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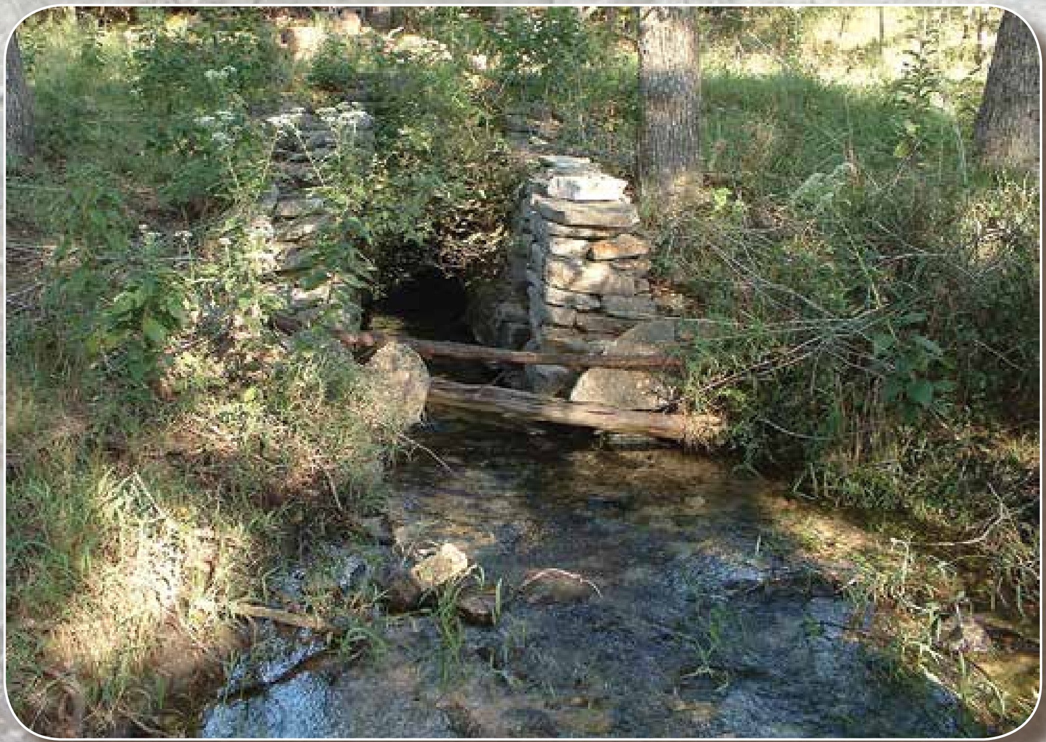
Geodatabase and Characteristics of Springs Within and Surrounding the Trinity Aquifer Outcrops in Northern Bexar County, Texas, 2010–11



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Background, Spring (113) near Leon Creek in the Trinity aquifer outcrop, northern Bexar County, Texas. Photograph taken on Tuesday, October 5, 2010.

Front cover, Spring (104) near the headwaters of Leon Creek in the Trinity aquifer outcrop, northern Bexar County, Texas. Photograph taken on Tuesday, October 5, 2010.

Back cover, Dam with overflow pipe discharging water from spring (109) near Lee Creek in the Trinity aquifer outcrop, northern Bexar County, Texas. Photograph taken on Monday, November 15, 2010.

Geodatabase and Characteristics of Springs Within and Surrounding the Trinity Aquifer Outcrops in Northern Bexar County, Texas, 2010–11

Allan K. Clark, Diana E. Pedraza, Robert R. Morris, and Travis J. Garcia

Prepared in cooperation with Trinity Glen Rose Groundwater Conservation District, Edwards Aquifer Authority, and San Antonio River Authority

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C=(°F-32)/1.8

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (μS/cm at 25 °C).

Geodatabase and Characteristics of Springs Within and Surrounding the Trinity Aquifer Outcrops in Northern Bexar County, Texas, 2010–11

By Allan K. Clark, Diana E. Pedraza, Robert R. Morris, and Travis J. Garcia

Abstract

The U.S. Geological Survey, in cooperation with the Trinity Glen Rose Groundwater Conservation District, the Edwards Aquifer Authority, and the San Antonio River Authority, developed a geodatabase of springs within and surrounding the Trinity aquifer outcrops in a 331-square-mile study area in northern Bexar County, Texas. The data used to develop the geodatabase were compiled from existing reports and databases, along with spring data collected between October 2010 and September 2011. Characteristics including the location, discharge, and water-quality properties were collected for known springs and documented in the geodatabase. A total of 141 springs were located within the study area, and 46 springs were field verified. The discharge at springs with flow ranged from 0.003 to 1.46 cubic feet per second. The specific conductance of the water discharging from the springs ranged from 167 to 1,130 microsiemens per centimeter at 25 degrees Celsius with a majority of values in the range of 500 microsiemens per centimeter at 25 degrees Celsius.

Introduction

The Trinity aquifer is a major source of water for central Texas and supplies water for domestic use, livestock use, and public supply use (Mace and others, 2000). Although considered a major aquifer in Texas (Ashworth and Hopkins, 1995), springflows from the Trinity aquifer are often much smaller compared to springflows from other major aquifers in Texas (Mace and others, 2000). Some springs issuing within and surrounding the Trinity aquifer outcrops are ephemeral; the typically small flows are often lost to evapotranspiration within a short distance of discharging to the surface. Of the water not lost to evapotranspiration, some will likely contribute recharge to the Edwards aquifer downgradient (Ashworth and Hopkins, 1995) (fig. 1).

Between 2000 and 2011, the population of Bexar County, Tex., increased 25.6 percent, whereas the population of Texas increased 22.6 percent and the population of the United States increased only 10.4 percent (U.S. Census Bureau, 2009, 2010, 2011). In Bexar County, this population growth has resulted in an increased demand for water from the Trinity aquifer. Additionally there are two military facilities in the study area that withdraw water from the Trinity aquifer. The effect of increased withdrawals from the Trinity aquifer on springflow has not been documented; however, the decreased storage in the Trinity aquifer as a result of drought and increased pumping has been noted in previous studies (Mace and others, 2000). Therefore, it is important to document the location, current discharge, and basic water-quality information of springs that may discharge from the Trinity aquifer in northern Bexar County to provide a baseline for future conditions. Accordingly, the U.S. Geological Survey (USGS), in cooperation with the Trinity Glen Rose Groundwater Conservation District, the Edwards Aquifer Authority, and the San Antonio River Authority, developed a geodatabase to document springs within and surrounding the upper and middle Trinity aquifer outcrops in northern Bexar County. Information pertaining to the springs in the study area was compiled from various Federal, State, and local agencies and entered into a geodatabase.

Purpose and Scope

The purpose of this report is to provide information on the compilation of geologic and hydrogeologic information pertaining to selected springs within and surrounding the Trinity aquifer outcrops in northern Bexar County. Detailed information for 141 springs in the study area were compiled from existing reports and databases, as well as from data collected onsite that include the location, discharge, and water-quality characteristics of selected springs. The focus of the geodatabase is the springs; however, existing information regarding hydrogeology, faulting, soils, and streams is also included in the geodatabase. All of the information that was compiled pertaining to the Trinity aquifer is for the upper and middle Trinity aquifers; no information was compiled pertaining to the lower Trinity aquifer.

