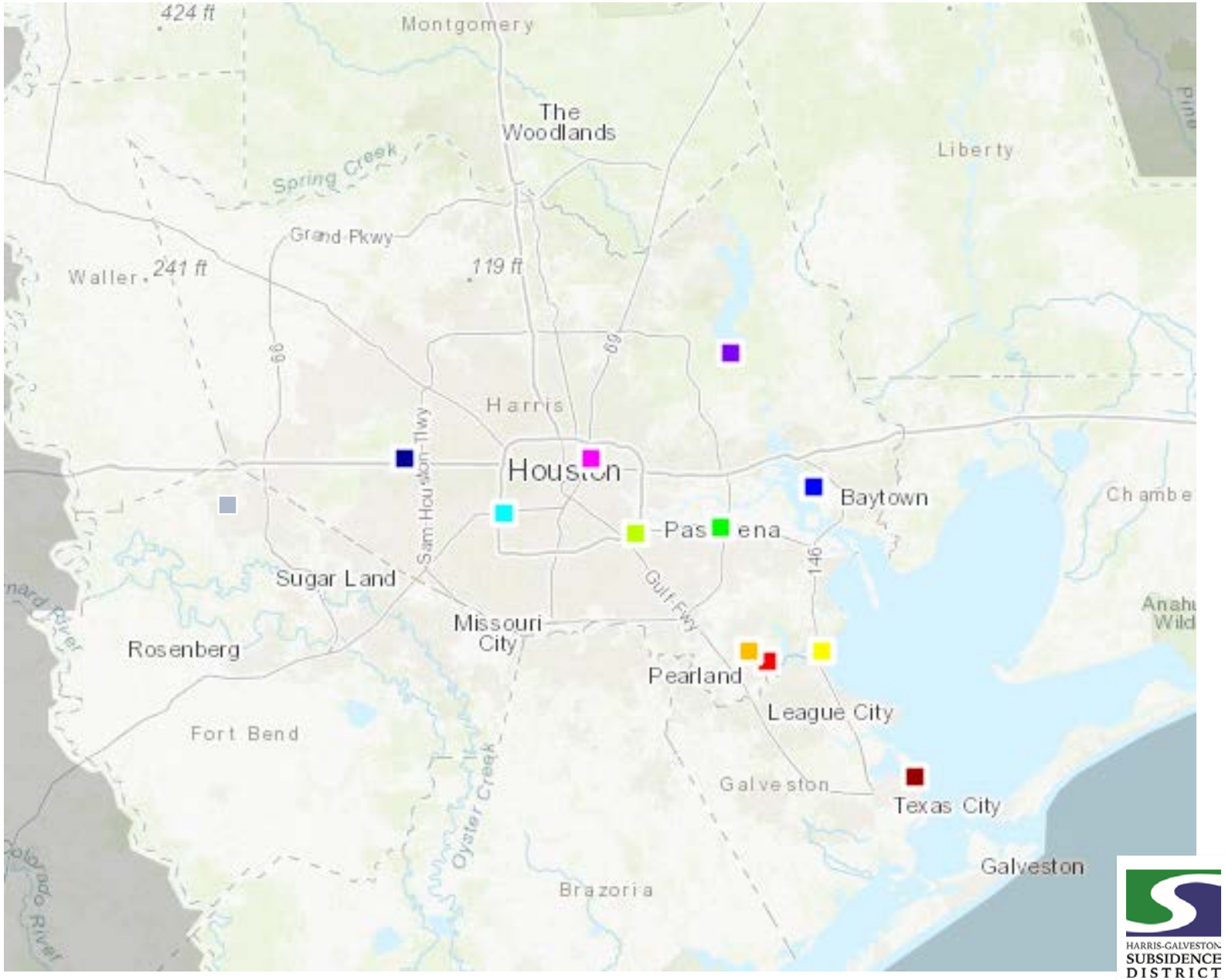
In cooperation with:

- Fort Bend Subsidence District
- University of Houston
- Lone Star Groundwater Conservation District
- Brazoria County Groundwater Conservation District

