

Welcome to the Public Hearing for the 2020 Annual Groundwater Report

- Participants will be muted upon joining the meeting.
- We will open the meeting to public testimony at the end of the hearing. If you would like to provide testimony on the information presented in the presentation, please use the chat to let the organizer know, or raise your hand.
- The meeting is being recorded including all chat between participants.
- For any problems, please chat with the organizer.



2020 ANNUAL GROUNDWATER REPORT

Public Hearing – April 29, 2021

Subsidence District Mission



- The Subsidence District was created in 1975 to prevent land subsidence in Harris and Galveston counties through the management of groundwater.
- Land subsidence contributes to flooding, threatening the economic health of the area
- Efforts to prevent subsidence by the District and the regulated community have required significant investment in order to create a more resilient infrastructure to mitigate flooding while securing reliable water sources for future needs
- Annual groundwater hearing required by enabling act to receive testimony regarding the effects of groundwater withdrawals on subsidence

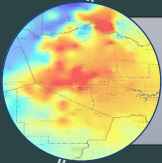
Agenda



Climate



Groundwater Use



Groundwater Levels



Subsidence Data

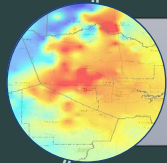
Agenda



Climate



Groundwater Use



Groundwater Levels



Subsidence Data

Weather Service Climate Stations

Location of weather service climate stations that were used for rainfall data.

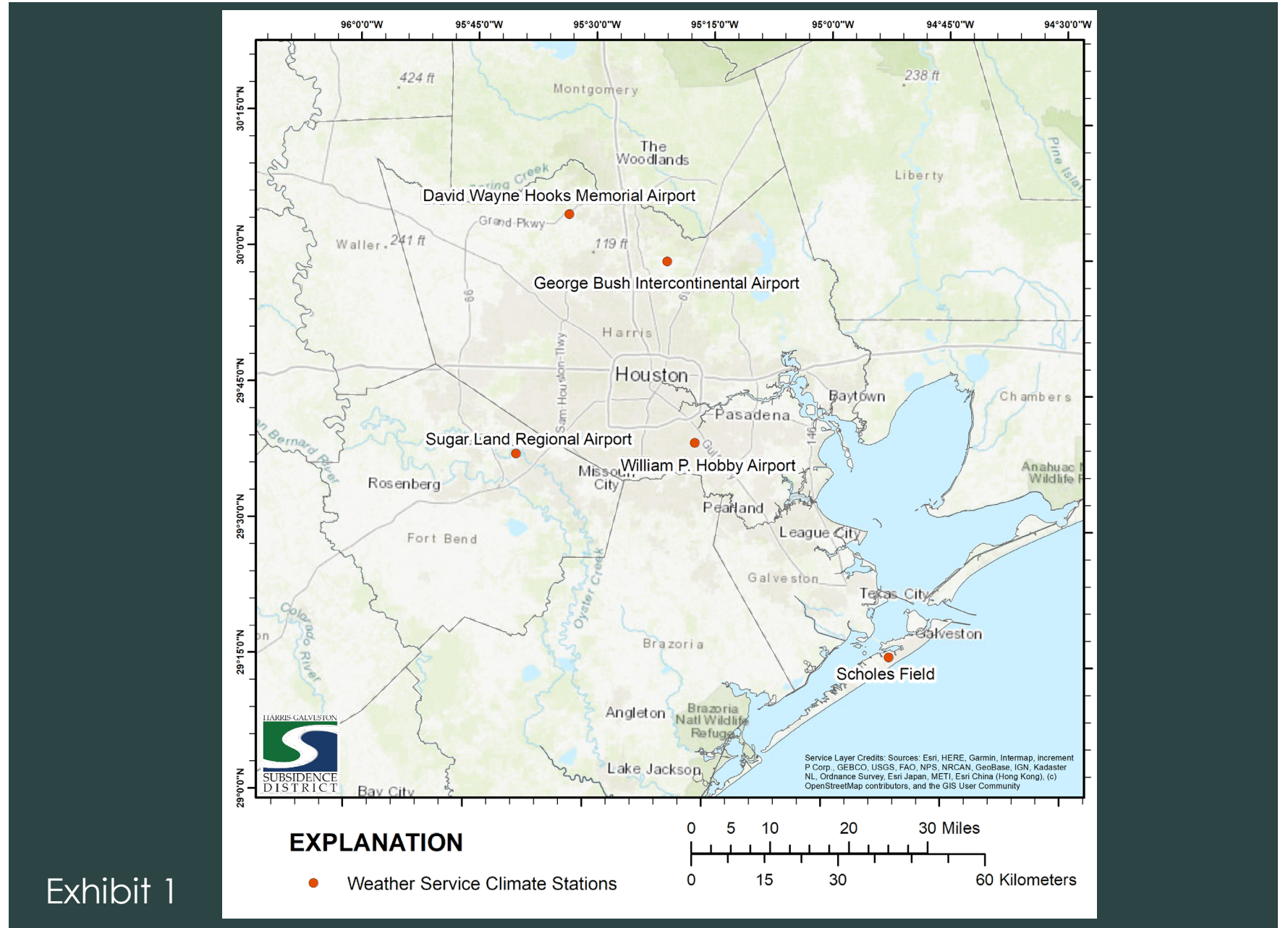
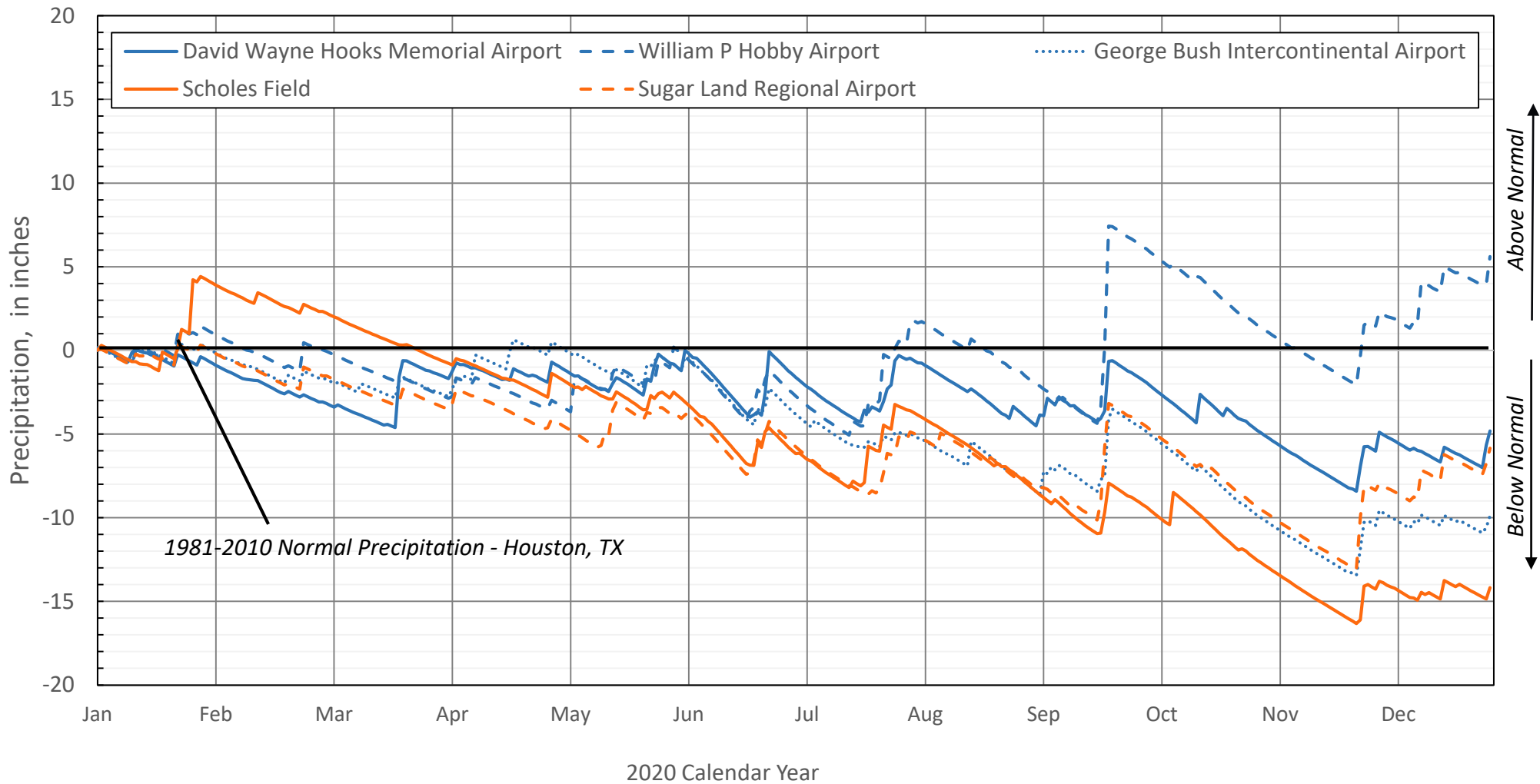


Exhibit 1

2020 Cumulative Precipitation Departure From 1981 - 2010 Normal



1981-2010 Normal Precipitation - Houston, TX

Data source: NOAA NWS

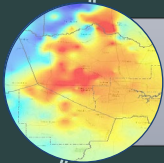
Agenda



Climate



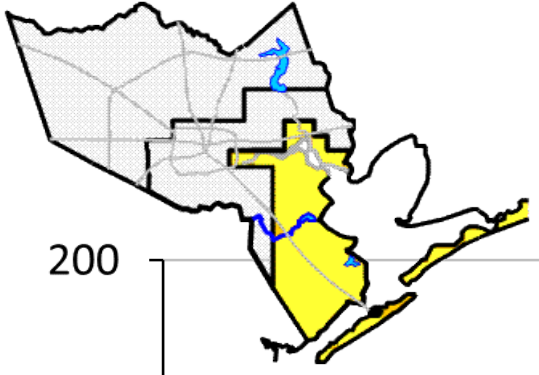
Groundwater Use



Groundwater Levels



Subsidence Data



Groundwater Withdrawals

Grouped by use – Regulatory Area One

Public Indust. All Irrig.

2020 – 8.1 MGD
 (2019 – 9.5 MGD; -15%)
 (1976 – 138.1 MGD; -94%)

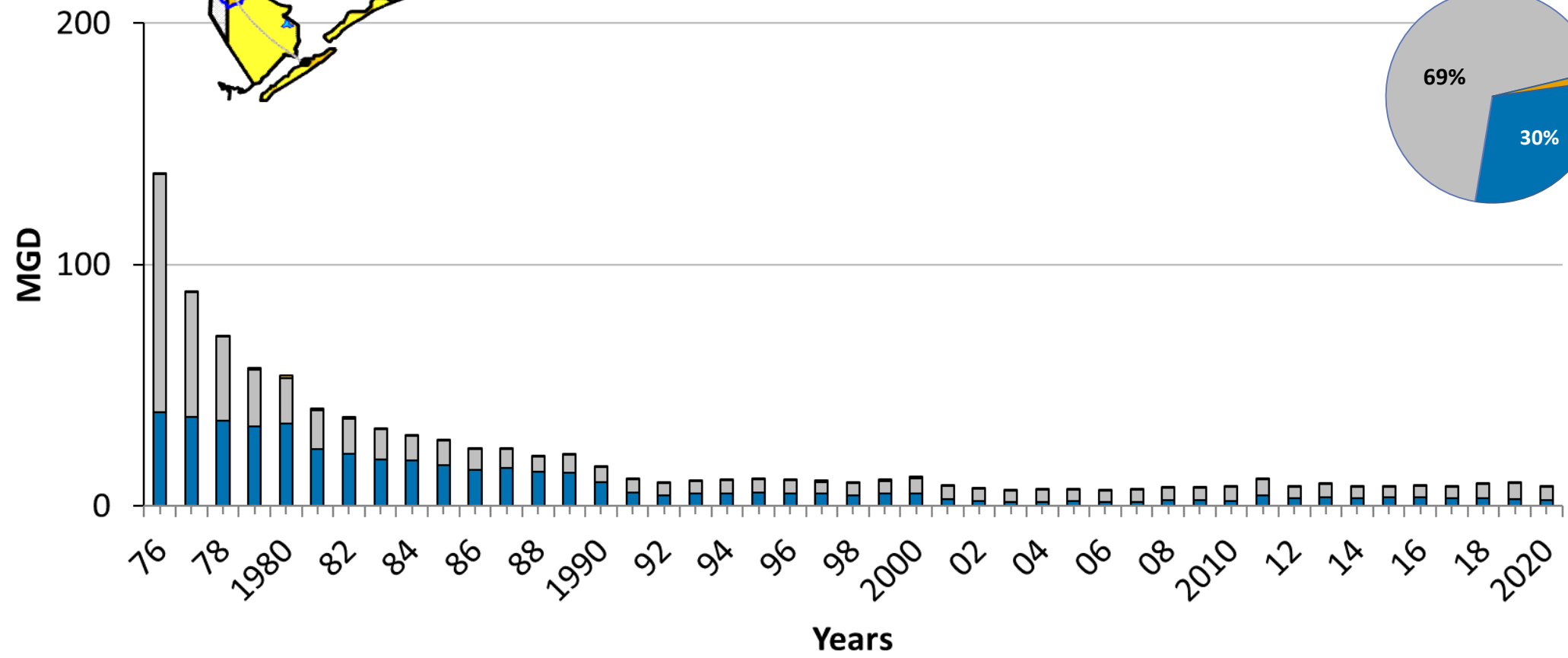
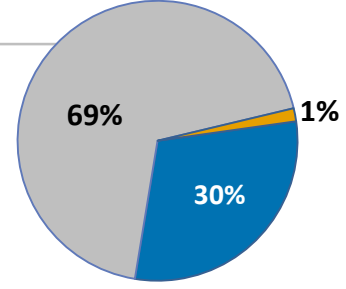
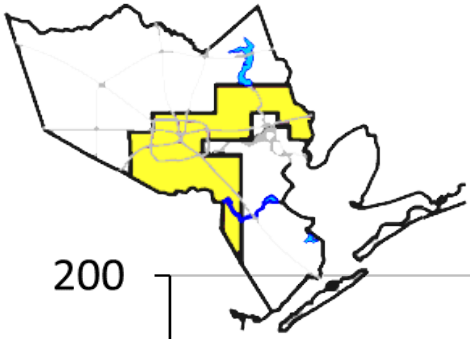


Exhibit 3

PROVISIONAL - SUBJECT TO CHANGE



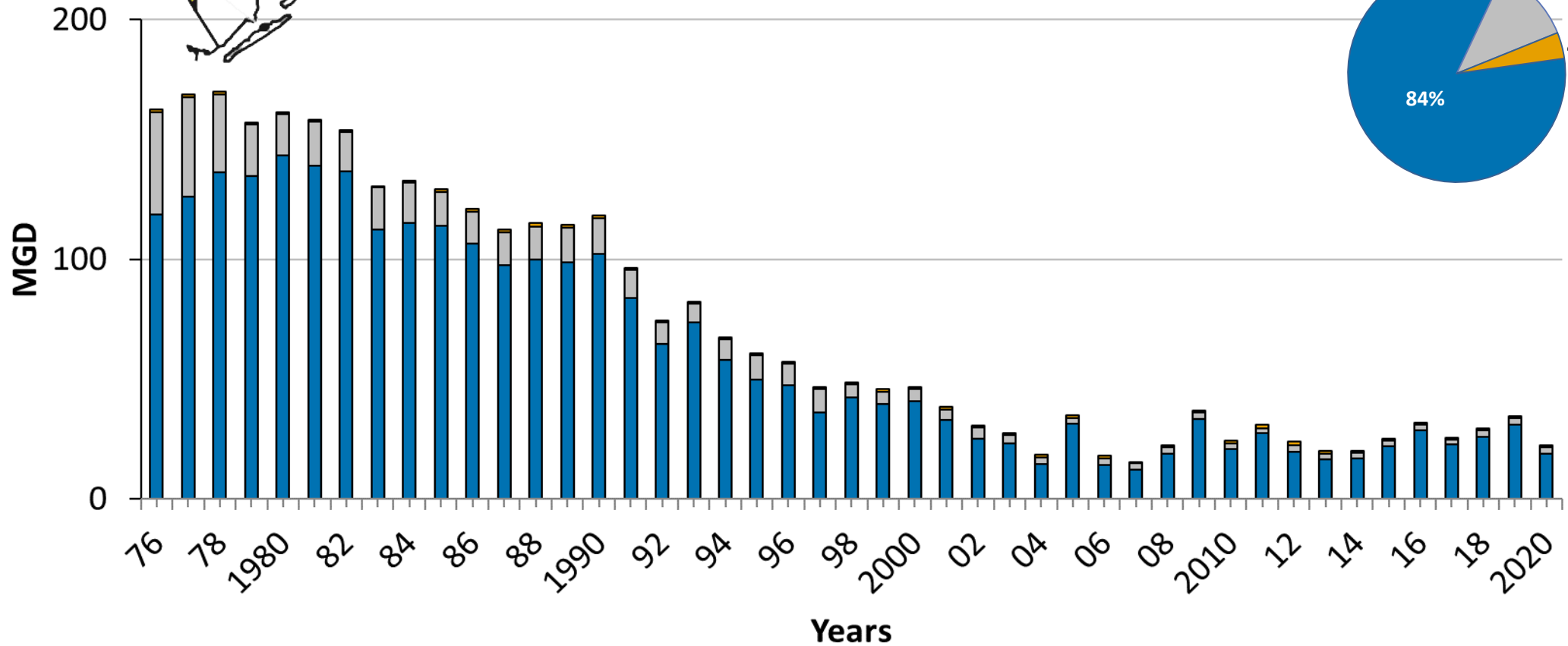
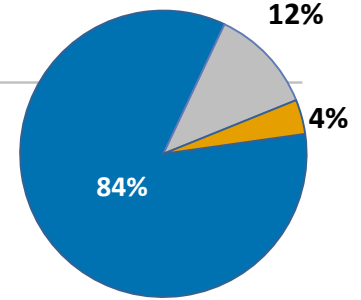


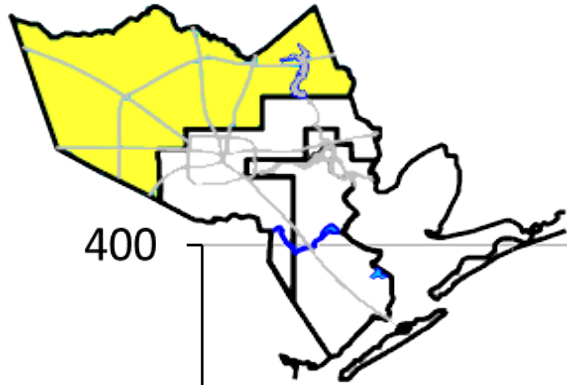
Groundwater Withdrawals

Grouped by use – Regulatory Area Two

Public Indust. All Irrig.

