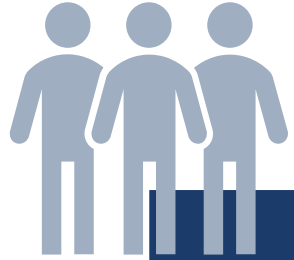


Welcome to the Public Hearing for the 2023 Annual Groundwater Report



IN-PERSON ATTENDEES

- Check to make sure your mobile devices are muted.
- This board room is equipped with microphones that will be recording throughout the entirety of the hearing. Please be mindful of this to not disturb the audio for our virtual attendees.
- Public testimony and Q&As will be available at the end of this hearing.



VIRTUAL ATTENDEES

- Virtual attendees will be muted for the entirety of the hearing.
- The webinar will be recorded, including all chat between participants.
- For audio/visual issues, please chat with the organizer.

HARRIS-GALVESTON



SUBSIDENCE
DISTRICT

2023 Annual Groundwater Report

Public Hearing - April 25, 2024

DRAFT REPORT

Harris-Galveston Subsidence District

The Harris-Galveston Subsidence District (HGSD) is a special-purpose district created by the Texas Legislature in 1975 to prevent further land subsidence in Harris and Galveston counties.



GROUNDWATER REGULATION

- Collaborating with local groundwater conservation districts, regional water providers, and other water agencies to manage groundwater use through water planning and well permitting.

SCIENCE & RESEARCH

- Utilizing the highest quality data and research to monitor groundwater usage, aquifer characteristics, and land surface changes as well as analyzing the best-available predictive models.

WATER CONSERVATION

- Equipping permittees, residents, businesses, and educators with water conservation tools and resources to reduce water usage and empower the community to value water.

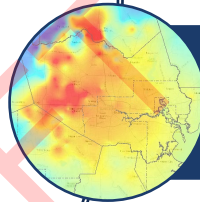
Agenda



Climate



Water Use



Groundwater Levels



Subsidence

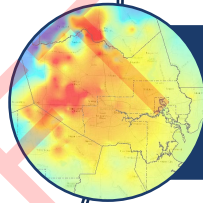
Agenda



Climate



Water Use



Groundwater Levels



Subsidence

Exhibit 1

Location of National Weather Service (NWS) climate stations used for rainfall data for the 2023 calendar year.

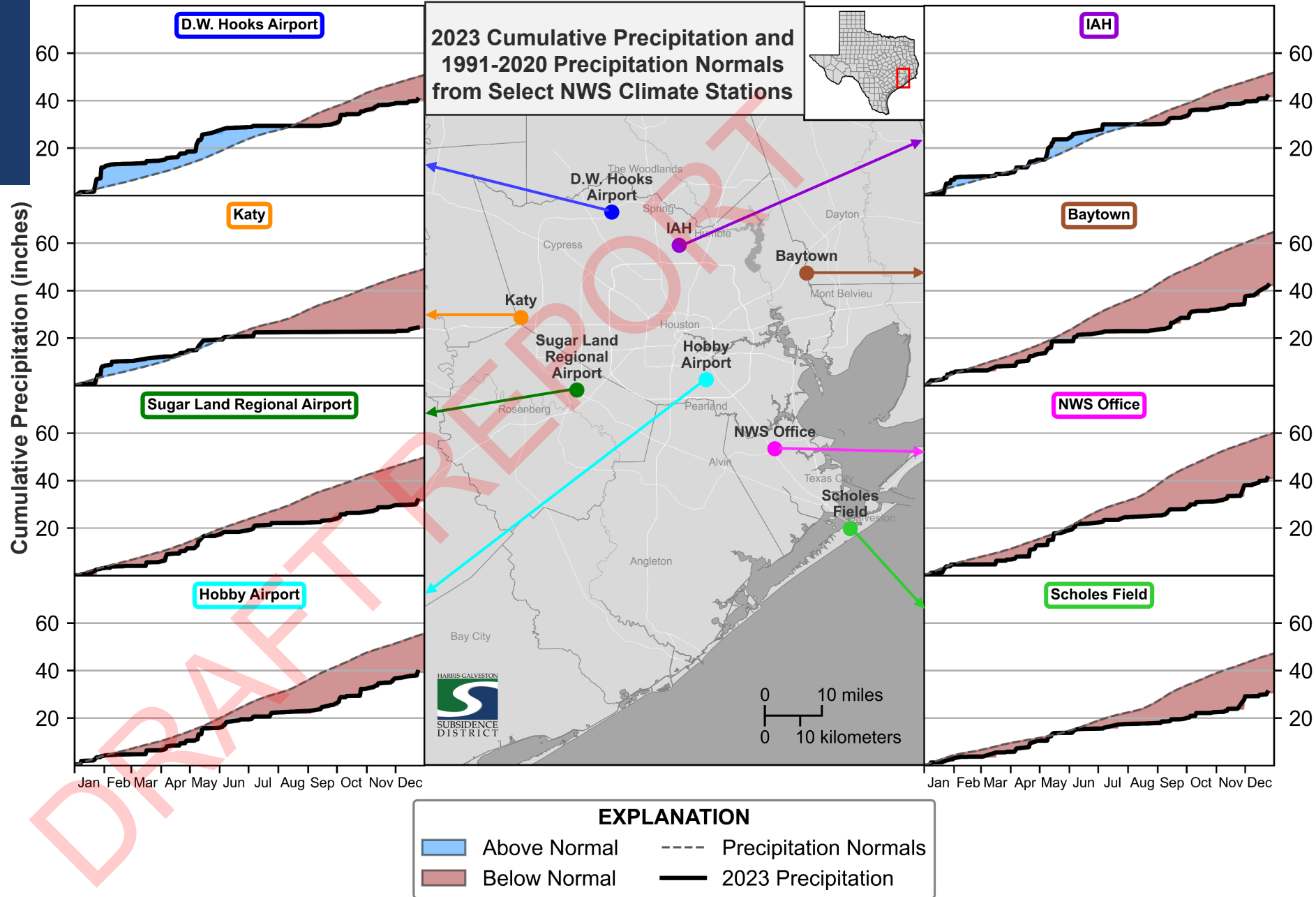
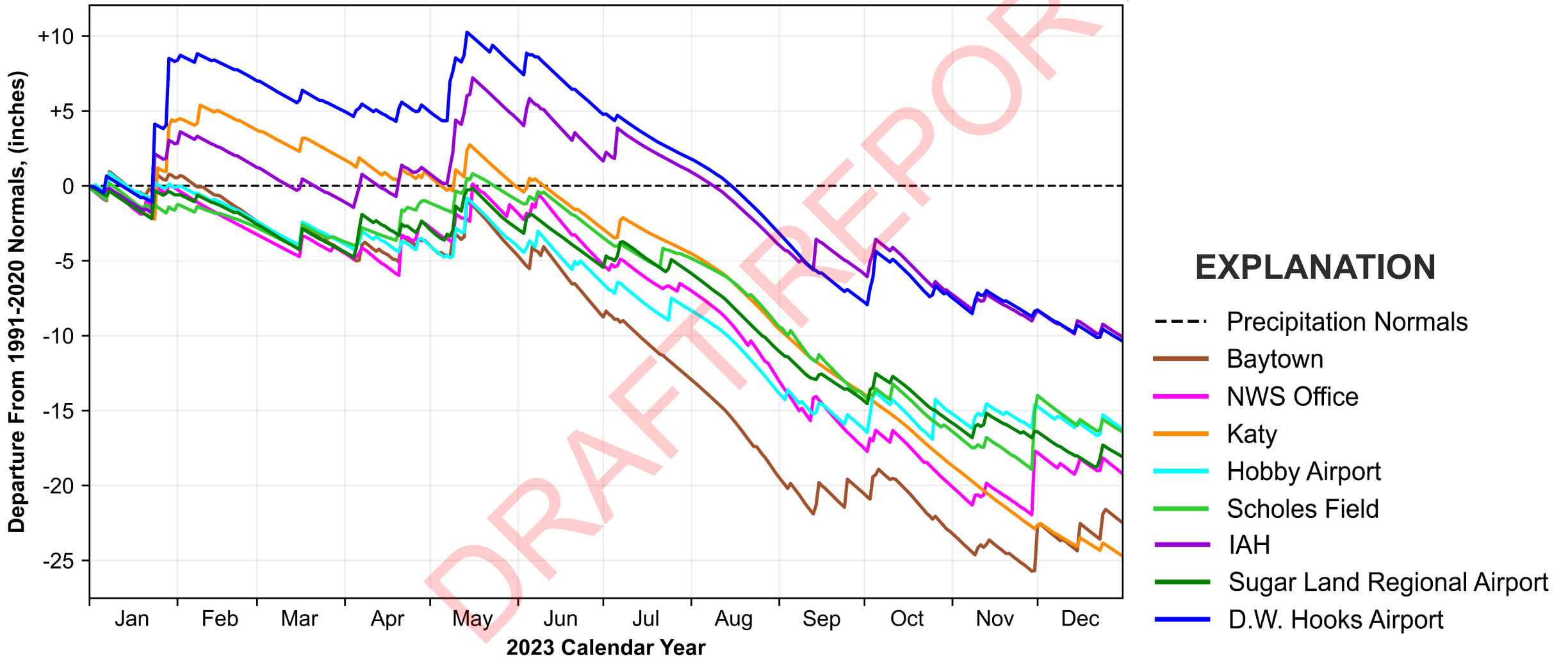


Exhibit 2 | 2023 Precipitation Data



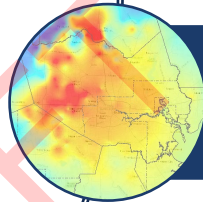
Agenda



Climate



Water Use

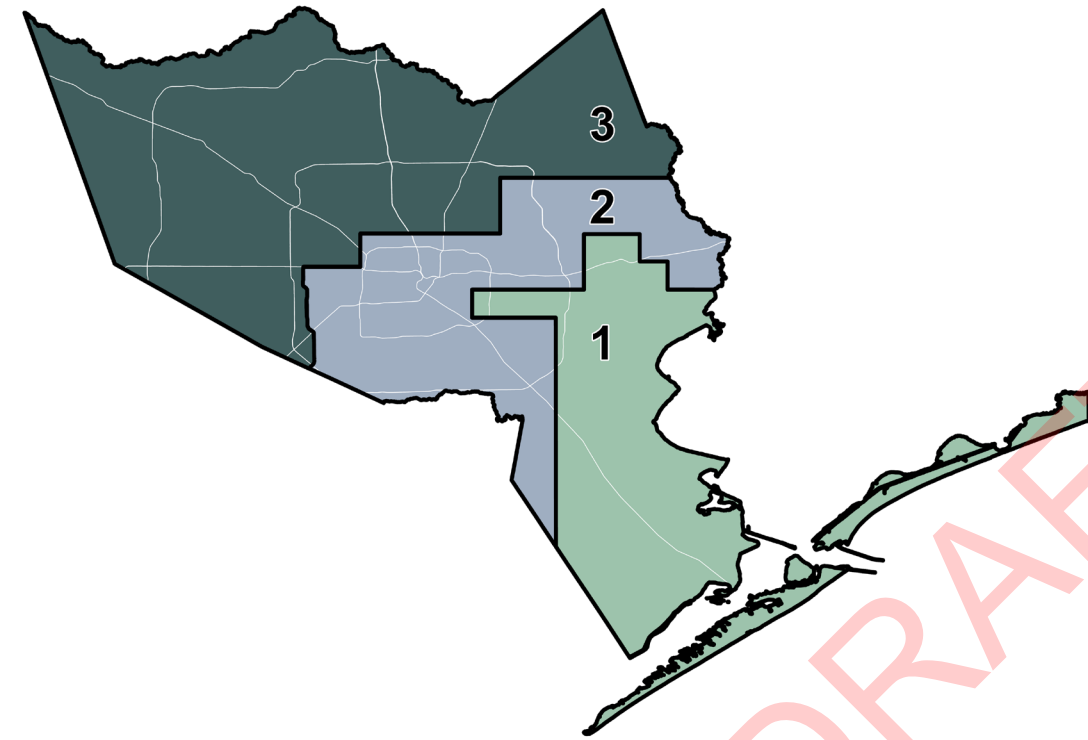


Groundwater Levels



Subsidence

HGSD Regulatory Areas



Area 1: no more than 10% of Total Water Demand (TWD) may be sourced from groundwater.

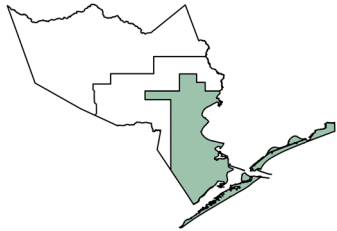
Area 2: no more than 20% of TWD may be sourced from groundwater.

- Groundwater Reduction Plan (GRP) may be approved with conditions.

Area 3: no more than 20% of TWD may be sourced from groundwater.

- Permittees operating within an approved GRP have the following requirements:
 - 2010 – no more than 70% of TWD from groundwater
 - 2025 – no more than 40% of TWD from groundwater
 - 2035 – no more than 20% of TWD from groundwater

Exhibit 3 | Regulatory Area 1



Groundwater Withdrawals Grouped by Use

■ Public ■ Industrial ■ All Irrigation

2023: 8.8 MGD

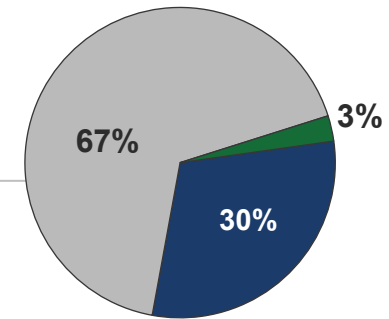
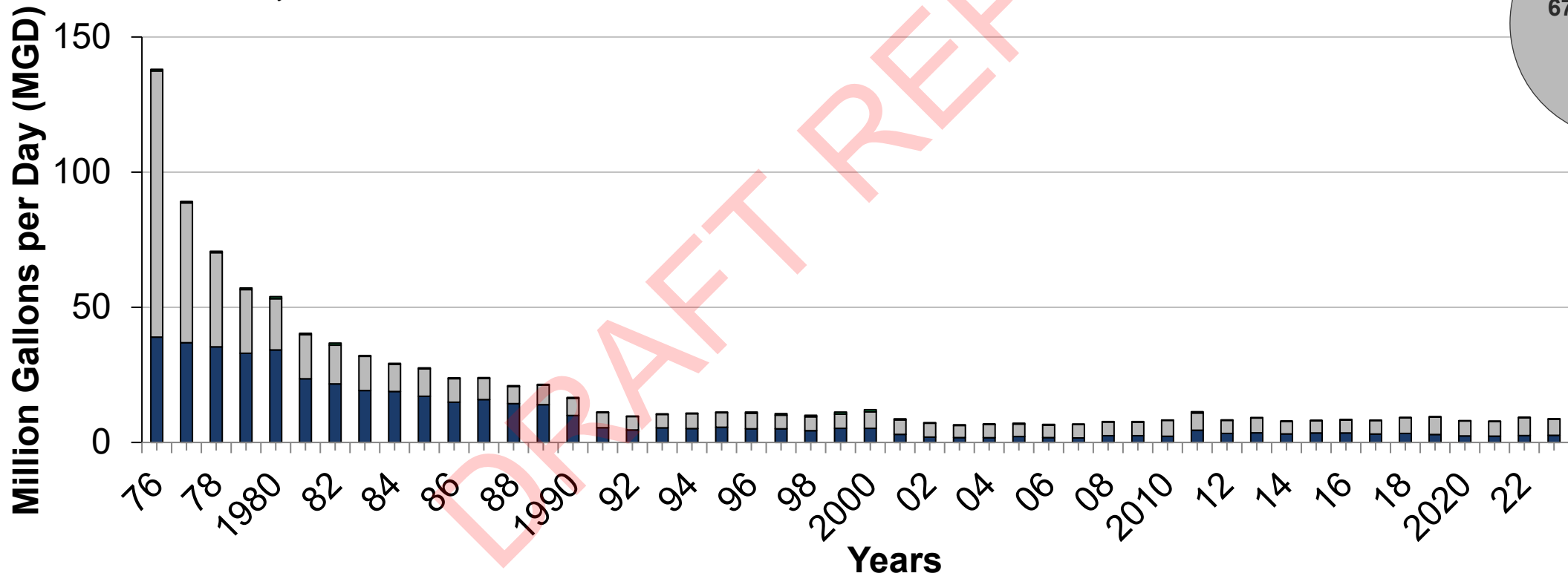
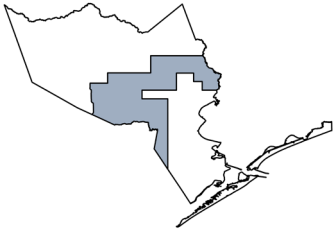