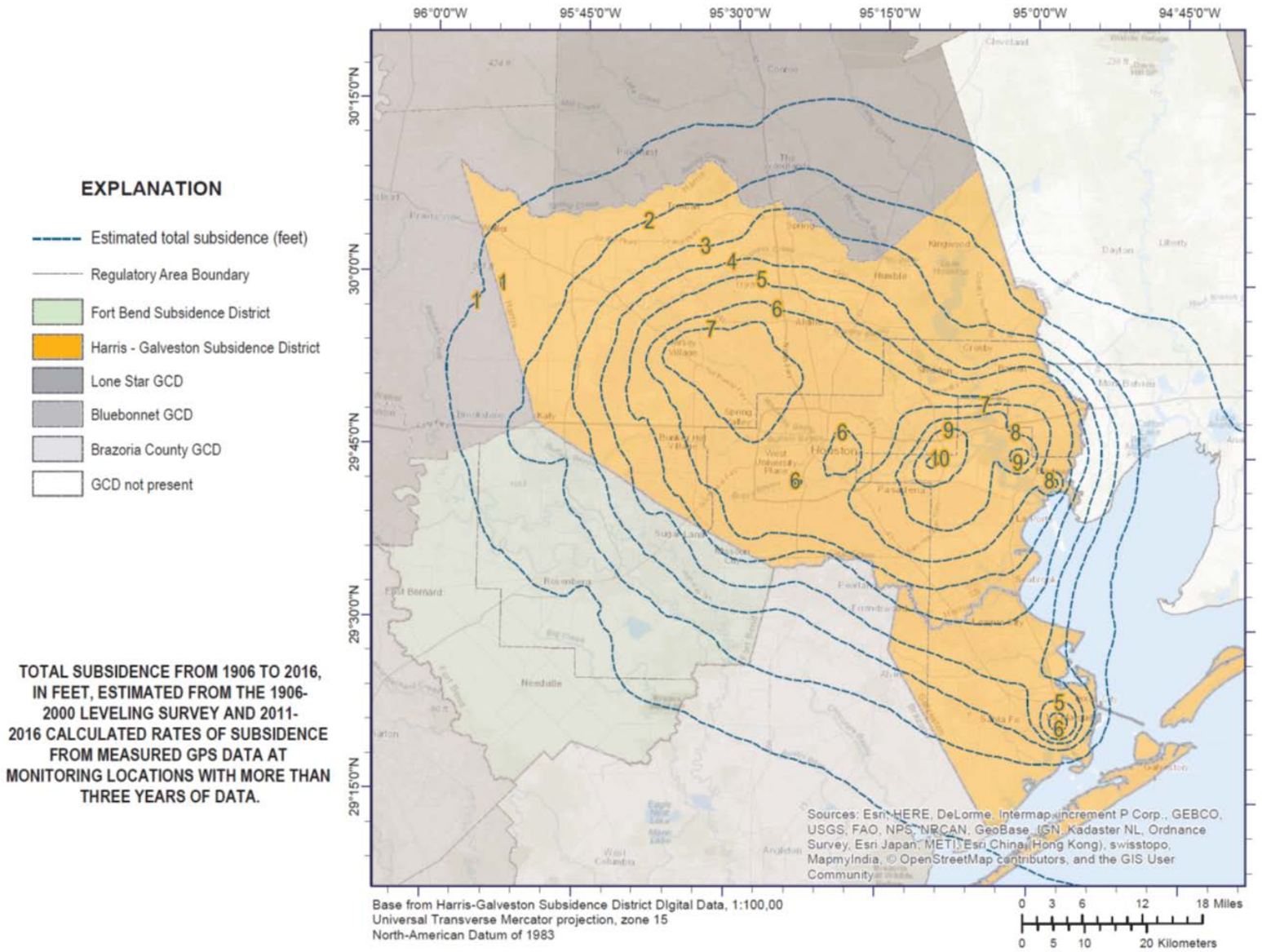


USGS Extensometer Data

- A total of 12 extensometer locations
- 2 sites have co-located deep and shallow monitoring
  - Baytown
  - Clear Lake



Estimated Total Subsidence 1906-2016



- Total subsidence over the period of development has been estimated based on traditional benchmark surveying from 1906-2000 and the calculated subsidence rates from measured GPS vertical movement data from sites active in 2016 with more than three years of vertical movement data.
- The largest magnitude of historical subsidence has occurred in the ship channel area of Eastern Harris County.

