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In cooperation with the Harris-Galveston Subsidence District, City of Houston, Fort Bend Subsidence District, and Lone Star Groundwater Conservation District

Water-Level Altitudes 2009 and Water-Level Changes in the Chicot, Evangeline, and Jasper Aquifers and Compaction 1973–2008 in the Chicot and Evangeline Aquifers, Houston-Galveston Region, Texas

Scientific Investigations Map 3081

U.S. Department of the Interior
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Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) and North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

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Abstract

This report, done in cooperation with the Harris-Galveston Subsidence District, the City of Houston, the Fort Bend Subsidence District, and the Lone Star Groundwater Conservation District, is one in an annual series of reports that depicts water-level altitudes and water-level changes in the Chicot, Evangeline, and Jasper aquifers, and compaction in the Chicot and Evangeline aquifers in the Houston-Galveston region, Texas. The report (excluding appendixes) contains 16 sheets and 15 tables: 3 sheets are maps showing current-year (2009) water-level altitudes for each aquifer, respectively; 3 sheets are maps showing 1-year (2008–09) water-level changes for each aquifer, respectively; 3 sheets are maps showing 5-year (2004–09) water-level changes for each aquifer, respectively; 4 sheets are maps showing long-term (1990–2009 and 1977–2009) water-level changes for the Chicot and Evangeline aquifers, respectively; 1 sheet is a map showing long-term (2000–2009) water-level change for the Jasper aquifer; 1 sheet is a map showing site locations of borehole extensometers; and 1 sheet comprises graphs showing measured compaction of subsurface material at the sites from 1973 or later through 2008, respectively. Tables listing the data used to construct the aquifer-data maps and the compaction graphs are included.

Introduction

This report is one in an annual series of reports that depicts water-level altitudes and water-level changes in the Chicot, Evangeline, and Jasper aquifers, and compaction in the Chicot and Evangeline aquifers in the Houston-Galveston region, Texas. The Houston-Galveston region comprises Harris, Galveston, Fort Bend, Waller, and Montgomery Counties and adjacent parts of Brazoria, Grimes, Walker, San Jacinto, Liberty, and Chambers Counties. The report was done in cooperation with the Harris-Galveston Subsidence District, the City of Houston, the Fort Bend Subsidence District, and the Lone Star Groundwater Conservation District.

The U.S. Geological Survey (USGS) has published annual reports of water-level altitudes and water-level changes for the Chicot and Evangeline aquifers in the Houston-Galveston region since 1979; and annual reports of same for the Fort Bend subregion (Fort Bend County and adjacent areas) since 1990. The USGS first published a water-level-altitude map for the Jasper aquifer in the greater Houston area (primarily Montgomery County) in 2001.

This report contains maps showing current-year (2009) water-level altitudes for each of the three aquifers; maps showing 1-year (2008–09) water-level changes for each aquifer; maps showing 5-year (2004–09) water-level changes for each aquifer; maps showing long-term (1990–2009 and 1977–2009) water-level changes for the Chicot and Evangeline aquifers; and a map showing long-term (2000–2009) water-level change for the Jasper aquifer. The report also contains graphs showing measured compaction of subsurface material at 11 sites from 1973 or later through 2008. Tables listing the data used to construct each of the maps and the compaction graphs also are included. The text included here, except for a brief summary of the geohydrology of the region, is intended to document the methods used to construct the maps rather than to describe water-level altitudes and changes in the three aquifers.

Geohydrology

The Chicot aquifer (in Holocene- and Pleistocene-age sediments), Evangeline aquifer (in Pliocene- and Miocene-age sediments), and Jasper aquifer (in Miocene-age sediments) are the three primary aquifers in the Gulf Coast aquifer system (Baker, 1979; 1986). The lowermost Jasper aquifer is separated from the Evangeline aquifer by the Burkeville confining unit. The hydrogeologic units are laterally discontinuous fluvial-deltaic deposits of gravel, sand, silt, and clay that dip and thicken from northwest to southeast. The aquifers thus crop out in bands inland from and approximately parallel to the coast and become progressively more deeply buried and confined toward the coast. The Chicot aquifer outcrop, which comprises the youngest sediments, is the closest of the aquifer outcrops to the coast, followed farther inland by the Evangeline aquifer outcrop and then farthest inland by the Jasper aquifer outcrop.

The Chicot aquifer can be differentiated from the geologically similar Evangeline aquifer on the basis of hydraulic conductivity (Carr and others, 1985, p. 10). The Jasper aquifer can be differentiated from the Evangeline aquifer in the outcrops on the basis of water levels (higher in the Jasper than in the Evangeline) and in the downdip parts of the aquifers on the basis of position relative to the Burkeville confining unit.

The water in the aquifers is fresh (less than 1,000 milligrams per liter dissolved solids concentration) in the region but becomes more saline in the downdip and deeply buried parts of the aquifers near the coast (Baker, 1979). In the natural groundwater-flow system, water recharges the aquifers in the unconfined outcrop areas, moves downward and coastward, and discharges upward as diffuse upward leakage in the confined downdip areas.

