Appendix A – Exhibits Presented at Public Hearing held on May 28, 2020

Harris-Galveston Subsidence District Presentation
Subsidence District Mission

• The Subsidence District was created in 1976 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.

PROVISIONAL – SUBJECT TO CHANGE
Agenda

- Climate
- Groundwater Use
- Groundwater Levels
- Subsidence Data

PROVISIONAL – SUBJECT TO CHANGE
Weather Service Climate Stations

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

PROVISIONAL – SUBJECT TO CHANGE

Exhibit 1

EXPLANATION

- Weather Service Climate Stations

GALVESTON, TX - 2019

Exhibit 2

PROVISIONAL – SUBJECT TO CHANGE
Agenda

- Climate
- Groundwater Use
- Groundwater Levels
- Subsidence Data

Groundwater Withdrawals
Grouped by Regulatory Area - Regulatory Area One

- Public
- Indust.
- All Irrig.

2019 9.5 MGD

Exhibit 5
Exhibit 6

Groundwater Withdrawals
Grouped by Regulatory Area - Regulatory Area Two

Public  Indust.  All Irrig.

Exhibit 7

Groundwater Withdrawals
Grouped by Regulatory Area - Regulatory Area Three

Public  Indust.  All Irrig.
Groundwater Withdrawals
Grouped by Use - Entire District
- Public
- Indust.
- All Irrig.

Groundwater Withdrawals
Grouped by Regulatory Area - Entire District
- Area 1
- Area 2
- Area 3

Exhibit 8

Exhibit 9
Alternative Water Utilized (Surface and Reclaimed Water)
Grouped by Source- Entire District
- Trinity
- San Jacinto
- Brazos

Total Water Demand
Grouped by Source- Entire District
- Groundwater
- Trinity
- San Jacinto
- Brazos
- Reclaimed Water
Groundwater Withdrawals (Tri-County) Grouped by County

Harris
Galveston
Fort Bend

2019 303.7 MGD

Years

Exhibit 12
Note: 1990 is the first year for which Fort Bend data are available since that District’s inception)

Agenda

Climate
Groundwater Use
Groundwater Levels
Subsidence Data
USGS Presentation

Agenda

- Climate
- Groundwater Use
- Groundwater Levels
- Subsidence Data
GPS Monitoring Network

Location and Map Identification of GPS Monitoring Sites that record periodic or continuous GPS data within Harris and Surrounding Counties, Texas, 2019.

PROVISIONAL – SUBJECT TO CHANGE

Annual Subsidence Rate

Annual subsidence rate, in centimeters per year (cm/yr), estimated from three or more years of periodic or continuous GPS data measured at GPS monitoring sites in Harris and Surrounding Counties, Texas, 2015-2019.

PROVISIONAL – SUBJECT TO CHANGE
Regulatory Area Three

Annual subsidence rate (cm/yr) estimated from three or more years of periodic or continuous GPS data measured at GPS monitoring sites in Harris County, Texas, 2015-2019.

PROVISIONAL – SUBJECT TO CHANGE

Exhibit 15

Period of Record Plot

GPS monitoring site P001, located in Jersey Village, has the greatest subsidence measuring at 71.8 cm since 1994.

PROVISIONAL – SUBJECT TO CHANGE
GPS Monitoring Site P006, located near the West Houston Airport, has subsided 57.3 cm since 1997.

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**Regulatory Area Two**

Annual subsidence rate (cm/yr) estimated from 3 or more years of periodic or continuous GPS data measured at GPS monitoring sites in Harris and Galveston Counties, Texas, 2015-2019.

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**Exhibit 17**

**Exhibit 18**
GPS monitoring site P041, located in the Westbury neighborhood has measured 9 cm of subsidence since 2011.

Regulatory Area One

Annual subsidence rate (cm/yr) estimated from 3 or more years of periodic or continuous GPS data measured at GPS monitoring sites in Harris and Galveston Counties, Texas, 2015-2019.

PROVISIONAL – SUBJECT TO CHANGE
GPS monitoring site P024, located in LaPorte, measured uplift of 3 cm since 2002.

Surrounding Counties

Annual subsidence rate (cm/yr) estimated from 3 or more years of periodic or continuous GPS data measured at GPS monitoring sites in Brazoria, Fort Bend, Waller, Montgomery, Liberty and Chambers Counties, Texas, 2015-2019.
Fort Bend County

Annual subsidence rate (cm/yr) estimated from 3 or more years of periodic or continuous GPS data measured at GPS monitoring sites in Fort Bend County, Texas, 2015-2019.

