Ground-Water and Surface-Water Hydrology of Camp Swift, Bastrop County, Texas

Final Report

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EXECUTIVE SUMMARY

Ground-water and surface-water investigations of Camp Swift, Bastrop County, Texas, were conducted to provide the Texas Army National Guard with information needed to preserve environmental quality and resources while planning and conducting training and preparedness activities. Spatial information such as surface geology, watersheds, elevation data, floodplains, well locations, and water levels was converted to digital files and submitted to the Texas Army National Guard Geographic Information System office at Camp Mabry, Austin, Texas, for future use in managing the training facility. Similar investigations were conducted on Camps Barkeley, Bowie, Mabry, and Maxey, and Fort Wolters. Results of those studies are presented separately.

Previously published reports and public data files were examined to obtain background information on the camp and surrounding area. These data were used to guide more focused studies on the training facility. Ground-water studies included locating existing wells on and near the camp; installing new wells as needed; testing and sampling selected wells; determining ground-water levels, chemical compositions, and aquifer hydraulic properties; and developing a conceptual model of ground-water flow. Surface-water studies focused on delineating watersheds and mapping floodplains.

The principal ground-water sources at Camp Swift are strata in the Wilcox Group. From deepest to shallowest, these units are the Hooper, Simsboro, and Calvert Bluff Formations and alluvium along Big Sandy and McLaughlin Creeks and Dogwood Branch. Wells in the Hooper and Simsboro Formations show a gradual recovery from low levels during the drought years in the 1950's. Wells in the Calvert Bluff and alluvium show fluctuating but generally steady water levels over the same time period. Water levels in the Calvert Bluff are higher than those in the Simsboro, indicating potential for downward ground-water flow. Such flow is probably slow because low-permeability strata separate the two aquifer units. Ground waters are fresh to brackish, changing with depth from a calcium-bicarbonate type in alluvium to mixed calcium-bicarbonate and sodium-chloride types in the Hooper Formation.

Camp Swift resides in the Colorado River Basin drainage area. Most of the camp grounds are within the Dogwood Creek, McLaughlin Creek, or Dogwood Branch subdrainage basins. Areas that would be flooded after a 100-yr storm are confined to the immediate vicinity of Dogwood Branch. Flooded areas are larger in the McLaughlin Creek subdrainage basin, and they are widest in the northeastern portion of the training facility.

INTRODUCTION

This report summarizes ground-water and surface-water studies at Camp Swift, Bastrop County, Texas, conducted by the Bureau of Economic Geology (BEG) for the Texas Army National Guard. This work was part of a larger study of Texas Army National Guard training facilities that included Camp Barkeley (Taylor County), Camp Bowie (Brown County), Camp Mabry (Travis County), Camp Maxey (Lamar County), and Fort Wolters (Parker County). These investigations, in conjunction with aquatic and biological surveys conducted by the Texas Parks and Wildlife Department, provide information needed by the Texas Army National Guard to plan training and preparedness activities in a way that will protect and enhance environmental resources without compromising training needs and national security readiness. Reports of similar investigations on the other training facilities are presented separately.

This report contains results of hydrogeologic and hydrologic analyses and describes how we prepared data files for Geographic Information System (GIS) coverages of the camp and surrounding area. The hydrogeologic analyses contain information regarding hydrostratigraphy, camp and perimeter well surveys, monitor well drilling, well testing, aquifer properties, ground-water levels, ground-water chemistry, and a conceptual ground-water flow model. The hydrologic analyses contain information regarding streams and drainage basins on and near the camp, watershed delineations, stream-flow duration, flood frequency, and floodplain analysis. The GIS data preparation section contains descriptions of the original data sets, how they were obtained, and how they were processed to obtain GIS coverages for the camp.

Regional Setting

Camp Swift is located in Bastrop County between the cities of Bastrop and Elgin on the upper Gulf Coastal Plain (fig. 1). The area is characterized by nearly level to gently sloping ridge tops with generally steep side slopes and narrow to broad valleys. Drainage channels are clearly incised in valleys and are part of the Colorado River Basin drainage area (Baker, 1979).

Soils on the camp consist of the Patilo-Demona-Silstid and the Axtell-Tabor associations (Baker, 1979). The Patilo-Demona-Silstid association has gently sloping ridge tops to strongly sloping side slopes. The Patilo and Demona soils have a sandy surface layer and slightly to moderately permeable lower layers on the uplands, usually consisting of sandy clay or sandy clay loam. Silstid soils are mostly confined to drainage areas and foot slopes. The Axtell-Tabor association has nearly level to gently sloping ridge tops and gently to strongly sloping side slopes.

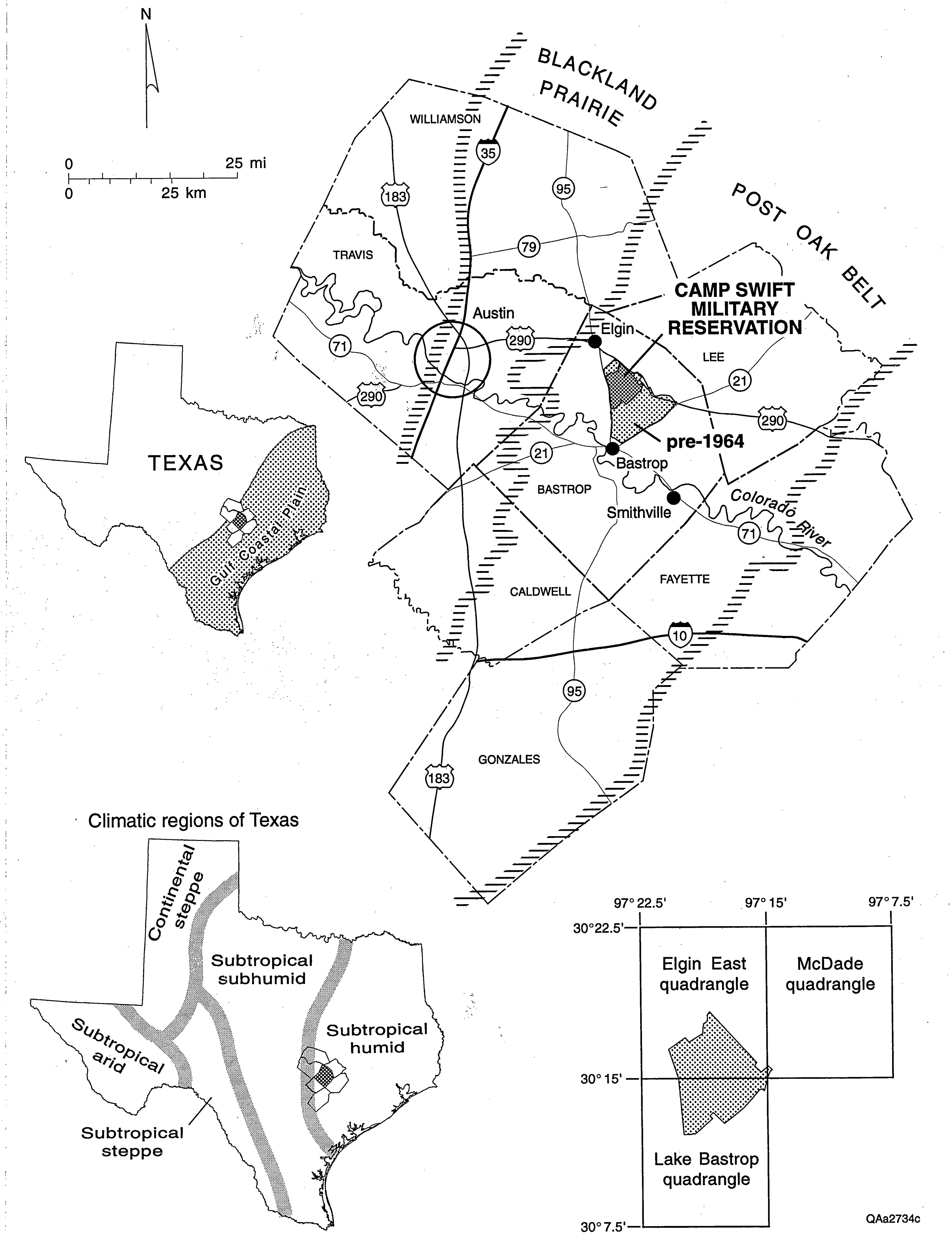

Figure 1. Index map of Central Texas region showing location of Camp Swift study area (darkly shaded area), major highways and towns, and immediate ecological provinces (Blackland Prairie and Post Oak Belt); lightly shaded area around Camp Swift indicates extent of base before transfer to Texas Army National Guard in 1964. Insets show climatic regions of Texas (after Larkin and Bomar, 1983) and 7.5-minute topographic quadrangles containing study area (from Avakian and Wermund, 1993).

These soils have a loamy surface layer and very slightly permeable lower layers, usually consisting of mottled clay or sandy clay.

Camp Swift lies within in the Oak-Hickory vegetation region (Kier and others, 1977) delineated westward by the Blackland Prairie and eastward by the Fayette Prairie (Tharp, 1939). In Bastrop County the Blackland Prairie and Oak-Hickory zones merge, with timber groves standing as islands in the prairie vegetation and as grassland inclusions in the oak-hickory forest (Tharp, 1939). In addition to the native woods and grasslands, there are croplands, cleared pastures, and rangelands (Baker, 1979).

Camp Swift is located in the subtropical humid climate region (fig. 1) (Larkin and Bomar, 1983). The climate is dominated by tropical marine air from the Gulf of Mexico, modified by a westward decrease in moisture content. The influence of continental air varies seasonally (Larkin and Bomar, 1983).

The closest recording weather station is in Austin, Texas, about 22 miles west of Camp Swift. Reports from the Austin station show that winds are typically from the south and southeast throughout the year. Average wind speeds range from 8 to 11 mph, with highest speeds in April and lowest speeds in July and October (Bomar, 1983). On average about 21 cold fronts per year move through Austin, usually accompanied by northerly winds (Bomar, 1983).

The mean annual precipitation measured in Austin is 31.5 inches, with highest precipitation rates between May and October (Bomar, 1983). Mean monthly low temperatures range from 39°F in January to 74°F in July, averaging 58°F. Mean monthly high temperatures range from 59°F during the coldest month of winter to a high of 95°F in July, with an average of 79°F.

The average annual gross lake-surface evaporation rate ranges from 59 inches in the eastern part of Bastrop County to 61 inches toward the west. Highest rates of approximately 8 inches occur during July, and lowest rates of about 2.5 inches occur during January (Larkin and Bomar, 1983).

Geology and Hydrostratigraphy

The Calvert Bluff Formation and creek alluvium underlie Camp Swift (figs. 2 and 3). The Calvert Bluff Formation is the upper formation of the Wilcox Group, which also includes the Hooper Formation (lower) and the Simsboro Formation (middle) (fig. 2). The Calvert Bluff Formation consists of weakly to moderately consolidated, massive to thin-bedded, clayey, fine-grained to very fine grained sandstone, siltstone, and claystone (Avakian and Wermund, 1993).

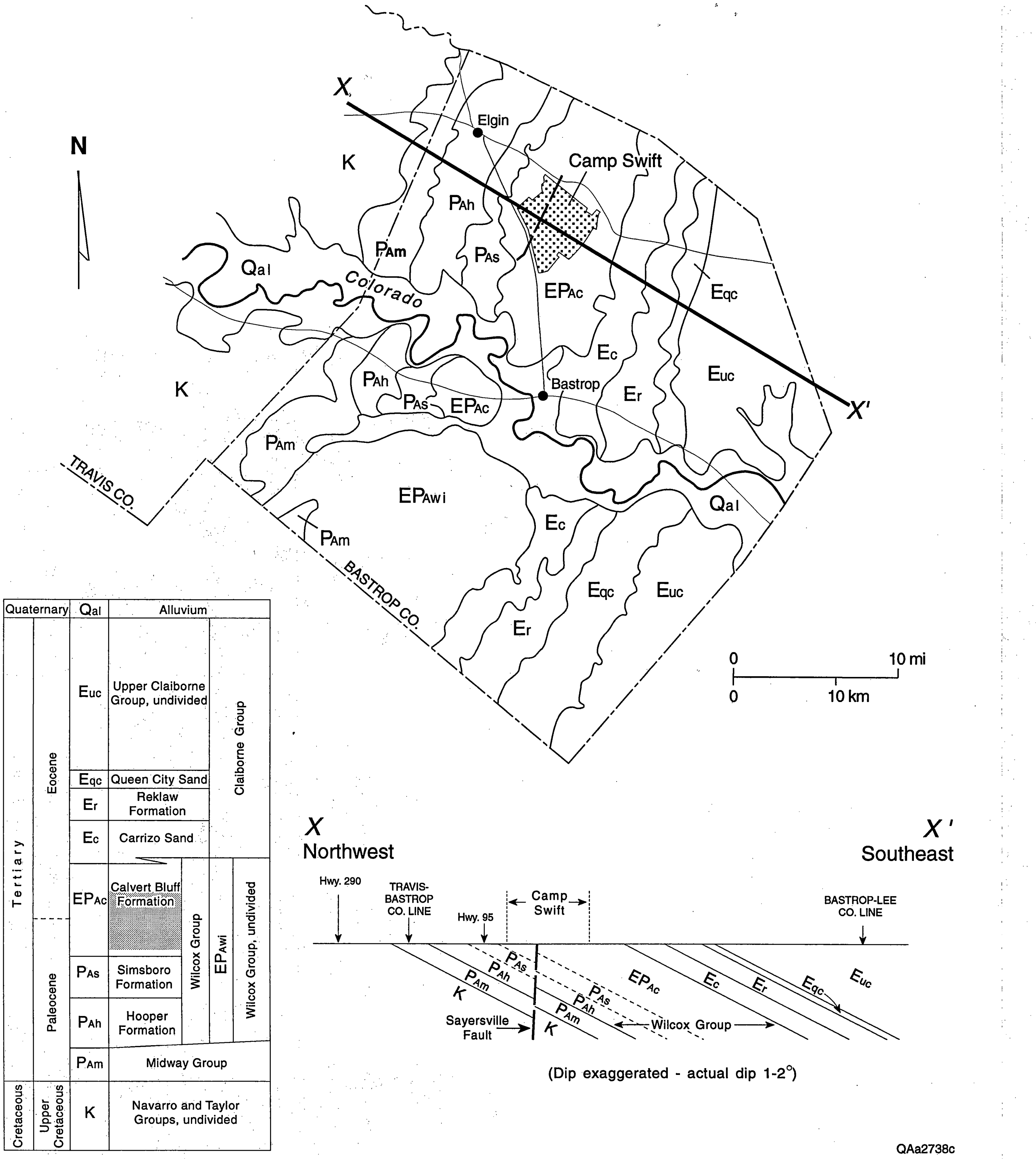

Figure 2. Generalized geologic map, schematic cross section, and stratigraphic column for Bastrop and easternmost Travis Counties (from Avakian and Wermund, 1993).

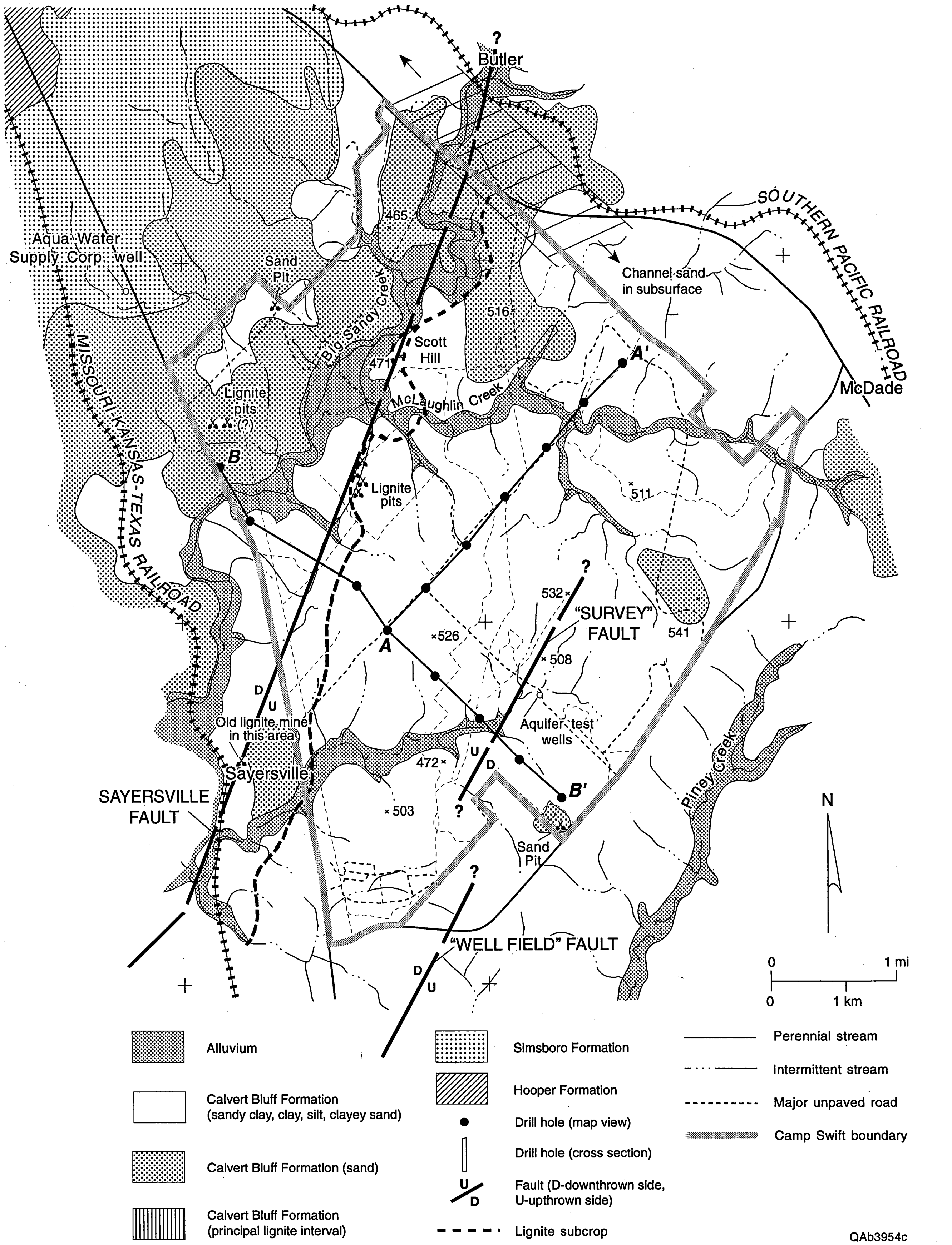

Figure 3. (a) Geologic map of Camp Swift (adapted from Avakian and Wermund, 1993).

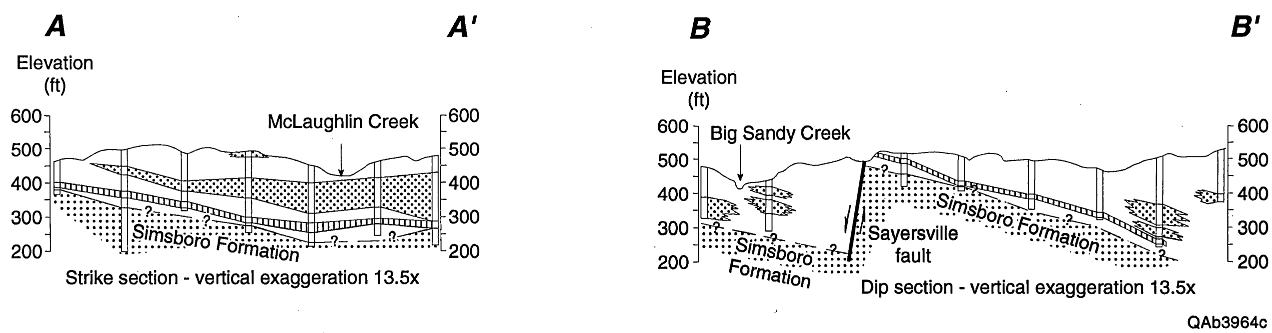

Figure 3. (b) Geologic cross sections of Camp Swift (adapted from Avakian and Wermund, 1993).

The formation varies from light gray in sandy units to brown in muddy units and typically weathers yellowish-brown to red. Lignite beds and ironstone concretions are common in the lower 200 ft and occur less commonly higher in the formation. Beneath Camp Swift, the thickness of the Calvert Bluff Formation ranges from as little as 25 ft near the Sayersville Fault to as much as 500 ft beneath the southwestern edge of Camp Swift (Gaylord and others, 1985) (figs. 2 and 3). The Calvert Bluff Formation is sandier in the northern reaches and in a few small areas in the southern part of the camp (Henry and Basciano, 1979) (fig. 3).

Unconsolidated alluvium and colluvium underlie stream valleys and form thin veneers on upland surfaces north of Sandy Creek (fig. 3) (Avakian and Wermund, 1993). Principal locations of alluvium are along Big Sandy Creek, McLaughlin Creek, and Dogwood Branch (fig. 3). Stream-valley alluvium consists of interbedded clay, silt, and sand with varying amounts of gravel. The veneers on the upland surfaces are part of the soil profile and contain abundant pebbles and cobbles of petrified wood, quartzite, and other siliceous rocks.

