U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
PUERTO RICO ENVIRONMENTAL QUALITY BOARD

SCIENTIFIC INVESTIGATIONS MAP 2947
Potentiometric Surface of the Alluvial Aquifer and Hydrologic Conditions in the Juana Díaz area, Puerto Rico, June 29 - July 1, 2005
By José M. Rodríguez and others

Potentiometric Surface of the Alluvial Aquifer and Hydrologic Conditions in the Juana Díaz area, Puerto Rico, June 29 - July 1, 2005

By José M. Rodríguez, Luis Santiago-Rivera, and Fernando Gómez-Gómez

A synoptic survey of the hydrologic conditions in the Juana Díaz area, Puerto Rico, was conducted between June 29 and July 1, 2005, to define the spatial distribution of the potentiometric surface of the alluvial aquifer. The study area encompasses 21 square miles of the more extensive South Coastal Plain Alluvial Aquifer system and is bounded along the north by foothills of the Cordillera Central mountain chain, to the south by the Caribbean Sea, the east by the Río Descalabrado and to the west by the Río Inabón. Ground water in the Juana Díaz area is in the Quaternary-age alluvial deposits and the middle-Tertiary age Ponce Limestone and Juana Díaz Formation (Giusti, 1968). The hydraulic properties of the Ponce Limestone in the Juana Díaz area are unknown, and the Juana Díaz Formation is a unit of poor permeability due to its high clay content. Consequently, the Ponce Limestone and the Juana Díaz Formation are generally considered to be the base of the alluvial aquifer in the Juana Díaz area with ground-water flow occurring primarily within the alluvial deposits.

The potentiometric-surface map of the alluvial aquifer was delineated using ground-water level measurements taken at existing wells. The water-level measurements were taken at wells that were either not pumping during the survey or were shut down for a brief period. In the latter case, a recovery period of 30 minutes was allowed for the drawdown in the wellbore to achieve a near static level position representative of the aquifer at the measurement point. Land-surface altitude from U.S. Geological Survey (USGS) 1:20,000 scale topographic maps (Playa de Ponce, Ponce, Río Descalabrado, and Santa Isabel) were used to refer ground-water levels to mean sea level datum (National Geodetic Vertical Datum of 1929). In addition to the ground-water level measurements, the potentiometric-surface contours were delineated using hydrologic features, such as drainage ditches and saturated intermittent streams that were considered as aquifer drains and losing streams, respectively.

The survey included ground-water level measurements in 38 wells, instantaneous stream-discharge measurements at 8 locations in streams and irrigation canals, and estimates of ground-water withdrawal rates at 20 active production wells. Specific conductance was measured at the wellhead from water samples collected at pumping wells. The survey was conducted after a period of above-average precipitation. Cumulative rainfall between January 1 and May 31, 2005, at the Juana Díaz Camp National Weather Service (NWS) station 665020 (fig. 1) and Santa Isabel 2ENE NWS station 668940 (not shown on map) located about 4 miles southeast of Central Cortada was 22.34 and 12.15 inches, respectively; these amounts are about 2 and 1.5 times, respectively, above normal for this period. Ground-water levels measured at the USGS Cabrera observation well, 180020066261500, located near Río Descalabrado, are presented in figure 2 for the period of record from 1997 to 2005 and in figure 3 for the period from January to July 2005. Water levels in this observation well increased by 6.87 feet from April 13 to June 30, 2005 (fig. 3).

The general direction of ground-water flow is indicated by flow lines drawn perpendicular to the potentiometric-surface contours on the plate. The general direction of ground-water flow in the alluvial aquifer is to the south with minor flow components to the southwest and southeast. During the synoptic survey, the ground-water levels ranged from 1 foot below to 122 feet above mean sea level. The potentiometric-surface contours indicate that the alluvial aquifer is gaining water from the streams that traverse the coastal plain. In general, the potentiometric surface during July 2005 had overall altitudes and contour patterns similar to those observed in March 1987 (Rodríguez-del-Río and Gómez-Gómez, 1990). The water levels during both synoptic studies were within 4-foot differences in wells located to the south of the 10-foot contour shown on the plate. The greatest difference between water levels measured in July 2005 and March 1987 was observed in a well located near the northern limit of the coastal plain near the Río Descalabrado at Barrio Río Cañas Abajo, Juana Díaz, where the water level was 20 feet above mean sea level in this survey as compared to 52 feet above mean sea level in March 1987. In this general area, crops are irrigated by large capacity wells; however, during the synoptic survey, wells were not in use due to recent rainfall.

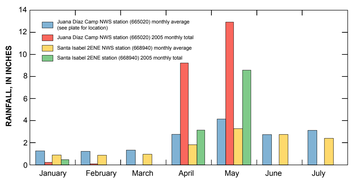


Figure 1. Rainfall at Juana Díaz Camp (665020) and Santa Isabel 2ENE (668940) National Weather Service stations.