2020 – 22.4 MGD
 (2019 – 34.5 MGD; -35%)
 (1976 – 162.3 MGD; -86%)





Groundwater Withdrawals

Grouped by use – Regulatory Area Three

Public Indust. All Irrig.

2020 – 177.7 MGD
 (2019 – 184.3 MGD; -4%)
 (1976 – 155.9 MGD; 14%)

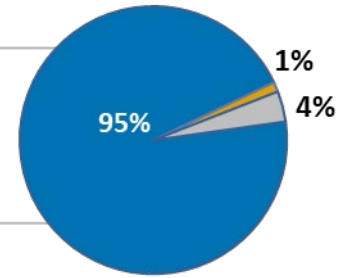
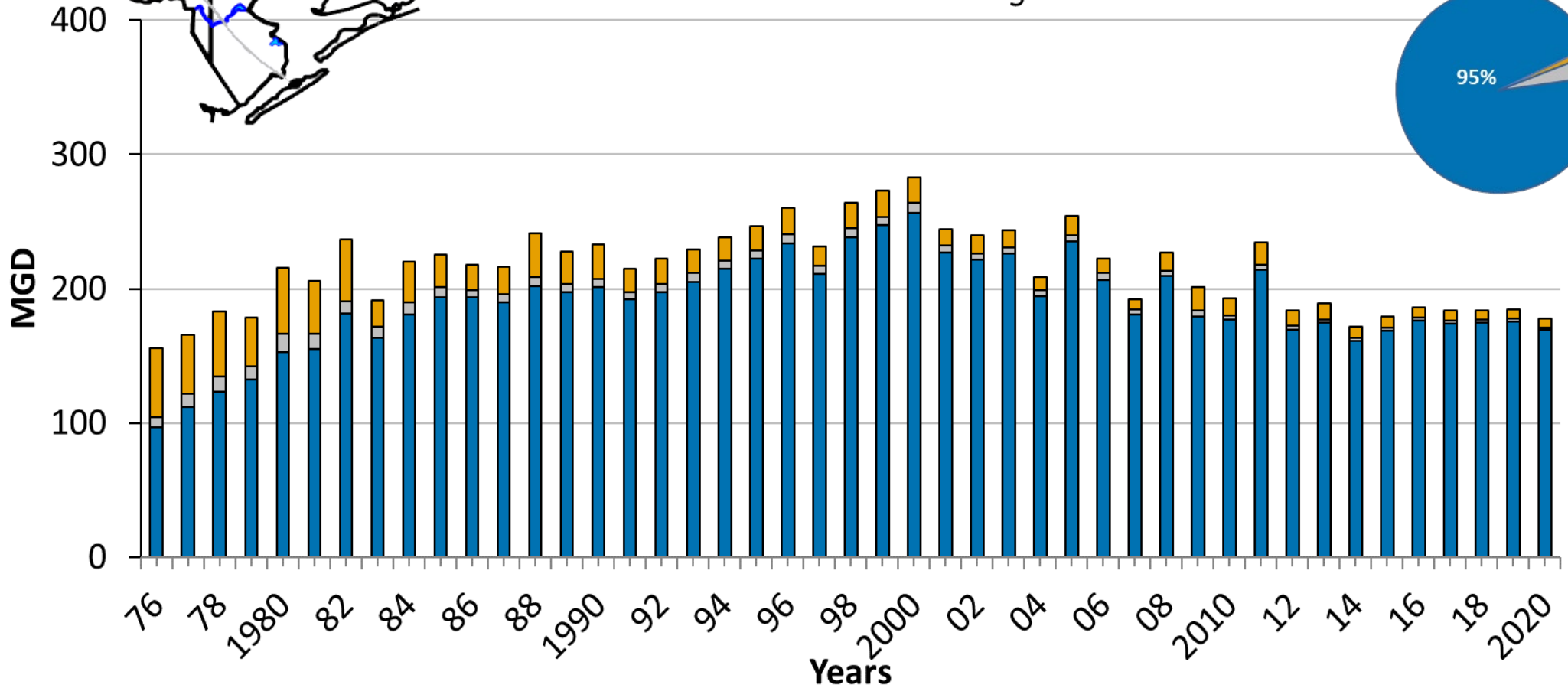


Exhibit 5

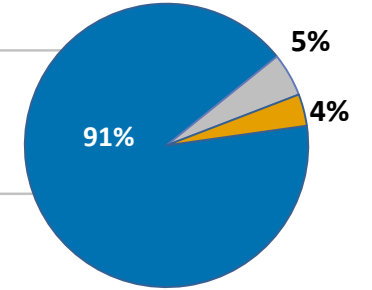
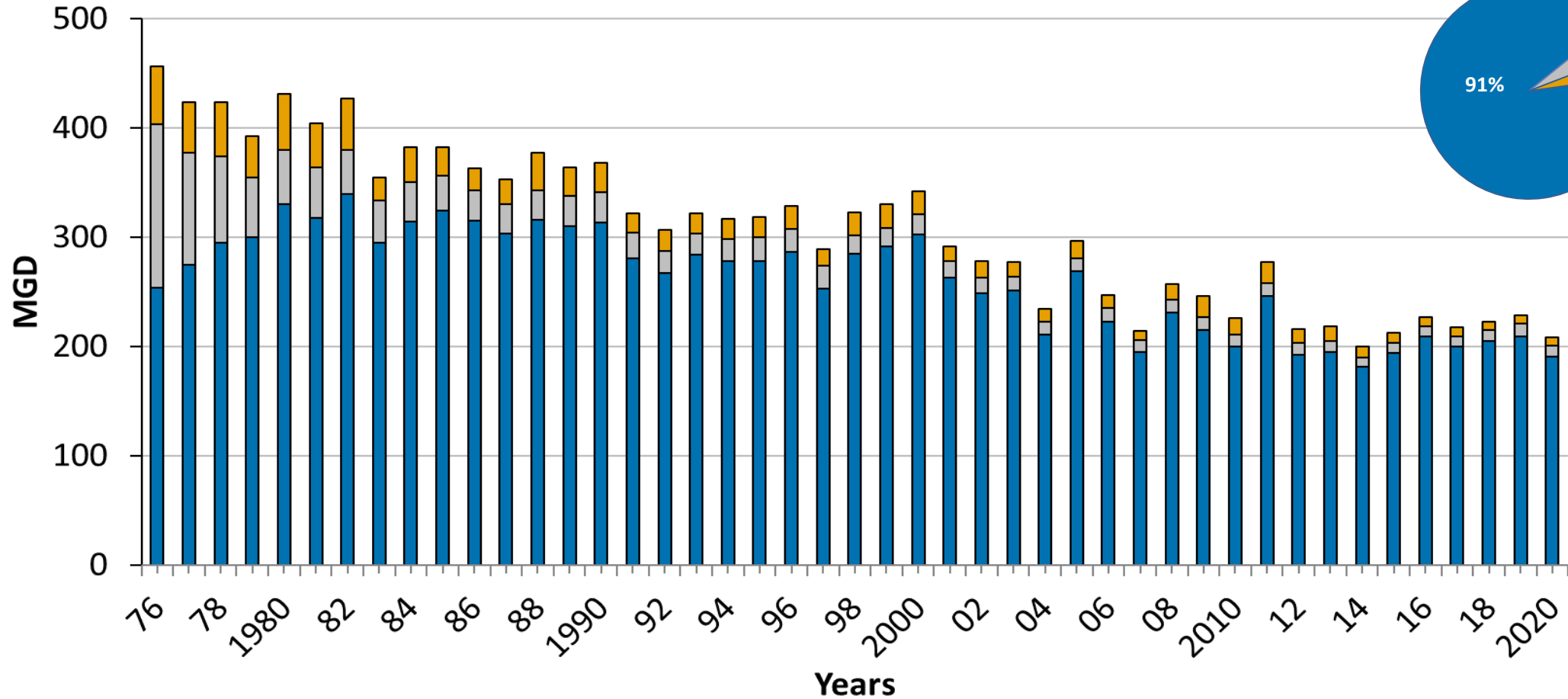
PROVISIONAL - SUBJECT TO CHANGE

Groundwater Withdrawals

Grouped by Use - Entire District

Public Indust. All Irrig.

2020 – 208.1 MGD
 (2019 – 228.3 MGD; -9%)
 (1976 – 456.3 MGD; -54%)

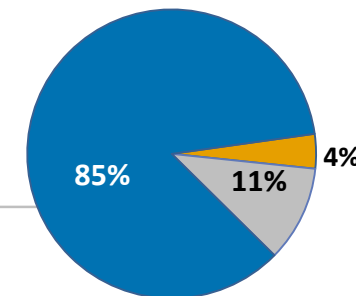
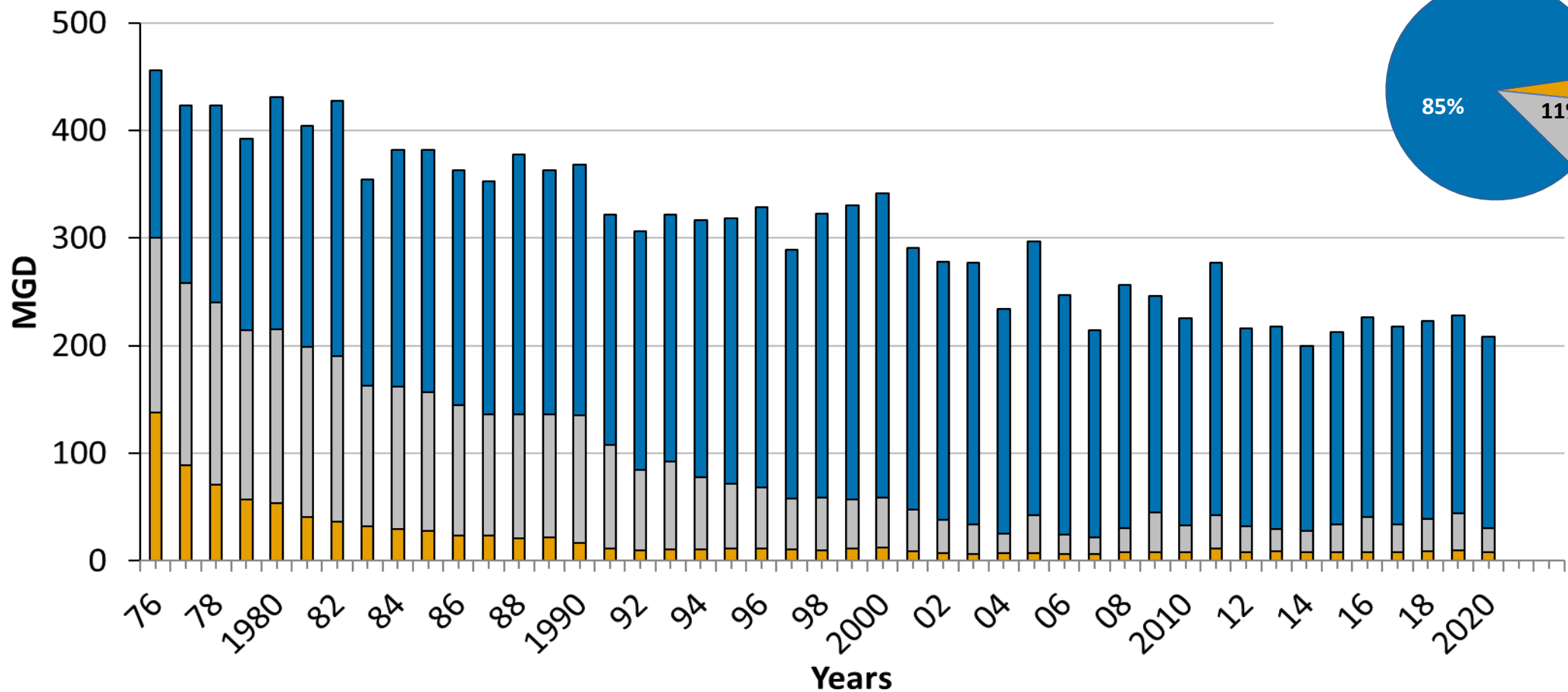


Groundwater Withdrawals

Grouped by Regulatory Area - Entire District

Area 1 Area 2 Area 3

2020 – 208.1 MGD
 (2019 – 228.3 MGD; -9%)
 (1976 – 456.3 MGD; -54%)

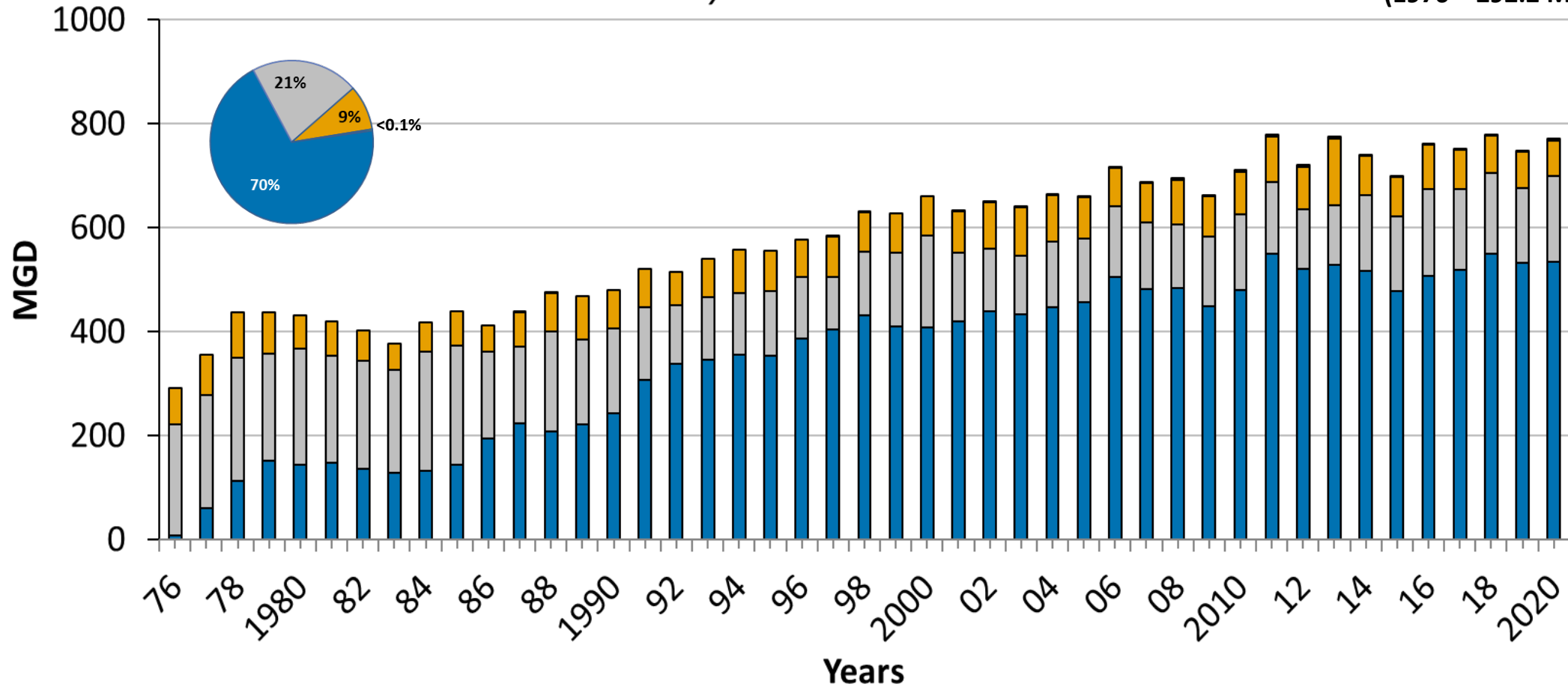


Alternative Water Utilized (Surface and Reclaimed Water)

Grouped by Source- Entire District

2020 – 770.5 MGD
 (2019 – 746.7 MGD; 3%)
 (1976 – 292.2 MGD; 164%)

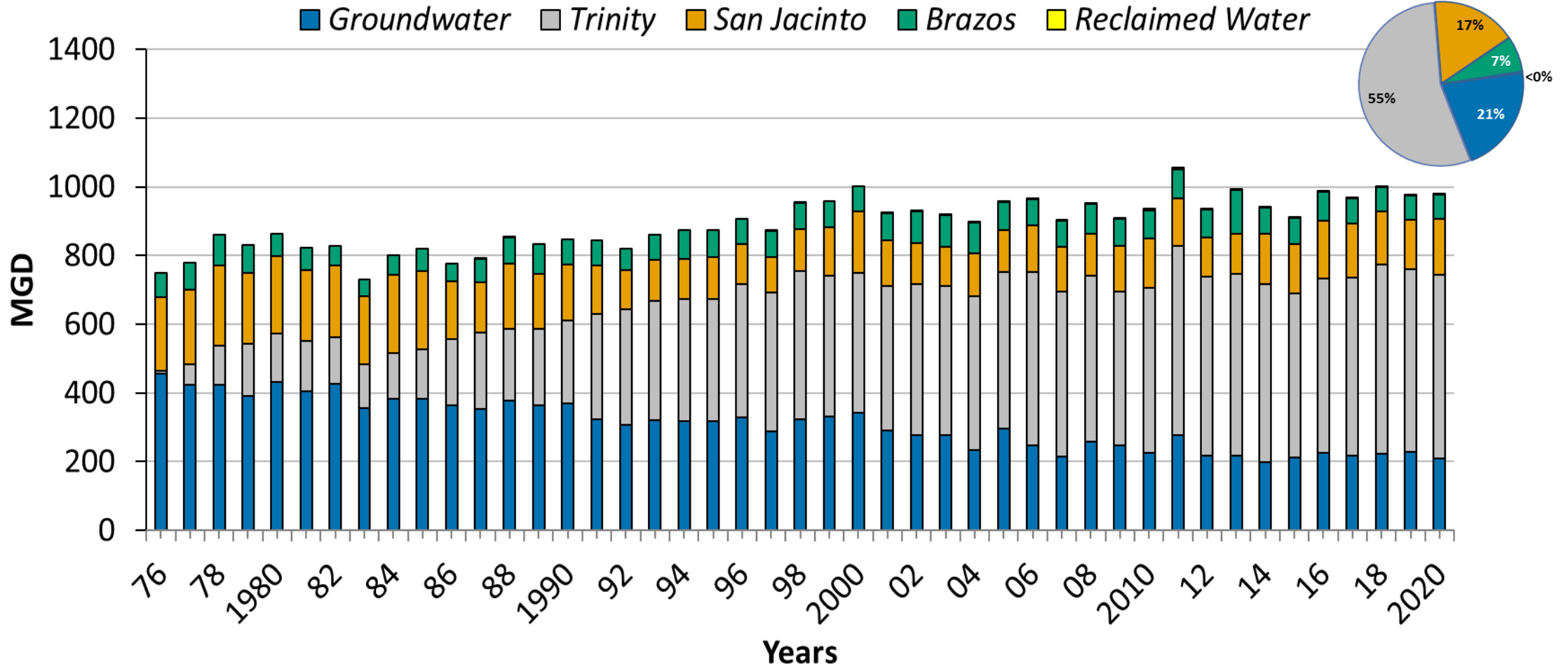
Trinity San Jacinto Brazos Reclaimed



Total Water Demand

Grouped by Source- Entire District

2020 – 978.6 MGD
 (2019 – 975.1 MGD; 0.4%)
 (1976 – 748.6 MGD; 30.9%)