Follett (1970) recognized the Wilcox Group as the most important water-bearing strata in Bastrop County. The Simsboro and Hooper Formations are the main water-producing intervals in the Wilcox Group, both of which underlie Camp Swift (fig. 2). The Simsboro Formation consists mostly of weakly to slightly consolidated, crossbedded kaolinitic quartz sandstone with some siltstone and claystone (Avakian and Wermund, 1993). The Hooper Formation consists of mudstone, sand, and sandstone with a few thin and discontinuous beds of lignite (Avakian and Wermund, 1993).

METHODS

Ground-Water Analysis

The Camp Swift area has been previously characterized by investigations of lignite resources and mining potential as well as hydrogeologic and physical environment studies. Reports by the Texas Water Development Board (TWDB) (Austin, 1954; Follett, 1970; Thorkildsen and Price, 1991), U.S. Geological Survey (USGS) (Guyton, 1942; Gaylord and others, 1985), The University of Texas at Austin Bureau of Economic Geology (BEG) (Avakian and Wermund, 1993), U.S. Department of Interior (1982), and Argonne National Laboratory (Dennis, 1993) summarize much of the general hydrogeologic information for the area. Other more specific hydrogeology reports were prepared by Hydro-Search, Inc. (1981), and Science Applications, Inc. (1982). Geologic information related to lignite resources was included in BEG reports by Kaiser and others (1978), Henry and Basciano (1979), Henry and others (1980), and Kaiser and others (1980). These reports and data listings provided a regional hydrogeologic framework and guided our site-specific studies to those areas of the camp where hydrogeologic information was sparse.

Our methods of investigation included a well inventory on and off the camp, installation of monitor wells, well testing, and ground-water sampling. We used all this information to develop a conceptual model, or general idea, of how ground water flows in the Camp Swift area.

Well Inventory

We conducted inventories on the camp and around the perimeter of the camp to locate and, if possible, measure wells. On the camp, we tried to locate all wells. This was accomplished through interviews with National Guard archeologists and camp personnel. In addition, we drove on all camp roads in our search for wells. Old topographic maps (circa 1904) provided guidance for locating potential wells near old homesteads on the camp. For all located wells, we made detailed measurements and descriptions of well location, type, depth, water level, diameter, and casing construction.

The perimeter well survey was required because mapping water levels and understanding ground-water systems at the training facility required data beyond the site boundaries and because the data base available from State agencies typically contained records for less than half of the existing wells in an area. The perimeter well survey also provided information concerning the use of local ground-water resources in proximity to the camp and potential receptors to ground-water flowing beneath the camp. Our approach to the perimeter well survey was to search for wells visible from the roadway, meet the well owners, and measure water levels and electrical conductivities in as many wells as possible. In addition, we interviewed residents and local drillers regarding ground-water wells and general ground-water conditions.

Monitor Well Installation

Monitor wells were installed to obtain hydrogeologic data from poorly characterized areas on the camp. The installation of monitor wells at Camp Swift included selecting and staking appropriate sites for well locations, arranging access to the well sites and a water source, drilling and purging the borehole, installing casing, and developing the cased well.

We drilled the monitor wells with a Central Mine Equipment 75 drilling rig. Depending on the geology, we used hollow stem augering, solid stem boring, rotary/wet coring, or a combination thereof to install the wells. Where possible, we collected core and cuttings for inspection. After the well was drilled, we augered or flushed the cuttings from the hole and developed the well with a bailer, usually removing one to two wellbore volumes of water. Well completion consisted of installing 2-inch well screen and pipe, placing a sandpack around the screen, placing a bentonite seal above the sandpack, grouting to within a few feet of land surface, installing a well guard, and cementing the guard in place with a well pad. We installed either 10- or 20-ft-long 0.010-inch slotted screen in the wells. The sandpack consisted of 20/40 sand and straddled the screen. We installed locking above-ground well guards on each of the wells. Once the well was completed and the cement had dried, we developed the well again with a bailer or an electrical submersible pump.

Well Testing

We conducted bail tests in the two wells we drilled on the camp. We also attempted to test a hand-dug well and a USGS well. The bail tests involved using a bailer to quickly remove water from the well and monitoring water-level recovery with an electronic water-level meter. Recovery data were input into a spreadsheet, and transmissivity was interpreted using the Hvorslev (1951) method and the Cooper and others (1967) curve matching method. A hand-dug well in the northern part of the camp was tested, but we found that the water level never recovered because the well was probably sealed from the aquifer. The USGS well had its wellbore blocked by debris.

Ground-Water Sampling

Ground-water samples were collected from the two monitoring wells drilled during this project. In both cases, samples were obtained by bailing the well. Our procedure was to first remove and discard one bailer volume (~500 mL) to rinse the bailer before sampling. A second bailer volume was then collected and used to measure pH and temperature at the well site. Water from the next bailer run was used to rinse field filtration equipment. Ground water produced by subsequent bailer runs was passed through a 0.45 μm filter and collected in sample bottles that had first been rinsed three times with filtered sample water. Aliquots intended for cation and trace metal analyses were preserved by adding 5 mL of 6N nitric acid to each 500 mL sample to lower the pH to a value less than 2. Aliquots for all other analyses were filtered but otherwise untreated.

Surface-Water Analysis

Several surface-water studies have previously been conducted in the Camp Swift area. Gaylord and others (1985) monitored four stream-flow gauges in the immediate area and analyzed flood hydrographs for Big Sandy Creek and Dogwood Creek. Peak discharges for these creeks were determined by U.S. Bureau of Land Management (U.S. Department of the Interior, 1980). FEMA (1991) estimated 100-yr floodplains for the Camp Swift area. Avakian and Wermund (1993) prepared drainage basin maps for the camp area.

Watershed Delineation

Maps delineating watersheds on training facilities are important tools for combining training activities with environmental stewardship. Providing watershed delineations based on digital elevation data in GIS format rather than as paper copy has the advantages that (1) map coverages can be exported to the Texas National Guard for their use in other applications and (2) such digital data can subsequently be developed into watershed models in which the effects of various scenarios of precipitation amount and duration can be examined. Digital elevation models (DEMs) at the 1:24,000 scale are currently available for the Elgin, Lake Bastrop, and McDade quadrangles, which include the Camp Swift area. For this report, we generated watershed maps from the DEM data using routines provided in the ArcInfo (ESRI, 1993) software package.

Floodplain Analysis

We further constrained FEMA (1991) floodplain maps by conducting a more detailed analysis of smaller tributaries in the watersheds. Floodplain analysis involves determining the area adjacent to a river or stream that will flood for a specified return period (for example, a 100-yr flood). The standard procedure is to determine the 100-yr flood at key points on the stream and use backwater computation to determine stages upstream (Linsley and others, 1982, p. 452). If available, the 100-yr flood is statistically determined from the stream-gauge record. In the case of Camp Swift, long-term discharge data are available on Big Sandy Creek on the outlet side of the camp. In cases where these data are lacking, regional frequency methods or loss rate and unit hydrograph techniques applied to the 100-yr rainfall data can be used (Linsley and others, 1982, p. 452).

Our floodplain analysis consisted of (1) designing 100-yr 24-h synthetic storms, (2) determining the 100-yr flood hydrographs at strategic points in the watersheds,

(3) determining 100-yr flooding surfaces, and (4) mapping the 100-yr floodplains on 1:24,000 USGS topographic maps.

To design the 100-yr 24-h synthetic storms, we first used maps published by the U.S. Weather Bureau (Herschfield, 1961, as shown in Chow, 1964, p. 9–56) to determine the 100-yr 24-h rainfall. We then used these rainfall rates with the SCS Type II distribution (Bedient and Huber, 1988) to generate the storms.

To determine the 100-yr flood hydrographs, we used HEC-1 (Hydrologic Engineering Center, 1981) with SCS unit hydrographs (Soil Conservation Service, 1957) and Muskingum routing (McCarthy, 1938). Input to HEC-1 included subbasin drainage area, runoff curve numbers, basin lag, routing storage coefficient, and routing weight factor. Runoff curve numbers are used to define the unit hydrographs and are a function of soil type, vegetation, land use, antecedent moisture, and the hydrologic properties of the catchment surface. Basin lag, also called catchment lag, is the elapsed time, or response time, between rainfall and runoff occurrence and is partly a function of hydraulic length, catchment gradient, drainage density, and drainage patterns. The routing storage coefficient, or time constant, is a function of the channel reach length and the speed of the flood wave. The routing weight factor is a function of the flow and channel characteristics that affect the dispersion of the flood wave downstream.

We delineated detailed subwatersheds and determined subwatershed drainage area with ArcInfo (ESRI, 1993). We calculated weighted curve numbers in ArcInfo for each subwatershed using STATSGO (Soil Conservation Service, 1991) digital hydrologic soil data and land-use data assuming moderate antecedent moisture conditions (I_a = 0.25 inch). Because the majority of the watersheds were not gauged, we estimated the basin lag, t_p, using (Linsley and others, 1982, p. 224):

$$t_p = C_t \left(\frac{L L_c}{\sqrt{s}} \right)^n \tag{1}$$

where C_t is a constant that varies between 1.8 and 2.2 for units of miles (Snyder, 1938), L is the stream distance to the divide, L_c is the stream distance, n is 0.35 for valley drainage areas (Linsley and others, 1982, p. 225), and s is the channel gradient. For this study, we chose a mean C_t value of 2.0. We assigned the routing storage coefficient to 0.20, a typical value for most natural streams (Linsley and others, 1982, p. 219). We measured L, L_c, and s from USGS 1:24,000 topographic sheets. We estimated the routing traveltime constant, K, using (Linsley and others, 1982, p. 465–541):

$$K = \frac{bL\sqrt{A}}{\sqrt{s}} \tag{2}$$

where A is the drainage area and b is a constant between 0.04 and 0.08 for L in miles and A in square miles. For this study, we chose a mean b value of 0.06. With the above data input into HEC-1, we modeled 100-yr flood hydrographs for subwatersheds on or just outside the camp. We recorded peak flows for these 100-yr flood hydrographs for assessing flooding depths.

We used HEC-RAS (Hydrologic Engineering Center, 1995) to estimate 100-yr flooding surfaces at the locations where we determined the flood hydrographs. Input to HEC-RAS included: topographic cross sections at hydrograph locations, stream lengths between cross sections, Manning's n values, discharge rates, and stream-flow boundary conditions. We measured topographic cross sections from USGS 1:24,000 topographic sheets perpendicular to the stream path. Using a map roll gauge, we measured stream lengths between cross sections from the topographic sheets. We assumed Manning's n values to be 0.06 on the banks (Hydrologic Engineering Center, 1995) and 0.05 in and near the stream channel. HEC-1 supplied the peak 100-yr discharge rates for each hydrograph location. We assigned the stream-flow boundary condition at the output end of the model as a critical depth boundary. In all simulations, we assumed subcritical flow. After inputting the above information, HEC-RAS determined the flood surface at each of the chosen locations.

We mapped the 100-yr floodplains by transcribing the 100-yr flood surfaces estimated by HEC-RAS onto USGS 1:24,000 topographic sheets and interpolated between hydrograph locations. Once mapped, we digitized the floodplains in ArcInfo GIS and printed maps.

Surface-Water Quality

Water-quality data is available for many of the stream-flow gauging stations near training facilities. The information was obtained in digital form from the USGS.

GIS Data Preparation

Wherever possible, spatial information was input to a geographic information system (GIS). Data bases with spatial coordinates were uploaded into the GIS, and interpreted data such as contour maps were digitized and attributed. The information was imported to the ArcInfo GIS software system so data coverages could be overlaid and compared with each other. Well postings and hydrologic and hydrogeologic analyses were posted on new USGS topographic maps to facilitate data transfer and to ensure the best possible spatial accuracy.

A data dictionary was prepared for the coverages so that subsequent users can know the methods of data preparation and the accuracy of the information. GIS data files were delivered to the Adjutant General's Office of the Texas Army National Guard at Camp Mabry for inclusion in their GIS program.

GROUND-WATER HYDROLOGY

Well Inventory

Archeological reports; TWDB records; conversations with Sergeant West, Camp Swift Facility Manager; and a field survey of camp grounds provided information for locating wells on Camp Swift. We located seven wells or well sites and identified eight other potential sites that may have wells but that we could not locate during our survey of Camp Swift (fig. 4).

- **CSW-B001** is a 4-inch-diameter drilled well with a measured depth greater than 200 ft and a water level of 109 ft below land surface. The casing is made of PVC and extends 1.00 ft above grade. The well is located within a small fenced area and does not have a locking well vault. Well and water depths are difficult to measure because the wellbore is very crooked. The USGS drilled this well to assess the local geology and measure selected hydrogeologic properties of the Wilcox Group as related to potential lignite mining on Camp Swift (Gaylord and others, 1985). At completion, this well (USGS #C-12, TWDB #58-54-303) was 220 ft deep and completed in the basal part of the Calvert Bluff Formation with screen from 200 to 220 ft.

- **CSW-B002** is a 4-inch-diameter drilled well with a measured depth of 72 ft and a water level 66.2 ft below land surface. The casing is made of PVC and extends 0.5 ft above grade. The well is located within a small fenced area 50 ft south of CSW-B001 and does not have a locking well vault. The USGS drilled this well to assess the local geology and measure selected hydrogeologic properties of the Wilcox Group as related to potential lignite mining on Camp Swift (Gaylord and others, 1985). At completion, this well (USGS #C-13, TWDB #58-54-304) was 330 ft deep and completed in the upper part of the Simsboro Formation with screen from 250 to 330 ft. Our depth measurement of 75 ft suggests that either this well has caved or there is an obstruction in the well.

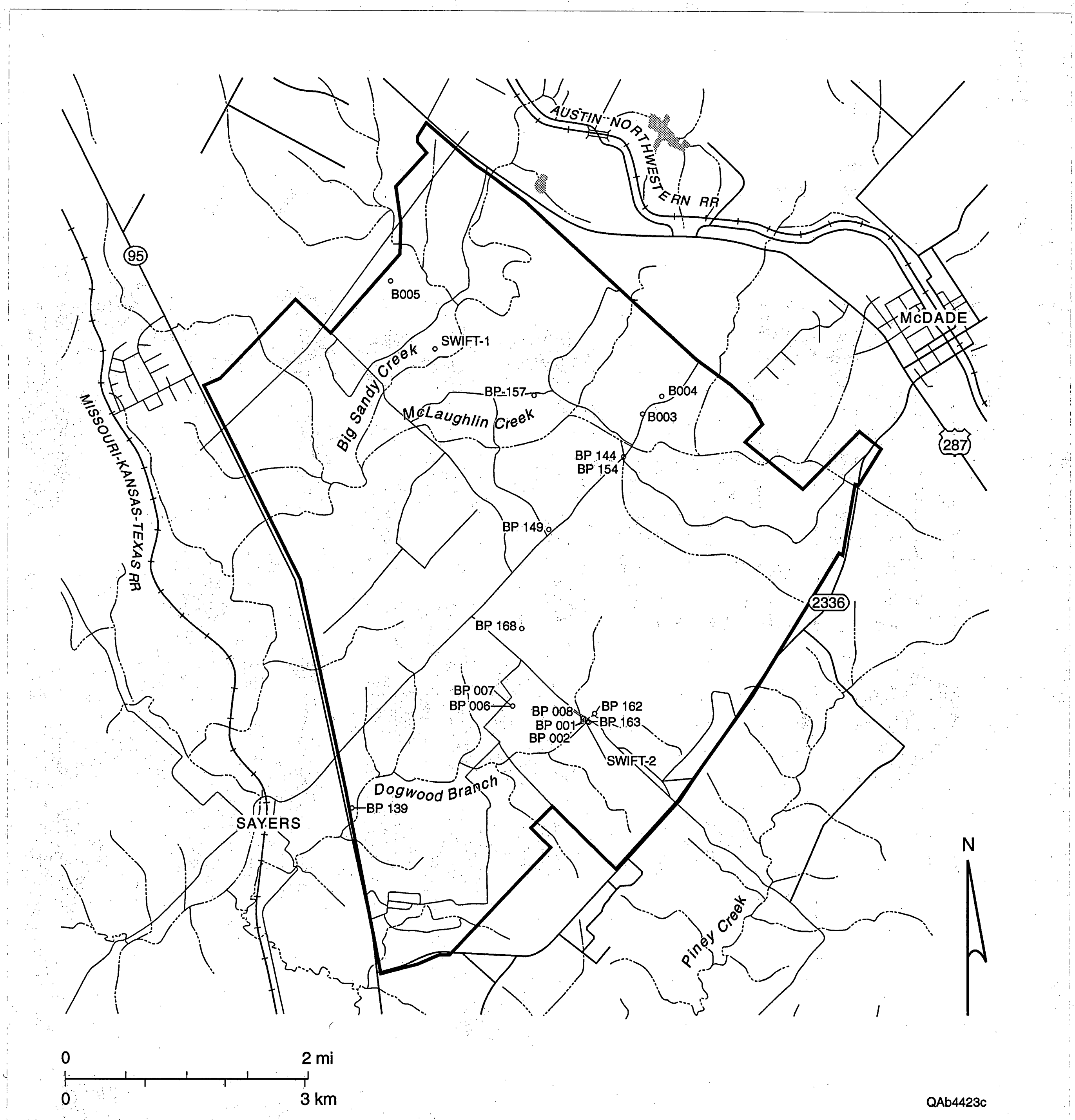

Figure 4. Well locations on Camp Swift including monitor wells drilled during this study.

- **CSW-B003** is a hand-dug cistern located at an old home site. The cistern has a diameter of 3 ft with a brick crown that extends 0.43 ft above ground surface. The cistern is 16.4 ft deep and currently holds no water. Cistern sides appear to be sealed with mortar. The cistern is uncovered and holds several pieces of trash. This cistern is noted by the cultural resources staff of the Adjutant General's Department as the 41BP156 site or Westbrook Housesite (William R. Furr, personal communication, 1995).

- **CSW-B004** is a hand-dug cistern located at an old home site several feet from CSW-B003. The cistern has a diameter of 3 ft with a brick crown that extends 1 ft above ground surface. The cistern is 15.4 ft deep and currently holds no water. Cistern sides appear to be sealed with mortar. The cistern is uncovered and contains several pieces of trash. This cistern is noted by the cultural resources staff of the Adjutant General's Department as the 41BP156 site or Westbrook Housesite (William R. Furr, personal communication, 1995).

- **CSW-B005** is a hand-dug well located near the northern boundary of the camp. The well has a diameter of 2.5 ft with a brick crown that extends 3.5 ft above ground surface. The well is 18.5 ft deep with a depth to water of 13.5 ft. The sides of the well are made of brick at least to water level and probably to depth. The cistern is uncovered and contains some debris. There was an oily sheen on the water surface when we surveyed this well.

- **CSW-B006** is a cistern in the southwest part of the camp. The cistern has a diameter of 3 ft and does not protrude above ground surface. The cistern is filled with debris to 3 ft below ground surface, uncovered, and holds no water. This cistern is noted by the cultural resources staff of the Adjutant General's Department as the 41BP158 site or Beck Housesite (William R. Furr, personal communication, 1995).

- **CSW-B007** is a partially filled cistern 20 ft east of CSW-B006. The cistern has a diameter of 3 ft and does not extend above ground level. The cistern is filled with debris to 8 ft below ground surface, is uncovered, and holds no water. This cistern is noted by the cultural resources staff of the Adjutant General's Department as the 41BP158 site or Beck Housesite (William R. Furr, personal communication, 1995).

- **CSW-B008** is a 4-inch-diameter drilled well of unknown depth and a water level of 77 ft below land surface. The casing is made of PVC and extends 1.5 ft above grade. The well is located within a small fenced area 50 ft north of CSW-B001 and does not have a locking well vault. The USGS drilled this well to assess the local geology and measure selected hydrogeologic properties of the Wilcox Group as related to potential lignite mining on Camp Swift (Gaylord and others, 1985). At completion, this well (USGS #C-11, TWDB #58-54-302) was 500 ft deep and completed in the Simsboro Formation with screen from 240 to 490 ft.

The cultural resources staff of the Adjutant General's Department report several other locations as possible well sites (William R. Furr, personal communication, 1995). However, we were unable to locate wells or cisterns at any of these sites. At a few sites we found what appeared to be mounds of dirt in the approximate location of the well sites. Therefore, many of these wells may have been filled since the archeological survey. There may be other historic wells on Camp Swift yet to be discovered. These wells will be difficult to locate because of the thick brush and changing anthropogenic landmarks.

During the 1970's, more than 70 lignite exploration wells were drilled on Camp Swift. These boreholes have apparently been backfilled, and no record of their existence is filed with the TWDB or the Texas Natural Resources Conservation Commission. Gaylord and others (1985) include a map showing the locations of these boreholes.

A total of 83 wells were mapped during the well survey around the camp perimeter (fig. 5) (app. 1). Measurements of water level and/or conductivity data were obtained from 15 wells. Well depths given for 31 wells ranged from 40 to 1,100 ft for private wells and from 505 to 1,558 ft for municipal water-supply wells. Of the 31 wells, 12 were 100 ft deep or less, 8 ranged from 101 to 250 ft deep, 9 ranged from 400 to 750 ft deep, and 2 were more than 1,000 ft deep. Depth to water, measured in nine wells and estimated by the owners for four others, ranged from 20 to 50 ft in seven wells, from 51 to 60 ft in two wells, and from 61 to 100 ft in one well; it was greater than 150 ft in three wells. In addition, one well of 80-ft depth was flowing, and one of 50- to 60-ft estimated depth was dry. Measured electrical conductance values ranged from 480 to 725 $\mu\Omega$, or approximately 300 to 465 mg/L total dissolved solids (TDS). These data show that all measured wells had fresh water (<1000 mg/L TDS). High iron content was a common observation of well users. In general, well water is used for domestic purposes, including yard and garden irrigation. The presence of at least two water-supply systems in the general area appears to be reducing reliance on private wells as a source of domestic water.