Exhibit 4 | Regulatory Area 2



Groundwater Withdrawals Grouped by Use

■ Public ■ Industrial ■ All Irrigation

2023: 30.9 MGD

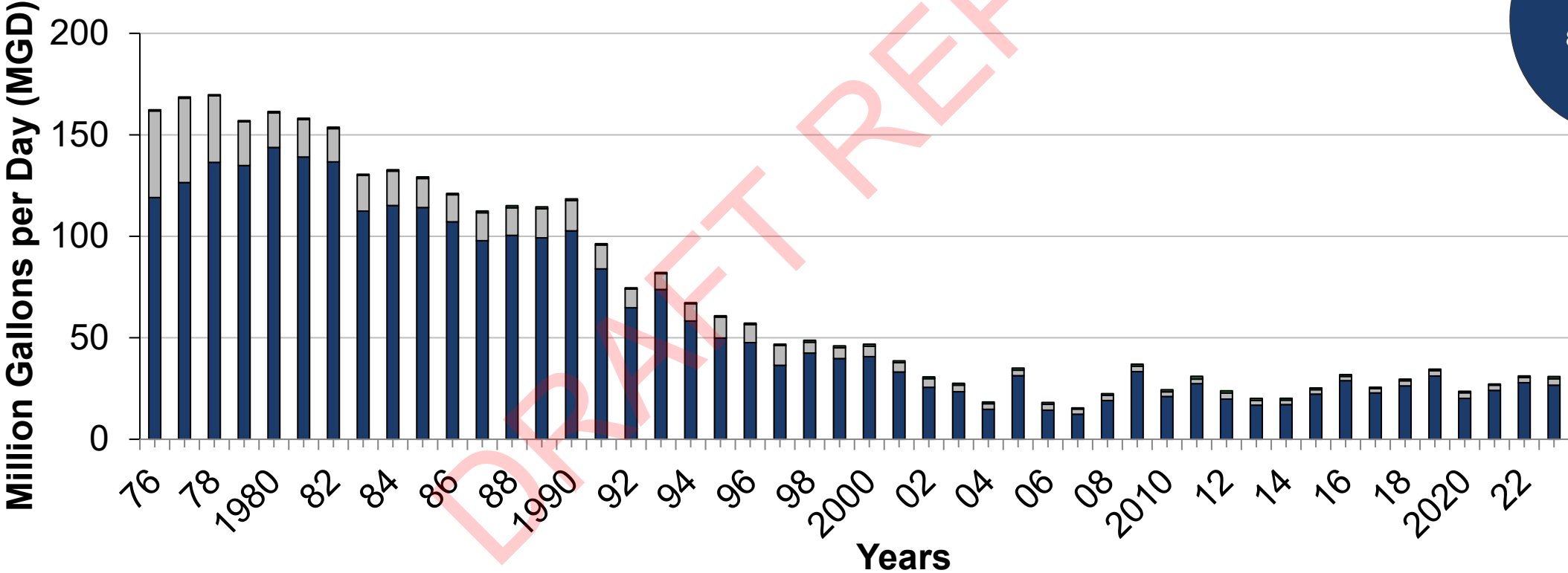
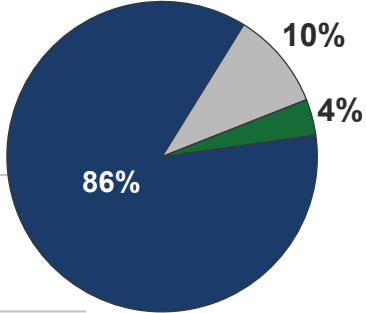
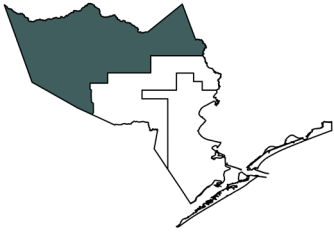


Exhibit 5 | Regulatory Area 3



Groundwater Withdrawals Grouped by Use

2023: 212.8 MGD

■ Public ■ Industrial ■ All Irrigation

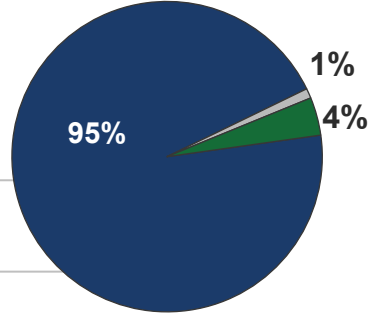
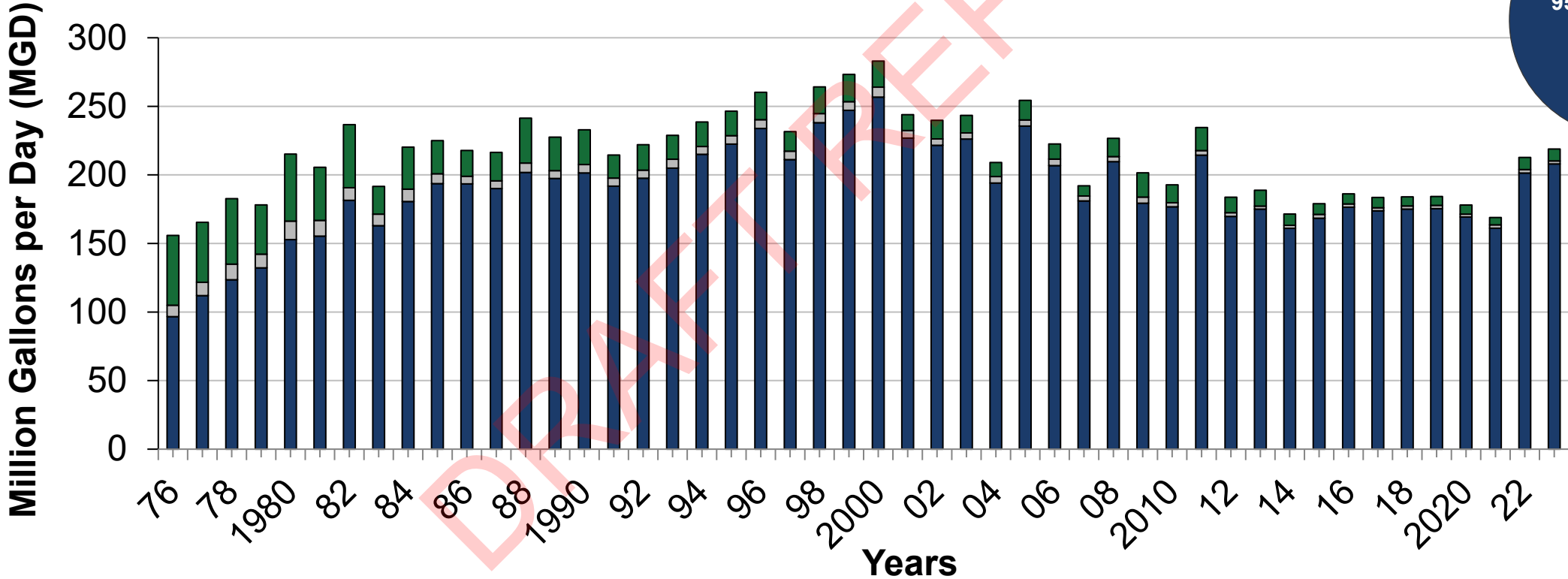
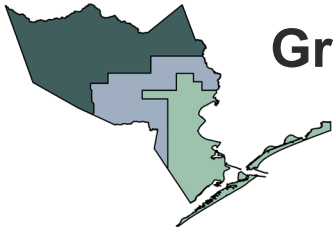


Exhibit 6 | Entire District



Groundwater Withdrawals Grouped by Regulatory Area

2023: 258.6 MGD

Area 1 Area 2 Area 3

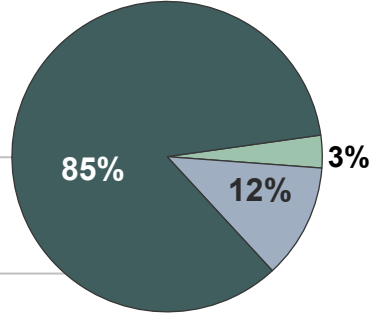
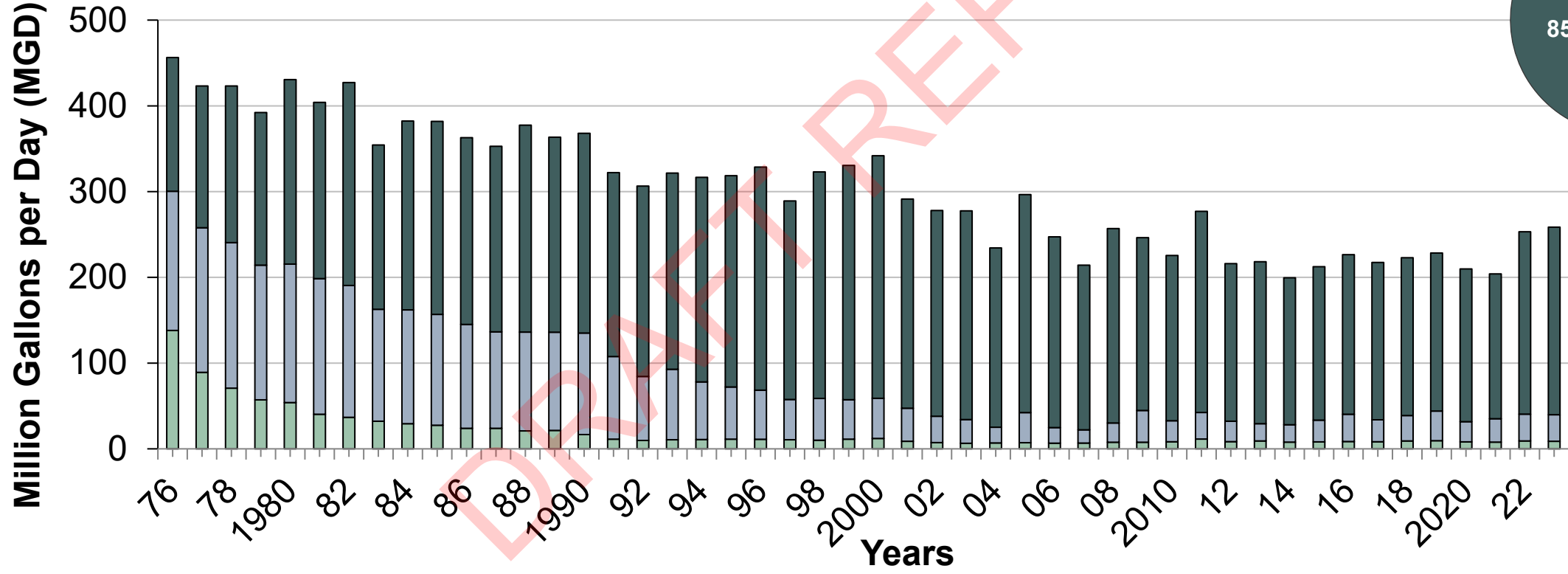
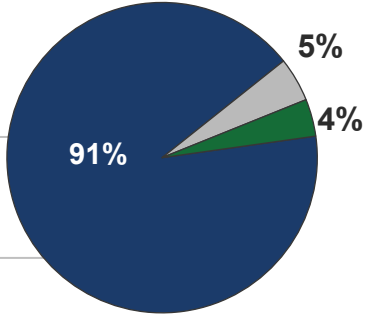
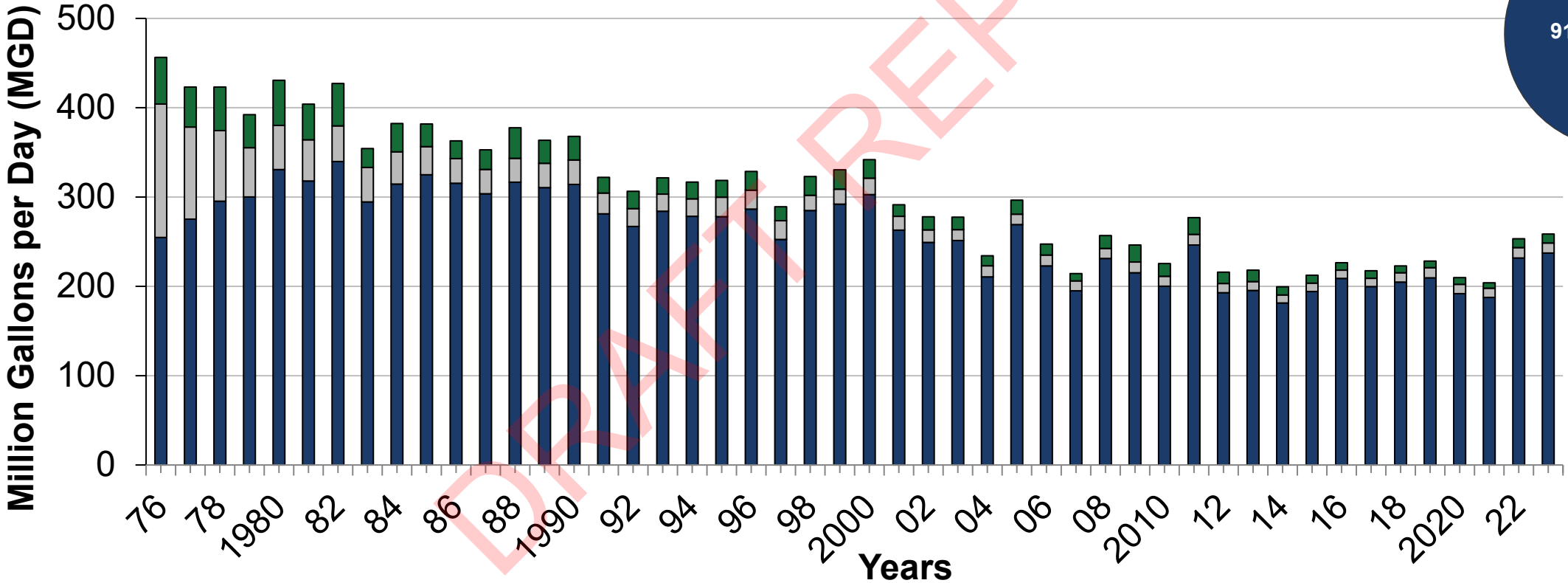


Exhibit 7 | Entire District

Groundwater Withdrawals Grouped by Use

2023: 258.6 MGD

Public Industrial All Irrigation



Alternative Water Sources

Surface water sources:

- Trinity River
- San Jacinto River
- Brazos River

Reclaimed water is also utilized throughout the District.

EXPLANATION

-  HGSD Jurisdiction
-  Brazos River Basin
-  San Jacinto River Basin
-  San Jacinto-Brazos River Basin
-  Trinity River Basin
-  Trinity-San Jacinto River Basin