The specific conductance values of ground water ranged from 450 to 1,360 microsiemens per centimeter at 25 degrees Celsius. In the alluvial deposits along the coastal plain, specific conductance values ranged from 450 to 860 microsiemens per centimeter at 25 degrees Celsius. Specific conductance values greater than 1,000 microsiemens per centimeter at 25 degrees Celsius were measured in wells near the outcrops of the Juana Díaz Formation. Higher specific conductance values in ground water from wells near the Juana Díaz Formation are associated with its marine origin (Giusti, 1968). In general, ground-water withdrawals in the study area are for public-supply water and irrigation purposes. Public-supply water withdrawals were estimated to be 4.5 million gallons per day based on instantaneous well-discharge meter readings obtained during the survey. Ground-water withdrawals for irrigation purposes are unknown, but about 4,000 acres of land were under cultivation according to 2004 aerial photos.

Instantaneous surface-water discharge measurements were taken at selected sites along the Río Inabón, Río Jacaguas, Río Cañas, Río Descalabrado, and the Canal de Juana Díaz (plate) to estimate ground- and surface-water interactions during the synoptic survey. The instantaneous stream discharge measurements taken on July 1, 2005, along the Canal de Juana Díaz indicated a flow rate of 23.7 cubic feet per second near the town of Juana Díaz and 19.4 cubic feet per second near the Río Descalabrado (plate). The difference in flow between each set of measurements at the irrigation canals may be caused by infiltration losses and diversion for irrigation. The instantaneous discharge measured near the coast in the Río Inabón, Río Jacaguas, and Río Descalabrado were 14.5, 34.8, and 2.8 cubic feet per second, respectively. The streamflow in the Río Cañas was estimated at 3 cubic feet per second near the northern boundary of the coastal plain; however, the channel was observed to be dry at about 1.18 miles downstream.

REFERENCES CITED

Bawiec, Walter, 2001, Geology, geochemistry, geophysics, mineral occurrences, and mineral resources assessment for the Commonwealth of Puerto Rico: U.S. Geological Survey Open-File Report 98-38.

Giusti, E.V., 1968, Water resources of the Juana Díaz area, Puerto Rico - A preliminary appraisal, 1966: U.S. Geological Survey Water-Resources Bulletin 8, 43 p.

Rodríguez-del-Río, Félix, and Gómez-Gómez, Fernando, 1990, Potentiometric surface of the alluvial aquifer and hydrologic conditions in the Santa Isabel-Juana Díaz area, Puerto Rico, March to April,1987: U.S. Geological Survey Water-Resources Investigations Report 89-4116, 2 sheets.

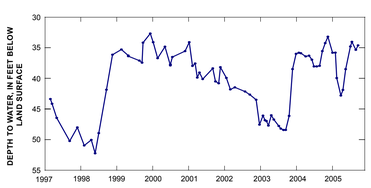


Figure 2. Ground-water levels at U.S. Geological Survey Cabrera observation well (180020066261500) Juana Díaz, Puerto Rico (see plate for location).