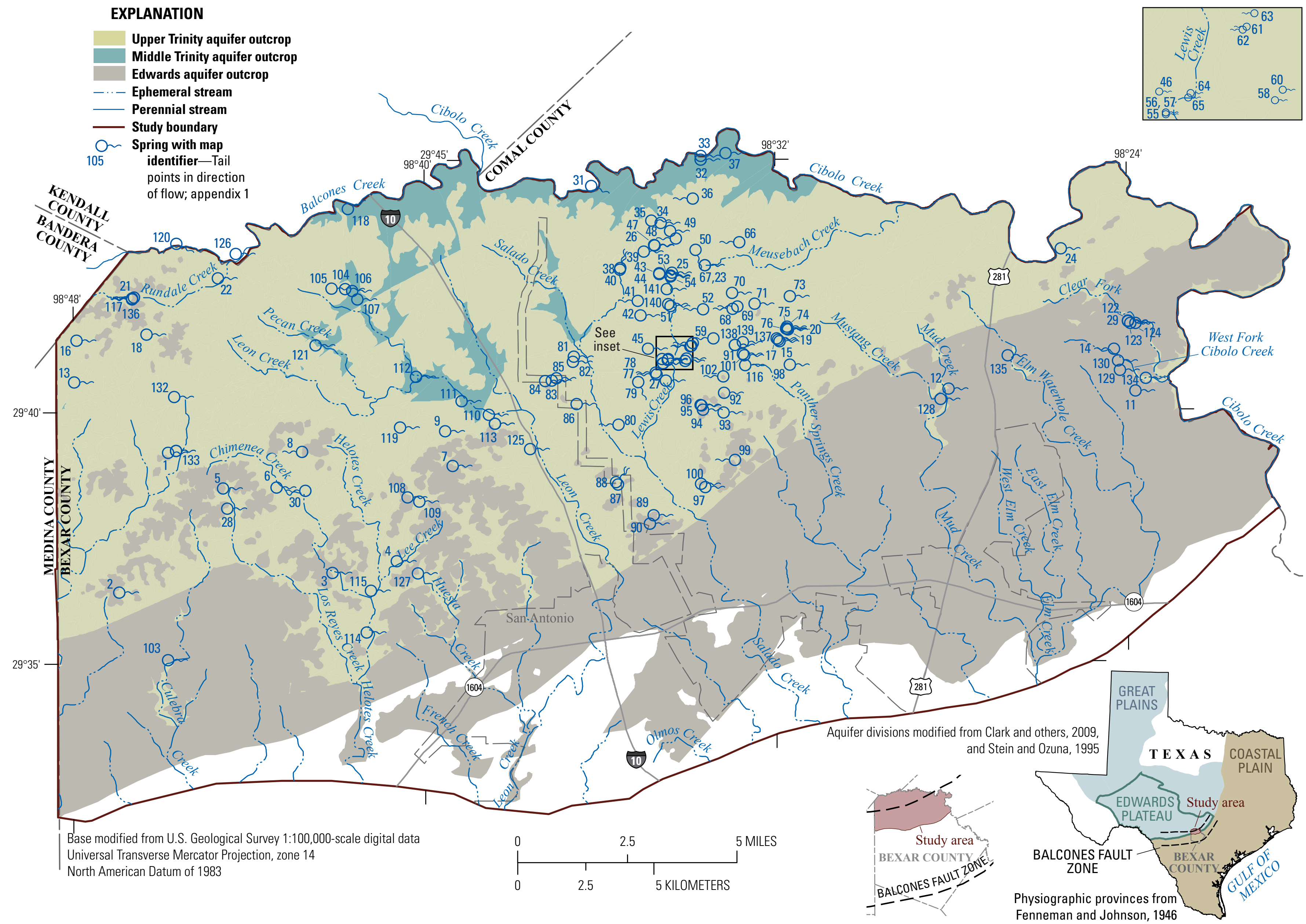

Figure 1. Springs, streams, and outcrops of the Edwards and Trinity aquifers in the study area in northern Bexar County, Texas.

Description of the Study Area

The study area encompasses 331 square miles in northern Bexar County coincident with the outcrops of the Edwards and Trinity aquifers within Bexar County (fig. 1). The study area has been characterized in previous reports such as Stein and Ozuna (1995) and Clark and others (2009), which concentrated on the hydrogeology of the Edwards and Trinity aquifer outcrops, respectively. The predominant soils within the study area are shallow (U.S. Department of Agriculture, 1991), and there are few agricultural activities (mostly the growing of grass and feed crops in stream valleys) (Ashworth, 1983). The study area is within the Balcones fault zone, which is the transition between the Edwards Plateau section of the Great Plains physiographic province and the Coastal Plain physiographic province (Fenneman and Johnson, 1946) (fig. 1). Land surface elevations range from 769 to 1,898 feet (ft) above the North American Vertical Datum of 1988; the maximum relief is approximately 1,100 ft. A subtropical, subhumid climate prevails in the study area, which is characterized by hot summers and mild winters (Larkin and Bomar, 1983). The average annual rainfall is approximately 32.27 inches (in.) (National Oceanic and Atmospheric Administration, 2011).

Previous Hydrogeologic Investigations

Lozo and Smith (1964) established the nomenclature of the Trinity Group, and Ashworth (1983) subdivided the Trinity aquifer into the upper Trinity, middle Trinity, and lower Trinity aquifers. As part of the regional aquifer-system analysis of the Edwards and Trinity aquifer system, Barker and others (1994) described the hydrogeologic framework of the aquifers. Brune (1975) compiled the locations and discharge information of 281 springs in Texas. Brune (1981) included a description of springs in 183 of the 254 counties in Texas, with discharge data and anecdotes about the springs from the 15th century to the early 1980s. Heitmuller and Reece (2003) created a database of historically documented springs and discharge measurements in Texas; their database included information on 1,891 springs and a total of 6,924 discharge measurements. Heitmuller and Williams (2006) created a database of historical water-quality data for selected springs in Texas by ecoregion; their database combined previously compiled and published water-quality data from various sources and documented the compilation of water-quality data for 232 springs in Texas.

Geologic Framework

The study area contains outcrops of the Edwards and Trinity Groups (fig. 2, table 1). The Glen Rose Limestone (fig. 2, table 1) of the Trinity Group consists of beds of moderately resistant, massive, chalky limestone that alternate with beds of less resistant, clay-rich limestone (Livingston and others, 1936). Ashworth (1983) stated that the Glen Rose Limestone is approximately 721–770 ft thick in the San Antonio, Tex., area; Clark (2003, 2005) documented thicknesses ranging from 715 to 810 ft (table 1). George (1952) informally separated the Glen Rose Limestone into upper and lower members (fig. 2, table 1) on the basis of the presence of a thin, regionally extensive bed containing an abundance of the small pelecypod *Corbula martinae*. Perkins (1974) stated that the lower member of the Glen Rose Limestone is composed of limestone, dolostone, and dolomitic limestone. The upper member of the Glen Rose Limestone consists of a layer of 10–20 ft of partially to mostly dissolved evaporites composed of highly altered crystalline limestone and chalky mudstone overlain by 135–180 ft of alternating wackestone, packstone, and mudstone. Overlying this is 10–20 ft of dissolved evaporites and carbonate rock with collapse structures, which in turn is overlain by 240–270 ft of alternating and interfingering mudstone, marl, wackestone, and packstone with local evaporites (table 1).

The Kainer Formation (fig. 2, table 1) of the Edwards Group consists of fossiliferous mudstone and wackestone that grade upward into dolomitic mudstone with evaporites and terminates in a miliolid grainstone (Stein and Ozuna, 1995). The basal nodular member (fig. 2, table 1) of the Kainer Formation is a shaly, nodular limestone: burrowed mudstone to wackestone (Stein and Ozuna, 1995). The basal nodular is approximately 50–60 ft thick in the study area.

All of these units are highly faulted by the Balcones fault zone (fig. 1), a tensional zone that is approximately 20 miles wide with numerous high-angle, mostly normal, subparallel faults that are dropped down in an en echelon (stairstep) pattern to the southeast, toward the Gulf of Mexico (George, 1952; fig. 1). These faults often displace stratigraphically younger rocks against older ones. Total vertical displacement across Bexar County is more than 3,400 ft (Maclay, 1995), and the combined displacement of the faults in the study area varies from approximately 1,200 ft in the east to approximately 1,400 ft in the west; in the study area, displacement on faults ranges from tens of feet to several hundred feet (Small, 1986; Clark and others, 2009).