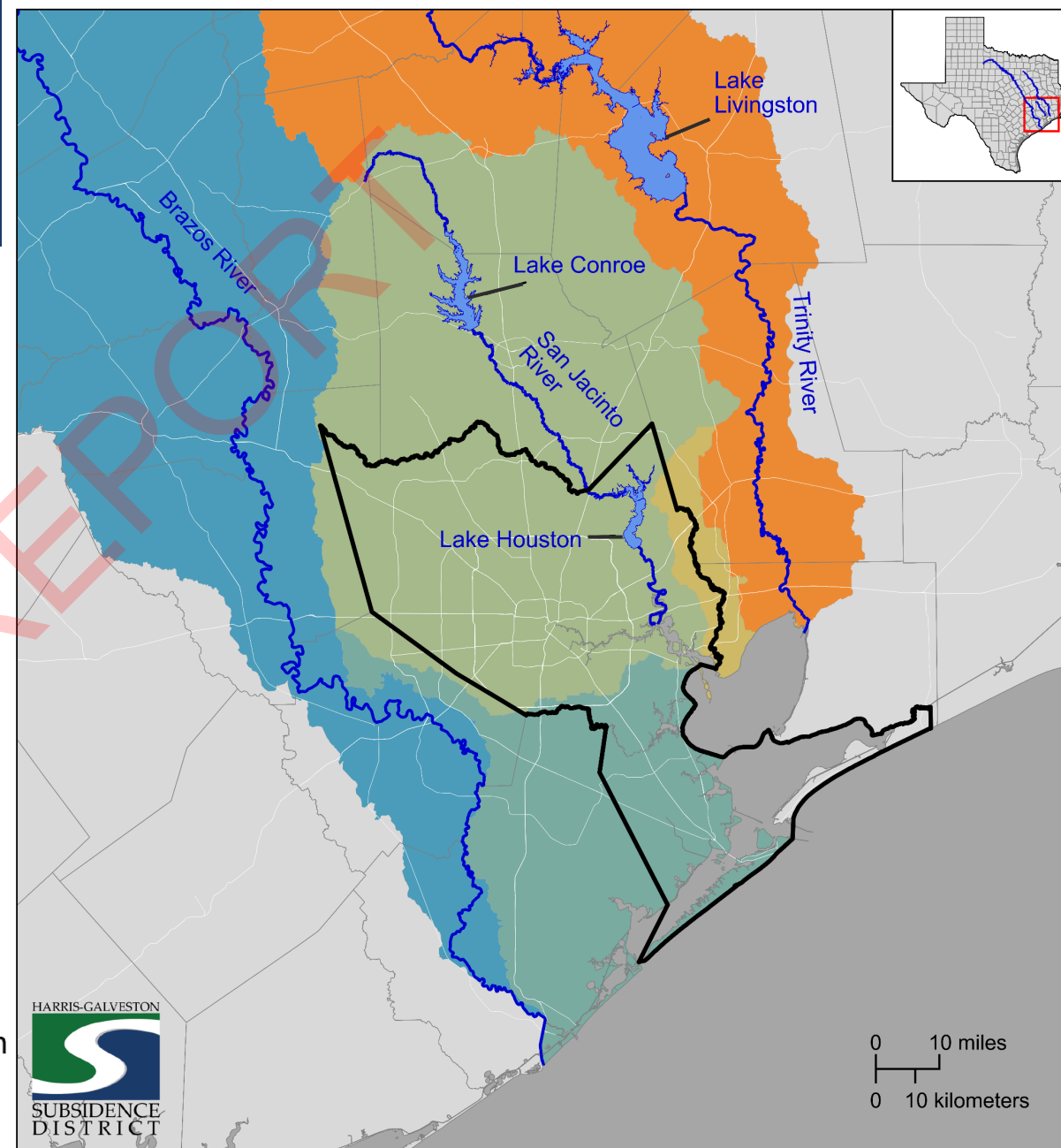


Exhibit 8 | Alternative Water Used for Entire District

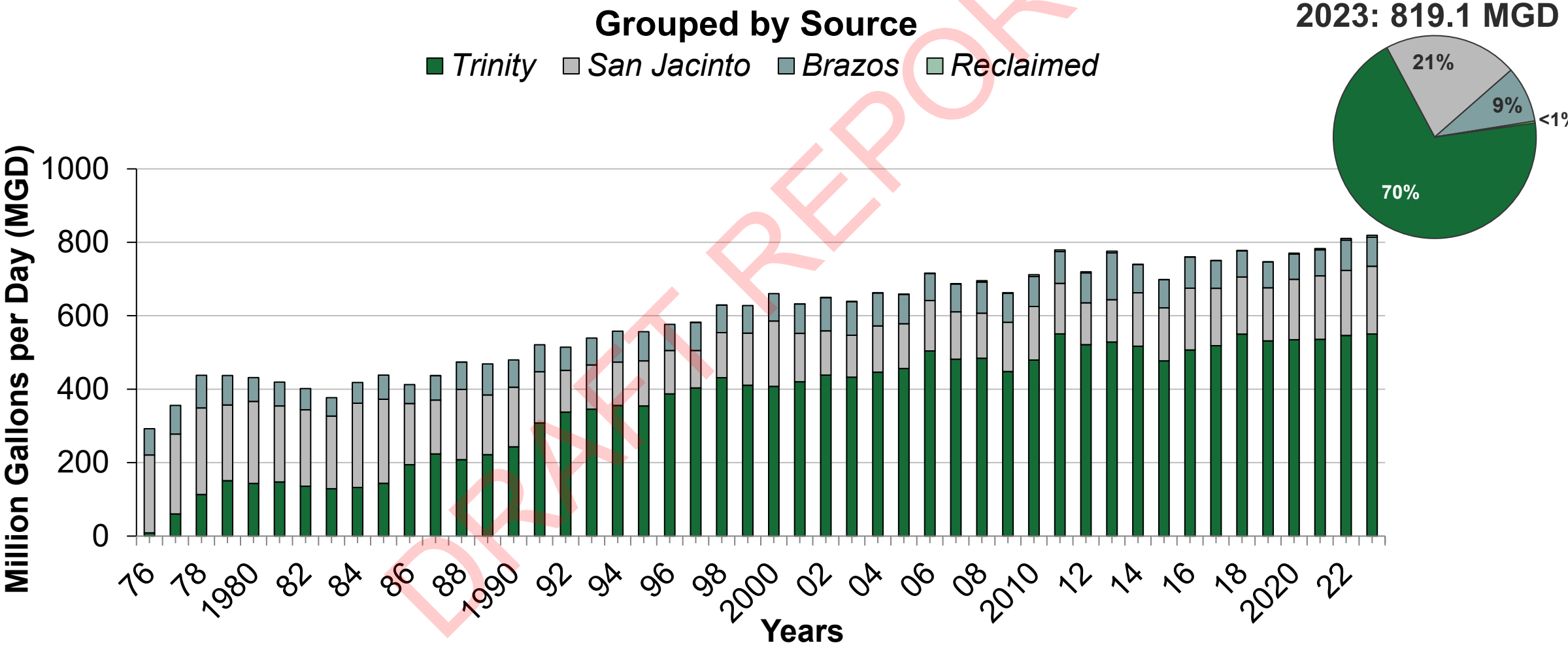
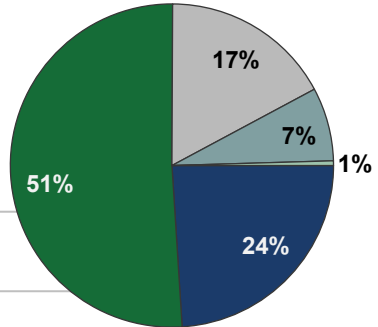
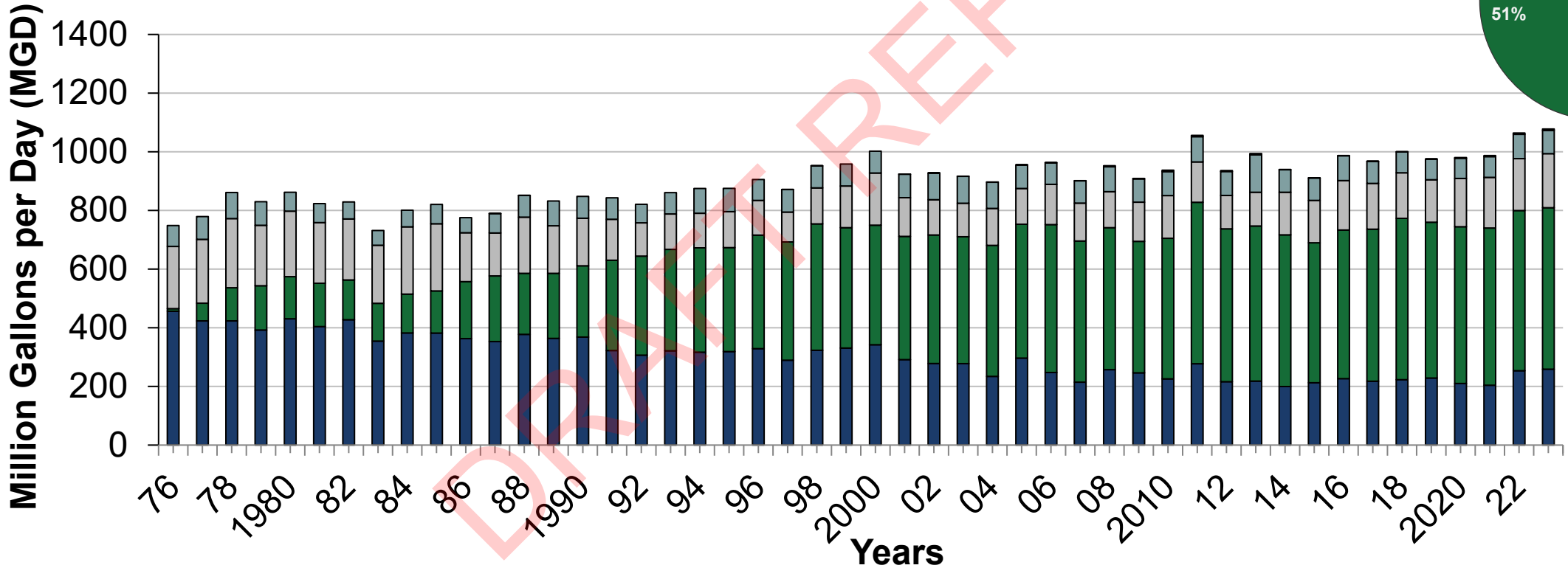


Exhibit 9 | Total Water Demand

Grouped by Source

■ Groundwater
 ■ Trinity
 ■ San Jacinto
 ■ Brazos
 ■ Reclaimed Water

2023: 1077.7 MGD



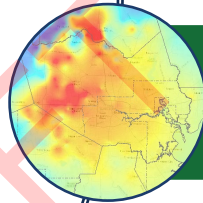
Agenda



Climate



Water Use



Groundwater Levels



Subsidence

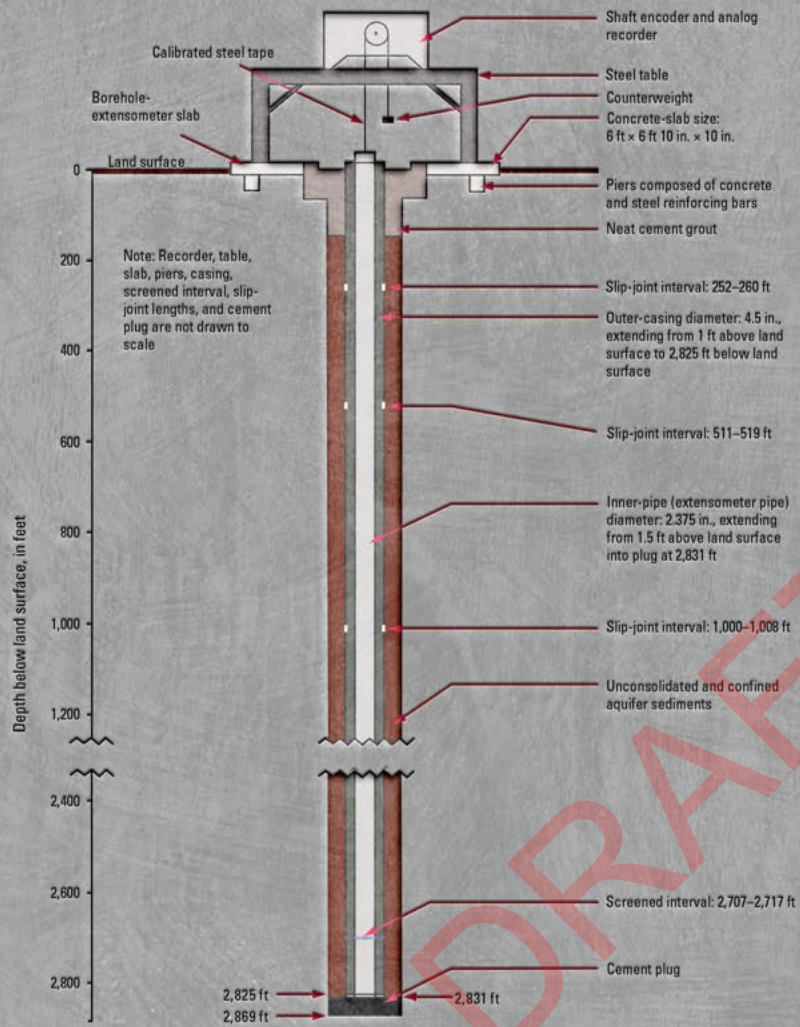


DIAGRAM OF A BOREHOLE EXTENSOMETER

Groundwater-level Altitudes, Long-Term Change & Compaction

CHICOT/EVANGELINE AND JASPER AQUIFERS

RESEARCH IN COOPERATION WITH THE HARRIS-GALVESTON & FORT BEND SUBSIDENCE DISTRICTS, BRAZORIA GROUNDWATER CONSERVATION DISTRICT, THE CITY OF HOUSTON AND LONE STAR GROUNDWATER CONSERVATION DISTRICT

2024 Water-Level Map Series

- Chicot and Evangeline Aquifers (undifferentiated)

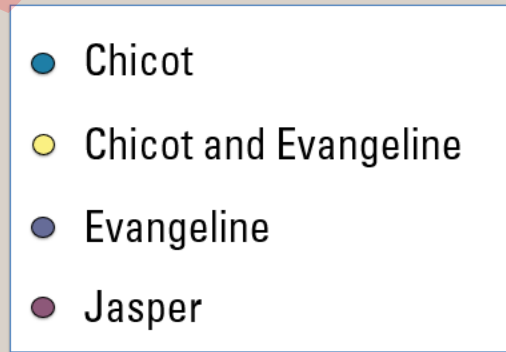
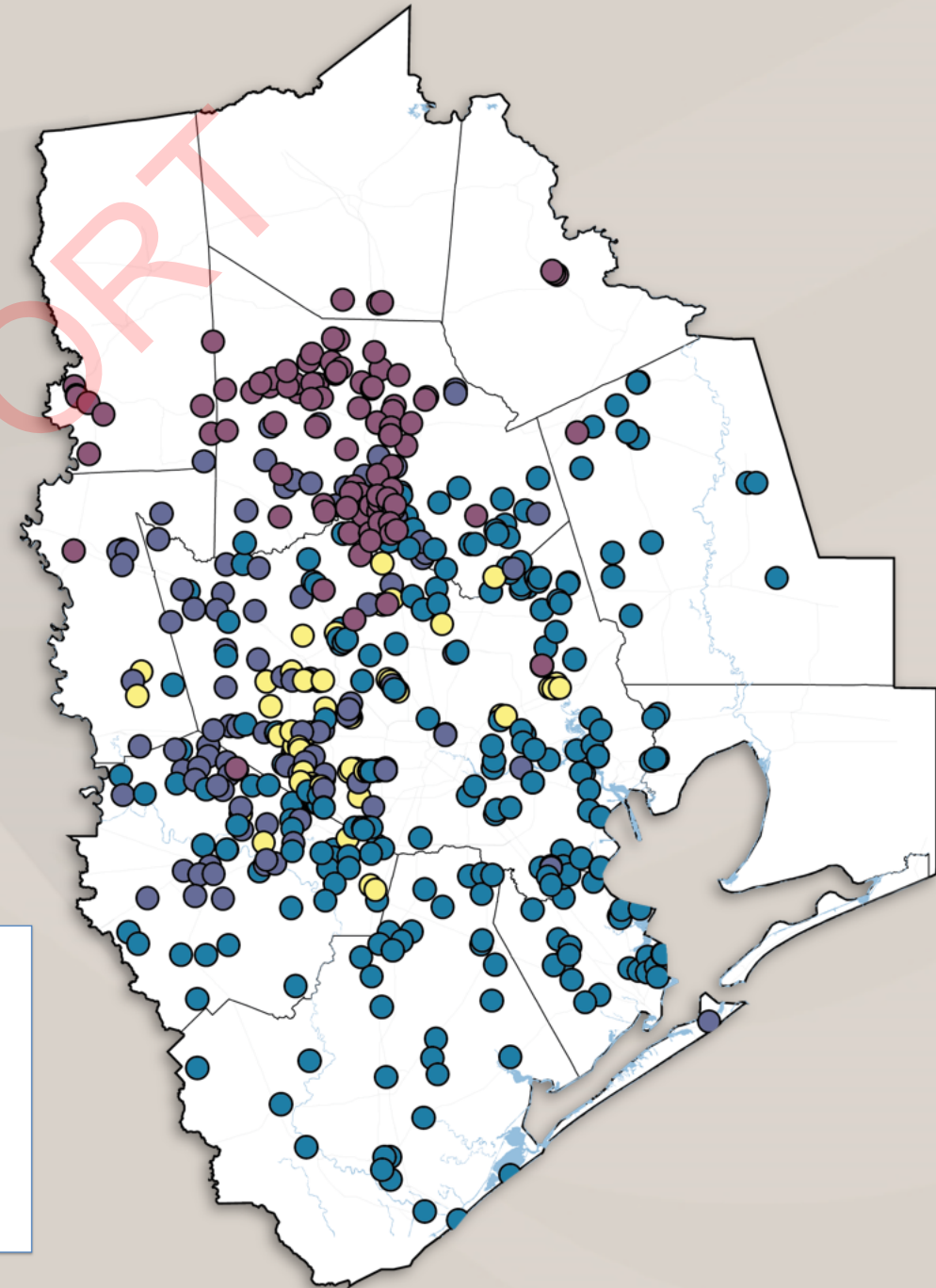
- 2024 Water-Level Altitude
- 2023 to 2024 Water-Level Change
- 2019 to 2024 Water-Level Change
- 1990 to 2024 Water-Level Change
- 1977 to 2024 Water-Level Change

- Jasper Aquifer

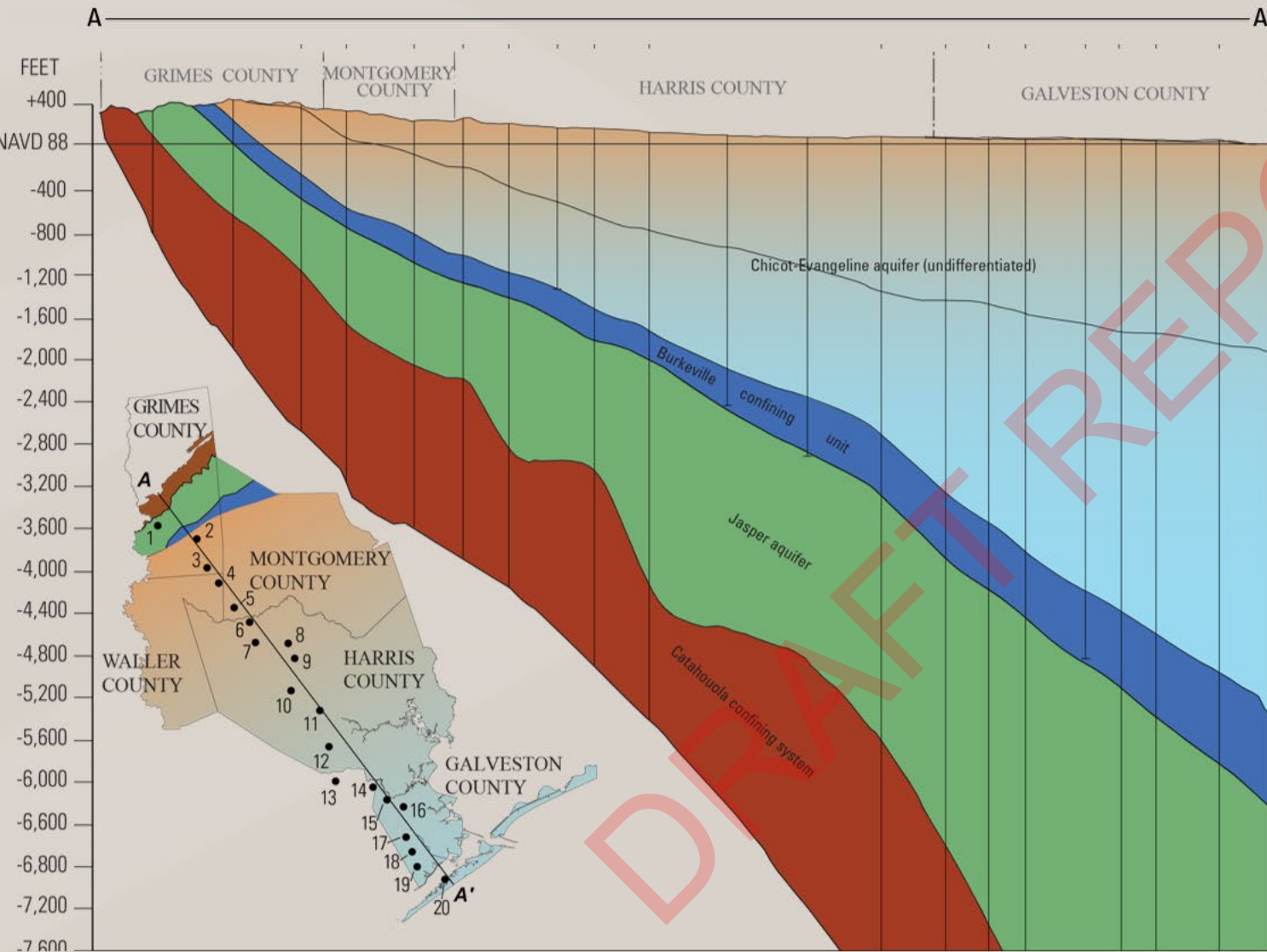
- 2024 Water-Level Altitude
- 2023 to 2024 Water-Level Change
- 2019 to 2024 Water-Level Change
- 2000 to 2024 Water-Level Change

- Compaction 1973 to 2023

- Compaction Data from 14 Extensometers



Geology and Hydrology



In 2021 and Moving Forward			
Geologic units ¹		Hydrogeologic units ¹	
Alluvial, terrace, and dune deposits		Chicot-Evangeline aquifer (undifferentiated)	
Beaumont Formation			
Lissie Formation	Montgomery Formation		
	Bentley Formation		
Willis Sand			
Goliad Sand (upper part)			
Goliad Sand (lower part)			
Lagarto Clay (upper part)			
Lagarto Clay (middle part)			Burkeville confining unit
Lagarto Clay (lower part)			Jasper aquifer
Oakville Sandstone		Catahoula Confining System	
Catahoula Formation	Upper Catahoula Formation		
	Frio Formation		

- Chicot and Evangeline aquifers (undifferentiated)
 - combined for annual regional-scale assessments
 - Updated aquifer tops and bases*
 - Chicot thickened across much of southeast Harris County
 - Distribution of Evangeline wells changed significantly