One local driller informed us that water-producing sands are insufficiently continuous to make generalizations about well depths in any given area. Wells in the area appear to produce from the Wilcox Group; most wells are probably producing from the Simsboro Formation, with the

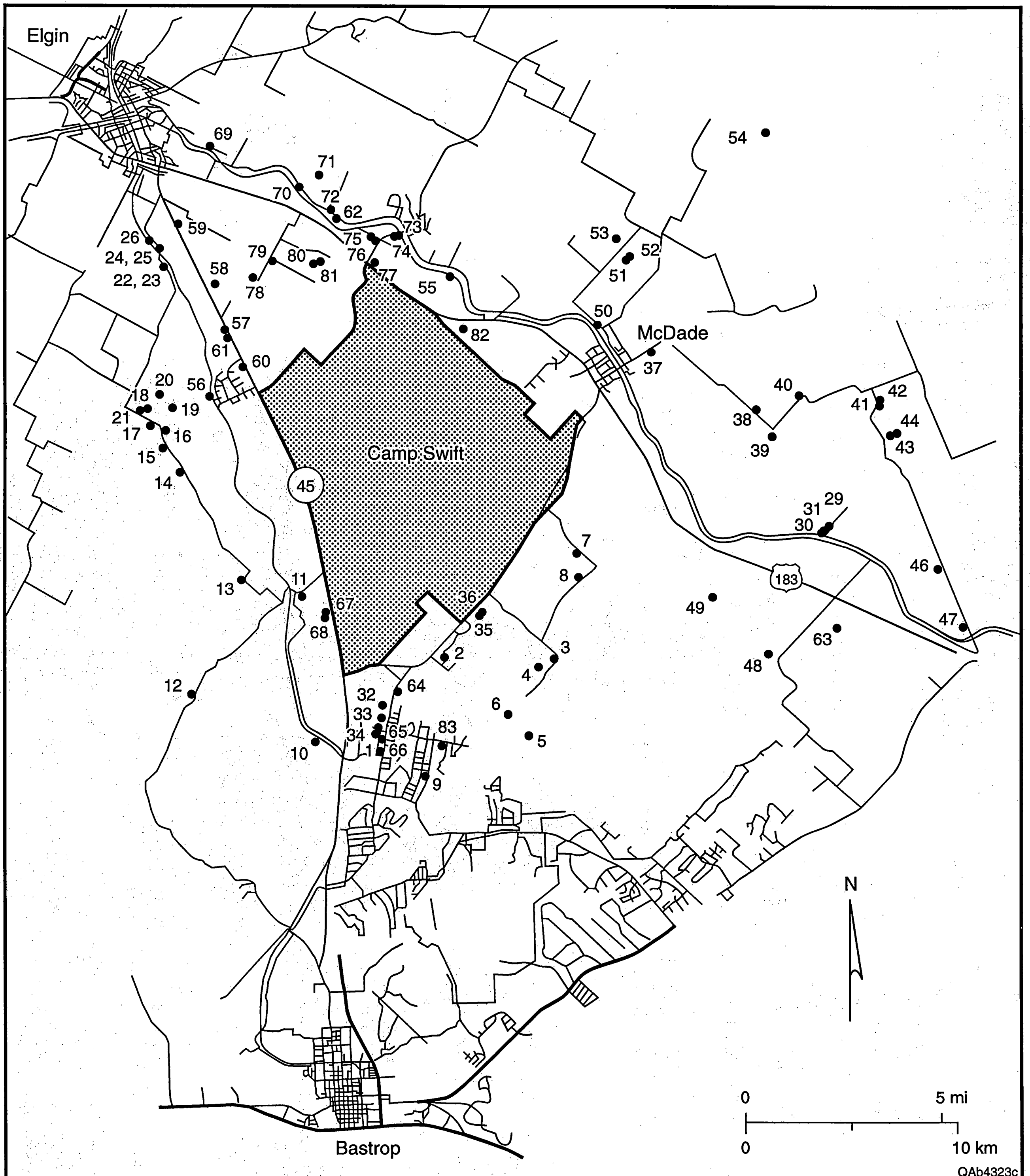

Figure 5. Private wells located near Camp Swift.

possible exception of some shallow, hand-dug wells in the Calvert Bluff Formation and the two deep wells (>1000 ft), which may produce from the Hooper Formation.

Monitoring Well Construction

We drilled and completed two wells in the Calvert Bluff Formation on Camp Swift. Well SWIFT-1 is located in the northern part of the camp (fig. 4) and is 57.1 ft deep in the sandy portion of the Calvert Bluff Formation. Well SWIFT-2 is located in the central part of the camp near the USGS well field (fig. 4) and is 51 ft deep in the clayey portion of the Calvert Bluff Formation. We used solid stem boring to install SWIFT-1 and hollow stem augering to install SWIFT-2. Detailed well schematics and drilling reports are included in appendix 2.

Ground-Water Levels

TWDB board files had sufficient water-level data to construct long-term hydrographs for the Hooper Formation (fig. 6a), the Simsboro Formation (fig. 6b), the Calvert Bluff Formation (fig. 6c), and the alluvium (fig. 6d). A well (58-46-102) drilled into the Hooper Formation 1 mi north of Elgin shows an increase in water level after a period of steady levels during the 1950's (fig. 6a). This well is located in the outcrop of the Hooper Formation and is likely showing water-level recovery since the major drought during the 1950's. Ground-water pumpage has not caused large local or regional declines in Bastrop County (Follett, 1970).

A well (58-46-301) drilled into the Simsboro Formation 5 mi east of Elgin shows a similar water-level response (fig. 6b) to the well in the Hooper Formation (fig. 6a). This Simsboro well is located in the outcrop and again is likely showing water-level recovery since the major drought during the 1950's.

A well (58-61-201) drilled into the Calvert Bluff Formation outcrop 5 mi west of Bastrop shows a rather steady water-level elevation with small fluctuations likely due to variations in rainfall (fig. 6c). A well (58-60-301) drilled into Cedar Creek alluvium overlying the Wilcox Group outcrop about 10 mi west of Bastrop also shows a relatively steady water-level elevation with small fluctuations likely due to variations in rainfall (fig. 6d).

We also obtained water-level data from monitor wells at the Powell Bend lignite mine from the Railroad Commission of Texas (RRC). The Powell Bend lignite mine is located to the southwest of Camp Swift and has five wells that have been measured over the last 9 yr. These wells were drilled through the Calvert Bluff Formation and into the upper Simsboro Formation

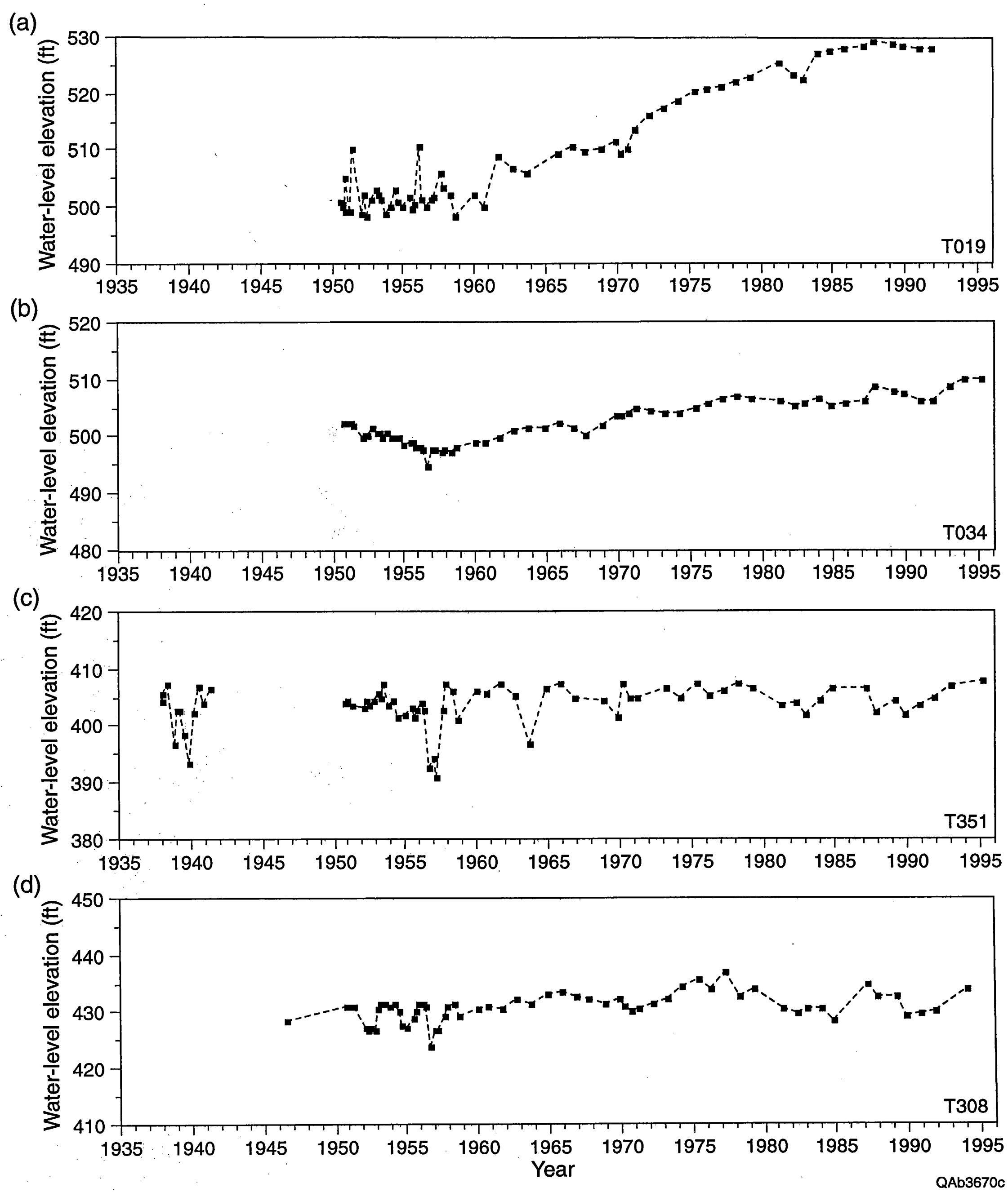

Figure 6. Water levels measured in Bastrop County in (a) the Hooper Formation in well 58-46-102, (b) the Simsboro Formation in well 58-46-301, (c) the Calvert Bluff Formation in well 58-61-201 and (d) alluvium overlying the Wilcox Group in well 58-60-301.

where they were completed. The purpose of the wells was to monitor water-level and water-chemistry fluctuations to assess impact of surface mining of lignite. The wells show somewhat similar water-level responses, with a period of little water-level change from 1987 to mid-1992 and water-level oscillations since mid-1992 (fig. 7). Other hydrographs from formations in the Bastrop and Camp Swift area are included in Avakian and Wermund (1993), Follett (1970), and Thorkildsen and Price (1991).

Water levels in wells on the camp did not show much variation during the course of the project (table 1). There is a decline in water level in well SWIFT-1 from November 1995 to March 1996 that is perhaps due to seasonal variation (there was very little rainfall during this time). Well CSW-B001 (in the Simsboro) had water levels drop 1.2 ft from August to November, 1995. Water levels in the other camp wells were fairly steady.

Measurements in the USGS wells show that the water-level elevation in the Calvert Bluff Formation is about 40 ft higher than the water-level elevation in the underlying Simsboro Formation. This indicates that there is a downwardly directed ground-water flow gradient that will cause ground water from the Calvert Bluff to move downward into the Simsboro. This vertical transfer of ground water probably occurs at a slow rate owing to low-permeability beds between the two aquifers.

Water levels in the Calvert Bluff are strongly influenced by topography, with water flow generally directed downslope. Figure 8 shows our interpretation of water levels in the Calvert Bluff in the Camp Swift area. Our interpretation differs from Gaylord and others (1985) because we used our two shallow wells to constrain mapping inside the camp, whereas Gaylord and others did not have any water-level information inside the camp in the shallow Calvert Bluff. Water level in SWIFT-1 was deeper than we would have expected given the anticipated topographic control on water levels. This anomaly might be due to the close proximity of the well (~2,000 ft) from the Sayersville Fault (fig. 2), which has over 200 ft of throw. It is possible that the fault plane acts to redirect Calvert Bluff ground water into the Simsboro Formation.

Water levels in the Simsboro Formation are moving downdip in a generally uniform manner with cones of depression near large municipal well fields (fig. 9).

Hydraulic Properties

Various aquifer tests have been performed in each of the formations either reported in TWDB files or in publications. Alluvium in Bastrop County has two measured well yields of 25 and

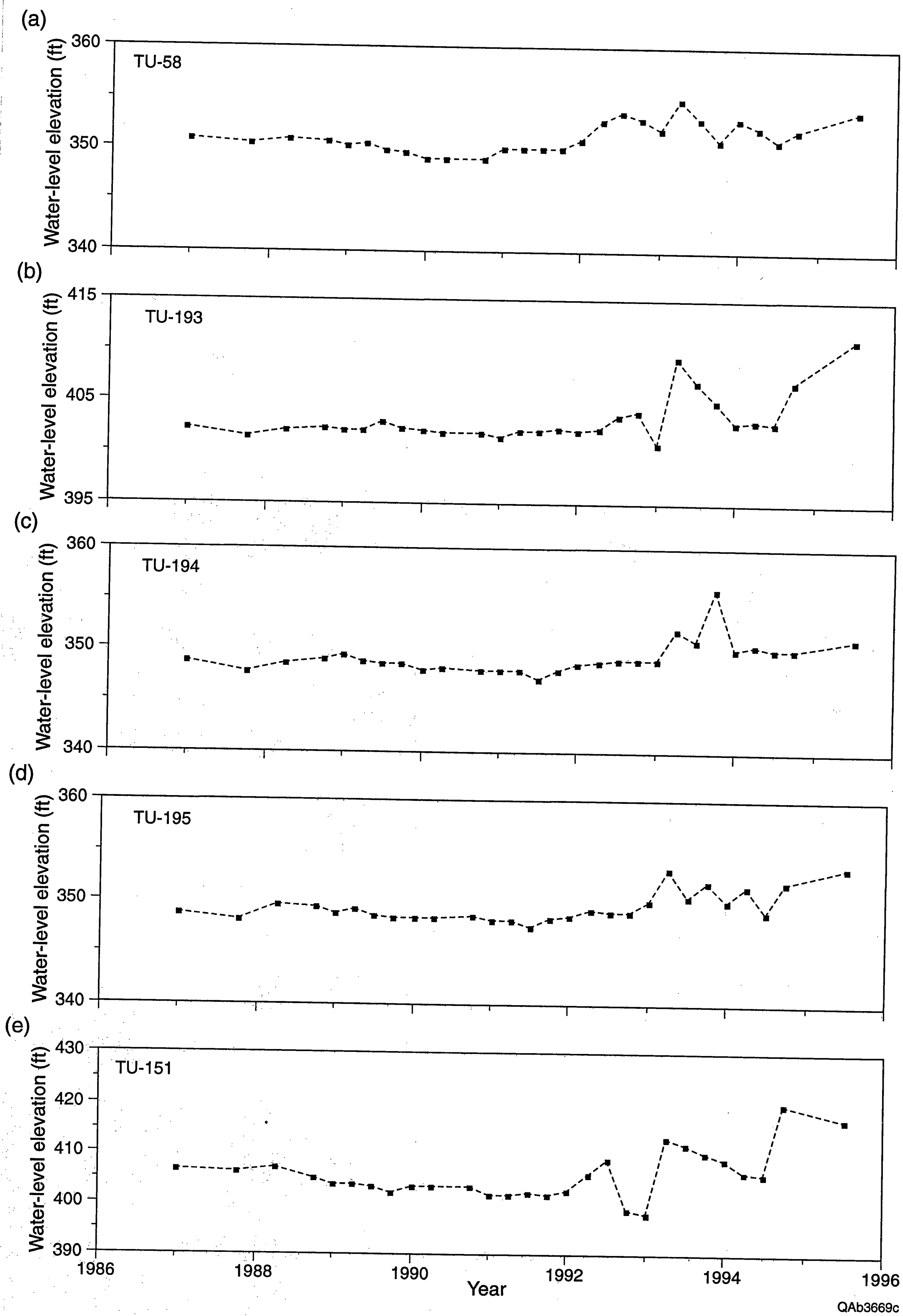

Figure 7. Water-level fluctuations in the Simsboro Formation underlying the Calvert Bluff Formation at the Powell Bend lignite mine just southwest of Camp Swift. Note that TU-151 (e) is at a different scale.

Table 1. Water-level measurements in Camp Swift wells.

Date	Time	Depth to water (ft)	Water-level elevation (ft)
SWIFT-1			
11/2/95	0932	37.99	414.01
11/21/95	1035	39.34	412.66
3/6/96	0927	39.78	412.22
SWIFT-2			
3/6/96	1050	38.69	433.86
CSW-B001			
9/25/95	1100	108.85	361.15
11/21/95	1147	110.09	359.91
3/6/96	1120	110.10	359.90
CSW-B002			
9/25/95	1115	66.81	403.19
11/21/95	1147	66.94	403.06
3/6/96	1120	66.86	403.14
CSW-B005			
9/26/95	0955	17	453
11/2/95	0944	17.65	452.35
11/21/95	1100	17.78	452.22
3/6/96	1010	17.61	452.39
CSW-B008			
9/25/95	-	77	393
11/21/95	1147	78.67	391.33
3/6/96	1120	78.48	391.52

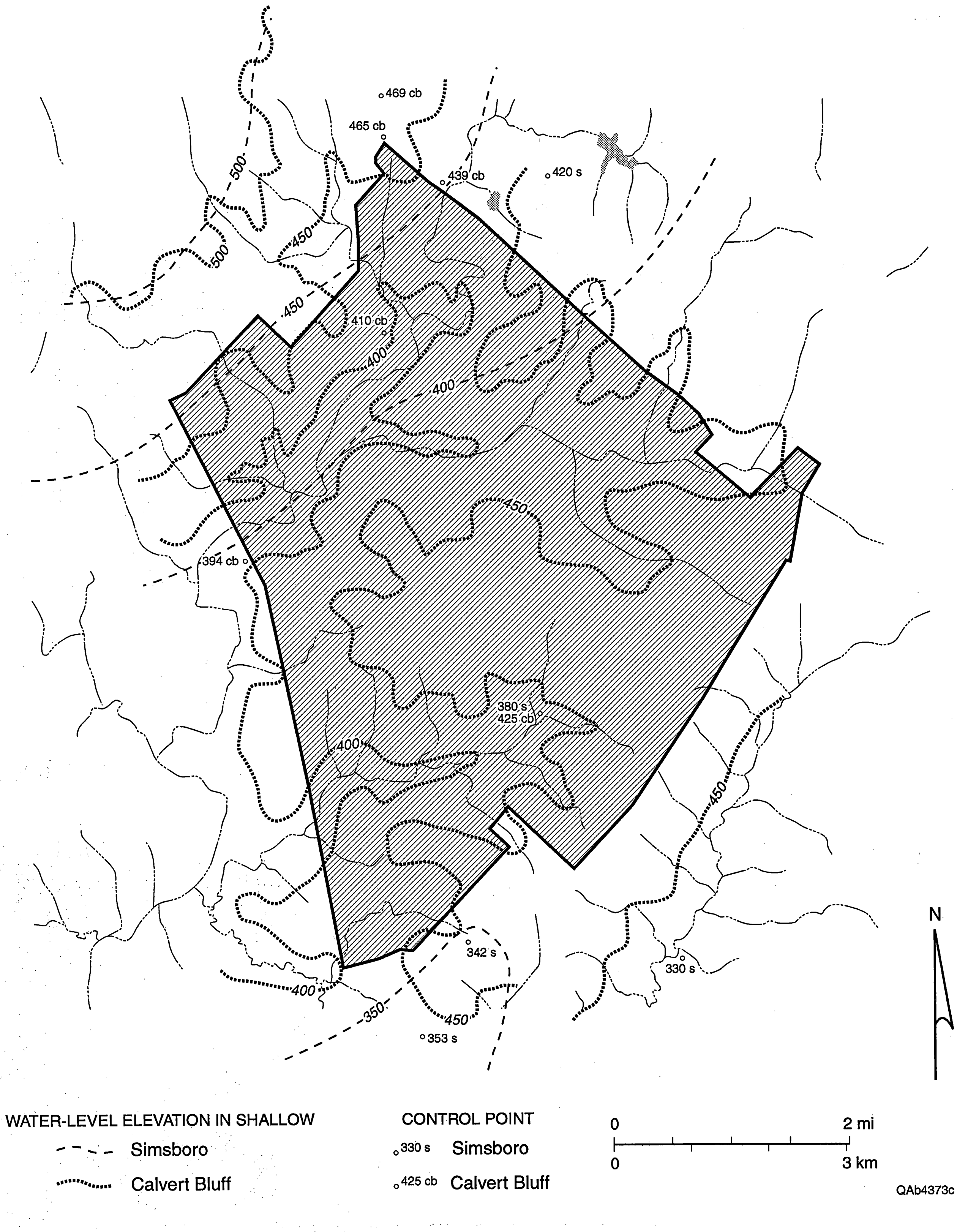

Figure 8. Water-level map of the shallow Calvert Bluff and Simsboro Formations in the Camp Swift area.