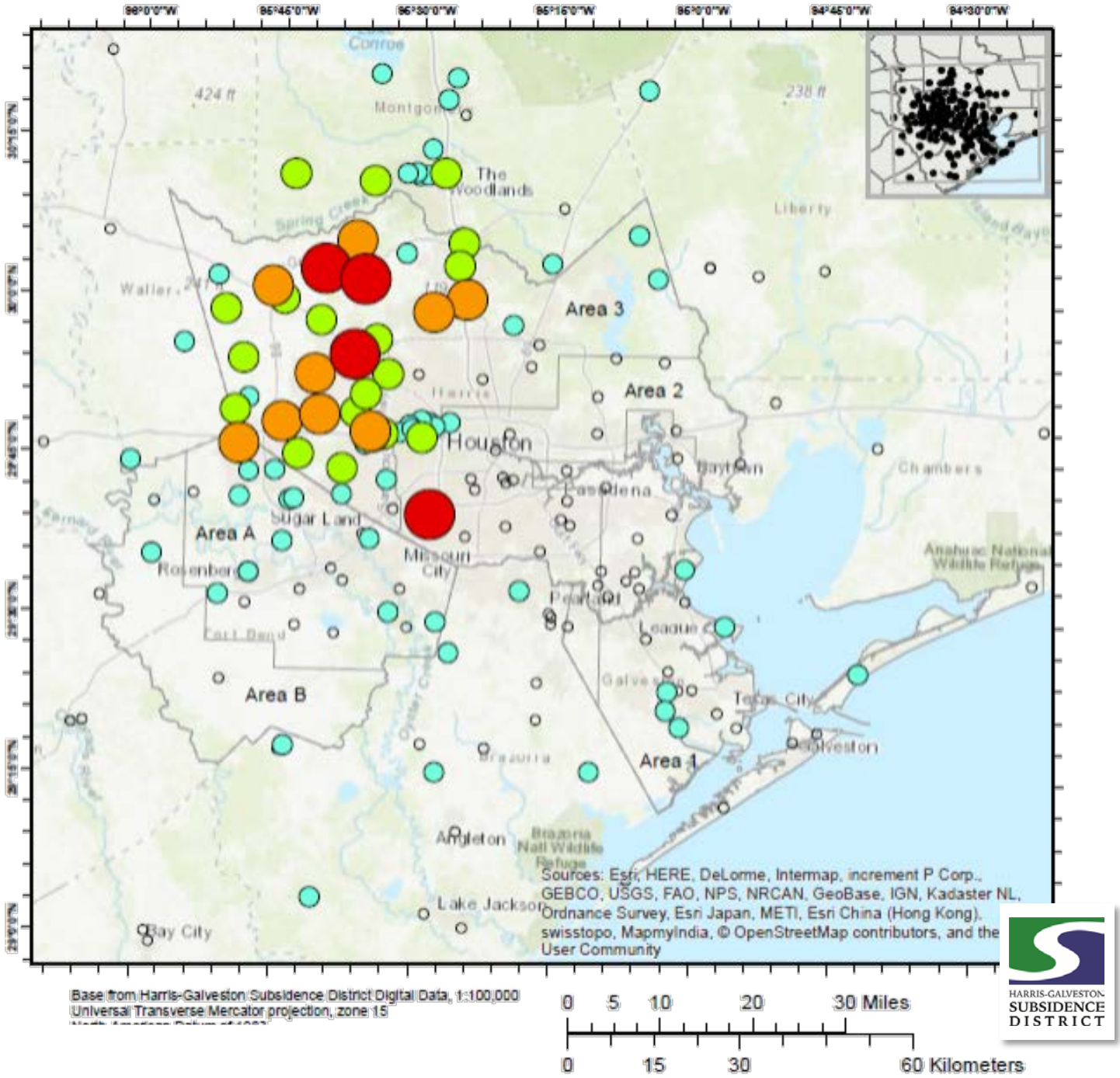
HARRIS-GALVESTON SUBSIDENCE DISTRICT

Estimated Annual Rate of Subsidence 2014-2018

EXPLANATION

Subsidence Rate (2014-2018) cm/year

- Greater than 2.0
- 1.9 - 1.5
- 1.4 - 1.0