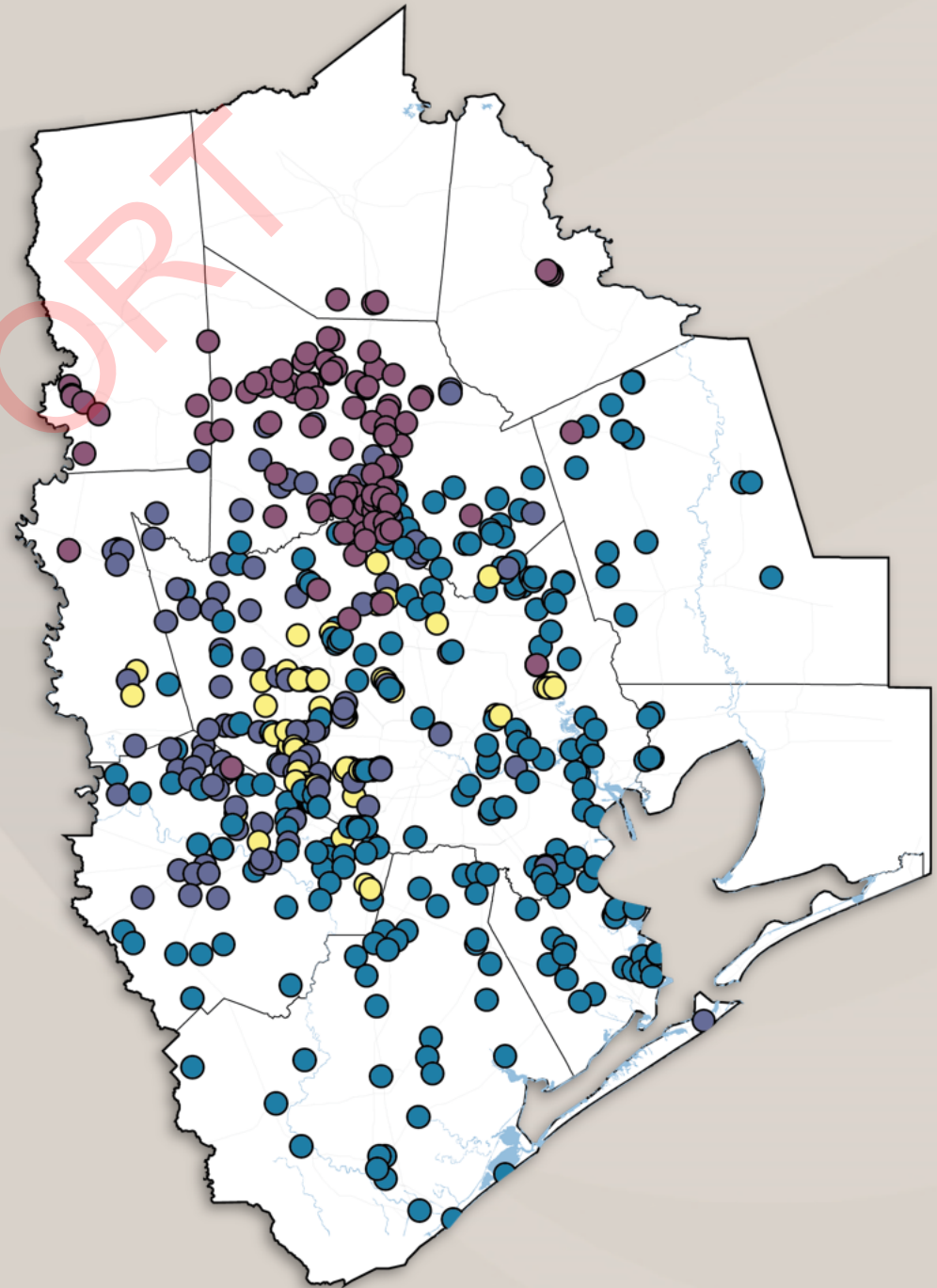
¹Young, S.C., Kelley, V.A., Deeds, N., Hudson, C., Piemonti, D., Ewing, T.E., Banerji, D., Seifert, J., and Lyman, P., 2017

*Young, S.C., and Draper, C., 2020

Network



- Data collected across 11 counties
- Data collection from **12-12-2023** to **3-07-2024**
- Well Types:
 - Public Supply, Irrigation, Industrial, Observation
- Chicot and Evangeline (undifferentiated) water-levels: **478**
- Jasper water-levels: **88**
- Number of wells used to create the 2024 altitude maps
 - Chicot and Evangeline (undifferentiated): *444*
 - Jasper: *84*



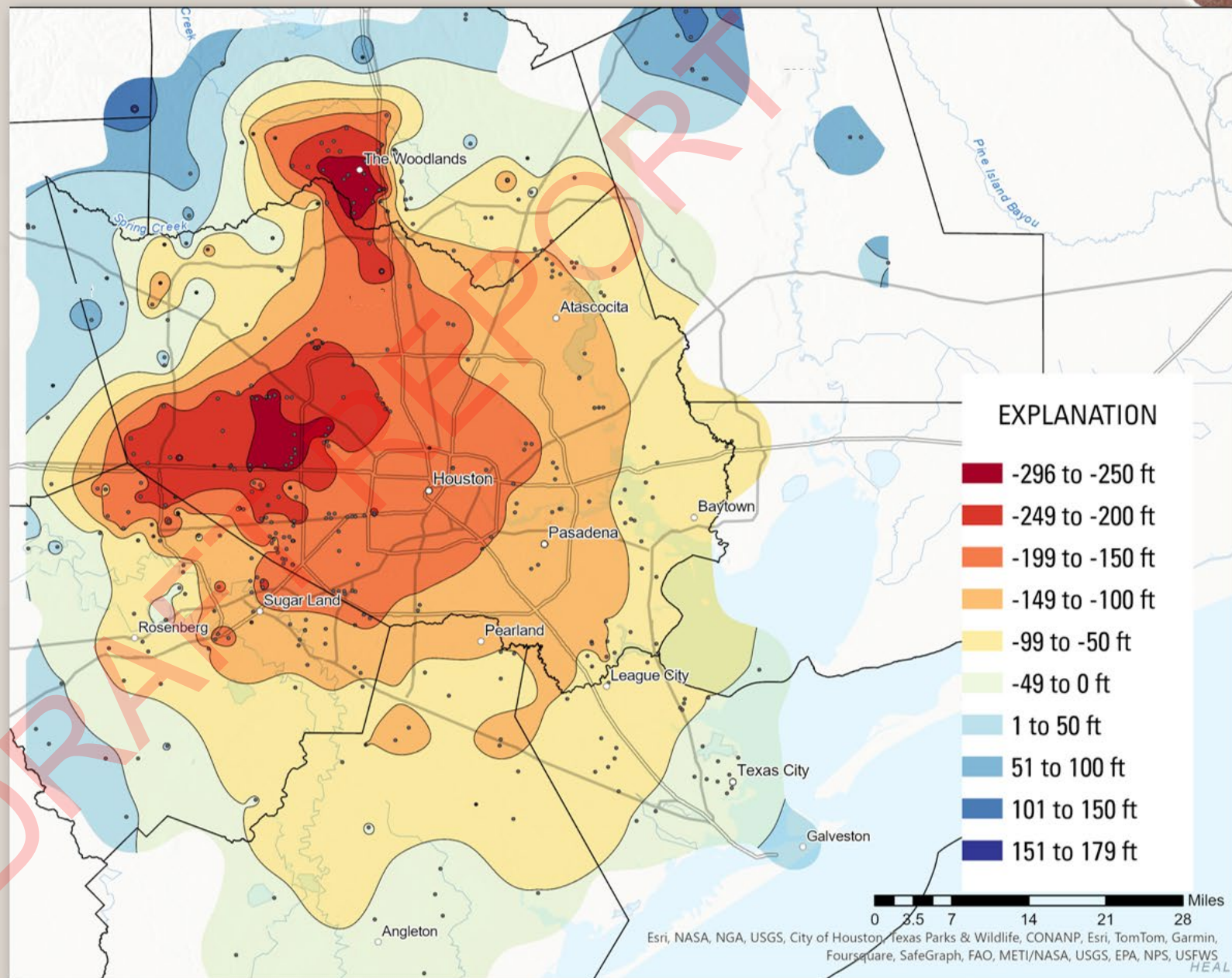
Water-Level Altitude

Chicot and Evangeline (undifferentiated)

Altitudes are referenced from NAVD 88

Lowest altitudes in south-central portion of Montgomery County and west-central Harris County

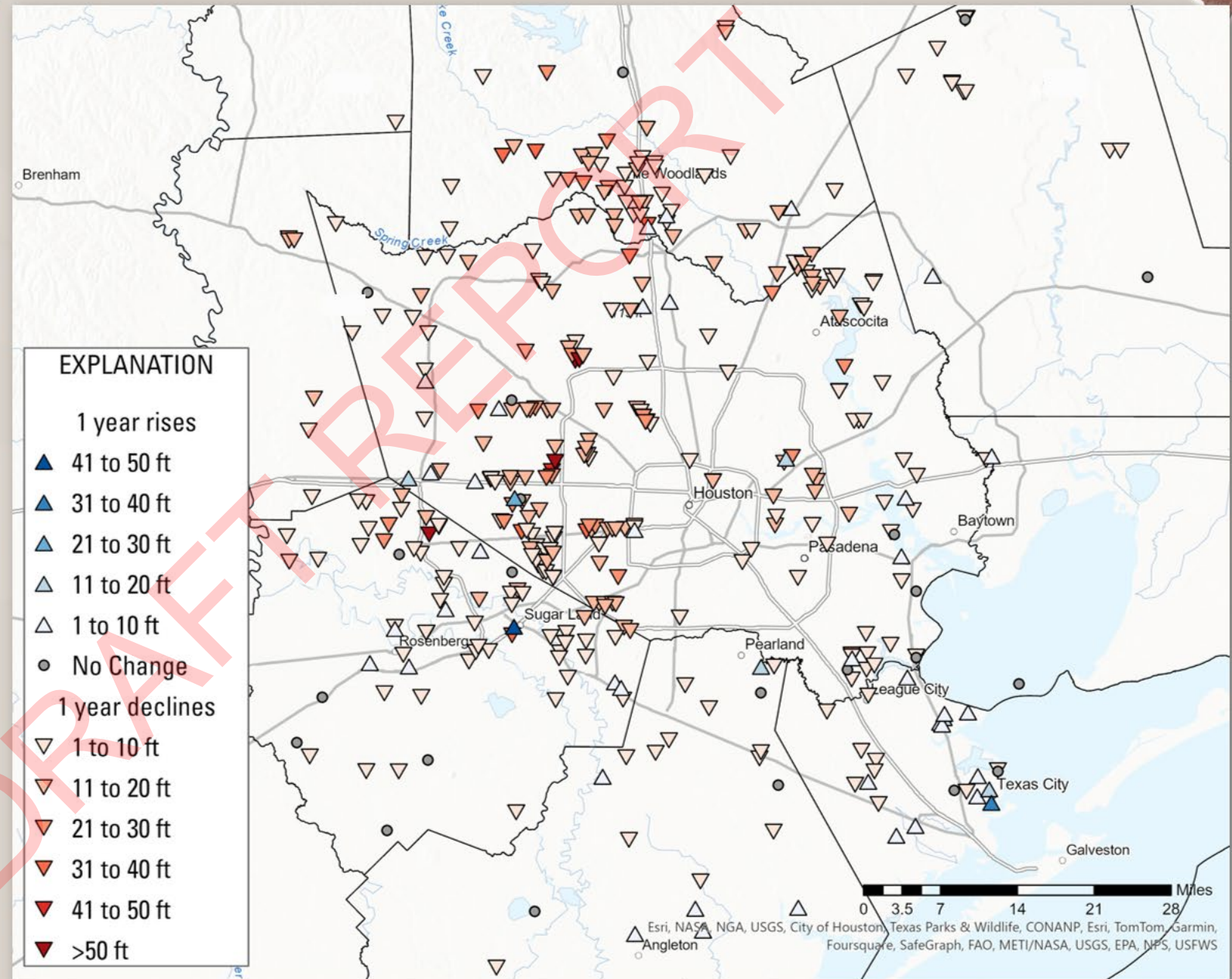
Highest altitudes in portions of south-eastern Grimes County, and northern Liberty County



2023 to 2024 Water-Level Change

Chicot and Evangeline (undifferentiated)

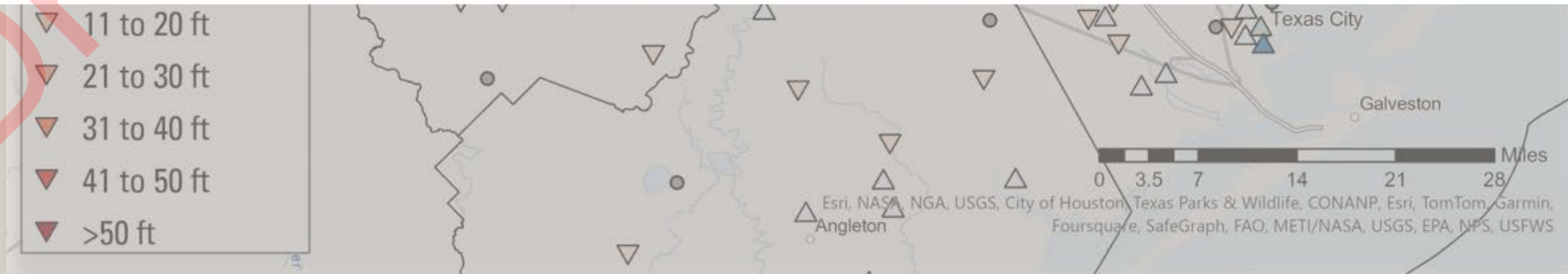
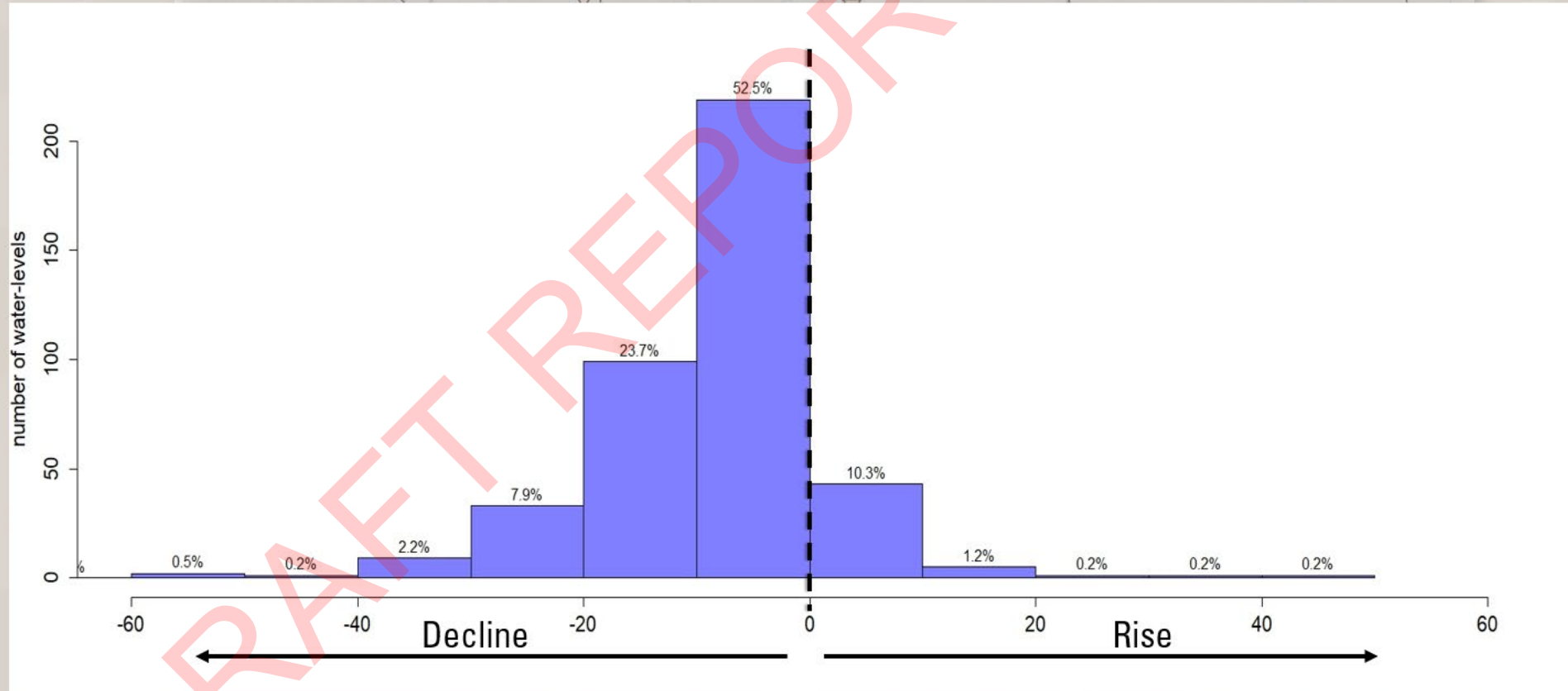
- 416 water-level pairs
 - Mostly declines
 - Over half (52.5%) are declines of less than 10 ft.
 - Largest declines (>50 ft):
 - portions of northwestern, southwestern and western Harris County
 - 1 in Fort Bend County
 - Largest rises (> 40 ft):
 - 1 in Fort Bend County



2023 to 2024 Water-Level Change

Chicot and Evangeline (undifferentiated)

