HARRIS-GALVESTON
SUBSIDENCE
DISTRICT

2022 ANNUAL GROUNDWATER REPORT

Determination of Groundwater Withdrawal and Subsidence in Harris and Galveston Counties

EXECUTIVE SUMMARY

Harris-Galveston Subsidence District Report 2023-01

Harris-Galveston Subsidence District
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Executive Summary

Groundwater has been the primary source of water for municipal, agricultural, and industrial users over the last century. The rapid increase in population in the 1950s, due to the expansion of the industrial complex in the Houston Ship Channel area, led to a dramatic increase in water demand and groundwater withdrawal. The reliance on groundwater and subsequent subsidence that was caused by its regional development resulted in the creation of the Harris-Galveston Subsidence District (District) in 1975. The District's mission is to regulate the use of groundwater in Harris and Galveston counties to minimize subsidence that can cause infrastructure damage and contribute to flooding.

This report comprises the 47th Annual Groundwater Report for the District. Pursuant to District Resolution No. 2023-1098 passed on February 8, 2023, the Board of Directors held a public hearing at 9:00 a.m. on April 27, 2023, to present climatic conditions, groundwater use, groundwater levels and measured subsidence within the District through December 31, 2022. This report provides an overview of the information presented during the Public Hearing.

Description of Study Area

Harris and Galveston counties withdraw groundwater from the Gulf Coast Aquifer System which includes two primary water-bearing units: the shallow, hydrologically connected, system of the Chicot and Evangeline Aquifers and the deeper Jasper Aquifer. The regionally confining Burkeville unit separates the shallow and deeper systems. Only a small percentage of the total groundwater withdrawn within the District comes from the Jasper Aquifer; consequently, most of the subsidence that has occurred in the District can be sourced to clay compaction in the shallow water-bearing units.

The District's Regulatory Plan was developed to reduce groundwater withdrawal to a level that ceases ongoing subsidence and prevents future subsidence within the District. Since 1999, the District has been separated into three regulatory areas (**Figure 1**). Utilizing a novel regulatory approach, the amount of groundwater that a permittee may use is dependent upon their total water demand and location within a specific regulatory area. Regulatory Area One permittees can produce groundwater for up to 10% of their total water demand; whereas, Regulatory Areas Two and Three permittees can produce groundwater for up to 20% of their total water demand unless they are in a certified groundwater reduction plan.

The District's Regulatory Plan requires permittees to convert to alternative water supplies to reduce their reliance on groundwater sources. The primary alternative water supply used in the Houston region is surface water sourced from three river basins: the Brazos River Basin, the San Jacinto River Basin, and the Trinity River Basin.

In the 1950s, the City of Houston along with other entities in the region began the development of several water supply reservoirs within the San Jacinto and Trinity River Basins to provide water for the rapidly growing area. Today, water treatment plants served by these surface water sources and the Brazos River Basin are operated by the City of Houston, the City of Sugar Land, the City of Richmond, the Gulf Coast Water Authority, the Brazosport Water Authority, and others.