- 0.9 - 0.5
- Subsidence Rate less than 0.5 cm/yr or period of record less than 3 yrs



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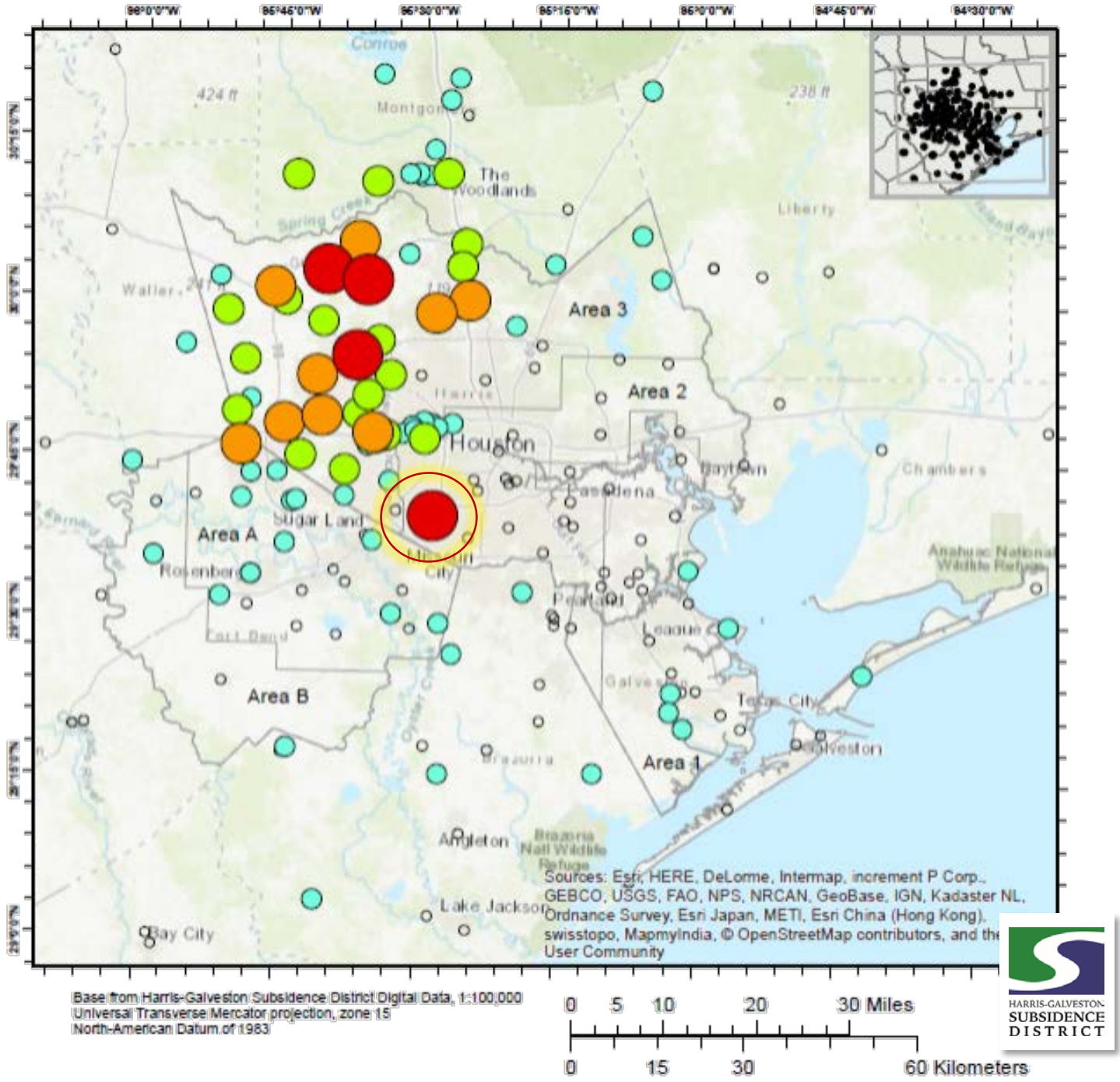
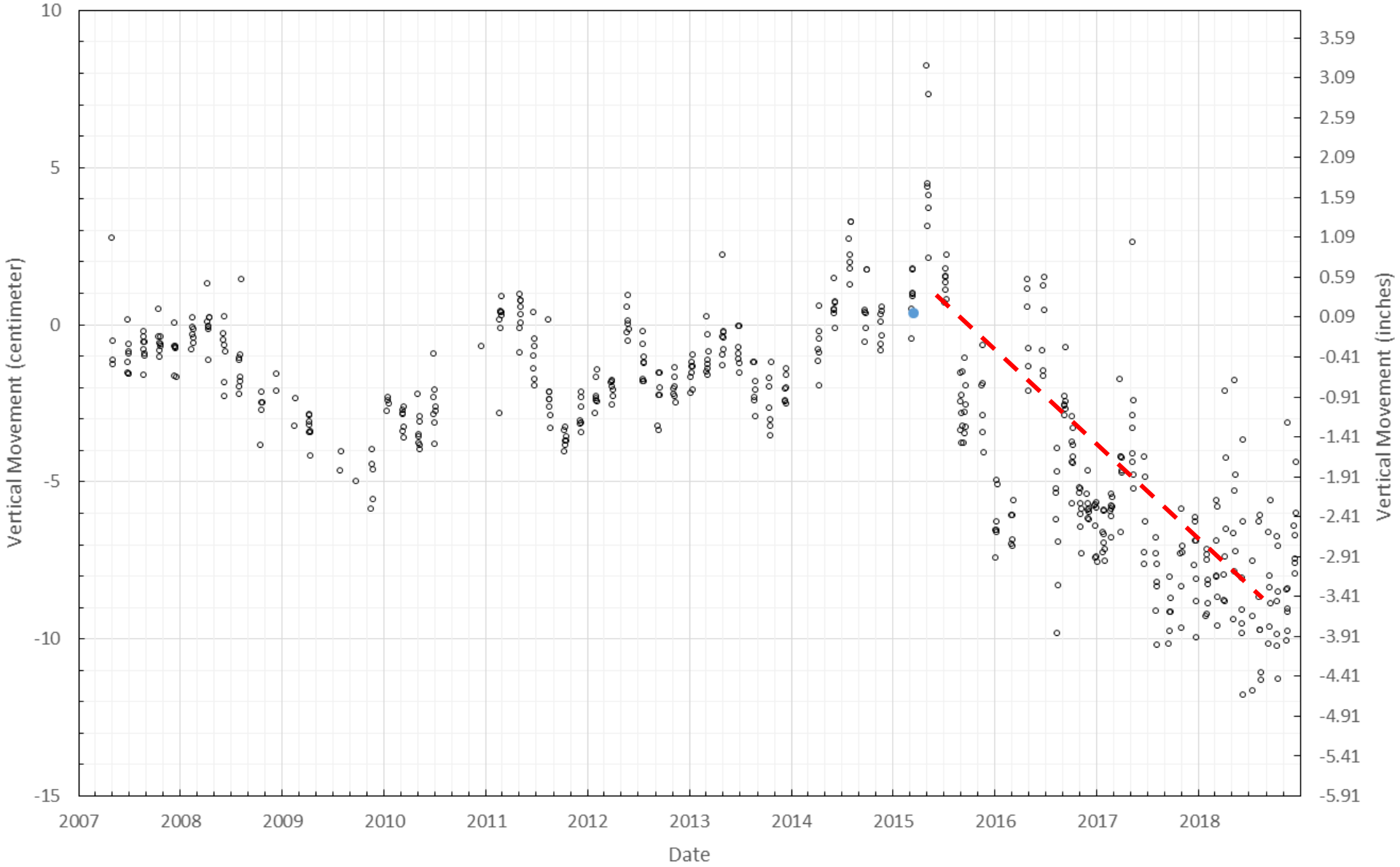