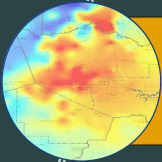
Agenda



Climate



Groundwater Use



Groundwater Levels



Subsidence Data

USGS Presentation

PROVISIONAL - SUBJECT TO CHANGE

Groundwater-level Altitudes (2021) and Changes Over Time in the Chicot-Evangeline (undifferentiated) and Jasper Aquifers and Compaction in the Chicot and Evangeline Portions of the Undifferentiated Aquifer (1973-2020)

For the Houston-Galveston Region

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4/29/2021



HARRIS-GALVESTON
SUBSIDENCE DISTRICT



Fort Bend
Subsidence District



Brazoria County
Groundwater Conservation District

2021 Water-Level Altitude Map Series

■ Chicot-Evangeline Aquifer (undifferentiated)

- *2021 Water-Level Altitude*
- *2020 to 2021 Water-Level Change*
- *2016 to 2021 Water-Level Change*
- *1990 to 2021 Water-Level Altitude Change*
- *1977 to 2021 Water-Level Altitude Change*

■ Jasper Aquifer

- *2021 Water-Level Altitude*
- *2020 to 2021 Water-Level Change*
- *2016 to 2021 Water-Level Change*
- *2000 to 2021 Water-Level Altitude Change*

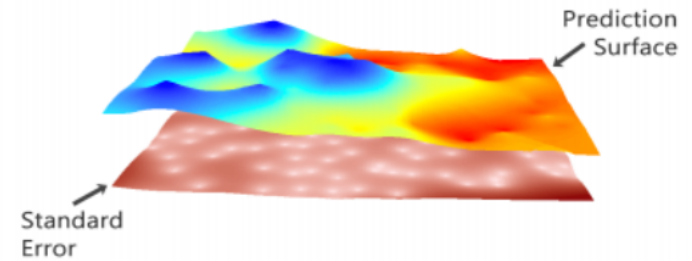
■ Compaction 1973-2020

- *Compaction Data from 14 Extensometers*

Important Updates for 2021

- Chicot-Evangeline aquifer (undifferentiated) have been combined into a “shallow” aquifer system
 - *GULF 2023 model - updated tops and bases*
 - *Chicot thickened significantly in much of the region, particularly in central and south-east Harris County*
 - *Many of the wells previously designated as Evangeline are now designated as Chicot*
 - *Re-creation of the Chicot-Evangeline 1977 and 1990 and the Jasper 2000 needed*

- Altitude and Change maps are now represented by shaded grids (Kriging)

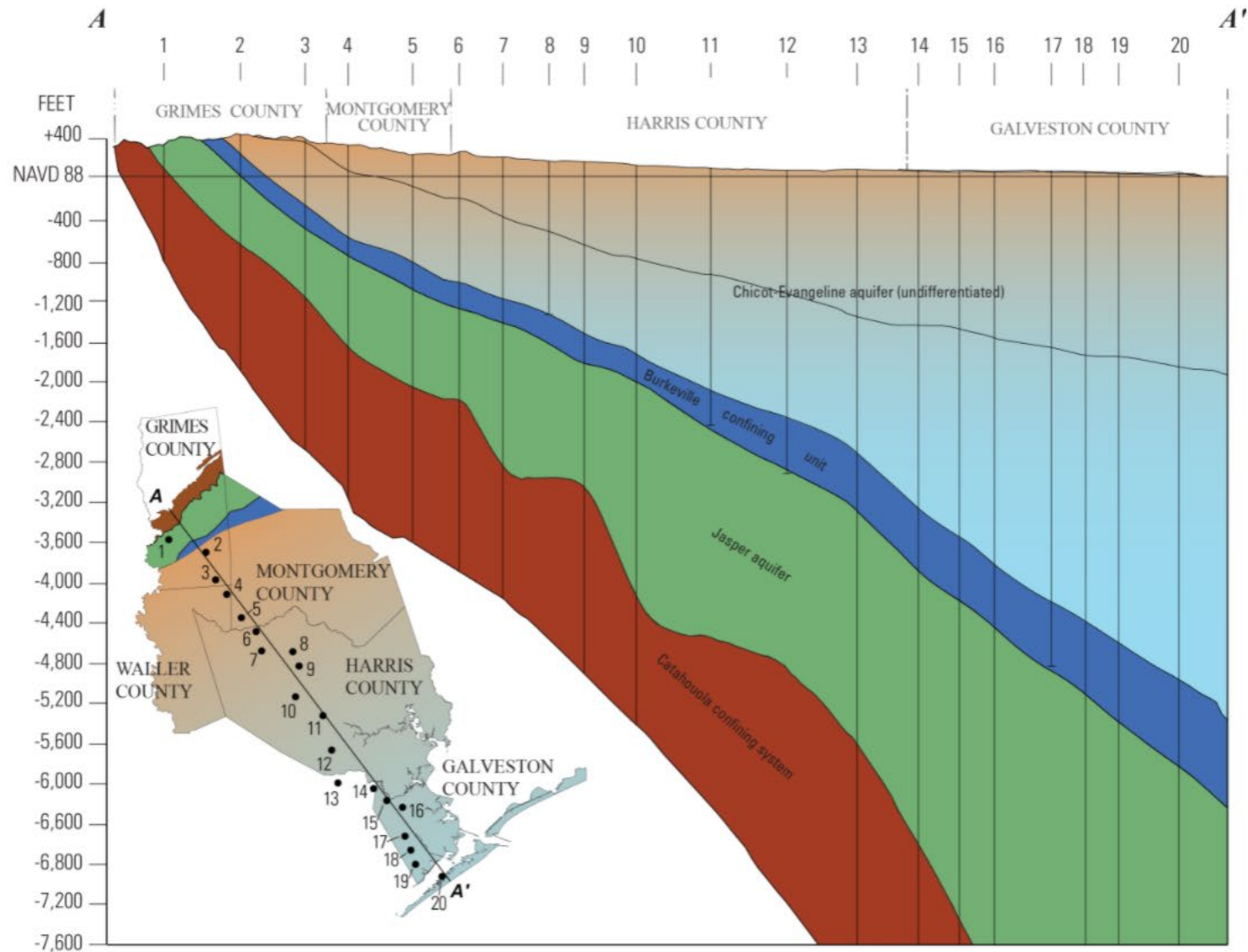


Geologic timescale		Prior to 2021		In 2021 and Moving Forward		
System	Series	Geologic units		Hydrogeologic units		
Quaternary	Holocene	Alluvium		Alluvial, terrace, and dune deposits		
	Pleistocene	Beaumont Formation		Beaumont Formation		
		Lissie Formation	Montgomery Formation	Chicot aquifer	Lissie Formation	Montgomery Formation
			Bentley Formation		Bentley Formation	
Willis Sand		Willis Sand		Chicot - Evangeline aquifer (undifferentiated)		
Tertiary	Pliocene	Goliad Sand			Evangeline aquifer	Goliad Sand (upper part)
		Fleming Formation Lagarto Clay			Burkeville confining unit	Goliad Sand (lower part)
	Miocene	Oakville Sandstone		Jasper aquifer	Lagarto Clay (upper part)	Burkeville confining unit
Catahoula Sandstone		Upper part of Catahoula Sandstone	Catahoula Confining System	Lagarto Clay (middle part)	Jasper aquifer	
		Anahuac Formation		Lagarto Clay (lower part)		
Oligocene	Frio Formation	Catahoula Formation	Upper Catahoula Formation	Frio Formation	Catahoula Confining System	

Network

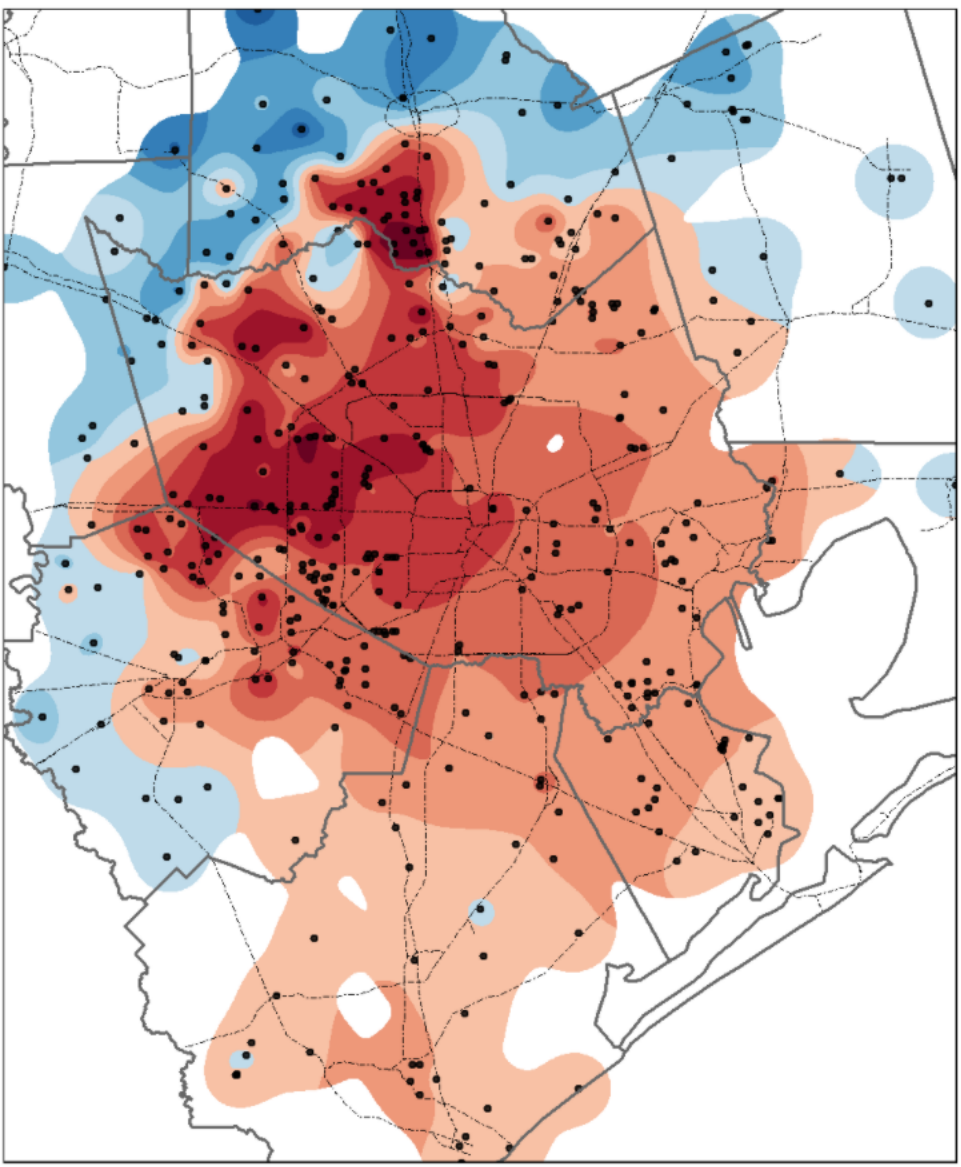
- Data were collected across 11 counties (Harris and surrounding) from 2020-11-23 to 2021-03-11
- Requires collaboration and agreements with well owners and operators (MUDs)
- Variety of well types including public supply, irrigation, industrial and observation
- Number of Chicot-Evangeline water-levels collected: **527**
- Number of Jasper water-levels collected: **105**
- Number of wells used to create 2021 Altitude maps
 - *Chicot-Evangeline: 434*
 - *Jasper: 93*

Stratigraphic cross section

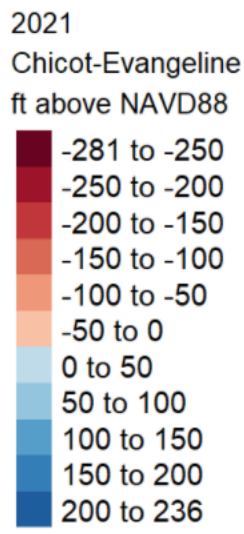


VERTICAL SCALE GREATLY EXAGGERATED

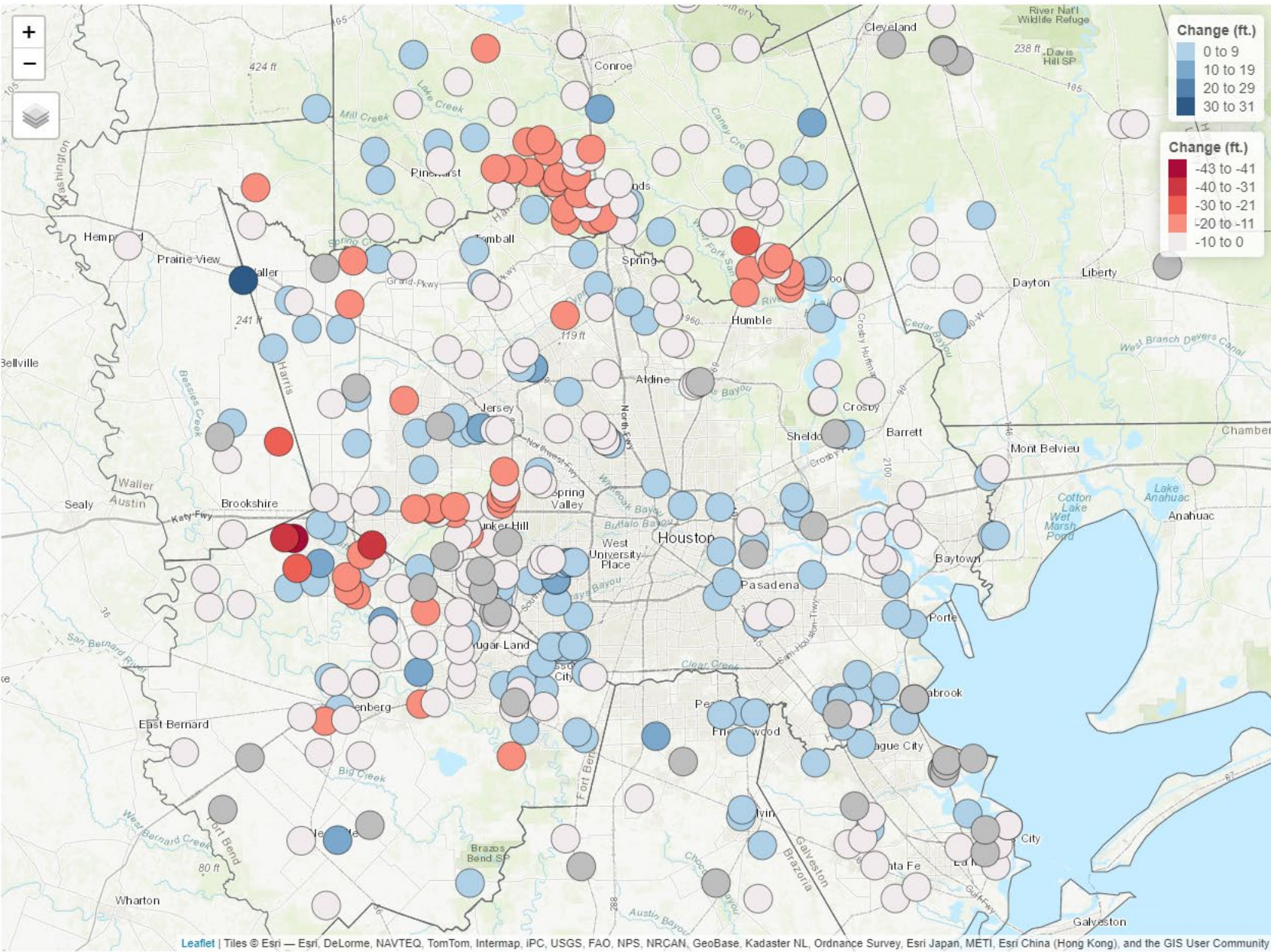
Chicot-Evangeline 2021 Altitude



- Data Summary:
Min : -281
Mean : -46
Max : 236
- Highest areas of usage in western Harris County, and the south-central portion of Montgomery County