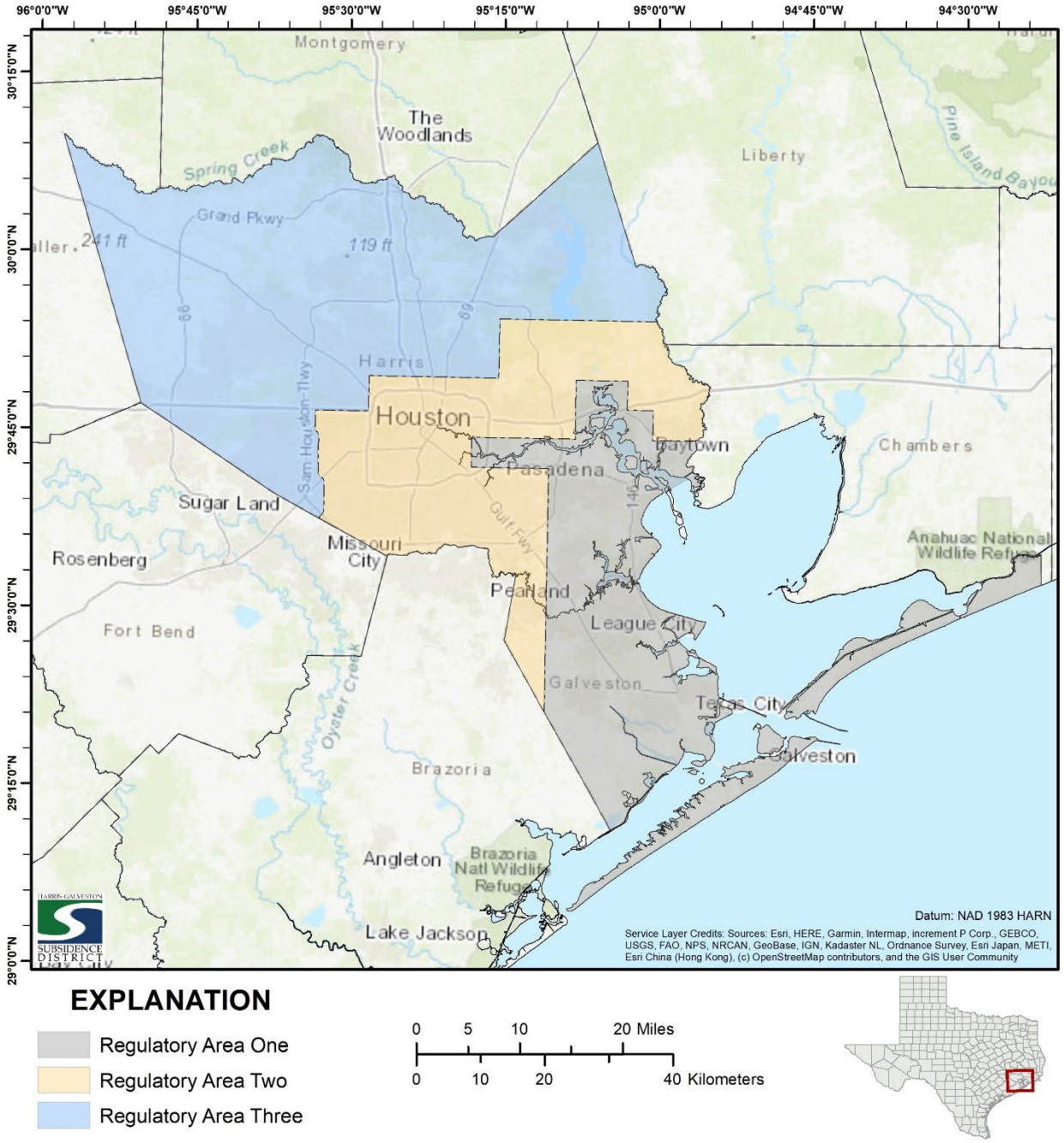

Figure 1. Location of the Harris-Galveston Subsidence District Regulatory Areas.

Climate

Annual variations in precipitation can significantly impact the total water demand in the District. Groundwater use patterns fluctuate during periods of climatic variation, which results in changes in aquifer water levels and, potentially, in subsidence rates. During periods of excessive rainfall, total water demand can decline; conversely, during periods of drought, water use can increase, resulting in declining water levels in the aquifer and increased subsidence rates. **Figure 2** shows the 2022 cumulative precipitation for eight (8) climate stations compared to the 1991-2020 normal precipitation level. The 2022 calendar year began with below normal rainfall for

seven (7) out of eight (8) National Weather Service (NWS) climate stations analyzed for the region. The year progressed with all stations recording below the 1991-2020 averaged normal precipitation and worsened in the summer months, where an exceptional drought was classified for the region. All climate stations ended 2022 with rainfall accumulations below normal for with some stations measuring over 20 inches below normal, marking a sharp change in rainfall from previous years where rainfall was near to above normal.