75 gal/min. The Calvert Bluff Formation has well yields that range from 3 to 600 gal/min with a geometric mean of 80 gal/min and specific capacities that range from 38 to 800 $ft^2\ d^{-1}$ with a geometric mean of 251 $ft^2\ d^{-1}$ (fig. 10a). Using the method of Razack and Huntley (1991), this mean specific capacity corresponds to a transmissivity of 1,400 $ft^2\ d^{-1}$. We did not find any pumping test reports for wells in the Calvert Bluff Formation in the area.

The Simsboro Formation has well yields that range from 11 to 1,200 gal/min with a geometric mean of 250 gal/min and specific capacities that range from 630 to 10,000 $ft^2\ d^{-1}$ with a geometric mean of 2,500 $ft^2\ d^{-1}$ (fig. 10b). Using the method of Razack and Huntley (1991), this mean specific capacity corresponds to a transmissivity of 4,300 $ft^2\ d^{-1}$. The average values of transmissivity and storativity of the old Camp Swift wells tested by Guyton (1942) are 6,000 $ft^2\ d^{-1}$ and 0.0004, respectively (Gaylord and others, 1985).

The Hooper Formation has well yields that range from 8 to 250 gal/min with a geometric mean of 80 gal/min and specific capacities that range from 77 to 520 $ft^2\ d^{-1}$ with a geometric mean of 250 $ft^2\ d^{-1}$ (fig. 10c). Using the method of Razack and Huntley (1991), this mean specific capacity corresponds to a transmissivity of 1,400 $ft^2\ d^{-1}$.

We conducted site-specific aquifer tests in the monitor wells we drilled in the Calvert Bluff on Camp Swift. Monitor well SWIFT-1, drilled into the sandy portion of the Calvert Bluff, had a transmissivity of about 9 to 10 $ft^2\ d^{-1}$ based on the interpretation of a bail test (fig. 11). Monitor well SWIFT-2, drilled into the clayey portion of the Calvert Bluff, had a transmissivity of about 0.7 $ft^2\ d^{-1}$ based on the interpretation of a bail test (fig. 12).

Ground-Water Chemistry

TWDB files contain water chemistry data for the alluvium and the Calvert Bluff, Simsboro, and Hooper Formations for Bastrop County (table 2). TDS for the alluvium range from 291 to 612 mg/L with a geometric mean of 380 mg/L (fig. 13a). TDS for the Calvert Bluff Formation range from 226 to 2,187 mg/L with a geometric mean of 500 mg/L (fig. 13b). Three of the samples (12 percent) were brackish (1,000 mg/L $<$ TDS $<$ 10,000 mg/L). TDS for the Simsboro Formation range from 129 to 1,116 mg/L with a geometric mean of 380 mg/L (fig. 13c). Two of the samples (5 percent) were brackish. TDS for the Hooper Formation range from 246 to 1,411 mg/L with a geometric mean of 490 mg/L (fig. 13d). Two of the samples (13 percent) were brackish.

Waters from the alluvium are calcium-bicarbonate in composition (fig. 14a). Waters from the Calvert Bluff Formation are sodium-bicarbonate and calcium-sulfate in composition (fig. 14b).

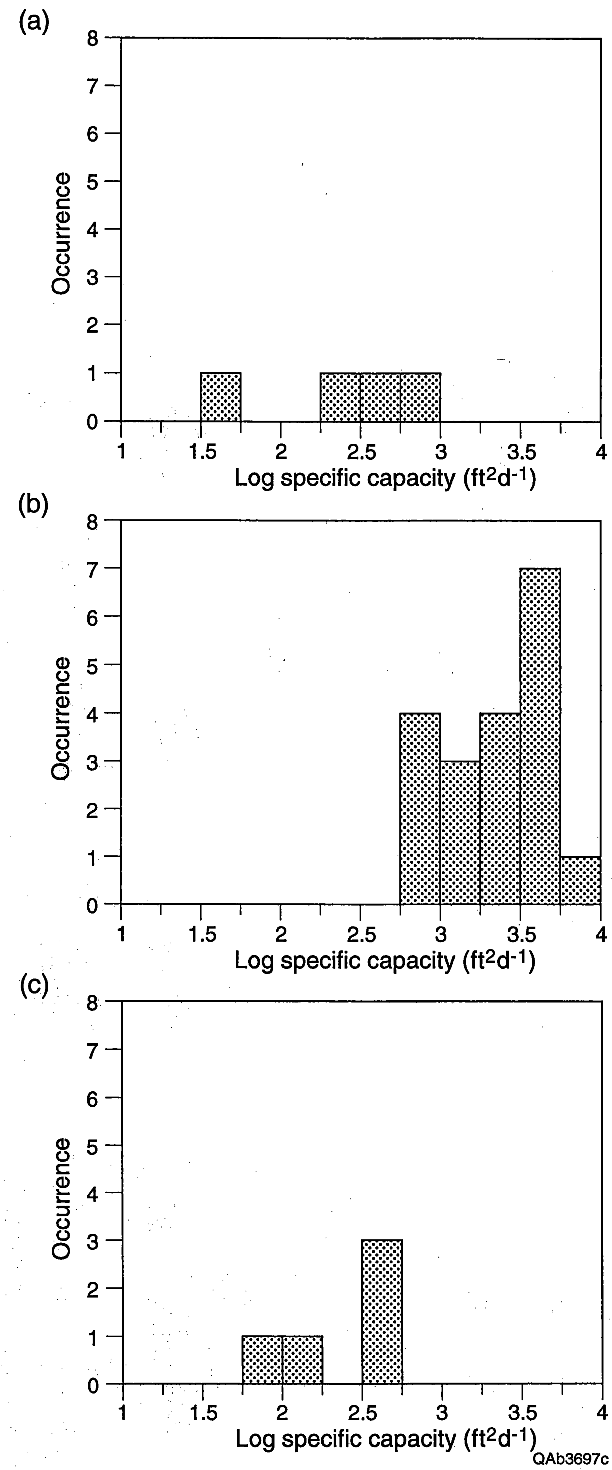

Figure 9. Histograms of specific capacity for the (a) Calvert Bluff, (b) Simsboro, and (c) Hooper Formations in Bastrop County.

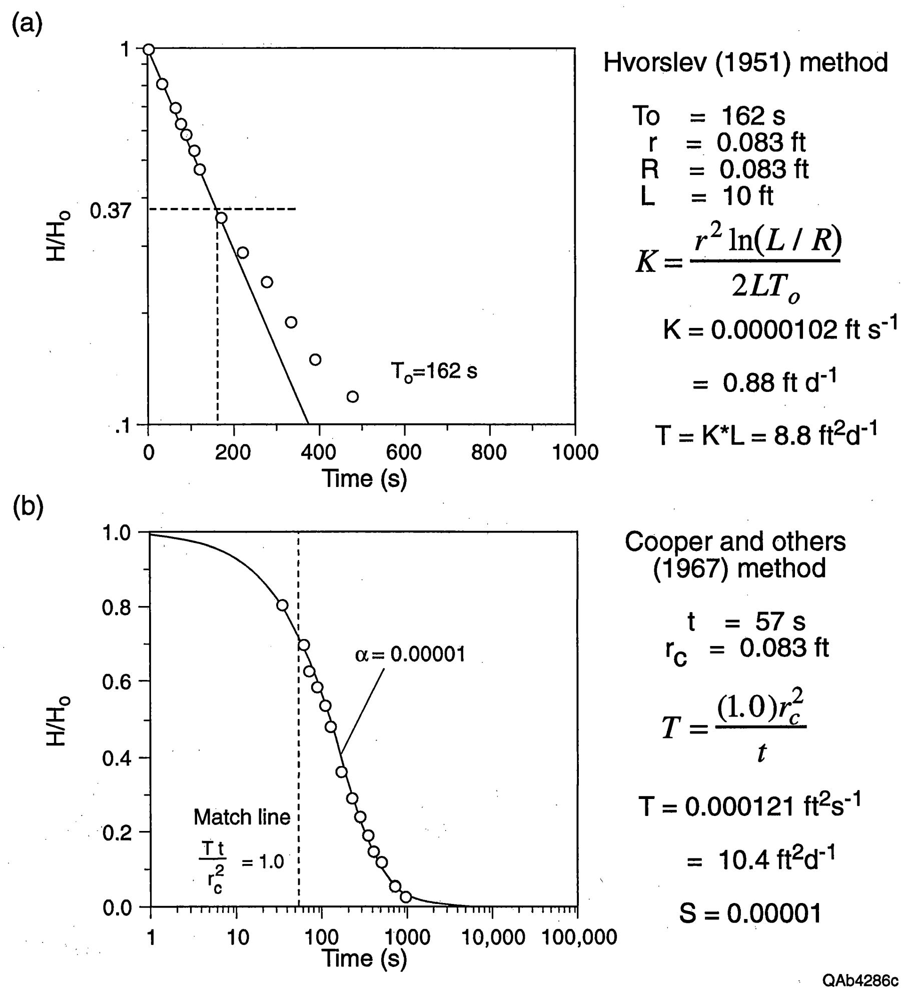

Figure 10. Results of a bail test at SWIFT-1.

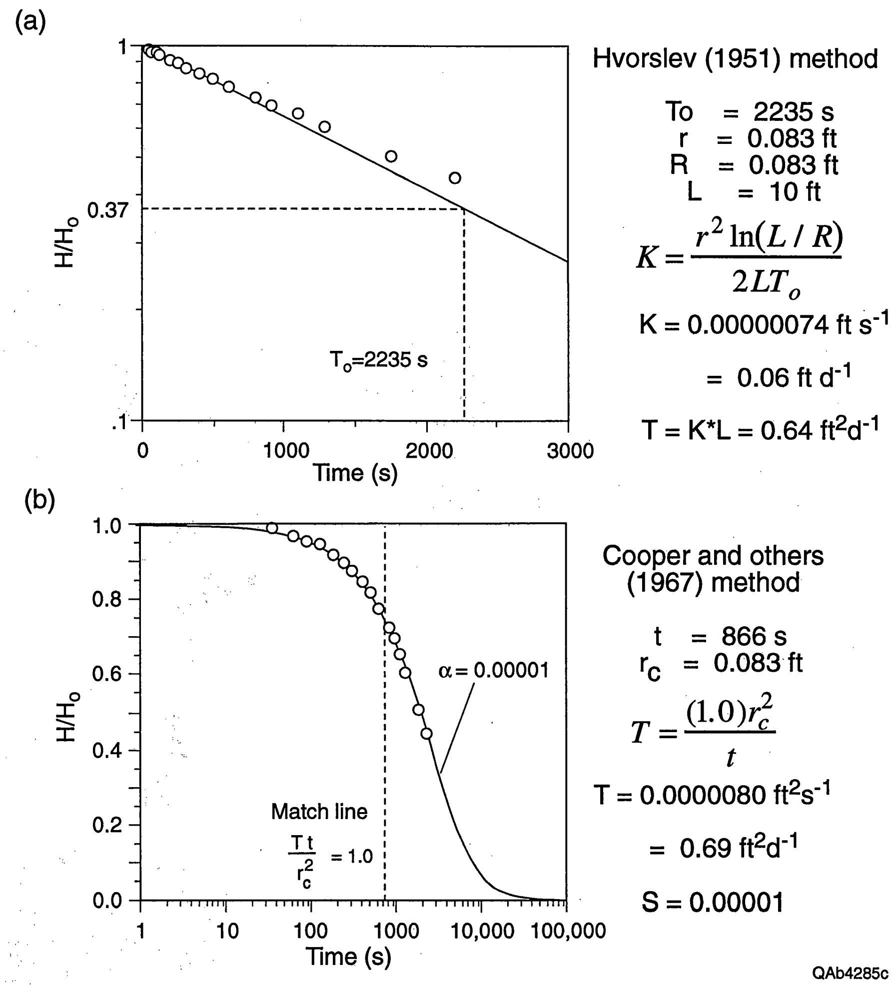

Figure 11. Results of a bail test at SWIFT-2.

Table 2. Most recent chemical analyses of ground waters from the alluvium, Calvert Bluff Formation, Simsboro Formation, and Hooper Formation.

State well number	YR	Temp (C°)	Si (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Sr (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	NO_3 (mg/L)	pH	TDS (mg/L)	Total alk (mg/L)	Total hardness (mg/L)	Spec. cond. (mΩ)
Alluvium:																		
5853105	1978	-	19	104	46	45	-	-	466	72	42	0.4	55	7.4	612	382	449	905
5862104	1949	-	24	94	8	18	-	-	298	29	23	-	3.8	8.2	346	244.26	270	568
5862204	1942	-	14	75	16	47	-	-	271	38	34	0.2	-	7.3	357	222.13	203	-
5862205	1958	-	-	91	21	20	-	-	329	51	33	0.2	5.8	7.4	383	269.67	-	630
5862206	1957	-	-	67	13	25	-	-	248	24	40	0.3	0.4	7.4	291	203.28	224	549
5862207	1957	-	-	66	15	26	-	-	240	29	41	0.3	-	7.3	295	196.72	-	572
5863917	1972	-	15	117	8	32	-	-	285	43	45	0.2	78	7.2	478	234	326	755
5864703	1952	21	22	87	8	29	-	-	290	20	30	-	19	7.6	357	237.7	253	597
5864711	1972	-	19	110	14	9	-	-	357	15	13	0.2	22	7.5	377	293	332	700
Calvert Bluff Formation:																		
5846304	1980	26	40	52	7	34	5	-	90	60	77	0.1	0.1	6.7	319	74	161	560
5846601	1952	-	23	21	9	66	-	-	180	25	40	-	0.5	8.3	273	147.54	88	462
5846606	1946	-	-	436	144	165	-	-	-	1640	255	-	1.2	-	-	-	1680	-
5847102	1956	-	-	-	-	-	-	-	49	120	270	-	0.6	7	-	40.15	-	1090
5847402	1953	-	117	18	9	33	-	-	8	83	44	-	-	5.7	307	6.56	83	366
5847701	1989	27	34	86	19	50	5.8	-	222.1	135	50	0.4	0.04	7	489	182	292	790
5847702	1955	-	-	236	77	232	-	-	250	631	390	-	-	-	1688	204.92	908	-
5847703	1964	24	49	150	39	99	-	-	184	350	166	0.3	-	6.2	943	150.82	534	1420
5847704	1964	24	37	122	33	70	-	-	242	264	83	0.5	-	6.9	728	198.36	440	1040
5847705	1964	-	46	64	15	27	4.8	-	166	77	50	0.3	0.2	7.3	365	136.07	221	568
5847706	1966	-	46	300	61	53	6	-	364	612	119	-	-	6.7	1375	298.36	1000	-
5847708	1972	-	92	64	27	65	-	-	0	103	222	0.2	0.4	5.1	573	0	270	900
5847905	1965	27	27	24	5	70	-	-	216	27	20	0.3	0.2	7.4	279	177.05	83	449
5854203	1953	21	20	28	6	28	-	-	46	23	29	-	70	6.9	226	37.7	98	370
5854515	1981	-	51	474	103	103	6	-	521.1	879	315	0.2	0.04	8.1	2187	427	1606	4134
5855103	1972	-	53	62	14	25	-	-	148	66	53	0.9	0.4	7	347	121.31	210	584
5855105	1964	24	44	154	50	69	-	-	270	302	144	0.4	0	6.5	896	221.31	590	1340
5855201	1988	25	23	48.4	8.98	29	6.9	-	122	40	62	0.1	0.04	6.9	278	100	158	474
5855504	1980	24	42	61	11	26	8	-	200	57	32	0.1	0.1	7.7	335	164	199	481
5855704	1980	26	17	37	9	67	4	-	231	62	22	0.1	0.3	8.1	331	189	129	592
5855706	1953	24	22	25	8	73	-	-	224	44	18	-	0.2	8.1	300	183.61	96	487

Table 2 (cont.)

State well number	YR	Temp (C°)	Si (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Sr (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	NO_3 (mg/L)	pH	TDS (mg/L)	Total alk (mg/L)	Total hardness (mg/L)	Spec. cond. (mΩ)
Calvert Bluff Formation (cont.):																		
5861304	1953	22	44	72	6	34	-	-	131	124	17	-	21	6.9	382	107.38	204	576
5861801	1946	-	-	-	-	-	-	-	364	120	202	-	52	-	-	335.03	-	-
5862107	1966	-	14	2	2	258	1.5	-	568	51	42	0.4	0.2	8	650	465.57	14	1080
5862110	1966	26	14	3	2	288	1.6	-	632	48	56	0.7	0	8.1	724	518.03	14	1700
5862302	1980	27	18	39	9	120	5	-	253	145	36	0.1	0.1	8	496	207	134	900
5862303	1989	-	8.43	34.51	8.31	69.91	4.51	-	224.5	52	29	0.1	0.04	8.3	317	184	120	-
5862406	1977	29	13	9	3	199	-	-	315	145	48	0.2	0.4	8.1	572	258	34	920
5862506	1980	26	13	8	3	210	-	-	315	152	52	0.3	1.2	8.5	598	264	31	1050
Simsboro Formation:																		
5846204	1950	-	42	93	48	194	-	-	100	66	490	-	11	7.7	993	81.97	430	1840
5846301	1950	-	28	139	50	198	-	-	132	46	580	-	11	7.2	1116	108.2	552	2140
5846303	1955	-	42	43	11	45	6.4	-	40	42	132	0.1	-	6.5	341	32.79	152	611
5846410	1980	-	-	-	-	-	-	-	-	10	-	-	-	6.1	-	-	-	-
5846501	1972	-	-	40	10	49	-	-	22	39	133	0.2	0.4	5.8	282	18	143	608
5846502	1951	-	21	22	5	25	-	-	39	14	60	-	-	5.8	166	31.97	77	-
5846503	1950	-	-	-	-	-	-	-	82	180	256	-	-	7.6	-	67.19	-	1440
5846508	1966	23	30	36	4	20	3.7	-	84	15	46	0.1	0.2	6.3	196	68.85	104	335
5846509	1943	-	30	27	9	50	5.8	-	26	30	118	0.4	1	7.4	283	21.31	104	-
5846510	1951	-	12	27	6	30	-	-	39	22	76	-	0.05	5.7	192	31.97	96	-
5846511	1967	-	26	9	3	26	-	-	21	12	43	-	-	5.3	129	17	33	224
5846512	1980	22	10	26	7	32	6	-	16	32	86	0.1	0.4	6.1	207	13	93	423
5846516	1989	25	34	43	8.1	39	3.8	-	153.8	20	49	0.2	0.04	6.5	272	126	140	460
5846611	1989	26	52	68	12	33	4.2	-	136.7	91	59	0.2	0.04	6.8	386	112	219	645
5846707	1966	-	20	52	13	42	3	-	226	59	26	0.2	-	7.5	326	185.25	183	548
5847109	1966	-	29	130	16	37	3.2	-	300	105	83	0.2	0.2	6.7	551	245.9	390	914
5853809	1967	-	36	24	4	23	1.5	-	78	60	42	0.4	0.2	6.6	229	63.93	75	277
5853905	1953	-	34	95	19	66	-	-	294	92	85	-	0.5	7.4	536	240.98	315	915
5854205	1978	-	44	89	16	22	-	-	228	88	37	0.3	0.4	7.8	408	187	287	700
5854305	1980	-	-	-	-	-	-	-	-	69	-	-	-	7.4	-	-	-	-
5854306	1980	-	-	-	-	-	-	-	-	140	-	-	-	7.3	-	-	-	-
5854403	1988	23	13	51.4	10.6	28	3.4	-	244	11	27	0.4	0.1	7.4	264	200	172	463
5854501	1946	26	36	78	12	49	-	-	244	74	52	0.4	0	7.3	421	200	244	-

Table 2 (cont.)