Chicot-Evangeline 1 year change



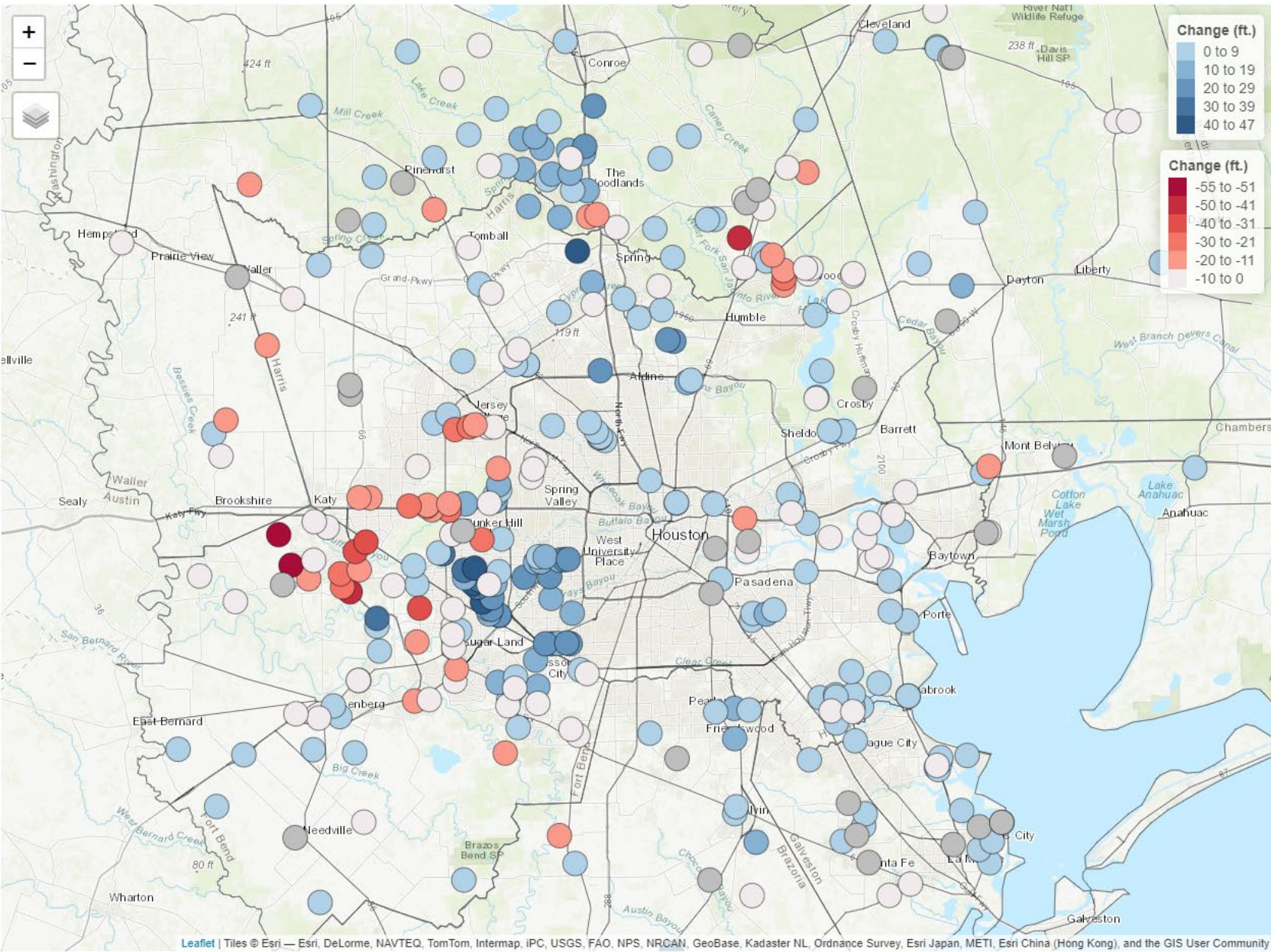
Number of wells: 409

Rises: 35.2%

Declines: 55%

No Change: 9.8%

Chicot-Evangeline 5 year change



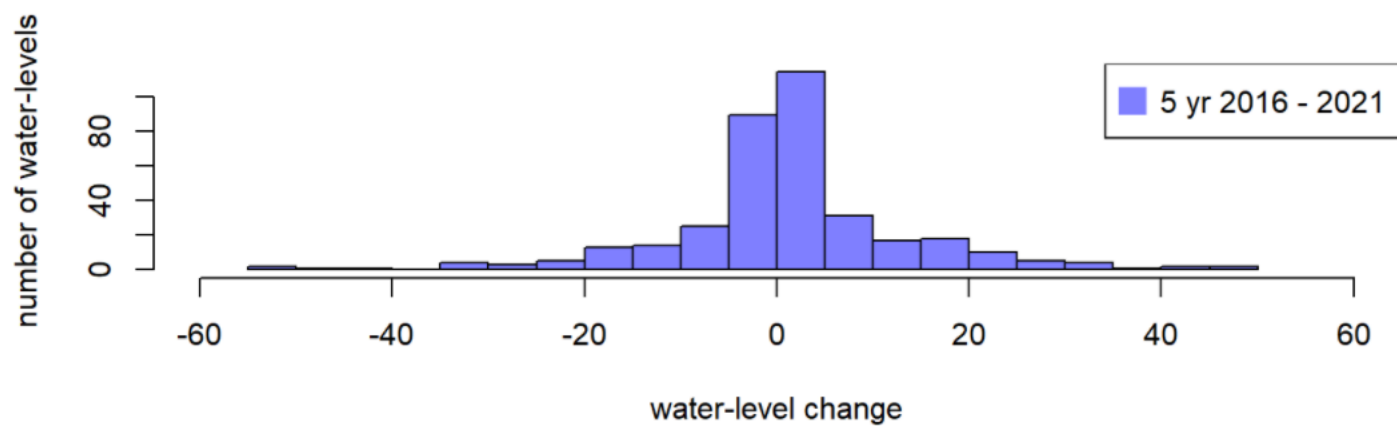
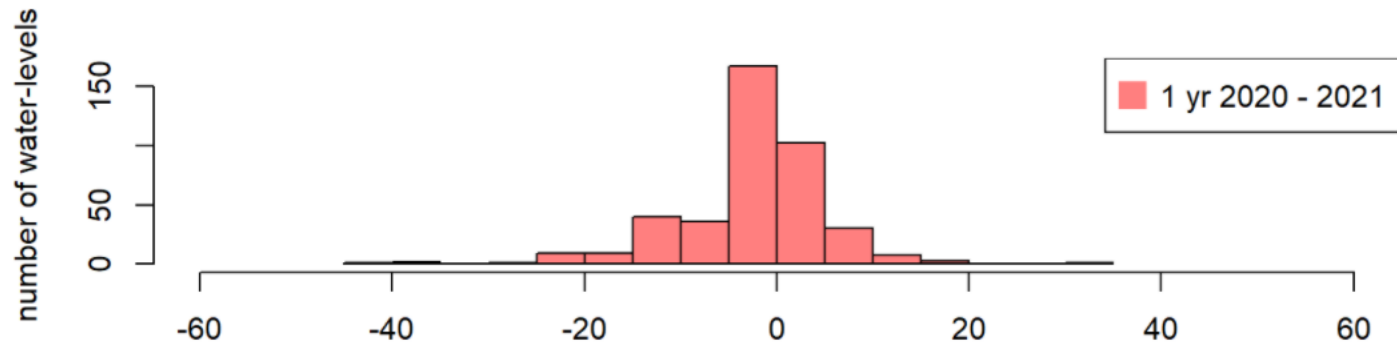
Number of wells: 361

Rises: 56.5%

Declines: 34.6%

No Change: 8.9%

Chicot-Evangeline 1 and 5 year comparison



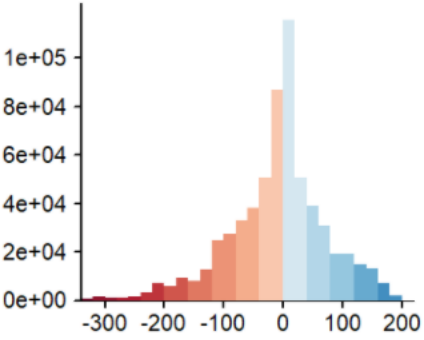
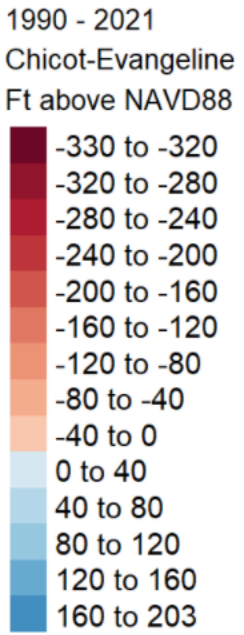
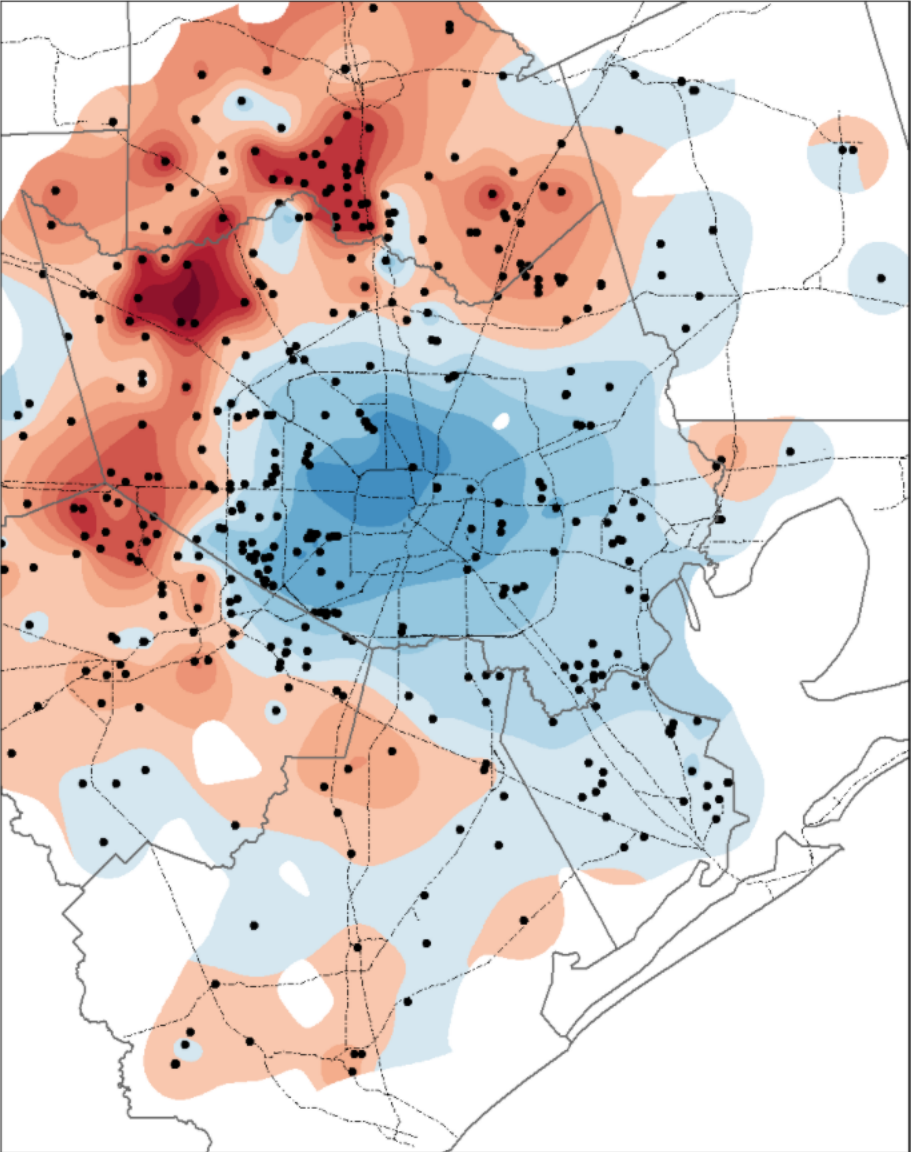
■ 2020 - 2021 Changes

- 35% rises, 55% declines, 10% no change
- ~ 41% (167) - declines in the 0 - 5 ft range
- ~ 25% (102) - rises in the 0 - 5 ft range

■ 2016 - 2021 Changes

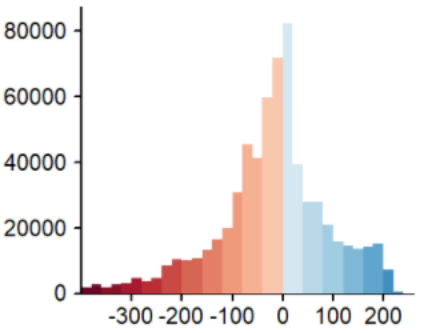
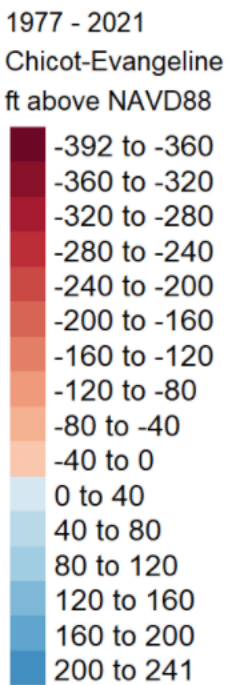
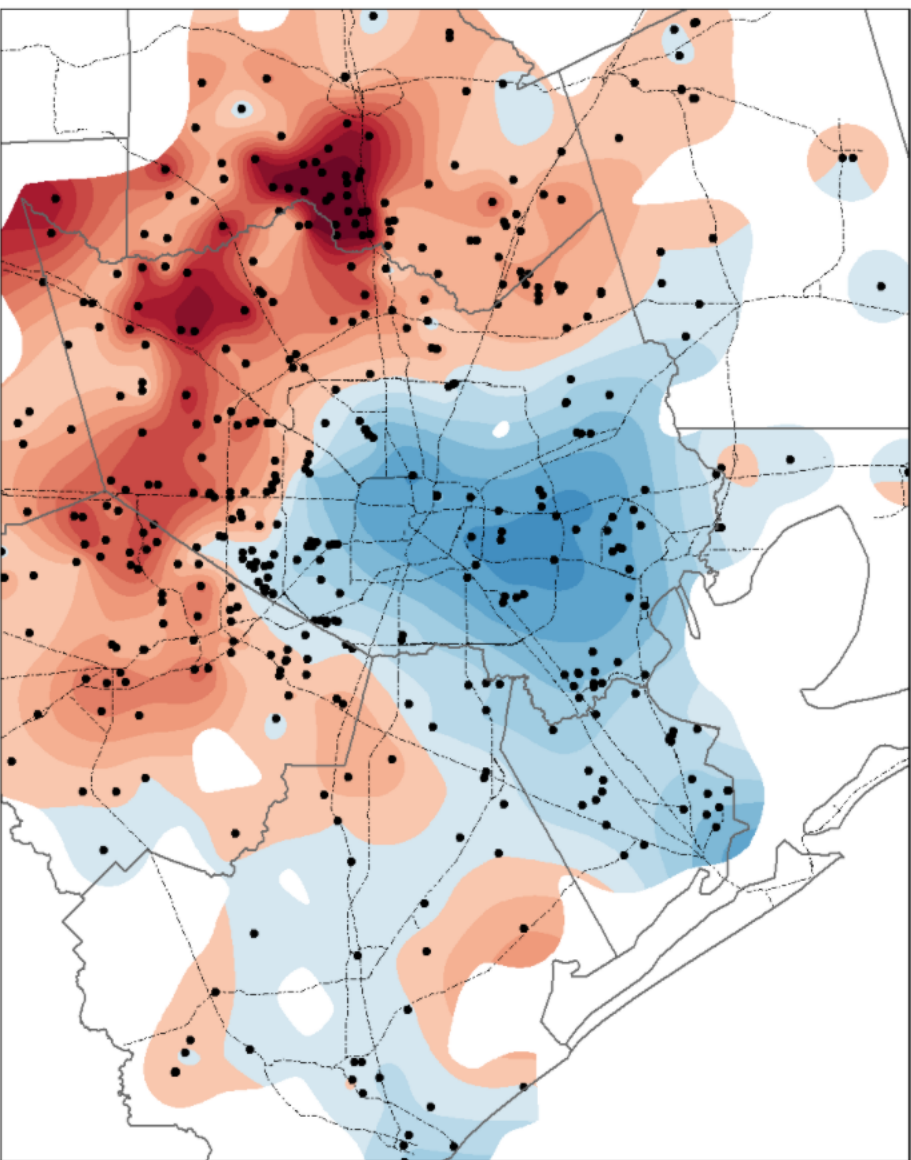
- 57% rises, 35% declines, 9% no change
- ~ 32% (114) - rises in the 0 - 5 ft range
- ~ 25% (89) - declines in the 0 - 5 ft range

Chicot-Evangeline water-level change since 1990



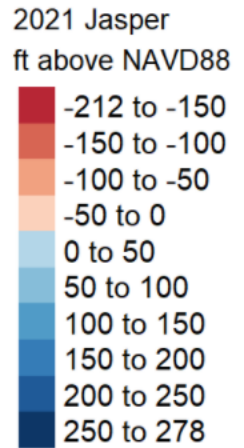
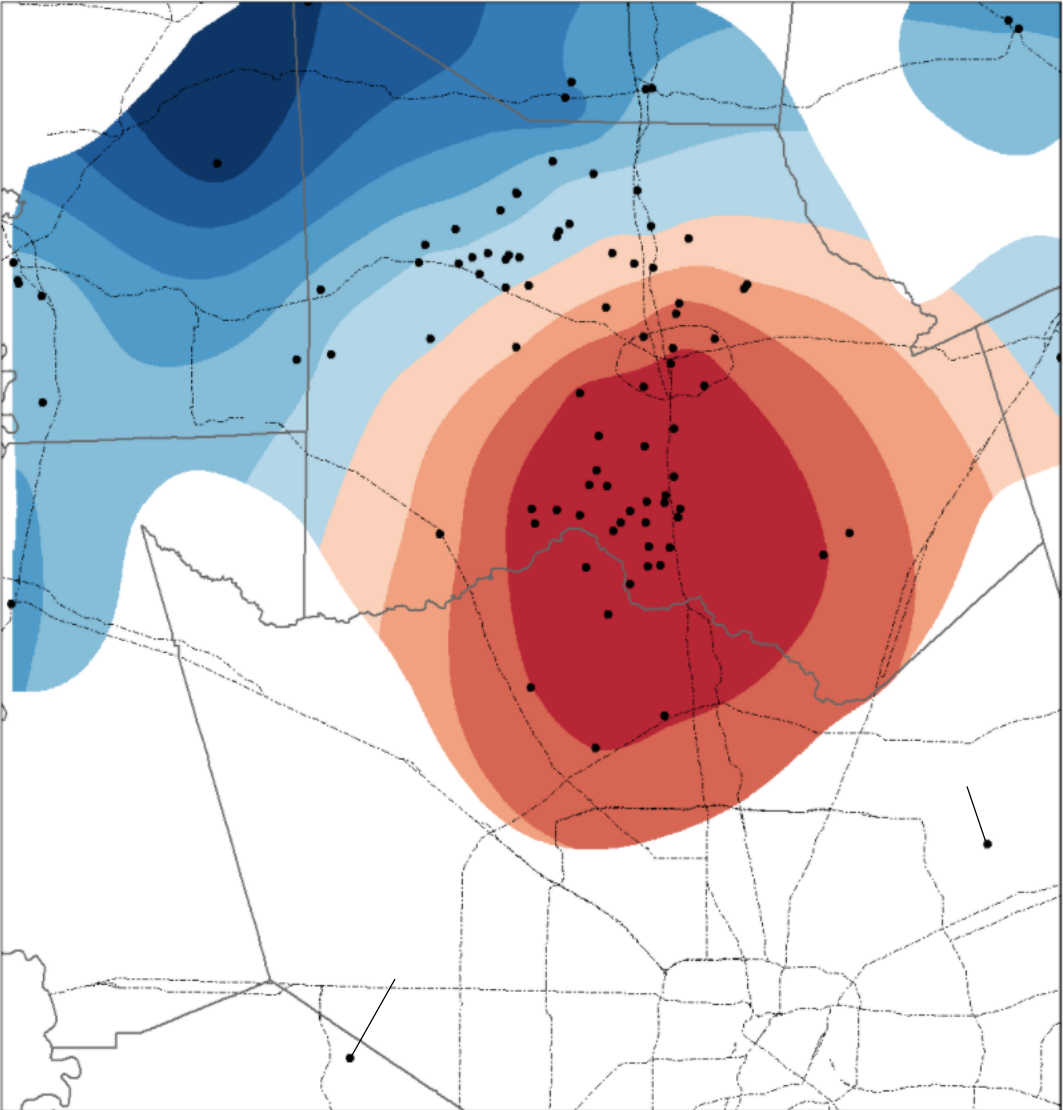
- Data Summary:
Min : -330
Mean : -9
Max : 203
- Water-level rises across most of central and eastern Harris County as well as Galveston and Brazoria Counties
- Water-level declines in the Northern part of Fort Bend County, NW portions of Harris County, and most of Montgomery County
- Data points are those that were collected this year (2021), and fall within the bounds of the overall mean variance for the 1990 **Chicot-Evangeline altitude**