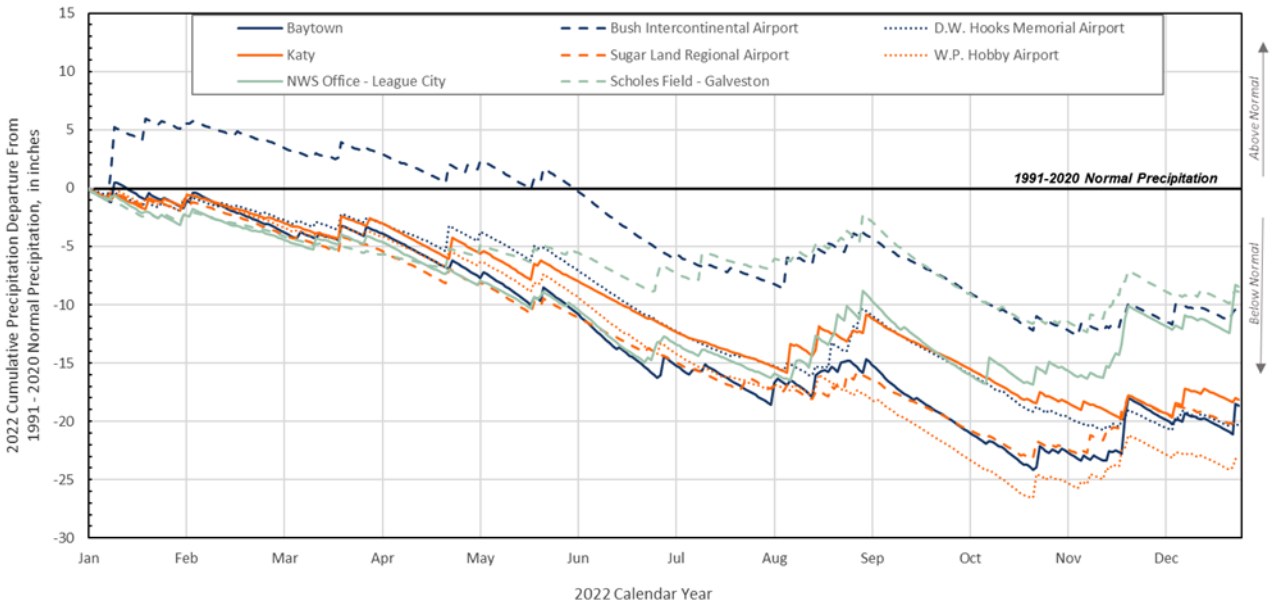

Figure 2. Cumulative precipitation departure, in inches, from 1991-2020 normal precipitation (sourced from https://www.ncei.noaa.gov/data/normals-daily/1991-2020/access/) at selected NOAA-NWS Climate Stations in the Houston region. Individual climate station data are sourced from NOWData – NOAA Online Weather Data accessed via https://www.weather.gov/wrh/Climate?wfo=hgx

Water Use

Since 1976, water users in the District have been working to change their source water from groundwater to alternative sources of water, primarily treated surface water in an effort to prevent subsidence. The total water demand sourced from groundwater dropped from about 60 percent in 1976 to about 24 percent in 2022. Most of the current groundwater use occurs in Regulatory Area Three where the regulatory compliance timeline will not be completed until 2035. The three-primary water uses in the District are public supply, industrial, and irrigation. The overall groundwater use within the District in 2022 is 252.9 million gallons per day (MGD), which is a 24 percent increase in pumpage from 2021 (**Figure 3**). Public supply groundwater use remains the largest single-use category at 231.63 MGD, a 24 percent increase from 2021, and accounts for 92 percent of groundwater used in the District.