State well number	YR	Temp (C°)	Si (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Sr (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	NO_3 (mg/L)	pH	TDS (mg/L)	Total alk (mg/L)	Total hardness (mg/L)	Spec. cond. (mΩ)
Simsboro Formation (cont.):																		
5854502	1946	27	-	78	11	47	-	-	236	68	54	0.4	-	7.4	374	193.44	240	-
5854503	1980	27	41	94	8	32	-	-	231	75	52	0.3	0.1	7.7	415	189	270	735
5854504	1946	27	-	66	12	61	-	-	243	74	49	0.4	0	7.3	381	199.18	214	-
5854505	1946	27	-	68	12	68	-	-	243	85	55	0.4	0	7.2	407	199.18	219	-
5854506	1975	-	-	87	12	26	-	-	238	71	40	0.3	8	-	361	195	266	-
5854507	1944	-	-	81	12	30	-	-	244	59	39	0.4	0.4	7.3	341	200	252	-
5854508	1942	-	-	74	11	32	-	-	206	61	48	-	-	-	327	168.85	230	-
5854513	1980	-	-	-	-	-	-	-	-	2000	-	-	-	6.6	-	-	-	-
5854516	1993	27	35	88	10	28	3.4	0.46	222.1	66	41	0.24	0.04	7.1	381	182	261	591
5854702	1953	-	28	82	8	20	-	-	294	30	8	-	0.2	7.8	320	240.98	238	556
5854705	1967	-	29	46	5	26	3.6	-	168	15	28	0.3	0.2	7	235	137.7	135	384
5854707	1978	-	23	55	8	33	3	-	205	45	27	0.2	0.4	8.3	295	168	171	504
5854801	1980	28	22	35	4	121	-	-	375	0	42	0.2	0.1	7.8	408	307	105	750
5855209	1993	36	22	12	4	80	3.4	1.11	214.8	23	12	0.18	0.04	8	263	176	47	362
5861203	1953	-	46	148	22	65	-	-	262	80	214	-	0.4	6.9	704	214.75	460	1230
5861305	1956	-	-	-	-	-	-	-	124	-	24	-	-	6.9	-	101.61	-	737
5861307	1960	-	36	106	14	41	-	-	137	260	18	1	0	6.3	543	112.3	322	756
5862114	1987	-	-	7	2	256	-	-	464	103	58	0.4	0.04	8.6	665	398	24	1215
5862115	1989	26	14	5.9	3.6	279	3.4	-	521.1	82	54	0.3	0.04	8.2	700	431	29	1100
5862116	1993	26	14	3.9	2	340	3.7	0.36	649.2	36	107	1.24	0.04	8.5	839	552	18	1223
5862305	1986	-	-	3	1	432	-	-	647	4	279	2.3	0	8.3	1053	554	14	1800
5862409	1987	-	-	4	2	325	-	-	655	56	81	1.4	0.04	9.1	804	559	19	1485
Hooper Formation:																		
5838802	1950	-	34	18	7	68	-	-	139	15	56	-	15	7.9	281	113.93	73	462
5838906	1983	-	43	62	11	29	-	-	149	29	84	0.2	0	7.7	331	122	202	525
5845905	1950	23	-	-	-	-	-	-	233	120	240	-	-	8.4	-	222.59	-	1400
5845906	1976	-	29	222	42	117	-	-	422	213	294	0.3	1.3	7.4	1126	346	730	1740
5846101	1950	-	32	70	15	51	-	-	248	22	86	-	0	8.2	397	203.22	236	691
5846102	1950	-	12	165	68	258	-	-	334	191	550	-	3.5	7.4	1411	273.69	691	691
5846103	1950	-	71	6	4	57	-	-	115	14	24	0	14	6.8	246	94.26	30	316
5846105	1957	-	39	43	13	169	-	-	201	83	197	-	-	7.2	642	164.75	161	1140
5846206	1980	23	46	110	2	42	-	-	337	26	53	0.2	0.1	7.6	445	276	281	648

Table 2 (cont.)

State well number	YR	Temp (C°)	Si (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Sr (mg/L)	HCO_3 (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	NO_3 (mg/L)	pH	TDS (mg/L)	Total alk (mg/L)	Total hardness (mg/L)	Spec. cond. (mΩ)
Hooper Formation (cont.):																		
5846207	1950	-	32	94	17	72	-	-	266	22	144	0	21	7.2	532	218.03	304	952
5846208	1980	24	28	71	11	52	-	-	256	27	68	0.3	0.1	7.7	383	210	223	592
5846211	1980	25	36	140	10	24	-	-	277	31	130	0.1	0.1	8.5	514	239	392	775
5846402	1966	-	-	-	-	-	-	-	398	33	8	-	-	8.8	-	-	-	778
5846413	1980	-	-	-	-	-	-	-	-	69	-	-	-	7.4	-	-	-	-
5846504	1980	-	-	-	-	-	-	-	-	30	-	-	-	7.1	-	-	-	-
5846513	1970	-	29	72	12	51	-	-	235	22	88	-	-	8.1	389	193	229	-
5846515	1993	26	35	65	11	40	3.7	0.44	242.9	23	39	0.44	0.04	7.7	337	199	207	548
5854706	1980	26	15	10	3	214	-	-	381	16	125	0.3	3	8.3	573	-	39	1057
5860307	1946	22	-	-	-	-	-	-	234	100	69	-	41	-	-	191.75	-	-
5860308	1946	22	-	-	-	-	-	-	372	20	52	-	12	-	-	304.83	-	-
5861110	1974	-	31	18	7	256	-	-	394	5	216	0.5	2.5	-	729	323	74	1170
5861206	1988	25	13	71.5	13.9	43	4.5	-	280.6	17	90	0.2	0.04	7.6	391	230	236	700

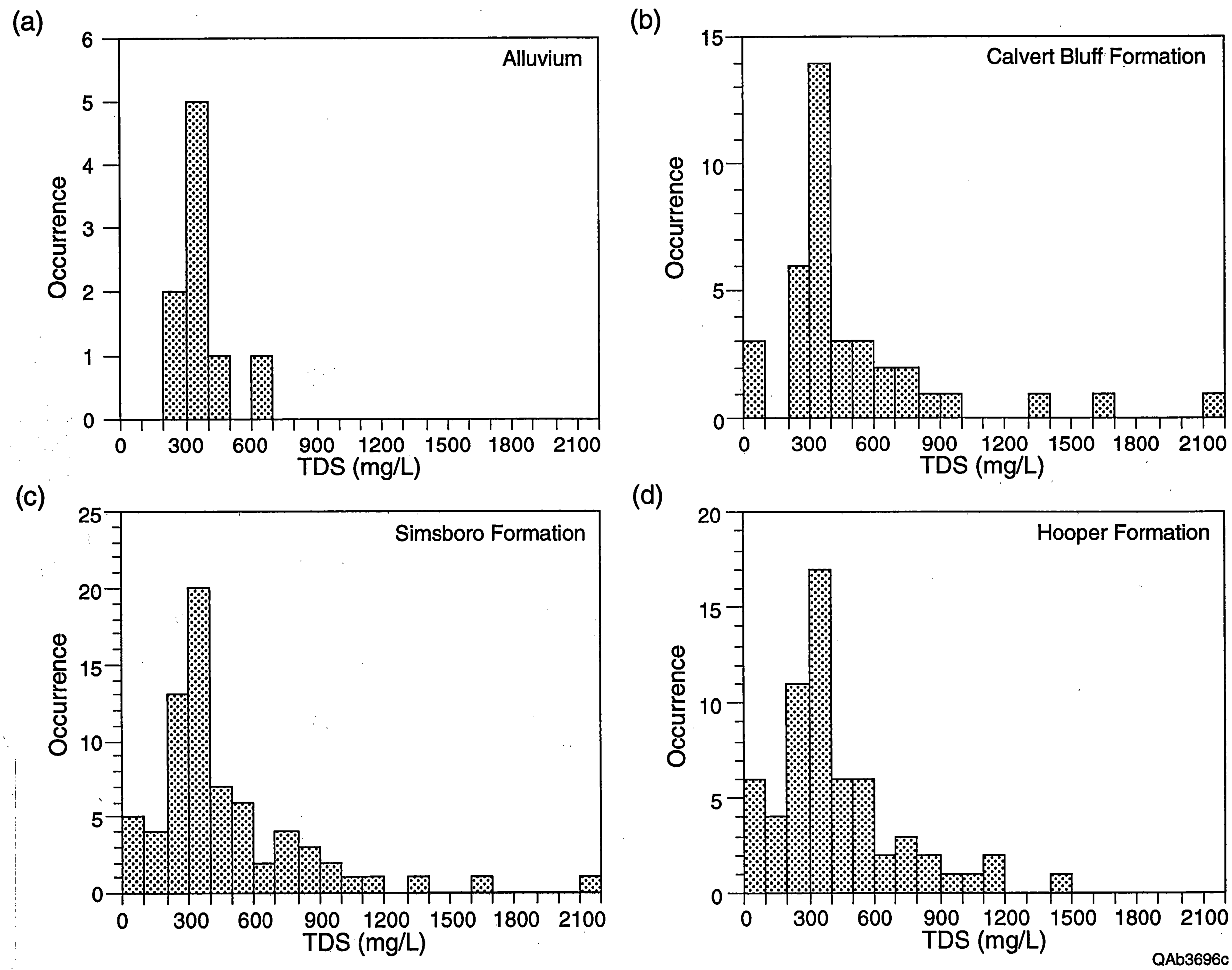

Figure 12. Histograms of total dissolved solids (TDS) in (a) the alluvium, (b) the Calvert Bluff Formation, (c) the Simsboro Formation, and (d) the Hooper Formation of Bastrop County.

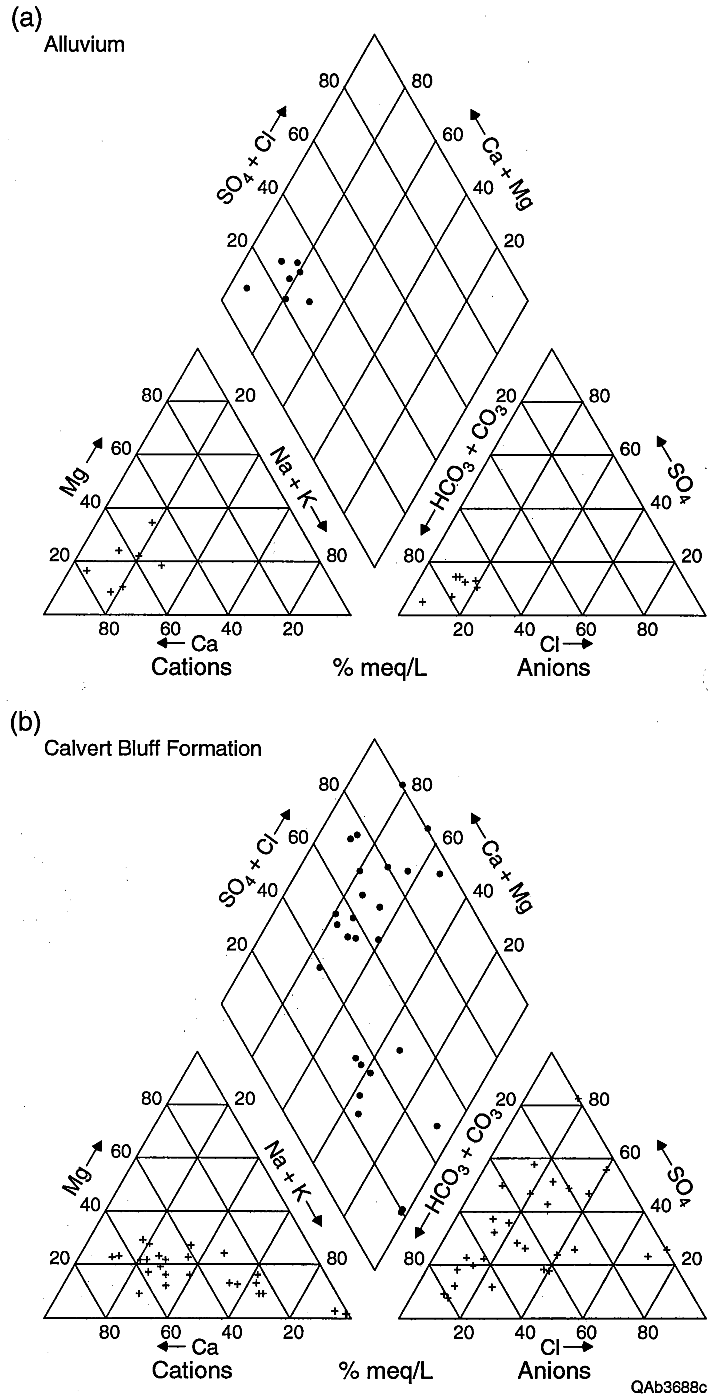

Figure 13. Trilinear diagram showing chemical composition of ground-water samples from the (a) alluvium and the (b) Calvert Bluff Formation in Bastrop County.

Waters from the Simsboro Formation are a mixed calcium and sodium-bicarbonate type with some sodium-chloride type waters (fig. 15a). Waters from the Hooper Formation are a calcium-bicarbonate with some sodium-chloride type waters (fig. 15b).

Powell Bend Mine, located just southwest of the camp, has several wells penetrating the Simsboro that have quarterly water-chemistry data since 1987 that we culled from RRC files (app. 3). These data document temporal variations in water quality in these wells. The site geologist suggested that the mine never affected water quality in the Simsboro (mining of coal was in the Calvert Bluff). There are, however, some interesting variations in water quality that are perhaps related to recharge events because these wells are of limited depth (~100 ft). These data should be considered semiquantitative because of the nonideal collection and analysis methods.

Results from the chemical analyses on ground water collected from the Camp Swift monitor wells are shown in table 3. Water from SWIFT-1 is a sodium-bicarbonate type, whereas water from SWIFT-2 is a mixed-cation-chloride type.

Conceptual Flow Model

A conceptual flow model is a hypothesis of ground-water flow based on the available hydrogeologic information. The following conceptual ground-water flow model is based on the geology and topography of Camp Swift and surrounding area, water-level measurements in wells on and around the camp, and hydrologic properties measured as part of this study and reported in previous investigations. According to this model, rain falls on the outcrop of the Calvert Bluff Formation and a small percentage percolates into the ground to recharge the shallow unconfined aquifer. Recharge to the aquifer is greater at higher elevations and in sandier patches of the outcrop. This water moves from topographic highs toward topographic lows where it discharges to local creeks and streams. Some of the ground water follows longer flow paths and discharges into locally major topographic lows such as Big Sandy Creek and Dogwood Branch. A small amount of ground water moves parallel to bedding and continues downdip toward the east. There also may be flow from the Calvert Bluff Formation into the underlying Simsboro Formation, especially near the Sayersville Fault.

Ground-water flow in the Simsboro Formation is from the east toward the west beneath Camp Swift. Recharge for the Simsboro Formation is mainly derived from the outcrop east of Camp Swift, though lesser amounts of water may come from the Calvert Bluff Formation by cross-formational or cross-fault flow. A schematic of our conceptual model is shown in figure 16.

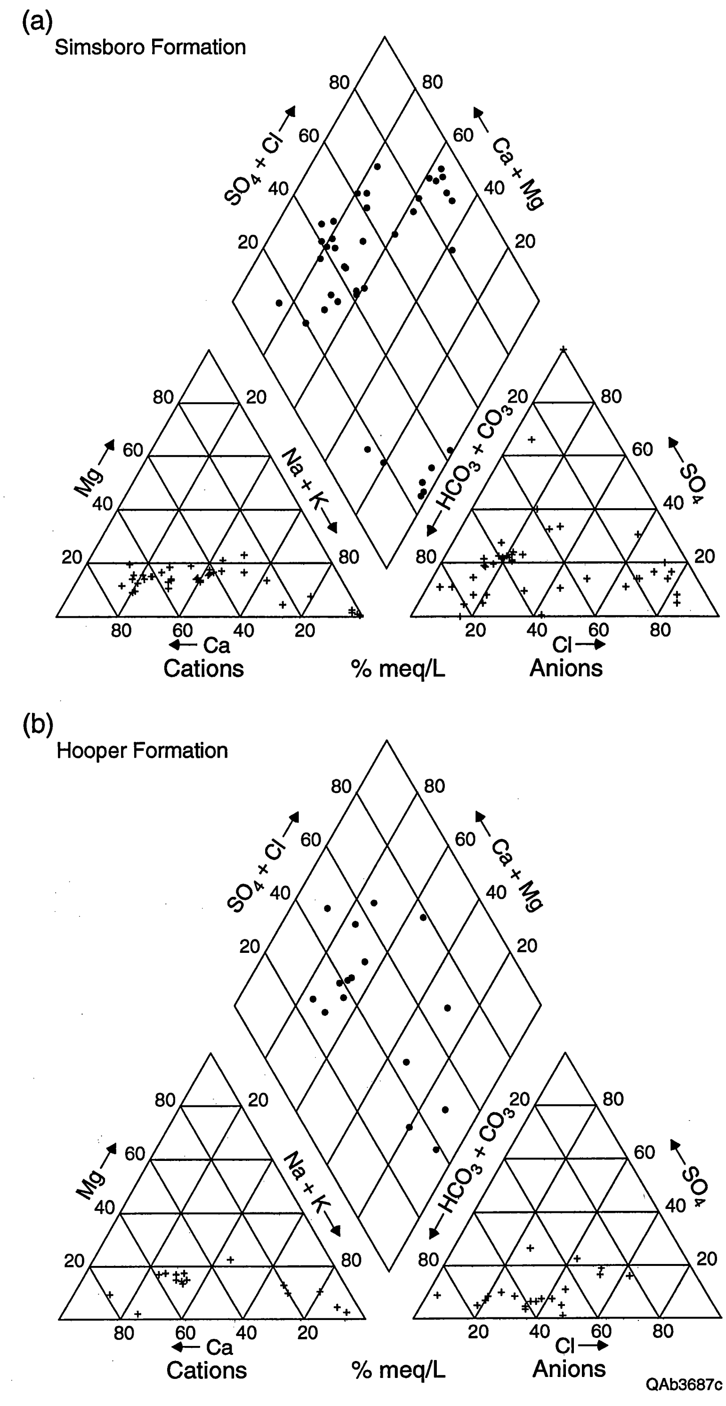

Figure 14. Trilinear diagram showing chemical composition of ground-water samples from the (a) Simsboro and the (b) the Hooper Formations in Bastrop County.

Table 3. Chemical analyses of ground water from Camp Swift monitor wells (mg/L).

Well	SWIFT-1	SWIFT-2
pH	6.0	6.1
T (C)	20.8	17.6
Na	33.2	909
K	7.7	12.0
Mg	3.6	338.9
Ca	13.2	830.0
Cl	24.5	1964.0
Br	0.4	4.9
NO_3	0.3	na
SO_4	24.9	2143.0
HCO_3	79.1	156
Tritium (TU)	5 (4)	

na = not analyzed
(n) = 1 standard deviation of tritium counting data

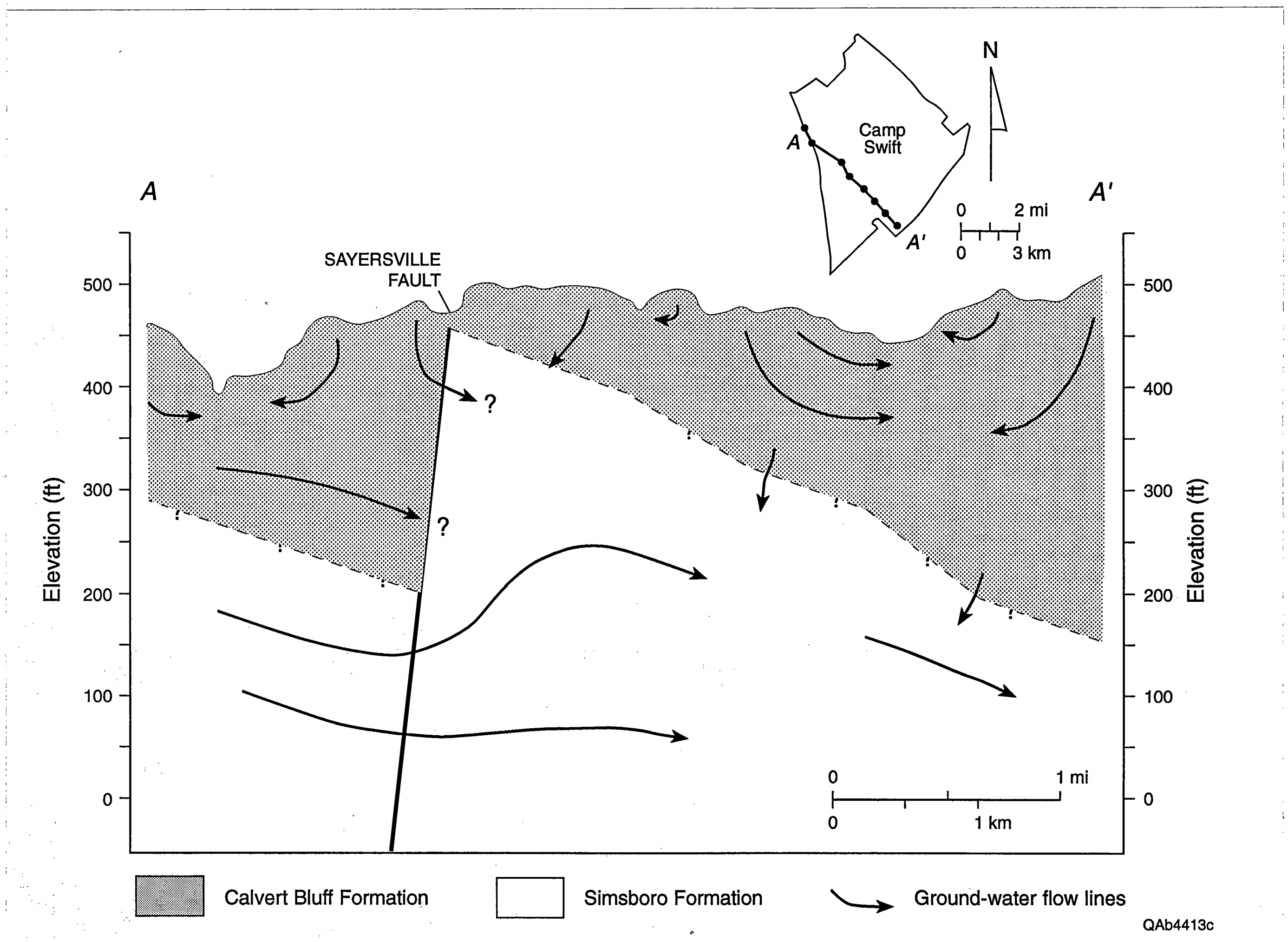

Figure 15. Schematic of the conceptual ground-water flow model for Camp Swift. Cross section after Gaylord and others (1985).