PA41

Vertical Movement - Period of Record - Horizontal Reference Frame 16



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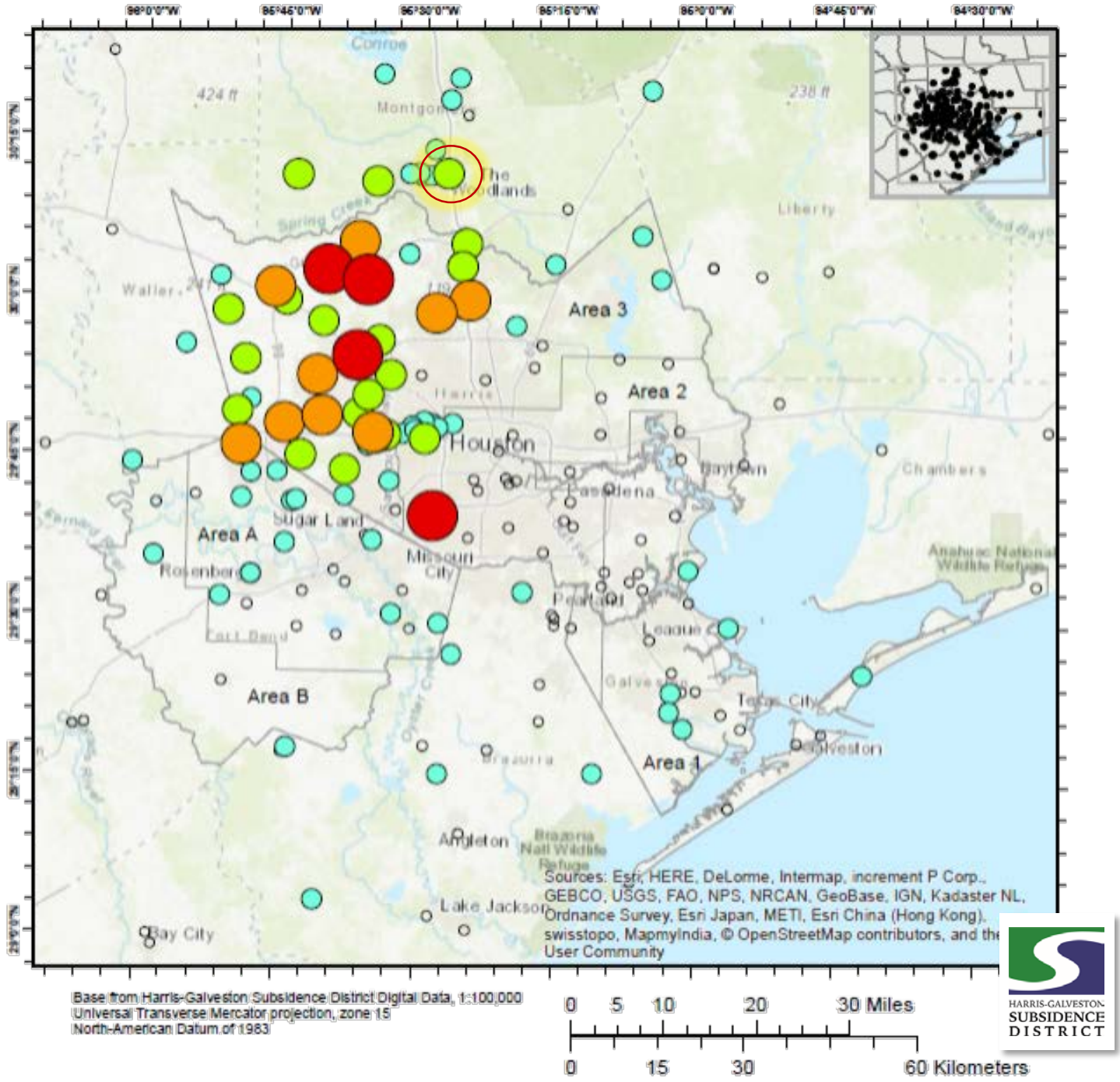
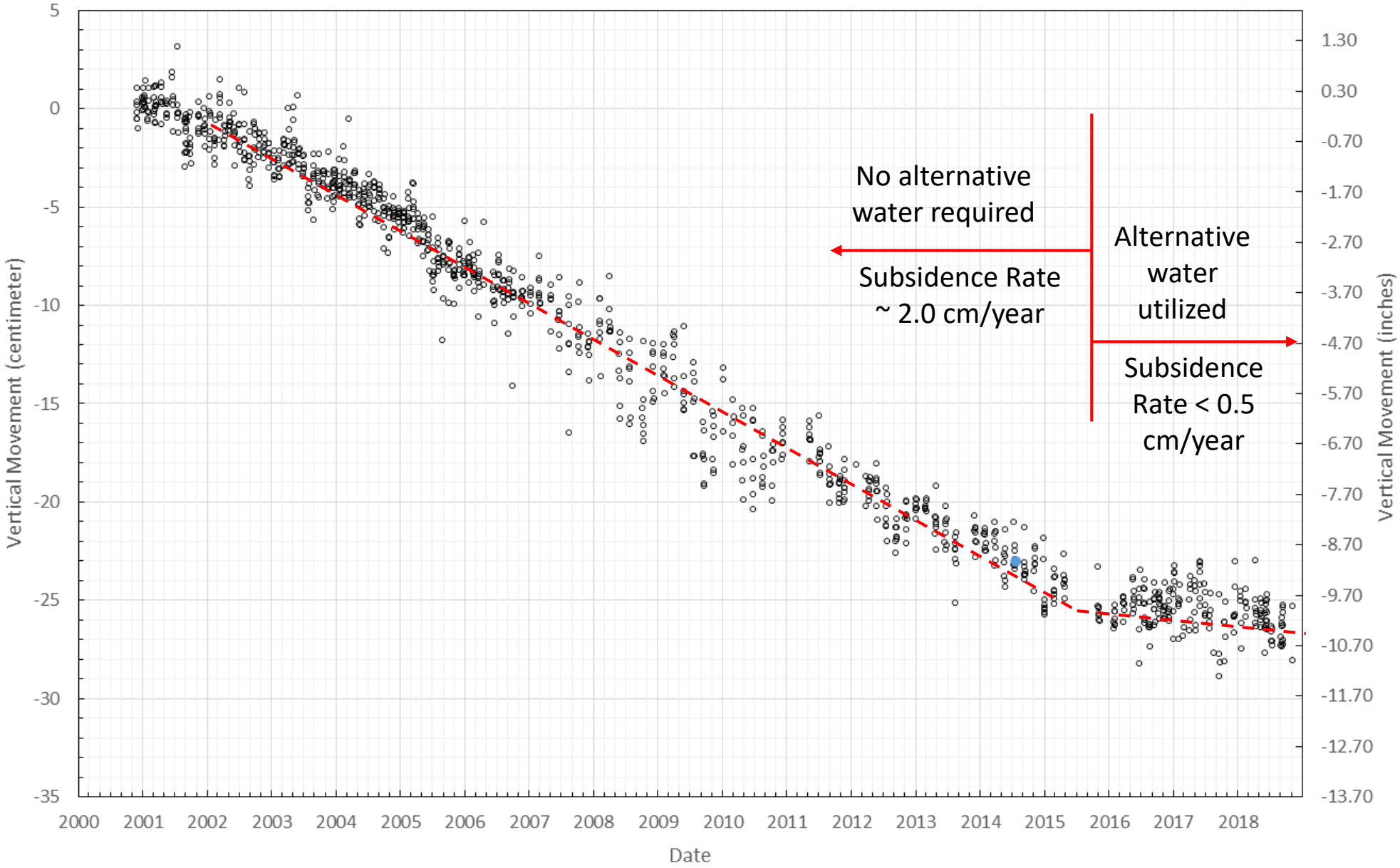