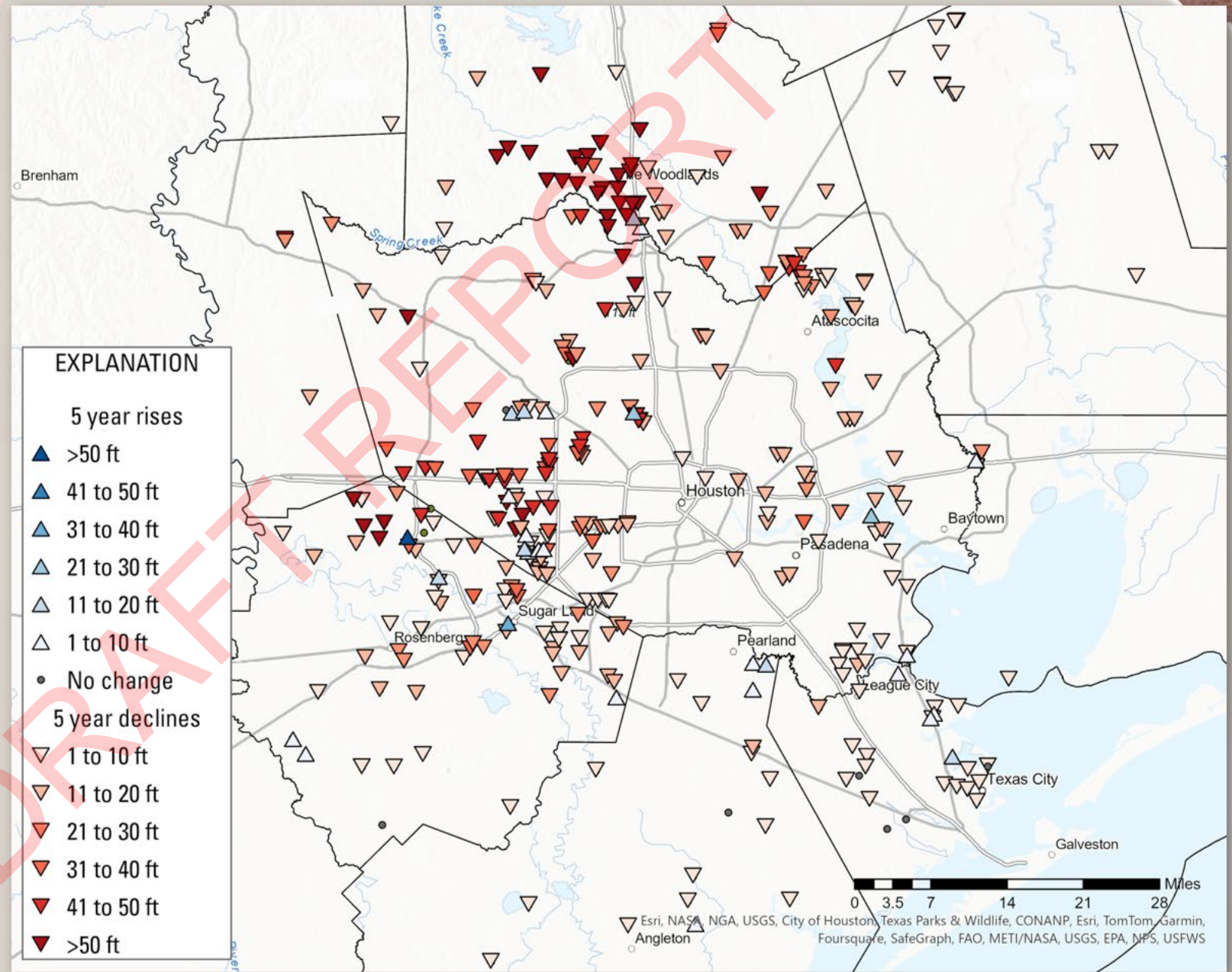
- 416 water-level pairs
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 - Largest declines (>50 ft):
 - portions of northwestern, southwestern and western Harris County
 - 1 in Fort Bend County
- Largest rises (> 40 ft):
 - 1 in Fort Bend County



2019 to 2024 Water-Level Change

Chicot and Evangeline (undifferentiated)

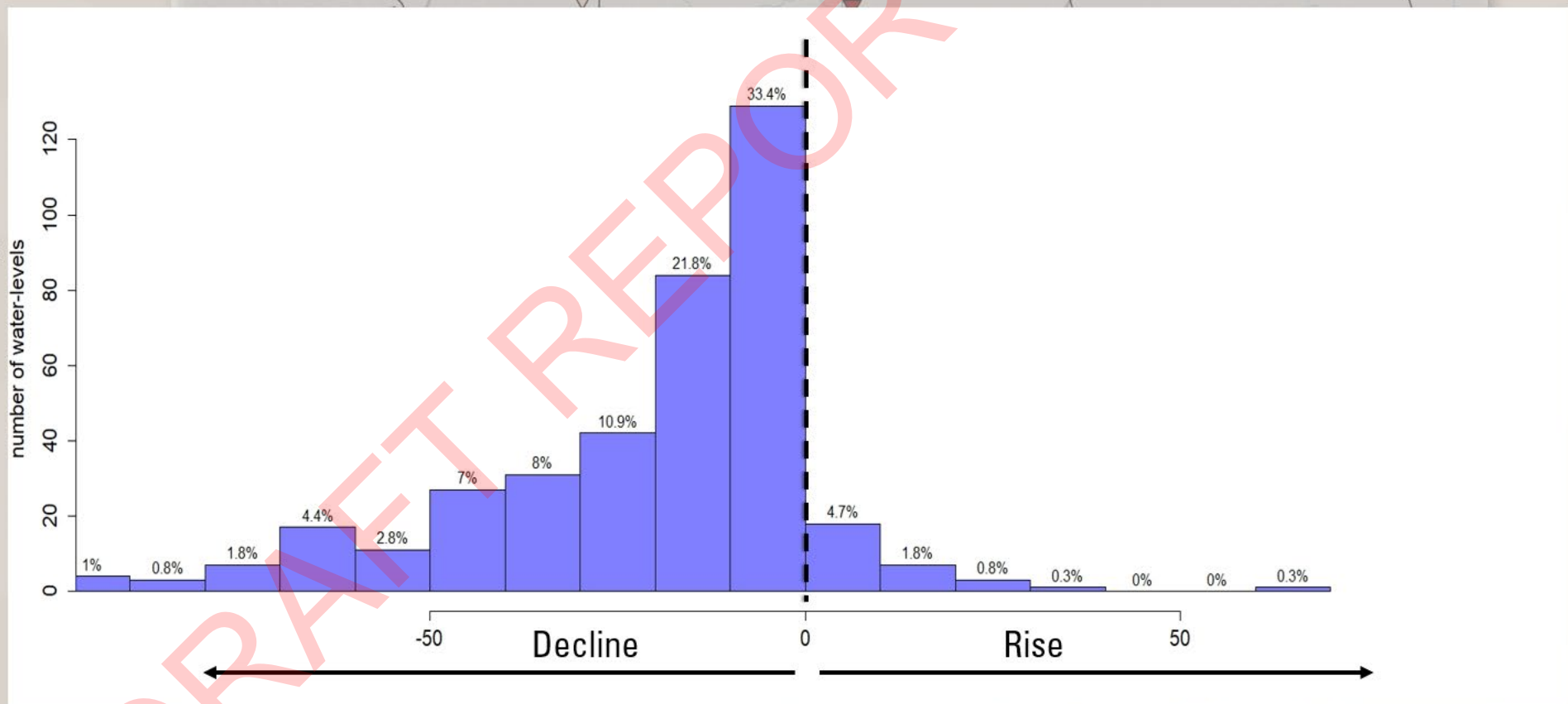
- 385 water-level pairs
 - Mostly declines
 - More than a third (33.4%) are declines of less than 10 feet.
 - Largest declines (>50 ft):
 - portions of south-western, north-western and northern Harris county
 - northern Fort Bend County
 - south-central Montgomery County
 - Largest rises (> 50 ft):
 - 1 in Fort Bend County



2019 to 2024 Water-Level Change

Chicot and Evangeline (undifferentiated)

- 385 water-level pairs
 - Mostly declines
 - More than a third (33.4%) are declines of less than 10 feet.
 - Largest declines (>50 ft):
 - portions of south-western, north-western and northern Harris county
 - northern Fort Bend County
 - south-central Montgomery County
 - Largest rises (> 50 ft):
 - 1 in Fort Bend County



Long term change

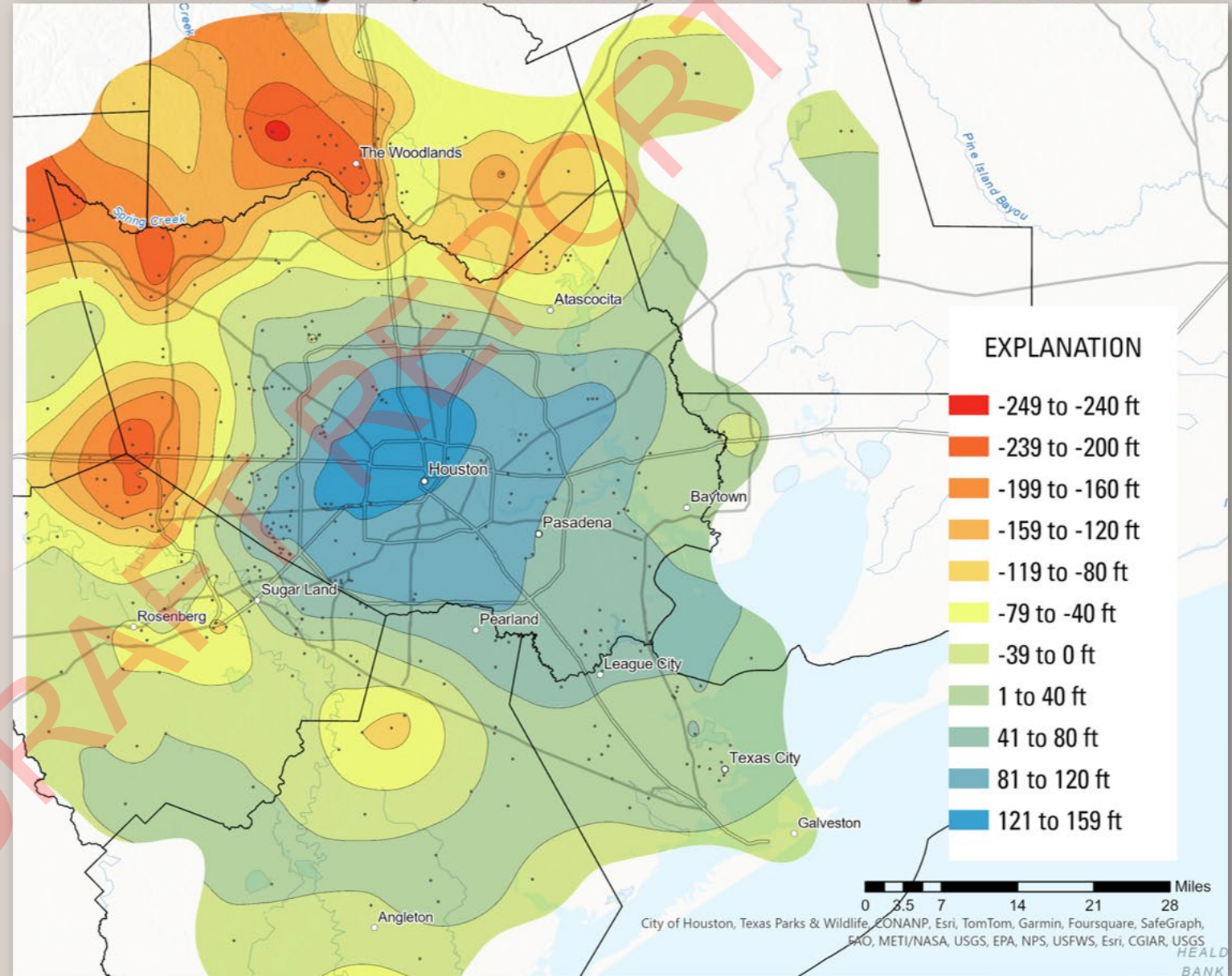
Water level rises (blues):

- most of central and eastern Harris County
- portions of Galveston County
- portions of Liberty, Chambers, Brazoria, and Fort Bend Counties

Water-level declines (yellows and reds):

- central Brazoria County
- northern Fort Bend County
- western and NW Harris County
- portions of Waller County
- portions of Montgomery County

Chicot and Evangeline (undifferentiated) Water-Level Change 1990 to 2024



Long term change

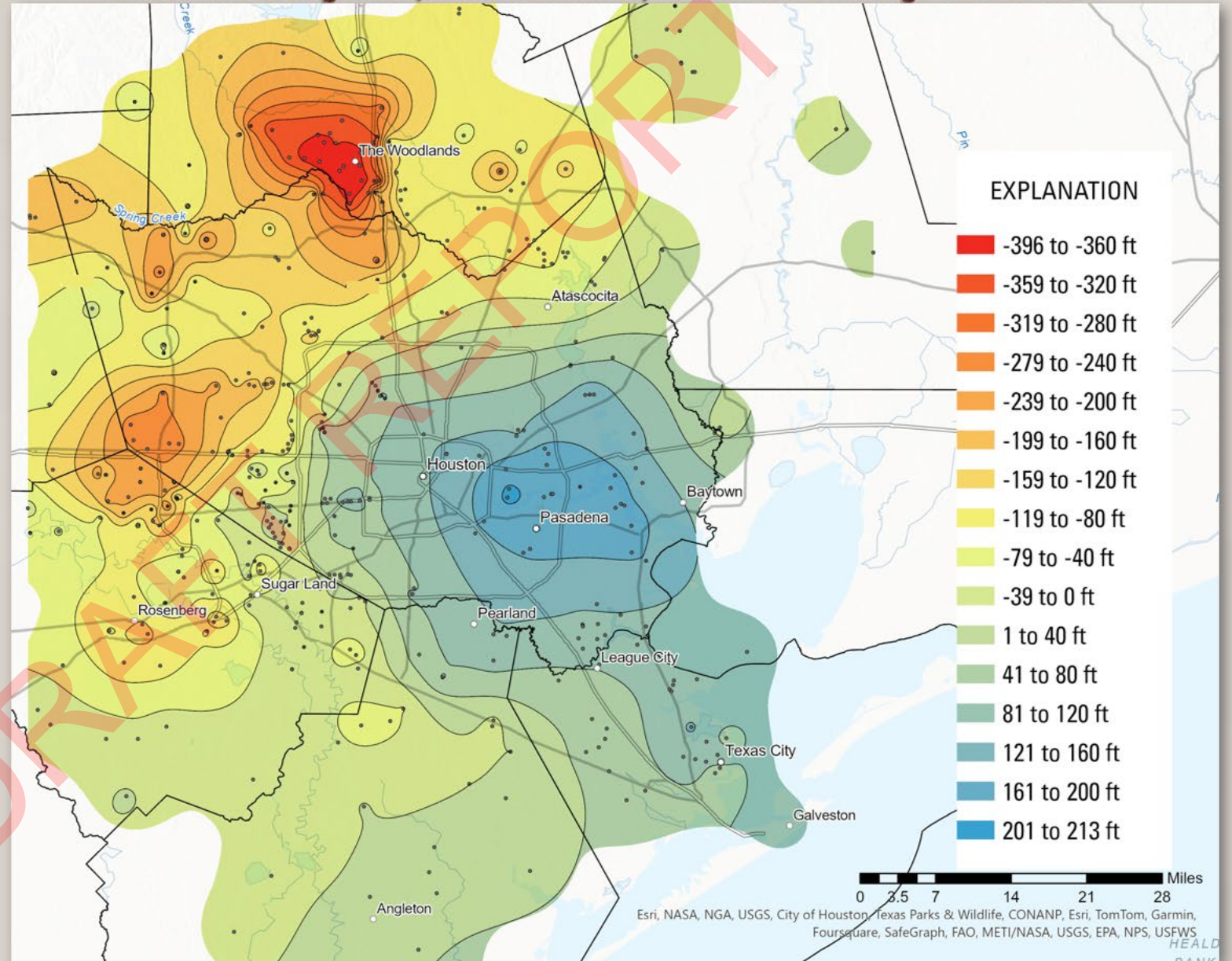
Water-level rises (blues):

- most of central and eastern Harris County
- Galveston County

Water-level declines (yellows and reds):

- western Brazoria County
- much of Fort Bend County
- western and NW Harris County
- portions of Waller County
- portions of Montgomery County

Chicot and Evangeline (undifferentiated) Water-Level Change 1977 to 2024



Water-Level Altitude

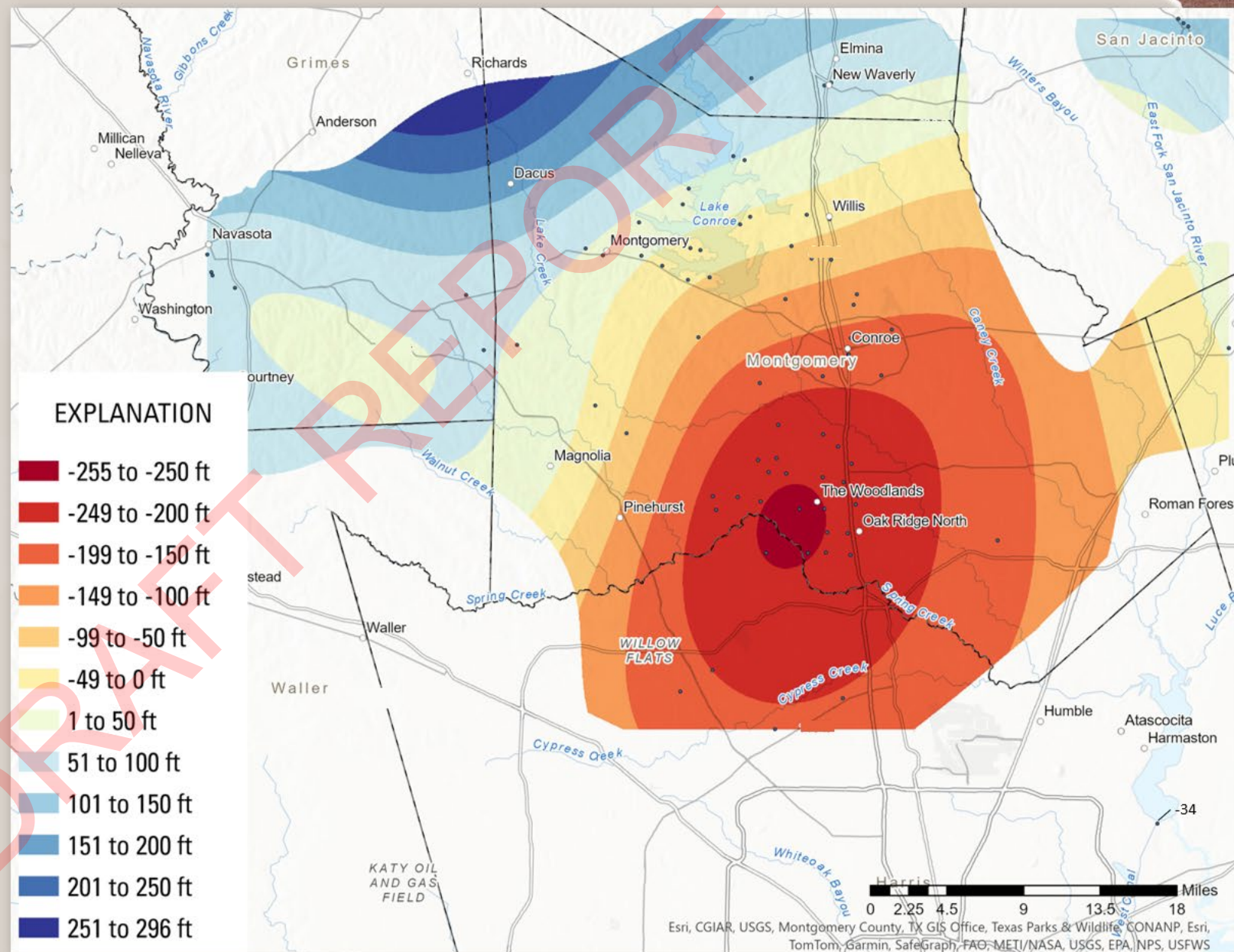
Jasper

Altitudes are referenced from NAVD 88

General trend of altitudes deepening in down-dip direction (NW-SE)