Hydrogeologic Characteristics

The formations of the Trinity Group compose the Trinity aquifer (fig. 2). The upper member of the Glen Rose Limestone composes the upper Trinity aquifer (Ashworth, 1983; table 1). The upper Trinity aquifer is a relatively impermeable hydrogeologic unit that restricts infiltration of surface water and groundwater flow (Ashworth, 1983; Clark and others, 2009). Clark (2003, 2005) subdivided the upper Trinity aquifer into five mappable units (A–E). Clark and others (2009) extended the five earlier hydrostratigraphic unis (Clark 2003, 2005) through northern Bexar County and informally renamed the units from top to bottom as the “cavernous,” “Camp Bullis,” “upper evaporite,” “fossiliferous,” and “lower evaporite” hydrostratigraphic

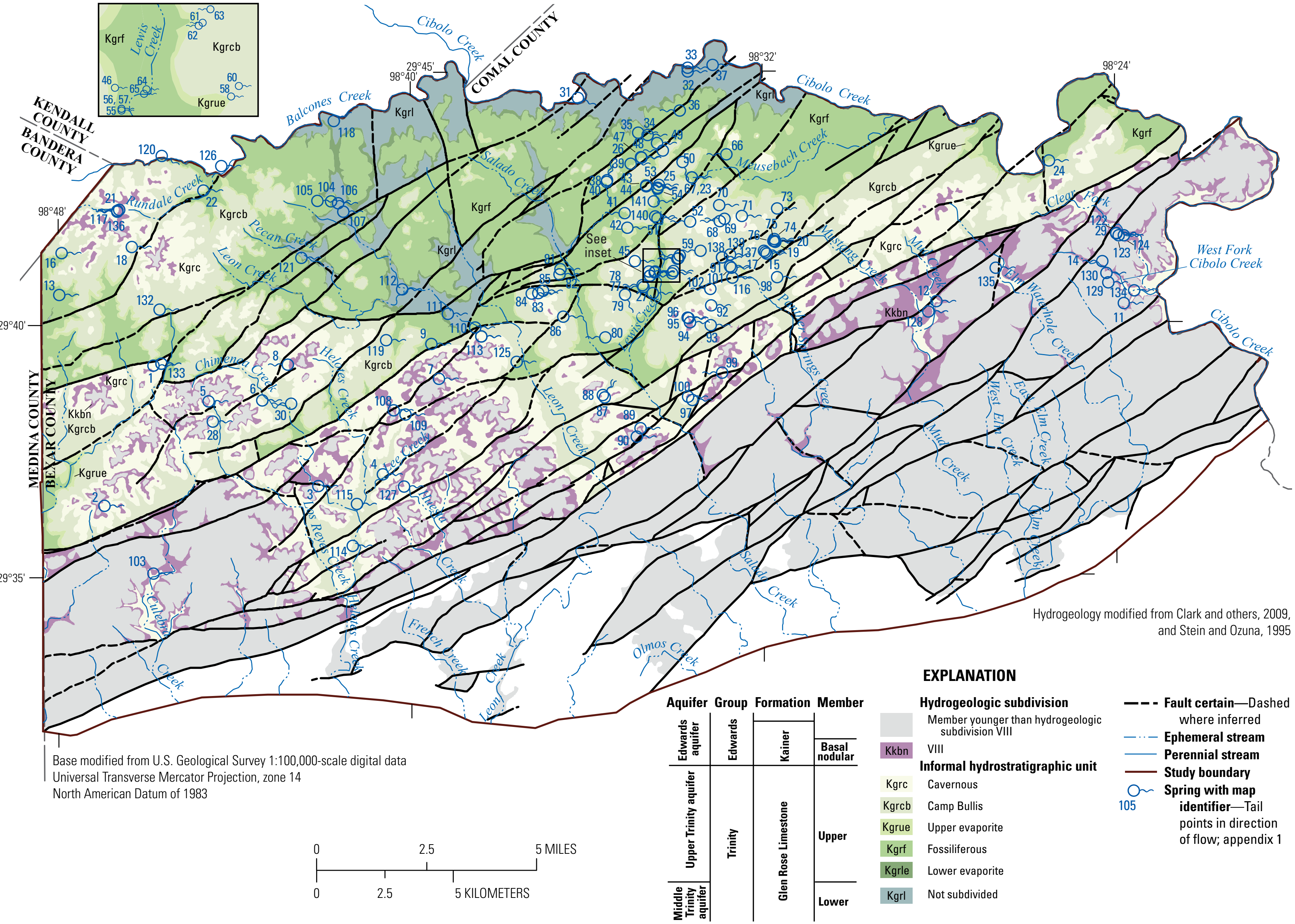

Figure 2. Hydrogeology and faulting of the study area, northern Bexar County, Texas.

Table 1. Hydrogeologic subdivisions/hydrostratigraphic units and characteristics of the geologic members of the Edwards and Trinity aquifer outcrops in the study area, northern Bexar County, Texas.

[*, not exposed in the study area; --, not subdivided]

<table>
<tr><th>Group[1]</th><th>Formation[1]</th><th>Member[1]</th><th>Thickness (feet)[2]</th><th>Lithology</th><th colspan="2">Aquifer[3]</th><th>Informal hydrostratigraphic unit[4] (formal hydrogeologic subdivision where shaded)[5]</th><th>Number of springs[6]</th></tr>
<tr><td>Edwards</td><td>Kainer</td><td>Basal nodular</td><td>50–60</td><td>Shaly, nodular limestone: burrowed mudstone and miliolid grainstone (Stein and Ozuna, 1995)</td><td colspan="2">Edwards</td><td>VIII</td><td>8</td></tr>
<tr><td rowspan="8">Trinity</td><td rowspan="6">Glen Rose Limestone</td><td rowspan="5">Upper</td><td>120</td><td>Alternating and interfingering mudstone, wackestone, and packstone with local evaporites (Clark and others, 2009)</td><td rowspan="8">Trinity</td><td rowspan="5">Upper Trinity</td><td>Cavernous (interval A of Clark, 2003, 2005)</td><td>27</td></tr>
<tr><td>120–150</td><td>Alternating and interfingering mudstone, marl, wackestone, and packstone (Clark and others, 2009)</td><td>Camp Bullis (interval B of Clark, 2003, 2005)</td><td>42</td></tr>
<tr><td>10–20</td><td>Dissolved evaporites and carbonate rock with collapsed structures; areas of recrystallized limestone (Clark and others, 2009)</td><td>Upper evaporite (interval C of Clark, 2003, 2005)</td><td>19</td></tr>
<tr><td>135–180</td><td>Alternating wackestone, packstone, and mudstone; common Orbitolina minutia (Romer); massive boundstone (biostrome) near top of subdivision (Clark and others, 2009)</td><td>Fossiliferous (interval D of Clark, 2003, 2005)</td><td>33</td></tr>
<tr><td>10–20</td><td>Partially to mostly dissolved sequence of evaporites consisting of highly altered crystalline limestone and chalky mudstone; corbula bed (Clark and others, 2009)</td><td>Lower evaporite (interval E of Clark, 2003, 2005)</td><td>1</td></tr>
<tr><td>Lower</td><td>320</td><td>Limestone, dolostone, and dolomitic limestone; diverse mollusk assemblages and locally rudist reefs (Perkins, 1974)</td><td rowspan="3">Middle Trinity</td><td>--</td><td>11</td></tr>
<tr><td>Bexar Shale</td><td>--</td><td>60–70</td><td>*</td><td>--</td><td>*</td></tr>
<tr><td>Cow Creek Limestone</td><td>--</td><td>50–70</td><td>*</td><td>--</td><td>*</td></tr>
</table>

[1]Modified from Forgotson (1956), Rose (1972), and Ashworth (1983).

[2]From Maclay (1995), Barker and Ardis (1996), Clark (2003, 2005), and Clark and others (2009).

[3]Modified from Stein and Ozuna (1995), Clark (2003, 2005), and Clark and others (2009).

[4]Modified from Clark (2003, 2005) and Clark and others (2009).

[5]From Maclay and Small (1986).

[6]Springs identified by the hydrogeologic subdivision where the spring is located.

units (fig. 2, table 1). The lower member of the Glen Rose Limestone, along with the underlying Bexar Shale and Cow Creek Limestone, compose the middle Trinity aquifer (Ashworth, 1983; table 1). The hydrogeologic units that compose the lower Trinity aquifer are not found at the surface in the study area (Perkins, 1974; Clark and others, 2009).

In the study area in northern Bexar County, Veni (1994) and Clark (2003) observed that the upper Trinity aquifer exhibits greater porosity and more permeability in its outcrops and shallow subcrops than is typically observed in the upper Trinity aquifer outside of northern Bexar County. Compared to the Edwards aquifer, the Trinity aquifer generally has higher hydraulic heads (Ashworth, 1983), lower porosity, and lower primary permeability (Clark, 2003). Because of its relatively low primary permeability, most recharge entering the outcrop of the Trinity aquifer enters through dissolution channels that range in size from minute openings to large caverns, some of which can take in large quantities of water (Livingston and others, 1936) (table 1).

Faults are an important hydrogeologic feature in the Edwards and Trinity aquifers in the study area. According to George (1952), some faults may act as barriers to groundwater flow and result in water being deflected parallel to the strike of the fault. George (1952) observed water-level and water-quality differences on opposite sides of faults that juxtaposed the younger Edwards aquifer against the older Trinity aquifer.