PA13

Vertical Movement - Period of Record - Horizontal Reference Frame 16



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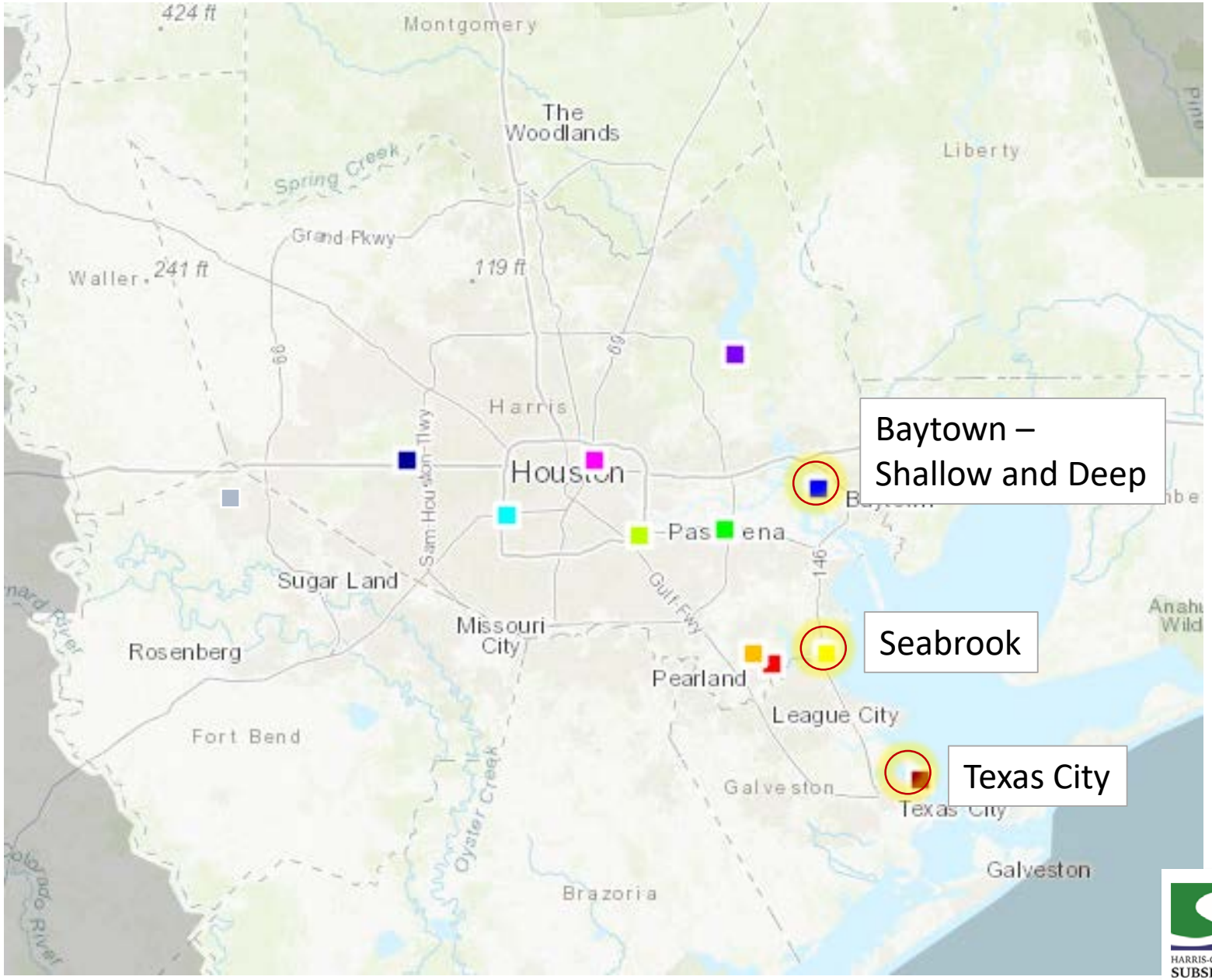