Lowest altitudes in south-central Montgomery County and north-central Harris County

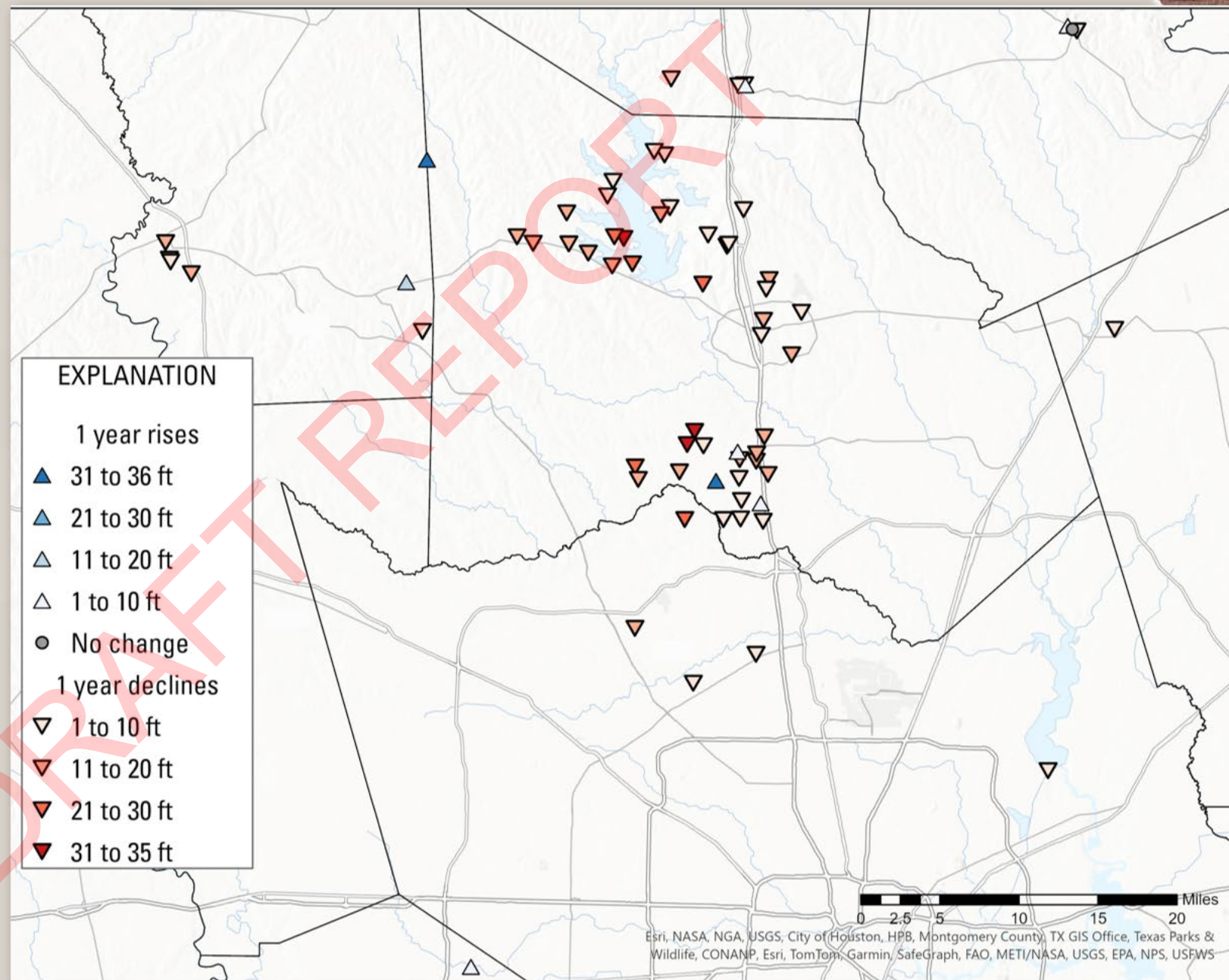
Cinco Mud (Fort Bend County) – 36.9 ft above NAVD 88



2023 to 2024 Water-Level Change

Jasper

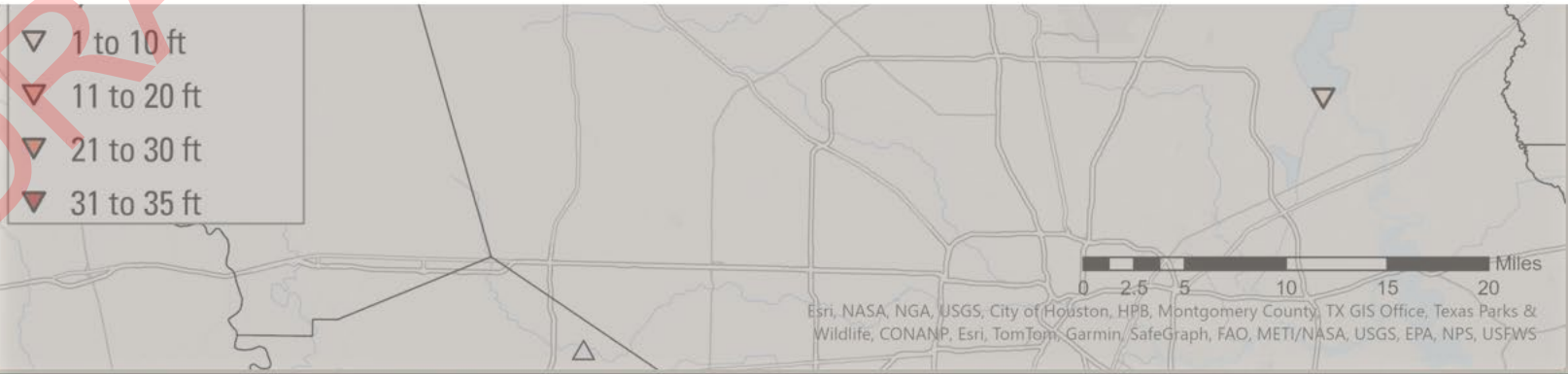
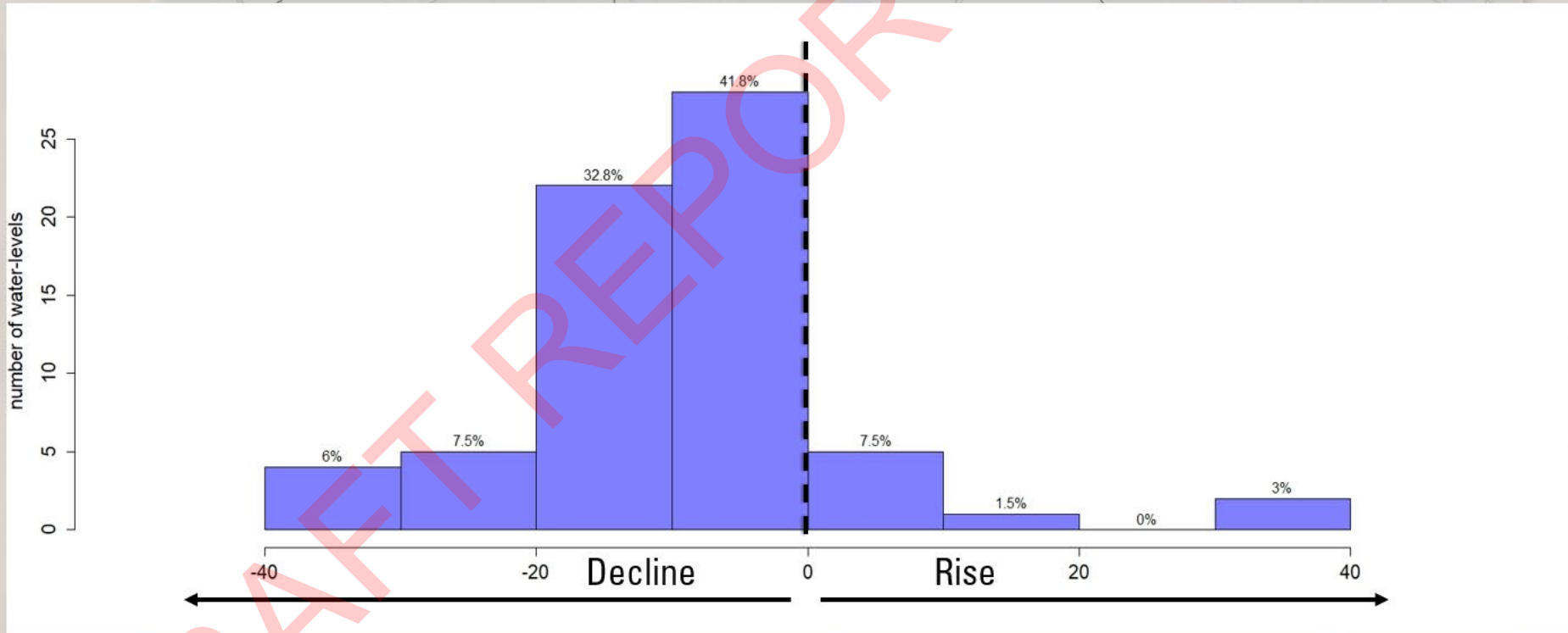
- 67 water-level pairs
 - Mostly declines (~88%)
 - About 75% were between 1 and 20 feet of decline
 - Largest declines (>30 ft):
 - 2 in south-central Montgomery County
 - 1 in central Montgomery County
 - Largest rises (> 30 ft):
 - 1 in west-central Montgomery County
 - 1 in south-central Montgomery County



2023 to 2024 Water-Level Change

Jasper

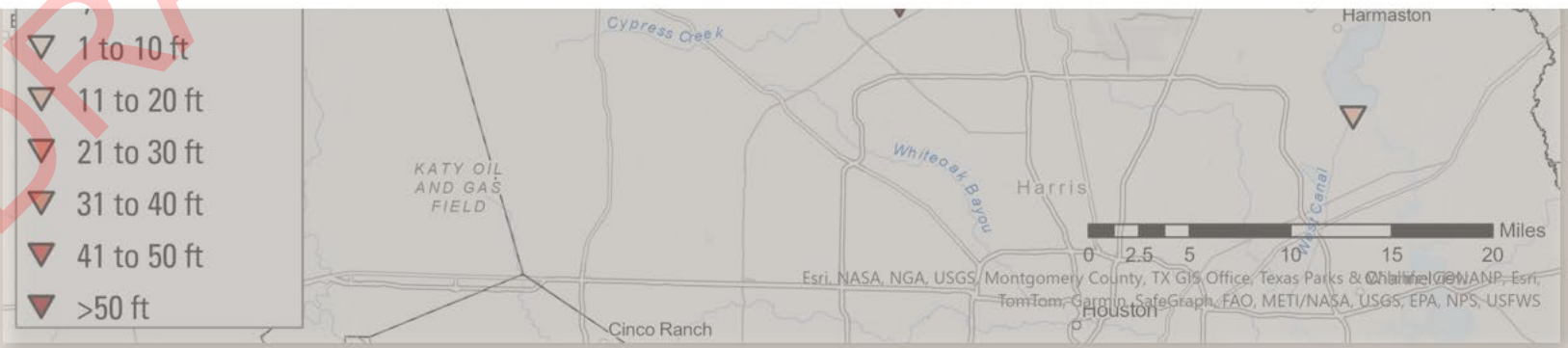
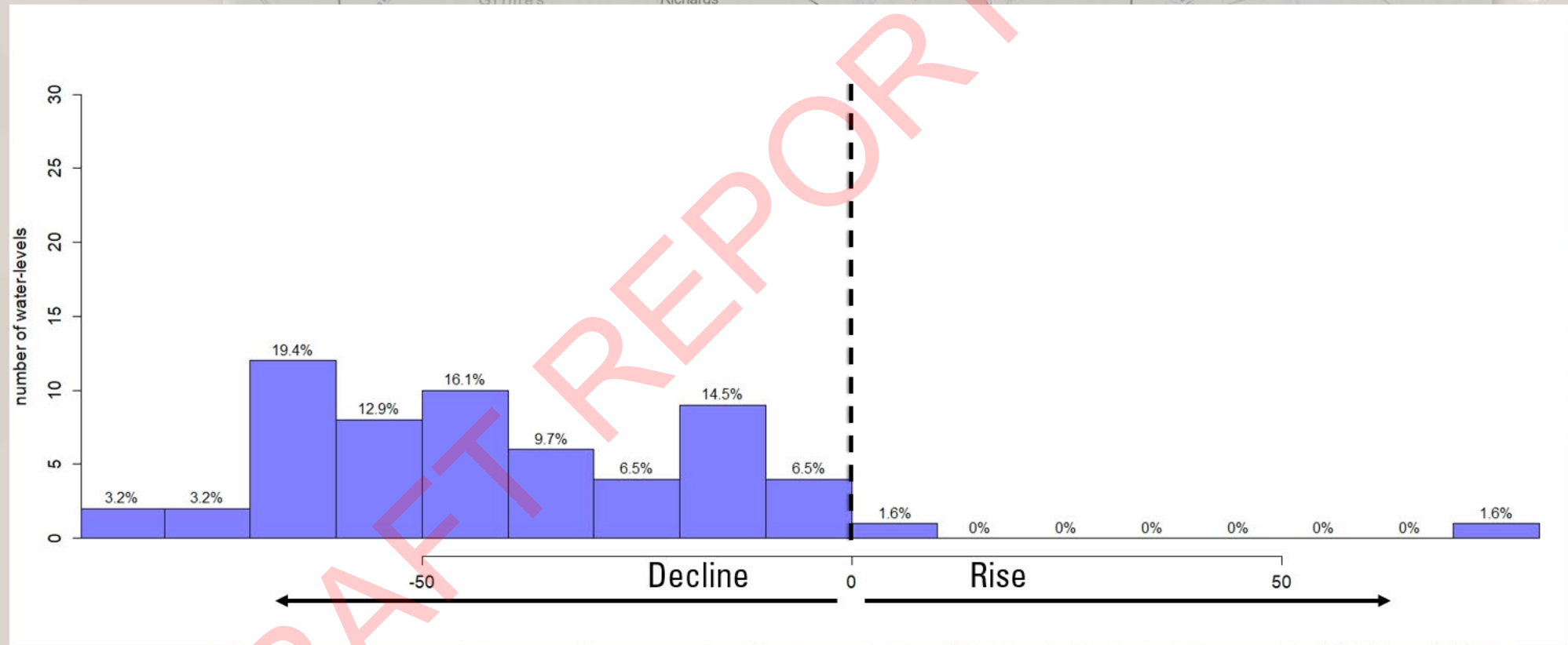
- 67 water-level pairs
 - Mostly declines (~88%)
 - About 75% were between 1 and 20 feet of decline
 - Largest declines (>30 ft):
 - 2 in south-central Montgomery County
 - 1 in central Montgomery County
 - Largest rises (> 30 ft):
 - 1 in west-central Montgomery County
 - 1 in south-central Montgomery County



2019 to 2024 Water-Level Change

Jasper

- 62 water-level pairs
 - Mostly declines
 - Only 2 rises
 - Declines >50 ft across much of central and southern Montgomery County



Long term change

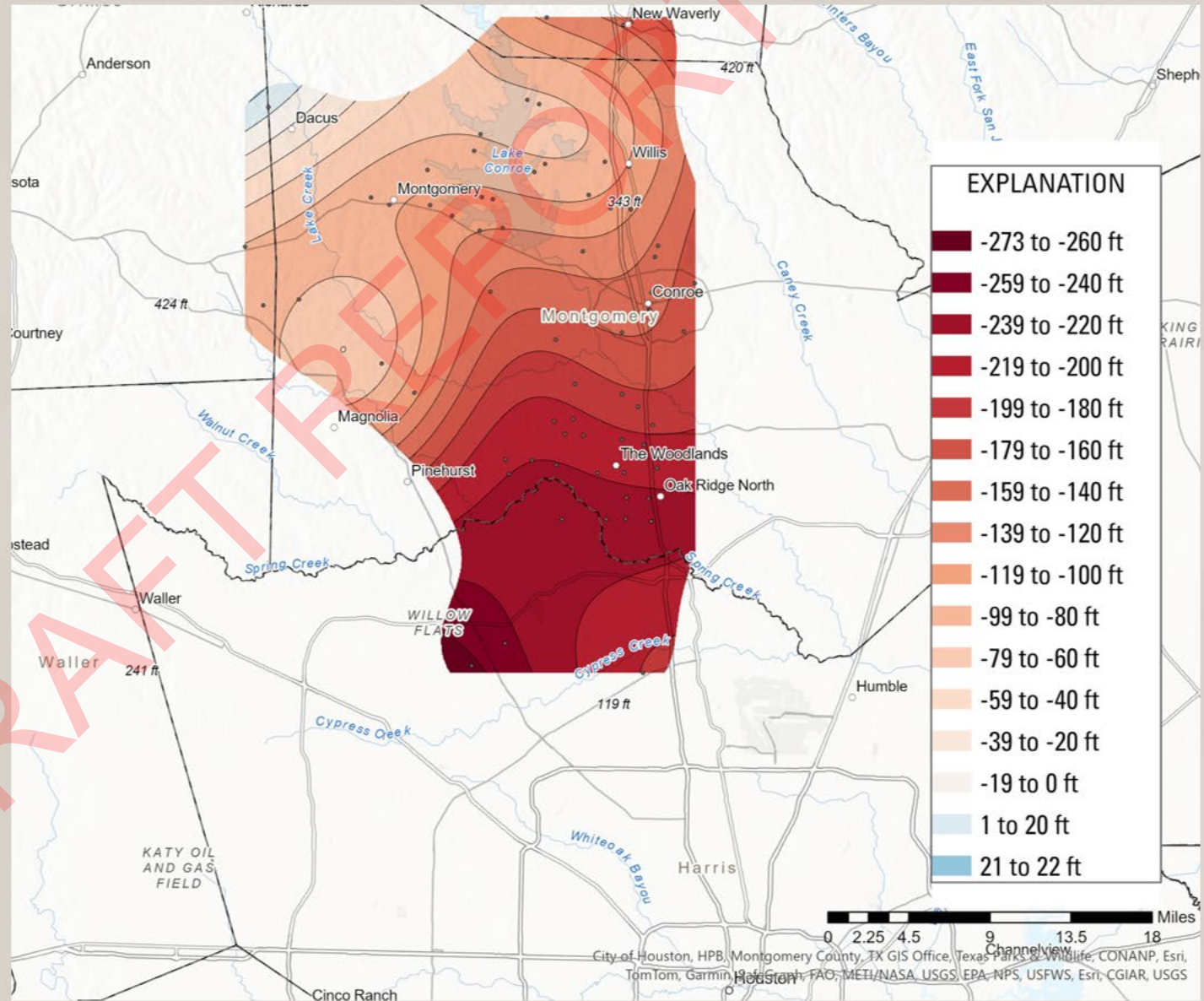
Water-level rises (blues):