The authors express appreciation to the owners and operators of wells throughout the study area. This report could not have been done without their assistance in granting access to wells and providing pertinent information.

Water-Level Altitudes and Water-Level Changes

Water-level altitudes were obtained by steel tape, by air line, and from reports of well operators. Most wells are pumped once daily, but some are pumped more frequently. Multiple measurements were made when wells were not being pumped; however, antecedent conditions and pumping status of nearby wells were not always known. Most measurements were made in January and February, the months when water levels usually are highest. Water-level altitude is indicated on the maps by contours of equal water-level altitude at various intervals.

For the 1-year (2008–09) change maps, water-level changes were computed as the difference in water-level altitude at each point (well) for which a water-level-altitude measurement was made in 2009 and 2008. Change on the 1-year maps is indicated by point differences.

For the 5-year (2004–09) change maps, water-level changes were computed the same as for the 1-year maps—the difference in water-level altitude at each point for which a water-level-altitude measurement was made in 2009 and 2004. Change on the 5-year maps is indicated by contours of equal water-level change. Each 5-year map was created by contouring the set of mapped point differences.

For the historical (2000–2009, 1990–2009, 1977–2009) change maps, water-level changes were computed as the difference in water-level altitude at each point (well) for which a water-level-measurement was made in 2009 and the water-level altitude at that point on a gridded surface of the historical water-level-altitude map. Change on the historical maps is indicated by contours of equal water-level change. Each historical change map was created by contouring the set of mapped point differences. Gridded-surface altitude values for historical water-level altitudes rather than actual measured values were used to compute differences (mapped point values) because many of the wells measured in 2000, 1990, and 1977 have been destroyed or were not measured in 2009. Thus using the gridded surface yielded many more point values than would have been available using the subset of wells measured in both 2009 and the historical year. For the subset of wells measured in both 2009 and the historical year, the mapped point values used were the differences in water-level altitudes between 2009 and the historical year rather than the differences between 2009 altitude values and historical-year gridded-surface values—although the historical-year altitude and gridded values are equal for the majority of points and very close for most others.

For the Chicot and Evangeline aquifers, maps show approximate water-level altitudes in 2009, water-level changes from 2008 to 2009, and approximate water-level changes from 2004 to 2009, from 1990 to 2009, and from 1977 to 2009 (figs. 1–5, Chicot aquifer; figs. 6–10, Evangeline aquifer). For the Jasper aquifer, maps show approximate water-level altitudes in 2009, water-level changes from 2008 to 2009, and approximate water-level changes from 2004 to 2009 and 2000 to 2009 (figs. 11–14).

For the Chicot aquifer maps, 186 water-level measurements were used for the 2009 altitude (table 1), 177 water-level pairs were used for the 2008–09 change (table 2), 145 water-level pairs for the 2004–09 change (table 3), 156 water-level pairs for the 1990–2009 change (table 4), and 144 water-level pairs for the 1977–2009 change (table 5).

For the Evangeline aquifer maps, 354 water-level measurements were used for the 2009 altitude (table 6), 319 water-level pairs were used for the 2008–09 change (table 7), 230 water-level pairs for the 2004–09 change (table 8), 293 water-level pairs for the 1990–2009 change (table 9), and 254 water-level pairs for the 1977–2009 change (table 10).

For the Jasper aquifer maps, 91 water-level measurements were used for the 2009 altitude (table 11), 74 water-level pairs were used for the 2008–09 change (table 12), 60 water-level pairs for the 2004–09 change (table 13), and 76 water-level pairs for the 2000–2009 change (table 14).

Three maps, one for each aquifer (appendix 1), show the locations of wells used to make each map. Sequential index numbers for wells on each map link the well locations to the tabular data for the respective map, as the index numbers are common to both the map and the associated table.

Most land-surface altitudes for wells of this report are estimates from USGS 7.5-minute topographic quadrangle maps. For this report, land-surface altitudes for the wells in Harris County are from a Light Detection and Ranging

(LiDAR)-based digital elevation model (DEM). Estimates of land-surface altitude from topographic maps are likely to be less accurate than those derived from the LiDAR-based DEM. Use of the DEM as the source of land-surface altitudes thus results in changes in land-surface altitude for some wells in Harris County, presumably to more accurate values, hence the reason for using the DEM. More explanation regarding use of the LiDAR-based DEM and the effect of its use on the water-level-change maps are in appendix 2.

Compaction

Compaction of subsurface material is measured continuously by 13 borehole extensometers at 11 sites (fig. 15). Graphs of compaction from 1973 or later through 2008 for 12 of the 13 extensometers are shown in figure 16; data for the graphs are listed in table 15. Compaction measured by the shallower of two extensometers at the Clear Lake site is not shown because it is similar to that measured by the deeper extensometer at the site.

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