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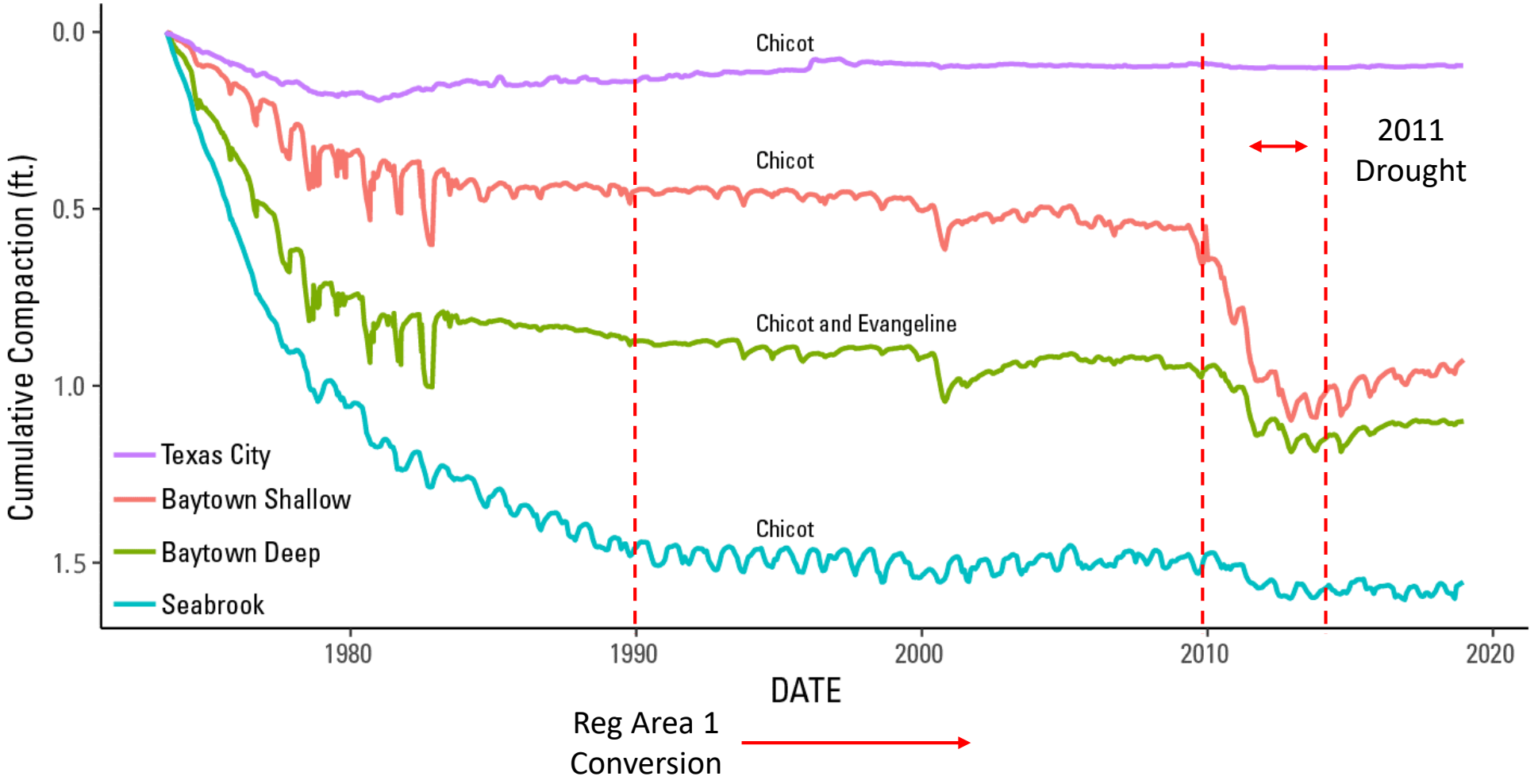

2018 Groundwater Report

- The 2018 Groundwater Report was approved by our Board of Directors on June 12, 2019
- The report will be posted on the District website in the coming weeks at https://hgsubsidence.org/

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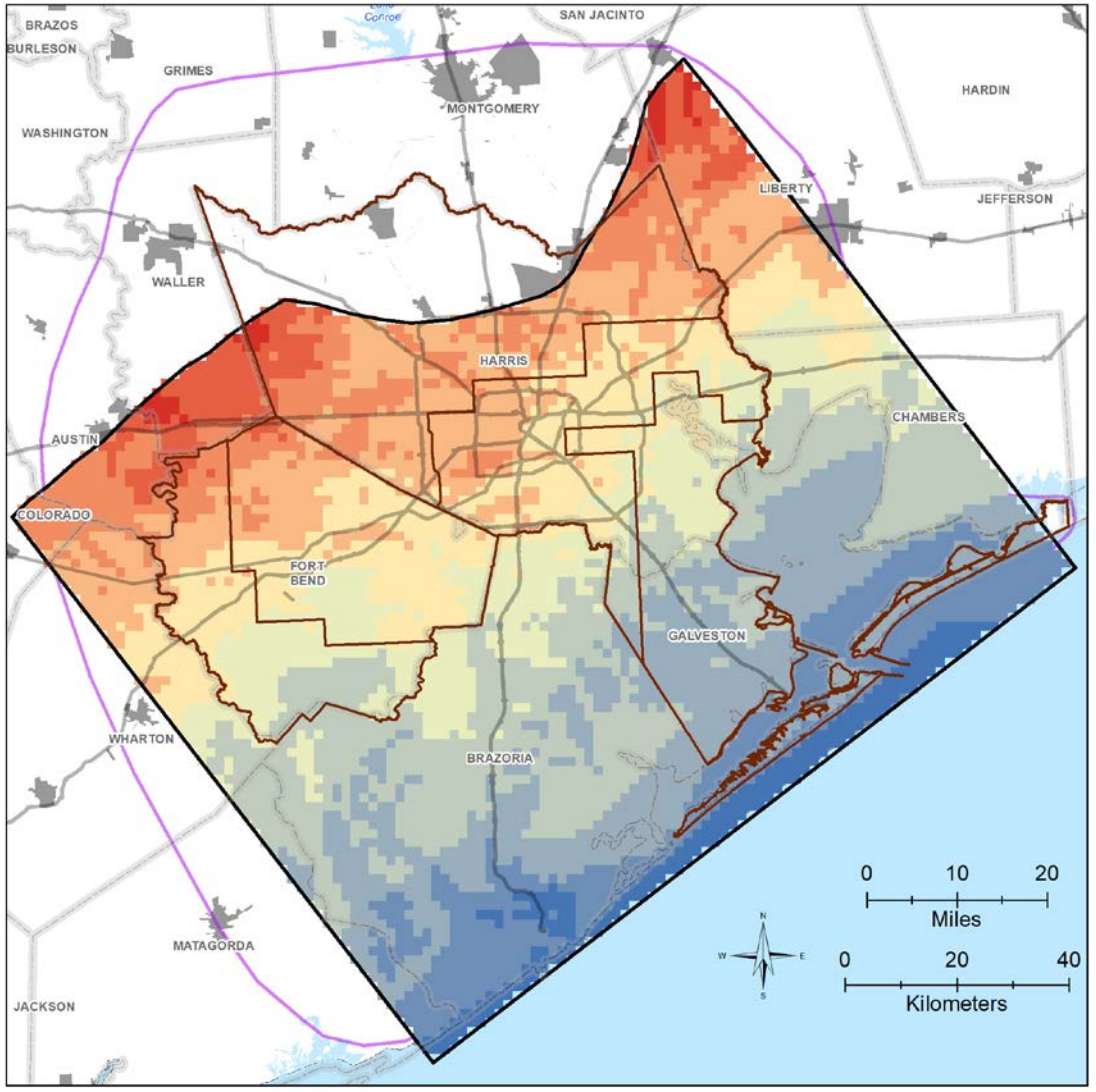
HARRIS-GALVESTON SUBSIDENCE DISTRICT