SURFACE-WATER HYDROLOGY

Principal Streams and Watersheds

Camp Swift resides in the Colorado River Basin (zone 3; TDWR, 1983). The northern part of the camp is drained by Big Sandy Creek and its tributaries, which include Dogwood Creek, McLaughlin Creek, and various unnamed creeks. McLaughlin Creek collects runoff from the northeastern half of the camp and empties into Big Sandy Creek in the northwest part of the camp. The southern part of the camp is drained by Dogwood Branch and to a lesser degree by a tributary to Harris Creek, both of which empty into Big Sandy Creek west of the camp. Big Sandy creek ultimately empties into the Colorado River.

Most of Camp Swift lies in the Big Sandy Creek watershed, which includes the Dogwood Creek, McLaughlin Creek, and Dogwood Branch subbasins (fig. 17). A very small part of the camp in the southeast is included in the Piney Creek watershed (fig. 17).

Stream-flow Duration and Flood Frequency

There is one currently operating stream gauge just outside Camp Swift on Big Sandy Creek. Big Sandy Creek has flows as high as 2,400 cubic feet per second (cfs) (fig. 18a). Big Sandy Creek flows 85 percent of the time (fig. 18b). Using a Log Pearson Type III fit to the annual maxima series, there is a 50-percent chance of having an annual flood greater than 1,200 cfs in Big Sandy Creek (fig. 18c). Stream-flow characteristics of Big Sandy Creek are summarized by U.S. Department of the Interior (1980), Gaylord and others (1985), and Avakian and Wermund (1993). U.S. Department of the Interior (1980, table 2-7, p. A4-5–A4-8) estimated the 100-yr flow at Big Sandy Creek on the west side of the camp to be 20,850 cfs, at the mouth of McLaughlin Creek to be 6,780 cfs, and where Dogwood Branch crosses Highway 95 to be 4,470 cfs.

Floodplain Analysis

FEMA (1991) published flood hazard boundaries for Big Sandy Creek, McLaughlin Creek, Dogwood Creek, and their tributaries. We transferred the FEMA (1991) floodplains to USGS 1:24,000 topographic sheets and better constrained the floodplains on the tributaries (fig. 19). Flooded areas are generally confined to the drainages of creeks on the camp (fig. 19). Flooding adjacent to Dogwood and McLaughlin Creeks would be relatively minor. Larger areas adjacent to Big Sandy Creek would be flooded following a major storm, especially at lowlying confluence points.

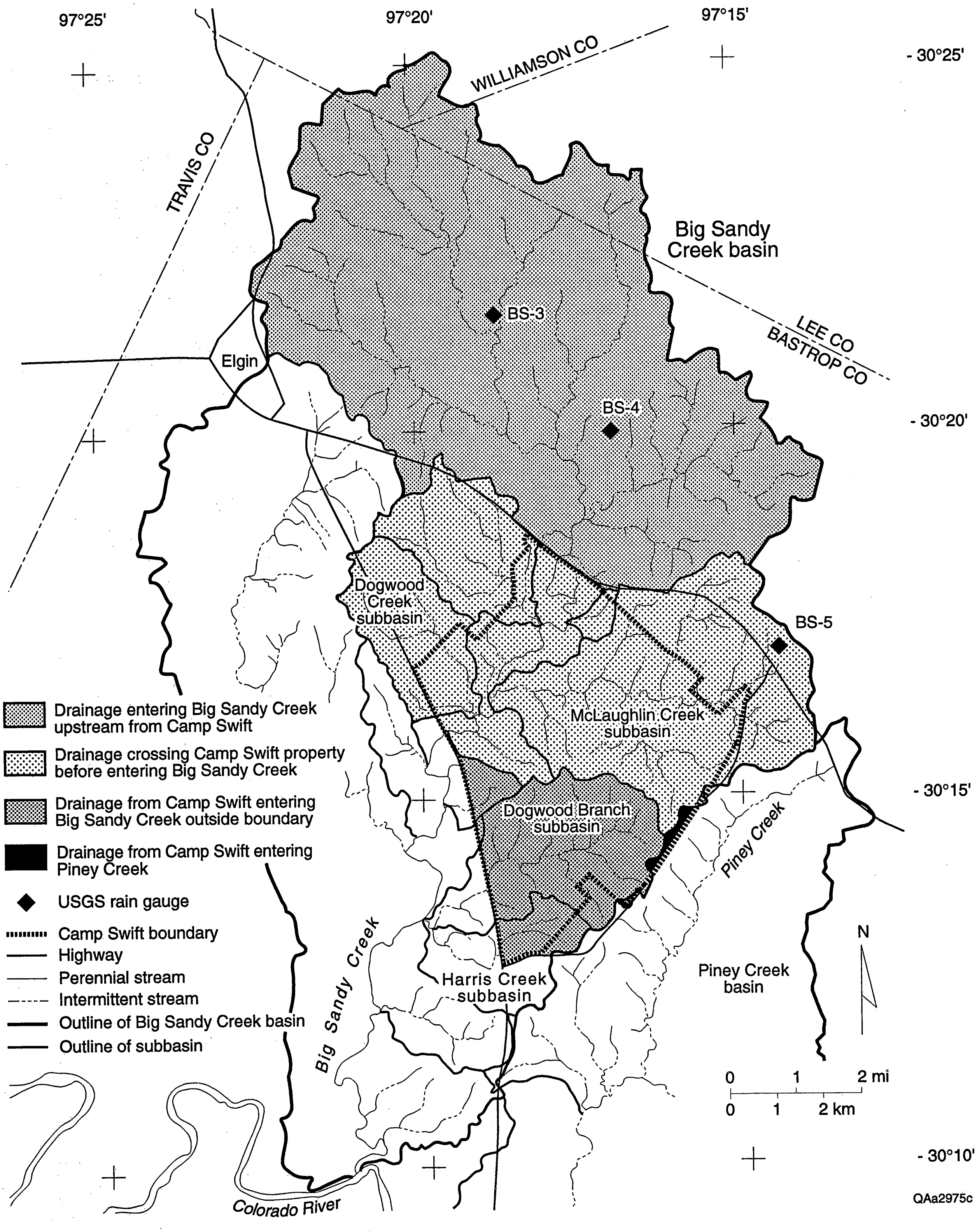

Figure 16. Watershed delineations for Camp Swift.

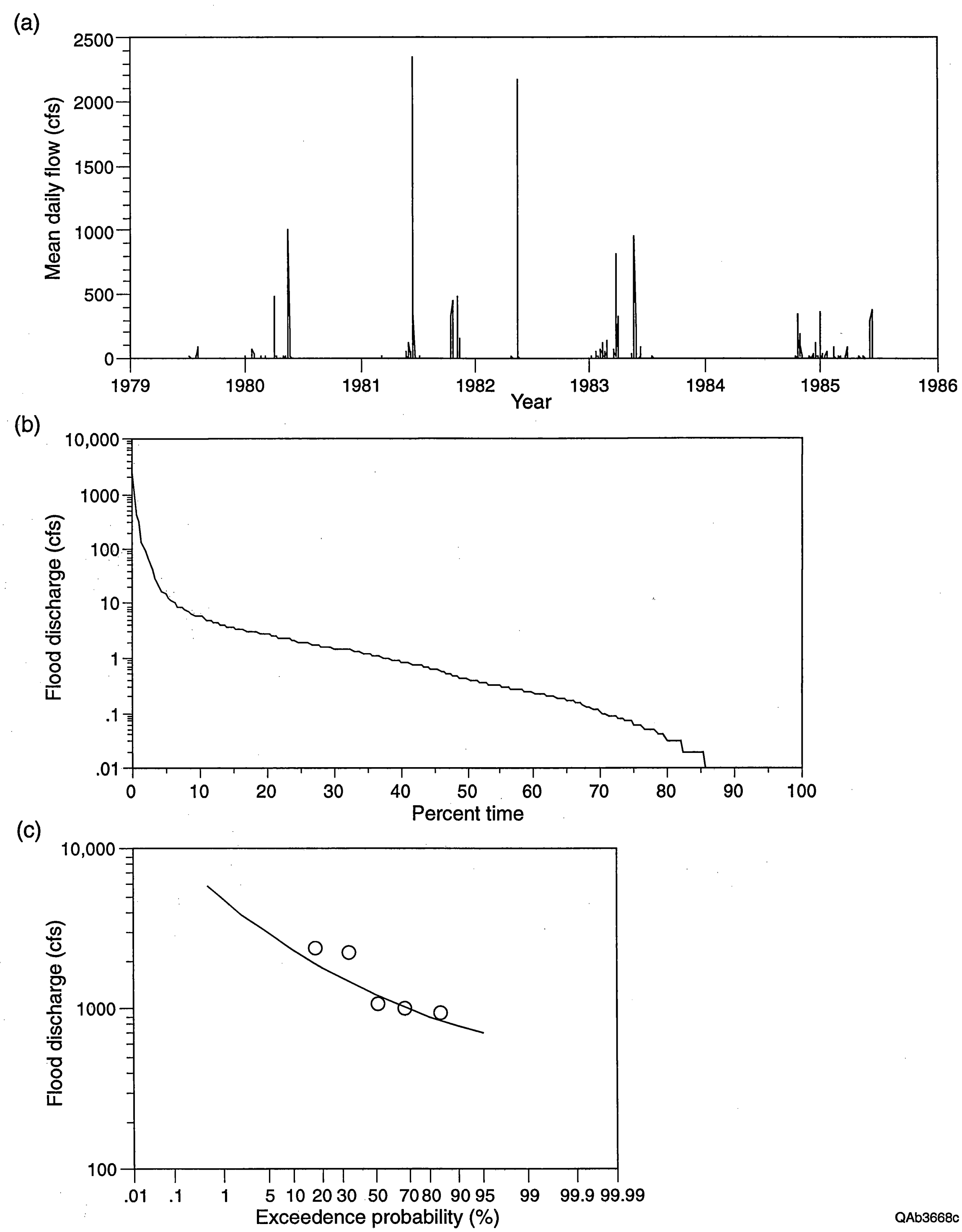

Figure 17. (a) Mean daily flow, (b) flow duration, and (c) flood frequency analysis with a log Pearson Type III fit for a stream gauge on Big Sandy Creek near Elgin.

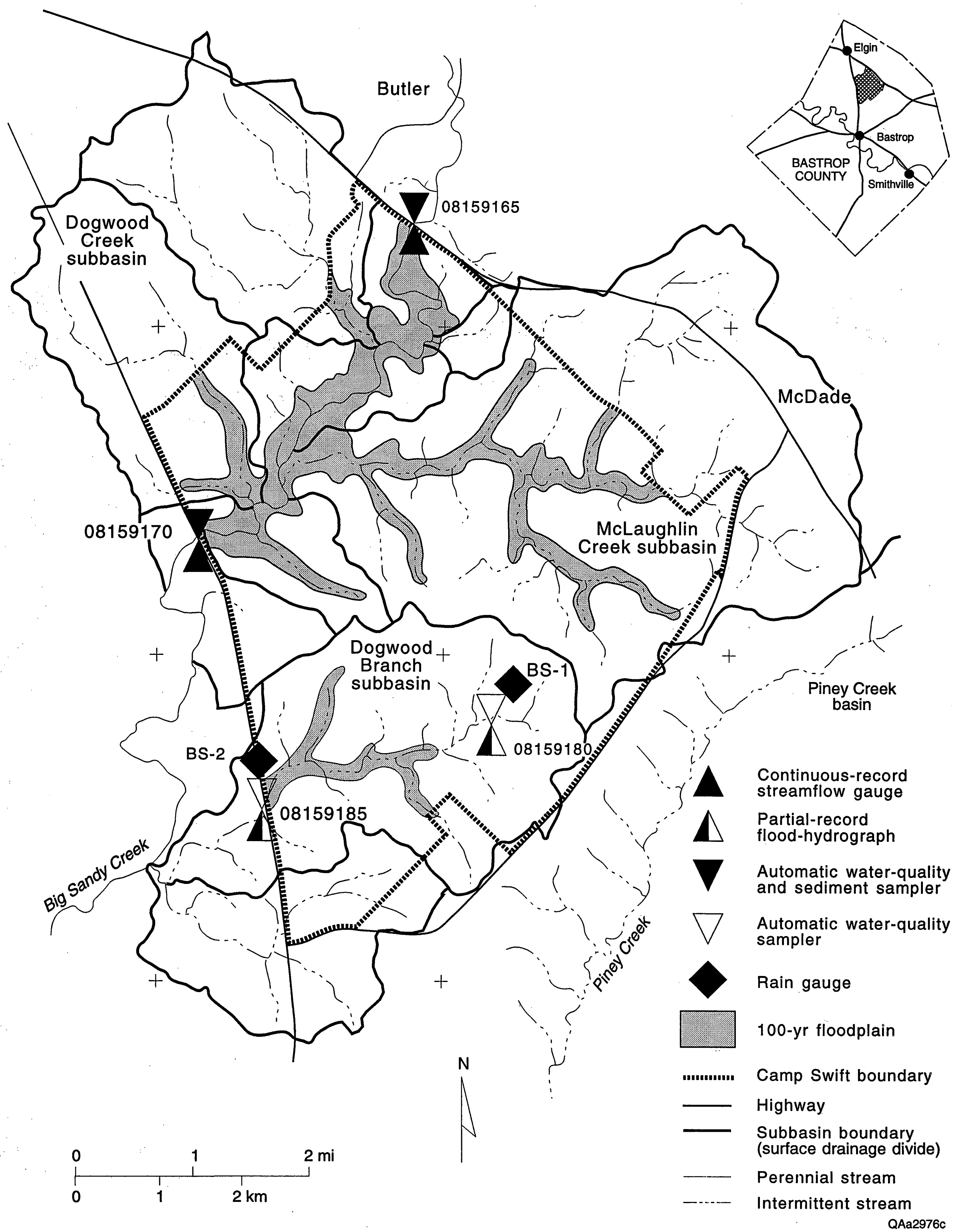

Figure 18. One-hundred-year floodplains for Camp Swift.

GIS DATA PREPARATION

Several layers of data and information were automated for inclusion into a geographical information system (GIS). These layers include:

- Roads
- Watersheds
- Digital elevation map (DEM)
- Floodplains
- Soil maps
- Location of off-camp wells
- Location of on-camp wells
- Water-level maps

The data dictionary for these layers is included in appendix 4.

SUMMARY

The hydrogeologic survey located 83 ground-water wells around Camp Swift and 7 wells on the camp grounds. Eight potential well sites on Camp Swift were identified, but wells were not found. Ground water is pumped from near-surface alluvium and from strata within the Wilcox Group, primarily the Hooper, Simsboro, and Calvert Bluff Formations. Water levels in wells from the Hooper and Simsboro Formations show a gradual rise following dry periods in the 1950's, whereas water levels in shallower strata show fluctuations but no long-term trends. Ground-water recharge is primarily from precipitation on topographically high regions where the Calvert Bluff Formation is exposed and in the more sandy parts of the camp. This water percolates downward toward topographically low regions where it discharges to local creeks or streams. A small amount of recharge probably continues down stratigraphic dip to the east. Some flow from the Calvert Bluff Formation to the Simsboro Formation may also occur, primarily near the Sayersville Fault that cuts through the camp from northeast to southwest. Ground-water quality is fresh to brackish. Calcium-bicarbonate, sodium-bicarbonate, calcium-sulfate, and sodium-chloride water types are produced from wells on and near Camp Swift.

The northern part of the camp is drained by Big Sandy Creek and its tributaries Dogwood Creek, McLaughlin Creek, and several unnamed creeks. The southern part of the camp is drained primarily by Dogwood Branch and other, smaller tributaries, all of which flow into Big Sandy Creek west of the camp and ultimately to the Colorado River. Most of Camp Swift is in the Big Sandy Creek watershed, which includes the Dogwood Creek, McLaughlin Creek, and Dogwood Branch subbasins. A 100-yr flood would submerge small areas adjacent to McLaughlin Creek and Dogwood Branch, with wider flooding in the west-central and northern parts of the training facility where stream valleys are wider.

Chemical contamination or spills on recharge areas are the principal threats to ground-water quality on Camp Swift. Such contamination, particularly on sandy, topographically high exposures of the Calvert Bluff Formation could be transported downward to the shallow, unconfined aquifer system. Chemical contamination or debris in streambeds or floodplain areas are the principal threats to surface-water quality because they may be washed into the surface-water system during or after heavy rainfalls.

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REFERENCES

Austin, G. M., 1954, Records of wells in Bastrop County, Texas: Texas Board of Water Engineers, Bulletin 5413, 43 p. with plates.

Avakian, A. J., and Wermund, E. G., 1993, Physical environment of Camp Swift Military Reservation, Bastrop County, Texas: baseline information for National Guard Land Condition–Trend Analysis Program: The University of Texas at Austin, Bureau of Economic Geology, 70 p.

Baker, F. E., 1979, Soil survey of Bastrop County: U.S. Department of Agriculture and Soil Conservation Service: U.S. Government Printing Office, 123 p.

Bedient, P. B., and Huber, W. C., 1988, Hydrology and floodplain analysis: Reading, Massachusetts, Addison-Wesley Publishing Company, 630 p.

Bomar, G. W., 1983, Texas weather: Austin, Texas, University of Texas Press, 265 p.

Chow, V. T., 1964, Handbook of applied hydrology, a compendium of water-resources technology: New York, McGraw-Hill Book Company, variously paginated.

Cooper, H. H., Bredehoeft, J. D., and Papadopulos, I. S., 1967, Response of a finite-diameter well to an instantaneous charge of water: Water Resources Research, v. 3, p. 263–269.

Dennis, C. B., 1993, Preliminary assessment report for Camp Swift Military Reservation, Installation 48070, Bastrop County, Texas: Argonne National Laboratory, Applied Geosciences and Environmental Management Section, Environmental Research Division, report no. IR-CR-93080, 61 p.

ESRI, 1993, Cell-based modeling with Grid: ArcInfo user's guide: Redmond, California, Environmental Systems Research Institute, variously paginated.

Federal Emergency Management Agency (FEMA), 1991, Flood insurance rate map (FIRM), Bastrop County, Texas and incorporated areas, August 19, 1991–Panels 0 (48021C0000 map index and street index), 75 (48021C0075 - includes north half of Camp Swift area), and 150 (48021C0150 - includes south half of Camp Swift area): Federal Emergency Management Agency, scale 1:24,000.

Follett, C. R., 1970, Ground-water resources of Bastrop County, Texas: Texas Water Development Board, Report 109, 138 p. with plates.

Gaylord, J. L., Slade, R. M., Jr., Ruiz, L. M., Welborn, C. T., and Baker, E. T., Jr., 1985, Water resources appraisal of the Camp Swift lignite area, Central Texas: U.S. Geological Survey, Water-Resources Investigations Report 84-4333, 164 p.

Guyton, W. F., 1942, Results of pumping tests of wells at Camp Swift, Texas: U.S. Geological Survey open-file report, 32 p.

Henry, C. D., and Basciano, J. M., 1979, Environmental geology of the Wilcox Group lignite belt, East Texas: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations 98, 28 p.

Henry, C. D., Basciano, J. M., and Duex, J. W., 1980, Hydrology and water quality of the Eocene Wilcox Group, significance for lignite development in East Texas: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 80-3, 9 p.

Herschfield, D. M., 1961, Rainfall frequency atlas of the United States, for durations from 30 minutes to 24 hours and return periods from 1 to 100 years: U.S. Weather Bureau, Technical Report 40, variously paginated.

Hvorslev, M. J., 1951, Time lag and soil permeability in ground-water observations: Vicksburg, Mississippi, U.S. Army Corps of Engineers Bulletin, no. 36, 50 p.

Hydrologic Engineering Center, 1981, HEC-1 Flood hydrograph package, user's manual and programmer's manual: updated 1988: Davis, California, U.S. Army Corp of Engineers, variously paginated.

__________ 1995, HEC-RAS river analysis system: Davis, California, U.S. Army Corp of Engineers, variously paginated.

Hydro-Search, Inc., 1981, Preliminary hydrogeologic investigation related to possible mining operations Bastrop County, Texas: Consultant report submitted to the Lower Colorado River Authority, Project No. 1266-81, variously paginated.

Kaiser, W. R., Ayers, Jr., W. B., and La Brie, L. W., 1980, Lignite resources in Texas: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 104, p. 52.

Kaiser, W. R., Johnston, J. E., and Bach, W. N., 1978, Sand-body geometry and the occurrence of lignite in the Eocene of Texas: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 78-4, 19 p.

Kier, R. S., Garner, L. E. and Brown, L. F. Jr., 1977, Land Resources of Texas: The University of Texas at Austin, Bureau of Economic Geology, 42 p.

Larkin, T. J., and Bomar, G. W.,1983, Climatic atlas of Texas: Texas Department of Water Resources, 151 p.