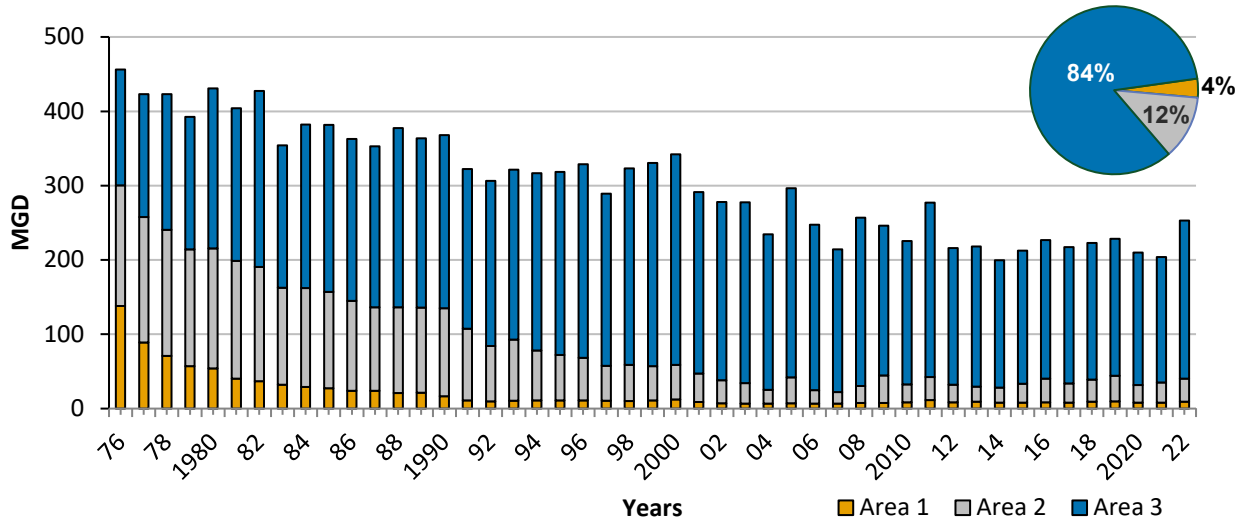

Figure 3. Groundwater withdrawals, in million gallons per day, by regulatory area from 1976 to 2022. In 2022, a total of 9.2 MGD of groundwater was used in Regulatory Area One, with 31.1 MGD used in Regulatory Area Two and 212.6 MGD used in Regulatory Area Three. The pie chart shows the percentage of each Regulatory Area from the total groundwater used in 2022.

The District's Regulatory Plan requires permittees to convert to alternative water supplies to reduce their reliance on groundwater. Our region's primary alternative water supply is surface water sourced from three river basins: the Brazos River Basin, the San Jacinto River Basin and the Trinity River Basin. In 2022, the total alternative water use was 810.6 MGD, with the Trinity River remaining the single largest source of alternative water, providing a total of 546.2 MGD in surface water supply. Groundwater remains the second largest source of water supply within the District as a whole. The total water use for the District was 1,063.5 MGD in 2022, which is eight (8) percent higher than the reported water use in 2021 (**Figure 4**).

