Subsidence in the Greater Houston Area – Past, Present and Future

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Harris County and the seven surrounding counties (Brazoria, Chambers, Fort Bend, Galveston, Liberty, Montgomery, and Waller), when combined are larger than 32 of the individual states in the United States of America. It is not surprising, that the greater Houston area has many significant challenges ahead that many states will not likely face. But some problems are common to most places. The greater Houston area has been facing water issues for years and will continue to face significant infrastructure requirements in the future. Based on the calendar year 2001, Harris and Galveston Counties combined for an average daily total water demand of 1 billion gallons of water. Fortunately, about 70% of that total water demand was met with surface water. Surface water utilization was not always the case in the past, which is why the Harris-Galveston Coastal Subsidence District was created.

Greater Houston is no stranger to subsidence, which is caused predominantly by the over-reliance of groundwater. The first known description of subsidence in the 1920's, however, was not the result of groundwater pumpage, but rather from oil and gas withdrawal in the Goose Creek area of Baytown. The fluids withdrawn from very shallow oil and gas fields allowed the clay layers to compact beneath the land surface. Approximately two feet of subsidence resulted from early 20^{th} century oil and gas withdrawal. The amount of subsidence first identified in Goose Creek, would pale in comparison to what would occur over the next 60 years. The growth of greater Houston since the 1920's demanded significant water supplies. The aquifers beneath land surface, yielded amazing amounts of high quality water. The area grew substantially on the basis of an already distributed groundwater source. Since the original two feet of subsidence from oil and gas withdrawal, the increasing population's thirst for groundwater yielded as much as five times more subsidence.

In the early 1970's, groundwater pumpage was approaching 450 million gallons per day (mgd). Subsidence had resulted in elevation losses that threatened entire subdivisions with complete destruction from tidal flooding. The major elements of Houston's economy were at risk of significant flooding, including the Port of Houston, the Ship Channel industries, industries in Baytown and Texas City, the Port of Galveston, NASA's Johnson Space Center, the Texas Medical Center, and all the businesses located downtown. The Texas Legislature created the Harris-Galveston Coastal Subsidence District in 1975, to tackle on the problem of subsidence.

The District first focused on the coastal areas, which were most at risk due to the lower elevations. An Area of Concentrated Emphasis (ACE) was created based on elevations subject to hurricane tidal surges of 30 feet. The District required groundwater permittees

within the ACE to review all options for reducing groundwater withdrawals. Cities and industries were largely cooperative and began significantly reducing groundwater withdrawals within a few years. From 1976 to 1985, within what is now Regulatory Areas 1 and 2 (loosely the ACE), groundwater pumpage was reduced from 300 mgd to 155 mgd. As of 2001, Regulatory Areas 1 and 2, combine for only 16% of all the groundwater pumped within Harris and Galveston Counties, 278 mgd.

In 1985 the District developed a Regulatory Plan which divided the District into eight regulatory areas, with the main focus on the coastal areas. The coastal areas were defined as Area 1, the immediate coastal frontage area and Area 2 as the low elevation areas (roughly less than more 30 feet), with requirements to reduce groundwater pumpage to no more than 10% and 20% of total water demand, respectively. These areas were largely successful in implementing alternative sources of water. Groundwater pumpage decreased at a steady rate in Areas 1 and 2. Subsidence slowed to a crawl in most parts of Areas 1 and 2 by the late 80's and stabilized in the 90's and since. While the District saw great success in Galveston County and southeastern Harris County, north and west Harris County began to subside at increasing rates. In current Area 3, groundwater pumpage increased significantly through the late 80's and showed no signs of stopping. Subsidence rates in northwest Harris County were beginning to equal the all time historic high rates from eastern Harris County at one-tenth to one-quarter a foot per year.

In 1992, with the coastal areas succeeding in reducing subsidence rates, the District revised the Regulatory Plan, re-dividing the District into seven regulatory areas, with new focus on central, north and west Harris County. The 1992 Regulatory Plan was soon overhauled to accommodate the significant differences between the coastal and the non-coastal areas within the District. Instead of many regulatory areas, the District opted for three. The boundaries of Areas 1 and 2 remained basically intact. As of 1999, Areas 1 and 2 were predominantly converted to surface-water, with only a few entities yet to convert from groundwater.

In comparison to only a few large cities in Areas 1 and 2, the north and west parts of Harris County contain approximately 400 municipal utility districts (MUDs), in addition the City of Houston and a few other smaller cities. North and west Harris County were combined into one area, Regulatory Area 3, to allow for the MUDs and cities to work together to reduce groundwater pumpage much the way the cities had cooperated in Areas 1 and 2.

The current Plan, 1999 Regulatory Plan, was innovative in regulating groundwater. By combining Area 3 into one area and giving clearly stated groundwater reduction goals of 30% by 2010, 70% by 2020, and 80% by 2030, the District allowed entities to work together in ways that would best fit their individual needs, while collectively solving the regional problem of subsidence. Permittees in Area 3 are allowed to join into groups to submit Groundwater Reduction Plans (GRPs) which would meet the District's goals with efficient and effective plans. Another key element to the 1999 Regulatory Plan was the development of a Disincentive Fee to ensure compliance with the District's goals. The Disincentive fee, currently at $3.00 per 1,000 gallons, is a direct disincentive to the

continued reliance on groundwater. The Disincentive Fee went into effect in Areas 1 and 2 in 2001, and has proven a very good tool to convert the remaining entities that relied on 100% groundwater. Starting in 2003, if a permittee in Area 3, does not have a GRP certified by the District, the Disincentive Fee will be applied to the amount of groundwater the permittee pumps above 20% of their total water demand.

Currently, a majority of permittees will likely comply with the District's 1999 Regulatory Plan requirements, by virtue of their participation in a GRP. The City of Houston received certification of their GRP and are in the process of adding possibly 150 MUDs and other entities to their GRP. The North Harris County Regional Water Authority and the West Harris County Regional Water Authority have submitted GRPs for certification, which should take place within the first half of 2003. A number of smaller individual GRPs have been certified with more expected, in order to avoid Disincentive Fees. If the District is forced to bill Disincentive Fees, all fees collected will be set aside to grant to projects that will help reduce the over-reliance on groundwater.

The District is committed to reducing current subsidence rates and protecting against future subsidence. Over the next 50 years, the greater Houston area is expected to more than double, essentially adding the City of Los Angeles to what is now the 4th largest city in the USA. If the increasing population were to use groundwater to quench its thirst, another 5 feet of subsidence would result through 2030 in northwest Harris County. Just as alarming, however, would be that the coastal areas would experience from 1 to 3 feet of additional subsidence. The main economic sectors of greater Houston would be flooded, without the 1999 Regulatory Plan being implemented. With implementation virtually no subsidence will occur in the high risk, coastal areas and maybe only 2 to 2.5 feet of additional subsidence in northwest Harris County. It is possible that even more groundwater reductions than currently required may occur faster than expected, possibly resulting in subsidence through 2030 of only as much as 1 to 1.5 feet.