- slight rises in northwestern Montgomery County and small portion of Grimes County

Water-level declines (reds):

- Most of Montgomery County – declines increasing in general down-dip direction into northern Harris County

Jasper Water-Level Change 2000 to 2024



Compaction 1973 - 2023

Compaction Interval:

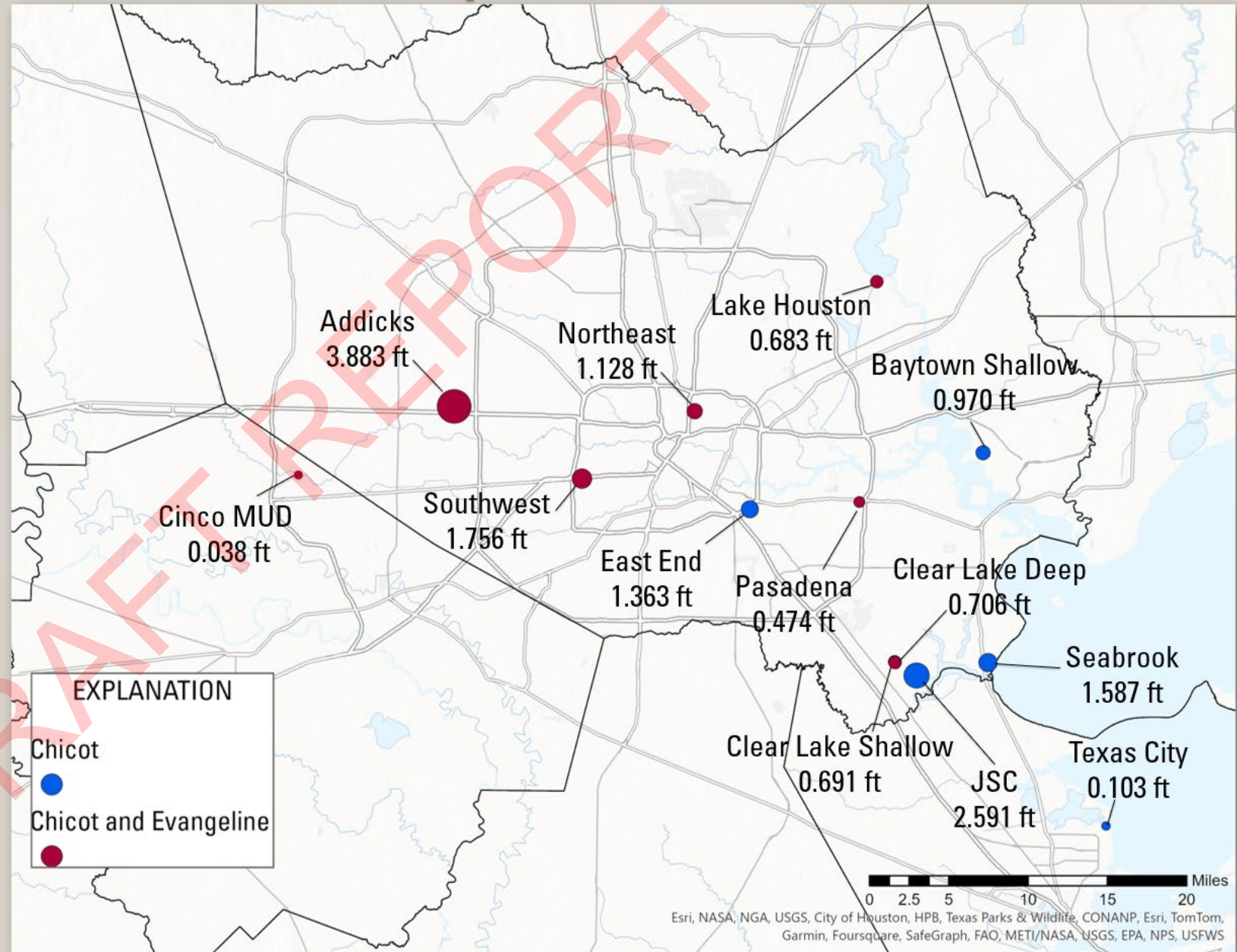
Chicot

1. 1973 | Baytown Shallow 0.970 ft.
2. 1973 | East End 1.363 ft.
3. 1973 | Johnson Space Center 2.591 ft.
4. 1973 | Seabrook 1.587 ft.
5. 1973 | Texas City 0.103 ft.
6. 1976 | Clear Lake Shallow 0.691 ft.

Compaction Interval:

Chicot and Evangeline

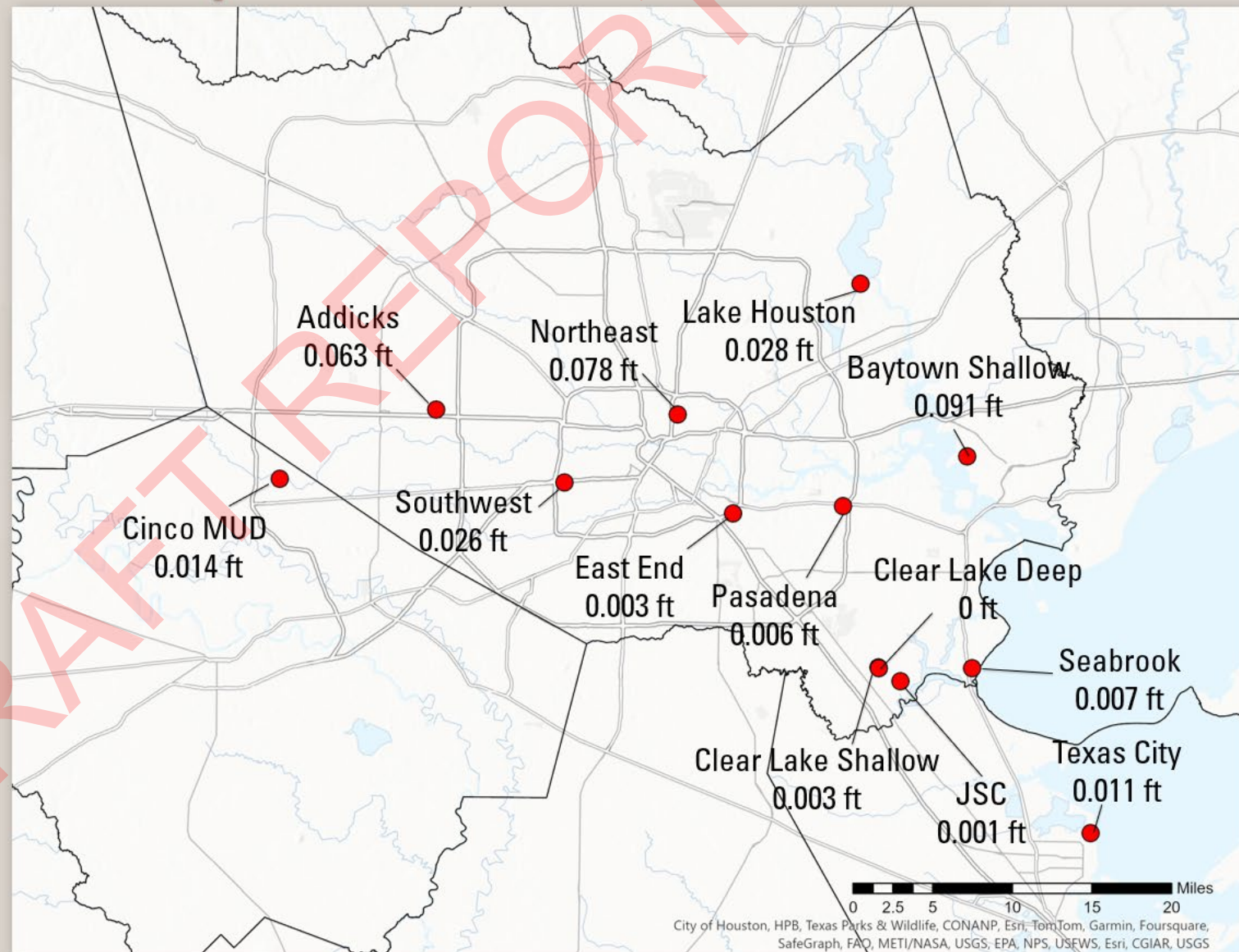
7. 1973 | Baytown Deep --- ft.
8. 1974 | Addicks 3.883 ft.
9. 1974 | Pasadena 0.474 ft.
10. 1976 | Clear Lake Deep 0.706 ft.
11. 1980 | Lake Houston 0.683 ft.
12. 1980 | Northeast 1.128 ft.
13. 1980 | Southwest 1.756 ft.
14. 2017 | Cinco MUD 0.038 ft.



2023 Compaction Summary

- No sites recorded expansion for the period
- Compaction ranged from 0.000 ft to 0.078 ft

Compaction December 2022 to December 2023



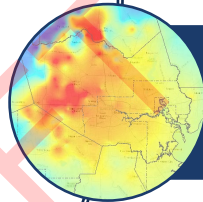
Agenda



Climate



Water Use



Groundwater Levels



Subsidence

Subsidence Monitoring

All HGSD-operated global positioning system (GPS) stations are constructed in a custom design.

GPS data are collected for approximately one week every two months (i.e., periodic monitoring).

DRAFT REPORT

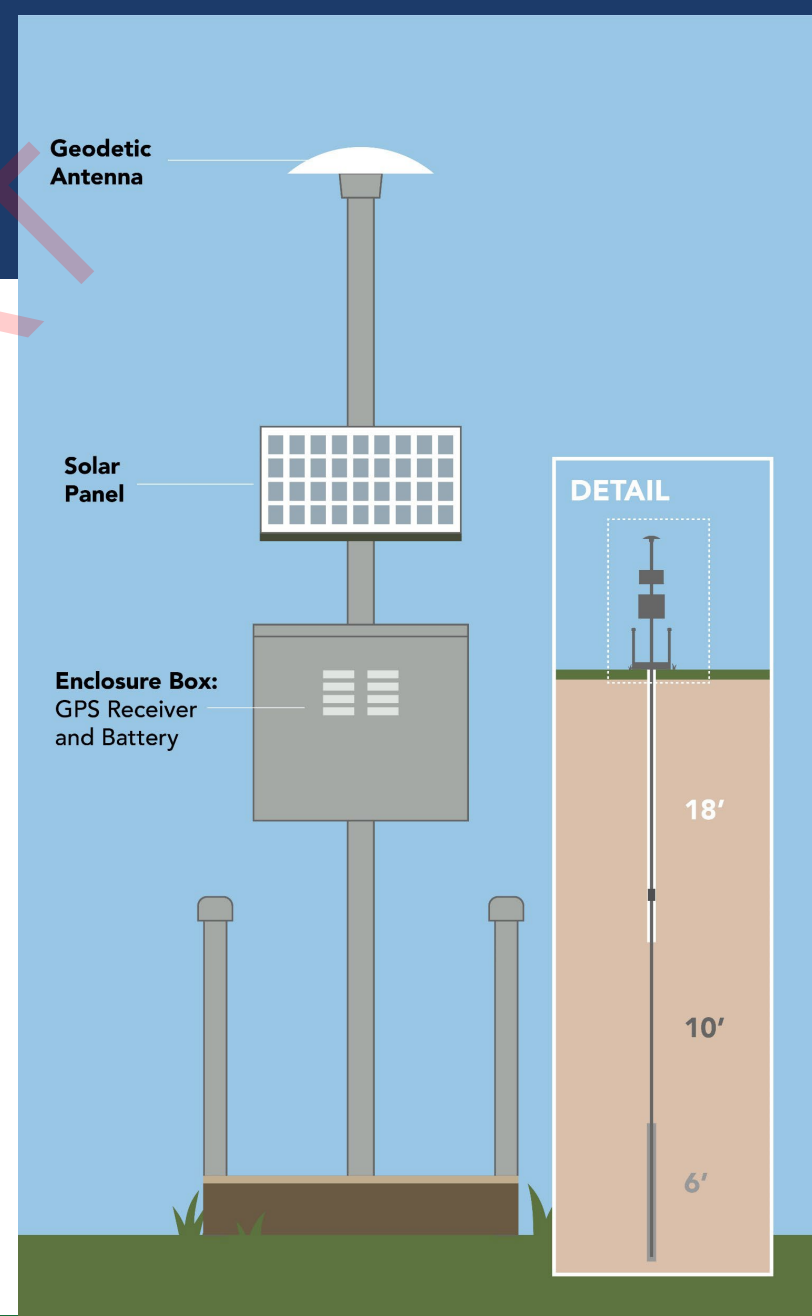










Exhibit 10 | Subsidence Monitoring Network

Location and operator of GPS stations that monitor land surface deformation periodically or continuously within southeast Texas in 2023.

EXPLANATION

-  HGSD Jurisdiction
-  Harris-Galveston Subsidence District
-  Fort Bend Subsidence District
-  University of Houston
-  Texas Department of Transportation
-  Brazoria County Groundwater Conservation District
-  Lone Star Groundwater Conservation District
-  Other Operators

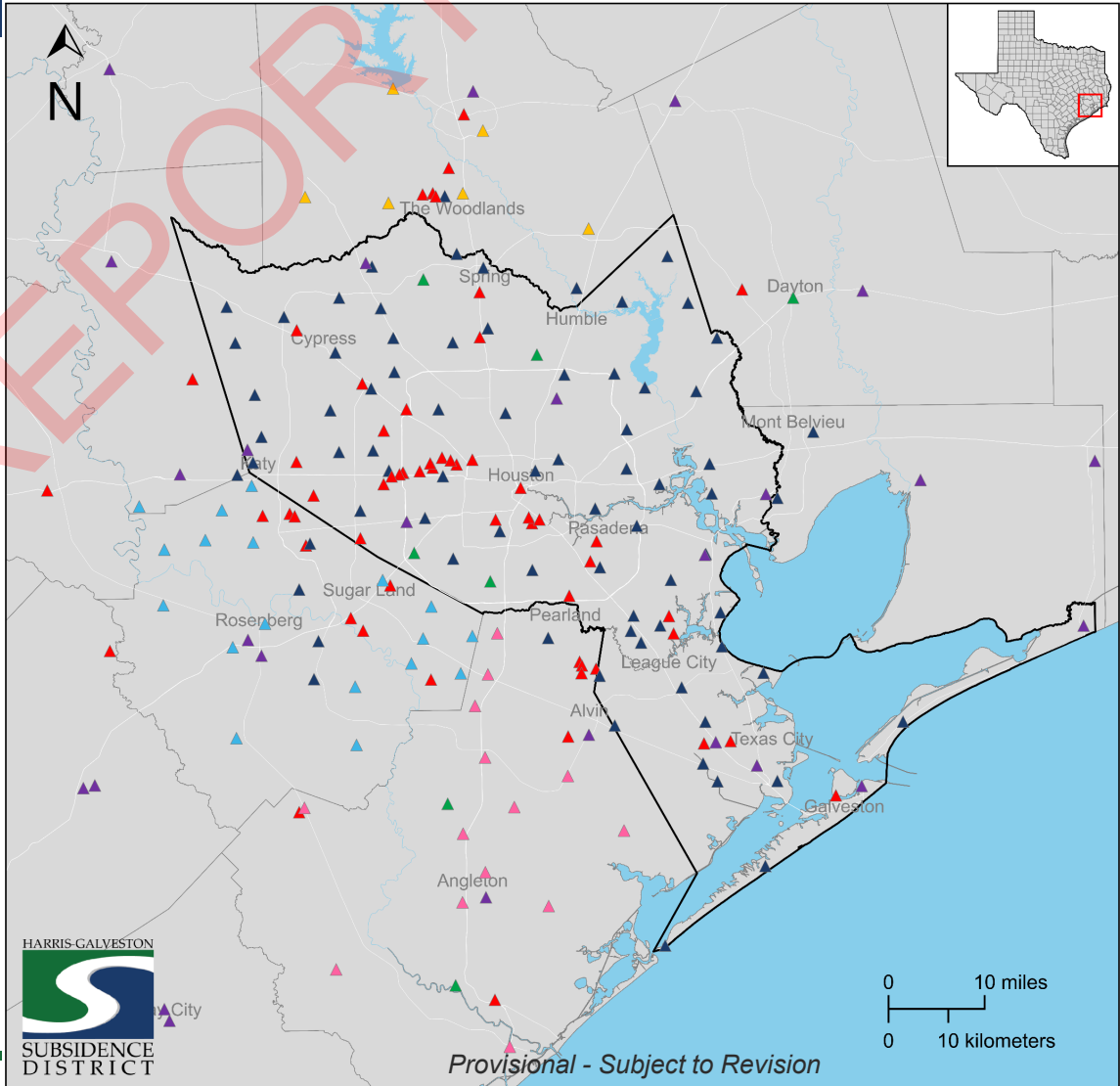


Exhibit 11 | Subsidence Rates

Annual subsidence rate, in centimeters per year (cm/yr.), estimated from GPS data collected at active stations with three or more years of data averaged from 2019 to 2023.