Methods

A field reconnaissance of springs in the study area was done between October 2010 and September 2011 to verify the existing data and collect additional data pertaining to the springs (discharge measurements, water-quality data, property owner and photographic documentation). A total of 46 of the 141 springs (fig. 1, app. 1) were visited during the field reconnaissance.

Location data were collected by using a hand-held Global Positioning System (GPS) unit or a digital camera with an integrated GPS unit, both with horizontal accuracy of tens of feet. After a spring was verified, it was assigned a USGS station number based on its location. The hydrostratigraphic unit outcropping at each spring was determined by overlaying existing hydrogeologic maps with the point information (latitude and longitude) obtained for each spring. The discharge measurements of springflow were made according to USGS methods detailed in Sauer and Turnipseed (2010) and Rantz and others (1982) by using a rod-mounted FlowTracker (Acoustic Doppler Velocimeter [ADV]) (Xylem Analytics, 2012a). A number of the springs could not be measured at the orifice for reasons such as inundation of the discharge location, the presence of multiple small orifices, or a channel that was either too shallow or too narrow to accommodate the measuring equipment. In situations where a direct measurement made by using the ADV was not possible, the springflow was estimated by measuring the time required to fill a container of known volume three times and then using the average to compute the springflow rate. Where the physical setting of the spring did not allow for the filling of a known volume, the amount of flow was approximated by making rudimentary estimates of the depth, width, and velocity. The specific conductance of springflow was measured in-place by using methods described by Radtke and others (2005). Specific-conductance measurements were made by using a YSI 6920 V2 multiparameter water-quality instrument (sonde) (Xylem Analytics, 2012b).

Geodatabase Design

A geodatabase contains spatial and tabular data and allows users to associate tabular data with physical and spatial components. By providing a framework to organize and understand data attributes such as the geographic location and water-quality characteristics, geographically referenced data can be manipulated to produce maps, make queries, and perform other types of spatial analyses. The geodatabase for this study was developed by using the Environmental Systems Research Institute (ESRI) geographic information system (GIS) software (ArcGIS) (Environmental Systems Research Institute, Inc., 2008; Zeiler, 1999). A geodatabase includes spatial layers of data, called feature classes, which represent the various types of vector geometry such as points, lines, and polygons. These data are referenced to a specific location and related to one another thematically within the geodatabase. In the geodatabase for the study area, a point feature class is used to represent the location for each spring. Additional detailed information about each feature is stored in an attribute table linked to the point feature class to form a relationship class. Relationship classes are created to connect data from the information table to the geographic feature class by using unique identifiers (app. 1).

A preliminary geodatabase was first developed to store all of the data for this study. Revisions were made to the geodatabase to reflect changes resulting from onsite verification of existing spring-related data and to add discharge and water-quality data collected during 2010–11. The geodatabase developed for this study provides an accurate spatial representation of the springs within and surrounding the upper and middle Trinity aquifer outcrops in the study area. A simplified schematic depicts data sources, the feature class (springs), and attribute tables, which contain the information pertaining to the study area (fig. 3).

Data Input

Historical data were formatted as needed and imported into the geodatabase. This information was used to populate the spring data table (app. 1). Field-verified springs were assigned a USGS station number derived from the latitude and longitude. Unique identifiers were assigned to all springs

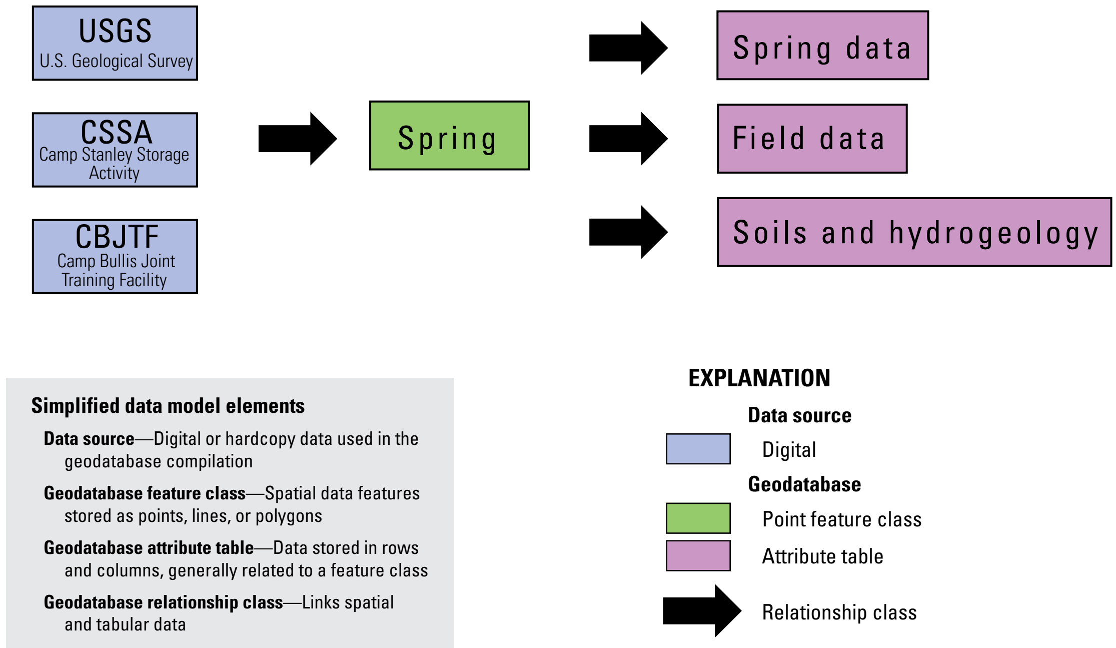

Figure 3. Simplified geodatabase data model for data from springs in the study area in northern Bexar County, Texas.

for use in the spring feature class. The fields populated in the spring data table (app. 1) include the map identifier, unique identifier, USGS station number (if applicable), name of spring (if known), source of the spring name, longitude and latitude in decimal degrees, field verified, specific conductance, discharge, field visit date, hydrostratigraphic unit at surface, and soil type at surface. Relationships between spring feature classes and attribute tables were created by using the unique identifier. The unique identifier is common to the spring feature class and attribute tables and was used to build the relationship class (Zeiler, 1999).

Data Quality

All springs were tentatively identified according to the surficial expression of the aquifer where the spring was located. At 26 of the springs, no discharge was evident (app. 1); the property owners of where these 26 springs were located indicated that these springs had been flowing until the beginning of the current (2010–12) drought. Property access and time constraints prohibited the verification of the remaining springs. When onsite verification was not possible, springs were identified from previously published data. Quality-assurance methods of database querying were applied to identify duplicate records. Duplicate names accounted for most of the errors. A few springs were visited more than once, and data from different visits were sometimes initially entered into the database with slightly different coordinates. Upon verification of duplicate springs, the multiple sets of information were combined into a single spring record. Because of different field visit dates, four springs have two record entries, one for each field visit date; all other springs have only one field visit date (app. 1).

Metadata

Metadata for the information input to the geodatabase were written by using Federal Geographic Data Committee (FGDC) standards (Federal Geographic Data Committee, 2009). The metadata include source information (title, abstract, publication date, and author) and geographic elements (geographic extent, projection information, and database elements such as attribute label definitions). The metadata were reviewed by using the Geospatial Metadata Validation Service (Schweitzer, 2003) and internal USGS personnel.

Spring Locations and Characteristics

Information pertaining to spring locations and characteristics were obtained from published reports, USGS 1:24,000-scale topographic maps, and available digital databases of springs. Data from existing USGS reports (Heitmuller and Reece, 2003; Heitmuller and Williams, 2006; Clark and others, 2009), Camp Bullis Joint Training Facility, Camp Stanley Storage Activity, and private property owners were included. Existing data regarding digital elevation models, hydrogeology, and soils were also included in the geodatabase. Discharge and specific conductance collected during the field reconnaissance in 2010 and 2011were integrated into the geodatabase.

A total of 141 springs were located within the study area, and 46 springs were field verified. The discharge at springs with flow ranged from 0.003 to 1.46 cubic feet per second. Most of the springs with identified discharge were found where the upper and middle parts of the Trinity aquifer outcrop. During field reconnaissance, eight springs were identified that discharge near the base of the Edwards aquifer outcrop. The gradational nature of the contact between the Edwards and Trinity Groups made the exact location of the lithologic change difficult to determine. Furthermore, because of the steep terrain where these springs were located, the contact between the Edwards and Trinity Groups was sometimes indistinct. These springs were tentatively identified as issuing from hydrogeologic subdivision VIII of the Edwards aquifer and were included in the geodatabase because of their proximity to the upper part of the Trinity aquifer outcrop. Detailed water-quality analyses that were beyond the scope of this study could be done to determine if the water issuing from most of the springs is consistent with water found in the Trinity or Edwards aquifers or if it represents a blend of water from both aquifers.