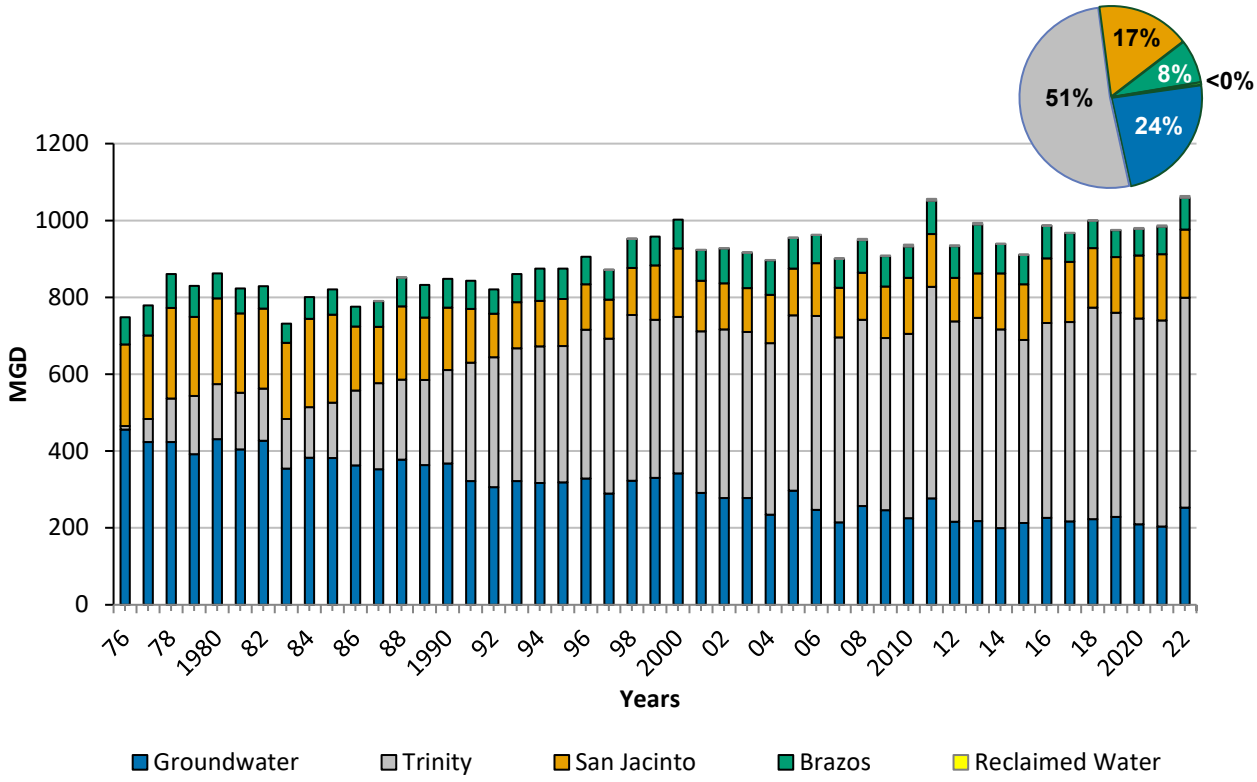

Figure 4. Total water use for the District, in million gallons per day, by source water, from 1976 to 2022. The reported total water use for the District in 2022 was 1,063.5 MGD. The pie chart shows the percentage of each water source from the total water demand in 2022.

Groundwater Levels

Annually, since 1975, the United States Geological Survey (USGS) has measured the water level in hundreds of wells throughout the Houston region in cooperation with the District through a joint funding agreement along with additional cities, subsidence districts, and groundwater conservation districts to monitor and provide reports on groundwater level altitude data for the Chicot/Evangeline and Jasper Aquifers. Since aquifer water level is the best measure of the pressure in the aquifer, this information is also vital to understanding the impact of changes in water use on subsidence.

The change in water level in the Chicot and Evangeline (undifferentiated) aquifers since 1977 clearly shows the impact of District regulation on the aquifers (**Figure 5**). Generally, Regulatory Areas One and Two have seen a significant rise in the potentiometric water level up to 228 feet (69.5 meters) in the Chicot and Evangeline (undifferentiated) aquifers. The area of rise results from the reduction of groundwater use required by the District's Regulatory Plan. Conversely, in Regulatory Area Three and southern Montgomery County, water levels remain significantly lower than the historical benchmark. The maximum decline for the Chicot and Evangeline (undifferentiated) aquifer occurs in southern Montgomery County, with 371 feet (113 meters) change from 1977 to 2023.