Chicot-Evangeline water-level change since 1977



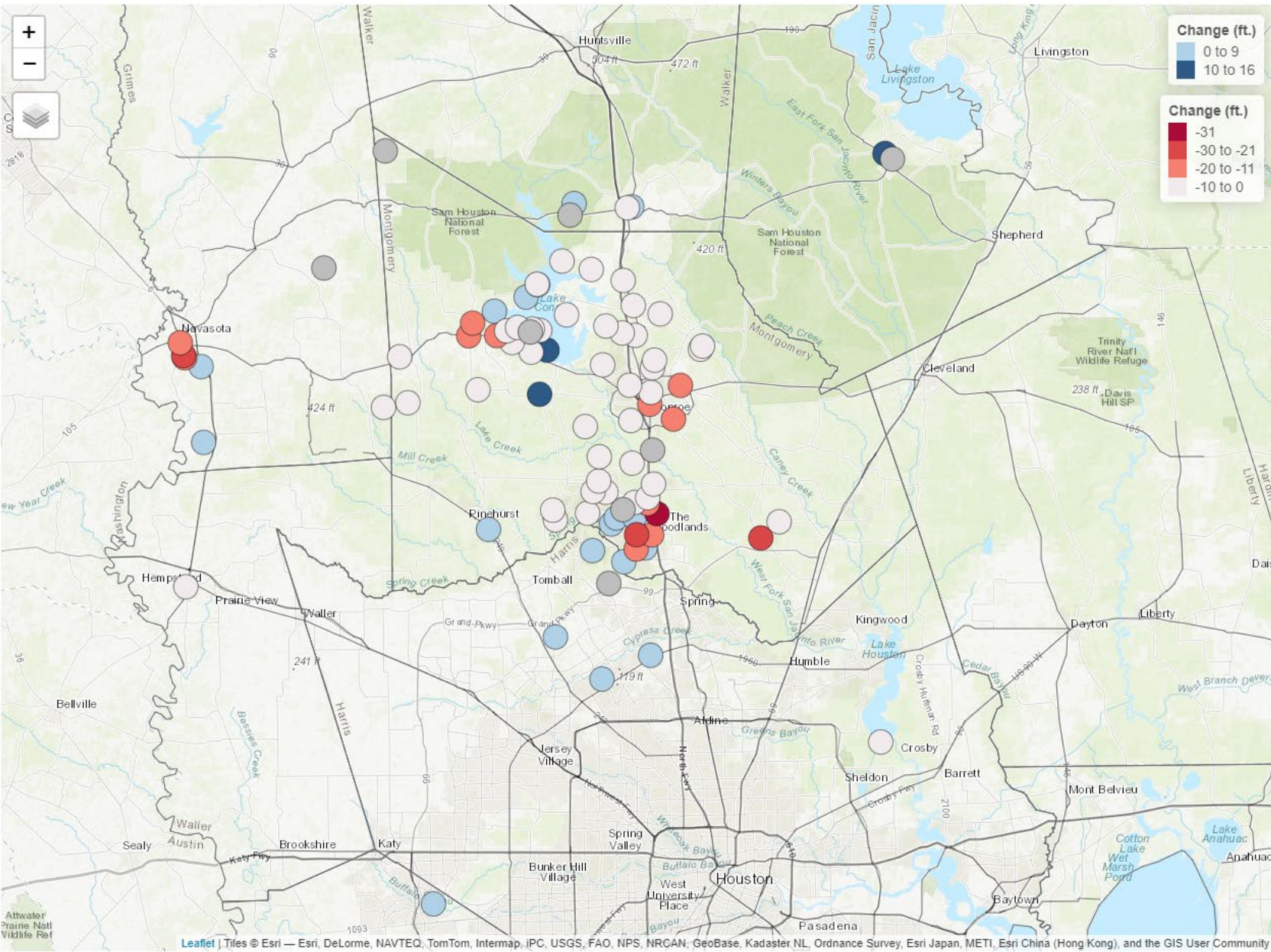
- Data Summary:
Min : -392
Mean : -19
Max : 241
- Water-level rises across most of central and eastern Harris County as well as Galveston County
- Water-level declines in the Northern part of Fort Bend County, NW portions of Harris County, and most of Montgomery County
- Data points are those that were collected this year (2021), and fall within the bounds of the overall mean variance for the 1977 Chicot-Evangeline altitude

Jasper 2021 Altitude



- Data Summary:
Min : -212
Mean : 2
Max : 278
- General trend of deepening water levels in downdip (NW - SE) direction
- Deepest water levels in south-central Montgomery County along border with Harris County

Jasper 1 year change



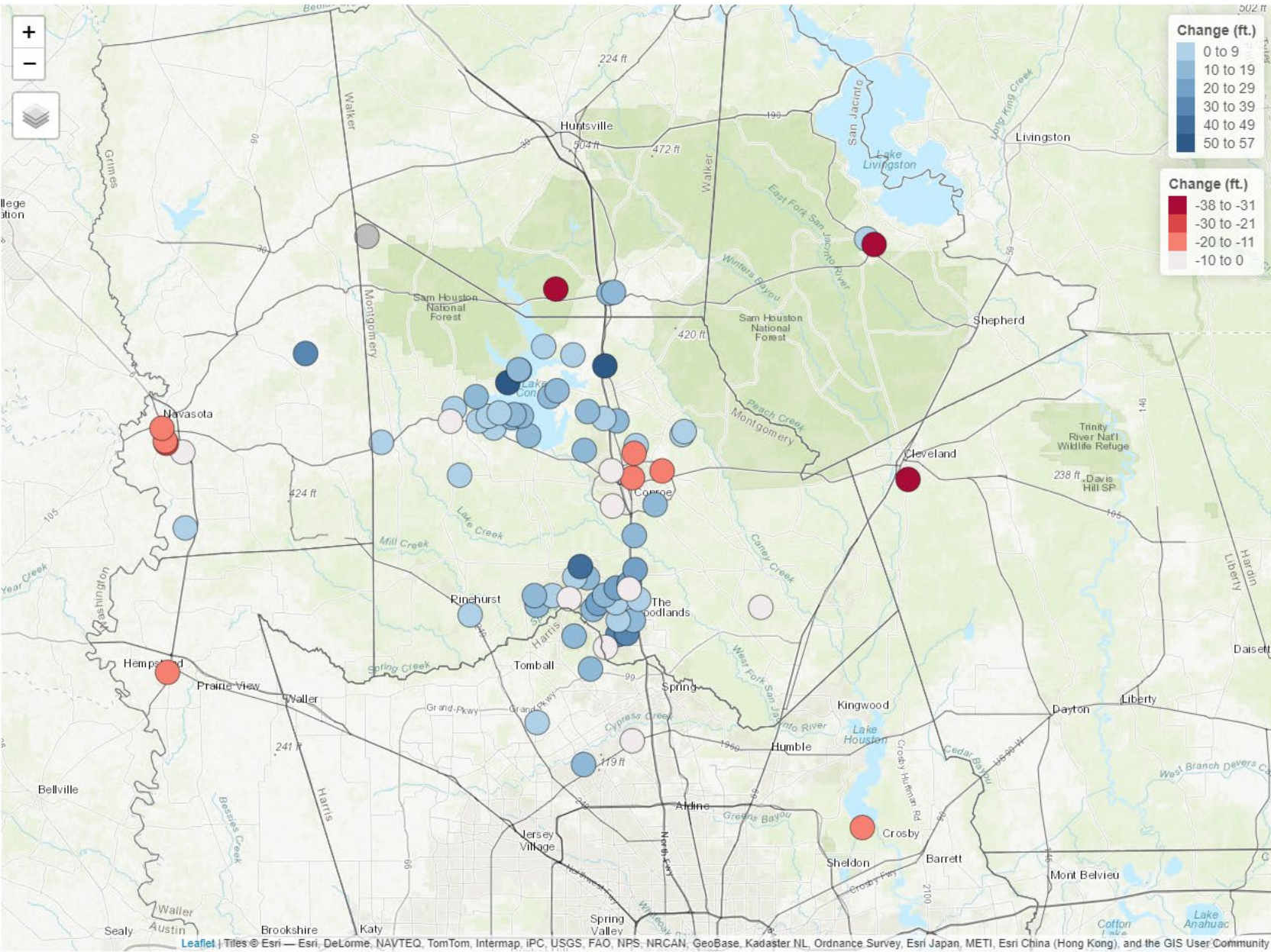
Number of wells: 88

Rises: 22.7%

Declines: 68.2%

No Change: 9.1%

Jasper 5 year change



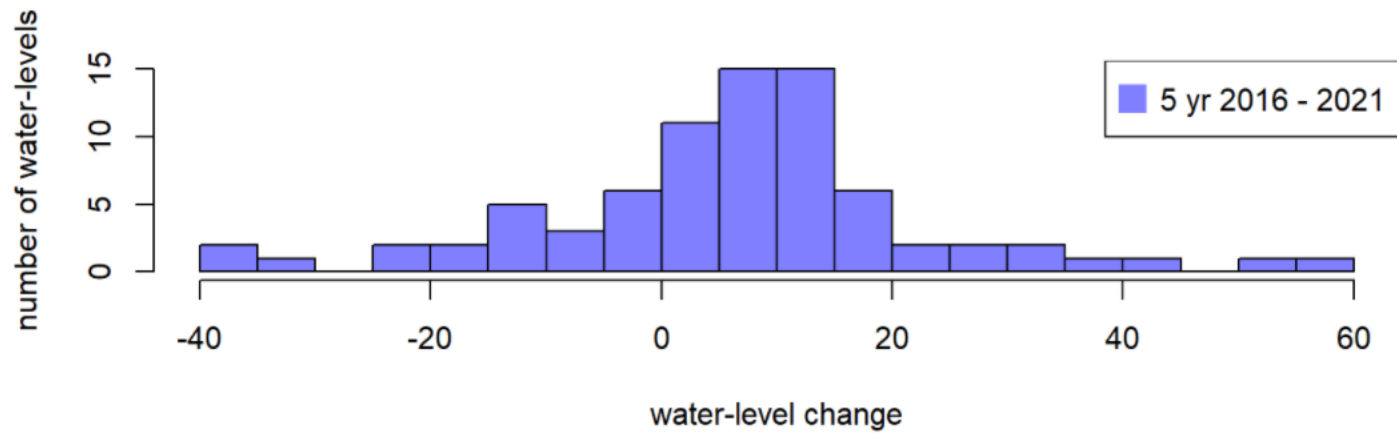
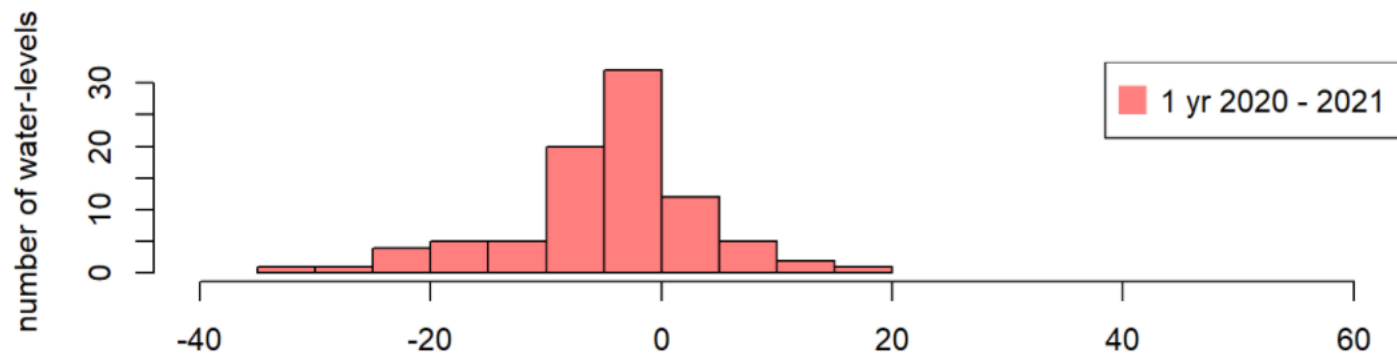
Number of wells: 78

Rises: 73.1%

Declines: 25.6%

No Change: 1.3%

Jasper 1 and 5 year change comparison



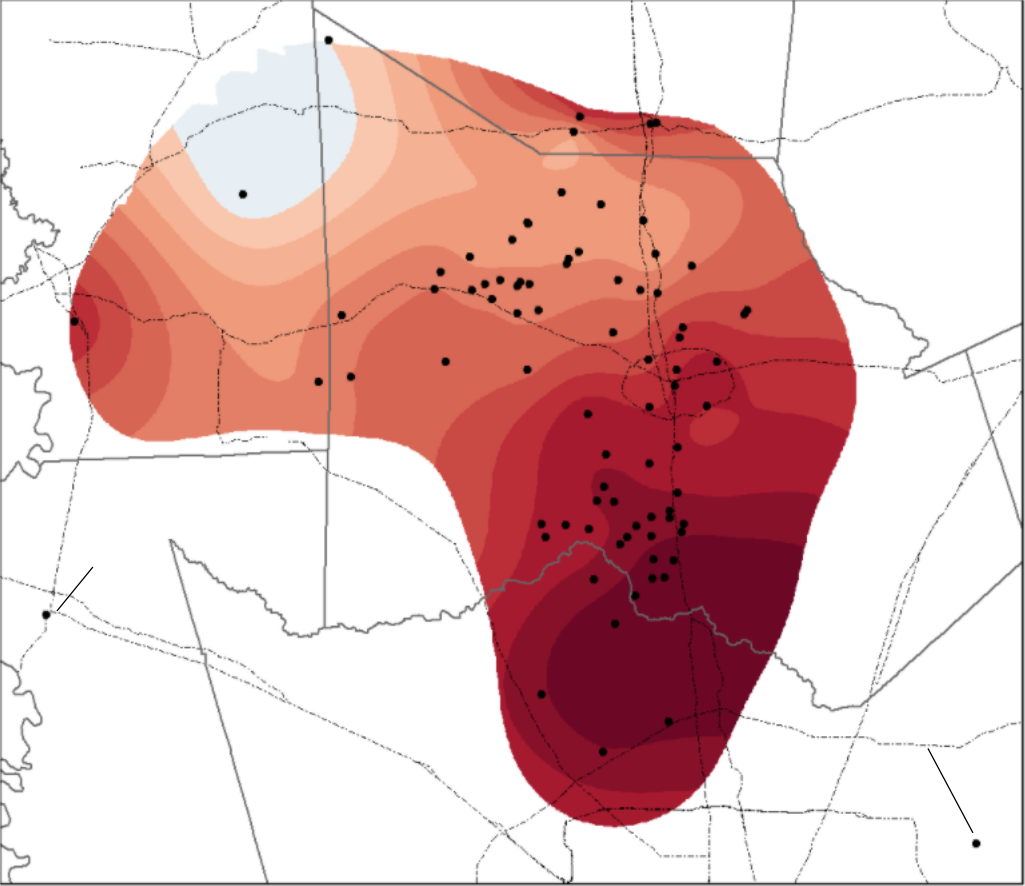
2020 - 2021 Changes

- *Primarily water-level declines (~ 67%)*
- *~ 37% (33) - declines in the 0 - 5 ft range*
- *~ 22% (20) - declines in the 6 - 10 ft range*

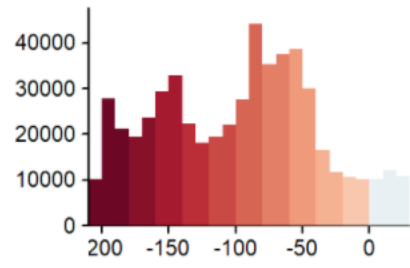
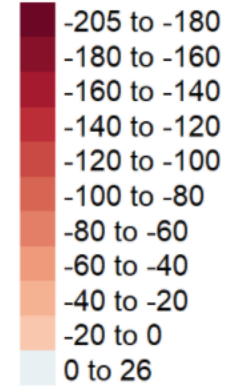
2016 - 2021 Changes

- *Primarily water-level rises (~ 73%)*
- *~ 65% (41) - rises in the 0 - 15 ft range*

Jasper water-level change since 2000

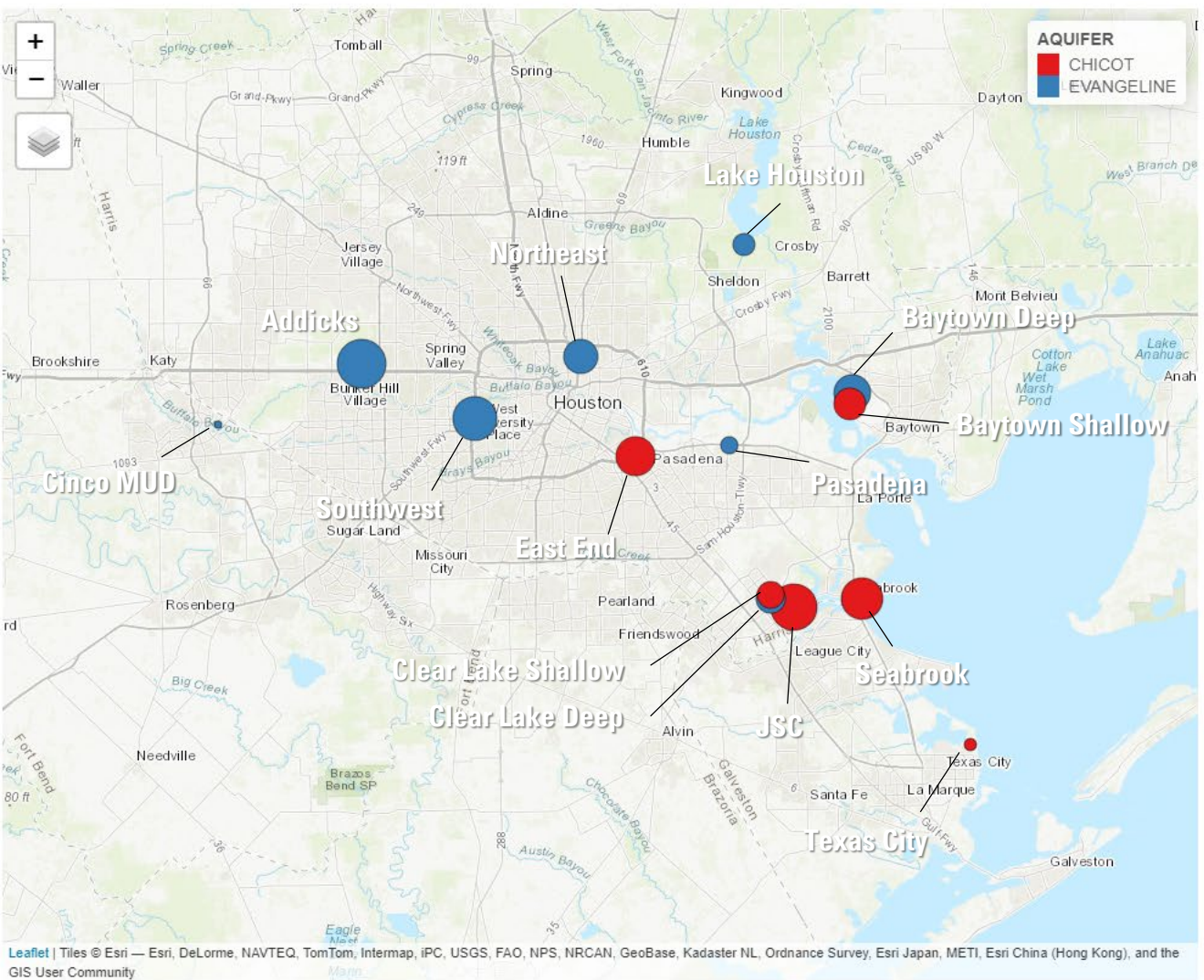


2000 - 2021 Jasper
ft above NAVD88



- Data Summary:
Min : -205
Mean : -98
Max : 26
- General trend of declining water levels in downdip (NW - SE) direction
- Area with greatest declines near Harris - Montgomery County border
- Data points are those that were collected this year (2021), and fall within the bounds of the overall mean variance for the 2000 Jasper altitude