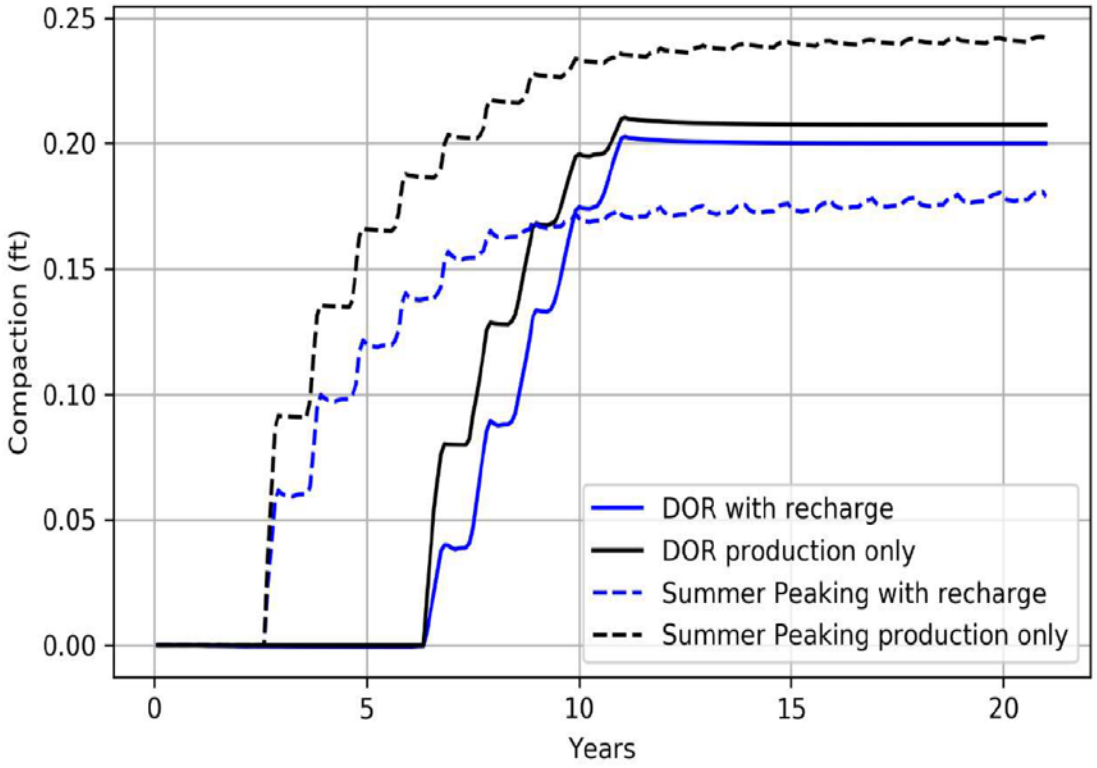
Brackish Groundwater Development Study

- Estimation of the Subsidence Risk for the development of Jasper Aquifer
- Multiple models were developed to simulate hypothetical development
- Study shows that the Jasper is susceptible to compaction particularly in area where the Jasper is nearer the surface (northern Harris and Montgomery County)



Aquifer Storage and Recovery Evaluation

- Evaluated hypothetical subsidence-neutral ASR project:
  - Drought of Record
  - Seasonal Peaking
- Preliminary results show there is no “free lunch” as anytime the clays in the system begin to depressurize, compaction occurs
- Seasonal Peaking has less of impact on compaction when compared to just using groundwater for the entirety of demand



Other Ongoing Science and Research Studies

- Evaluation of Projected Population and Water Demands in Fort Bend County
  - This is a Fort Bend Subsidence District study to investigate recent population, migration and water use data from 2010 to 2017 to evaluate short-term projections utilized in the 2013 District Regulatory Plan
  - Preliminary results suggest that the population and water demand data utilized for 2013 Regulatory Plan are reasonable.
  - Project is underway; expect completion later this summer
- Evaluation of a potential multi-year permitting methodology
  - The purpose of this study is to evaluate the potential for a permitting methodology that allows for the accounting of small overages in permitted allocation so long as the total amount of water used over the time period is not exceeded

HARRIS-GALVESTON SUBSIDENCE DISTRICT

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HARRIS-GALVESTON SUBSIDENCE DISTRICT

Upcoming Activities

- 2023 Regulatory Plan Update – planned to start in 2020
  - Update the Regulatory Plan to account for future water needs and subsidence risk
  - Address specific policy questions regarding the regulatory plan and rules
- Monitoring Program
  - Research program with SMU to map land deformation over Houston area using multi-temporal InSAR (interferometric synthetic-aperture radar) Processing – planned for 2020
  - Continuation of research program with University of Houston to maintain and process GPS monitoring network data

HARRIS-GALVESTON SUBSIDENCE DISTRICT

Questions? For More Information...

Links:

- Harris Galveston 2018 Annual Report
  - https://hgsubsidence.org/
- USGS Water Level Altitude and Extensometer Data
  - https://txpub.usgs.gov/houston_subsidence/viewer/index.html

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