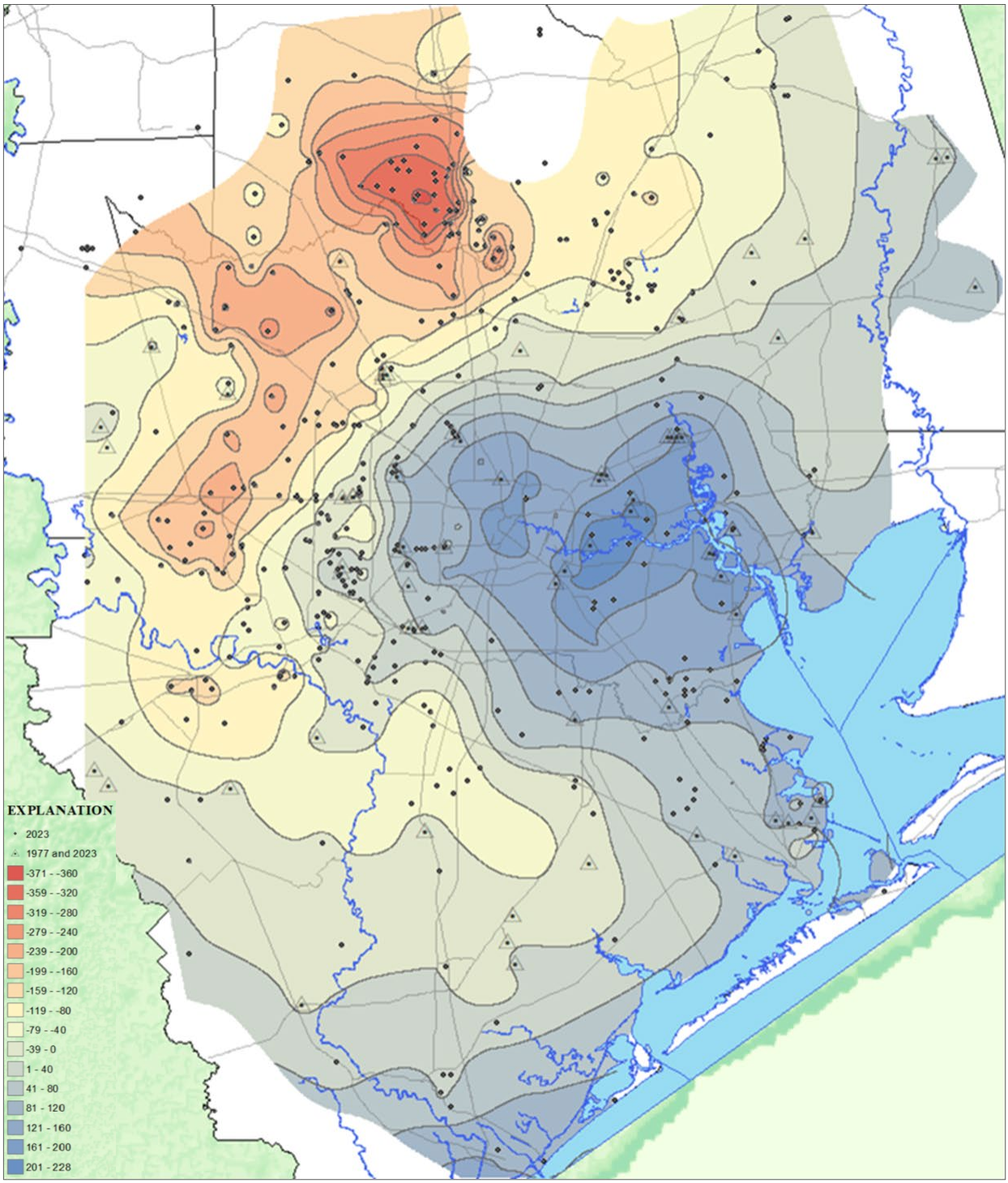

Figure 5. Potentiometric water level change at wells screened in the Chicot/Evangeline Aquifer, Houston region, Texas, 1977 to 2023 (Source: USGS provisional data – preliminary and subject to change).

Subsidence

Since the 1990s, the District has utilized global positioning system (GPS) technology to monitor land surface deformation. Working collaboratively with universities and local agencies, the subsidence monitoring network has grown to over 230 GPS stations throughout the region. The average annual rate of vertical movement is a useful measure to show current conditions at a GPS station. The 2018 to 2022 subsidence rates, which are the linear regression of GPS data over that time interval, are shown in **Figure 6**. The annual rates of subsidence observed in Regulatory Areas One and Two are stable, since both areas have reached their full regulatory conversion level (1990 and 2002, respectively) and Chicot/Evangeline water levels have risen. Subsidence rates are generally above 0.5 centimeters per year throughout Regulatory Area Three, as groundwater is still the primary water source in this area, and groundwater levels are significantly below the historical benchmarks. The highest subsidence rates (i.e., over two centimeters per year) were measured in Katy within northeastern Fort Bend County and southeastern Waller County.