The specific hydrogeologic or Trinity aquifer unit identified at surface where each spring was located is listed in table 1 and appendix 1. Specific conductance was measured in 21 springs and ranged from 167 to 1,130 microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C). There were nine springs that measured between 600 and 1,130 µS/cm at 25 °C. Of these, one was tentatively identified as issuing from hydrogeologic subdivision VIII of the Edwards aquifer, three from the cavernous hydrostratigraphic unit of the upper Trinity aquifer, one from the Camp Bullis hydrostratigraphic unit of the upper Trinity aquifer, two from the fossiliferous hydrostratigraphic unit of the upper Trinity aquifer, and two from the middle Trinity aquifer (fig. 2, table 1). Of the springs with a specific conductance less than 600 µS/cm at 25 °C, one was tentatively identified as issuing from the hydrogeologic subdivision VIII of the Edwards aquifer, three from the cavernous hydrostratigraphic unit of the upper Trinity aquifer, two from the Camp Bullis hydrostratigraphic unit of the upper Trinity aquifer, one from the fossiliferous hydrostratigraphic unit of the upper Trinity aquifer, and four from the middle Trinity aquifer (fig. 2, table 1). Follow-up studies to qualify the geochemical characteristics of the springs are needed; geochemical investigations including detailed water-quality analyses would help to confirm the aquifer or combination of aquifers that supply flow to each spring.

Soils were included in the geodatabase because of the relationship between soil type and underlying geology; changes in soil type might aid in the determination of the hydrostratigraphic unit that springs are issuing from if bedrock is not evident. In the Natural Resources Conservation Service (2012) data, the type of soil is related to the percent slope, so the soil data are presented with percent slope in the geodatabase. The soil and slope data may aid in further analyses that use the geodatabase.

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Appendix 1—Geodatabase and Characteristics of Springs Within and Surrounding the Upper and Middle Trinity Aquifer Outcrops in Northern Bexar County, Texas, 2010–11

Appendix 1. Geodatabase and characteristics of springs within and surrounding the upper and middle Trinity aquifer outcrops in northern Bexar County, Texas, 2010–11.

[USGS, U.S. Geological Survey; dd, decimal degrees; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; ft^3/s, cubic feet per second; MM/DD/YY, month/day/year; GNIS, Geographic Names Information System; TWDB, Texas Water Development Board; --, not applicable; nm, not measured. Green shading indicates informal hydrostratigraphic unit; gray shading indicates formal hydrogeologic subdivision; blue shading indicates aquifer]

Map identifier	Unique identifier	USGS station number	Name of spring	Source of spring name	Longitude (dd)	Latitude (dd)	Field verified	Specific conductance (µS/cm at 25 °C)	Discharge (ft^3/s)	Field visit date (MM/DD/YY)	Field observation at land surface	Soil type at surface
1	SPNG_1	--	Unnamed	--	-98.7614	29.6535	No	nm	nm	--	Cavernous	Brackett-Eckrant association, 20 to 60 percent slopes
2	SPNG_2	--	Pastora Spring	GNIS	-98.78	29.6072	No	nm	nm	--	Cavernous	Brackett-Eckrant association, 20 to 60 percent slopes
3	SPNG_3	--	Unnamed	--	-98.6991	29.6136	No	nm	nm	--	Cavernous	Eckrant cobbly clay, 1 to 5 percent slopes
4	SPNG_4	--	Unnamed	--	-98.6748	29.6174	No	nm	nm	--	Camp Bullis	Brackett-Eckrant association, 20 to 60 percent slopes
5	SPNG_5	293830098442601	Morales Spring	GNIS	-98.7406	29.6417	Yes	nm	nm	--	Camp Bullis	Brackett-Eckrant association, 20 to 60 percent slopes
6	SPNG_6	--	Unnamed	--	-98.7203	29.6419	No	nm	nm	--	Camp Bullis	Krum clay, 1 to 5 percent slopes
7	SPNG_7	--	Unnamed	--	-98.6534	29.6489	No	nm	nm	--	Cavernous	Krum clay, 1 to 5 percent slopes
8	SPNG_8	--	Unnamed	--	-98.7158	29.6537	No	nm	nm	--	Cavernous	Krum clay, 1 to 5 percent slopes
9	SPNG_9	--	Unnamed	--	-98.6562	29.6605	No	nm	nm	--	Fossiliferous	Krum clay, 1 to 5 percent slopes
10	SPNG_10	--	Unnamed	--	-98.6373	29.6629	No	nm	nm	--	Cavernous	Lewisville silty clay, 0 to 1 percent slopes
11	SPNG_11	294023098233901	Devine Spring	GNIS	-98.3943	29.6731	Yes	570	0.003	10/15/10	Cavernous	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
12	SPNG_12	--	Unnamed	--	-98.4651	29.6739	No	nm	nm	--	VIII[1]	Eckrant cobbly clay, 1 to 5 percent slopes
13	SPNG_13	--	Hamilton Spring	GNIS	-98.797	29.6769	No	nm	nm	--	Fossiliferous	Eckrant cobbly clay, 5 to 15 percent slopes
14	SPNG_14	--	Indian Springs	GNIS	-98.4076	29.687	No	nm	nm	--	VIII[1]	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
15	SPNG_15	--	Unnamed	--	-98.5292	29.6899	No	nm	nm	--	Upper evaporite	Krum clay, 1 to 5 percent slopes
16	SPNG_16	--	Jack Mountain Spring	GNIS	-98.7961	29.6908	No	nm	nm	--	Upper evaporite	Brackett-Eckrant association, 20 to 60 percent slopes
17	SPNG_17	294125098314602	6820611	TWDB	-98.5298	29.6904	Yes	nm	0	05/14/12	Upper evaporite	Krum clay, 1 to 5 percent slopes
18	SPNG_18	--	Wolf Head Spring	GNIS	-98.7695	29.6927	No	nm	nm	--	Camp Bullis	Eckrant-Rock outcrop complex, 15 to 60 percent slopes

Appendix 1. Geodatabase and characteristics of springs within and surrounding the upper and middle Trinity aquifer outcrops in northern Bexar County, Texas, 2010–11.—Continued

[USGS, U.S. Geological Survey; dd, decimal degrees; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; ft^3/s, cubic feet per second; MM/DD/YY, month/day/year; GNIS, Geographic Names Information System; TWDB, Texas Water Development Board; --, not applicable; nm, not measured. Green shading indicates informal hydrostratigraphic unit; gray shading indicates formal hydrogeologic subdivision; blue shading indicates aquifer]