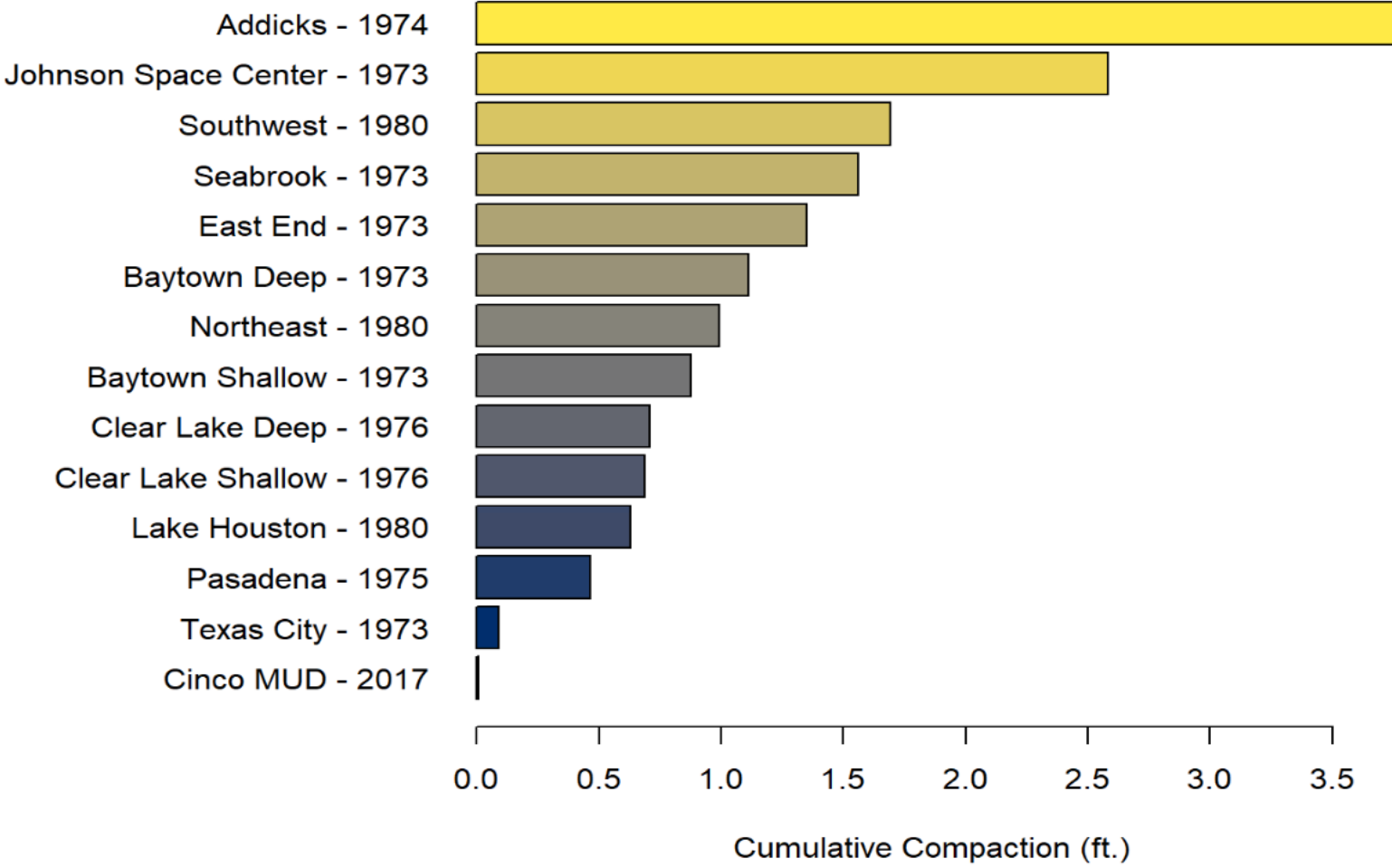
Compaction



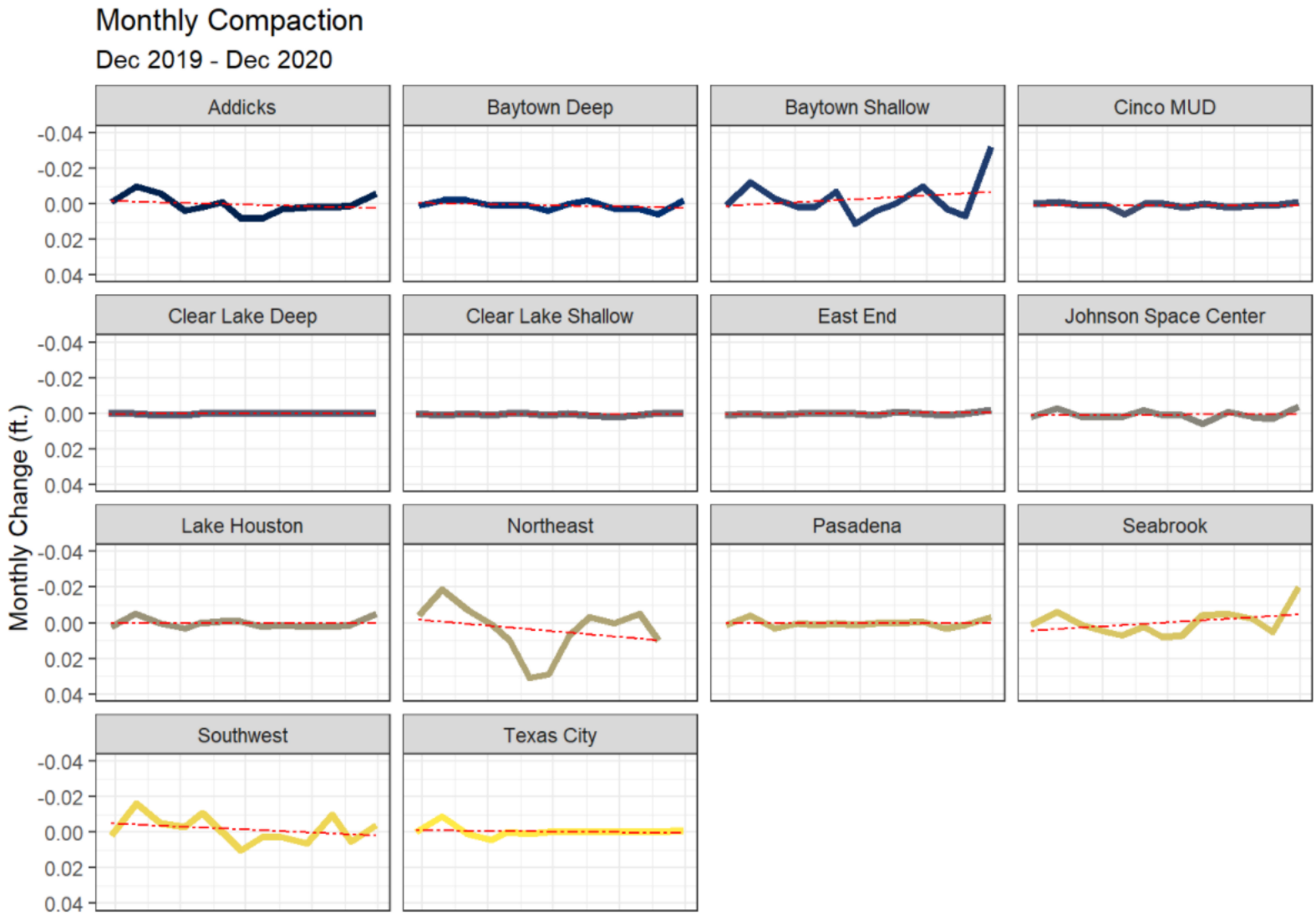
■ **Cumulative compaction recorded at each location as of December 2020**

- 1974-Addicks-3.760 ft.
- 1973-Baytown Deep-1.110 ft.
- 1973-Baytown Shallow-0.875 ft.
- 2017-Cinco MUD-0.006 ft.
- 1976-Clear Lake Deep-0.706 ft.
- 1976-Clear Lake Shallow-0.685 ft.
- 1973-East End-1.350 ft.
- 1973-Johnson Space Center-2.580 ft.
- 1980-Lake Houston-0.628 ft.
- 1980-Northeast-0.990 ft.
- 1975-Pasadena-0.464 ft.
- 1973-Seabrook-1.560 ft.
- 1980-Southwest-1.690 ft.
- 1973-Texas City-0.090 ft.

Compaction (cont.)



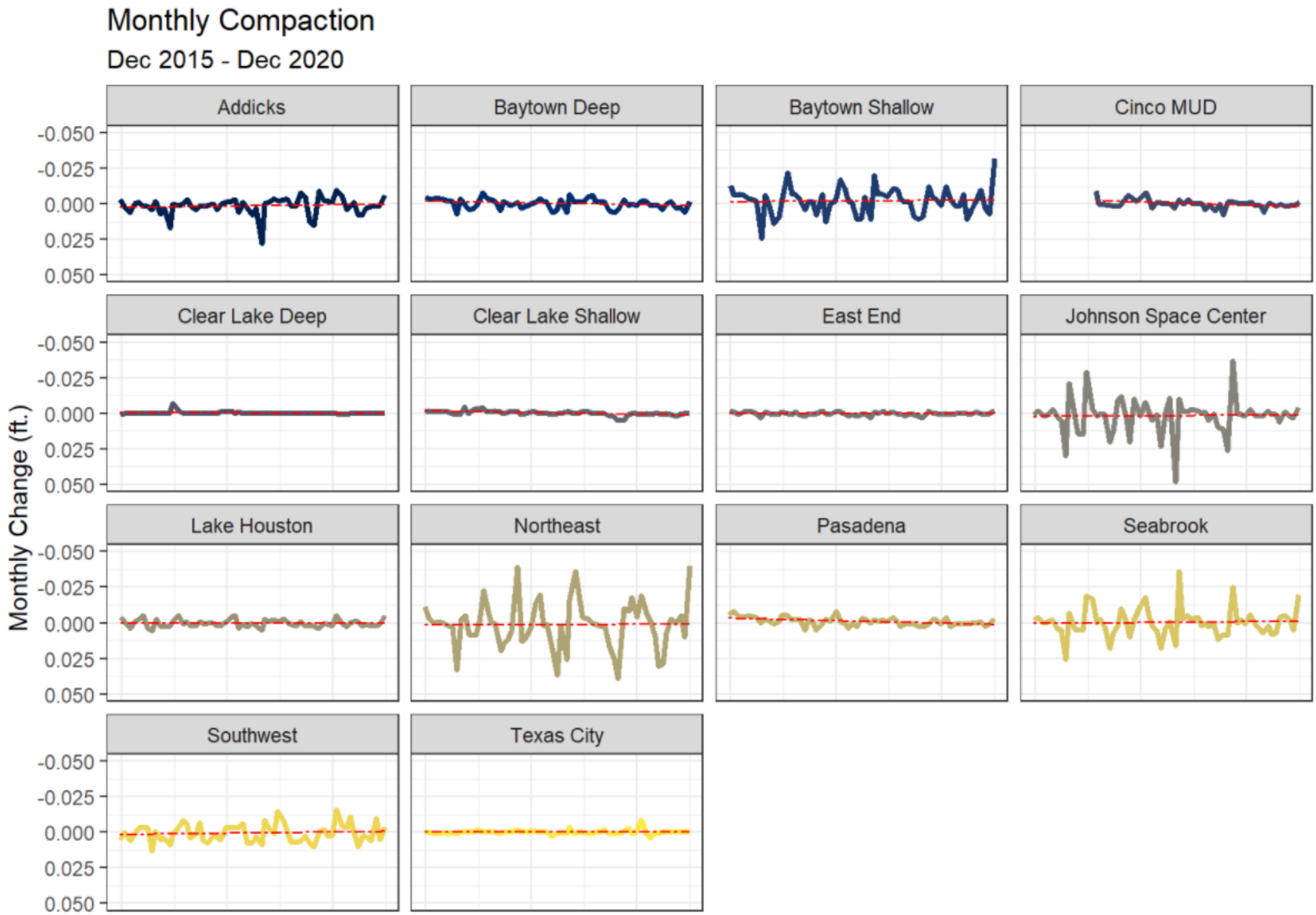
Compaction 1 year monthly changes



- Slight increase (compaction) in trend
 - Addicks
 - Northeast
 - Southwest
 - Baytown Deep
- Slight decrease (uplift) in trend
 - Baytown Shallow
 - Seabrook

Monthly change in land surface elevation at each location

Compaction 5 year monthly changes

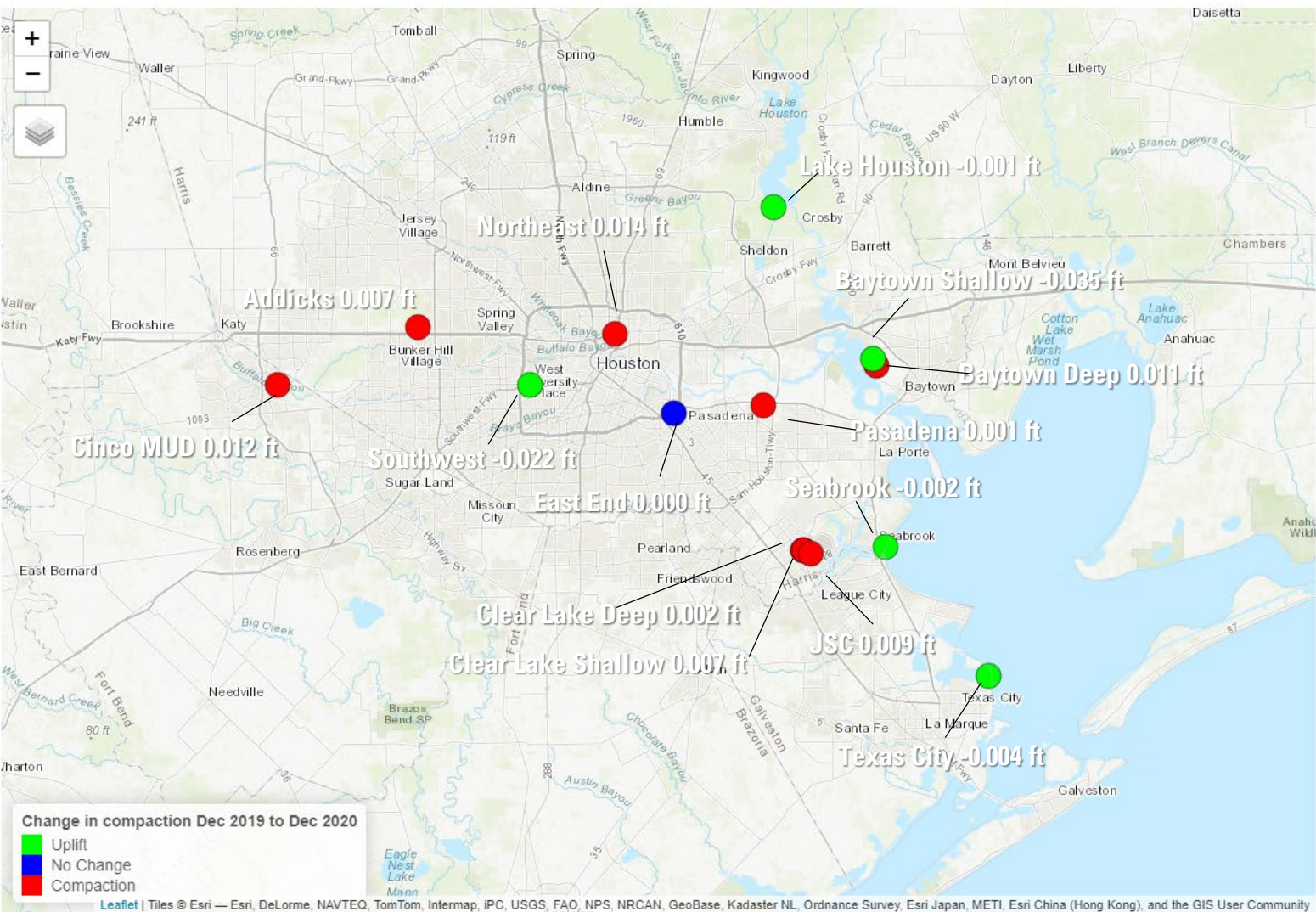


- Slight increase (compaction) in trend
 - Pasadena
 - Cinco MUD

- Slight decrease (uplift) in trend
 - Addicks
 - Seabrook
 - Baytown Shallow

Monthly change in land surface elevation at each location

Summary: Compaction



Absolute changes for the period December 2019 through December 2020, in ft.

- 5 sites recorded uplift ranging from 0.001 ft. to 0.035 ft.
- 8 sites recorded compaction ranging from 0.001 ft. to 0.014 ft.
- 1 site recorded no change

2021 Water-Level Altitude Map Series

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Christopher Braun, Hydrologist | Groundwater Specialist - clbraun@usgs.gov

John Ellis, Hydrologist | Studies Chief - jellis@usgs.gov



Fort Bend
Subsidence District



Brazoria County
Groundwater Conservation District

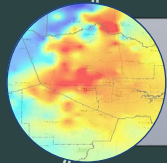
Agenda



Climate



Groundwater Use



Groundwater Levels



Subsidence Data



Subsidence Measurement Method

Global positioning system (GPS) station P051, located in Humble, is constructed in the Port-a-Measure (PAM) design and collects GPS data periodically.