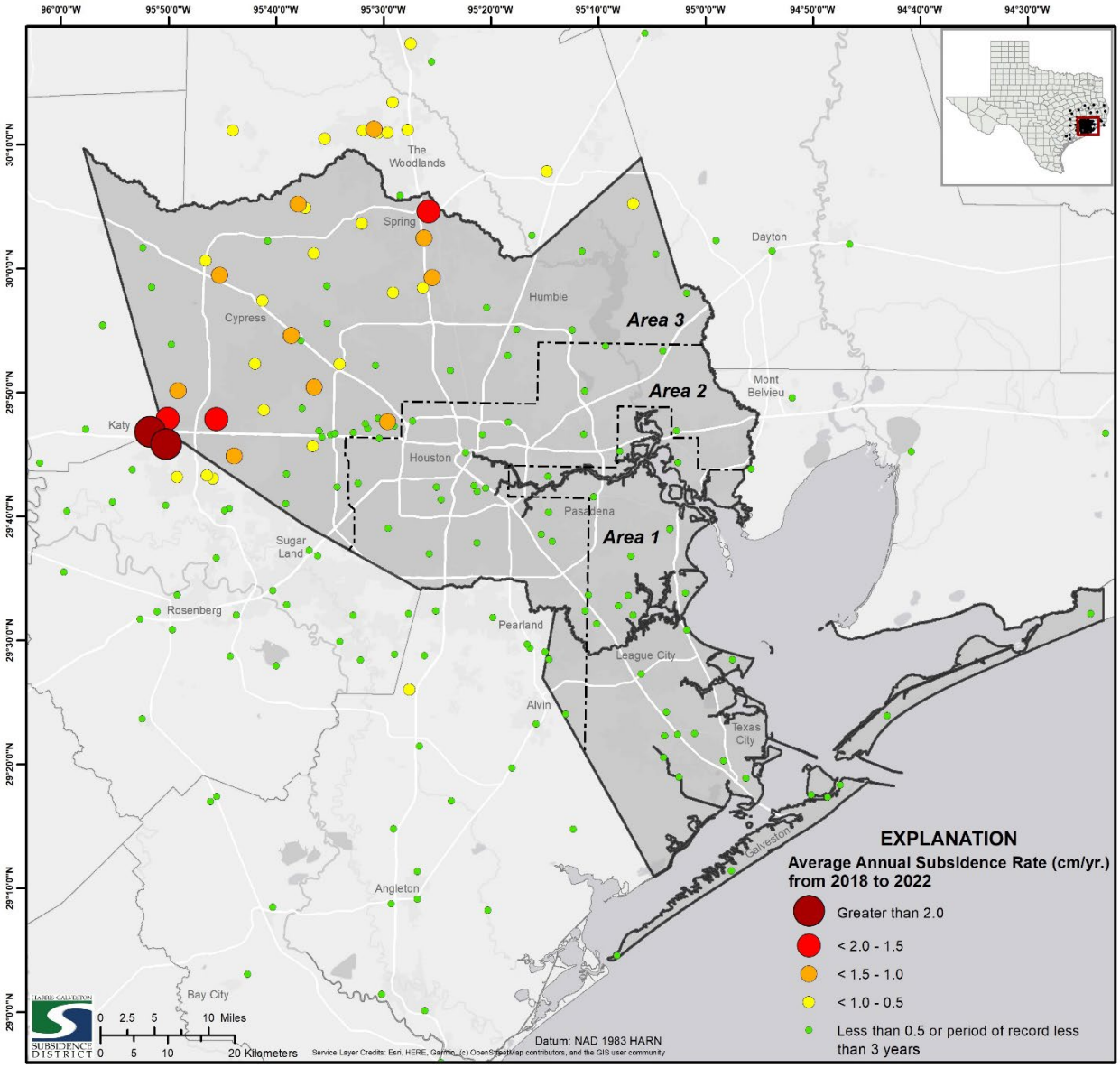

Figure 6. Annual subsidence rate, measured in centimeters per year, from 2018 to 2022, referenced to Houston20 and estimated from three or more years of GPS data collected from GPS stations in Harris, Galveston and surrounding counties, Texas.