Map identifier	Unique identifier	USGS station number	Name of spring	Source of spring name	Longitude (dd)	Latitude (dd)	Field verified	Specific conductance (µS/cm at 25 °C)	Discharge (ft^3/s)	Field visit date (MM/DD/YY)	Field observation at land surface	Soil type at surface
19	SPNG_19	--	Unnamed	--	-98.5261	29.6938	No	nm	nm	--	Upper evaporite	Krum clay, 1 to 5 percent slopes
20	SPNG_20	--	Unnamed	--	-98.5263	29.6941	No	nm	nm	--	Camp Bullis	Krum clay, 1 to 5 percent slopes
21	SPNG_21	--	Unnamed	--	-98.7802	29.7051	No	nm	nm	--	Cavernous	Brackett gravelly clay loam, 12 to 20 percent slopes
22	SPNG_22	--	Unnamed	--	-98.7424	29.7113	No	nm	nm	--	Fossiliferous	Krum clay, 1 to 5 percent slopes
23	SPNG_23	--	Unnamed	--	-98.5575	29.7152	No	nm	nm	--	Fossiliferous	Krum clay, 1 to 5 percent slopes
24	SPNG_24	--	Unnamed	--	-98.4223	29.7204	No	nm	nm	--	Upper evaporite	Eckrant cobbly clay, 5 to 15 percent slopes
25	SPNG_25	--	Unnamed	--	-98.5699	29.7128	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes
26	SPNG_26	--	Unnamed	--	-98.5766	29.7218	No	nm	nm	--	Fossiliferous	Krum clay, 1 to 5 percent slopes
27	SPNG_27	294037098342101	6820510	TWDB	-98.5725	29.677	Yes	617	0	05/14/12	Fossiliferous	Krum clay, 1 to 5 percent slopes
28	SPNG_28	--	Unnamed	--	-98.739	29.6349	No	nm	nm	--	Camp Bullis	Brackett-Eckrant association, 20 to 60 percent slopes
29	SPNG_29	--	Unnamed	--	-98.3969	29.6961	No	nm	nm	--	VIII[1]	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
30	SPNG_30	--	Unnamed	--	-98.7146	29.6408	No	nm	nm	--	Upper evaporite	Krum clay, 1 to 5 percent slopes
31	SPNG_31	--	Unnamed	--	-98.6007	29.7409	No	nm	nm	--	Middle Trinity	Oakalla soils, 0 to 2 percent slopes, frequently flooded
32	SPNG_32	--	Unnamed	--	-98.5589	29.7502	No	nm	nm	--	Middle Trinity	Tarpley clay, 1 to 3 percent slopes
33	SPNG_33	--	Unnamed	--	-98.559	29.7515	No	nm	nm	--	Middle Trinity	Orif soils, 0 to 1 percent slopes, frequently flooded
34	SPNG_34	--	Unnamed	--	-98.5742	29.7293	No	nm	nm	--	Fossiliferous	Eckrant cobbly clay, 1 to 5 percent slopes
35	SPNG_35	--	Unnamed	--	-98.5777	29.7301	No	nm	nm	--	Lower evaporite	Krum clay, 1 to 5 percent slopes
36	SPNG_36	--	Unnamed	--	-98.5672	29.7374	No	nm	nm	--	Fossiliferous	Anhalt clay, 0 to 1 percent slopes
37	SPNG_37	294509098325801	6812802	TWDB	-98.5494	29.7524	Yes	nm	0	05/14/12	Middle Trinity	Eckrant cobbly clay, 5 to 15 percent slopes
38	SPNG_38	--	Unnamed	--	-98.5916	29.7161	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes

Appendix 1. Geodatabase and characteristics of springs within and surrounding the upper and middle Trinity aquifer outcrops in northern Bexar County, Texas, 2010–11.—Continued

[USGS, U.S. Geological Survey; dd, decimal degrees; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; ft^3/s, cubic feet per second; MM/DD/YY, month/day/year; GNIS, Geographic Names Information System; TWDB, Texas Water Development Board; --, not applicable; nm, not measured. Green shading indicates informal hydrostratigraphic unit; gray shading indicates formal hydrogeologic subdivision; blue shading indicates aquifer]

Map identifier	Unique identifier	USGS station number	Name of spring	Source of spring name	Longitude (dd)	Latitude (dd)	Field verified	Specific conductance (µS/cm at 25 °C)	Discharge (ft^3/s)	Field visit date (MM/DD/YY)	Field observation at land surface	Soil type at surface
39	SPNG_39	--	Unnamed	--	-98.5807	29.7199	No	nm	nm	--	Upper evaporite	Brackett gravelly clay loam, 5 to 12 percent slopes
40	SPNG_40	--	Unnamed	--	-98.5917	29.7158	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes
41	SPNG_41	--	Unnamed	--	-98.5882	29.7035	No	nm	nm	--	Fossiliferous	Krum clay, 1 to 5 percent slopes
42	SPNG_42	--	Unnamed	--	-98.582	29.6987	No	nm	nm	--	Fossiliferous	Brackett gravelly clay loam, 5 to 12 percent slopes
43	SPNG_43	--	Unnamed	--	-98.5748	29.7126	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes
44	SPNG_44	--	Unnamed	--	-98.5748	29.7124	No	nm	nm	--	Upper evaporite	Brackett gravelly clay loam, 5 to 12 percent slopes
45	SPNG_45	--	Unnamed	--	-98.5791	29.6876	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes
46	SPNG_46	--	Unnamed	--	-98.5739	29.6842	No	nm	nm	--	Fossiliferous	Brackett gravelly clay loam, 5 to 12 percent slopes
47	SPNG_47	--	Unnamed	--	-98.5767	29.722	No	nm	nm	--	Fossiliferous	Krum clay, 1 to 5 percent slopes
48	SPNG_48	--	Unnamed	--	-98.5736	29.7242	No	nm	nm	--	Fossiliferous	Brackett gravelly clay loam, 5 to 12 percent slopes
49	SPNG_49	--	Unnamed	--	-98.5707	29.7266	No	nm	nm	--	Upper evaporite	Brackett gravelly clay loam, 5 to 12 percent slopes
50	SPNG_50	--	Unnamed	--	-98.5624	29.7185	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes
51	SPNG_51	--	Unnamed	--	-98.5706	29.7018	No	nm	nm	--	Upper evaporite	Krum clay, 1 to 5 percent slopes
52	SPNG_52	--	Unnamed	--	-98.5634	29.7007	No	nm	nm	--	Camp Bullis	Krum clay, 1 to 5 percent slopes
53	SPNG_53	--	Unnamed	--	-98.5705	29.7119	No	nm	nm	--	Upper evaporite	Krum clay, 1 to 5 percent slopes
54	SPNG_54	--	Unnamed	--	-98.5705	29.7115	No	nm	nm	--	Upper evaporite	Krum clay, 1 to 5 percent slopes
55	SPNG_55	294058098342401	6820515	TWDB	-98.5734	29.6827	Yes	nm	0	05/14/12	Fossiliferous	Krum clay, 1 to 5 percent slopes
56	SPNG_56	294058098342402	6820516	TWDB	-98.5734	29.6828	Yes	nm	0	05/14/12	Fossiliferous	Krum clay, 1 to 5 percent slopes
57	SPNG_57	294058098342403	6820517	TWDB	-98.5734	29.6828	Yes	nm	0	05/14/12	Fossiliferous	Krum clay, 1 to 5 percent slopes
58	SPNG_58	--	Unnamed	--	-98.5651	29.6836	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes

Appendix 1. Geodatabase and characteristics of springs within and surrounding the upper and middle Trinity aquifer outcrops in northern Bexar County, Texas, 2010–11.—Continued

[USGS, U.S. Geological Survey; dd, decimal degrees; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; ft^3/s, cubic feet per second; MM/DD/YY, month/day/year; GNIS, Geographic Names Information System; TWDB, Texas Water Development Board; --, not applicable; nm, not measured. Green shading indicates informal hydrostratigraphic unit; gray shading indicates formal hydrogeologic subdivision; blue shading indicates aquifer]

Map identifier	Unique identifier	USGS station number	Name of spring	Source of spring name	Longitude (dd)	Latitude (dd)	Field verified	Specific conductance (µS/cm at 25 °C)	Discharge (ft^3/s)	Field visit date (MM/DD/YY)	Field observation at land surface	Soil type at surface
59	SPNG_59	--	Unnamed	--	-98.5596	29.691	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 12 to 20 percent slopes
60	SPNG_60	--	Unnamed	--	-98.5645	29.6843	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes
61	SPNG_61	--	Unnamed	--	-98.5679	29.6885	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes
62	SPNG_62	--	Unnamed	--	-98.5682	29.6883	No	nm	nm	--	Upper evaporite	Krum clay, 1 to 5 percent slopes
63	SPNG_63	--	Unnamed	--	-98.5673	29.6894	No	nm	nm	--	Camp Bullis	Eckrant cobbly clay, 1 to 5 percent slopes
64	SPNG_64	--	Unnamed	--	-98.5715	29.6841	No	nm	nm	--	Fossiliferous	Krum clay, 1 to 5 percent slopes
65	SPNG_65	294102098341801	6820518	TWDB	-98.5717	29.6838	Yes	nm	0	--	Fossiliferous	Krum clay, 1 to 5 percent slopes
66	SPNG_66	--	Unnamed	--	-98.5496	29.7229	No	nm	nm	--	Fossiliferous	Eckrant cobbly clay, 1 to 5 percent slopes
67	SPNG_67	--	Unnamed	--	-98.5575	29.7153	No	nm	nm	--	Fossiliferous	Krum clay, 1 to 5 percent slopes
68	SPNG_68	--	Unnamed	--	-98.5521	29.7008	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 12 to 20 percent slopes
69	SPNG_69	--	Unnamed	--	-98.5504	29.7015	No	nm	nm	--	Camp Bullis	Eckrant cobbly clay, 1 to 5 percent slopes
70	SPNG_70	--	Unnamed	--	-98.5472	29.706	No	nm	nm	--	Camp Bullis	Eckrant cobbly clay, 1 to 5 percent slopes
71	SPNG_71	--	Unnamed	--	-98.5387	29.7024	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 12 to 20 percent slopes
72	SPNG_72	--	Unnamed	--	-98.5462	29.6887	No	nm	nm	--	Camp Bullis	Krum clay, 1 to 5 percent slopes
73	SPNG_73	--	Unnamed	--	-98.5252	29.7048	No	nm	nm	--	Upper evaporite	Krum clay, 1 to 5 percent slopes
74	SPNG_74	--	Unnamed	--	-98.5264	29.6948	No	nm	nm	--	Camp Bullis	Krum clay, 1 to 5 percent slopes
75	SPNG_75	--	Unnamed	--	-98.5264	29.6942	No	nm	nm	--	Camp Bullis	Krum clay, 1 to 5 percent slopes
76	SPNG_76	--	Unnamed	--	-98.5268	29.6942	No	nm	nm	--	Camp Bullis	Krum clay, 1 to 5 percent slopes
77	SPNG_77	--	Unnamed	--	-98.5811	29.679	No	nm	nm	--	Fossiliferous	Eckrant cobbly clay, 1 to 5 percent slopes
78	SPNG_78	--	Unnamed	--	-98.5815	29.6797	No	nm	nm	--	Upper evaporite	Eckrant cobbly clay, 1 to 5 percent slopes