Exhibit 23

Exhibit 24

P004
Period of Record Plot

GPS monitoring site P004, located in Sugar Land, has measured 28.4 cm of subsidence since 1994.
Period of Record Plot

GPS monitoring site P029, located in Katy, has measured 21.5 cm of subsidence since 2007.

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Surrounding Counties

Annual subsidence rate (cm/yr) estimated from 3 or more years of periodic or continuous GPS data measured at GPS monitoring sites in Montgomery County, Texas, 2015-2019.

PROVISIONAL – SUBJECT TO CHANGE
Period of Record Plot

GPS monitoring site P068, located in The Woodlands, has measured 8.2 cm of subsidence since 2011.

PROVISIONAL – SUBJECT TO CHANGE

Period of Record Plot

GPS monitoring site P013, located in The Woodlands, has measured 26.7 cm of subsidence since 2000.

PROVISIONAL – SUBJECT TO CHANGE
Surrounding Counties

Annual subsidence rate (cm/yr) estimated from 3 or more years of periodic or continuous GPS data measured at GPS monitoring sites in Brazoria County, Texas, 2015-2019.

PROVISIONAL – SUBJECT TO CHANGE

Exhibit 29

P088 Period of Record Plot

GPS monitoring site P088, located in Rosharon, has measured 2.7 cm of subsidence since 2016.

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Exhibit 30
Appendix A – Exhibits Presented at Public Hearing held on May 28, 2020

United States Geological Survey Presentation
Overview

- Approach and Methods
- Gulf Coast Aquifer System
- Groundwater Monitoring Network
- Groundwater-Level Maps by Aquifer
  - Current water-level altitudes
  - 1-year and 5-year water-level change
  - Long term water-level altitude change
- Cumulative Compaction
**Approach and Methods**

- Measure static water-levels
- Data interpretation
- Final Publication

#### Measure static water-levels

- 673 public supply, irrigation, industrial, and observation wells in 11-county Houston-Galveston region
- Measured between December and March with USGS approved methods

#### Data interpretation

- Data and analysis:
  1. Quality assured
  2. Peer reviewed by USGS prior to annual hearing and public comment period

#### Final Publication

- Data, interpretations, depictions, and documents are archived, published, and made available to the public

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**Groundwater Network**

- Strong collaboration with local well owners, municipalities, MUDs, PUDs, SUDs
- Chicot and Evangeline aquifers are hydraulically connected: withdrawals from one aquifer can affect heads in the other
- Number of wells used to construct 2020 contours:
  - Chicot (173)
  - Evangeline (326)
  - Jasper (112)
Hydrologic section of the Gulf Coast aquifer system
2020 Gulf Coast Water-Level Altitude Map Series

1977 - 2020 Chocot water-level altitude change
Contour interval: 20 feet
Range: 120 to 200
Water-level-altitude changes range from 128 ft of decline to 203 ft of rise
HGSD 1 - HGSD 2 - HGSD 3
FB A - FB B - A1

Chocot 1977 to 2020 Well Points:

- Chocot 1977 to 2020 Contours:

2020 Evangeline Water-Level Altitude
Contour interval: 50 feet
Range: 200 to 250
Water-level-altitude values range from 237 ft above datum to 252 ft below datum

Evangeline 2020 Altitude Well Points:

- Evangeline 2020 Altitude Contours:
### Summary: Groundwater Levels

#### 1 Year Changes (2019 to 2020)
- **Chicot**: about 41% declines in the 1 to 10 ft range
- **Evangeline**: about 49% declines in the 1 to 10 ft range
- **Jasper**: about 49% declines in the 1 to 10 ft range

#### 5 Year Changes (2015 to 2020)
- **Chicot**: about 57% rises in the 1 to 10 ft range
- **Evangeline**: about 27% rises in the 1 to 10 ft range and about 24% declines in the 1 to 10 ft range
- **Jasper**: about 65% greater than 10 feet of rise

### Summary: Groundwater Levels (cont.)
- Chicot water-level altitudes since 1990 and 1977 show mostly rises (~64% and ~64%)
- Evangeline water-level altitudes since 1990 indicate mostly rises (~62%)
- Evangeline water-level altitudes since 1977 indicate mostly (~66%) declines
- Over the period of 2000 to 2020, about 99% of water-level altitudes in the Jasper aquifer have declined.
Summary: Compaction

For the Period December 2018 through December 2019

- Four (4) sites recorded uplift ranging from 0.001 ft to 0.017 ft.
- Nine (9) sites recorded compaction ranging from 0.004 ft to 0.044 ft.
- One (1) compaction site recorded no change