Exhibit 10

Subsidence Monitoring Network

Location and operator of GPS stations that monitor land-surface elevation periodically or continuously within the greater Houston-Galveston region 2020.

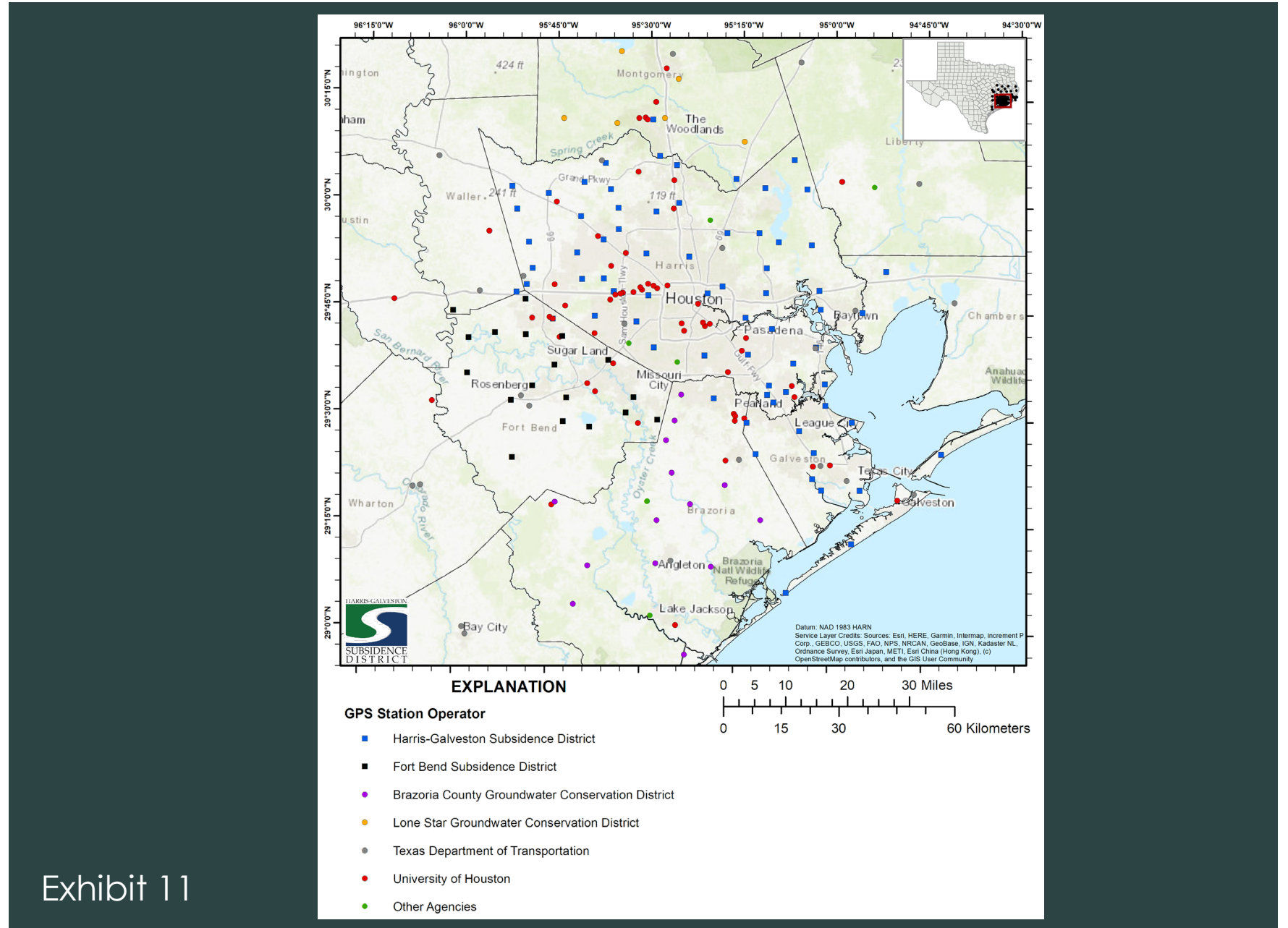


Exhibit 11

Annual Subsidence Rate

Annual subsidence rate, in centimeters per year (cm/yr), measured at GPS stations with three more years of periodic or continuous GPS data in Harris and Surrounding Counties, Texas, 2016-2020.

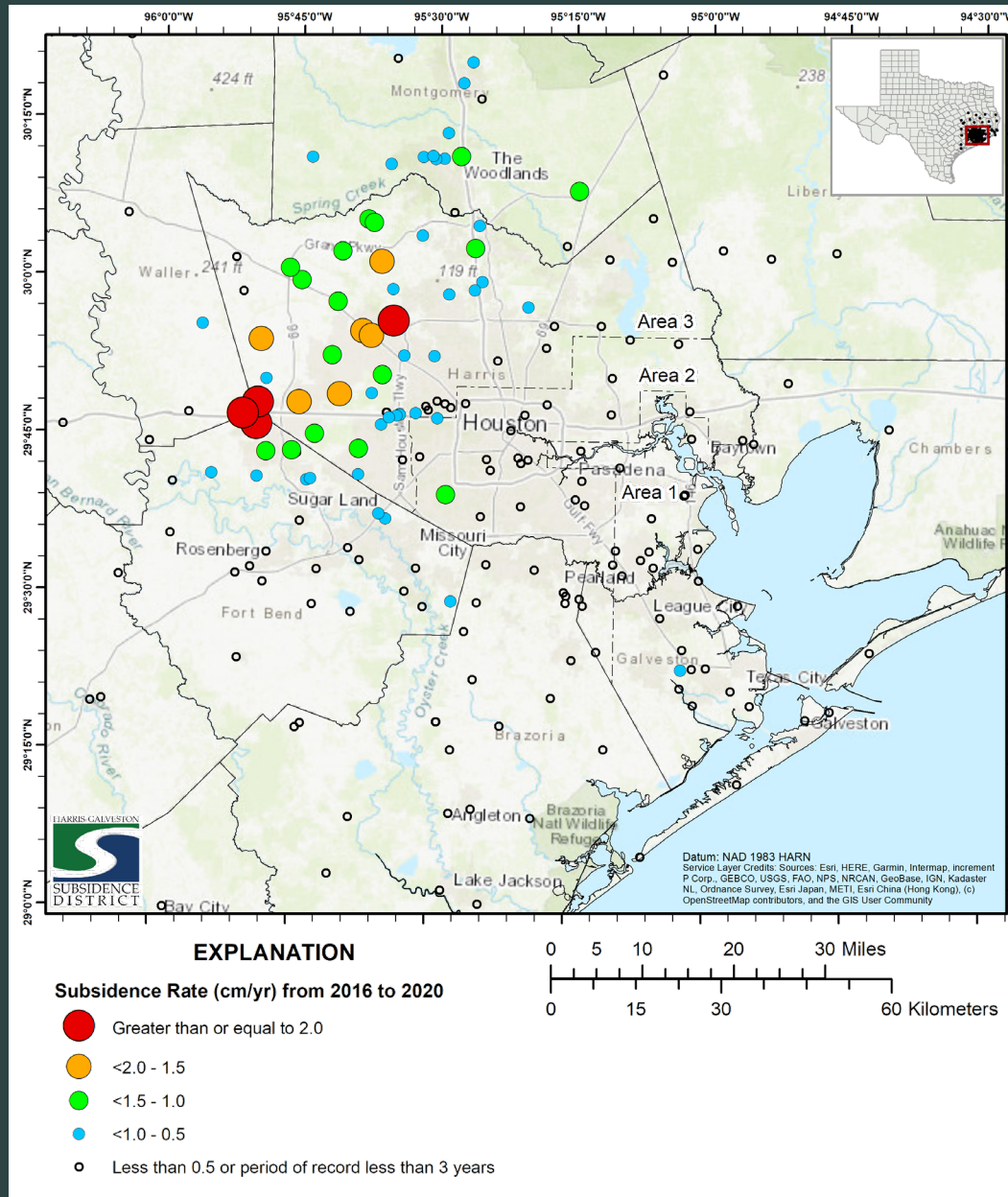


Exhibit 12

Regulatory Area One

Annual subsidence rate (cm/yr) estimated from three or more years of periodic or continuous GPS data measured at GPS stations in Harris and Galveston Counties, Texas, 2016-2020.

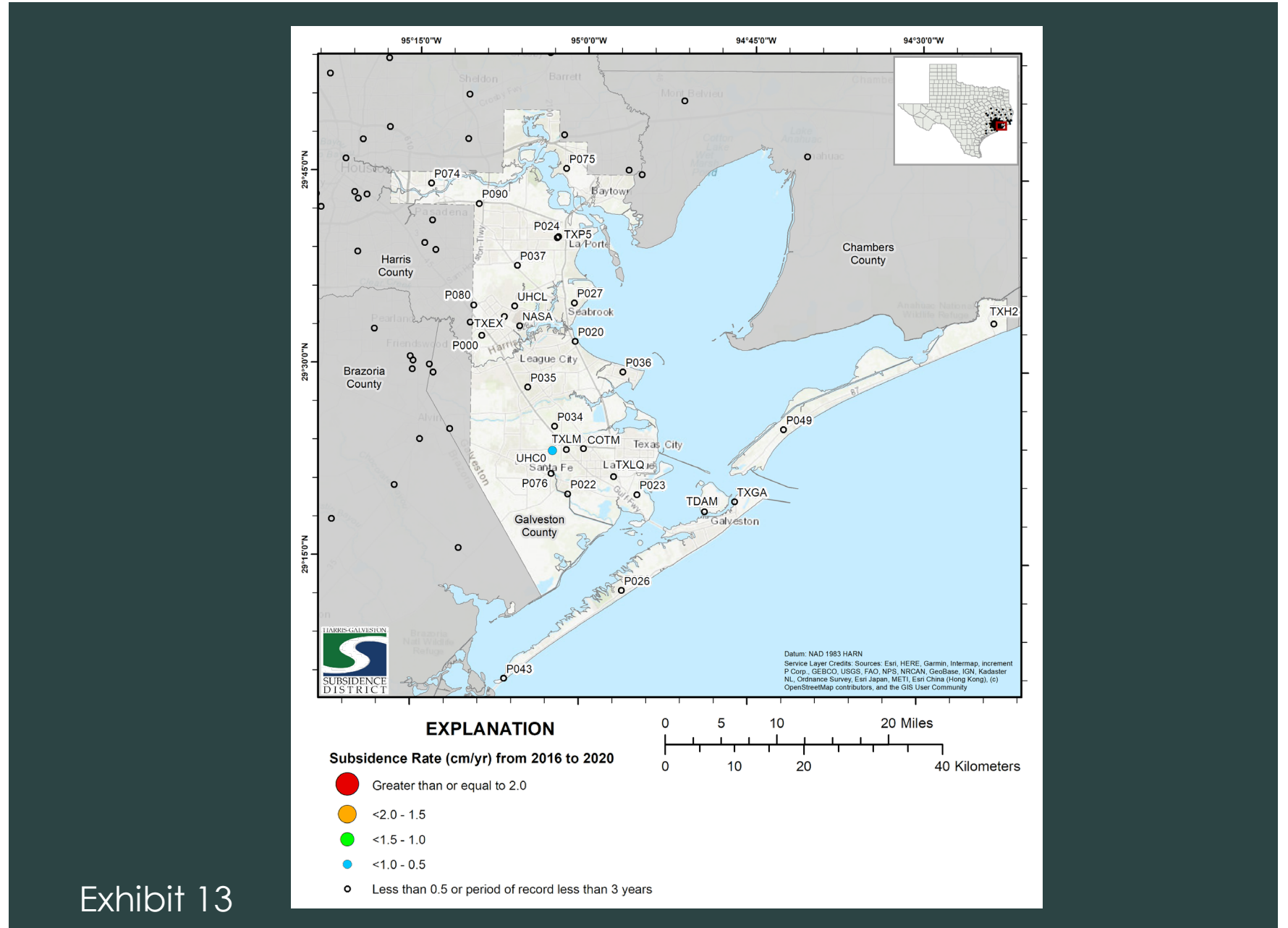


Exhibit 13

P035 Period of Record Plot

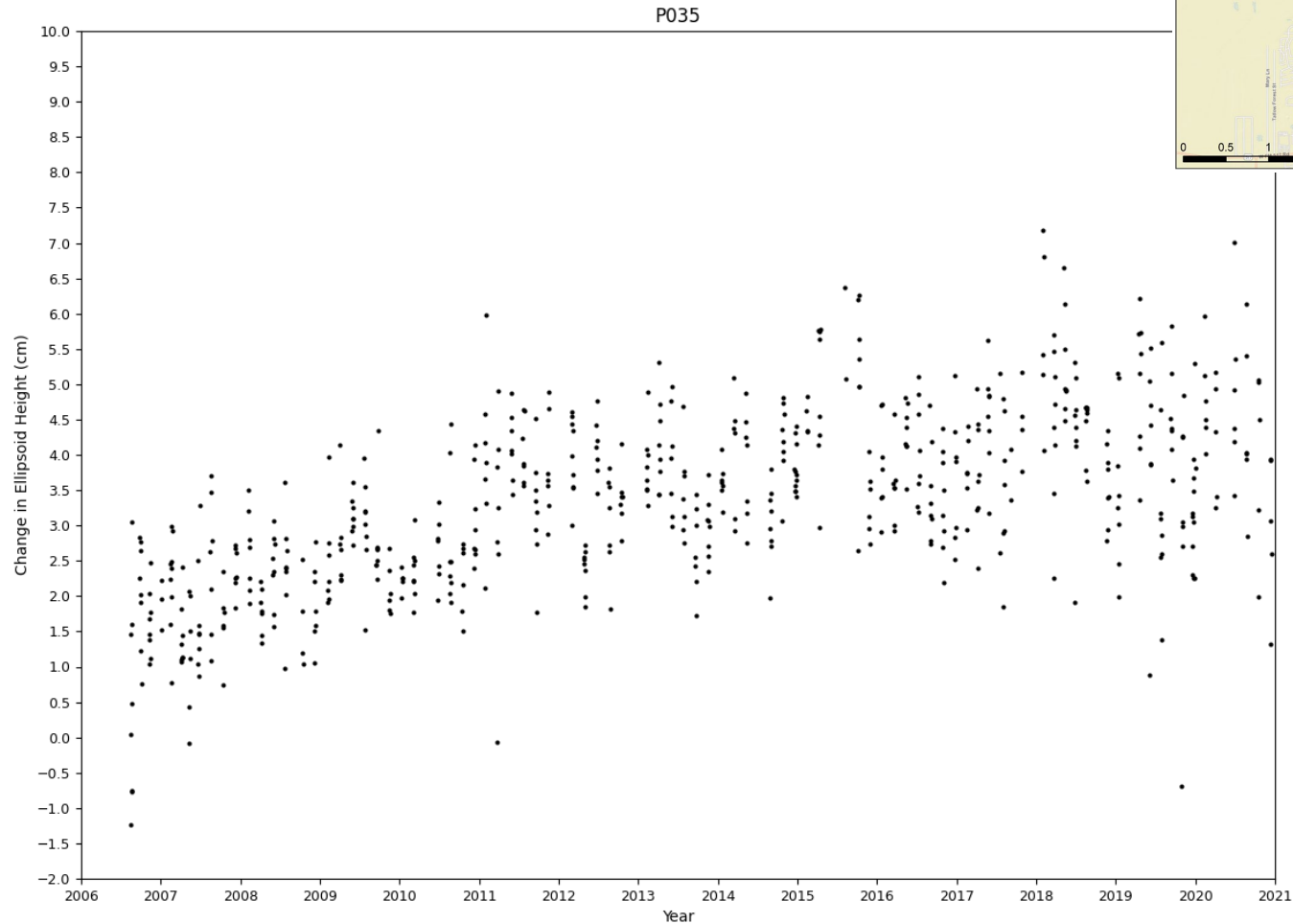


Exhibit 14

GPS station P035, located in Dickinson, shows a generally flat trend with approximately 4 cm of uplift over 14 years.

Regulatory Area Two

Annual subsidence rate (cm/yr) estimated from three or more years of periodic or continuous GPS data measured at GPS stations in Harris and Galveston Counties, Texas, 2016 - 2020.

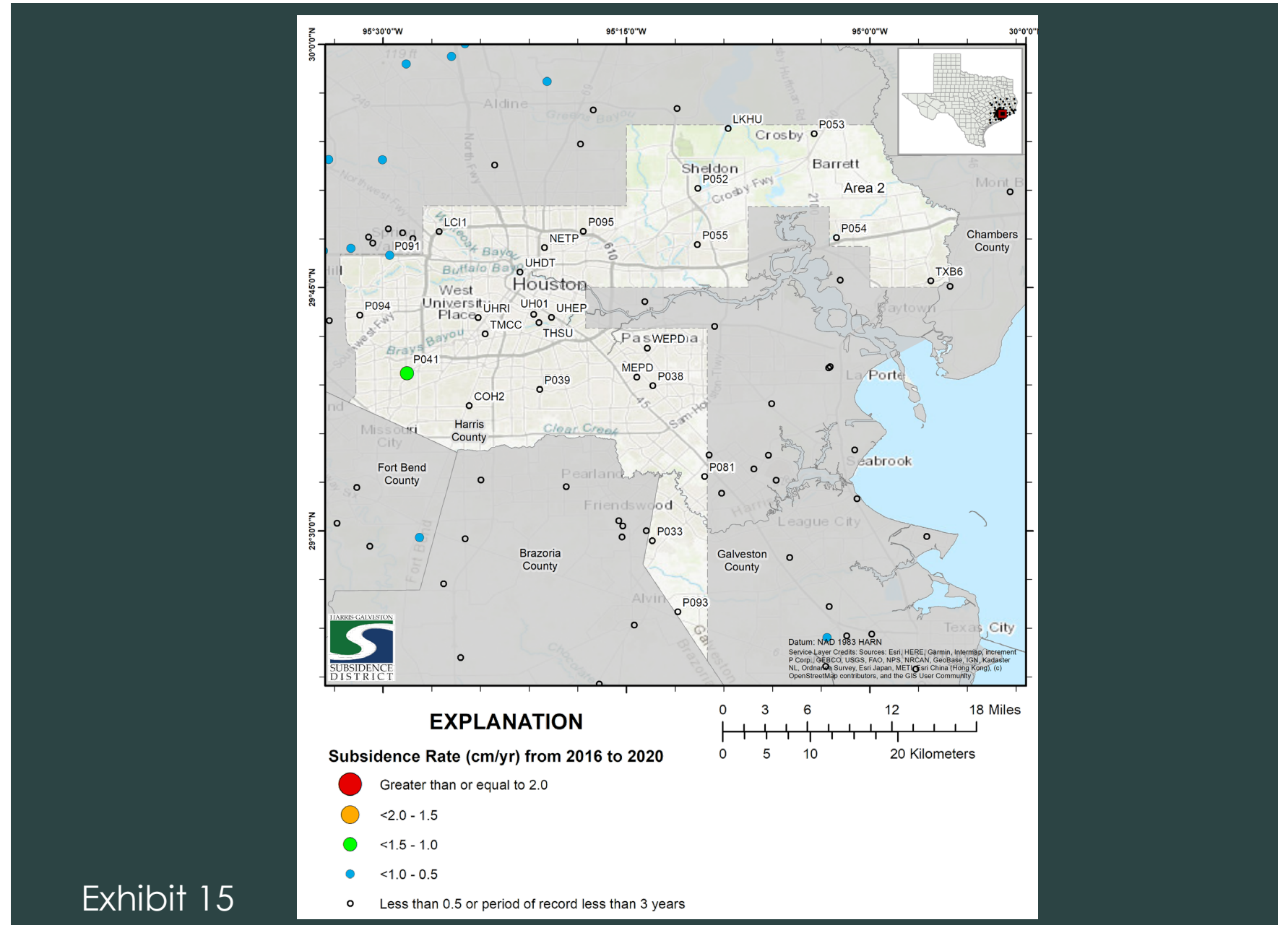


Exhibit 15

P041 Period of Record Plot

GPS station P041, located in the Brays Oak District, has measured about 9 cm of subsidence since 2007.