Appendix 1. Geodatabase and characteristics of springs within and surrounding the upper and middle Trinity aquifer outcrops in northern Bexar County, Texas, 2010–11.—Continued

[USGS, U.S. Geological Survey; dd, decimal degrees; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; ft³/s, cubic feet per second; MM/DD/YY, month/day/year; GNIS, Geographic Names Information System; TWDB, Texas Water Development Board; --, not applicable; nm, not measured. Green shading indicates informal hydrostratigraphic unit; gray shading indicates formal hydrogeologic subdivision; blue shading indicates aquifer]

Map identi-fier	Unique identifier	USGS station number	Name of spring	Source of spring name	Longitude (dd)	Latitude (dd)	Field verified	Specific conduc-tance (µS/cm at 25 °C)	Dis-charge (ft³/s)	Field visit date (MM/DD/YY)	Field observation at land surface	Soil type at surface
79	SPNG_79	--	Unnamed	--	-98.5841	29.6747	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 12 to 20 percent slopes
80	SPNG_80	--	Unnamed	--	-98.5956	29.6624	No	nm	nm	--	Upper evaporite	Eckrant cobbly clay, 1 to 5 percent slopes
81	SPNG_81	--	Unnamed	--	-98.6074	29.685	No	nm	nm	--	Fossiliferous	Eckrant cobbly clay, 1 to 5 percent slopes
82	SPNG_82	--	Unnamed	--	-98.6077	29.6833	No	nm	nm	--	Fossiliferous	Eckrant cobbly clay, 5 to 15 percent slopes
83	SPNG_83	--	Unnamed	--	-98.6157	29.6771	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 12 to 20 percent slopes
84	SPNG_84	--	Unnamed	--	-98.6182	29.677	No	nm	nm	--	Cavernous	Brackett gravelly clay loam, 12 to 20 percent slopes
85	SPNG_85	--	Unnamed	--	-98.6139	29.6779	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 12 to 20 percent slopes
86	SPNG_86	--	Unnamed	--	-98.6063	29.6694	No	nm	nm	--	Camp Bullis	Eckrant cobbly clay, 1 to 5 percent slopes
87	SPNG_87	--	Unnamed	--	-98.5925	29.6445	No	nm	nm	--	Cavernous	Brackett gravelly clay loam, 12 to 20 percent slopes
88	SPNG_88	--	Unnamed	--	-98.5919	29.6448	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 12 to 20 percent slopes
89	SPNG_89	--	Unnamed	--	-98.5773	29.6324	No	nm	nm	--	Cavernous	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
90	SPNG_90	--	Unnamed	--	-98.5786	29.6296	No	nm	nm	--	VIII[1]	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
91	SPNG_91	--	Unnamed	--	-98.5431	29.6858	No	nm	nm	--	Upper evaporite	Krum clay, 1 to 5 percent slopes
92	SPNG_92	--	Unnamed	--	-98.5503	29.6729	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes
93	SPNG_93	--	Unnamed	--	-98.5506	29.6663	No	nm	nm	--	Camp Bullis	Krum clay, 1 to 5 percent slopes
94	SPNG_94	--	Unnamed	--	-98.5584	29.6673	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes
95	SPNG_95	--	Unnamed	--	-98.559	29.6687	No	nm	nm	--	Camp Bullis	Brackett gravelly clay loam, 5 to 12 percent slopes

Appendix 1. Geodatabase and characteristics of springs within and surrounding the upper and middle Trinity aquifer outcrops in northern Bexar County, Texas, 2010–11.—Continued

[USGS, U.S. Geological Survey; dd, decimal degrees; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; ft^3/s, cubic feet per second; MM/DD/YY, month/day/year; GNIS, Geographic Names Information System; TWDB, Texas Water Development Board; --, not applicable; nm, not measured. Green shading indicates informal hydrostratigraphic unit; gray shading indicates formal hydrogeologic subdivision; blue shading indicates aquifer]

Map identifier	Unique identifier	USGS station number	Name of spring	Source of spring name	Longitude (dd)	Latitude (dd)	Field verified	Specific conductance (µS/cm at 25 °C)	Discharge (ft^3/s)	Field visit date (MM/DD/YY)	Field observation at land surface	Soil type at surface
96	SPNG_96	--	Unnamed	--	-98.5592	29.6688	No	nm	nm	--	Cavernous	Brackett-Eckrant association, 20 to 60 percent slopes
97	SPNG_97	--	Unnamed	--	-98.5577	29.6417	No	nm	nm	--	Cavernous	Krum clay, 1 to 5 percent slopes
98	SPNG_98	--	Unnamed	--	-98.5254	29.6822	No	nm	nm	--	Camp Bullis	Eckrant cobbly clay, 1 to 5 percent slopes
99	SPNG_99	--	Unnamed	--	-98.5515	29.6506	No	nm	nm	--	Cavernous	Brackett gravelly clay loam, 12 to 20 percent slopes
100	SPNG_100	--	Unnamed	--	-98.5593	29.6427	No	nm	nm	--	Cavernous	Brackett gravelly clay loam, 5 to 12 percent slopes
101	SPNG_101	--	Unnamed	--	-98.5426	29.6853	No	nm	nm	--	Upper evaporite	Krum clay, 1 to 5 percent slopes
102	SPNG_102	--	Unnamed	--	-98.5559	29.6783	No	nm	nm	--	Cavernous	Brackett gravelly clay loam, 5 to 12 percent slopes
103	SPNG_103	293505098454101	6826602	TWDB	-98.7615	29.5847	Yes	nm	nm	01/19/11	Cavernous	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
104	SPNG_104	294227098413800	6819521	TWDB	-98.694	29.7077	Yes	570	1.46	10/13/10	Middle Trinity	Krum clay, 1 to 5 percent slopes
104	SPNG_104	294227098413800	6819521	TWDB	-98.694	29.7077	Yes	671	nm	3/18/2011	Middle Trinity	Krum clay, 1 to 5 percent slopes
105	SPNG_105	294228098415700	6819522	TWDB	-98.6993	29.7079	Yes	nm	nm	10/04/10	Fossiliferous	Brackett gravelly clay loam, 12 to 20 percent slopes
106	SPNG_106	294225098412800	6819523	TWDB	-98.6914	29.7071	Yes	1,130	0	03/18/11	Middle Trinity	Eckrant cobbly clay, 1 to 5 percent slopes
107	SPNG_107	294215098412200	6819524	TWDB	-98.6895	29.7043	Yes	nm	nm	10/04/10	Middle Trinity	Eckrant cobbly clay, 1 to 5 percent slopes
108	SPNG_108	293819098401401	6819816	TWDB	-98.6706	29.6386	Yes	854	0.106	10/20/10	Cavernous	Krum clay, 1 to 5 percent slopes
108	SPNG_108	293819098401401	6819816	TWDB	-98.6706	29.6386	Yes	954	0	8/19/2011	Cavernous	Krum clay, 1 to 5 percent slopes
109	SPNG_109	293813098395801	6819924	TWDB	-98.6662	29.6371	Yes	779	0.023	10/20/10	Cavernous	Krum clay, 1 to 5 percent slopes
110	SPNG_110	293957098382201	6819925	TWDB	-98.6396	29.6659	Yes	167	0	11/12/10	Camp Bullis	Tinn and Frio soils, 0 to 1 percent slopes, frequently flooded
111	SPNG_111	294013098385901	6819647	TWDB	-98.6499	29.6704	Yes	388	0	11/12/10	Middle Trinity	Tinn and Frio soils, 0 to 1 percent slopes, frequently flooded
112	SPNG_112	294043098400201	6819525	TWDB	-98.6673	29.6786	Yes	450	nm	11/12/10	Middle Trinity	Patrick soils, 3 to 5 percent slopes, rarely flooded