Linsley, R. K., Jr., Kohler, M. A., and Paulhus, J. L. H., 1982, Hydrology for engineers: New York, McGraw-Hill Book Company, 508 p.

McCarthy, G. T., 1938, The unit hydrograph and flood routing: unpublished paper presented at a conference of the North Atlantic Division: U.S. Army Corps of Engineers, variously paginated.

Razack, M., and Huntley, David, 1991, Assessing transmissivity from specific capacity in a large and heterogeneous alluvial aquifer: Ground Water, v. 29, no. 6, p. 856–861.

Science Applications, Inc., 1982, Camp Swift hydrologic evaluation: Consultant's report prepared for the United States Department of the Interior, Office of Surface Mining under contract no. J 5110092, task order no. 1, 77 p.

Snyder, F. F., 1938, Synthetic unit hydrographs: Transactions of the American Geophysical Union, v. 19, pt. 1, p. 447–454.

Soil Conservation Service, 1957, Use of storm and watershed characteristics in synthetic hydrograph analysis and application: Washington, D.C., U.S. Department of Agriculture, variously paginated.

__________ 1991, State soil geographic data base (STATSGO): Washington, D.C., U.S. Department of Agriculture, miscellaneous publication no. 1492, variously paginated.

TDWR, 1983, Water for Texas, planning for the future: Texas Department of Water Resources, Austin, Texas, 39 p.

Tharp, B. C., 1939, The vegetation of Texas: Houston, The Texas Academy of Science, The Anson Jones Press, 74 p.

Thorkildsen, David, and Price, R. D., 1991, Ground-water resources of the Carrizo-Wilcox aquifer in the Central Texas region: Texas Water Development Board, Report 332, 46 p. with plates.

U.S. Department of the Interior, 1980, Proposed Camp Swift lignite leasing—Bastrop County, Texas, vols. 1 and 2: final environmental impact statement: Bureau of Land Management, New Mexico State Office, variously paginated.

__________ 1982, Camp Swift, Texas, Petition Evaluation Document: prepared by the U.S. Office of Surface Mining Reclamation and Enforcement, 522 SMCRA Evaluation OSM-PE-4, 389 p.

Appendix 1

Well Inventory Data Base

Appendix 1. Well inventory data base.

Well no.	Cond. (μΩ)	Depth (ft)	Water level (ft BTOC)	Casing height (ft)	Diameter (inches)	Casing material	Well use	Owner	Topographic quadrangle	Land-surface elevation (ft)
S001	-	-	-	-	-	-	water supply	Aqua Water	Lake Bastrop	-
S002	-	-	-	-	-	-	-	-	Lake Bastrop	-
S003	-	~600	160.02	1.00	4	PVC	domestic	Parma	Lake Bastrop	487
S004	725	-	-	-	-	-	domestic	-	Lake Bastrop	-
S005	-	-	-	-	4	PVC	-	-	Lake Bastrop	-
S006	-	-	-	-	-	-	-	-	Lake Bastrop	496
S007	-	696	-	-	-	-	domestic	-	Smithville NW	528
S008	-	-	-	-	-	-	domestic	-	Smithville NW	-
S009	-	-	-	-	-	-	-	-	Lake Bastrop	-
S010	-	-	-	-	-	-	-	Powell Bend Mine	Lake Bastrop	-
S011	-	~200	47.12	0.28	4	PVC	unused	Ray Shannon	Lake Bastrop	418
S012	650	-	-	-	-	-	-	Steiner Ranch	Lake Bastrop	-
S013	-	-	-	-	-	-	-	-	Lake Bastrop	-
S014	-	-	-	-	-	-	-	-	Elgin East	-
S015	-	-	-	-	-	-	-	Kenneth Wilson	Elgin East	-
S016	-	-	-	-	-	-	-	-	Elgin East	-
S017	-	-	-	-	-	-	-	-	Elgin East	-
S018	-	-	-	-	-	-	-	-	Elgin East	-
S019	550	~65	~59	-	36	-	stock water	-	Elgin East	-
S020	-	-	-	-	-	-	-	-	Elgin East	-
S021	-	-	-	-	-	-	-	-	Elgin East	-
S022	-	126	-	-	-	-	unused	Mrs. Hughes	Elgin East	-
S023	-	~100	dry	-	~48	-	-	Mrs. Hughes	Elgin East	-
S024	-	165	~65	-	-	-	-	-	Elgin East	-
S025	-	~65	~45	-	-	-	-	-	Elgin East	-
S026	-	-	-	-	-	-	-	-	Elgin East	-
S027	-	-	-	-	-	-	-	-	McDade	-
S028	570	692	170.93	1.48	9	PVC	domestic	Charles Stanley	McDade	568
S029	-	-	-	-	-	-	-	Arthur Mundine	Smithville NW	-
S030	-	~97-100	38.73	0.00	3	PVC	unused	Arthur Mundine	Smithville NW	540
S031	-	-	-	-	-	-	-	Arthur Mundine	Smithville NW	-
S032	-	-	-	-	-	-	plugged	UT Env. Sci. Park	Lake Bastrop	-
S033	-	-	-	-	-	-	plugged	UT Env. Sci. Park	Lake Bastrop	-
S034	-	-	-	-	-	-	plugged	UT Env. Sci. Park	Lake Bastrop	-
S035	-	-	-	-	-	-	filled in	-	Lake Bastrop	-
S036	-	~110	-	-	-	-	-	-	Lake Bastrop	520
S037	-	-	-	-	-	-	-	-	McDade	-

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Well no.	Cond. (μΩ)	Depth (ft)	Water level (ft BTOC)	Casing height (ft)	Diameter (inches)	Casing material	Well use	Owner	Topographic quadrangle	Land-surface elevation (ft)
S038	-	~400	-	-	-	-	-	-	McDade	-
S039	-	-	-	-	-	-	-	-	McDade	-
S040	-	-	-	-	-	-	-	-	McDade	-
S041	-	-	-	-	-	-	-	-	McDade	-
S042	-	-	-	-	-	-	-	-	McDade	-
S043	-	1100	-	-	-	-	domestic	-	McDade	480
S044	-	~80	flowing	-	-	-	-	-	McDade	460
S045	-	126	-	-	-	-	-	-	McDade	-
S046	-	-	-	-	-	-	-	-	Smithville NW	-
S047	-	-	-	-	-	-	-	-	Smithville NW	-
S048	-	-	-	-	-	-	-	-	Smithville NW	-
S049	-	-	-	-	-	-	-	-	Smithville NW	-
S050	-	-	36.05	1.83	~30	brick	unused	-	McDade	551
S051	-	-	-	-	-	-	-	-	McDade	-
S052	-	-	-	-	-	-	-	-	McDade	-
S053	-	-	-	-	-	-	-	-	McDade	-
S054	-	-	-	-	-	-	-	Ray Edwards	McDade	-
S055	-	250	57.88	0.18	4	PVC	garden	Duggars	Elgin East	480
S056	-	-	-	-	-	-	-	-	Elgin East	-
S057	-	484	-	-	4.5	-	domestic	Aqua Water Supply	Elgin East	-
S058	-	-	-	-	-	-	-	-	Elgin East	-
S059	-	-	-	-	-	-	nursery	-	Elgin East	-
S060	-	725	-	-	4	-	domestic	Aqua Water Supply	Elgin East	-
S061	-	642	-	-	4.5	-	domestic	Aqua Water Supply	Elgin East	-
S062	-	505	-	-	4.5	-	domestic	Aqua Water Supply	Elgin East	-
S063	-	1558	-	-	5	-	domestic	Aqua Water Supply	Smithville NW	-
S064	-	-	-	-	-	-	-	Aqua Water Supply	Lake Bastrop	-
S065	-	-	-	-	-	-	-	Aqua Water Supply	Lake Bastrop	-
S066	-	-	-	-	-	-	-	Aqua Water Supply	Lake Bastrop	-
S067	480	197	47.12	0.28	4	PVC	garden	Fay Pannell	Lake Bastrop	415
S068	-	~50-60	dry	2.50	-	concrete	-	Fay Pannell	Lake Bastrop	405
S069	-	-	-	-	-	-	domestic	Bill Walton	Elgin East	-
S070	-	~110-120	~90	-	-	-	-	-	Elgin East	544
S071	-	-	-	-	-	-	-	-	Elgin East	-
S072	-	-	-	-	-	-	-	-	Elgin East	-
S073	-	-	-	-	-	-	-	-	Elgin East	-
S074	-	-	-	-	-	-	-	-	Elgin East	-

Appendix 1. Well inventory data base.

Well no.	Cond. (μΩ)	Depth (ft)	Water level (ft BTOC)	Casing height (ft)	Diameter (inches)	Casing material	Well use	Owner	Topographic quadrangle	Land-surface elevation (ft)
S075	-	40	-	-	-	-	-	-	Elgin East	-
S076	-	~50-60	35.58	0.43	4	PVC	domestic	Earl Hold	Elgin East	505
S077	-	80	~20	-	-	-	lawn	Stagner	Elgin East	484
S078	-	-	-	-	-	-	-	-	Elgin East	-
S079	-	-	-	-	-	-	-	J. L. Christensen	Elgin East	-
S080	-	100	-	-	-	-	-	-	Elgin East	-
S081	-	100	-	-	-	-	-	-	Elgin East	-
S082	-	80	52.83	0.58	4	iron	unused	Zane Cole	Elgin East	502
S083	-	525	-	-	4	PVC	domestic	Fay Pannell's daughter	Lake Bastrop	-

All depths reported by owners
~ indicates owner-supplied information
BTOC = below top of casing
Land-surface elevations estimated from USGS topographic maps

Appendix 2

Well Schematics and Drilling Reports for Monitor Wells

Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087

Please use black ink.

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, Texas 78711-3087
512-239-0530

Camp Swift #1

1) OWNER Texas National Guard (Name) **ADDRESS** P.O. Box 5218 (Street or RFD) Austin (City) Tx (State) 78763 (Zip)

2) ADDRESS OF WELL: County Bastrop Camp Swift Rt. 2, Box 151-X (Street, RFD or other) Bastrop (City) Texas (State) 78602-9737 (Zip) **GRID #** 58-46-8

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☒ Testwell

If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) 30° 17' 14" 97° 18' 26" N

6) WELL LOG: Date Drilling: Started 10/31 19 95 Completed 11/1 19 95

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
3 1/4	Surface	57.05

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☐ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☒ Other Rock bit

From (ft.)	To (ft.)	Description and color of formation material
		N/A Rock Bitted

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☒ Straight Wall ☐ Underreamed ☐ Gravel Packed ☐ Other

If Gravel Packed give interval . . . from ____ ft. to ____ ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2"	N	PVC Schedule 40 - 40'	2' Above Surface	35.0'	
2"	N	PVC Schedule 40 - 20'	35.0'	55.0'	.010

9) CEMENTING DATA: [Rule 338.44(1)]

Cemented from 4" Above Surface ft. to 3.05 ft. No. of Sacks Used 4

____ ft. to ____ ft. No. of Sacks Used ____

Method used Hand Poured

Cemented by Drill Crew

Distance to septic system field lines or other concentrated contamination N/A ft.

Method of verification of above distance N/A

10) SURFACE COMPLETION

☒ Specified Surface Slab Installed [Rule 338.44 (2) (A)]
☒ Specified Steel Sleeve Installed [Rule 338.44 (3)(A)]
☐ Pitless Adapter Used [Rule 338.44 (3)(b)]
☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:

Static level ____ ft. below land surface Date ____
Artesian flow ____ gpm. Date ____

12) PACKERS: Type Depth

13) TYPE PUMP: ☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other ____

Depth to pump bowls, cylinder, jet, etc., ____ ft.

14) WELL TESTS: Type test: ☐ Pump ☐ Bailer ☐ Jetted

Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

15) WATER QUALITY: Did you knowingly penetrate any strata which contained undesirable constituents? ☐ Yes ☐ No

Type of water? ____ Depth of strata ____

Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME University of Texas/Bureau of Economic Geology (Type or Print) **WELL DRILLER'S LICENSE NO.** 3187-M

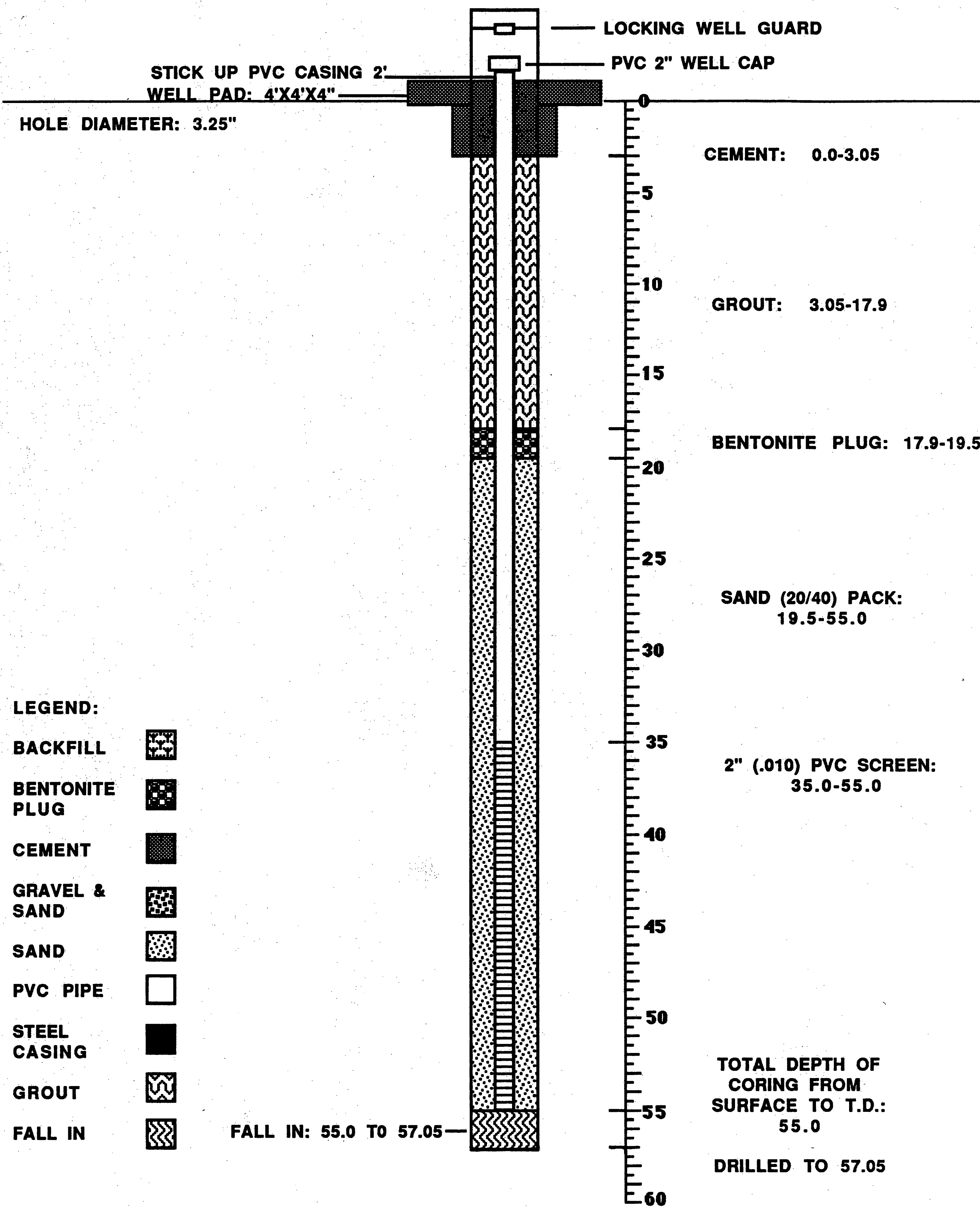
ADDRESS P.O. Box X University Station (Street or RFD) Austin (City) Texas (State) 78701 (Zip)

(Signed) James Doss (Licensed Well Driller) (Signed) Jordan Forman (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94) TNRCC COPY

WATER MONITOR SCHEMATIC
CAMP SWIFT #1
DRILL DATE: 11/1/95
NATIONAL GUARD PROJECT



Send original copy by certified mail to: TNRCC, P.O. Box 13087, Austin, TX 78711-3087 — *Please use black ink.*

ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

State of Texas WELL REPORT

Texas Water Well Drillers Advisory Council
P.O. Box 13087
Austin, Texas 78711-3087
512-239-0530

Camp Swift #2

1) OWNER Texas National Guard (Name) **ADDRESS** P.O. Box 5218 (Street or RFD) Austin (City) Tx (State) 78763 (Zip)

2) ADDRESS OF WELL: County Bastrop — Camp Swift Rt. 2, Box 151- (Street, RFD or other) Bastrop (City) Texas (State) 78602-9737 (Zip) **GRID #** 58-54-3

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell

If Public Supply well, were plans submitted to the TNRCC? ☐ Yes ☐ No

5) 30° 14' 32" 97° 17' 9" N

6) WELL LOG: Date Drilling: Started 1/3 19 96 Completed 1/3 19 96

DIAMETER OF HOLE

Dia. (in.)	From (ft.)	To (ft.)
7 7/8	Surface	50.95

7) DRILLING METHOD (Check): ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☐ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☒ Other Augered

From (ft.)	To (ft.)	Description and color of formation material
0.0	13.5	Light brown sand
13.5	23.5	Light brown, red and grey clay
23.5	28.5	Dark brown clay with sand
28.5	48.5	Light black flakey sand & clay
48.5	50.75	Grey and dark brown clay
50.75	50.95	Grey rock

(Use reverse side if necessary)

8) Borehole Completion (Check): ☐ Open Hole ☒ Straight Wall ☐ Underreamed ☐ Gravel Packed ☐ Other

If Gravel Packed give interval . . . from ______ ft. to ______ ft.

CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casting Screen
2"	N	PVC Schedule 40 - 50'	2.5' Above Surface	40.9	
2"	N	PVC Schedule 40 - 10'	40.9	50.9'	.010

9) CEMENTING DATA: [Rule 338.44(1)]

Cemented from 4" Above Surface ft. to 1.0 ft. No. of Sacks Used 2

Cemented from ______ ft. to ______ ft. No. of Sacks Used ______

Method used Hand Poured

Cemented by Drill Crew

Distance to septic system field lines or other concentrated contamination N/A ft.

Method of verification of above distance N/A

10) SURFACE COMPLETION

☒ Specified Surface Slab Installed [Rule 338.44 (2) (A)]

☒ Specified Steel Sleeve Installed [Rule 338.44 (3)(A)]

☐ Pitless Adapter Used [Rule 338.44 (3)(b)]

☐ Approved Alternative Procedure Used [Rule 338.71]

11) WATER LEVEL:

Static level ______ ft. below land surface Date ______

Artesian flow ______ gpm. Date ______

12) PACKERS: Type Depth

13) TYPE PUMP: ☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other

Depth to pump bowls, cylinder, jet, etc., ______ ft.

14) WELL TESTS: Type test: ☐ Pump ☐ Bailer ☐ Jetted

Yield: ______ gpm with ______ ft. drawdown after ______ hrs.