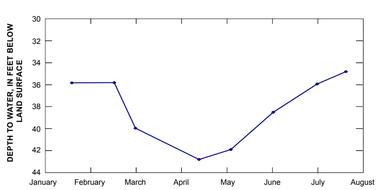
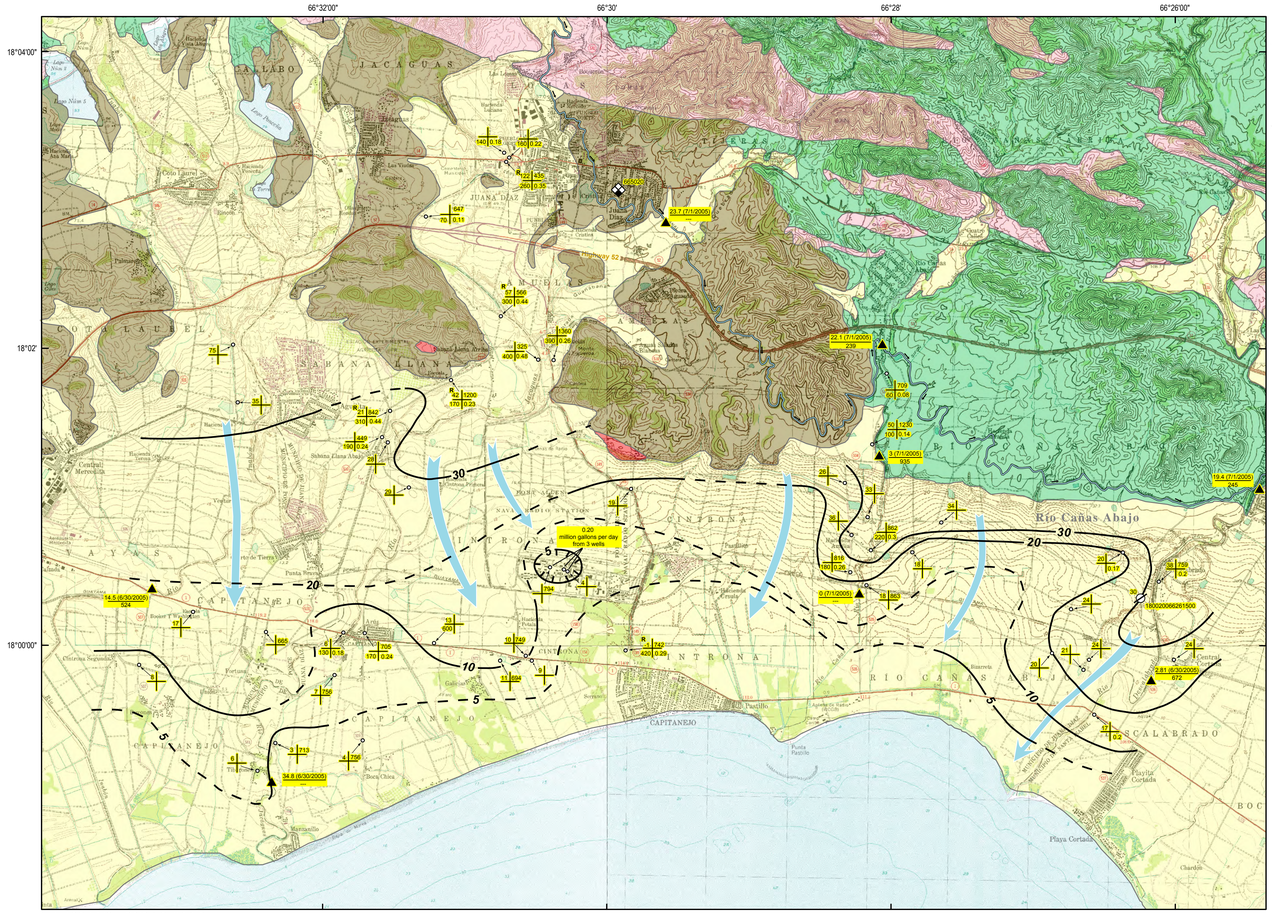
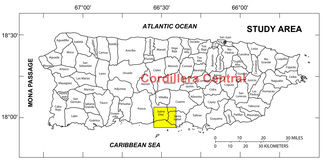


Figure 3. Ground-water levels at U.S. Geological Survey Cabrera observation well (180020066261500), Juana Díaz, Puerto Rico, from January to July 2005 (see plate for location).





EXPLANATION

Geology

- QUATERNARY ALLUVIAL AND SURFICIAL DEPOSITS
- PONCE LIMESTONE
- JUANA DÍAZ FORMATION
- OTHER TERTIARY NON-VOLCANICLASTIC TERRANES
- VOLCANICLASTIC TERRANES

R 21 | 842 / 310 | 0.44 — GROUND-WATER LEVEL DATA CONTROL POINT - Number on top left quadrant is the measured water level, in feet above mean sea level. Number on top right quadrant is specific conductance, in microsiemens per centimeter at 25 degrees Celsius. Number on bottom left quadrant is instantaneous discharge rate, in gallons per minute, and number in bottom right quadrant is average well discharge, in million gallons per day for June 2005. **R**, indicates that water level was recovering after pumping was discontinued for at least 30 minutes prior to measurement

30 / 180020066261500 — U.S. GEOLOGICAL SURVEY OBSERVATION WELL AND IDENTIFICATION NUMBER - Number to the left is the measured water level, in feet above mean sea level

30 — POTENTIOMETRIC CONTOUR - Shows altitude at which water level would have stood in tightly cased well. Hachures indicate depression of potentiometric surface. Dashed line indicates where approximately located. Contour interval variable at 5 and 10 feet. Datum is mean sea level

DIRECTION OF GROUND-WATER FLOW

JUANA DÍAZ IRRIGATION CANAL AND DIRECTION OF FLOW

19.4 (7/1/2005) / 245 — STREAM OR IRRIGATION CANAL FLOW MEASUREMENT SITE- Number on top is the instantaneous discharge rate, in cubic feet per second, date of measurement is shown in parentheses. Number on bottom is specific conductance, in microsiemens per centimeter at 25 degrees Celsius

665020 — NATIONAL WEATHER SERVICE STATION AND IDENTIFICATION NUMBER

Base from U.S. Geological Survey Digital Raster Graphic for the Ponce, Playa de Ponce, Santa Isabel and Río Descalabrado quadrangles 1989
Geologic information modified from Bawiec, 2001
Lambert conformal conic projection. Datum North American Datum (NAD) of 1927

POTENTIOMETRIC SURFACE OF THE ALLUVIAL AQUIFER AND HYDROLOGIC CONDITIONS IN THE JUANA DÍAZ AREA, PUERTO RICO, JUNE 29 - JULY 1, 2005
By José M. Rodríguez, Luis Santiago-Rivera, and Fernando Gómez-Gómez

0 0.5 1 1.5 2 MILES
0 0.5 1 1.5 2 KILOMETERS