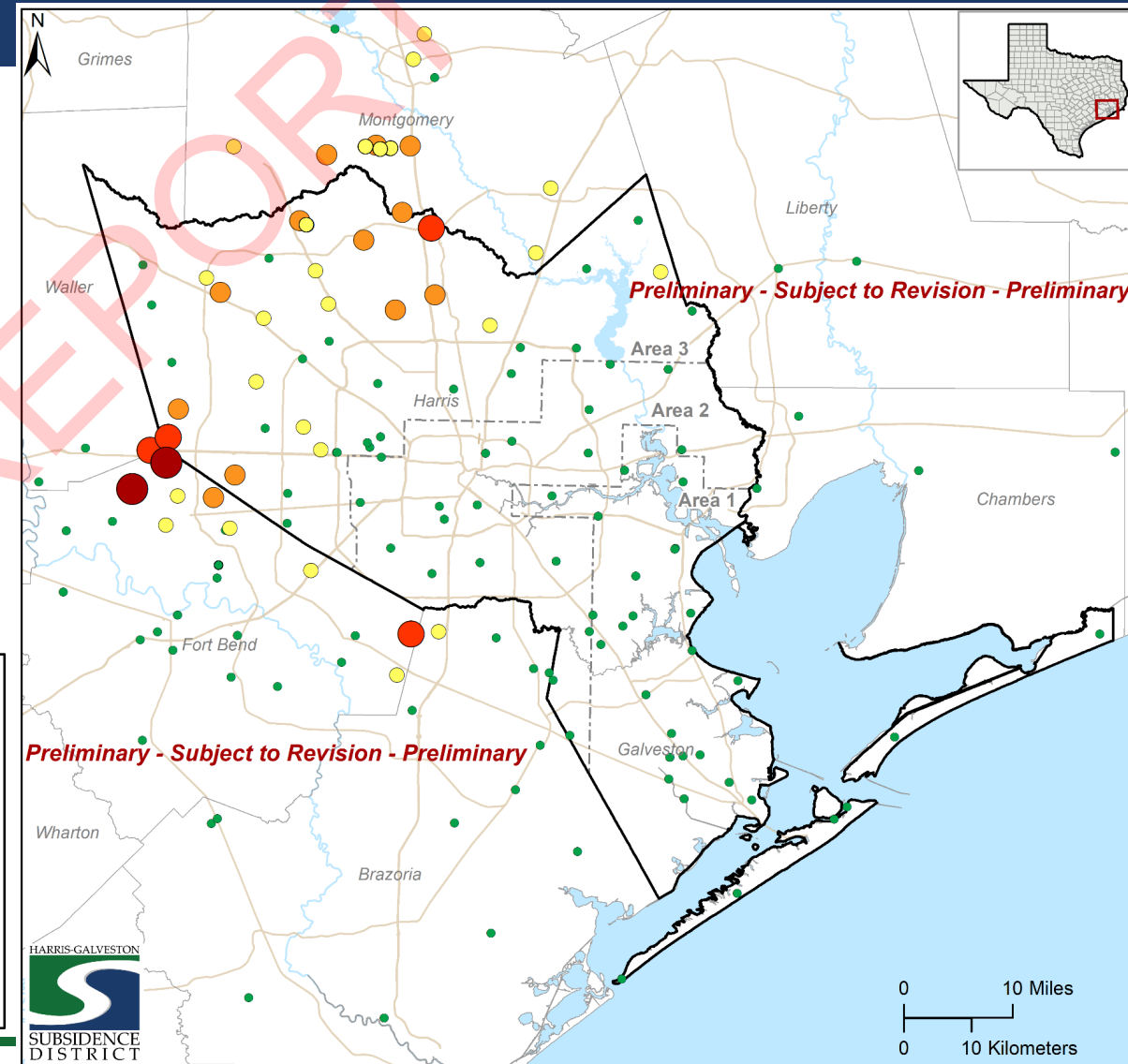
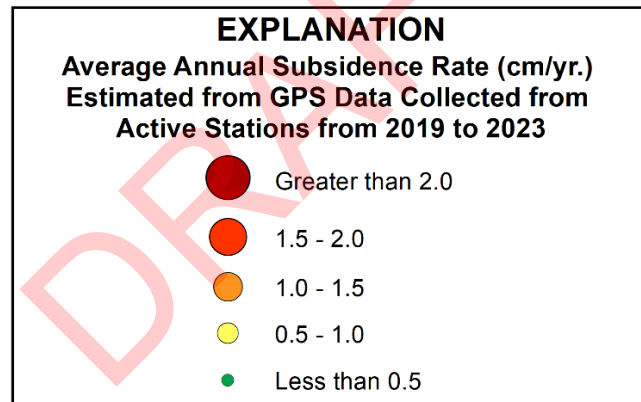
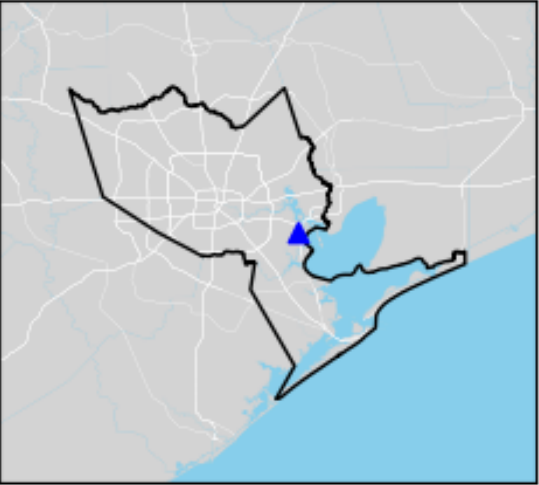


Exhibit 12 | Subsidence Data in La Porte

GPS station P024, located in La Porte, has measured a total of about 7 cm of uplift since 2002.



Processed GPS data (source: UH) over period of record. Processed data (grey circles) located inside the outlier boundary (red dashed lines) are used when calculating subsidence rates. Processed GPS data identified as outliers (red circles) are excluded from subsidence rate calculations and are shown for informational purposes only.

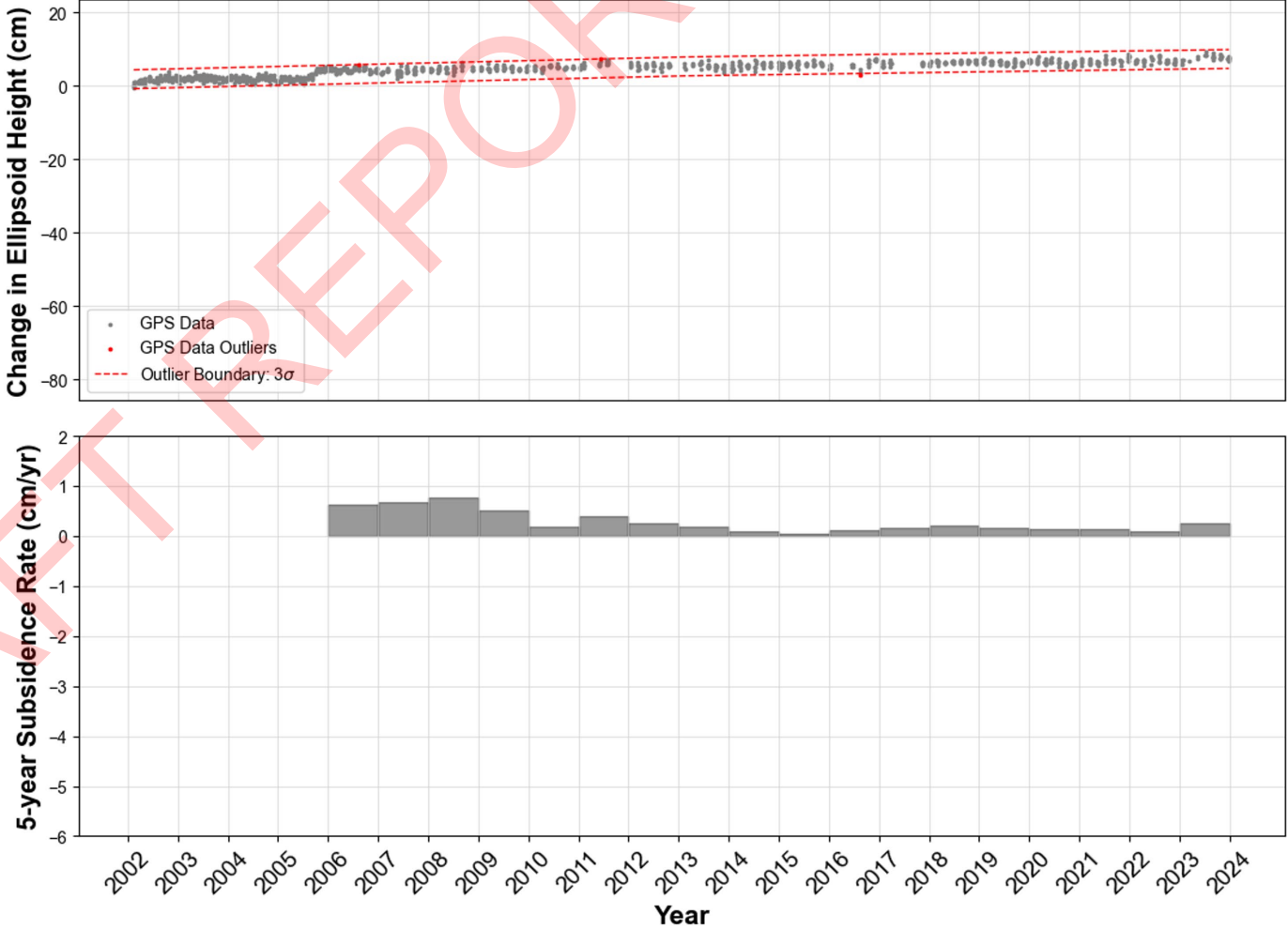
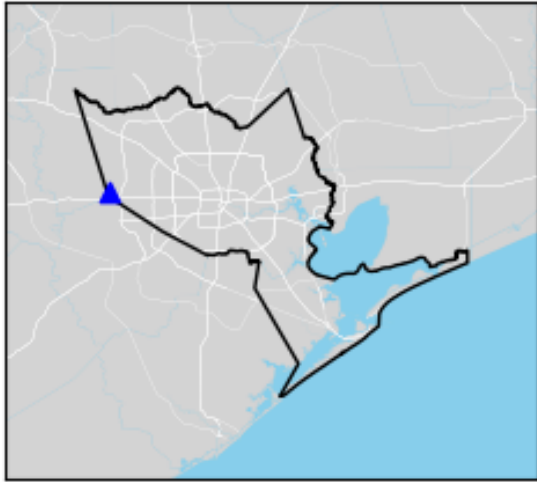
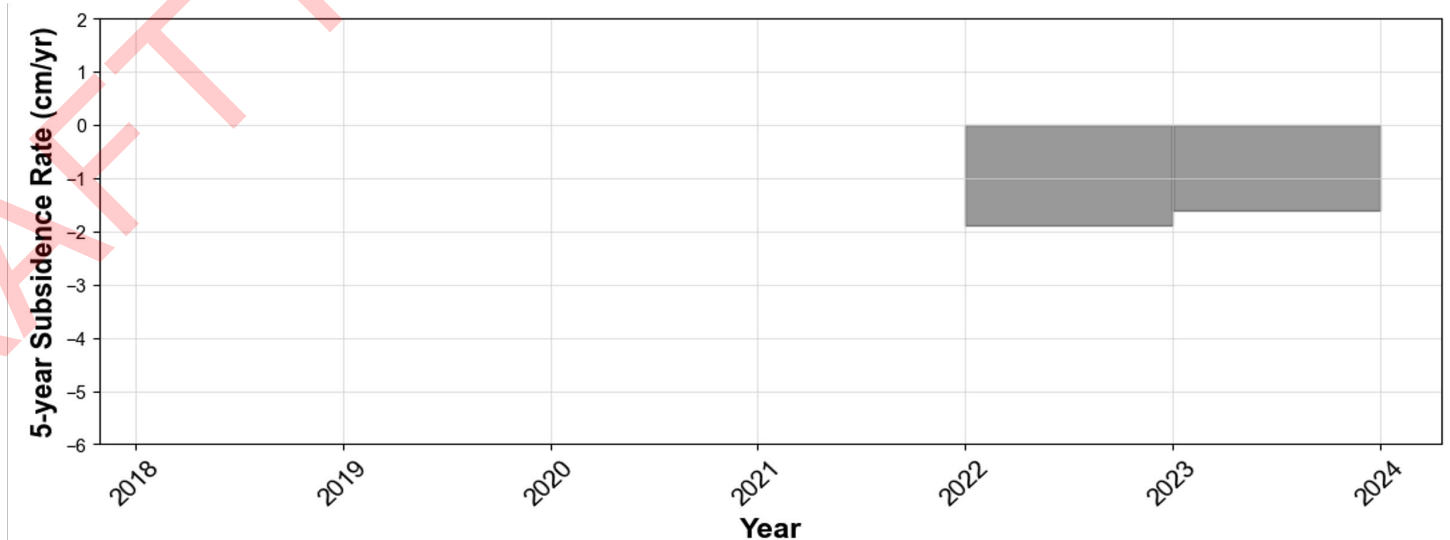
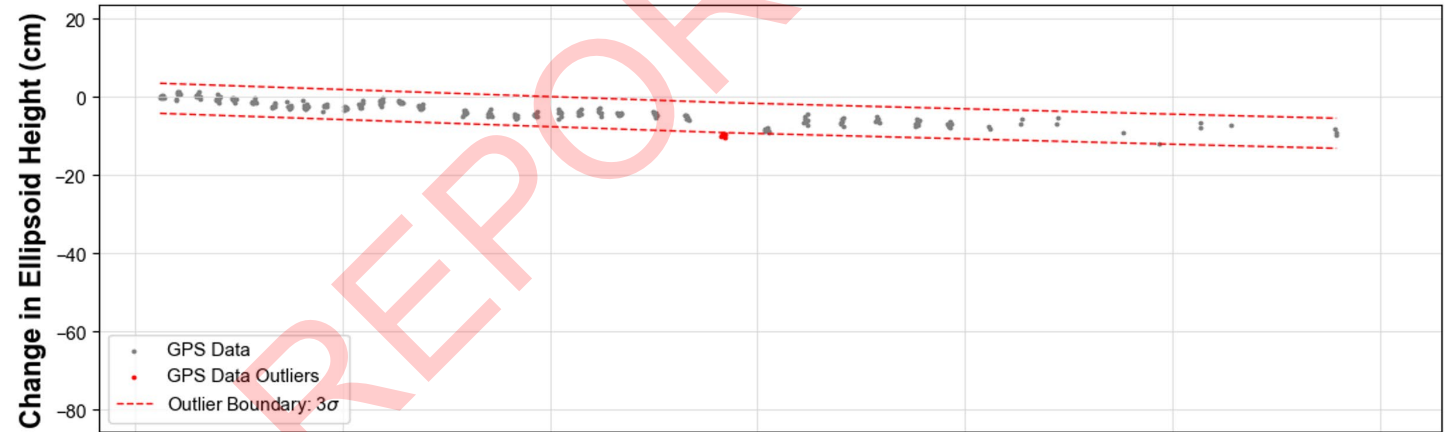


Exhibit 13 | Subsidence Data in Katy

GPS station P098, located in Katy, has measured a total of about 8.7 cm of subsidence since 2018.



Processed GPS data (source: UH) over period of record. Processed data (grey circles) located inside the outlier boundary (red dashed lines) are used when calculating subsidence rates. Processed GPS data identified as outliers (red circles) are excluded from subsidence rate calculations and are shown for informational purposes only.



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 options.

Thank you for attending the Public Hearing for the 2023 Annual Groundwater Report



- Record will be open until **May 3, 2024**. You may provide comments by sending an email to info@subsidence.org.
- The 2023 Annual Groundwater Report will be presented to the Harris-Galveston Subsidence District Board of Directors on **May 8, 2024**.
- The 2023 Annual Groundwater Report will be posted on HGSD's website at www.hgsubsidence.org upon approval from HGSD's Board of Directors.



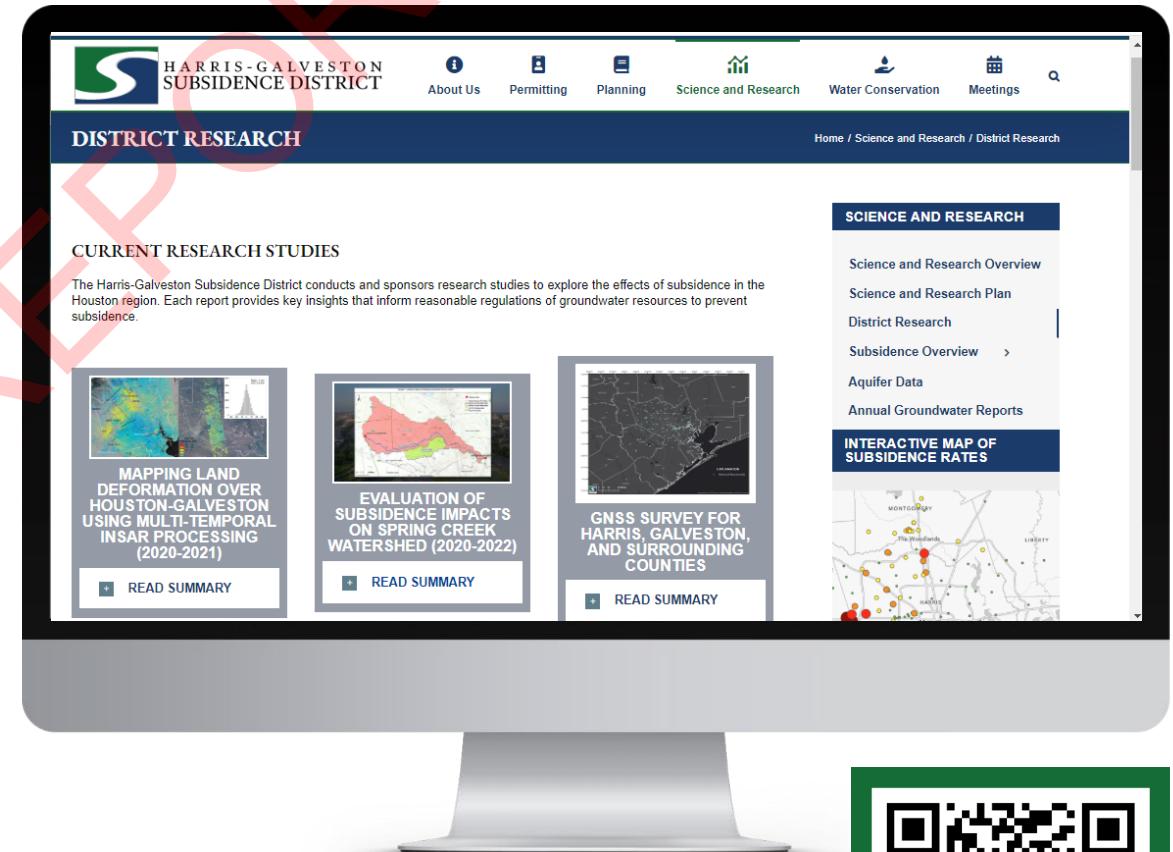
Additional HGSD Research & Publications

Subsidence Monitoring

- InSAR
- Benchmark Surveys
- GPS Data Processing

Subsidence Impacts

- Aquifer Storage and Recovery Assessment
- Brackish Groundwater Investigations





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