Appendix 1. Geodatabase and characteristics of springs within and surrounding the upper and middle Trinity aquifer outcrops in northern Bexar County, Texas, 2010–11.—Continued

[USGS, U.S. Geological Survey; dd, decimal degrees; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; ft^3/s, cubic feet per second; MM/DD/YY, month/day/year; GNIS, Geographic Names Information System; TWDB, Texas Water Development Board; --, not applicable; nm, not measured. Green shading indicates informal hydrostratigraphic unit; gray shading indicates formal hydrogeologic subdivision; blue shading indicates aquifer]

Map identifier	Unique identifier	USGS station number	Name of spring	Source of spring name	Longitude (dd)	Latitude (dd)	Field verified	Specific conductance (µS/cm at 25 °C)	Discharge (ft^3/s)	Field visit date (MM/DD/YY)	Field observation at land surface	Soil type at surface
113	SPNG_113	293947098381501	6819910	TWDB	-98.6374	29.6629	Yes	828	0.013	11/12/10	Cavernous	Lewisville silty clay, 0 to 1 percent slopes
113	SPNG_113	293947098381501	6819910	TWDB	-98.6374	29.6629	Yes	828	0.008	8/19/2011	Cavernous	Lewisville silty clay, 0 to 1 percent slopes
114	SPNG_114	293537098411001	6827214	TWDB	-98.6862	29.5938	Yes	490	0.110	11/02/10	Camp Bullis	Tinn and Frio soils, 0 to 1 percent slopes, frequently flooded
115	SPNG_115	293627098410401	6827215	TWDB	-98.6845	29.6076	Yes	568	0.250	11/22/10	Camp Bullis	Tinn and Frio soils, 0 to 1 percent slopes, frequently flooded
115	SPNG_115	293627098410401	6827215	TWDB	-98.6845	29.6076	Yes	698	nm	8/19/2011	Camp Bullis	Tinn and Frio soils, 0 to 1 percent slopes, frequently flooded
116	SPNG_116	294056098323201	Panther Springs	GNIS	-98.5423	29.6821	Yes	648	nm	11/29/10	Camp Bullis	Krum clay, 1 to 5 percent slopes
117	SPNG_117	294217098464601	6818602	TWDB	-98.7795	29.7047	Yes	598	0.005	12/01/10	Cavernous	Brackett gravelly clay loam, 12 to 20 percent slopes
118	SPNG_118	294408098413001	6819214	TWDB	-98.6932	29.7353	Yes	506	0.595	12/02/10	Middle Trinity	Oakalla soils, 0 to 2 percent slopes, frequently flooded
119	SPNG_119	293942098402401	6819817	TWDB	-98.6733	29.6617	Yes	463	0	12/09/10	Fossiliferous	Brackett gravelly clay loam, 12 to 20 percent slopes
120	SPNG_120	294318098453001	6818302	TWDB	-98.7584	29.7218	Yes	624	0.433	12/08/10	Fossiliferous	Krum silty clay, 1 to 3 percent slopes
121	SPNG_121	294120098421902	6819526	TWDB	-98.7054	29.689	Yes	608	nm	03/18/11	Middle Trinity	Lewisville silty clay, 1 to 3 percent slopes
122	SPNG_122	294146098234902	6821602	TWDB	-98.397	29.6963	Yes	741	0.007	04/05/11	VIII[1]	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
123	SPNG_123	294143098234602	6821608	TWDB	-98.3961	29.6955	Yes	nm	0	04/05/11	VIII[1]	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
124	SPNG_124	294143098233802	6821609	TWDB	-98.3941	29.6954	Yes	nm	0	04/05/11	Cavernous	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
125	SPNG_125	293915098372602	6820720	TWDB	-98.6241	29.6544	Yes	nm	0	04/01/11	Fossiliferous	Lewisville silty clay, 0 to 1 percent slopes
126	SPNG_126	294310098440801	6819109	TWDB	-98.7356	29.7194	Yes	nm	nm	04/01/11	Fossiliferous	Oakalla soils, 0 to 2 percent slopes, frequently flooded
127	SPNG_127	293647098400201	Huesta Springs	GNIS	-98.6667	29.6133	Yes	493	0.018	12/10/10	Cavernous	Eckrant-Rock outcrop complex, 15 to 60 percent slopes

Appendix 1. Geodatabase and characteristics of springs within and surrounding the upper and middle Trinity aquifer outcrops in northern Bexar County, Texas, 2010–11.—Continued

[USGS, U.S. Geological Survey; dd, decimal degrees; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; ft³/s, cubic feet per second; MM/DD/YY, month/day/year; GNIS, Geographic Names Information System; TWDB, Texas Water Development Board; --, not applicable; nm, not measured. Green shading indicates informal hydrostratigraphic unit; gray shading indicates formal hydrogeologic subdivision; blue shading indicates aquifer]

Map identifier	Unique identifier	USGS station number	Name of spring	Source of spring name	Longitude (dd)	Latitude (dd)	Field verified	Specific conductance (µS/cm at 25 °C)	Discharge (ft³/s)	Field visit date (MM/DD/YY)	Field observation at land surface	Soil type at surface
128	SPNG_128	--	Unnamed	--	-98.4683	29.6706	No	nm	nm	--	Cavernous	Eckrant cobbly clay, 1 to 5 percent slopes
129	SPNG_129	294048098235701	Walnut Spring	GNIS	-98.4001	29.6799	Yes	469	0	10/15/10	VIII[1]	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
130	SPNG_130	294059098240101	Cherry Spring	GNIS	-98.4007	29.683	No	nm	nm	--	VIII[1]	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
131	SPNG_131	293912098453201	6818903	TWDB	-98.7583	29.6542	Yes	nm	0	09/07/11	Fossiliferous	Krum clay, 1 to 5 percent slopes
132	SPNG_132	294020098453201	6818601	TWDB	-98.759	29.6721	Yes	nm	0	09/07/11	Fossiliferous	Krum clay, 1 to 5 percent slopes
133	SPNG_133	293916098452801	6818604	TWDB	-98.7583	29.6542	Yes	nm	0	09/07/11	Fossiliferous	Krum clay, 1 to 5 percent slopes
134	SPNG_134	294038098232401	6821606	TWDB	-98.3903	29.6772	Yes	nm	0	03/04/09	Cavernous	Eckrant-Rock outcrop complex, 15 to 60 percent slopes
135	SPNG_135	294105098263301	6821520	TWDB	-98.4427	29.6849	Yes	nm	0	03/18/11	Cavernous	Crawford and Bexar stony soils
136	SPNG_136	294216098464601	6818603	TWDB	-98.7795	29.7044	Yes	nm	0	12/01/10	Cavernous	Brackett gravelly clay loam, 12 to 20 percent slopes
137	SPNG_137	294126098314702	6820610	TWDB	-98.5303	29.6908	Yes	nm	0	05/14/12	Upper evaporite	Krum clay, 1 to 5 percent slopes
138	SPNG_138	294119098324502	6820511	TWDB	-98.5462	29.6887	Yes	nm	0	05/14/12	Camp Bullis	Krum clay, 1 to 5 percent slopes
139	SPNG_139	294122098323502	6820512	TWDB	-98.5432	29.6897	Yes	nm	0	05/14/12	Camp Bullis	Krum clay, 1 to 5 percent slopes
140	SPNG_140	294208098341602	6820513	TWDB	-98.5715	29.7024	Yes	nm	0	05/14/12	Fossiliferous	Krum clay, 1 to 5 percent slopes
141	SPNG_141	294226098341702	6820514	TWDB	-98.5719	29.7074	Yes	nm	0	05/14/12	Fossiliferous	Krum clay, 1 to 5 percent slopes

[1]Hydrogeologic subdivision VIII of the Edwards aquifer (Maclay and Small, 1986).

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