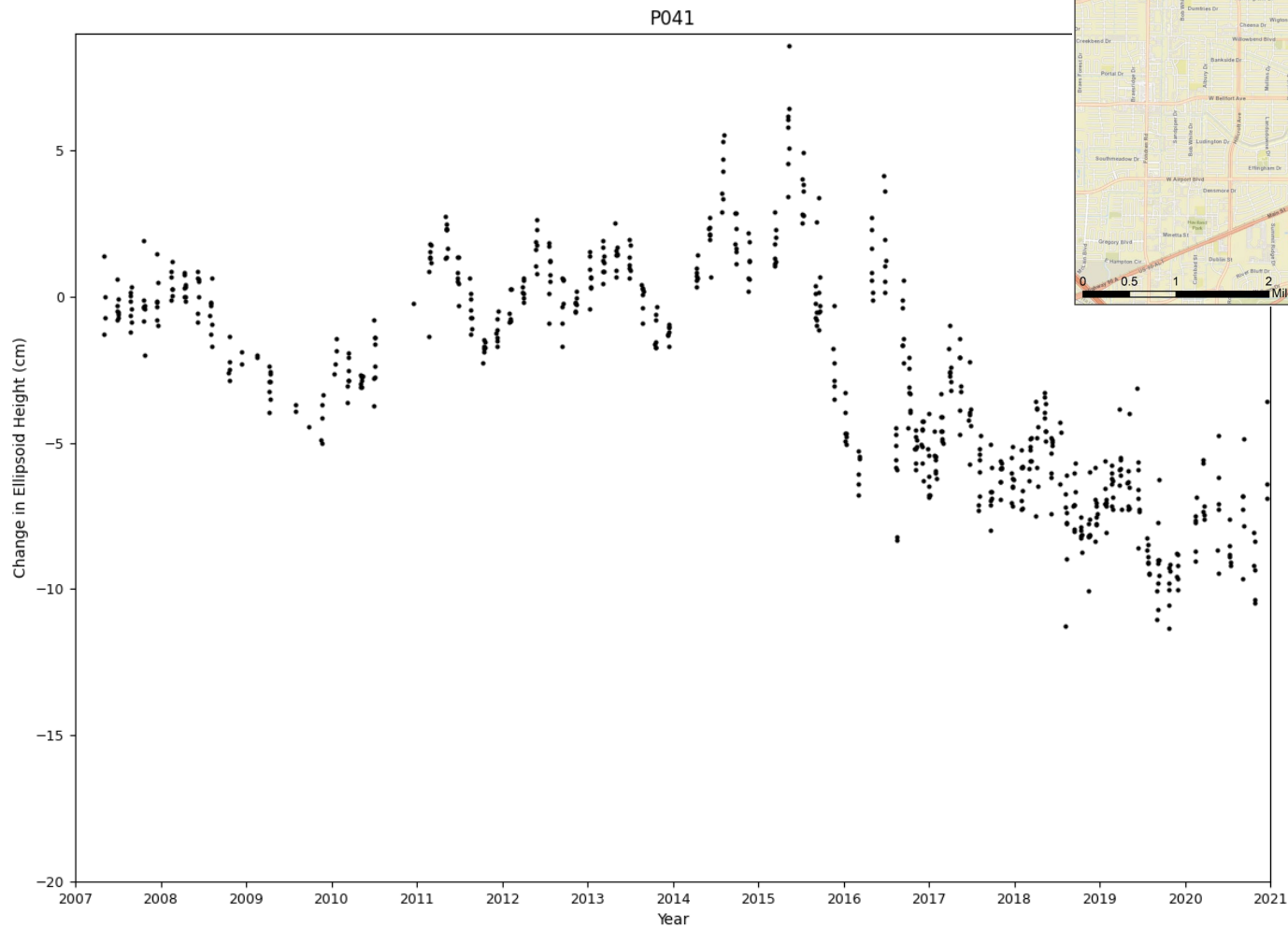
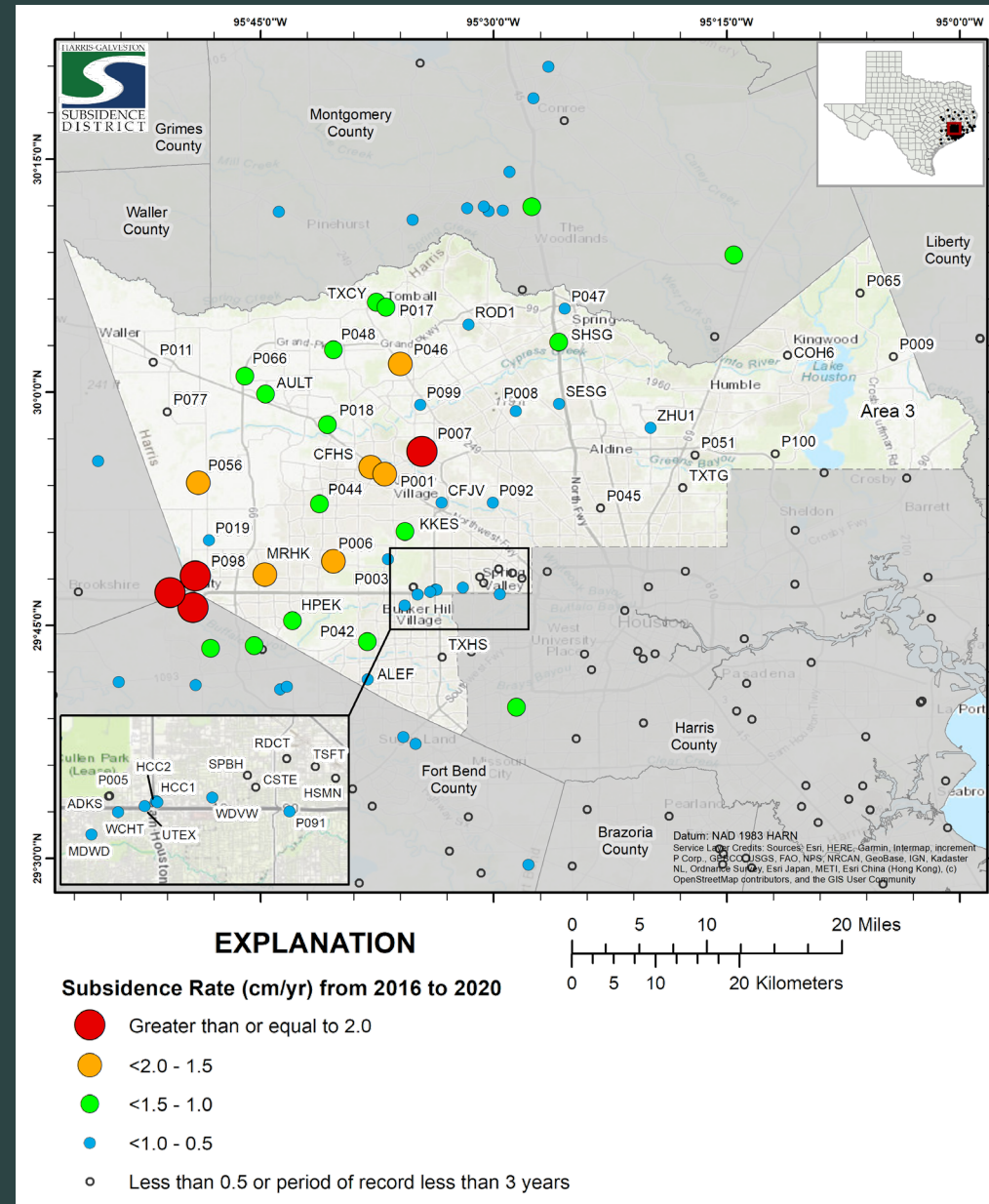


Exhibit 16

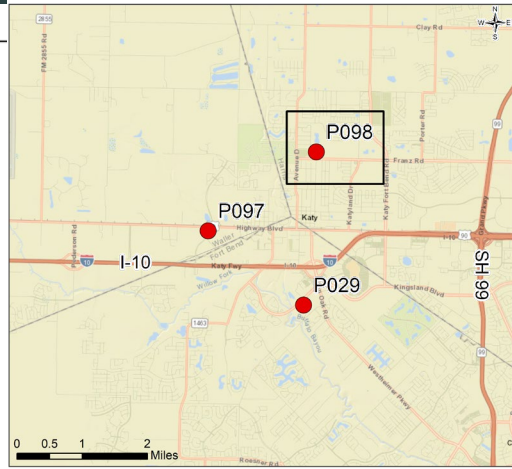
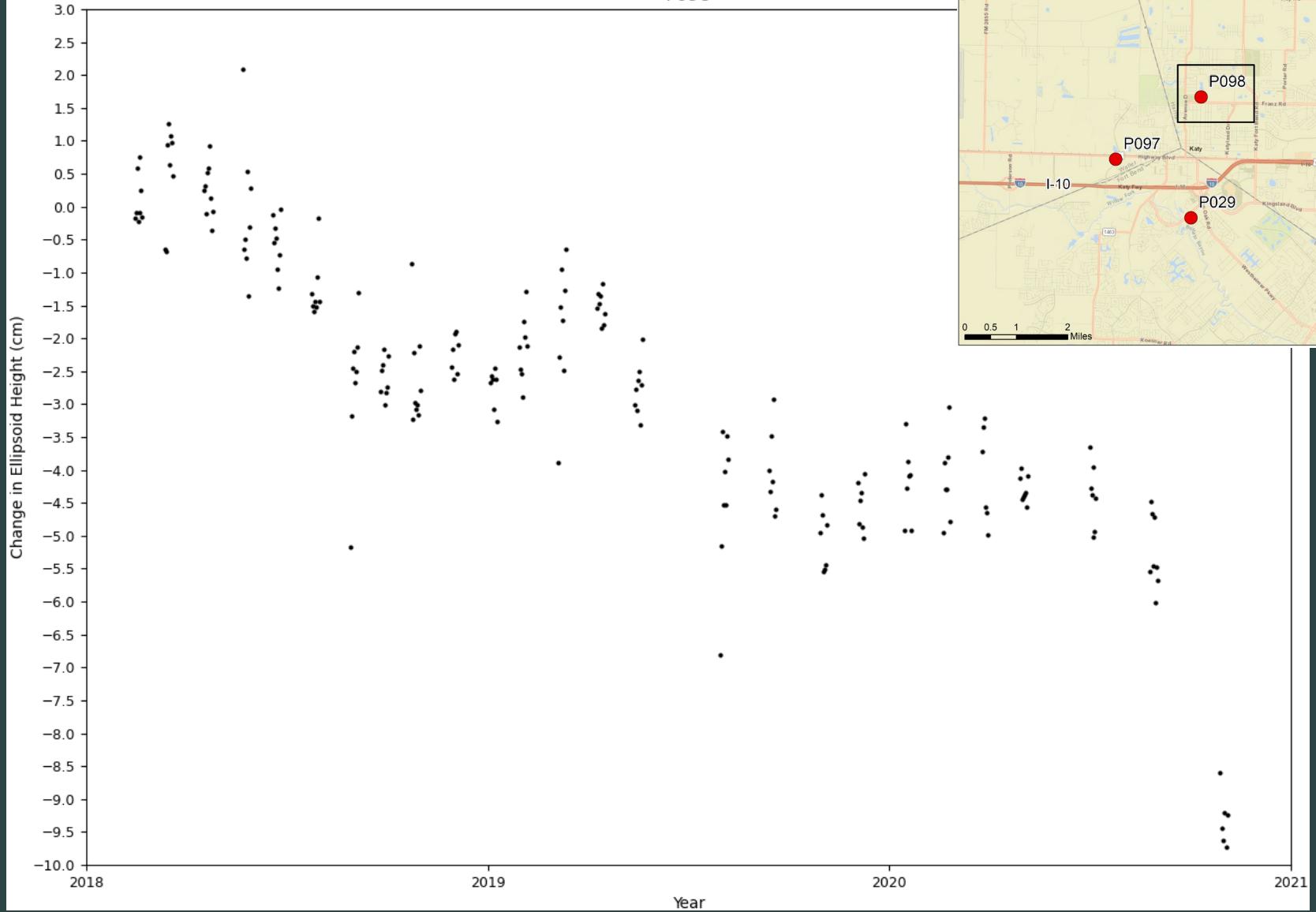


Regulatory Area Three

Annual subsidence rate (cm/yr) estimated from three or more years of periodic or continuous GPS data measured at GPS stations in Harris County, Texas, 2016-2020.



P098



P098 Period of Record Plot

GPS station P098, located in Katy, has subsided about 6 cm since 2018.

Exhibit 18



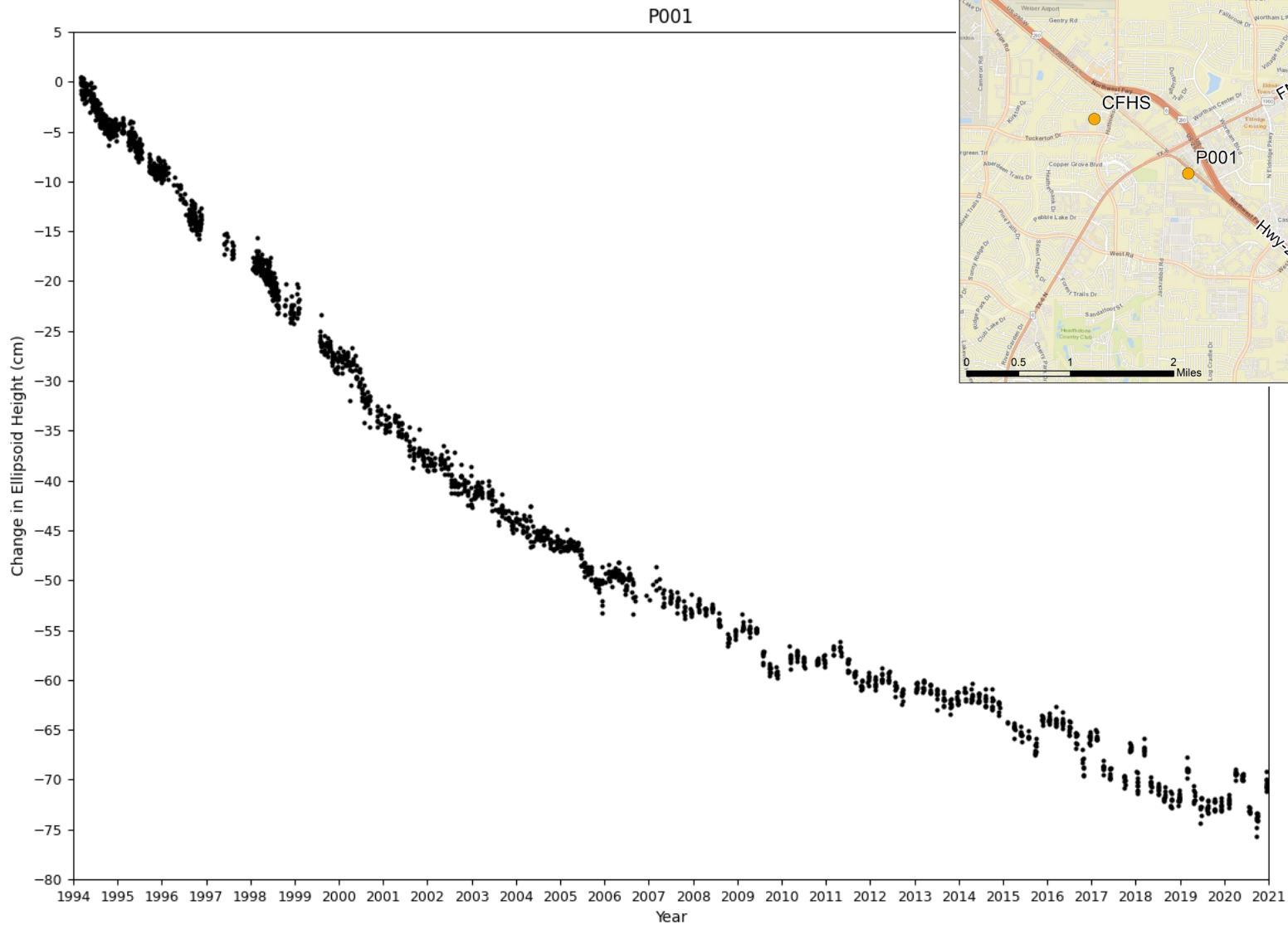


Exhibit 19

P001 Period of Record Plot

GPS station P001, located in Jersey Village, has the greatest subsidence measuring about 71 cm since 1994.



Testimony and Public Comment

- Any person who wishes to appear at the hearing and present testimony, evidence, exhibits or other information may do so in person, by counsel, via email to info@subsidence.org or any combination of these.

Thank you for attending the Public Hearing for the 2020 Annual Groundwater Report

- Record will be open until May 6, 2021. You may provide comments by sending an email to info@subsidence.org.
- The 2020 Annual Groundwater Report will be presented to the Harris-Galveston Subsidence District Board of Directors on May 12, 2021.
- The 2020 Annual Groundwater Report will be posted on the District's website once approved by the District's Board of Directors.



2020 ANNUAL GROUNDWATER REPORT

Public Hearing – April 29, 2021