15) WATER QUALITY: Did you knowingly penetrate any strata which contained undesirable constituents? ☐ Yes ☐ No

Type of water? ______ Depth of strata ______

Was a chemical analysis made? ☐ Yes ☐ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 15 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME University of Texas/Bureau of Economic Geology (Type or Print) **WELL DRILLER'S LICENSE NO.** 3187-M

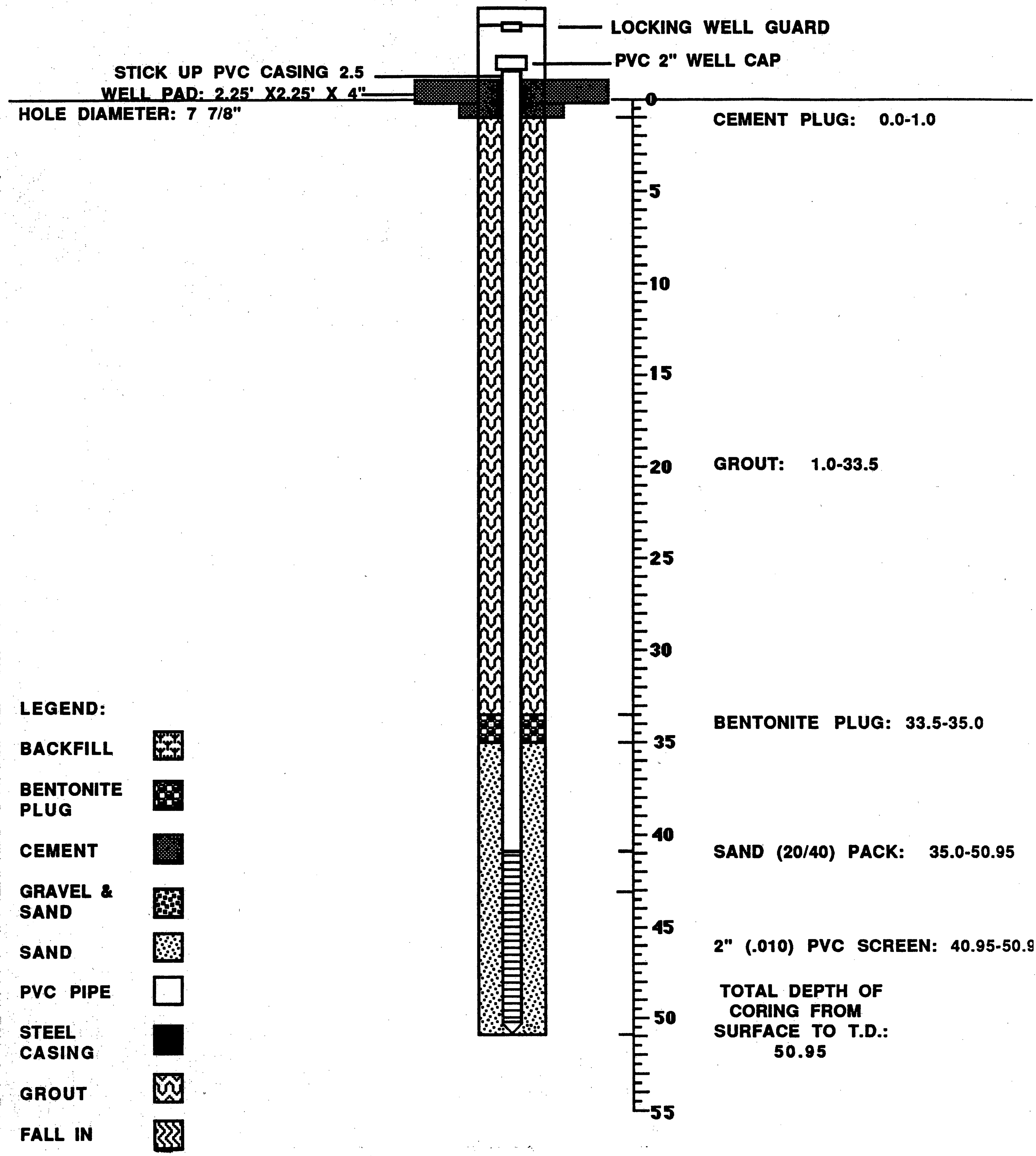
ADDRESS P.O. Box X University Station (Street or RFD) Austin (City) Texas (State) 78701 (Zip)

(Signed) James Doss (Licensed Well Driller) (Signed) Jordan Forman (Registered Driller Trainee)

Please attach electric log, chemical analysis, and other pertinent information, if available.

TNRCC-0199 (Rev. 11-01-94) TNRCC COPY

WATER MONITOR SCHEMATIC
CAMP SWIFT #2
DRILL DATE: 1/3/96
NATIONAL GUARD PROJECT



Appendix 3

Water-Level and Water-Quality Data from Powell Bend Mine

Appendix 3. Water-level and water-quality data from Powell Bend Mine.

Well TU-58

Depth: 115 ft

Date	Water level (ft amsl*)	Cl (mg L^{-1})	Fe (mg L^{-1})	Mn (mg L^{-1})	TDS (mg L^{-1})	SO_4 (mg L^{-1})	pH
1987.00	350.9	43	3.22	0.67	636	144	6.7
1987.75	350.5	48	3.24	0.65	710	204	6.5
1988.25	351	47	2.5	0.62	608	136	6.9
1988.50	-	51	2.42	1.14	632	75	6.88
1988.75	350.7	43	2.29	0.53	626	120	7
1989.00	350.4	18	2.2	0.56	578	100	6.8
1989.25	350.5	40	3.12	0.73	573	128	7
1989.50	349.9	42	2.35	0.56	601	139	6.7
1989.75	349.6	41	2.27	0.57	572	133	6.6
1990.00	349.1	40	2.72	0.58	528	125	7.3
1990.25	349	41	2.61	0.58	636	127	6.7
1990.75	349.1	41	2.6	0.65	617	132	6.8
1991.00	350	40	2.82	0.61	597	115	6.9
1991.25	350	42	2.51	0.55	616	121	6.9
1991.50	350	47	2.17	0.36	560	130	6.9
1991.75	350	45	2.57	0.63	574	145	6.8
1992.00	351	43	3.22	0.54	526	125	6.8
1992.25	352.9	56	2.66	<0.01	605	163	6.92
1992.50	353.6	57	2.66	0.55	597	130	7.12
1992.75	353	74	2.21	0.29	301	41	7.3
1993.00	352	57	5.92	0.51	702	113	6.78
1993.25	355	57	5.66	0.15	685	204	6.65
1993.50	353	145	7.54	1.1	1606	694	6.85
1993.75	351	211	7.52	1.43	1811	216	6.76
1994.00	353	212	7.85	-	2179	700	6.48
1994.25	352.3	224	11.62	2.47	2692	1309	6.49
1994.50	351	167	10.47	1.6	2122	1050	6.5
1994.75	352	278	8.54	1.63	-	986	6.13
1995.50	354	-	-	-	-	-	-

Appendix 3 (cont.)

Well TU-151

Depth: 80 ft

Date	Water level (ft amsl*)	Cl (mg L^{-1})	Fe (mg L^{-1})	Mn (mg L^{-1})	TDS (mg L^{-1})	SO_4 (mg L^{-1})	pH
1987.00	406.8	44	3.96	0.75	1980	143	6.8
1987.75	406.3	320	2.87	0.77	2000	713	6.2
1988.25	407.4	301	4.01	0.7	1948	627	6.7
1988.50	-	343	3.5	0.83	2018	724	6.68
1988.75	405.3	315	3.6	0.73	2020	725	6.8
1989.00	404.1	49	3.89	0.72	2208	540	6.6
1989.25	404.1	290	4.45	0.91	2035	660	6.7
1989.50	403.3	326	3.91	0.71	1932	728	6.6
1989.75	402.4	301	2.13	0.64	1927	734	6.6
1990.00	403.4	323	3.45	0.66	1980	710	7.1
1990.25	403.4	325	3.66	0.71	2214	682	6.6
1990.75	403.4	333	3.63	0.78	2136	675	6.6
1991.00	401.6	332	3.98	0.78	1920	710	6.7
1991.25	401.6	334	4.04	0.74	2264	802	6.7
1991.50	402.1	309	0.15	0.52	2221	748	6.8
1991.75	401.8	319	4.04	0.71	1936	772	6.7
1992.00	402.8	346	4.06	0.77	2142	812	6.7
1992.25	406	301	<0.01	<0.01	2915	832	6.79
1992.50	409	367	3.79	0.75	2362	841	6.74
1992.75	399	56	3.89	0.5	667	80	6.9
1993.00	398	42	23.88	0.64	707	103	6.79
1993.25	413	70	1.3	0.08	514	74	7.17
1993.50	412	315	7.92	0.81	1962	660	6.85
1993.75	410	310	7.79	0.76	2029	702	6.73
1994.00	409	303	2.08	-	1934	584	6.62
1994.25	406.6	241	4.2	0.81	1960	730	8.24
1994.50	406	322	4.65	0.64	2504	650	6.81
1994.75	420	332	2.53	0.62	-	842	6.68
1995.50	417.1	-	-	-	-	-	-

Appendix 3 (cont.)

Well TU-193

Depth: 75 ft

Date	Water level (ft amsl*)	Cl (mg L^{-1})	Fe (mg L^{-1})	Mn (mg L^{-1})	TDS (mg L^{-1})	SO_4 (mg L^{-1})	pH
1987.00	402.3	828	2.18	0.37	2340	95	7
1987.75	401.6	796	2.11	0.34	1958	80	6.6
1988.25	402.2	683	2.03	0.4	2360	66	7.1
1988.50	-	915	0.28	0.23	2614	97	7.06
1988.75	402.4	840	2	0.27	2142	65	7.1
1989.00	402.2	860	2.81	0.42	2610	28	6.8
1989.25	402.1	850	2.38	0.39	2335	74	7.1
1989.50	402.9	859	2.11	0.36	1977	96	6.9
1989.75	402.4	866	2.39	0.34	2246	90	7
1990.00	402.2	846	3.41	0.33	2345	87	7.5
1990.25	402	884	2.17	0.4	2315	44	7.1
1990.75	402	831	1.94	0.37	2256	73	6.9
1991.00	401.6	332	3.98	0.78	1920	710	6.7
1991.25	402.2	118	0.07	0.01	644	89	7.8
1991.50	402.2	893	1.82	0.12	2104	88	7
1991.75	402.4	839	2.19	0.31	2238	81	7
1992.00	402.2	856	2.39	0.28	2183	86	7
1992.25	402.42	475	2.34	<0.01	2723	91	6.93
1992.50	403.6	1024	2.79	0.33	2286	28	6.99
1992.75	404	839	2.69	0.36	2316	5	7.3
1993.00	401	888	2.4	0.32	218*	27	7
1993.25	409.22	709	2.75	0.34	2830	70	6.94
1993.50	407	909	2.13	0.34	2503	428	7
1993.75	405	911	4.48	0.37	2851	97	7.06
1994.00	403	847	2.41	-	2132	74	6.92
1994.25	403.2	84	3.14	0.33	2556	67	7.19
1994.50	403	864	2.19	0.3	3356	50	7.13
1994.75	407	848	2.11	0.29	-	33	7
1995.50	411.22	-	-	-	-	-	-

Appendix 3 (cont.)

Well TU-194

Depth: 145 ft

Date	Water level (ft amsl*)	Cl (mg L^{-1})	Fe (mg L^{-1})	Mn (mg L^{-1})	TDS (mg L^{-1})	SO_4 (mg L^{-1})	pH
1987.00	348.8	62	10.91	0.57	964	74	7.2
1987.75	347.8	62	14.2	0.64	788	72	8.3
1988.25	348.7	67	4.7	0.68	494	76	7.2
1988.50	-	69	22.45	1.1	516	83	7.35
1988.75	349.1	61	19.9	0.51	372	74	7.3
1989.00	349.4	59	5.73	0.49	506	73	7
1989.25	348.8	56	5.45	0.64	586	68	7.1
1989.50	348.7	56	5.45	0.64	586	68	7.1
1989.75	348.7	60	7.04	0.54	569	75	7.1
1990.00	348	62	40.37	1.34	502	75	7.6
1990.25	348.2	64	3.51	0.6	504	69	7.2
1990.75	348	63	6.5	0.61	522	71	7
1991.00	348.1	61	11.03	0.72	485	64	7.1
1991.25	348.1	106	0.02	0.01	2200	81	7
1991.50	347.1	59	1.27	0.36	584	77	7.2
1991.75	348.1	60	4.48	0.57	480	75	7
1992.00	348.6	62	5.41	0.54	535	69	7.3
1992.25	348.76	66	2.91	0.53	601	78	7.16
1992.50	349	69	5.33	0.46	479	68	7.25
1992.75	349	63	2.13	0.41	593	40	7.4
1993.00	349	60	10.12	0.59	483	62	7.2
1993.25	352.06	-	-	-	-	-	-
1993.50	351	65	2.29	0.36	487	82	7.33
1993.75	356	78	5.42	0.44	489	79	7.22
1994.00	350	59	3.89	-	502	155	7.12
1994.25	350.6	84	9.65	0.56	510	6	7.33
1994.50	350	64	7.74	0.5	744	50	7.17
1994.75	350	86	4.12	0.43	-	118	7.05
1995.50	351.06	-	-	-	-	-	-

Appendix 3 (cont.)

Well TU-195

Depth: 115 ft

Date	Water level (ft amsl*)	Cl (mg L^{-1})	Fe (mg L^{-1})	Mn (mg L^{-1})	TDS (mg L^{-1})	SO_4 (mg L^{-1})	pH
1987.00	348.9	73	0.18	0.12	556	85	7.2
1987.75	348.3	67	0.38	0.16	472	67	6.9
1988.25	349.6	68	0.22	0.12	468	64	7.3
1988.50	-	78	0.58	0.2	534	75	7.28
1988.75	349.4	73	0.42	0.09	500	85	7.3
1989.00	348.8	48	0.45	0.17	644	76	7.2
1989.25	349.2	40	0.6	0.23	513	128	7.3
1989.50	348.6	74	0.61	0.2	519	90	7.1
1989.75	348.4	74	0.44	0.24	501	85	6.9
1990.00	348.5	72	0.6	0.2	472	79	7.7
1990.25	348.5	74	0.62	0.21	530	80	7
1990.75	348.6	76	0.5	0.24	508	75	7.2
1991.00	348.2	72	0.49	0.17	557	67	7.3
1991.25	348.2	148	0.56	0.16	492	154	7.3
1991.50	347.6	72	0.4	0.01	524	75	7.3
1991.75	348.4	73	0.42	0.13	487	88	7.2
1992.00	348.6	69	0.51	0.15	500	74	7.3
1992.25	349.35	74	0.63	<0.01	479	72	7.22
1992.50	349	74	0.84	0.09	468	45	7.33
1992.75	349	265	1.08	0.27	2188	375	7.3
1993.00	350	68	4.25	0.54	512	70	7.22
1993.25	353.28	69	1.78	0.36	514	77	7.21
1993.50	350.5	75	0.92	0.2	503	82	7.26
1993.75	352	62	1.78	0.23	521	81	7.26
1994.00	350	74	2.73	-	557	143	7.12
1994.25	351.5	51	1.26	<0.01	518	42	7.44
1994.50	349	77	1.21	0.86	628	91	7.26
1994.75	352	72	1.53	1.13	-	96	7.19
1995.50	353.55	-	-	-	-	-	-

Appendix 3 (cont.)

Well BPB-WW1

Date	Water level (ft amsl*)	Cl (mg L^{-1})	Fe (mg L^{-1})	Mn (mg L^{-1})	TDS (mg L^{-1})	SO_4 (mg L^{-1})	pH
1987.00	-	49	0.76	0.16	478	36	7.4
1987.75	-	49	0.58	0.15	418	36	7.4
1988.25	-	52	1.84	0.25	396	37	7.3
1988.50	-	58	1.79	0.45	516	40	7.45
1988.75	-	53	0.78	0.09	374	39	7.5
1989.00	-	22	0.89	0.16	478	21	7.3
1989.25	-	46	1.25	0.23	414	34	7.4
1989.50	-	47	0.41	0.19	497	41	7.4
1989.75	-	49	0.57	0.17	488	38	7.4
1990.00	-	49	0.59	0.2	376	40	8.1
1990.25	-	52	0.53	0.09	397	37	7.5
1990.75	-	52	0.48	0.22	452	39	7.4
1991.00	-	52	0.88	0.2	404	40	7.3
1991.25	-	120	0.6	0.14	426	89	7.6
1991.50	-	48	0.01	0.01	455	36	7.9
1991.75	-	52	0.98	0.17	458	42	7.6
1992.00	-	56	0.66	0.18	441	42	7.4
1992.25	-	58	0.7	<0.01	428	39	7.58
1992.50	-	57	1.8	0.17	375	22	7.44
1992.75	-	55	1.46	0.24	400	21	7.6
1993.00	272	52	1.83	0.25	382	33	7.48
1993.25	237.28	51	0.4	0.18	390	29	7.71
1993.50	231	55	1.06	0.21	393	51	7.69
1993.75	361	49	0.27	0.04	373	33	8.17
1994.00	365	50	1.7	-	387	42	7.58
1994.25	231	53	0.04	<0.01	350	26	7.97
1994.50	237	52	0.05	0.01	366	31	7.75
1994.75	361	51	0.11	0.01	-	36	7.77
1995.50	237.28	-	-	-	-	-	-

*amsl = above mean sea level

Appendix 4

Data Dictionary for GIS Coverages

GIS DATA DICTIONARY

Several layers of spatial hydrologic and hydrogeologic data were input to the Bureau of Economic Geology GIS system. Maps were digitized using a Calcomp digitizing table, under the ArcEdit module of GIS ArcInfo, on a Sparc500 Workstation. When possible, the data from the paper originals of the U.S. Geological Survey (USGS) 1:24,000-scale, 7.5-minute topographic maps were either transferred on Mylar or digitized during one session to minimize the distortions related to environmental factors. The digital data base, regardless of the original projection, will be delivered in the Universal Transverse Mercator (UTM) coordinate system, with the following parameters:

Ellipsoid: Clarke 1866
Horizontal Datum: NAD27
Units: meters
Zone 14

The digital data represent the following.

Digital Elevation Models (DEM) were acquired from MicroPath at 1:24,000 scale, where available (View, Buffalo Gap, Paris, Lake Bastrop, Elgin East, McDade, Graford East, Mineral Wells East, Mineral Wells West, and Whitt), or were created from digital elevation contours and streams using the Grid module of ArcInfo (Topogrid). The cell size for DEMs is 30 m, with a horizontal accuracy of ±3 m and a vertical accuracy of ±10 m. The DEMs were used to delineate watersheds of interest.

Watersheds represent polygon coverages encompassing the drainage areas. They were outlined from DEMs for Camp Swift, Camp Mabry, Camp Barkeley, and Fort Wolters or were defined from USGS topographic quads and then transferred to a digital format. Possible inaccuracy might be related to human error and imperfections of the digitizing equipment. Given the USGS-stated positional accuracy of ±40 ft for its 7.5-minute quads, and the inadvertent positional shifts that may have been introduced during the digitizing process, it can be estimated that the positional accuracy of most features will be approximately ±50 ft.

Floodplains are polygon coverages, digitized from USGS topographic quads, with the aforementioned accuracy estimate.

Well locations are point coverages, digitized from USGS topographic quadrangles; they include existing and recently drilled wells, with an internally assigned well name (number) as an item in the Point Attribute Table (PAT). They include wells on and around the camps.

Soil maps are generalized soil maps at 1:250,000 scale compiled by the U.S. Department of Agriculture Soil Conservation Service. They contain polygons describing groups of soil types and attached attribute tables with extensive sets of numerical values, including their hydrologic properties, which were used to specify the percentage of the map unit occupied by soils in each hydrologic group. The digital data were obtained from the Texas Natural Resources Information System (TNRIS) ftp site.

Water levels represent water-level contours, which, owing to scarcity of control points and the inherent interpolation problems of the software, were hand drawn and then digitized from Mylar overlays.

Cultural features include roads and generalized streams at 1:24,000 scale, at various extents around the camp. They were obtained from the TNRIS ftp site and are the latest version of Texas Department of Transportation (TxDOT) urban maps. These files were originally digitized from USGS 7.5-minute quadrangles. Updates are made periodically using TxDOT highway construction plans, aerial photographs, official city maps, and field inventory. These files contain most of the features found on 7.5-minute quads, except for items such as contour lines, fence lines, jeep trails, electrical transmission lines, oil and gas pipelines, and control data monuments.

The county map files are based on the following map projection system:

TEXAS STATEWIDE MAPPING SYSTEM (NAD27)

Projection: Lambert Conformal Conic

Ellipsoid: Clarke 1866

Datum: North American 1927

Longitude of Origin: 100 degrees west (-100)

Latitude of Origin: 31 degrees 10 minutes north

Standard Parallel #1: 27 degrees 25 minutes north latitude

Standard Parallel #2: 34 degrees 55 minutes north latitude

False Easting: 3,000,000 ft

False Northing: 3,000,000 ft

Unit of Measure: feet (international)

Positional Accuracy: These digital maps were created primarily for the purpose of producing county/urban published maps. Certain features, particularly railroads and streams, have been displaced in congested areas so as to insure map readability at county map scales.

Miscalculation of false northing and easting required reprojection of the DGN digital files, at the correct values (914,400 ft), in order to obtain the perfect overlay with several preexisting county and quadrangle files.

CAMP SWIFT

Base maps: the USGS 7.5′ topographic quadrangles, McDade, Elgin East, and Lake Bastrop, are in the State Plane coordinate system, Central Zone (5351), datum NAD27, units in feet.

Coverage name	Coverage type	Initial projection	Final projection	Source	Accuracy	Description
Offcamprdutm	Arc	Texas State Plane	UTM	TXDOT digital county files	±50 ft	Highways and off-camp well locations
Arcamprdutm	Arc	Texas State Plane	UTM	TXDOT digital county files	±50 ft	Highways near the camp
Boundutm	Polygon	State Plane Central Zone	UTM	Texas Parks and Wildlife digital files	unknown	Camp boundary
Streamsutm	Arc	UTM	UTM	Delineated from DEM	±40 ft	Streams and rivers in the contributing watersheds delineated from watershed analysis; threshold = 5,000
Wshedutm	Polygon	UTM	UTM	Digitized from USGS 7.5′ topographic quads	±40 ft	Watersheds corresponding to stream segments
Fplainutm	Polygon	State Plane Central Zone	UTM	Digitized from USGS 7.5′ topographic quads	±40 ft RMS = 0.005	Floodplains
Fpstreamutm	Arc	State Plane Central Zone	UTM	Digitized from USGS 7.5′ topographic quads	±40 ft RMS = 0.004	Stream orders and cross sections used for the HEC-RAS model
Soilsutm	Polygon	Texas State Plane	UTM	STATSGO digital database	unknown	1:2,500,000-scale distribution of soils in the watersheds
Sfswellsutm	Point	State Plane Central Zone	UTM	Digitized from USGS 7.5′ topographic quads	±40 ft RMS = 0.004	Location of off-camp wells
Sfcwellsutm	Point	State Plane Central Zone	UTM	Digitized from USGS 7.5′ topographic quads	±40 ft RMS = 0.002	Location of on-camp wells
Wlevels	Arc	State Plane Central Zone	UTM	Digitized from USGS 7.5′ topographic quads	±40 ft RMS = 0.005	Digitized water-level contour maps